Relatório 2 para a reunião 04 do grupo de otimização do mach2D

Nome: **Diego Fernando Moro**

Data: **15 a 16/10/12**

## Índice:



## A – Avaliação do efeito de 'dt' usando diferentes "dt's" e solvers.

**Microcomputador utilizado:**

**Intel Core i5 - 2450M – 2,5 GHz – 4 GB de memória RAM – HD de 750 GB**

**PARAMETROS 1**

**Utilizou-se nas tabelas a seguir os seguintes parâmetros:**

*- imax = 1*
*- nitm_u = nitm_p = 4*
*- tolu = tolp = 1d-2*
*- num = 1*
*- kg = coord = 1*
*- modvis = modtur = ccTw = 0*
*- beta = 0.d0*
*- Solver variável: MSI puro (0), TDMAXY (1), TDMAX (2), MSI e TDMAX (3), MSI e GS(4)*
*- Critério de parada: Erro de máquina para a variação de Fd**

**- MALHA DE 56 x 20 NÓS**

**Tabela 1 Malha de 56x20 nós, Tempo**

| | | TEMPO por ESQUEMA (s) | | | | |
|---|---|---|---|---|---|---|
| Simulações | dt | MSI(0) | TDMAXY(1) | TDMAX(2) | MSI e TDMAX (3) | MSI e GS (4) |
| | 5.00E-05 | NC | NC | NC | NC | NC |
| Back.01_X_01 | 4.00E-05 | 0.421 | NC | NC | 0.328 | 0.281 |
| Back.01_X_02 | 3.00E-05 | **0.296** | NC | NC | **0.280** | **0.250** |
| Back.01_X_03 | 2.00E-05 | 0.483 | 2.465 | NC | 0.359 | 0.328 |
| Back.01_X_04 | 1.00E-05 | 0.780 | **0.936** | NC | 1.622 | 0.765 |

**Tabela 2 Malha de 56x20 nós, It**

| | | it por ESQUEMA | | | | |
|---|---|---|---|---|---|---|
| Simulações | dt | MSI(0) | TDMAXY(1) | TDMAX(2) | MSI e TDMAX (3) | MSI e GS (4) |
| | 5.00E-05 | NC | NC | NC | NC | NC |
| Back.01_X_01 | 4.00E-05 | 400 | NC | NC | 400 | 325 |
| Back.01_X_02 | 3.00E-05 | 275 | NC | NC | 325 | 275 |
| Back.01_X_03 | 2.00E-05 | 450 | 2400 | NC | 475 | 375 |
| Back.01_X_04 | 1.00E-05 | 825 | 900 | NC | 775 | 925 |

**Tabela 3 Malha de 56x20 nós, Cd**

| | | Cd por ESQUEMA | | | | |
|---|---|---|---|---|---|---|
| Simulações | dt | MSI(0) | TDMAXY(1) | TDMAX(2) | MSI e TDMAX (3) | MSI e GS (4) |
| | 5.00E-05 | NC | NC | NC | NC | NC |
| Back.01_X_01 | 4.00E-05 | 1.04708700468259E+00 | NC | NC | 1.04708700468259E+00 | 1.04708700468259E+00 |
| Back.01_X_02 | 3.00E-05 | 1.04708700468259E+00 | NC | NC | 1.04708700468259E+00 | 1.04708700468259E+00 |
| Back.01_X_03 | 2.00E-05 | 1.04708700468259E+00 | 1.04708700468259E+00 | NC | 1.04708700468259E+00 | 1.04708700468259E+00 |
| Back.01_X_04 | 1.00E-05 | 1.04708700468259E+00 | 1.04708700468259E+00 | NC | 1.04708700468259E+00 | 1.04708700468259E+00 |

**Tabela 4 Malha de 56x20 nós, Fd***

| | | Fd* por ESQUEMA | | | | |
|---|---|---|---|---|---|---|
| Simulações | dt | MSI(0) | TDMAXY(1) | TDMAX(2) | MSI e TDMAX (3) | MSI e GS (4) |
| | 5.00E-05 | NC | NC | NC | NC | NC |
| Back.01_X_01 | 4.00E-05 | 9.71806331865671E-01 | NC | NC | 9.71806331865670E-01 | 9.71806331865671E-01 |
| Back.01_X_02 | 3.00E-05 | 9.71806331865671E-01 | NC | NC | 9.71806331865671E-01 | 9.71806331865671E-01 |
| Back.01_X_03 | 2.00E-05 | 9.71806331865671E-01 | 9.71806331865672E-01 | NC | 9.71806331865671E-01 | 9.71806331865671E-01 |
| Back.01_X_04 | 1.00E-05 | 9.71806331865671E-01 | 9.71806331865671E-01 | NC | 9.71806331865671E-01 | 9.71806331865671E-01 |

**Tabela 5 Malha de 56x20 nós, d(Fd*)**

| | | d(Fd*) por ESQUEMA | | | | |
|---|---|---|---|---|---|---|
| Simulações | dt | MSI(0) | TDMAXY(1) | TDMAX(2) | MSI e TDMAX (3) | MSI e GS (4) |
| | 5.00E-05 | NC | NC | NC | NC | NC |
| Back.01_X_01 | 4.00E-05 | 0.00000000000000E+00 | NC | NC | 0.00000000000000E+00 | 0.00000000000000E+00 |
| Back.01_X_02 | 3.00E-05 | 0.00000000000000E+00 | NC | NC | 0.00000000000000E+00 | 0.00000000000000E+00 |
| Back.01_X_03 | 2.00E-05 | 0.00000000000000E+00 | 0.00000000000000E+00 | NC | 0.00000000000000E+00 | 0.00000000000000E+00 |
| Back.01_X_04 | 1.00E-05 | 0.00000000000000E+00 | 0.00000000000000E+00 | NC | 0.00000000000000E+00 | 0.00000000000000E+00 |

## - MALHA DE 112 x 40 NÓS

**Tabela 6 Malha de 112x40 nós, Tempo**

| | | TEMPO por ESQUEMA (s) | | | | |
|---|---|---|---|---|---|---|
| Simulações | dt | MSI(0) | TDMAXY(1) | TDMAX(2) | MSI e TDMAX (3) | MSI e GS (4) |
| | 3.00E-05 | NC | NC | NC | NC | NC |
| Back.02_X_01 | 2.00E-05 | **2.714** | NC | NC | **2.230** | **2.369** |
| Back.02_X_02 | 1.00E-05 | 5.086 | NC | NC | 3.438 | 3.012 |
| Back.02_X_03 | 9.00E-06 | 5.117 | NC | NC | 3.776 | 3.845 |
| Back.02_X_04 | 8.00E-06 | 5.164 | NC | NC | 4.039 | 4.662 |

**Tabela 7 Malha de 112x40 nós, It**

| | | it por ESQUEMA | | | | |
|---|---|---|---|---|---|---|
| Simulações | dt | MSI(0) | TDMAXY(1) | TDMAX(2) | MSI e TDMAX (3) | MSI e GS (4) |
| | 3.00E-05 | NC | NC | NC | NC | NC |
| Back.02_X_01 | 2.00E-05 | 575 | NC | NC | 650 | 650 |
| Back.02_X_02 | 1.00E-05 | 1100 | NC | NC | 1000 | 825 |
| Back.02_X_03 | 9.00E-06 | 1150 | NC | NC | 975 | 1025 |
| Back.02_X_04 | 8.00E-06 | 1200 | NC | NC | 1175 | 1275 |

**Tabela 8 Malha de 112x40 nós, Cd**

| | | Cd por ESQUEMA | | | | |
|---|---|---|---|---|---|---|
| Simulações | dt | MSI(0) | TDMAXY(1) | TDMAX(2) | MSI e TDMAX (3) | MSI e GS (4) |
| | 3.00E-05 | NC | NC | NC | NC | NC |
| Back.02_X_01 | 2.00E-05 | 1.01695616174926E+00 | NC | NC | 1.01695616174926E+00 | 1.01695616174926E+00 |
| Back.02_X_02 | 1.00E-05 | 1.01695616174926E+00 | NC | NC | 1.01695616174926E+00 | 1.01695616174926E+00 |
| Back.02_X_03 | 9.00E-06 | 1.01695616174926E+00 | NC | NC | 1.01695616174926E+00 | 1.01695616174926E+00 |
| Back.02_X_04 | 8.00E-06 | 1.01695616174926E+00 | NC | NC | 1.01695616174926E+00 | 1.01695616174926E+00 |

**Tabela 9 Malha de 112x40 nós, Fd***

| | | Fd* por ESQUEMA | | | | |
|---|---|---|---|---|---|---|
| Simulações | dt | MSI(0) | TDMAXY(1) | TDMAX(2) | MSI e TDMAX (3) | MSI e GS (4) |
| | 3.00E-05 | NC | NC | NC | NC | NC |
| Back.02_X_01 | 2.00E-05 | 9.69814641819739E-01 | NC | NC | 9.69814641819739E-01 | 9.69814641819739E-01 |
| Back.02_X_02 | 1.00E-05 | 9.69814641819739E-01 | NC | NC | 9.69814641819739E-01 | 9.69814641819739E-01 |
| Back.02_X_03 | 9.00E-06 | 9.69814641819739E-01 | NC | NC | 9.69814641819739E-01 | 9.69814641819739E-01 |
| Back.02_X_04 | 8.00E-06 | 9.69814641819739E-01 | NC | NC | 9.69814641819739E-01 | 9.69814641819739E-01 |

**Tabela 10 Malha de 112x40 nós, d(Fd*)**

| | | d(Fd*) por ESQUEMA | | | | |
|---|---|---|---|---|---|---|
| Simulações | dt | MSI(0) | TDMAXY(1) | TDMAX(2) | MSI e TDMAX (3) | MSI e GS (4) |
| | 3.00E-05 | NC | NC | NC | NC | NC |
| Back.02_X_01 | 2.00E-05 | 0.00000000000000E+00 | NC | NC | 0.00000000000000E+00 | 0.00000000000000E+00 |
| Back.02_X_02 | 1.00E-05 | 0.00000000000000E+00 | NC | NC | 0.00000000000000E+00 | 0.00000000000000E+00 |
| Back.02_X_03 | 9.00E-06 | 0.00000000000000E+00 | NC | NC | 0.00000000000000E+00 | 0.00000000000000E+00 |
| Back.02_X_04 | 8.00E-06 | 0.00000000000000E+00 | NC | NC | 0.00000000000000E+00 | 0.00000000000000E+00 |

## - MALHA DE 224 x 80 NÓS

**Tabela 11 Malha de 224x80 nós, Tempo**

| | | TEMPO por ESQUEMA (s) | | | | |
|---|---|---|---|---|---|---|
| Simulações | dt | MSI(0) | TDMAXY(1) | TDMAX(2) | MSI e TDMAX (3) | MSI e GS (4) |
| | 2.00E-05 | NC | NC | NC | NC | NC |
| Back.03_X_01 | 1.00E-05 | 35.373 | NC | NC | **22.433** | 26.323 |
| Back.03_X_02 | 9.00E-06 | 36.720 | NC | NC | 25.711 | 28.016 |
| Back.03_X_03 | 8.00E-06 | **31.388** | NC | NC | 25.911 | **22.578** |
| Back.03_X_04 | 7.00E-06 | 33.839 | NC | NC | 23.293 | 25.916 |

**Tabela 12 Malha de 224x80 nós, It**

| | | it por ESQUEMA | | | | |
|---|---|---|---|---|---|---|
| Simulações | dt | MSI(0) | TDMAXY(1) | TDMAX(2) | MSI e TDMAX (3) | MSI e GS (4) |
| | 2.00E-05 | NC | NC | NC | NC | NC |
| Back.03_X_01 | 1.00E-05 | 1600 | NC | NC | 1375 | 1525 |
| Back.03_X_02 | 9.00E-06 | 1650 | NC | NC | 1575 | 1625 |
| Back.03_X_03 | 8.00E-06 | 1425 | NC | NC | 1550 | 1300 |
| Back.03_X_04 | 7.00E-06 | 1575 | NC | NC | 1400 | 1500 |

**Tabela 13 Malha de 224x80 nós, Cd**

| | | Cd por ESQUEMA | | | | |
|---|---|---|---|---|---|---|
| Simulações | dt | MSI(0) | TDMAXY(1) | TDMAX(2) | MSI e TDMAX (3) | MSI e GS (4) |
| | 2.00E-05 | NC | NC | NC | NC | NC |
| Back.03_X_01 | 1.00E-05 | 1.00083632872860E+00 | NC | NC | 1.00083632872861E+00 | 1.00083632872861E+00 |
| Back.03_X_02 | 9.00E-06 | 1.00083632872861E+00 | NC | NC | 1.00083632872861E+00 | 1.00083632872861E+00 |
| Back.03_X_03 | 8.00E-06 | 1.00083632872861E+00 | NC | NC | 1.00083632872861E+00 | 1.00083632872861E+00 |
| Back.03_X_04 | 7.00E-06 | 1.00083632872861E+00 | NC | NC | 1.00083632872861E+00 | 1.00083632872861E+00 |

**Tabela 14 Malha de 224x80 nós, Fd***

| | | Fd* por ESQUEMA | | | | |
|---|---|---|---|---|---|---|
| Simulações | dt | MSI(0) | TDMAXY(1) | TDMAX(2) | MSI e TDMAX (3) | MSI e GS (4) |
| | 2.00E-05 | NC | NC | NC | NC | NC |
| Back.03_X_01 | 1.00E-05 | 9.69191404807217E-01 | NC | NC | 9.69191404807218E-01 | 9.69191404807217E-01 |
| Back.03_X_02 | 9.00E-06 | 9.69191404807218E-01 | NC | NC | 9.69191404807218E-01 | 9.69191404807218E-01 |
| Back.03_X_03 | 8.00E-06 | 9.69191404807218E-01 | NC | NC | 9.69191404807218E-01 | 9.69191404807218E-01 |
| Back.03_X_04 | 7.00E-06 | 9.69191404807218E-01 | NC | NC | 9.69191404807218E-01 | 9.69191404807218E-01 |

**Tabela 15 Malha de 224x80 nós, d(Fd*)**

| | | d(Fd*) por ESQUEMA | | | | |
|---|---|---|---|---|---|---|
| Simulações | dt | MSI(0) | TDMAXY(1) | TDMAX(2) | MSI e TDMAX (3) | MSI e GS (4) |
| | 2.00E-05 | NC | NC | NC | NC | NC |
| Back.03_X_01 | 1.00E-05 | 0.00000000000000E+00 | NC | NC | 2.22044604925031E-16 | 0.00000000000000E+00 |
| Back.03_X_02 | 9.00E-06 | 0.00000000000000E+00 | NC | NC | 1.11022302462515E-16 | 2.22044604925031E-16 |
| Back.03_X_03 | 8.00E-06 | 0.00000000000000E+00 | NC | NC | 0.00000000000000E+00 | 0.00000000000000E+00 |
| Back.03_X_04 | 7.00E-06 | 0.00000000000000E+00 | NC | NC | 0.00000000000000E+00 | 0.00000000000000E+00 |

## - MALHA DE 448 x 160 NÓS

**Tabela 16 Malha de 448x160 nós, Tempo**

| | | TEMPO por ESQUEMA (s) | | | | |
|---|---|---|---|---|---|---|
| Simulações | dt | MSI(0) | TDMAXY(1) | TDMAX(2) | MSI e TDMAX (3) | MSI e GS (4) |
| | 6.00E-06 | NC | NC | NC | NC | NC |
| Back.04_X_01 | 5.00E-06 | 429.440 | NC | NC | 247.022 | 304.018 |

**Tabela 17 Malha de 448x160 nós, It**

| | | it por ESQUEMA | | | | |
|---|---|---|---|---|---|---|
| Simulações | dt | MSI(0) | TDMAXY(1) | TDMAX(2) | MSI e TDMAX (3) | MSI e GS (4) |
| | 6.00E-06 | NC | NC | NC | NC | NC |
| Back.04_X_01 | 5.00E-06 | 3675 | NC | NC | 3375 | 4075 |

**Tabela 18 Malha de 448x16nós, Cd**

| | | Cd por ESQUEMA | | | | |
|---|---|---|---|---|---|---|
| Simulações | dt | MSI(0) | TDMAXY(1) | TDMAX(2) | MSI e TDMAX (3) | MSI e GS (4) |
| | 6.00E-06 | NC | NC | NC | NC | NC |
| Back.04_X_01 | 5.00E-06 | 1.00083632872860E+00 | NC | NC | 1.00083632872861E+00 | 1.00083632872861E+00 |

**Tabela 19 Malha de 448x160 nós, Fd***

| | | Fd* por ESQUEMA | | | | |
|---|---|---|---|---|---|---|
| Simulações | dt | MSI(0) | TDMAXY(1) | TDMAX(2) | MSI e TDMAX (3) | MSI e GS (4) |
| | 6.00E-06 | NC | NC | NC | NC | NC |
| Back.04_X_01 | 5.00E-06 | 9.68190179976763E-01 | NC | NC | 9.68190179976774E-01 | 9.68190179976764E-01 |

**Tabela 20 Malha de 448x160 nós, d(Fd*)**

| | | d(Fd*) por ESQUEMA | | | | |
|---|---|---|---|---|---|---|
| Simulações | dt | MSI(0) | TDMAXY(1) | TDMAX(2) | MSI e TDMAX (3) | MSI e GS (4) |
| | 6.00E-06 | NC | NC | NC | NC | NC |
| Back.04_X_01 | 5.00E-06 | 0.00000000000000E+00 | NC | NC | 0.00000000000000E+00 | 0.00000000000000E+00 |

**PARAMETROS 2**

**Utilizou-se nas tabelas a seguir os seguintes parâmetros:**

*- imax = 2*

*- nitm_u = nitm_p = 4*

*- tolu = 1d-1*

*- tolp = 1d-2*

*- num = 1*

*- kg = coord = 1*

*- modvis = modtur = ccTw = 0*

*- beta = 0.d0*

*Critério de parada: Erro de máquina para a variação de Fd**

**- MALHA DE 56 x 20 NÓS**

**Tabela 21 Malha de 56x20 nós, Tempo**

| | | TEMPO por ESQUEMA (s) | | | | |
|---|---|---|---|---|---|---|
| Simulações | dt | MSI(0) | TDMAXY(1) | TDMAX(2) | MSI e TDMAX (3) | MSI e GS (4) |
| | 5.00E-05 | NC | NC | NC | NC | NC |
| Back2.01_X_01 | 4.00E-05 | 0.367 | 3.880 | NC | 0.710 | 0.440 |
| Back2.01_X_02 | 3.00E-05 | **0.280** | 1.210 | NC | **0.390** | **0.390** |
| Back2.01_X_03 | 2.00E-05 | 0.456 | **0.540** | NC | 0.570 | 0.440 |
| Back2.01_X_04 | 1.00E-05 | 0.830 | 1.170 | 1.330 | 0.760 | 0.860 |

**Tabela 22 Malha de 56x20 nós, It**

| | | it por ESQUEMA | | | | |
|---|---|---|---|---|---|---|
| Simulações | dt | MSI(0) | TDMAXY(1) | TDMAX(2) | MSI e TDMAX (3) | MSI e GS (4) |
| | 5.00E-05 | NC | NC | NC | NC | NC |
| Back2.01_X_01 | 4.00E-05 | 325 | 3225 | NC | 725 | 425 |
| Back2.01_X_02 | 3.00E-05 | 250 | 975 | NC | 400 | 375 |
| Back2.01_X_03 | 2.00E-05 | 400 | 450 | NC | 600 | 425 |
| Back2.01_X_04 | 1.00E-05 | 750 | 975 | 1625 | 800 | 850 |

**Tabela 23 Malha de 56x20 nós, Cd**

| | | Cd por ESQUEMA | | | | |
|---|---|---|---|---|---|---|
| Simulações | dt | MSI(0) | TDMAXY(1) | TDMAX(2) | MSI e TDMAX (3) | MSI e GS (4) |
| | 5E-05 | NC | NC | NC | NC | NC |
| Back2.01_X_01 | 4E-05 | 1.04708700468259E+00 | 1.04708700468259E+00 | NC | 1.04708700468259E+00 | 1.04708700468259E+00 |
| Back2.01_X_02 | 3E-05 | 1.04708700468259E+00 | 1.04708700468259E+00 | NC | 1.04708700468259E+00 | 1.04708700468259E+00 |
| Back2.01_X_03 | 2E-05 | 1.04708700468259E+00 | 1.04708700468259E+00 | NC | 1.04708700468259E+00 | 1.04708700468259E+00 |
| Back2.01_X_04 | 1E-05 | 1.04708700468259E+00 | 1.04708700468259E+00 | 1.047087E+00 | 1.04708700468259E+00 | 1.04708700468259E+00 |

**Tabela 24 Malha de 56x20 nós, Fd***

| | | Fd* por ESQUEMA | | | | |
|---|---|---|---|---|---|---|
| Simulações | dt | MSI(0) | TDMAXY(1) | TDMAX(2) | MSI e TDMAX (3) | MSI e GS (4) |
| | 5.00E-05 | NC | NC | NC | NC | NC |
| Back2.01_X_01 | 4.00E-05 | 9.71806331865671E-01 | 9.71806331865670E-01 | NC | 9.71806331865671E-01 | 9.71806331865671E-01 |
| Back2.01_X_02 | 3.00E-05 | 9.71806331865671E-01 | 9.71806331865671E-01 | NC | 9.71806331865671E-01 | 9.71806331865671E-01 |
| Back2.01_X_03 | 2.00E-05 | 9.71806331865671E-01 | 9.71806331865671E-01 | NC | 9.71806331865671E-01 | 9.71806331865671E-01 |
| Back2.01_X_04 | 1.00E-05 | 9.71806331865671E-01 | 9.71806331865671E-01 | 9.718063E-01 | 9.71806331865671E-01 | 9.71806331865671E-01 |

**Tabela 25 Malha de 56x20 nós, d(Fd*)**

| | | d(Fd*) por ESQUEMA | | | | |
|---|---|---|---|---|---|---|
| Simulações | dt | MSI(0) | TDMAXY(1) | TDMAX(2) | MSI e TDMAX (3) | MSI e GS (4) |
| | 5.00E-05 | NC | NC | NC | NC | NC |
| Back2.01_X_01 | 4.00E-05 | 0.00000000000000E+00 | 0.00000000000000E+00 | NC | 0.00000000000000E+00 | 0.00000000000000E+00 |
| Back2.01_X_02 | 3.00E-05 | 0.00000000000000E+00 | 0.00000000000000E+00 | NC | 0.00000000000000E+00 | 0.00000000000000E+00 |
| Back2.01_X_03 | 2.00E-05 | 0.00000000000000E+00 | 0.00000000000000E+00 | NC | 0.00000000000000E+00 | 0.00000000000000E+00 |
| Back2.01_X_04 | 1.00E-05 | 0.00000000000000E+00 | 0.00000000000000E+00 | 0.000E+00 | 0.00000000000000E+00 | 0.00000000000000E+00 |

## - MALHA DE 112 x 40 NÓS

**Tabela 26 Malha de 112x40 nós, Tempo**

| | | TEMPO por ESQUEMA (s) | | | | |
|---|---|---|---|---|---|---|
| Simulações | dt | MSI(0) | TDMAXY(1) | TDMAX(2) | MSI e TDMAX (3) | MSI e GS (4) |
| | 3.00E-05 | NC | NC | NC | NC | NC |
| Back2.02_X_01 | 2.00E-05 | **2.040** | NC | NC | **2.297** | **2.407** |
| Back2.02_X_02 | 1.00E-05 | 3.920 | **6.824** | NC | 3.430 | 3.680 |
| Back2.02_X_03 | 9.00E-06 | 4.631 | 7.188 | NC | 4.369 | 4.119 |
| Back2.02_X_04 | 8.00E-06 | 5.570 | 7.400 | NC | 4.756 | 4.906 |

**Tabela 27 Malha de 112x40 nós, It**

| | | it por ESQUEMA | | | | |
|---|---|---|---|---|---|---|
| Simulações | dt | MSI(0) | TDMAXY(1) | TDMAX(2) | MSI e TDMAX (3) | MSI e GS (4) |
| | 3.00E-05 | NC | NC | NC | NC | NC |
| Back2.02_X_01 | 2.00E-05 | 425 | NC | NC | 550 | 550 |
| Back2.02_X_02 | 1.00E-05 | 825 | 1350 | NC | 825 | 825 |
| Back2.02_X_03 | 9.00E-06 | 950 | 1425 | NC | 1050 | 950 |
| Back2.02_X_04 | 8.00E-06 | 1150 | 1500 | NC | 1125 | 1100 |

**Tabela 28 Malha de 112x40 nós, Cd**

| | | Cd por ESQUEMA | | | | |
|---|---|---|---|---|---|---|
| Simulações | dt | MSI(0) | TDMAXY(1) | TDMAX(2) | MSI e TDMAX (3) | MSI e GS (4) |
| | 3.00E-05 | NC | NC | NC | NC | NC |
| Back2.02_X_01 | 2.00E-05 | 1.01695616174926E+00 | NC | NC | 1.01695616174926E+00 | 1.01695616174926E+00 |
| Back2.02_X_02 | 1.00E-05 | 1.01695616174926E+00 | 1.01695616174926E+00 | NC | 1.01695616174926E+00 | 1.01695616174926E+00 |
| Back2.02_X_03 | 9.00E-06 | 1.01695616174926E+00 | 1.01695616174926E+00 | NC | 1.01695616174926E+00 | 1.01695616174926E+00 |
| Back2.02_X_04 | 8.00E-06 | 1.01695616174926E+00 | 1.01695616174926E+00 | NC | 1.01695616174926E+00 | 1.01695616174926E+00 |

**Tabela 29 Malha de 112x40 nós, Fd***

| | | Fd* por ESQUEMA | | | | |
|---|---|---|---|---|---|---|
| Simulações | dt | MSI(0) | TDMAXY(1) | TDMAX(2) | MSI e TDMAX (3) | MSI e GS (4) |
| | 3.00E-05 | NC | NC | NC | NC | NC |
| Back2.02_X_01 | 2.00E-05 | 9.69814641819739E-01 | NC | NC | 9.69814641819739E-01 | 9.69814641819739E-01 |
| Back2.02_X_02 | 1.00E-05 | 9.69814641819739E-01 | 9.69814641819739E-01 | NC | 9.69814641819739E-01 | 9.69814641819739E-01 |
| Back2.02_X_03 | 9.00E-06 | 9.69814641819739E-01 | 9.69814641819739E-01 | NC | 9.69814641819739E-01 | 9.69814641819739E-01 |
| Back2.02_X_04 | 8.00E-06 | 9.69814641819739E-01 | 9.69814641819739E-01 | NC | 9.69814641819739E-01 | 9.69814641819739E-01 |

**Tabela 30 Malha de 112x40 nós, d(Fd*)**

| | | d(Fd*) por ESQUEMA | | | | |
|---|---|---|---|---|---|---|
| Simulações | dt | MSI(0) | TDMAXY(1) | TDMAX(2) | MSI e TDMAX (3) | MSI e GS (4) |
| | 3.00E-05 | NC | NC | NC | NC | NC |
| Back2.02_X_01 | 2.00E-05 | 0.00000000000000E+00 | NC | NC | 0.00000000000000E+00 | 0.00000000000000E+00 |
| Back2.02_X_02 | 1.00E-05 | 0.00000000000000E+00 | NC | NC | 0.00000000000000E+00 | 0.00000000000000E+00 |
| Back2.02_X_03 | 9.00E-06 | 0.00000000000000E+00 | NC | NC | 0.00000000000000E+00 | 0.00000000000000E+00 |
| Back2.02_X_04 | 8.00E-06 | 0.00000000000000E+00 | NC | NC | 0.00000000000000E+00 | 0.00000000000000E+00 |

## - MALHA DE 224 x 80 NÓS

**Tabela 31 Malha de 224x80 nós, Tempo**

| | | TEMPO por ESQUEMA (s) | | | | |
|---|---|---|---|---|---|---|
| Simulações | dt | MSI(0) | TDMAXY(1) | TDMAX(2) | MSI e TDMAX (3) | MSI e GS (4) |
| | 2.00E-05 | NC | NC | NC | NC | NC |
| Back2.03_X_01 | 1.00E-05 | **22.887** | NC | NC | **18.604** | **20.948** |
| Back2.03_X_02 | 9.00E-06 | 24.297 | NC | NC | 22.155 | 23.095 |
| Back2.03_X_03 | 8.00E-06 | 29.152 | NC | NC | 23.070 | 28.251 |
| Back2.03_X_04 | 7.00E-06 | 30.847 | NC | NC | 29.072 | 28.996 |

**Tabela 32 Malha de 224x80 nós, It**

| | | it por ESQUEMA | | | | |
|---|---|---|---|---|---|---|
| Simulações | dt | MSI(0) | TDMAXY(1) | TDMAX(2) | MSI e TDMAX (3) | MSI e GS (4) |
| | 2.00E-05 | NC | NC | NC | NC | NC |
| Back2.03_X_01 | 1.00E-05 | 1000 | NC | NC | 925 | 1025 |
| Back2.03_X_02 | 9.00E-06 | 1075 | NC | NC | 1125 | 1125 |
| Back2.03_X_03 | 8.00E-06 | 1300 | NC | NC | 1175 | 1400 |
| Back2.03_X_04 | 7.00E-06 | 1375 | NC | NC | 1425 | 1400 |

**Tabela 33 Malha de 224x80 nós, Cd**

| | | Cd por ESQUEMA | | | | |
|---|---|---|---|---|---|---|
| Simulações | dt | MSI(0) | TDMAXY(1) | TDMAX(2) | MSI e TDMAX (3) | MSI e GS (4) |
| | 2.00E-05 | NC | NC | NC | NC | NC |
| Back2.03_X_01 | 1.00E-05 | 1.00083632872861E+00 | NC | NC | 1.00083632872861E+00 | 1.00083632872861E+00 |
| Back2.03_X_02 | 9.00E-06 | 1.00083632872861E+00 | NC | NC | 1.00083632872861E+00 | 1.00083632872861E+00 |
| Back2.03_X_03 | 8.00E-06 | 1.00083632872861E+00 | NC | NC | 1.00083632872861E+00 | 1.00083632872861E+00 |
| Back2.03_X_04 | 7.00E-06 | 1.00083632872861E+00 | NC | NC | 1.00083632872861E+00 | 1.00083632872861E+00 |

**Tabela 34 Malha de 224x80 nós, Fd***

| | | Fd* por ESQUEMA | | | | |
|---|---|---|---|---|---|---|
| Simulações | dt | MSI(0) | TDMAXY(1) | TDMAX(2) | MSI e TDMAX (3) | MSI e GS (4) |
| | 2.00E-05 | NC | NC | NC | NC | NC |
| Back2.03_X_01 | 1.00E-05 | 9.69191404807218E-01 | NC | NC | 9.69191404807218E-01 | 9.69191404807218E-01 |
| Back2.03_X_02 | 9.00E-06 | 9.69191404807218E-01 | NC | NC | 9.69191404807218E-01 | 9.69191404807217E-01 |
| Back2.03_X_03 | 8.00E-06 | 9.69191404807218E-01 | NC | NC | 9.69191404807218E-01 | 9.69191404807218E-01 |
| Back2.03_X_04 | 7.00E-06 | 9.69191404807218E-01 | NC | NC | 9.69191404807217E-01 | 9.69191404807218E-01 |

**Tabela 35 Malha de 224x80 nós, d(Fd*)**

| | | d(Fd*) por ESQUEMA | | | | |
|---|---|---|---|---|---|---|
| Simulações | dt | MSI(0) | TDMAXY(1) | TDMAX(2) | MSI e TDMAX (3) | MSI e GS (4) |
| | 2.00E-05 | NC | NC | NC | NC | NC |
| Back2.03_X_01 | 1.00E-05 | 0.00000000000000E+00 | NC | NC | 0.00000000000000E+00 | 0.00000000000000E+00 |
| Back2.03_X_02 | 9.00E-06 | 0.00000000000000E+00 | NC | NC | 0.00000000000000E+00 | 0.00000000000000E+00 |
| Back2.03_X_03 | 8.00E-06 | 0.00000000000000E+00 | NC | NC | 0.00000000000000E+00 | 0.00000000000000E+00 |
| Back2.03_X_04 | 7.00E-06 | 0.00000000000000E+00 | NC | NC | 0.00000000000000E+00 | 0.00000000000000E+00 |

**- MALHA DE 448 x 160 NÓS**

**Tabela 36 Malha de 448x160 nós, Tempo**

| | | TEMPO por ESQUEMA (s) | | | | |
|---|---|---|---|---|---|---|
| Simulações | dt | MSI(0) | TDMAXY(1) | TDMAX(2) | MSI e TDMAX (3) | MSI e GS (4) |
| | 6.00E-06 | NC | NC | NC | NC | NC |
| Back2.04_X_01 | 5.00E-06 | 212.655 | NC | NC | 194.503 | 253.092 |
| Back2.04_X_02 | 4.00E-06 | 351.201 | NC | NC | 227.301 | 308.335 |

**Tabela 37 Malha de 448x160 nós, It**

| | | it por ESQUEMA | | | | |
|---|---|---|---|---|---|---|
| Simulações | dt | MSI(0) | TDMAXY(1) | TDMAX(2) | MSI e TDMAX (3) | MSI e GS (4) |
| | 6.00E-06 | NC | NC | NC | NC | NC |
| Back2.04_X_01 | 5.00E-06 | 2150 | NC | NC | 2125 | 2425 |
| Back2.04_X_02 | 4.00E-06 | 2625 | NC | NC | 2600 | 2450 |

**Tabela 38 Malha de 448x16nós, Cd**

| | | Cd por ESQUEMA | | | | |
|---|---|---|---|---|---|---|
| Simulações | dt | MSI(0) | TDMAXY(1) | TDMAX(2) | MSI e TDMAX (3) | MSI e GS (4) |
| | 6.00E-06 | NC | NC | NC | NC | NC |
| Back2.04_X_01 | 5.00E-06 | 9.91474208982338E-01 | NC | NC | 9.91474208982337E-01 | 9.91474208982337E-01 |
| Back2.04_X_02 | 4.00E-06 | 9.91474208982337E-01 | NC | NC | 9.91474208982338E-01 | 9.91474208982336E-01 |

**Tabela 39 Malha de 448x160 nós, Fd***

| | | Fd* por ESQUEMA | | | | |
|---|---|---|---|---|---|---|
| Simulações | dt | MSI(0) | TDMAXY(1) | TDMAX(2) | MSI e TDMAX (3) | MSI e GS (4) |
| | 6.00E-06 | NC | NC | NC | NC | NC |
| Back2.04_X_01 | 5.00E-06 | 9.68190179976769E-01 | NC | NC | 9.68190179976768E-01 | 9.68190179976768E-01 |
| Back2.04_X_02 | 4.00E-06 | 9.68190179976768E-01 | NC | NC | 9.68190179976769E-01 | 9.68190179976766E-01 |

**Tabela 40 Malha de 448x160 nós, d(Fd*)**

| | | d(Fd*) por ESQUEMA | | | | |
|---|---|---|---|---|---|---|
| Simulações | dt | MSI(0) | TDMAXY(1) | TDMAX(2) | MSI e TDMAX (3) | MSI e GS (4) |
| | 6.00E-06 | NC | NC | NC | NC | NC |
| Back2.04_X_01 | 5.00E-06 | 0.00000000000000E+00 | NC | NC | 0.00000000000000E+00 | 0.00000000000000E+00 |
| Back2.04_X_02 | 4.00E-06 | 0.00000000000000E+00 | NC | NC | 0.00000000000000E+00 | 0.00000000000000E+00 |

# B - OTIMIZAÇÃO DAS SUBROTINAS DO MACH2D USANDO O PROGRAMA 'Intel(R) VTune(TM) Performance Analyzer 9.1'

**Microcomputador utilizado:**

**CFD-6 – Intel Core 2 Duo E6700 - 2,66 GHz – 8 GB de memória RAM – HD de 160 GB**

**A variável que é analisada aqui é o CPU_CLK_UNHALTED events.**
**Ela significa o número de ciclos de clock que a subrotina utiliza, no total.**
**Se este valor for alto, isto significa que a subrotina leva muitos ciclos de clock, ou seja, ela pode ser otimizada, não necessáriamente lenta.**

**- Para este estudo utilizou-se uma malha de 224x80 nós, dt=1d-5, itmax=1000, imax=2, nitm_u=nitm_p=4, tolu=1d-1, tolp=1d-2, solver = MSI**

**1)Versão GB_2012_10_01, simulação:** `SEN03_0001`

| Name | CPU_ sampl | INST_R samples | Clocks per... | CPU_CL % | INST_R % | CPU_CLK_UNH events | INST_RETIRED events | Segment | Offset | RVA | Size | Class | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| COEFFICIENTS_mp_GET_VELOCITIES_AT_FACES | 9,872 | 8,705 | 1.134 | 16.62% | 12.11% | 26,318,752,000 | 23,207,530,000 | 0xFFFFFFFF | 0xC52B0 | 0xC62B0 | 0x8510 | | COEFFICIE |
| MSI2D9_mp_FB2D9 | 9,110 | 14,385 | 0.633 | 15.34% | 20.01% | 24,287,260,000 | 38,350,410,000 | 0xFFFFFFFF | 0xDD260 | 0xDE260 | 0xC860 | | MSI2D9_m |
| MSI2D5_mp_FB2D5 | 8,329 | 14,396 | 0.579 | 14.03% | 20.02% | 22,205,114,000 | 38,379,736,000 | 0xFFFFFFFF | 0x3F7C0 | 0x407C0 | 0x9130 | | MSI2D5_m |
| MSI2D9_mp_LU2D9 | 6,132 | 7,570 | 0.810 | 10.33% | 10.53% | 16,347,912,000 | 20,181,620,000 | 0xFFFFFFFF | 0xE9AC0 | 0xEAAC0 | 0xAB60 | | MSI2D9_m |
| MSI2D5_mp_LU2D5 | 3,041 | 3,033 | 1.003 | 5.12% | 4.22% | 8,107,306,000 | 8,085,978,000 | 0xFFFFFFFF | 0x488F0 | 0x498F0 | 0x4BF0 | | MSI2D5_m |
| COEFFICIENTS_mp_GET_T_COEFFICIENTS_AND_SOURCE | 2,880 | 2,730 | 1.055 | 4.85% | 3.80% | 7,678,080,000 | 7,278,180,000 | 0xFFFFFFFF | 0xA1B60 | 0xA2B60 | 0xCBC0 | | COEFFICIE |
| COEFFICIENTS_mp_GET_INTERNAL_SIMPLEC_COEFFICIENTS | 2,323 | 2,170 | 1.071 | 3.91% | 3.02% | 6,193,118,000 | 5,785,220,000 | 0xFFFFFFFF | 0xD6120 | 0xD7120 | 0x3D80 | | COEFFICIE |
| SOLVERS_mp_NORM_L1_9D | 1,923 | 2,838 | 0.678 | 3.24% | 3.95% | 5,126,718,000 | 7,566,108,000 | 0xFFFFFFFF | 0x11C160 | 0x11D160 | 0xD50 | | SOLVERS_ |
| COEFFICIENTS_mp_GET_U_V_AT_REAL_NODES_WITH_PL | 1,720 | 1,384 | 1.243 | 2.90% | 1.93% | 4,585,520,000 | 3,689,744,000 | 0xFFFFFFFF | 0xDA1F0 | 0xDB1F0 | 0x1C00 | | COEFFICIE |
| COEFFICIENTS_mp_GET_U_SOURCE | 1,550 | 1,616 | 0.959 | 2.61% | 2.25% | 4,132,300,000 | 4,308,256,000 | 0xFFFFFFFF | 0x70D50 | 0x71D50 | 0x97F0 | | COEFFICIE |
| COEFFICIENTS_mp_GET_V_SOURCE | 1,547 | 1,610 | 0.961 | 2.60% | 2.24% | 4,124,302,000 | 4,292,260,000 | 0xFFFFFFFF | 0x91980 | 0x92980 | 0x80A0 | | COEFFICIE |
| COEFFICIENTS_mp_GET_P_SOURCE | 1,422 | 2,346 | 0.606 | 2.39% | 3.26% | 3,791,052,000 | 6,254,436,000 | 0xFFFFFFFF | 0xC01E0 | 0xC11E0 | 0x2820 | | COEFFICIE |
| COEFFICIENTS_mp_GET_P_COEFFICIENTS | 1,279 | 2,056 | 0.622 | 2.15% | 2.86% | 3,409,814,000 | 5,481,296,000 | 0xFFFFFFFF | 0xB8880 | 0xBC880 | 0x23B0 | | COEFFICIE |
| _intel_new_memset | 1,158 | 230 | 5.035 | 1.95% | 0.32% | 3,087,228,000 | 613,180,000 | 0xFFFFFFFF | 0x21B250 | 0x21C250 | 0x1560 | | _intel_new_ |
| COEFFICIENTS_mp_GET_U_COEFFICIENTS | 1,018 | 1,112 | 0.915 | 1.71% | 1.55% | 2,713,988,000 | 2,964,592,000 | 0xFFFFFFFF | 0x63530 | 0x64530 | 0x6B50 | | COEFFICIE |
| COEFFICIENTS_mp_GET_V_COEFFICIENTS | 887 | 1,132 | 0.784 | 1.49% | 1.57% | 2,364,742,000 | 3,017,912,000 | 0xFFFFFFFF | 0x83DC0 | 0x84DC0 | 0x6D20 | | COEFFICIE |
| _intel_new_memcpy | 829 | 93 | 8.914 | 1.40% | 0.13% | 2,210,114,000 | 247,938,000 | 0xFFFFFFFF | 0x21C7B0 | 0x21D7B0 | 0x23D0 | | _intel_new_ |
| COEFFICIENTS_mp_GET_VELOCITIES_AT_INTERNAL_FACES_WITH_PL | 772 | 766 | 1.008 | 1.30% | 1.07% | 2,058,152,000 | 2,042,156,000 | 0xFFFFFFFF | 0xDBDF0 | 0xDCDF0 | 0x1460 | | COEFFICIE |
| memset | 688 | 280 | 2.457 | 1.16% | 0.39% | 1,834,208,000 | 746,480,000 | 0xFFFFFFFF | 0x1C6060 | 0x1C7060 | 0xF0 | | memset |
| COEFFICIENTS_mp_GET_DENSITY_AT_FACES | 573 | 1,157 | 0.495 | 0.96% | 1.61% | 1,527,618,000 | 3,084,562,000 | 0xFFFFFFFF | 0x62B40 | 0x63B40 | 0x9F0 | | COEFFICIE |
| USER_mp_GET_THERMAL_CONDUCTIVITY_AT_FACES | 441 | 468 | 0.942 | 0.74% | 0.65% | 1,175,706,000 | 1,247,688,000 | 0xFFFFFFFF | 0xF5140 | 0xF6140 | 0x720 | | USER_mp_ |
| USER_mp_GET_LAMINAR_VISCOSITY_AT_FACES | 429 | 467 | 0.919 | 0.72% | 0.65% | 1,143,714,000 | 1,245,022,000 | 0xFFFFFFFF | 0xF4A20 | 0xF5A20 | 0x720 | | USER_mp_ |
| SOLVERS_mp_NORM_L1_5D | 315 | 501 | 0.629 | 0.53% | 0.70% | 839,790,000 | 1,335,666,000 | 0xFFFFFFFF | 0x11B980 | 0x11C980 | 0x7E0 | | SOLVERS_ |
| cvtas_t_to_a | 187 | 370 | 0.505 | 0.31% | 0.51% | 498,542,000 | 986,420,000 | 0xFFFFFFFF | 0x1987B0 | 0x1997B0 | 0x4320 | | cvtas_t_to_ |
| MAIN__ip_GET_NUMERICAL_SOLUTION | 122 | 21 | 5.810 | 0.21% | 0.03% | 325,252,000 | 55,986,000 | 0xFFFFFFFF | 0x1213A0 | 0x1223A0 | 0x5724 | | MAIN__ip_G |
| COEFFICIENTS_mp_GET_DENSITY_AT_NODES | 118 | 23 | 5.130 | 0.20% | 0.03% | 314,588,000 | 61,318,000 | 0xFFFFFFFF | 0x62910 | 0x63910 | 0x230 | | COEFFICIE |
| COEFFICIENTS_mp_GET_PRESSURE_DENSITY_CORRECTION_WITH_PL | 103 | 39 | 2.641 | 0.17% | 0.05% | 274,598,000 | 103,974,000 | 0xFFFFFFFF | 0xD9EA0 | 0xDAEA0 | 0x350 | | COEFFICIE |
| USER_mp_SET_CP_AND_GAMMA | 63 | 8 | 7.875 | 0.11% | 0.01% | 167,958,000 | 21,328,000 | 0xFFFFFFFF | 0xF46F0 | 0xF56F0 | 0x1B0 | | USER_mp_ |
| USER_mp_GET_A9D_B_RESCALING | 59 | 66 | 0.894 | 0.10% | 0.09% | 157,294,000 | 175,956,000 | 0xFFFFFFFF | 0x10FB10 | 0x110B10 | 0x58E0 | | USER_mp_ |
| USER_mp_SET_LAMINAR_VISCOSITY_AT_NODES | 50 | 2 | 25.000 | 0.08% | 0.00% | 133,300,000 | 5,332,000 | 0xFFFFFFFF | 0xF48A0 | 0xF58A0 | 0xC0 | | USER_mp_ |
| USER_mp_SET_THERMAL_CONDUCTIVITY_AT_NODES | 49 | 4 | 12.250 | 0.08% | 0.01% | 130,634,000 | 10,664,000 | 0xFFFFFFFF | 0xF4960 | 0xF5960 | 0xC0 | | USER_mp_ |
| cvt_ieee_t_to_text_ex | 41 | 54 | 0.759 | 0.07% | 0.08% | 109,306,000 | 143,964,000 | 0xFFFFFFFF | 0x180D90 | 0x181D90 | 0x13E0 | | cvt_ieee_t_ |
| USER_mp_SET_BCU | 38 | 13 | 2.923 | 0.06% | 0.02% | 101,308,000 | 34,658,000 | 0xFFFFFFFF | 0xF5860 | 0xF6860 | 0x3C00 | | USER_mp_ |
| USER_mp_SET_BCP | 33 | 17 | 1.941 | 0.06% | 0.02% | 87,978,000 | 45,322,000 | 0xFFFFFFFF | 0x100DE0 | 0x101DE0 | 0x2D70 | | USER_mp_ |
| USER_mp_SET_BCV | 32 | 9 | 3.556 | 0.05% | 0.01% | 85,312,000 | 23,994,000 | 0xFFFFFFFF | 0xF9460 | 0xFA460 | 0x3BE0 | | USER_mp_ |
| for__format_value | 27 | 25 | 1.080 | 0.05% | 0.03% | 71,982,000 | 66,650,000 | 0xFFFFFFFF | 0x15D3A0 | 0x15E3A0 | 0xCC0 | | for__format |
| USER_mp_SET_BCT | 25 | 12 | 2.083 | 0.04% | 0.02% | 66,650,000 | 31,992,000 | 0xFFFFFFFF | 0xFD040 | 0xFE040 | 0x3DA0 | | USER_mp_ |

**Figura 1 Versão original**

```
*** Efficiency: numerical solution 2D / analytic Q1D (dimensionless) ***

    1.000836328728611E+00 = discharge coefficient
    9.691914048072193E-01 = dynamic thrust
    9.752768908404300E-01 = pressure thrust at sea level (p = 101325 Pa)
    1.080533092655724E+00 = pressure thrust in the vacuum
    9.677277608885942E-01 = total thrust at sea level
    9.754462366605249E-01 = total thrust in the vacuum
    9.677277608885942E-01 = thrust coefficient at sea level
    9.754462366605249E-01 = thrust coefficient in the vacuum
    9.991643701326538E-01 = characterist velocity
    9.669190986681359E-01 = velocity of efective ejection at sea level
    9.746311246511808E-01 = velocity of efective ejection in the vacuum
    9.669190986681359E-01 = specific impulse at sea level
    9.746311246511810E-01 = specific impulse at vacuum


          0.000 = tcpuo: acumulated CPU time (s) (before interuption)
```

```
61.329 = dtcpu: CPU time (s) (after interuption)
61.329 = tcpu:  total CPU time (s)
```

## 2)Versão com algumas modificações no 'main.f90' : SEN03_0002

| Name | CPU_ sampl | INST_R samples | Clocks per... | CPU_CL % | INST_R % | CPU_CLK_UNH events | INST_RETIRED events | Segment | Offset | RVA | Size | Class | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| COEFFICIENTS_mp_GET_VELOCITIES_AT_FACES | 9,867 | 8,682 | 1.136 | 16.66% | 12.11% | 26,305,422,000 | 23,146,212,000 | 0xFFFFFFFF | 0xC52B0 | 0xC62B0 | 0x8510 | | COEFFICIE |
| MSI2D9_mp_FB2D9 | 9,127 | 14,394 | 0.634 | 15.41% | 20.07% | 24,332,582,000 | 38,374,404,000 | 0xFFFFFFFF | 0xDD260 | 0xDE260 | 0xC860 | | MSI2D9_m |
| MSI2D5_mp_FB2D5 | 8,286 | 14,389 | 0.576 | 13.99% | 20.07% | 22,090,476,000 | 38,361,074,000 | 0xFFFFFFFF | 0x3F7C0 | 0x407C0 | 0x9130 | | MSI2D5_m |
| MSI2D9_mp_LU2D9 | 6,135 | 7,579 | 0.809 | 10.36% | 10.57% | 16,355,910,000 | 20,205,614,000 | 0xFFFFFFFF | 0xE9AC0 | 0xEAAC0 | 0xAB60 | | MSI2D9_m |
| MSI2D5_mp_LU2D5 | 3,015 | 3,055 | 0.987 | 5.09% | 4.26% | 8,037,990,000 | 8,144,630,000 | 0xFFFFFFFF | 0x488F0 | 0x498F0 | 0x4BF0 | | MSI2D5_m |
| COEFFICIENTS_mp_GET_T_COEFFICIENTS_AND_SOURCE | 2,855 | 2,723 | 1.048 | 4.82% | 3.80% | 7,611,430,000 | 7,259,518,000 | 0xFFFFFFFF | 0xA1B60 | 0xA2B60 | 0xCBC0 | | COEFFICIE |
| COEFFICIENTS_mp_GET_INTERNAL_SIMPLEC_COEFFICIENTS | 2,364 | 2,137 | 1.106 | 3.99% | 2.98% | 6,302,424,000 | 5,697,242,000 | 0xFFFFFFFF | 0xD6120 | 0xD7120 | 0x3D80 | | COEFFICIE |
| SOLVERS_mp_NORM_L1_9D | 1,865 | 2,814 | 0.663 | 3.15% | 3.92% | 4,972,090,000 | 7,502,124,000 | 0xFFFFFFFF | 0x11C160 | 0x11D160 | 0xD50 | | SOLVERS_ |
| COEFFICIENTS_mp_GET_U_V_AT_REAL_NODES_WITH_PL | 1,732 | 1,356 | 1.277 | 2.92% | 1.89% | 4,617,512,000 | 3,615,096,000 | 0xFFFFFFFF | 0xDA1F0 | 0xDB1F0 | 0x1C00 | | COEFFICIE |
| COEFFICIENTS_mp_GET_U_SOURCE | 1,523 | 1,593 | 0.956 | 2.57% | 2.22% | 4,060,318,000 | 4,246,938,000 | 0xFFFFFFFF | 0x70D50 | 0x71D50 | 0x97F0 | | COEFFICIE |
| COEFFICIENTS_mp_GET_V_SOURCE | 1,513 | 1,632 | 0.927 | 2.55% | 2.28% | 4,033,658,000 | 4,350,912,000 | 0xFFFFFFFF | 0x91980 | 0x92980 | 0x80A0 | | COEFFICIE |
| COEFFICIENTS_mp_GET_P_SOURCE | 1,426 | 2,362 | 0.604 | 2.41% | 3.29% | 3,801,716,000 | 6,297,092,000 | 0xFFFFFFFF | 0xC01E0 | 0xC11E0 | 0x2820 | | COEFFICIE |
| COEFFICIENTS_mp_GET_P_COEFFICIENTS | 1,266 | 2,056 | 0.616 | 2.14% | 2.87% | 3,375,156,000 | 5,481,296,000 | 0xFFFFFFFF | 0xBB880 | 0xBC880 | 0x23B0 | | COEFFICIE |
| _intel_new_memset | 1,178 | 249 | 4.731 | 1.99% | 0.35% | 3,140,548,000 | 663,834,000 | 0xFFFFFFFF | 0x21D4E0 | 0x21E4E0 | 0x1560 | | _intel_new_ |
| COEFFICIENTS_mp_GET_U_COEFFICIENTS | 1,040 | 1,121 | 0.928 | 1.76% | 1.56% | 2,772,640,000 | 2,988,586,000 | 0xFFFFFFFF | 0x63530 | 0x64530 | 0x6B50 | | COEFFICIE |
| COEFFICIENTS_mp_GET_V_COEFFICIENTS | 896 | 1,136 | 0.789 | 1.51% | 1.58% | 2,388,736,000 | 3,028,576,000 | 0xFFFFFFFF | 0x83DC0 | 0x84DC0 | 0x6D20 | | COEFFICIE |
| _intel_new_memcpy | 819 | 94 | 8.713 | 1.38% | 0.13% | 2,183,454,000 | 250,604,000 | 0xFFFFFFFF | 0x21EA40 | 0x21FA40 | 0x23D0 | | _intel_new_ |
| COEFFICIENTS_mp_GET_VELOCITIES_AT_INTERNAL_FACES_WITH_PL | 786 | 761 | 1.033 | 1.33% | 1.06% | 2,095,476,000 | 2,028,826,000 | 0xFFFFFFFF | 0xDBDF0 | 0xDCDF0 | 0x1460 | | COEFFICIE |
| memset | 713 | 299 | 2.385 | 1.20% | 0.42% | 1,900,858,000 | 797,134,000 | 0xFFFFFFFF | 0x1C82F0 | 0x1C92F0 | 0xF0 | | memset |
| COEFFICIENTS_mp_GET_DENSITY_AT_FACES | 593 | 1,155 | 0.513 | 1.00% | 1.61% | 1,580,938,000 | 3,079,230,000 | 0xFFFFFFFF | 0x62B40 | 0x63B40 | 0x9F0 | | COEFFICIE |
| USER_mp_GET_THERMAL_CONDUCTIVITY_AT_FACES | 460 | 444 | 1.036 | 0.78% | 0.62% | 1,226,360,000 | 1,183,704,000 | 0xFFFFFFFF | 0xF5140 | 0xF6140 | 0x720 | | USER_mp_ |
| USER_mp_GET_LAMINAR_VISCOSITY_AT_FACES | 399 | 485 | 0.823 | 0.67% | 0.68% | 1,063,734,000 | 1,293,010,000 | 0xFFFFFFFF | 0xF4A20 | 0xF5A20 | 0x720 | | USER_mp_ |
| SOLVERS_mp_NORM_L1_5D | 322 | 517 | 0.623 | 0.54% | 0.72% | 858,452,000 | 1,378,322,000 | 0xFFFFFFFF | 0x11B980 | 0x11C980 | 0x7E0 | | SOLVERS_ |
| cvtas_t_to_a | 120 | 199 | 0.603 | 0.20% | 0.28% | 319,920,000 | 530,534,000 | 0xFFFFFFFF | 0x19AA40 | 0x19BA40 | 0x4320 | | cvtas_t_to_ |
| MAIN_jp_GET_NUMERICAL_SOLUTION | 113 | 20 | 5.650 | 0.19% | 0.03% | 301,258,000 | 53,320,000 | 0xFFFFFFFF | 0x123900 | 0x124900 | 0x5455 | | MAIN_jp_G |
| COEFFICIENTS_mp_GET_DENSITY_AT_NODES | 105 | 24 | 4.375 | 0.18% | 0.03% | 279,930,000 | 63,984,000 | 0xFFFFFFFF | 0x62910 | 0x63910 | 0x230 | | COEFFICIE |
| COEFFICIENTS_mp_GET_PRESSURE_DENSITY_CORRECTION_WITH_PL | 90 | 40 | 2.250 | 0.15% | 0.06% | 239,940,000 | 106,640,000 | 0xFFFFFFFF | 0xD9EA0 | 0xDAEA0 | 0x350 | | COEFFICIE |
| USER_mp_SET_CP_AND_GAMMA | 74 | 13 | 5.692 | 0.12% | 0.02% | 197,284,000 | 34,658,000 | 0xFFFFFFFF | 0xF46F0 | 0xF56F0 | 0x1B0 | | USER_mp_ |
| USER_mp_GET_A9D_B_RESCALING | 64 | 74 | 0.865 | 0.11% | 0.10% | 170,624,000 | 197,284,000 | 0xFFFFFFFF | 0x10FB10 | 0x110B10 | 0x58E0 | | USER_mp_ |
| USER_mp_SET_LAMINAR_VISCOSITY_AT_NODES | 48 | 3 | 16.000 | 0.08% | 0.00% | 127,968,000 | 7,998,000 | 0xFFFFFFFF | 0xF48A0 | 0xF58A0 | 0xC0 | | USER_mp_ |
| USER_mp_SET_THERMAL_CONDUCTIVITY_AT_NODES | 46 | 5 | 9.200 | 0.08% | 0.01% | 122,636,000 | 13,330,000 | 0xFFFFFFFF | 0xF4960 | 0xF5960 | 0xC0 | | USER_mp_ |
| USER_mp_SET_BCU | 40 | 12 | 3.333 | 0.07% | 0.02% | 106,640,000 | 31,992,000 | 0xFFFFFFFF | 0xF5860 | 0xF6860 | 0x3C00 | | USER_mp_ |
| USER_mp_SET_BCP | 36 | 25 | 1.440 | 0.06% | 0.03% | 95,976,000 | 66,650,000 | 0xFFFFFFFF | 0x100DE0 | 0x101DE0 | 0x2D70 | | USER_mp_ |
| for__interp_fmt | 32 | 35 | 0.914 | 0.05% | 0.05% | 85,312,000 | 93,310,000 | 0xFFFFFFFF | 0x16D160 | 0x16E160 | 0xD80 | | for__interp_ |
| USER_mp_SET_BCV | 30 | 10 | 3.000 | 0.05% | 0.01% | 79,980,000 | 26,660,000 | 0xFFFFFFFF | 0xF9460 | 0xFA460 | 0x3BE0 | | USER_mp_ |
| USER_mp_GET_A5D_B_RESCALING | 28 | 26 | 1.077 | 0.05% | 0.04% | 74,648,000 | 69,316,000 | 0xFFFFFFFF | 0x10B740 | 0x10C740 | 0x43D0 | | USER_mp_ |
| USER_mp_SET_BCT | 27 | 9 | 3.000 | 0.05% | 0.01% | 71,982,000 | 23,994,000 | 0xFFFFFFFF | 0xFD040 | 0xFE040 | 0x3DA0 | | USER_mp_ |

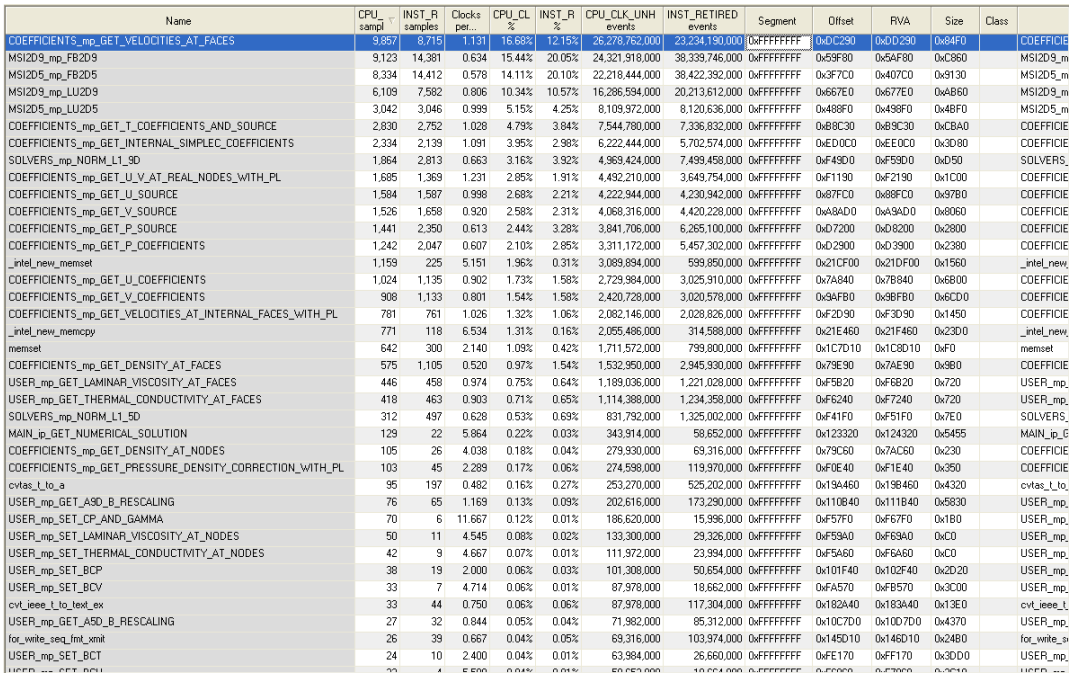
**Figura 2 Versão modificada**

```
*** Efficiency: numerical solution 2D / analytic Q1D (dimensionless) ***

    1.000836328728611E+00 = discharge coefficient
    9.691914048072193E-01 = dynamic thrust
    9.752768908404300E-01 = pressure thrust at sea level (p = 101325 Pa)
    1.080533092655724E+00 = pressure thrust in the vacuum
    9.677277608885942E-01 = total thrust at sea level
    9.754462366605249E-01 = total thrust in the vacuum
    9.677277608885942E-01 = thrust coefficient at sea level
    9.754462366605249E-01 = thrust coefficient in the vacuum
    9.991643701326538E-01 = characterist velocity
    9.669190986681359E-01 = velocity of efective ejection at sea level
    9.746311246511808E-01 = velocity of efective ejection in the vacuum
    9.669190986681359E-01 = specific impulse at sea level
    9.746311246511810E-01 = specific impulse at vacuum


     0.000 = tcpuo: acumulated CPU time (s) (before interuption)
    61.296 = dtcpu: CPU time (s) (after interuption)
    61.296 = tcpu:  total CPU time (s)
```

## 3)Versão com multiplicação por número constante nas subrotinas, ao invés de divisão e variáveis auxiliares para armazenamento do índice: SEN03_0003



| Name | CPU_ sampl | INST_R samples | Clocks per... | CPU_CL % | INST_R % | CPU_CLK_UNH events | INST_RETIRED events | Segment | Offset | RVA | Size | Class | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| COEFFICIENTS_mp_GET_VELOCITIES_AT_FACES | 9,857 | 8,715 | 1.131 | 16.68% | 12.15% | 26,278,762,000 | 23,234,190,000 | 0xFFFFFFFF | 0xDC290 | 0xDD290 | 0x84F0 | | COEFFICIE |
| MSI2D9_mp_FB2D9 | 9,123 | 14,381 | 0.634 | 15.44% | 20.05% | 24,321,918,000 | 38,339,746,000 | 0xFFFFFFFF | 0x59F80 | 0x5AF80 | 0xC860 | | MSI2D9_m |
| MSI2D5_mp_FB2D5 | 8,334 | 14,412 | 0.578 | 14.11% | 20.10% | 22,218,444,000 | 38,422,392,000 | 0xFFFFFFFF | 0x3F7C0 | 0x407C0 | 0x9130 | | MSI2D5_m |
| MSI2D9_mp_LU2D9 | 6,109 | 7,582 | 0.806 | 10.34% | 10.57% | 16,286,594,000 | 20,213,612,000 | 0xFFFFFFFF | 0x667E0 | 0x677E0 | 0xAB60 | | MSI2D9_m |
| MSI2D5_mp_LU2D5 | 3,042 | 3,046 | 0.999 | 5.15% | 4.25% | 8,109,972,000 | 8,120,636,000 | 0xFFFFFFFF | 0x488F0 | 0x498F0 | 0x4BF0 | | MSI2D5_m |
| COEFFICIENTS_mp_GET_T_COEFFICIENTS_AND_SOURCE | 2,830 | 2,752 | 1.028 | 4.79% | 3.84% | 7,544,780,000 | 7,336,832,000 | 0xFFFFFFFF | 0xB8C30 | 0xB9C30 | 0xCBA0 | | COEFFICIE |
| COEFFICIENTS_mp_GET_INTERNAL_SIMPLEC_COEFFICIENTS | 2,334 | 2,139 | 1.091 | 3.95% | 2.98% | 6,222,444,000 | 5,702,574,000 | 0xFFFFFFFF | 0xED0C0 | 0xEE0C0 | 0x3D80 | | COEFFICIE |
| SOLVERS_mp_NORM_L1_9D | 1,864 | 2,813 | 0.663 | 3.16% | 3.92% | 4,969,424,000 | 7,499,458,000 | 0xFFFFFFFF | 0xF49D0 | 0xF59D0 | 0xD50 | | SOLVERS_ |
| COEFFICIENTS_mp_GET_U_V_AT_REAL_NODES_WITH_PL | 1,685 | 1,369 | 1.231 | 2.85% | 1.91% | 4,492,210,000 | 3,649,754,000 | 0xFFFFFFFF | 0xF1190 | 0xF2190 | 0x1C00 | | COEFFICIE |
| COEFFICIENTS_mp_GET_U_SOURCE | 1,584 | 1,587 | 0.998 | 2.68% | 2.21% | 4,222,944,000 | 4,230,942,000 | 0xFFFFFFFF | 0x87FC0 | 0x88FC0 | 0x97B0 | | COEFFICIE |
| COEFFICIENTS_mp_GET_V_SOURCE | 1,526 | 1,658 | 0.920 | 2.58% | 2.31% | 4,068,316,000 | 4,420,228,000 | 0xFFFFFFFF | 0xA8AD0 | 0xA9AD0 | 0x8060 | | COEFFICIE |
| COEFFICIENTS_mp_GET_P_SOURCE | 1,441 | 2,350 | 0.613 | 2.44% | 3.28% | 3,841,706,000 | 6,265,100,000 | 0xFFFFFFFF | 0xD7200 | 0xD8200 | 0x2800 | | COEFFICIE |
| COEFFICIENTS_mp_GET_P_COEFFICIENTS | 1,242 | 2,047 | 0.607 | 2.10% | 2.85% | 3,311,172,000 | 5,457,302,000 | 0xFFFFFFFF | 0xD2900 | 0xD3900 | 0x2380 | | COEFFICIE |
| _intel_new_memset | 1,159 | 225 | 5.151 | 1.96% | 0.31% | 3,089,894,000 | 599,850,000 | 0xFFFFFFFF | 0x21CF00 | 0x21DF00 | 0x1560 | | _intel_new_ |
| COEFFICIENTS_mp_GET_U_COEFFICIENTS | 1,024 | 1,135 | 0.902 | 1.73% | 1.58% | 2,729,984,000 | 3,025,910,000 | 0xFFFFFFFF | 0x7A840 | 0x7B840 | 0x6B00 | | COEFFICIE |
| COEFFICIENTS_mp_GET_V_COEFFICIENTS | 908 | 1,133 | 0.801 | 1.54% | 1.58% | 2,420,728,000 | 3,020,578,000 | 0xFFFFFFFF | 0x9AFB0 | 0x9BFB0 | 0x6CD0 | | COEFFICIE |
| COEFFICIENTS_mp_GET_VELOCITIES_AT_INTERNAL_FACES_WITH_PL | 781 | 761 | 1.026 | 1.32% | 1.06% | 2,082,146,000 | 2,028,826,000 | 0xFFFFFFFF | 0xF2D90 | 0xF3D90 | 0x1450 | | COEFFICIE |
| _intel_new_memcpy | 771 | 118 | 6.534 | 1.31% | 0.16% | 2,055,486,000 | 314,588,000 | 0xFFFFFFFF | 0x21E460 | 0x21F460 | 0x23D0 | | _intel_new_ |
| memset | 642 | 300 | 2.140 | 1.09% | 0.42% | 1,711,572,000 | 799,800,000 | 0xFFFFFFFF | 0x1C7D10 | 0x1C8D10 | 0xF0 | | memset |
| COEFFICIENTS_mp_GET_DENSITY_AT_FACES | 575 | 1,105 | 0.520 | 0.97% | 1.54% | 1,532,950,000 | 2,945,930,000 | 0xFFFFFFFF | 0x79E90 | 0x7AE90 | 0x9B0 | | COEFFICIE |
| USER_mp_GET_LAMINAR_VISCOSITY_AT_FACES | 446 | 458 | 0.974 | 0.75% | 0.64% | 1,189,036,000 | 1,221,028,000 | 0xFFFFFFFF | 0xF5B20 | 0xF6B20 | 0x720 | | USER_mp_ |
| USER_mp_GET_THERMAL_CONDUCTIVITY_AT_FACES | 418 | 463 | 0.903 | 0.71% | 0.65% | 1,114,388,000 | 1,234,358,000 | 0xFFFFFFFF | 0xF6240 | 0xF7240 | 0x720 | | USER_mp_ |
| SOLVERS_mp_NORM_L1_5D | 312 | 497 | 0.628 | 0.53% | 0.69% | 831,792,000 | 1,325,002,000 | 0xFFFFFFFF | 0xF41F0 | 0xF51F0 | 0x7E0 | | SOLVERS_ |
| MAIN_ip_GET_NUMERICAL_SOLUTION | 129 | 22 | 5.864 | 0.22% | 0.03% | 343,914,000 | 58,652,000 | 0xFFFFFFFF | 0x123320 | 0x124320 | 0x5455 | | MAIN_ip_G |
| COEFFICIENTS_mp_GET_DENSITY_AT_NODES | 105 | 26 | 4.038 | 0.18% | 0.04% | 279,930,000 | 69,316,000 | 0xFFFFFFFF | 0x79C60 | 0x7AC60 | 0x230 | | COEFFICIE |
| COEFFICIENTS_mp_GET_PRESSURE_DENSITY_CORRECTION_WITH_PL | 103 | 45 | 2.289 | 0.17% | 0.06% | 274,598,000 | 119,970,000 | 0xFFFFFFFF | 0xF0E40 | 0xF1E40 | 0x350 | | COEFFICIE |
| cvtas_t_to_a | 95 | 197 | 0.482 | 0.16% | 0.27% | 253,270,000 | 525,202,000 | 0xFFFFFFFF | 0x19A460 | 0x19B460 | 0x4320 | | cvtas_t_to_ |
| USER_mp_GET_A9D_B_RESCALING | 76 | 65 | 1.169 | 0.13% | 0.09% | 202,616,000 | 173,290,000 | 0xFFFFFFFF | 0x110B40 | 0x111B40 | 0x5830 | | USER_mp_ |
| USER_mp_SET_CP_AND_GAMMA | 70 | 6 | 11.667 | 0.12% | 0.01% | 186,620,000 | 15,996,000 | 0xFFFFFFFF | 0xF57F0 | 0xF67F0 | 0x1B0 | | USER_mp_ |
| USER_mp_SET_LAMINAR_VISCOSITY_AT_NODES | 50 | 11 | 4.545 | 0.08% | 0.02% | 133,300,000 | 29,326,000 | 0xFFFFFFFF | 0xF59A0 | 0xF69A0 | 0xC0 | | USER_mp_ |
| USER_mp_SET_THERMAL_CONDUCTIVITY_AT_NODES | 42 | 9 | 4.667 | 0.07% | 0.01% | 111,972,000 | 23,994,000 | 0xFFFFFFFF | 0xF5A60 | 0xF6A60 | 0xC0 | | USER_mp_ |
| USER_mp_SET_BCP | 38 | 19 | 2.000 | 0.06% | 0.03% | 101,308,000 | 50,654,000 | 0xFFFFFFFF | 0x101F40 | 0x102F40 | 0x2D20 | | USER_mp_ |
| USER_mp_SET_BCV | 33 | 7 | 4.714 | 0.06% | 0.01% | 87,978,000 | 18,662,000 | 0xFFFFFFFF | 0xFA570 | 0xFB570 | 0x3C00 | | USER_mp_ |
| cvt_ieee_t_to_text_ex | 33 | 44 | 0.750 | 0.06% | 0.06% | 87,978,000 | 117,304,000 | 0xFFFFFFFF | 0x182A40 | 0x183A40 | 0x13E0 | | cvt_ieee_t_ |
| USER_mp_GET_A5D_B_RESCALING | 27 | 32 | 0.844 | 0.05% | 0.04% | 71,982,000 | 85,312,000 | 0xFFFFFFFF | 0x10C7D0 | 0x10D7D0 | 0x4370 | | USER_mp_ |
| for_write_seq_fmt_xmit | 26 | 39 | 0.667 | 0.04% | 0.05% | 69,316,000 | 103,974,000 | 0xFFFFFFFF | 0x145D10 | 0x146D10 | 0x24B0 | | for_write_s |
| USER_mp_SET_BCT | 24 | 10 | 2.400 | 0.04% | 0.01% | 63,984,000 | 26,660,000 | 0xFFFFFFFF | 0xFE170 | 0xFF170 | 0x3DD0 | | USER_mp_ |

**Figura 3 Versão modificada**

```
*** Efficiency: numerical solution 2D / analytic Q1D (dimensionless) ***

    1.000836328728611E+00 = discharge coefficient
    9.691914048072193E-01 = dynamic thrust
    9.752768908404300E-01 = pressure thrust at sea level (p = 101325 Pa)
    1.080533092655724E+00 = pressure thrust in the vacuum
    9.677277608885942E-01 = total thrust at sea level
    9.754462366605249E-01 = total thrust in the vacuum
    9.677277608885942E-01 = thrust coefficient at sea level
    9.754462366605249E-01 = thrust coefficient in the vacuum
    9.991643701326538E-01 = characterist velocity
    9.669190986681359E-01 = velocity of efective ejection at sea level
    9.746311246511808E-01 = velocity of efective ejection in the vacuum
    9.669190986681359E-01 = specific impulse at sea level
    9.746311246511810E-01 = specific impulse at vacuum


         0.000 = tcpuo: acumulated CPU time (s) (before interuption)
        61.391 = dtcpu: CPU time (s) (after interuption)
        61.391 = tcpu:  total CPU time (s)
```

**4)SUBROTINA:** COEFFICIENTS_mp_GET_T_COEFFICIENTS_AND_SOURCE: `SEN03_0004`

Utilizando-se uma variável auxiliar chamada inv_dt, que é a inversa de dt. Utilizou-se assim, a multiplicação por ‘inv_dt’ ao invés de divisão (que consome mais tempo computacional).

Houve uma redução de **7,544,780,000** ciclos de clock para **6,963,592,000**. A rotina que utilizava **4,79%** do tempo total, agora utiliza **4,43%.**

| Name | CPU_ sampl | INST_R samples | Clocks per... | CPU_CL % | INST_R % | CPU_CLK_UNH events | INST_RETIRED events | Segment | Offset | RVA | Size | Class | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| COEFFICIENTS_mp_GET_VELOCITIES_AT_FACES | 9,857 | 8,715 | 1.131 | 16.68% | 12.15% | 26,278,762,000 | 23,234,190,000 | 0xFFFFFFFF | 0xDC290 | 0xDD290 | 0x84F0 | | COEFFICIE |
| MSI2D9_mp_FB2D9 | 9,123 | 14,381 | 0.634 | 15.44% | 20.05% | 24,321,918,000 | 38,339,746,000 | 0xFFFFFFFF | 0x59F80 | 0x5AF80 | 0xC860 | | MSI2D9_m |
| MSI2D5_mp_FB2D5 | 8,334 | 14,412 | 0.578 | 14.11% | 20.10% | 22,218,444,000 | 38,422,392,000 | 0xFFFFFFFF | 0x3F7C0 | 0x407C0 | 0x9130 | | MSI2D5_m |
| MSI2D9_mp_LU2D9 | 6,109 | 7,582 | 0.806 | 10.34% | 10.57% | 16,286,594,000 | 20,213,612,000 | 0xFFFFFFFF | 0x667E0 | 0x677E0 | 0xAB60 | | MSI2D9_m |
| MSI2D5_mp_LU2D5 | 3,042 | 3,046 | 0.999 | 5.15% | 4.25% | 8,109,972,000 | 8,120,636,000 | 0xFFFFFFFF | 0x488F0 | 0x498F0 | 0x4BF0 | | MSI2D5_m |
| COEFFICIENTS_mp_GET_T_COEFFICIENTS_AND_SOURCE | 2,830 | 2,752 | 1.028 | 4.79% | 3.84% | 7,544,780,000 | 7,336,832,000 | 0xFFFFFFFF | 0xB8C30 | 0xB9C30 | 0xCBA0 | | COEFFICIE |
| COEFFICIENTS_mp_GET_INTERNAL_SIMPLEC_COEFFICIENTS | 2,334 | 2,139 | 1.091 | 3.95% | 2.98% | 6,222,444,000 | 5,702,574,000 | 0xFFFFFFFF | 0xED0C0 | 0xEE0C0 | 0x3D80 | | COEFFICIE |
| SOLVERS_mp_NORM_L1_9D | 1,864 | 2,813 | 0.663 | 3.16% | 3.92% | 4,969,424,000 | 7,499,458,000 | 0xFFFFFFFF | 0xF49D0 | 0xF59D0 | 0xD50 | | SOLVERS_ |
| COEFFICIENTS_mp_GET_U_V_AT_REAL_NODES_WITH_PL | 1,685 | 1,369 | 1.231 | 2.85% | 1.91% | 4,492,210,000 | 3,649,754,000 | 0xFFFFFFFF | 0xF1190 | 0xF2190 | 0x1C00 | | COEFFICIE |
| COEFFICIENTS_mp_GET_U_SOURCE | 1,584 | 1,587 | 0.998 | 2.68% | 2.21% | 4,222,944,000 | 4,230,942,000 | 0xFFFFFFFF | 0x87FC0 | 0x88FC0 | 0x97B0 | | COEFFICIE |
| COEFFICIENTS_mp_GET_V_SOURCE | 1,526 | 1,658 | 0.920 | 2.58% | 2.31% | 4,068,316,000 | 4,420,228,000 | 0xFFFFFFFF | 0xA8AD0 | 0xA9AD0 | 0x8060 | | COEFFICIE |
| COEFFICIENTS_mp_GET_P_SOURCE | 1,441 | 2,350 | 0.613 | 2.44% | 3.28% | 3,841,706,000 | 6,265,100,000 | 0xFFFFFFFF | 0xD7200 | 0xD8200 | 0x2800 | | COEFFICIE |
| COEFFICIENTS_mp_GET_P_COEFFICIENTS | 1,242 | 2,047 | 0.607 | 2.10% | 2.85% | 3,311,172,000 | 5,457,302,000 | 0xFFFFFFFF | 0xD2900 | 0xD3900 | 0x2380 | | COEFFICIE |
| _intel_new_memset | 1,159 | 225 | 5.151 | 1.96% | 0.31% | 3,089,894,000 | 599,850,000 | 0xFFFFFFFF | 0x21CF00 | 0x21DF00 | 0x1560 | | _intel_new_ |
| COEFFICIENTS_mp_GET_U_COEFFICIENTS | 1,024 | 1,135 | 0.902 | 1.73% | 1.58% | 2,729,984,000 | 3,025,910,000 | 0xFFFFFFFF | 0x7A840 | 0x7B840 | 0x6B00 | | COEFFICIE |
| COEFFICIENTS_mp_GET_V_COEFFICIENTS | 908 | 1,133 | 0.801 | 1.54% | 1.58% | 2,420,728,000 | 3,020,578,000 | 0xFFFFFFFF | 0x9AFB0 | 0x9BFB0 | 0x6CD0 | | COEFFICIE |
| COEFFICIENTS_mp_GET_VELOCITIES_AT_INTERNAL_FACES_WITH_PL | 781 | 761 | 1.026 | 1.32% | 1.06% | 2,082,146,000 | 2,028,826,000 | 0xFFFFFFFF | 0xF2D90 | 0xF3D90 | 0x1450 | | COEFFICIE |
| _intel_new_memcpy | 771 | 118 | 6.534 | 1.31% | 0.16% | 2,055,486,000 | 314,588,000 | 0xFFFFFFFF | 0x21E460 | 0x21F460 | 0x23D0 | | _intel_new_ |
| memset | 642 | 300 | 2.140 | 1.09% | 0.42% | 1,711,572,000 | 799,800,000 | 0xFFFFFFFF | 0x1C7D10 | 0x1C8D10 | 0xF0 | | memset |
| COEFFICIENTS_mp_GET_DENSITY_AT_FACES | 575 | 1,105 | 0.520 | 0.97% | 1.54% | 1,532,950,000 | 2,945,930,000 | 0xFFFFFFFF | 0x79E90 | 0x7AE90 | 0x9B0 | | COEFFICIE |
| USER_mp_GET_LAMINAR_VISCOSITY_AT_FACES | 446 | 458 | 0.974 | 0.75% | 0.64% | 1,189,036,000 | 1,221,028,000 | 0xFFFFFFFF | 0xF5B20 | 0xF6B20 | 0x720 | | USER_mp_ |
| USER_mp_GET_THERMAL_CONDUCTIVITY_AT_FACES | 418 | 463 | 0.903 | 0.71% | 0.65% | 1,114,388,000 | 1,234,358,000 | 0xFFFFFFFF | 0xF6240 | 0xF7240 | 0x720 | | USER_mp_ |
| SOLVERS_mp_NORM_L1_5D | 312 | 497 | 0.628 | 0.53% | 0.69% | 831,792,000 | 1,325,002,000 | 0xFFFFFFFF | 0xF41F0 | 0xF51F0 | 0x7E0 | | SOLVERS_ |
| MAIN_ip_GET_NUMERICAL_SOLUTION | 129 | 22 | 5.864 | 0.22% | 0.03% | 343,914,000 | 58,652,000 | 0xFFFFFFFF | 0x123320 | 0x124320 | 0x5455 | | MAIN_ip_G |
| COEFFICIENTS_mp_GET_DENSITY_AT_NODES | 105 | 26 | 4.038 | 0.18% | 0.04% | 279,930,000 | 69,316,000 | 0xFFFFFFFF | 0x79C60 | 0x7AC60 | 0x230 | | COEFFICIE |
| COEFFICIENTS_mp_GET_PRESSURE_DENSITY_CORRECTION_WITH_PL | 103 | 45 | 2.289 | 0.17% | 0.06% | 274,598,000 | 119,970,000 | 0xFFFFFFFF | 0xF0E40 | 0xF1E40 | 0x350 | | COEFFICIE |
| cvtas_t_to_a | 95 | 197 | 0.482 | 0.16% | 0.27% | 253,270,000 | 525,202,000 | 0xFFFFFFFF | 0x19A460 | 0x19B460 | 0x4320 | | cvtas_t_to_ |
| USER_mp_GET_A9D_B_RESCALING | 76 | 65 | 1.169 | 0.13% | 0.09% | 202,616,000 | 173,290,000 | 0xFFFFFFFF | 0x110B40 | 0x111B40 | 0x5830 | | USER_mp_ |
| USER_mp_SET_CP_AND_GAMMA | 70 | 6 | 11.667 | 0.12% | 0.01% | 186,620,000 | 15,996,000 | 0xFFFFFFFF | 0xF57F0 | 0xF67F0 | 0x1B0 | | USER_mp_ |
| USER_mp_SET_LAMINAR_VISCOSITY_AT_NODES | 50 | 11 | 4.545 | 0.08% | 0.02% | 133,300,000 | 29,326,000 | 0xFFFFFFFF | 0xF59A0 | 0xF69A0 | 0xC0 | | USER_mp_ |
| USER_mp_SET_THERMAL_CONDUCTIVITY_AT_NODES | 42 | 9 | 4.667 | 0.07% | 0.01% | 111,972,000 | 23,994,000 | 0xFFFFFFFF | 0xF5A60 | 0xF6A60 | 0xC0 | | USER_mp_ |
| USER_mp_SET_BCP | 38 | 19 | 2.000 | 0.06% | 0.03% | 101,308,000 | 50,654,000 | 0xFFFFFFFF | 0x101F40 | 0x102F40 | 0x2D20 | | USER_mp_ |
| USER_mp_SET_BCV | 33 | 7 | 4.714 | 0.06% | 0.01% | 87,978,000 | 18,662,000 | 0xFFFFFFFF | 0xFA570 | 0xFB570 | 0x3C00 | | USER_mp_ |
| cvt_ieee_t_to_text_ex | 33 | 44 | 0.750 | 0.06% | 0.06% | 87,978,000 | 117,304,000 | 0xFFFFFFFF | 0x182A40 | 0x183A40 | 0x13E0 | | cvt_ieee_t_ |
| USER_mp_GET_A5D_B_RESCALING | 27 | 32 | 0.844 | 0.05% | 0.04% | 71,982,000 | 85,312,000 | 0xFFFFFFFF | 0x10C7D0 | 0x10D7D0 | 0x4370 | | USER_mp_ |
| for_write_seq_fmt_xmit | 26 | 39 | 0.667 | 0.04% | 0.05% | 69,316,000 | 103,974,000 | 0xFFFFFFFF | 0x145D10 | 0x146D10 | 0x24B0 | | for_write_s |
| USER_mp_SET_BCT | 24 | 10 | 2.400 | 0.04% | 0.01% | 63,984,000 | 26,660,000 | 0xFFFFFFFF | 0xFE170 | 0xFF170 | 0x3DD0 | | USER_mp_ |

**Figura 4 Antes da Otimização**

| Name | CPU_ sampl | INST_R samples | Clocks per... | CPU_CL % | INST_R % | CPU_CLK_UNH events | INST_RETIRED events | Segment | Offset | RVA | Size | Class | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| COEFFICIENTS_mp_GET_VELOCITIES_AT_FACES | 9,868 | 8,688 | 1.136 | 16.73% | 12.12% | 26,308,088,000 | 23,162,208,000 | 0xFFFFFFFF | 0xDC290 | 0xDD290 | 0x84F0 | | COEFFICIE |
| MSI2D9_mp_FB2D9 | 9,156 | 14,395 | 0.636 | 15.52% | 20.07% | 24,409,896,000 | 38,377,070,000 | 0xFFFFFFFF | 0x59F80 | 0x5AF80 | 0xC860 | | MSI2D9_m |
| MSI2D5_mp_FB2D5 | 8,363 | 14,343 | 0.583 | 14.18% | 20.00% | 22,295,758,000 | 38,238,438,000 | 0xFFFFFFFF | 0x3F7C0 | 0x407C0 | 0x9130 | | MSI2D5_m |
| MSI2D9_mp_LU2D9 | 6,094 | 7,627 | 0.799 | 10.33% | 10.64% | 16,246,604,000 | 20,333,582,000 | 0xFFFFFFFF | 0x667E0 | 0x677E0 | 0xAB60 | | MSI2D9_m |
| MSI2D5_mp_LU2D5 | 3,023 | 3,068 | 0.985 | 5.13% | 4.28% | 8,059,318,000 | 8,179,288,000 | 0xFFFFFFFF | 0x488F0 | 0x498F0 | 0x4BF0 | | MSI2D5_m |
| COEFFICIENTS_mp_GET_T_COEFFICIENTS_AND_SOURCE | 2,612 | 2,690 | 0.971 | 4.43% | 3.75% | 6,963,592,000 | 7,171,540,000 | 0xFFFFFFFF | 0xB8C30 | 0xB9C30 | 0xCBA0 | | COEFFICIE |
| COEFFICIENTS_mp_GET_INTERNAL_SIMPLEC_COEFFICIENTS | 2,360 | 2,093 | 1.128 | 4.00% | 2.92% | 6,291,760,000 | 5,579,938,000 | 0xFFFFFFFF | 0xED0C0 | 0xEE0C0 | 0x3D80 | | COEFFICIE |
| SOLVERS_mp_NORM_L1_9D | 1,866 | 2,830 | 0.659 | 3.16% | 3.95% | 4,974,756,000 | 7,544,780,000 | 0xFFFFFFFF | 0xF49D0 | 0xF59D0 | 0xD50 | | SOLVERS_ |
| COEFFICIENTS_mp_GET_U_V_AT_REAL_NODES_WITH_PL | 1,697 | 1,341 | 1.265 | 2.88% | 1.87% | 4,524,202,000 | 3,575,106,000 | 0xFFFFFFFF | 0xF1190 | 0xF2190 | 0x1C00 | | COEFFICIE |
| COEFFICIENTS_mp_GET_U_SOURCE | 1,578 | 1,567 | 1.007 | 2.68% | 2.19% | 4,206,948,000 | 4,177,622,000 | 0xFFFFFFFF | 0x87FC0 | 0x88FC0 | 0x97B0 | | COEFFICIE |
| COEFFICIENTS_mp_GET_V_SOURCE | 1,545 | 1,689 | 0.915 | 2.62% | 2.36% | 4,118,970,000 | 4,502,874,000 | 0xFFFFFFFF | 0xA8AD0 | 0xA9AD0 | 0x8060 | | COEFFICIE |
| COEFFICIENTS_mp_GET_P_SOURCE | 1,419 | 2,384 | 0.595 | 2.41% | 3.32% | 3,783,054,000 | 6,355,744,000 | 0xFFFFFFFF | 0xD7200 | 0xD8200 | 0x2800 | | COEFFICIE |
| COEFFICIENTS_mp_GET_P_COEFFICIENTS | 1,244 | 2,047 | 0.608 | 2.11% | 2.85% | 3,316,504,000 | 5,457,302,000 | 0xFFFFFFFF | 0xD2900 | 0xD3900 | 0x2380 | | COEFFICIE |
| _intel_new_memset | 1,150 | 231 | 4.978 | 1.95% | 0.32% | 3,065,900,000 | 615,846,000 | 0xFFFFFFFF | 0x21CF00 | 0x21DF00 | 0x1560 | | _intel_new_ |
| COEFFICIENTS_mp_GET_U_COEFFICIENTS | 1,011 | 1,152 | 0.878 | 1.71% | 1.61% | 2,695,326,000 | 3,071,232,000 | 0xFFFFFFFF | 0x7A840 | 0x7B840 | 0x6B00 | | COEFFICIE |
| COEFFICIENTS_mp_GET_V_COEFFICIENTS | 898 | 1,120 | 0.802 | 1.52% | 1.56% | 2,394,068,000 | 2,985,920,000 | 0xFFFFFFFF | 0x9AFB0 | 0x9BFB0 | 0x6CD0 | | COEFFICIE |
| _intel_new_memcpy | 793 | 120 | 6.608 | 1.34% | 0.17% | 2,114,138,000 | 319,920,000 | 0xFFFFFFFF | 0x21E460 | 0x21F460 | 0x23D0 | | _intel_new_ |
| COEFFICIENTS_mp_GET_VELOCITIES_AT_INTERNAL_FACES_WITH_PL | 775 | 746 | 1.039 | 1.31% | 1.04% | 2,066,150,000 | 1,988,836,000 | 0xFFFFFFFF | 0xF2D90 | 0xF3D90 | 0x1450 | | COEFFICIE |
| memset | 706 | 294 | 2.401 | 1.20% | 0.41% | 1,882,196,000 | 783,804,000 | 0xFFFFFFFF | 0x1C7D10 | 0x1C8D10 | 0xF0 | | memset |
| COEFFICIENTS_mp_GET_DENSITY_AT_FACES | 562 | 1,138 | 0.494 | 0.95% | 1.59% | 1,498,292,000 | 3,033,908,000 | 0xFFFFFFFF | 0x79E90 | 0x7AE90 | 0x9B0 | | COEFFICIE |
| USER_mp_GET_THERMAL_CONDUCTIVITY_AT_FACES | 436 | 411 | 1.061 | 0.74% | 0.57% | 1,162,376,000 | 1,095,726,000 | 0xFFFFFFFF | 0xF6240 | 0xF7240 | 0x720 | | USER_mp_ |
| USER_mp_GET_LAMINAR_VISCOSITY_AT_FACES | 430 | 508 | 0.846 | 0.73% | 0.71% | 1,146,380,000 | 1,354,328,000 | 0xFFFFFFFF | 0xF5B20 | 0xF6B20 | 0x720 | | USER_mp_ |
| SOLVERS_mp_NORM_L1_5D | 329 | 541 | 0.608 | 0.56% | 0.75% | 877,114,000 | 1,442,306,000 | 0xFFFFFFFF | 0xF41F0 | 0xF51F0 | 0x7E0 | | SOLVERS_ |
| MAIN_ip_GET_NUMERICAL_SOLUTION | 127 | 18 | 7.056 | 0.22% | 0.03% | 338,582,000 | 47,988,000 | 0xFFFFFFFF | 0x123320 | 0x124320 | 0x5455 | | MAIN_ip_G |
| COEFFICIENTS_mp_GET_DENSITY_AT_NODES | 118 | 32 | 3.688 | 0.20% | 0.04% | 314,588,000 | 85,312,000 | 0xFFFFFFFF | 0x79C60 | 0x7AC60 | 0x230 | | COEFFICIE |
| cvtas_t_to_a | 88 | 219 | 0.402 | 0.15% | 0.31% | 234,608,000 | 583,854,000 | 0xFFFFFFFF | 0x19A460 | 0x19B460 | 0x4320 | | cvtas_t_to_ |
| COEFFICIENTS_mp_GET_PRESSURE_DENSITY_CORRECTION_WITH_PL | 87 | 33 | 2.636 | 0.15% | 0.05% | 231,942,000 | 87,978,000 | 0xFFFFFFFF | 0xF0E40 | 0xF1E40 | 0x350 | | COEFFICIE |
| USER_mp_SET_CP_AND_GAMMA | 82 | 16 | 5.125 | 0.14% | 0.02% | 218,612,000 | 42,656,000 | 0xFFFFFFFF | 0xF57F0 | 0xF67F0 | 0x1B0 | | USER_mp_ |
| USER_mp_GET_A9D_B_RESCALING | 72 | 66 | 1.091 | 0.12% | 0.09% | 191,952,000 | 175,956,000 | 0xFFFFFFFF | 0x110B40 | 0x111B40 | 0x5830 | | USER_mp_ |
| USER_mp_SET_THERMAL_CONDUCTIVITY_AT_NODES | 49 | 5 | 9.800 | 0.08% | 0.01% | 130,634,000 | 13,330,000 | 0xFFFFFFFF | 0xF5A60 | 0xF6A60 | 0xC0 | | USER_mp_ |
| USER_mp_SET_BCP | 45 | 25 | 1.800 | 0.08% | 0.03% | 119,970,000 | 66,650,000 | 0xFFFFFFFF | 0x101F40 | 0x102F40 | 0x2D20 | | USER_mp_ |
| USER_mp_SET_LAMINAR_VISCOSITY_AT_NODES | 39 | 6 | 6.500 | 0.07% | 0.01% | 103,974,000 | 15,996,000 | 0xFFFFFFFF | 0xF59A0 | 0xF69A0 | 0xC0 | | USER_mp_ |
| cvt_ieee_t_to_text_ex | 29 | 32 | 0.906 | 0.05% | 0.04% | 77,314,000 | 85,312,000 | 0xFFFFFFFF | 0x182A40 | 0x183A40 | 0x13E0 | | cvt_ieee_t_ |
| USER_mp_GET_A5D_B_RESCALING | 29 | 30 | 0.967 | 0.05% | 0.04% | 77,314,000 | 79,980,000 | 0xFFFFFFFF | 0x10C7D0 | 0x10D7D0 | 0x4370 | | USER_mp_ |
| USER_mp_SET_BCT | 29 | 10 | 2.900 | 0.05% | 0.01% | 77,314,000 | 26,660,000 | 0xFFFFFFFF | 0xFE170 | 0xFF170 | 0x3DD0 | | USER_mp_ |
| USER_mp_SET_BCU | 27 | 7 | 3.857 | 0.05% | 0.01% | 71,982,000 | 18,662,000 | 0xFFFFFFFF | 0xF6960 | 0xF7960 | 0x3C10 | | USER_mp_ |
| USER_mp_SET_BCV | 26 | 10 | 2.600 | 0.04% | 0.01% | 69,316,000 | 26,660,000 | 0xFFFFFFFF | 0xFA570 | 0xFB570 | 0x3C00 | | USER_mp_ |

**Figura 5 Depois da otimização**

```
*** Efficiency: numerical solution 2D / analytic Q1D (dimensionless) ***

    1.000836328728610E+00 = discharge coefficient
    9.691914048072187E-01 = dynamic thrust
    9.752768908404300E-01 = pressure thrust at sea level (p = 101325 Pa)
    1.080533092655724E+00 = pressure thrust in the vacuum
    9.677277608885935E-01 = total thrust at sea level
    9.754462366605242E-01 = total thrust in the vacuum
```

```
9.677277608885934E-01 = thrust coefficient at sea level
9.754462366605242E-01 = thrust coefficient in the vacuum
9.991643701326540E-01 = characterist velocity
9.669190986681352E-01 = velocity of efective ejection at sea level
9.746311246511806E-01 = velocity of efective ejection in the vacuum
9.669190986681352E-01 = specific impulse at sea level
9.746311246511807E-01 = specific impulse at vacuum


     0.000 = tcpuo: acumulated CPU time (s) (before interuption)
    61.297 = dtcpu: CPU time (s) (after interuption)
    61.297 = tcpu:  total CPU time (s)
```

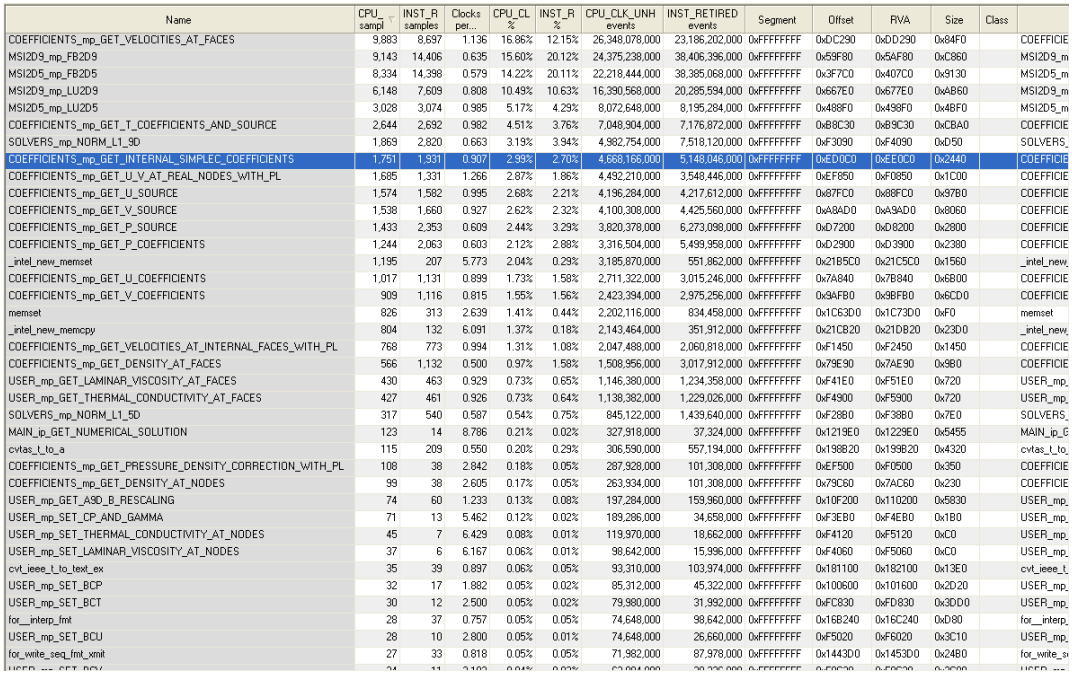
**5)SUBROTINA:** COEFFICIENTS_mp_GET_INTERNAL_SIMPLEC_COEFFICIENTS: `SEN03_0005`

Dividiu-se o cálculo em 2: um ciclo para encontrar a soma dos coeficientes au e av e outros dois ciclos para o cálculo. Foi criado 2 vetores, soma_au e soma_av, que são utilizados nos cálculos.

Houve uma redução de **6,291,760,000** ciclos de clock para **4,668,166,000.** A rotina que utilizava **4,00%** do tempo total, agora utiliza **2,99%.**

| Name | CPU_ sampl | INST_R samples | Clocks per... | CPU_CL % | INST_R % | CPU_CLK_UNH events | INST_RETIRED events | Segment | Offset | RVA | Size | Class | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| COEFFICIENTS_mp_GET_VELOCITIES_AT_FACES | 9,868 | 8,688 | 1.136 | 16.73% | 12.12% | 26,308,088,000 | 23,162,208,000 | 0xFFFFFFFF | 0xDC290 | 0xDD290 | 0x84F0 | | COEFFICIE |
| MSI2D9_mp_FB2D9 | 9,156 | 14,395 | 0.636 | 15.52% | 20.07% | 24,409,896,000 | 38,377,070,000 | 0xFFFFFFFF | 0x59F80 | 0x5AF80 | 0xC860 | | MSI2D9_m |
| MSI2D5_mp_FB2D5 | 8,363 | 14,343 | 0.583 | 14.18% | 20.00% | 22,295,758,000 | 38,238,438,000 | 0xFFFFFFFF | 0x3F7C0 | 0x407C0 | 0x9130 | | MSI2D5_m |
| MSI2D9_mp_LU2D9 | 6,094 | 7,627 | 0.799 | 10.33% | 10.64% | 16,246,604,000 | 20,333,582,000 | 0xFFFFFFFF | 0x667E0 | 0x677E0 | 0xAB60 | | MSI2D9_m |
| MSI2D5_mp_LU2D5 | 3,023 | 3,068 | 0.985 | 5.13% | 4.28% | 8,059,318,000 | 8,179,288,000 | 0xFFFFFFFF | 0x488F0 | 0x498F0 | 0x4BF0 | | MSI2D5_m |
| COEFFICIENTS_mp_GET_T_COEFFICIENTS_AND_SOURCE | 2,612 | 2,690 | 0.971 | 4.43% | 3.75% | 6,963,592,000 | 7,171,540,000 | 0xFFFFFFFF | 0xB8C30 | 0xB9C30 | 0xCBA0 | | COEFFICIE |
| COEFFICIENTS_mp_GET_INTERNAL_SIMPLEC_COEFFICIENTS | 2,360 | 2,093 | 1.128 | 4.00% | 2.92% | 6,291,760,000 | 5,579,938,000 | 0xFFFFFFFF | 0xED0C0 | 0xEE0C0 | 0x3D80 | | COEFFICIE |
| SOLVERS_mp_NORM_L1_9D | 1,866 | 2,830 | 0.659 | 3.16% | 3.95% | 4,974,756,000 | 7,544,780,000 | 0xFFFFFFFF | 0xF49D0 | 0xF59D0 | 0xD50 | | SOLVERS_ |
| COEFFICIENTS_mp_GET_U_V_AT_REAL_NODES_WITH_PL | 1,697 | 1,341 | 1.265 | 2.88% | 1.87% | 4,524,202,000 | 3,575,106,000 | 0xFFFFFFFF | 0xF1190 | 0xF2190 | 0x1C00 | | COEFFICIE |
| COEFFICIENTS_mp_GET_U_SOURCE | 1,578 | 1,567 | 1.007 | 2.68% | 2.19% | 4,206,948,000 | 4,177,622,000 | 0xFFFFFFFF | 0x87FC0 | 0x88FC0 | 0x97B0 | | COEFFICIE |
| COEFFICIENTS_mp_GET_V_SOURCE | 1,545 | 1,689 | 0.915 | 2.62% | 2.36% | 4,118,970,000 | 4,502,874,000 | 0xFFFFFFFF | 0xA8AD0 | 0xA9AD0 | 0x8060 | | COEFFICIE |
| COEFFICIENTS_mp_GET_P_SOURCE | 1,419 | 2,384 | 0.595 | 2.41% | 3.32% | 3,783,054,000 | 6,355,744,000 | 0xFFFFFFFF | 0xD7200 | 0xD8200 | 0x2800 | | COEFFICIE |
| COEFFICIENTS_mp_GET_P_COEFFICIENTS | 1,244 | 2,047 | 0.608 | 2.11% | 2.85% | 3,316,504,000 | 5,457,302,000 | 0xFFFFFFFF | 0xD2900 | 0xD3900 | 0x2380 | | COEFFICIE |
| _intel_new_memset | 1,150 | 231 | 4.978 | 1.95% | 0.32% | 3,065,900,000 | 615,846,000 | 0xFFFFFFFF | 0x21CF00 | 0x21DF00 | 0x1560 | | _intel_new_ |
| COEFFICIENTS_mp_GET_U_COEFFICIENTS | 1,011 | 1,152 | 0.878 | 1.71% | 1.61% | 2,695,326,000 | 3,071,232,000 | 0xFFFFFFFF | 0x7A840 | 0x7B840 | 0x6B00 | | COEFFICIE |
| COEFFICIENTS_mp_GET_V_COEFFICIENTS | 898 | 1,120 | 0.802 | 1.52% | 1.56% | 2,394,068,000 | 2,985,920,000 | 0xFFFFFFFF | 0x9AFB0 | 0x9BFB0 | 0x6CD0 | | COEFFICIE |
| _intel_new_memcpy | 793 | 120 | 6.608 | 1.34% | 0.17% | 2,114,138,000 | 319,920,000 | 0xFFFFFFFF | 0x21E460 | 0x21F460 | 0x23D0 | | _intel_new_ |
| COEFFICIENTS_mp_GET_VELOCITIES_AT_INTERNAL_FACES_WITH_PL | 775 | 746 | 1.039 | 1.31% | 1.04% | 2,066,150,000 | 1,988,836,000 | 0xFFFFFFFF | 0xF2D90 | 0xF3D90 | 0x1450 | | COEFFICIE |
| memset | 706 | 294 | 2.401 | 1.20% | 0.41% | 1,882,196,000 | 783,804,000 | 0xFFFFFFFF | 0x1C7D10 | 0x1C8D10 | 0xF0 | | memset |
| COEFFICIENTS_mp_GET_DENSITY_AT_FACES | 562 | 1,138 | 0.494 | 0.95% | 1.59% | 1,498,292,000 | 3,033,908,000 | 0xFFFFFFFF | 0x79E90 | 0x7AE90 | 0x9B0 | | COEFFICIE |
| USER_mp_GET_THERMAL_CONDUCTIVITY_AT_FACES | 436 | 411 | 1.061 | 0.74% | 0.57% | 1,162,376,000 | 1,095,726,000 | 0xFFFFFFFF | 0xF6240 | 0xF7240 | 0x720 | | USER_mp_ |
| USER_mp_GET_LAMINAR_VISCOSITY_AT_FACES | 430 | 508 | 0.846 | 0.73% | 0.71% | 1,146,380,000 | 1,354,328,000 | 0xFFFFFFFF | 0xF5B20 | 0xF6B20 | 0x720 | | USER_mp_ |
| SOLVERS_mp_NORM_L1_5D | 329 | 541 | 0.608 | 0.56% | 0.75% | 877,114,000 | 1,442,306,000 | 0xFFFFFFFF | 0xF41F0 | 0xF51F0 | 0x7E0 | | SOLVERS_ |
| MAIN_ip_GET_NUMERICAL_SOLUTION | 127 | 18 | 7.056 | 0.22% | 0.03% | 338,582,000 | 47,988,000 | 0xFFFFFFFF | 0x123320 | 0x124320 | 0x5455 | | MAIN_ip_G |
| COEFFICIENTS_mp_GET_DENSITY_AT_NODES | 118 | 32 | 3.688 | 0.20% | 0.04% | 314,588,000 | 85,312,000 | 0xFFFFFFFF | 0x79C60 | 0x7AC60 | 0x230 | | COEFFICIE |
| cvtas_t_to_a | 88 | 219 | 0.402 | 0.15% | 0.31% | 234,608,000 | 583,854,000 | 0xFFFFFFFF | 0x19A460 | 0x19B460 | 0x4320 | | cvtas_t_to_ |
| COEFFICIENTS_mp_GET_PRESSURE_DENSITY_CORRECTION_WITH_PL | 87 | 33 | 2.636 | 0.15% | 0.05% | 231,942,000 | 87,978,000 | 0xFFFFFFFF | 0xF0E40 | 0xF1E40 | 0x350 | | COEFFICIE |
| USER_mp_SET_CP_AND_GAMMA | 82 | 16 | 5.125 | 0.14% | 0.02% | 218,612,000 | 42,656,000 | 0xFFFFFFFF | 0xF57F0 | 0xF67F0 | 0x1B0 | | USER_mp_ |
| USER_mp_GET_A9D_B_RESCALING | 72 | 66 | 1.091 | 0.12% | 0.09% | 191,952,000 | 175,956,000 | 0xFFFFFFFF | 0x110B40 | 0x111B40 | 0x5830 | | USER_mp_ |
| USER_mp_SET_THERMAL_CONDUCTIVITY_AT_NODES | 49 | 5 | 9.800 | 0.08% | 0.01% | 130,634,000 | 13,330,000 | 0xFFFFFFFF | 0xF5A60 | 0xF6A60 | 0xC0 | | USER_mp_ |
| USER_mp_SET_BCP | 45 | 25 | 1.800 | 0.08% | 0.03% | 119,970,000 | 66,650,000 | 0xFFFFFFFF | 0x101F40 | 0x102F40 | 0x2D20 | | USER_mp_ |
| USER_mp_SET_LAMINAR_VISCOSITY_AT_NODES | 39 | 6 | 6.500 | 0.07% | 0.01% | 103,974,000 | 15,996,000 | 0xFFFFFFFF | 0xF59A0 | 0xF69A0 | 0xC0 | | USER_mp_ |
| cvt_ieee_t_to_text_ex | 29 | 32 | 0.906 | 0.05% | 0.04% | 77,314,000 | 85,312,000 | 0xFFFFFFFF | 0x182A40 | 0x183A40 | 0x13E0 | | cvt_ieee_t_ |
| USER_mp_GET_A5D_B_RESCALING | 29 | 30 | 0.967 | 0.05% | 0.04% | 77,314,000 | 79,980,000 | 0xFFFFFFFF | 0x10C7D0 | 0x10D7D0 | 0x4370 | | USER_mp_ |
| USER_mp_SET_BCT | 29 | 10 | 2.900 | 0.05% | 0.01% | 77,314,000 | 26,660,000 | 0xFFFFFFFF | 0xFE170 | 0xFF170 | 0x3DD0 | | USER_mp_ |
| USER_mp_SET_BCU | 27 | 7 | 3.857 | 0.05% | 0.01% | 71,982,000 | 18,662,000 | 0xFFFFFFFF | 0xF6960 | 0xF7960 | 0x3C10 | | USER_mp_ |
| USER_mp_SET_BCV | 26 | 10 | 2.600 | 0.04% | 0.01% | 69,316,000 | 26,660,000 | 0xFFFFFFFF | 0xFA570 | 0xFB570 | 0x3C00 | | USER_mp_ |

**Figura 6 Antes da Otimização**



| Name | CPU_ sampl | INST_R samples | Clocks per... | CPU_CL % | INST_R % | CPU_CLK_UNH events | INST_RETIRED events | Segment | Offset | RVA | Size | Class | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| COEFFICIENTS_mp_GET_VELOCITIES_AT_FACES | 9,883 | 8,697 | 1.136 | 16.86% | 12.15% | 26,348,078,000 | 23,186,202,000 | 0xFFFFFFFF | 0xDC290 | 0xDD290 | 0x84F0 | | COEFFICIE |
| MSI2D9_mp_FB2D9 | 9,143 | 14,406 | 0.635 | 15.60% | 20.12% | 24,375,238,000 | 38,406,396,000 | 0xFFFFFFFF | 0x59F80 | 0x5AF80 | 0xC860 | | MSI2D9_m |
| MSI2D5_mp_FB2D5 | 8,334 | 14,398 | 0.579 | 14.22% | 20.11% | 22,218,444,000 | 38,385,068,000 | 0xFFFFFFFF | 0x3F7C0 | 0x407C0 | 0x9130 | | MSI2D5_m |
| MSI2D9_mp_LU2D9 | 6,148 | 7,609 | 0.808 | 10.49% | 10.63% | 16,390,568,000 | 20,285,594,000 | 0xFFFFFFFF | 0x667E0 | 0x677E0 | 0xAB60 | | MSI2D9_m |
| MSI2D5_mp_LU2D5 | 3,028 | 3,074 | 0.985 | 5.17% | 4.29% | 8,072,648,000 | 8,195,284,000 | 0xFFFFFFFF | 0x488F0 | 0x498F0 | 0x4BF0 | | MSI2D5_m |
| COEFFICIENTS_mp_GET_T_COEFFICIENTS_AND_SOURCE | 2,644 | 2,692 | 0.982 | 4.51% | 3.76% | 7,048,904,000 | 7,176,872,000 | 0xFFFFFFFF | 0xB8C30 | 0xB9C30 | 0xCBA0 | | COEFFICIE |
| SOLVERS_mp_NORM_L1_9D | 1,869 | 2,820 | 0.663 | 3.19% | 3.94% | 4,982,754,000 | 7,518,120,000 | 0xFFFFFFFF | 0xF3090 | 0xF4090 | 0xD50 | | SOLVERS_ |
| COEFFICIENTS_mp_GET_INTERNAL_SIMPLEC_COEFFICIENTS | 1,751 | 1,931 | 0.907 | 2.93% | 2.70% | 4,668,166,000 | 5,148,046,000 | 0xFFFFFFFF | 0xED0C0 | 0xEE0C0 | 0x2440 | | COEFFICIE |
| COEFFICIENTS_mp_GET_U_V_AT_REAL_NODES_WITH_PL | 1,685 | 1,331 | 1.266 | 2.87% | 1.86% | 4,492,210,000 | 3,548,446,000 | 0xFFFFFFFF | 0xEF850 | 0xF0850 | 0x1C00 | | COEFFICIE |
| COEFFICIENTS_mp_GET_U_SOURCE | 1,574 | 1,582 | 0.995 | 2.68% | 2.21% | 4,196,284,000 | 4,217,612,000 | 0xFFFFFFFF | 0x87FC0 | 0x88FC0 | 0x97B0 | | COEFFICIE |
| COEFFICIENTS_mp_GET_V_SOURCE | 1,538 | 1,660 | 0.927 | 2.62% | 2.32% | 4,100,308,000 | 4,425,560,000 | 0xFFFFFFFF | 0xA8AD0 | 0xA9AD0 | 0x8060 | | COEFFICIE |
| COEFFICIENTS_mp_GET_P_SOURCE | 1,433 | 2,353 | 0.609 | 2.44% | 3.29% | 3,820,378,000 | 6,273,098,000 | 0xFFFFFFFF | 0xD7200 | 0xD8200 | 0x2800 | | COEFFICIE |
| COEFFICIENTS_mp_GET_P_COEFFICIENTS | 1,244 | 2,063 | 0.603 | 2.12% | 2.88% | 3,316,504,000 | 5,499,958,000 | 0xFFFFFFFF | 0xD2900 | 0xD3900 | 0x2380 | | COEFFICIE |
| _intel_new_memset | 1,195 | 207 | 5.773 | 2.04% | 0.29% | 3,185,870,000 | 551,862,000 | 0xFFFFFFFF | 0x21B5C0 | 0x21C5C0 | 0x1560 | | _intel_new_ |
| COEFFICIENTS_mp_GET_U_COEFFICIENTS | 1,017 | 1,131 | 0.899 | 1.73% | 1.58% | 2,711,322,000 | 3,015,246,000 | 0xFFFFFFFF | 0x7A840 | 0x7B840 | 0x6B00 | | COEFFICIE |
| COEFFICIENTS_mp_GET_V_COEFFICIENTS | 909 | 1,116 | 0.815 | 1.55% | 1.56% | 2,423,394,000 | 2,975,256,000 | 0xFFFFFFFF | 0x9AFB0 | 0x9BFB0 | 0x6CD0 | | COEFFICIE |
| memset | 826 | 313 | 2.639 | 1.41% | 0.44% | 2,202,116,000 | 834,458,000 | 0xFFFFFFFF | 0x1C63D0 | 0x1C73D0 | 0xF0 | | memset |
| _intel_new_memcpy | 804 | 132 | 6.091 | 1.37% | 0.18% | 2,143,464,000 | 351,912,000 | 0xFFFFFFFF | 0x21CB20 | 0x21DB20 | 0x23D0 | | _intel_new_ |
| COEFFICIENTS_mp_GET_VELOCITIES_AT_INTERNAL_FACES_WITH_PL | 768 | 773 | 0.994 | 1.31% | 1.08% | 2,047,488,000 | 2,060,818,000 | 0xFFFFFFFF | 0xF1450 | 0xF2450 | 0x1450 | | COEFFICIE |
| COEFFICIENTS_mp_GET_DENSITY_AT_FACES | 566 | 1,132 | 0.500 | 0.97% | 1.58% | 1,508,956,000 | 3,017,912,000 | 0xFFFFFFFF | 0x79E90 | 0x7AE90 | 0x9B0 | | COEFFICIE |
| USER_mp_GET_LAMINAR_VISCOSITY_AT_FACES | 430 | 463 | 0.929 | 0.73% | 0.65% | 1,146,380,000 | 1,234,358,000 | 0xFFFFFFFF | 0xF41E0 | 0xF51E0 | 0x720 | | USER_mp_ |
| USER_mp_GET_THERMAL_CONDUCTIVITY_AT_FACES | 427 | 461 | 0.926 | 0.73% | 0.64% | 1,138,382,000 | 1,229,026,000 | 0xFFFFFFFF | 0xF4900 | 0xF5900 | 0x720 | | USER_mp_ |
| SOLVERS_mp_NORM_L1_5D | 317 | 540 | 0.587 | 0.54% | 0.75% | 845,122,000 | 1,439,640,000 | 0xFFFFFFFF | 0xF28B0 | 0xF38B0 | 0x7E0 | | SOLVERS_ |
| MAIN_ip_GET_NUMERICAL_SOLUTION | 123 | 14 | 8.786 | 0.21% | 0.02% | 327,918,000 | 37,324,000 | 0xFFFFFFFF | 0x1219E0 | 0x1229E0 | 0x5455 | | MAIN_ip_G |
| cvtas_t_to_a | 115 | 209 | 0.550 | 0.20% | 0.29% | 306,590,000 | 557,194,000 | 0xFFFFFFFF | 0x198B20 | 0x199B20 | 0x4320 | | cvtas_t_to_ |
| COEFFICIENTS_mp_GET_PRESSURE_DENSITY_CORRECTION_WITH_PL | 108 | 38 | 2.842 | 0.18% | 0.05% | 287,928,000 | 101,308,000 | 0xFFFFFFFF | 0xEF500 | 0xF0500 | 0x350 | | COEFFICIE |
| COEFFICIENTS_mp_GET_DENSITY_AT_NODES | 99 | 38 | 2.605 | 0.17% | 0.05% | 263,934,000 | 101,308,000 | 0xFFFFFFFF | 0x79C60 | 0x7AC60 | 0x230 | | COEFFICIE |
| USER_mp_GET_A9D_B_RESCALING | 74 | 60 | 1.233 | 0.13% | 0.08% | 197,284,000 | 159,960,000 | 0xFFFFFFFF | 0x10F200 | 0x110200 | 0x5830 | | USER_mp_ |
| USER_mp_SET_CP_AND_GAMMA | 71 | 13 | 5.462 | 0.12% | 0.02% | 189,286,000 | 34,658,000 | 0xFFFFFFFF | 0xF3EB0 | 0xF4EB0 | 0x1B0 | | USER_mp_ |
| USER_mp_SET_THERMAL_CONDUCTIVITY_AT_NODES | 45 | 7 | 6.429 | 0.08% | 0.01% | 119,970,000 | 18,662,000 | 0xFFFFFFFF | 0xF4120 | 0xF5120 | 0xC0 | | USER_mp_ |
| USER_mp_SET_LAMINAR_VISCOSITY_AT_NODES | 37 | 6 | 6.167 | 0.06% | 0.01% | 98,642,000 | 15,996,000 | 0xFFFFFFFF | 0xF4060 | 0xF5060 | 0xC0 | | USER_mp_ |
| cvt_ieee_t_to_text_ex | 35 | 39 | 0.897 | 0.06% | 0.05% | 93,310,000 | 103,974,000 | 0xFFFFFFFF | 0x181100 | 0x182100 | 0x13E0 | | cvt_ieee_t_ |
| USER_mp_SET_BCP | 32 | 17 | 1.882 | 0.05% | 0.02% | 85,312,000 | 45,322,000 | 0xFFFFFFFF | 0x100600 | 0x101600 | 0x2D20 | | USER_mp_ |
| USER_mp_SET_BCT | 30 | 12 | 2.500 | 0.05% | 0.02% | 79,980,000 | 31,992,000 | 0xFFFFFFFF | 0xFC830 | 0xFD830 | 0x3DD0 | | USER_mp_ |
| for__interp_fmt | 28 | 37 | 0.757 | 0.05% | 0.05% | 74,648,000 | 98,642,000 | 0xFFFFFFFF | 0x16B240 | 0x16C240 | 0xD80 | | for__interp_ |
| USER_mp_SET_BCU | 28 | 10 | 2.800 | 0.05% | 0.01% | 74,648,000 | 26,660,000 | 0xFFFFFFFF | 0xF5020 | 0xF6020 | 0x3C10 | | USER_mp_ |
| for_write_seq_fmt_xmit | 27 | 33 | 0.818 | 0.05% | 0.05% | 71,982,000 | 87,978,000 | 0xFFFFFFFF | 0x1443D0 | 0x1453D0 | 0x24B0 | | for_write_s |

**Figura 7 Depois da otimização**

```
*** Efficiency: numerical solution 2D / analytic Q1D (dimensionless) ***

    1.000836328728610E+00 = discharge coefficient
    9.691914048072187E-01 = dynamic thrust
    9.752768908404300E-01 = pressure thrust at sea level (p = 101325 Pa)
    1.080533092655724E+00 = pressure thrust in the vacuum
    9.677277608885935E-01 = total thrust at sea level
    9.754462366605242E-01 = total thrust in the vacuum
    9.677277608885934E-01 = thrust coefficient at sea level
    9.754462366605242E-01 = thrust coefficient in the vacuum
    9.991643701326540E-01 = characterist velocity
    9.669190986681352E-01 = velocity of efective ejection at sea level
    9.746311246511806E-01 = velocity of efective ejection in the vacuum
    9.669190986681352E-01 = specific impulse at sea level
    9.746311246511807E-01 = specific impulse at vacuum


         0.000 = tcpuo: acumulated CPU time (s) (before interuption)
        60.875 = dtcpu: CPU time (s) (after interuption)
        60.875 = tcpu:  total CPU time (s)
```

**6)SUBROTINA:** COEFFICIENTS_mp_GET_VELOCITIES_AT_FACES: SEN03_0006

Utilizando-se uma variável auxiliar chamada inv_dt, que é a inversa de dt. Utilizou-se assim, a multiplicação por 'inv_dt' ao invés de divisão (que consome mais tempo computacional).

Houve uma redução de **26,308,088,000** ciclos de clock para **24,695,158,000** . A rotina que utilizava **16,73%** do tempo total, agora utiliza **16,00%.**

| Name | CPU_ sampl | INST_R samples | Clocks per... | CPU_CL % | INST_R % | CPU_CLK_UNH events | INST_RETIRED events | Segment | Offset | RVA | Size | Class | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| COEFFICIENTS_mp_GET_VELOCITIES_AT_FACES | 9,868 | 8,688 | 1.136 | 16.73% | 12.12% | 26,308,088,000 | 23,162,208,000 | 0xFFFFFFFF | 0xDC290 | 0xDD290 | 0x84F0 | | COEFFICIE |
| MSI2D9_mp_FB2D9 | 9,156 | 14,395 | 0.636 | 15.52% | 20.07% | 24,409,896,000 | 38,377,070,000 | 0xFFFFFFFF | 0x59F80 | 0x5AF80 | 0xC860 | | MSI2D9_m |
| MSI2D5_mp_FB2D5 | 8,363 | 14,343 | 0.583 | 14.18% | 20.00% | 22,295,758,000 | 38,238,438,000 | 0xFFFFFFFF | 0x3F7C0 | 0x407C0 | 0x9130 | | MSI2D5_m |
| MSI2D9_mp_LU2D9 | 6,094 | 7,627 | 0.799 | 10.33% | 10.64% | 16,246,604,000 | 20,333,582,000 | 0xFFFFFFFF | 0x667E0 | 0x677E0 | 0xAB60 | | MSI2D9_m |
| MSI2D5_mp_LU2D5 | 3,023 | 3,068 | 0.985 | 5.13% | 4.28% | 8,059,318,000 | 8,179,288,000 | 0xFFFFFFFF | 0x488F0 | 0x498F0 | 0x4BF0 | | MSI2D5_m |
| COEFFICIENTS_mp_GET_T_COEFFICIENTS_AND_SOURCE | 2,612 | 2,690 | 0.971 | 4.43% | 3.75% | 6,963,592,000 | 7,171,540,000 | 0xFFFFFFFF | 0xB8C30 | 0xB9C30 | 0xCBA0 | | COEFFICIE |
| COEFFICIENTS_mp_GET_INTERNAL_SIMPLEC_COEFFICIENTS | 2,360 | 2,093 | 1.128 | 4.00% | 2.92% | 6,291,760,000 | 5,579,938,000 | 0xFFFFFFFF | 0xED0C0 | 0xEE0C0 | 0x3D80 | | COEFFICIE |
| SOLVERS_mp_NORM_L1_9D | 1,866 | 2,830 | 0.659 | 3.16% | 3.95% | 4,974,756,000 | 7,544,780,000 | 0xFFFFFFFF | 0xF49D0 | 0xF59D0 | 0xD50 | | SOLVERS_ |
| COEFFICIENTS_mp_GET_U_V_AT_REAL_NODES_WITH_PL | 1,697 | 1,341 | 1.265 | 2.88% | 1.87% | 4,524,202,000 | 3,575,106,000 | 0xFFFFFFFF | 0xF1190 | 0xF2190 | 0x1C00 | | COEFFICIE |
| COEFFICIENTS_mp_GET_U_SOURCE | 1,578 | 1,567 | 1.007 | 2.68% | 2.19% | 4,206,948,000 | 4,177,622,000 | 0xFFFFFFFF | 0x87FC0 | 0x88FC0 | 0x97B0 | | COEFFICIE |
| COEFFICIENTS_mp_GET_V_SOURCE | 1,545 | 1,689 | 0.915 | 2.62% | 2.36% | 4,118,970,000 | 4,502,874,000 | 0xFFFFFFFF | 0xA8AD0 | 0xA9AD0 | 0x8060 | | COEFFICIE |
| COEFFICIENTS_mp_GET_P_SOURCE | 1,419 | 2,384 | 0.595 | 2.41% | 3.32% | 3,783,054,000 | 6,355,744,000 | 0xFFFFFFFF | 0xD7200 | 0xD8200 | 0x2800 | | COEFFICIE |
| COEFFICIENTS_mp_GET_P_COEFFICIENTS | 1,244 | 2,047 | 0.608 | 2.11% | 2.85% | 3,316,504,000 | 5,457,302,000 | 0xFFFFFFFF | 0xD2900 | 0xD3900 | 0x2380 | | COEFFICIE |
| _intel_new_memset | 1,150 | 231 | 4.978 | 1.95% | 0.32% | 3,065,900,000 | 615,846,000 | 0xFFFFFFFF | 0x21CF00 | 0x21DF00 | 0x1560 | | _intel_new_ |
| COEFFICIENTS_mp_GET_U_COEFFICIENTS | 1,011 | 1,152 | 0.878 | 1.71% | 1.61% | 2,695,326,000 | 3,071,232,000 | 0xFFFFFFFF | 0x7A840 | 0x7B840 | 0x6B00 | | COEFFICIE |
| COEFFICIENTS_mp_GET_V_COEFFICIENTS | 898 | 1,120 | 0.802 | 1.52% | 1.56% | 2,394,068,000 | 2,985,920,000 | 0xFFFFFFFF | 0x9AFB0 | 0x9BFB0 | 0x6CD0 | | COEFFICIE |
| _intel_new_memcpy | 793 | 120 | 6.608 | 1.34% | 0.17% | 2,114,138,000 | 319,920,000 | 0xFFFFFFFF | 0x21E460 | 0x21F460 | 0x23D0 | | _intel_new_ |
| COEFFICIENTS_mp_GET_VELOCITIES_AT_INTERNAL_FACES_WITH_PL | 775 | 746 | 1.039 | 1.31% | 1.04% | 2,066,150,000 | 1,988,836,000 | 0xFFFFFFFF | 0xF2D90 | 0xF3D90 | 0x1450 | | COEFFICIE |
| memset | 706 | 294 | 2.401 | 1.20% | 0.41% | 1,882,196,000 | 783,804,000 | 0xFFFFFFFF | 0x1C7D10 | 0x1C8D10 | 0xF0 | | memset |
| COEFFICIENTS_mp_GET_DENSITY_AT_FACES | 562 | 1,138 | 0.494 | 0.95% | 1.59% | 1,498,292,000 | 3,033,908,000 | 0xFFFFFFFF | 0x79E90 | 0x7AE90 | 0x9B0 | | COEFFICIE |
| USER_mp_GET_THERMAL_CONDUCTIVITY_AT_FACES | 436 | 411 | 1.061 | 0.74% | 0.57% | 1,162,376,000 | 1,095,726,000 | 0xFFFFFFFF | 0xF6240 | 0xF7240 | 0x720 | | USER_mp_ |
| USER_mp_GET_LAMINAR_VISCOSITY_AT_FACES | 430 | 508 | 0.846 | 0.73% | 0.71% | 1,146,380,000 | 1,354,328,000 | 0xFFFFFFFF | 0xF5B20 | 0xF6B20 | 0x720 | | USER_mp_ |
| SOLVERS_mp_NORM_L1_5D | 329 | 541 | 0.608 | 0.56% | 0.75% | 877,114,000 | 1,442,306,000 | 0xFFFFFFFF | 0xF41F0 | 0xF51F0 | 0x7E0 | | SOLVERS_ |
| MAIN_ip_GET_NUMERICAL_SOLUTION | 127 | 18 | 7.056 | 0.22% | 0.03% | 338,582,000 | 47,988,000 | 0xFFFFFFFF | 0x123320 | 0x124320 | 0x5455 | | MAIN_ip_G |
| COEFFICIENTS_mp_GET_DENSITY_AT_NODES | 118 | 32 | 3.688 | 0.20% | 0.04% | 314,588,000 | 85,312,000 | 0xFFFFFFFF | 0x79C60 | 0x7AC60 | 0x230 | | COEFFICIE |
| cvtas_t_to_a | 88 | 219 | 0.402 | 0.15% | 0.31% | 234,608,000 | 583,854,000 | 0xFFFFFFFF | 0x19A460 | 0x19B460 | 0x4320 | | cvtas_t_to_ |
| COEFFICIENTS_mp_GET_PRESSURE_DENSITY_CORRECTION_WITH_PL | 87 | 33 | 2.636 | 0.15% | 0.05% | 231,942,000 | 87,978,000 | 0xFFFFFFFF | 0xF0E40 | 0xF1E40 | 0x350 | | COEFFICIE |
| USER_mp_SET_CP_AND_GAMMA | 82 | 16 | 5.125 | 0.14% | 0.02% | 218,612,000 | 42,656,000 | 0xFFFFFFFF | 0xF57F0 | 0xF67F0 | 0x1B0 | | USER_mp_ |
| USER_mp_GET_A9D_B_RESCALING | 72 | 66 | 1.091 | 0.12% | 0.09% | 191,952,000 | 175,956,000 | 0xFFFFFFFF | 0x110B40 | 0x111B40 | 0x5830 | | USER_mp_ |
| USER_mp_SET_THERMAL_CONDUCTIVITY_AT_NODES | 49 | 5 | 9.800 | 0.08% | 0.01% | 130,634,000 | 13,330,000 | 0xFFFFFFFF | 0xF5A60 | 0xF6A60 | 0xC0 | | USER_mp_ |
| USER_mp_SET_BCP | 45 | 25 | 1.800 | 0.08% | 0.03% | 119,970,000 | 66,650,000 | 0xFFFFFFFF | 0x101F40 | 0x102F40 | 0x2D20 | | USER_mp_ |
| USER_mp_SET_LAMINAR_VISCOSITY_AT_NODES | 39 | 6 | 6.500 | 0.07% | 0.01% | 103,974,000 | 15,996,000 | 0xFFFFFFFF | 0xF59A0 | 0xF69A0 | 0xC0 | | USER_mp_ |
| cvt_ieee_t_to_text_ex | 29 | 32 | 0.906 | 0.05% | 0.04% | 77,314,000 | 85,312,000 | 0xFFFFFFFF | 0x182A40 | 0x183A40 | 0x13E0 | | cvt_ieee_t_ |
| USER_mp_GET_A5D_B_RESCALING | 29 | 30 | 0.967 | 0.05% | 0.04% | 77,314,000 | 79,980,000 | 0xFFFFFFFF | 0x10C7D0 | 0x10D7D0 | 0x4370 | | USER_mp_ |
| USER_mp_SET_BCT | 29 | 10 | 2.900 | 0.05% | 0.01% | 77,314,000 | 26,660,000 | 0xFFFFFFFF | 0xFE170 | 0xFF170 | 0x3DD0 | | USER_mp_ |
| USER_mp_SET_BCU | 27 | 7 | 3.857 | 0.05% | 0.01% | 71,982,000 | 18,662,000 | 0xFFFFFFFF | 0xF6960 | 0xF7960 | 0x3C10 | | USER_mp_ |
| USER_mp_SET_BCV | 26 | 10 | 2.600 | 0.04% | 0.01% | 69,316,000 | 26,660,000 | 0xFFFFFFFF | 0xFA570 | 0xFB570 | 0x3C00 | | USER_mp_ |

**Figura 8 Antes da Otimização**

| Name | CPU_ sampl | INST_R samples | Clocks per... | CPU_CL % | INST_R % | CPU_CLK_UNH events | INST_RETIRED events | Segment | Offset | RVA | Size | Class | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| COEFFICIENTS_mp_GET_VELOCITIES_AT_FACES | 9,263 | 8,700 | 1.065 | 16.00% | 12.16% | 24,695,158,000 | 23,194,200,000 | 0xFFFFFFFF | 0xDC290 | 0xDD290 | 0x84E0 | | COEFFICIE |
| MSI2D9_mp_FB2D9 | 9,110 | 14,434 | 0.631 | 15.73% | 20.18% | 24,287,260,000 | 38,481,044,000 | 0xFFFFFFFF | 0x59F80 | 0x5AF80 | 0xC860 | | MSI2D9_m |
| MSI2D5_mp_FB2D5 | 8,327 | 14,363 | 0.580 | 14.38% | 20.08% | 22,199,782,000 | 38,291,758,000 | 0xFFFFFFFF | 0x3F7C0 | 0x407C0 | 0x9130 | | MSI2D5_m |
| MSI2D9_mp_LU2D9 | 6,148 | 7,542 | 0.815 | 10.62% | 10.54% | 16,390,568,000 | 20,106,972,000 | 0xFFFFFFFF | 0x667E0 | 0x677E0 | 0xAB60 | | MSI2D9_m |
| MSI2D5_mp_LU2D5 | 3,017 | 3,130 | 0.964 | 5.21% | 4.38% | 8,043,322,000 | 8,344,580,000 | 0xFFFFFFFF | 0x488F0 | 0x498F0 | 0x4BF0 | | MSI2D5_m |
| COEFFICIENTS_mp_GET_T_COEFFICIENTS_AND_SOURCE | 2,637 | 2,722 | 0.969 | 4.55% | 3.81% | 7,030,242,000 | 7,256,852,000 | 0xFFFFFFFF | 0xB8C30 | 0xB9C30 | 0xCBA0 | | COEFFICIE |
| SOLVERS_mp_NORM_L1_9D | 1,875 | 2,829 | 0.663 | 3.24% | 3.96% | 4,998,750,000 | 7,542,114,000 | 0xFFFFFFFF | 0xF3080 | 0xF4080 | 0xD50 | | SOLVERS_ |
| COEFFICIENTS_mp_GET_INTERNAL_SIMPLEC_COEFFICIENTS | 1,755 | 1,930 | 0.909 | 3.03% | 2.70% | 4,678,830,000 | 5,145,380,000 | 0xFFFFFFFF | 0xED0B0 | 0xEE0B0 | 0x2440 | | COEFFICIE |
| COEFFICIENTS_mp_GET_U_V_AT_REAL_NODES_WITH_PL | 1,700 | 1,359 | 1.251 | 2.94% | 1.90% | 4,532,200,000 | 3,623,094,000 | 0xFFFFFFFF | 0xEF840 | 0xF0840 | 0x1C00 | | COEFFICIE |
| COEFFICIENTS_mp_GET_U_SOURCE | 1,578 | 1,589 | 0.993 | 2.73% | 2.22% | 4,206,948,000 | 4,236,274,000 | 0xFFFFFFFF | 0x87FC0 | 0x88FC0 | 0x97B0 | | COEFFICIE |
| COEFFICIENTS_mp_GET_V_SOURCE | 1,529 | 1,608 | 0.951 | 2.64% | 2.25% | 4,076,314,000 | 4,286,928,000 | 0xFFFFFFFF | 0xA8AD0 | 0xA9AD0 | 0x8060 | | COEFFICIE |
| COEFFICIENTS_mp_GET_P_SOURCE | 1,420 | 2,300 | 0.617 | 2.45% | 3.22% | 3,785,720,000 | 6,131,800,000 | 0xFFFFFFFF | 0xD7200 | 0xD8200 | 0x2800 | | COEFFICIE |
| COEFFICIENTS_mp_GET_P_COEFFICIENTS | 1,245 | 2,055 | 0.606 | 2.15% | 2.87% | 3,319,170,000 | 5,478,630,000 | 0xFFFFFFFF | 0xD2900 | 0xD3900 | 0x2380 | | COEFFICIE |
| _intel_new_memset | 1,189 | 238 | 4.996 | 2.05% | 0.33% | 3,169,874,000 | 634,508,000 | 0xFFFFFFFF | 0x21B5B0 | 0x21C5B0 | 0x1560 | | _intel_new_ |
| COEFFICIENTS_mp_GET_U_COEFFICIENTS | 1,017 | 1,122 | 0.906 | 1.76% | 1.57% | 2,711,322,000 | 2,991,252,000 | 0xFFFFFFFF | 0x7A840 | 0x7B840 | 0x6B00 | | COEFFICIE |
| COEFFICIENTS_mp_GET_V_COEFFICIENTS | 897 | 1,138 | 0.788 | 1.55% | 1.59% | 2,391,402,000 | 3,033,908,000 | 0xFFFFFFFF | 0x9AFB0 | 0x9BFB0 | 0x6CD0 | | COEFFICIE |
| memset | 820 | 316 | 2.595 | 1.42% | 0.44% | 2,186,120,000 | 842,456,000 | 0xFFFFFFFF | 0x1C63C0 | 0x1C73C0 | 0xF0 | | memset |
| _intel_new_memcpy | 800 | 114 | 7.018 | 1.38% | 0.16% | 2,132,800,000 | 303,924,000 | 0xFFFFFFFF | 0x21CB10 | 0x21DB10 | 0x23D0 | | _intel_new_ |
| COEFFICIENTS_mp_GET_VELOCITIES_AT_INTERNAL_FACES_WITH_PL | 770 | 757 | 1.017 | 1.33% | 1.06% | 2,052,820,000 | 2,018,162,000 | 0xFFFFFFFF | 0xF1440 | 0xF2440 | 0x1450 | | COEFFICIE |
| COEFFICIENTS_mp_GET_DENSITY_AT_FACES | 551 | 1,170 | 0.471 | 0.95% | 1.64% | 1,468,966,000 | 3,119,220,000 | 0xFFFFFFFF | 0x79E90 | 0x7AE90 | 0x9B0 | | COEFFICIE |
| USER_mp_GET_THERMAL_CONDUCTIVITY_AT_FACES | 427 | 484 | 0.882 | 0.74% | 0.68% | 1,138,382,000 | 1,290,344,000 | 0xFFFFFFFF | 0xF48F0 | 0xF58F0 | 0x720 | | USER_mp_ |
| USER_mp_GET_LAMINAR_VISCOSITY_AT_FACES | 412 | 424 | 0.972 | 0.71% | 0.59% | 1,098,392,000 | 1,130,384,000 | 0xFFFFFFFF | 0xF41D0 | 0xF51D0 | 0x720 | | USER_mp_ |
| SOLVERS_mp_NORM_L1_5D | 321 | 498 | 0.645 | 0.55% | 0.70% | 855,786,000 | 1,327,668,000 | 0xFFFFFFFF | 0xF28A0 | 0xF38A0 | 0x7E0 | | SOLVERS_ |
| COEFFICIENTS_mp_GET_DENSITY_AT_NODES | 125 | 24 | 5.208 | 0.22% | 0.03% | 333,250,000 | 63,984,000 | 0xFFFFFFFF | 0x79C60 | 0x7AC60 | 0x230 | | COEFFICIE |
| MAIN_ip_GET_NUMERICAL_SOLUTION | 112 | 23 | 4.870 | 0.19% | 0.03% | 298,592,000 | 61,318,000 | 0xFFFFFFFF | 0x1219D0 | 0x1229D0 | 0x5455 | | MAIN_ip_G |
| COEFFICIENTS_mp_GET_PRESSURE_DENSITY_CORRECTION_WITH_PL | 104 | 42 | 2.476 | 0.18% | 0.06% | 277,264,000 | 111,972,000 | 0xFFFFFFFF | 0xEF4F0 | 0xF04F0 | 0x350 | | COEFFICIE |
| cvtas_t_to_a | 100 | 213 | 0.469 | 0.17% | 0.30% | 266,600,000 | 567,858,000 | 0xFFFFFFFF | 0x198B10 | 0x199B10 | 0x4320 | | cvtas_t_to_ |
| USER_mp_SET_CP_AND_GAMMA | 81 | 11 | 7.364 | 0.14% | 0.02% | 215,946,000 | 29,326,000 | 0xFFFFFFFF | 0xF3EA0 | 0xF4EA0 | 0x1B0 | | USER_mp_ |
| USER_mp_GET_A9D_B_RESCALING | 53 | 76 | 0.697 | 0.09% | 0.11% | 141,298,000 | 202,616,000 | 0xFFFFFFFF | 0x10F1F0 | 0x1101F0 | 0x5830 | | USER_mp_ |
| USER_mp_SET_THERMAL_CONDUCTIVITY_AT_NODES | 50 | 8 | 6.250 | 0.09% | 0.01% | 133,300,000 | 21,328,000 | 0xFFFFFFFF | 0xF4110 | 0xF5110 | 0xC0 | | USER_mp_ |
| USER_mp_SET_LAMINAR_VISCOSITY_AT_NODES | 41 | 8 | 5.125 | 0.07% | 0.01% | 109,306,000 | 21,328,000 | 0xFFFFFFFF | 0xF4050 | 0xF5050 | 0xC0 | | USER_mp_ |
| cvt_ieee_t_to_text_ex | 37 | 45 | 0.822 | 0.06% | 0.06% | 98,642,000 | 119,970,000 | 0xFFFFFFFF | 0x1810F0 | 0x1820F0 | 0x13E0 | | cvt_ieee_t_ |
| for_write_seq_fmt_xmit | 36 | 41 | 0.878 | 0.06% | 0.06% | 95,976,000 | 109,306,000 | 0xFFFFFFFF | 0x1443C0 | 0x1453C0 | 0x24B0 | | for_write_s |
| USER_mp_SET_BCP | 35 | 28 | 1.250 | 0.06% | 0.04% | 93,310,000 | 74,648,000 | 0xFFFFFFFF | 0x1005F0 | 0x1015F0 | 0x2D20 | | USER_mp_ |
| USER_mp_SET_BCU | 33 | 10 | 3.300 | 0.06% | 0.01% | 87,978,000 | 26,660,000 | 0xFFFFFFFF | 0xF5010 | 0xF6010 | 0x3C10 | | USER_mp_ |
| USER_mp_SET_BCT | 28 | 15 | 1.867 | 0.05% | 0.02% | 74,648,000 | 39,990,000 | 0xFFFFFFFF | 0xFC820 | 0xFD820 | 0x3DD0 | | USER_mp_ |
| USER_mp_SET_BCV | 27 | 5 | 5.400 | 0.05% | 0.01% | 71,982,000 | 13,330,000 | 0xFFFFFFFF | 0xF8C20 | 0xF9C20 | 0x3C00 | | USER_mp_ |

**Figura 9 Depois da otimização**

```
*** Efficiency: numerical solution 2D / analytic Q1D (dimensionless) ***

    1.000836328728610E+00 = discharge coefficient
    9.691914048072187E-01 = dynamic thrust
    9.752768908404300E-01 = pressure thrust at sea level (p = 101325 Pa)
```

```
1.080533092655724E+00 = pressure thrust in the vacuum
9.677277608885935E-01 = total thrust at sea level
9.754462366605242E-01 = total thrust in the vacuum
9.677277608885934E-01 = thrust coefficient at sea level
9.754462366605242E-01 = thrust coefficient in the vacuum
9.991643701326540E-01 = characterist velocity
9.669190986681352E-01 = velocity of efective ejection at sea level
9.746311246511806E-01 = velocity of efective ejection in the vacuum
9.669190986681352E-01 = specific impulse at sea level
9.746311246511807E-01 = specific impulse at vacuum


     0.000 = tcpuo: acumulated CPU time (s) (before interuption)
    60.000 = dtcpu: CPU time (s) (after interuption)
    60.000 = tcpu:  total CPU time (s)
```

**7)SUBROTINA:** COEFFICIENTS_mp_GET_VELOCITIES_AT_FACES: SEN03_0007

Foi indexado a variável mp, agora usa-se apenas mpa(np), mpa(npe) e mpa(npn).

Houve uma redução de **24,695,158,000** ciclos de clock para **24,100,640**. A rotina que utilizava **16,00%** do tempo total, agora utiliza **15,68%.**

| Name | CPU_ sampl | INST_R samples | Clocks per... | CPU_CL % | INST_R % | CPU_CLK_UNH events | INST_RETIRED events | Segment | Offset | RVA | Size | Class | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| COEFFICIENTS_mp_GET_VELOCITIES_AT_FACES | 9,263 | 8,700 | 1.065 | 16.00% | 12.16% | 24,695,158,000 | 23,194,200,000 | 0xFFFFFFFF | 0xDC290 | 0xDD290 | 0x84E0 | | COEFFICIE |
| MSI2D9_mp_FB2D9 | 9,110 | 14,434 | 0.631 | 15.73% | 20.18% | 24,287,260,000 | 38,481,044,000 | 0xFFFFFFFF | 0x59F80 | 0x5AF80 | 0xC860 | | MSI2D9_m |
| MSI2D5_mp_FB2D5 | 8,327 | 14,363 | 0.580 | 14.38% | 20.08% | 22,199,782,000 | 38,291,758,000 | 0xFFFFFFFF | 0x3F7C0 | 0x407C0 | 0x9130 | | MSI2D5_m |
| MSI2D9_mp_LU2D9 | 6,148 | 7,542 | 0.815 | 10.62% | 10.54% | 16,390,568,000 | 20,106,972,000 | 0xFFFFFFFF | 0x667E0 | 0x677E0 | 0xAB60 | | MSI2D9_m |
| MSI2D5_mp_LU2D5 | 3,017 | 3,130 | 0.964 | 5.21% | 4.38% | 8,043,322,000 | 8,344,580,000 | 0xFFFFFFFF | 0x488F0 | 0x498F0 | 0x4BF0 | | MSI2D5_m |
| COEFFICIENTS_mp_GET_T_COEFFICIENTS_AND_SOURCE | 2,637 | 2,722 | 0.969 | 4.55% | 3.81% | 7,030,242,000 | 7,256,852,000 | 0xFFFFFFFF | 0xB8C30 | 0xB9C30 | 0xCBA0 | | COEFFICIE |
| SOLVERS_mp_NORM_L1_9D | 1,875 | 2,829 | 0.663 | 3.24% | 3.96% | 4,998,750,000 | 7,542,114,000 | 0xFFFFFFFF | 0xF3080 | 0xF4080 | 0xD50 | | SOLVERS_ |
| COEFFICIENTS_mp_GET_INTERNAL_SIMPLEC_COEFFICIENTS | 1,755 | 1,930 | 0.909 | 3.03% | 2.70% | 4,678,830,000 | 5,145,380,000 | 0xFFFFFFFF | 0xED0B0 | 0xEE0B0 | 0x2440 | | COEFFICIE |
| COEFFICIENTS_mp_GET_U_V_AT_REAL_NODES_WITH_PL | 1,700 | 1,359 | 1.251 | 2.94% | 1.90% | 4,532,200,000 | 3,623,094,000 | 0xFFFFFFFF | 0xEF840 | 0xF0840 | 0x1C00 | | COEFFICIE |
| COEFFICIENTS_mp_GET_U_SOURCE | 1,578 | 1,589 | 0.993 | 2.73% | 2.22% | 4,206,948,000 | 4,236,274,000 | 0xFFFFFFFF | 0x87FC0 | 0x88FC0 | 0x97B0 | | COEFFICIE |
| COEFFICIENTS_mp_GET_V_SOURCE | 1,529 | 1,608 | 0.951 | 2.64% | 2.25% | 4,076,314,000 | 4,286,928,000 | 0xFFFFFFFF | 0xA8AD0 | 0xA9AD0 | 0x8060 | | COEFFICIE |
| COEFFICIENTS_mp_GET_P_SOURCE | 1,420 | 2,300 | 0.617 | 2.45% | 3.22% | 3,785,720,000 | 6,131,800,000 | 0xFFFFFFFF | 0xD7200 | 0xD8200 | 0x2800 | | COEFFICIE |
| COEFFICIENTS_mp_GET_P_COEFFICIENTS | 1,245 | 2,055 | 0.606 | 2.15% | 2.87% | 3,319,170,000 | 5,478,630,000 | 0xFFFFFFFF | 0xD2900 | 0xD3900 | 0x2380 | | COEFFICIE |
| _intel_new_memset | 1,189 | 238 | 4.996 | 2.05% | 0.33% | 3,169,874,000 | 634,508,000 | 0xFFFFFFFF | 0x21B5B0 | 0x21C5B0 | 0x1560 | | _intel_new_ |
| COEFFICIENTS_mp_GET_U_COEFFICIENTS | 1,017 | 1,122 | 0.906 | 1.76% | 1.57% | 2,711,322,000 | 2,991,252,000 | 0xFFFFFFFF | 0x7A840 | 0x7B840 | 0x6B00 | | COEFFICIE |
| COEFFICIENTS_mp_GET_V_COEFFICIENTS | 897 | 1,138 | 0.788 | 1.55% | 1.59% | 2,391,402,000 | 3,033,908,000 | 0xFFFFFFFF | 0x9AFB0 | 0x9BFB0 | 0x6CD0 | | COEFFICIE |
| memset | 820 | 316 | 2.595 | 1.42% | 0.44% | 2,186,120,000 | 842,456,000 | 0xFFFFFFFF | 0x1C63C0 | 0x1C73C0 | 0xF0 | | memset |
| _intel_new_memcpy | 800 | 114 | 7.018 | 1.38% | 0.16% | 2,132,800,000 | 303,924,000 | 0xFFFFFFFF | 0x21CB10 | 0x21DB10 | 0x23D0 | | _intel_new_ |
| COEFFICIENTS_mp_GET_VELOCITIES_AT_INTERNAL_FACES_WITH_PL | 770 | 757 | 1.017 | 1.33% | 1.06% | 2,052,820,000 | 2,018,162,000 | 0xFFFFFFFF | 0xF1440 | 0xF2440 | 0x1450 | | COEFFICIE |
| COEFFICIENTS_mp_GET_DENSITY_AT_FACES | 551 | 1,170 | 0.471 | 0.95% | 1.64% | 1,468,966,000 | 3,119,220,000 | 0xFFFFFFFF | 0x79E90 | 0x7AE90 | 0x9B0 | | COEFFICIE |
| USER_mp_GET_THERMAL_CONDUCTIVITY_AT_FACES | 427 | 484 | 0.882 | 0.74% | 0.68% | 1,138,382,000 | 1,290,344,000 | 0xFFFFFFFF | 0xF48F0 | 0xF58F0 | 0x720 | | USER_mp_ |
| USER_mp_GET_LAMINAR_VISCOSITY_AT_FACES | 412 | 424 | 0.972 | 0.71% | 0.59% | 1,098,392,000 | 1,130,384,000 | 0xFFFFFFFF | 0xF41D0 | 0xF51D0 | 0x720 | | USER_mp_ |
| SOLVERS_mp_NORM_L1_5D | 321 | 498 | 0.645 | 0.55% | 0.70% | 855,786,000 | 1,327,668,000 | 0xFFFFFFFF | 0xF28A0 | 0xF38A0 | 0x7E0 | | SOLVERS_ |
| COEFFICIENTS_mp_GET_DENSITY_AT_NODES | 125 | 24 | 5.208 | 0.22% | 0.03% | 333,250,000 | 63,984,000 | 0xFFFFFFFF | 0x79C60 | 0x7AC60 | 0x230 | | COEFFICIE |
| MAIN_ip_GET_NUMERICAL_SOLUTION | 112 | 23 | 4.870 | 0.19% | 0.03% | 298,592,000 | 61,318,000 | 0xFFFFFFFF | 0x1219D0 | 0x1229D0 | 0x5455 | | MAIN_ip_G |
| COEFFICIENTS_mp_GET_PRESSURE_DENSITY_CORRECTION_WITH_PL | 104 | 42 | 2.476 | 0.18% | 0.06% | 277,264,000 | 111,972,000 | 0xFFFFFFFF | 0xEF4F0 | 0xF04F0 | 0x350 | | COEFFICIE |
| cvtas_t_to_a | 100 | 213 | 0.469 | 0.17% | 0.30% | 266,600,000 | 567,858,000 | 0xFFFFFFFF | 0x198B10 | 0x199B10 | 0x4320 | | cvtas_t_to_ |
| USER_mp_SET_CP_AND_GAMMA | 81 | 11 | 7.364 | 0.14% | 0.02% | 215,946,000 | 29,326,000 | 0xFFFFFFFF | 0xF3EA0 | 0xF4EA0 | 0x1B0 | | USER_mp_ |
| USER_mp_GET_A9D_B_RESCALING | 53 | 76 | 0.697 | 0.09% | 0.11% | 141,298,000 | 202,616,000 | 0xFFFFFFFF | 0x10F1F0 | 0x1101F0 | 0x5830 | | USER_mp_ |
| USER_mp_SET_THERMAL_CONDUCTIVITY_AT_NODES | 50 | 8 | 6.250 | 0.09% | 0.01% | 133,300,000 | 21,328,000 | 0xFFFFFFFF | 0xF4110 | 0xF5110 | 0xC0 | | USER_mp_ |
| USER_mp_SET_LAMINAR_VISCOSITY_AT_NODES | 41 | 8 | 5.125 | 0.07% | 0.01% | 109,306,000 | 21,328,000 | 0xFFFFFFFF | 0xF4050 | 0xF5050 | 0xC0 | | USER_mp_ |
| cvt_ieee_t_to_text_ex | 37 | 45 | 0.822 | 0.06% | 0.06% | 98,642,000 | 119,970,000 | 0xFFFFFFFF | 0x1810F0 | 0x1820F0 | 0x13E0 | | cvt_ieee_t_ |
| for_write_seq_fmt_xmit | 36 | 41 | 0.878 | 0.06% | 0.06% | 95,976,000 | 109,306,000 | 0xFFFFFFFF | 0x1443C0 | 0x1453C0 | 0x24B0 | | for_write_s |
| USER_mp_SET_BCP | 35 | 28 | 1.250 | 0.06% | 0.04% | 93,310,000 | 74,648,000 | 0xFFFFFFFF | 0x1005F0 | 0x1015F0 | 0x2D20 | | USER_mp_ |
| USER_mp_SET_BCU | 33 | 10 | 3.300 | 0.06% | 0.01% | 87,978,000 | 26,660,000 | 0xFFFFFFFF | 0xF5010 | 0xF6010 | 0x3C10 | | USER_mp_ |
| USER_mp_SET_BCT | 28 | 15 | 1.867 | 0.05% | 0.02% | 74,648,000 | 39,990,000 | 0xFFFFFFFF | 0xFC820 | 0xFD820 | 0x3DD0 | | USER_mp_ |
| USER_mp_SET_BCV | 27 | 5 | 5.400 | 0.05% | 0.01% | 71,982,000 | 13,330,000 | 0xFFFFFFFF | 0xF8C20 | 0xF9C20 | 0x3C00 | | USER_mp_ |

**Figura 10 Antes da Otimização**

| Name | CPU_ sampl | INST_R samples | Clocks per... | CPU_CL % | INST_R % | CPU_CLK_UNH events | INST_RETIRED events | Segment | Offset | RVA | Size | Class | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| MSI2D9_mp_FB2D9 | 9,146 | 14,415 | 0.634 | 15.86% | 19.99% | 24,383,236,000 | 38,430,390,000 | 0xFFFFFFFF | 0x59F80 | 0x5AF80 | 0xC860 | | MSI2D9_m |
| COEFFICIENTS_mp_GET_VELOCITIES_AT_FACES | 9,040 | 9,248 | 0.978 | 15.68% | 12.83% | 24,100,640,000 | 24,655,168,000 | 0xFFFFFFFF | 0xDC290 | 0xDD290 | 0x8810 | | COEFFICIE |
| MSI2D5_mp_FB2D5 | 8,273 | 14,417 | 0.574 | 14.35% | 20.00% | 22,055,818,000 | 38,435,722,000 | 0xFFFFFFFF | 0x3F7C0 | 0x407C0 | 0x9130 | | MSI2D5_m |
| MSI2D9_mp_LU2D9 | 6,136 | 7,551 | 0.813 | 10.64% | 10.47% | 16,358,576,000 | 20,130,966,000 | 0xFFFFFFFF | 0x667E0 | 0x677E0 | 0x4B60 | | MSI2D9_m |
| MSI2D5_mp_LU2D5 | 2,994 | 3,073 | 0.974 | 5.19% | 4.26% | 7,982,004,000 | 8,192,618,000 | 0xFFFFFFFF | 0x488F0 | 0x498F0 | 0x4BF0 | | MSI2D5_m |
| COEFFICIENTS_mp_GET_T_COEFFICIENTS_AND_SOURCE | 2,636 | 2,715 | 0.971 | 4.57% | 3.77% | 7,027,576,000 | 7,238,190,000 | 0xFFFFFFFF | 0xB8C30 | 0xB9C30 | 0xCBA0 | | COEFFICIE |
| SOLVERS_mp_NORM_L1_9D | 1,860 | 2,828 | 0.658 | 3.23% | 3.92% | 4,958,760,000 | 7,539,448,000 | 0xFFFFFFFF | 0xF33B0 | 0xF43B0 | 0xD50 | | SOLVERS_ |
| COEFFICIENTS_mp_GET_INTERNAL_SIMPLEC_COEFFICIENTS | 1,752 | 1,928 | 0.909 | 3.04% | 2.67% | 4,670,832,000 | 5,140,048,000 | 0xFFFFFFFF | 0xED3E0 | 0xEE3E0 | 0x2440 | | COEFFICIE |
| COEFFICIENTS_mp_GET_U_V_AT_REAL_NODES_WITH_PL | 1,686 | 1,377 | 1.224 | 2.92% | 1.91% | 4,494,876,000 | 3,671,082,000 | 0xFFFFFFFF | 0xEFB70 | 0xF0B70 | 0x1C00 | | COEFFICIE |
| COEFFICIENTS_mp_GET_U_SOURCE | 1,587 | 1,587 | 1.000 | 2.75% | 2.20% | 4,230,942,000 | 4,230,942,000 | 0xFFFFFFFF | 0x87FC0 | 0x88FC0 | 0x97B0 | | COEFFICIE |
| COEFFICIENTS_mp_GET_V_SOURCE | 1,519 | 1,639 | 0.927 | 2.63% | 2.27% | 4,049,654,000 | 4,369,574,000 | 0xFFFFFFFF | 0xA8AD0 | 0xA9AD0 | 0x8060 | | COEFFICIE |
| COEFFICIENTS_mp_GET_P_SOURCE | 1,444 | 2,342 | 0.617 | 2.50% | 3.25% | 3,849,704,000 | 6,243,772,000 | 0xFFFFFFFF | 0xD7200 | 0xD8200 | 0x2800 | | COEFFICIE |
| COEFFICIENTS_mp_GET_P_COEFFICIENTS | 1,245 | 2,053 | 0.606 | 2.16% | 2.85% | 3,319,170,000 | 5,473,298,000 | 0xFFFFFFFF | 0xD2900 | 0xD3900 | 0x2380 | | COEFFICIE |
| _intel_new_memset | 1,208 | 224 | 5.393 | 2.09% | 0.31% | 3,220,528,000 | 597,184,000 | 0xFFFFFFFF | 0x21B8E0 | 0x21C8E0 | 0x1560 | | _intel_new_ |
| COEFFICIENTS_mp_GET_U_COEFFICIENTS | 1,007 | 1,121 | 0.898 | 1.75% | 1.55% | 2,684,662,000 | 2,988,586,000 | 0xFFFFFFFF | 0x7A840 | 0x7B840 | 0x6B00 | | COEFFICIE |
| COEFFICIENTS_mp_GET_V_COEFFICIENTS | 888 | 1,110 | 0.800 | 1.54% | 1.54% | 2,367,408,000 | 2,959,260,000 | 0xFFFFFFFF | 0x9AFB0 | 0x9BFB0 | 0x6CD0 | | COEFFICIE |
| memset | 861 | 333 | 2.586 | 1.49% | 0.46% | 2,295,426,000 | 887,778,000 | 0xFFFFFFFF | 0x1C66F0 | 0x1C76F0 | 0xF0 | | memset |
| COEFFICIENTS_mp_GET_VELOCITIES_AT_INTERNAL_FACES_WITH_PL | 801 | 757 | 1.058 | 1.39% | 1.05% | 2,135,466,000 | 2,018,162,000 | 0xFFFFFFFF | 0xF1770 | 0xF2770 | 0x1450 | | COEFFICIE |
| _intel_new_memcpy | 799 | 136 | 5.875 | 1.39% | 0.19% | 2,130,134,000 | 362,576,000 | 0xFFFFFFFF | 0x21CE40 | 0x21DE40 | 0x23D0 | | _intel_new_ |
| COEFFICIENTS_mp_GET_DENSITY_AT_FACES | 527 | 1,114 | 0.473 | 0.91% | 1.55% | 1,404,982,000 | 2,969,924,000 | 0xFFFFFFFF | 0x79E90 | 0x7AE90 | 0x9B0 | | COEFFICIE |
| USER_mp_GET_THERMAL_CONDUCTIVITY_AT_FACES | 442 | 475 | 0.931 | 0.77% | 0.66% | 1,178,372,000 | 1,266,350,000 | 0xFFFFFFFF | 0xF4C20 | 0xF5C20 | 0x720 | | USER_mp_ |
| USER_mp_GET_LAMINAR_VISCOSITY_AT_FACES | 415 | 442 | 0.939 | 0.72% | 0.61% | 1,106,390,000 | 1,178,372,000 | 0xFFFFFFFF | 0xF4500 | 0xF5500 | 0x720 | | USER_mp_ |
| SOLVERS_mp_NORM_L1_5D | 302 | 499 | 0.605 | 0.52% | 0.69% | 805,132,000 | 1,330,334,000 | 0xFFFFFFFF | 0xF2BD0 | 0xF3BD0 | 0x7E0 | | SOLVERS_ |
| MAIN_ip_GET_NUMERICAL_SOLUTION | 127 | 18 | 7.056 | 0.22% | 0.02% | 338,582,000 | 47,988,000 | 0xFFFFFFFF | 0x121D00 | 0x122D00 | 0x5455 | | MAIN_ip_G |
| cvtas_t_to_a | 124 | 210 | 0.590 | 0.22% | 0.29% | 330,584,000 | 559,860,000 | 0xFFFFFFFF | 0x198E40 | 0x199E40 | 0x4320 | | cvtas_t_to_ |
| COEFFICIENTS_mp_GET_DENSITY_AT_NODES | 112 | 26 | 4.308 | 0.19% | 0.04% | 298,592,000 | 69,316,000 | 0xFFFFFFFF | 0x79C60 | 0x7AC60 | 0x230 | | COEFFICIE |
| COEFFICIENTS_mp_GET_PRESSURE_DENSITY_CORRECTION_WITH_PL | 106 | 46 | 2.304 | 0.18% | 0.06% | 282,596,000 | 122,636,000 | 0xFFFFFFFF | 0xEF820 | 0xF0820 | 0x350 | | COEFFICIE |
| USER_mp_SET_CP_AND_GAMMA | 78 | 12 | 6.500 | 0.14% | 0.02% | 207,948,000 | 31,992,000 | 0xFFFFFFFF | 0xF41D0 | 0xF51D0 | 0x1B0 | | USER_mp_ |
| USER_mp_GET_A9D_B_RESCALING | 62 | 64 | 0.969 | 0.11% | 0.09% | 165,292,000 | 170,624,000 | 0xFFFFFFFF | 0x10F520 | 0x110520 | 0x5830 | | USER_mp_ |
| USER_mp_SET_LAMINAR_VISCOSITY_AT_NODES | 47 | 7 | 6.714 | 0.08% | 0.01% | 125,302,000 | 18,662,000 | 0xFFFFFFFF | 0xF4380 | 0xF5380 | 0xC0 | | USER_mp_ |
| USER_mp_SET_BCP | 41 | 28 | 1.464 | 0.07% | 0.04% | 109,306,000 | 74,648,000 | 0xFFFFFFFF | 0x100920 | 0x101920 | 0x2D20 | | USER_mp_ |
| USER_mp_SET_BCV | 40 | 13 | 3.077 | 0.07% | 0.02% | 106,640,000 | 34,658,000 | 0xFFFFFFFF | 0xF8F50 | 0xF9F50 | 0x3C00 | | USER_mp_ |
| USER_mp_SET_THERMAL_CONDUCTIVITY_AT_NODES | 38 | 4 | 9.500 | 0.07% | 0.01% | 101,308,000 | 10,664,000 | 0xFFFFFFFF | 0xF4440 | 0xF5440 | 0xC0 | | USER_mp_ |
| USER_mp_GET_A5D_B_RESCALING | 30 | 37 | 0.811 | 0.05% | 0.05% | 79,980,000 | 98,642,000 | 0xFFFFFFFF | 0x10B1B0 | 0x10C1B0 | 0x4370 | | USER_mp_ |
| for_write_seq_fmt_xmit | 29 | 36 | 0.806 | 0.05% | 0.05% | 77,314,000 | 95,976,000 | 0xFFFFFFFF | 0x1446F0 | 0x1456F0 | 0x24B0 | | for_write_s |
| for__interp_fmt | 28 | 37 | 0.757 | 0.05% | 0.05% | 74,648,000 | 98,642,000 | 0xFFFFFFFF | 0x16B560 | 0x16C560 | 0xD80 | | for__interp_ |
| cvt_ieee_t_to_text_ex | 27 | 45 | 0.600 | 0.05% | 0.06% | 71,982,000 | 119,970,000 | 0xFFFFFFFF | 0x181420 | 0x182420 | 0x13E0 | | cvt_ieee_t_ |

**Figura 11 Depois da otimização**

```
*** Efficiency: numerical solution 2D / analytic Q1D (dimensionless) ***

    1.000836328728610E+00 = discharge coefficient
    9.691914048072184E-01 = dynamic thrust
    9.752768908404300E-01 = pressure thrust at sea level (p = 101325 Pa)
    1.080533092655724E+00 = pressure thrust in the vacuum
    9.677277608885931E-01 = total thrust at sea level
    9.754462366605240E-01 = total thrust in the vacuum
    9.677277608885931E-01 = thrust coefficient at sea level
    9.754462366605239E-01 = thrust coefficient in the vacuum
    9.991643701326540E-01 = characterist velocity
    9.669190986681350E-01 = velocity of efective ejection at sea level
    9.746311246511803E-01 = velocity of efective ejection in the vacuum
    9.669190986681351E-01 = specific impulse at sea level
    9.746311246511804E-01 = specific impulse at vacuum


     0.000 = tcpuo: acumulated CPU time (s) (before interuption)
    59.875 = dtcpu: CPU time (s) (after interuption)
    59.875 = tcpu:  total CPU time (s)
```

**8)SUBROTINA:** COEFFICIENTS_mp_GET_VELOCITIES_AT_FACES: `SEN03_0008`

Foi utilizado apenas 1 único ciclo para cálculo das velocidades, com casos especiais para i = nx - 1 e j = ny - 1.

Houve uma redução de **24,100,640,000** ciclos de clock para **22,085,144,000 .** A rotina que utilizava **15,68%** do tempo total, agora utiliza **14,55%.**

| Name | CPU_ sampl | INST_R samples | Clocks per... | CPU_CL % | INST_R % | CPU_CLK_UNH events | INST_RETIRED events | Segment | Offset | RVA | Size | Class | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| MSI2D9_mp_FB2D9 | 9,146 | 14,415 | 0.634 | 15.86% | 19.99% | 24,383,236,000 | 38,430,390,000 | 0xFFFFFFFF | 0x59F80 | 0x5AF80 | 0xC860 | | MSI2D9_m |
| COEFFICIENTS_mp_GET_VELOCITIES_AT_FACES | 9,040 | 9,248 | 0.978 | 15.68% | 12.83% | 24,100,640,000 | 24,655,168,000 | 0xFFFFFFFF | 0xDC290 | 0xDD290 | 0x8810 | | COEFFICIE |
| MSI2D5_mp_FB2D5 | 8,273 | 14,417 | 0.574 | 14.35% | 20.00% | 22,055,818,000 | 38,435,722,000 | 0xFFFFFFFF | 0x3F7C0 | 0x407C0 | 0x9130 | | MSI2D5_m |
| MSI2D9_mp_LU2D9 | 6,136 | 7,551 | 0.813 | 10.64% | 10.47% | 16,358,576,000 | 20,130,966,000 | 0xFFFFFFFF | 0x667E0 | 0x677E0 | 0xAB60 | | MSI2D9_m |
| MSI2D5_mp_LU2D5 | 2,994 | 3,073 | 0.974 | 5.19% | 4.26% | 7,982,004,000 | 8,192,618,000 | 0xFFFFFFFF | 0x488F0 | 0x498F0 | 0x4BF0 | | MSI2D5_m |
| COEFFICIENTS_mp_GET_T_COEFFICIENTS_AND_SOURCE | 2,636 | 2,715 | 0.971 | 4.57% | 3.77% | 7,027,576,000 | 7,238,190,000 | 0xFFFFFFFF | 0xB8C30 | 0xB9C30 | 0xCBA0 | | COEFFICIE |
| SOLVERS_mp_NORM_L1_9D | 1,860 | 2,828 | 0.658 | 3.23% | 3.92% | 4,958,760,000 | 7,539,448,000 | 0xFFFFFFFF | 0xF33B0 | 0xF43B0 | 0xD50 | | SOLVERS_ |
| COEFFICIENTS_mp_GET_INTERNAL_SIMPLEC_COEFFICIENTS | 1,752 | 1,928 | 0.909 | 3.04% | 2.67% | 4,670,832,000 | 5,140,048,000 | 0xFFFFFFFF | 0xED3E0 | 0xEE3E0 | 0x2440 | | COEFFICIE |
| COEFFICIENTS_mp_GET_U_V_AT_REAL_NODES_WITH_PL | 1,686 | 1,377 | 1.224 | 2.92% | 1.91% | 4,494,876,000 | 3,671,082,000 | 0xFFFFFFFF | 0xEFB70 | 0xF0B70 | 0x1C00 | | COEFFICIE |
| COEFFICIENTS_mp_GET_U_SOURCE | 1,587 | 1,587 | 1.000 | 2.75% | 2.20% | 4,230,942,000 | 4,230,942,000 | 0xFFFFFFFF | 0x87FC0 | 0x88FC0 | 0x97B0 | | COEFFICIE |
| COEFFICIENTS_mp_GET_V_SOURCE | 1,519 | 1,639 | 0.927 | 2.63% | 2.27% | 4,049,654,000 | 4,369,574,000 | 0xFFFFFFFF | 0xA8AD0 | 0xA9AD0 | 0x8060 | | COEFFICIE |
| COEFFICIENTS_mp_GET_P_SOURCE | 1,444 | 2,342 | 0.617 | 2.50% | 3.25% | 3,849,704,000 | 6,243,772,000 | 0xFFFFFFFF | 0xD7200 | 0xD8200 | 0x2800 | | COEFFICIE |
| COEFFICIENTS_mp_GET_P_COEFFICIENTS | 1,245 | 2,053 | 0.606 | 2.16% | 2.85% | 3,319,170,000 | 5,473,298,000 | 0xFFFFFFFF | 0xD2900 | 0xD3900 | 0x2380 | | COEFFICIE |
| _intel_new_memset | 1,208 | 224 | 5.393 | 2.09% | 0.31% | 3,220,528,000 | 597,184,000 | 0xFFFFFFFF | 0x21B8E0 | 0x21C8E0 | 0x1560 | | _intel_new_ |
| COEFFICIENTS_mp_GET_U_COEFFICIENTS | 1,007 | 1,121 | 0.898 | 1.75% | 1.55% | 2,684,662,000 | 2,988,586,000 | 0xFFFFFFFF | 0x7A840 | 0x7B840 | 0x6B00 | | COEFFICIE |
| COEFFICIENTS_mp_GET_V_COEFFICIENTS | 888 | 1,110 | 0.800 | 1.54% | 1.54% | 2,367,408,000 | 2,959,260,000 | 0xFFFFFFFF | 0x9AFB0 | 0x9BFB0 | 0x6CD0 | | COEFFICIE |
| memset | 861 | 333 | 2.586 | 1.49% | 0.46% | 2,295,426,000 | 887,778,000 | 0xFFFFFFFF | 0x1C66F0 | 0x1C76F0 | 0xF0 | | memset |
| COEFFICIENTS_mp_GET_VELOCITIES_AT_INTERNAL_FACES_WITH_PL | 801 | 757 | 1.058 | 1.39% | 1.05% | 2,135,466,000 | 2,018,162,000 | 0xFFFFFFFF | 0xF1770 | 0xF2770 | 0x1450 | | COEFFICIE |
| _intel_new_memcpy | 799 | 136 | 5.875 | 1.39% | 0.19% | 2,130,134,000 | 362,576,000 | 0xFFFFFFFF | 0x21CE40 | 0x21DE40 | 0x23D0 | | _intel_new_ |
| COEFFICIENTS_mp_GET_DENSITY_AT_FACES | 527 | 1,114 | 0.473 | 0.91% | 1.55% | 1,404,982,000 | 2,969,924,000 | 0xFFFFFFFF | 0x79E90 | 0x7AE90 | 0x9B0 | | COEFFICIE |
| USER_mp_GET_THERMAL_CONDUCTIVITY_AT_FACES | 442 | 475 | 0.931 | 0.77% | 0.66% | 1,178,372,000 | 1,266,350,000 | 0xFFFFFFFF | 0xF4C20 | 0xF5C20 | 0x720 | | USER_mp_ |
| USER_mp_GET_LAMINAR_VISCOSITY_AT_FACES | 415 | 442 | 0.939 | 0.72% | 0.61% | 1,106,390,000 | 1,178,372,000 | 0xFFFFFFFF | 0xF4500 | 0xF5500 | 0x720 | | USER_mp_ |
| SOLVERS_mp_NORM_L1_5D | 302 | 499 | 0.605 | 0.52% | 0.69% | 805,132,000 | 1,330,334,000 | 0xFFFFFFFF | 0xF2BD0 | 0xF3BD0 | 0x7E0 | | SOLVERS_ |
| MAIN_ip_GET_NUMERICAL_SOLUTION | 127 | 18 | 7.056 | 0.22% | 0.02% | 338,582,000 | 47,988,000 | 0xFFFFFFFF | 0x121D00 | 0x122D00 | 0x5455 | | MAIN_ip_G |
| cvtas_t_to_a | 124 | 210 | 0.590 | 0.22% | 0.29% | 330,584,000 | 559,860,000 | 0xFFFFFFFF | 0x198E40 | 0x199E40 | 0x4320 | | cvtas_t_to_ |
| COEFFICIENTS_mp_GET_DENSITY_AT_NODES | 112 | 26 | 4.308 | 0.19% | 0.04% | 298,592,000 | 69,316,000 | 0xFFFFFFFF | 0x79C60 | 0x7AC60 | 0x230 | | COEFFICIE |
| COEFFICIENTS_mp_GET_PRESSURE_DENSITY_CORRECTION_WITH_PL | 106 | 46 | 2.304 | 0.18% | 0.06% | 282,596,000 | 122,636,000 | 0xFFFFFFFF | 0xEF820 | 0xF0820 | 0x350 | | COEFFICIE |
| USER_mp_SET_CP_AND_GAMMA | 78 | 12 | 6.500 | 0.14% | 0.02% | 207,948,000 | 31,992,000 | 0xFFFFFFFF | 0xF41D0 | 0xF51D0 | 0x1B0 | | USER_mp_ |
| USER_mp_GET_A9D_B_RESCALING | 62 | 64 | 0.969 | 0.11% | 0.09% | 165,292,000 | 170,624,000 | 0xFFFFFFFF | 0x10F520 | 0x110520 | 0x5830 | | USER_mp_ |
| USER_mp_SET_LAMINAR_VISCOSITY_AT_NODES | 47 | 7 | 6.714 | 0.08% | 0.01% | 125,302,000 | 18,662,000 | 0xFFFFFFFF | 0xF4380 | 0xF5380 | 0xC0 | | USER_mp_ |
| USER_mp_SET_BCP | 41 | 28 | 1.464 | 0.07% | 0.04% | 109,306,000 | 74,648,000 | 0xFFFFFFFF | 0x100920 | 0x101920 | 0x2D20 | | USER_mp_ |
| USER_mp_SET_BCV | 40 | 13 | 3.077 | 0.07% | 0.02% | 106,640,000 | 34,658,000 | 0xFFFFFFFF | 0xF8F50 | 0xF9F50 | 0x3C00 | | USER_mp_ |
| USER_mp_SET_THERMAL_CONDUCTIVITY_AT_NODES | 38 | 4 | 9.500 | 0.07% | 0.01% | 101,308,000 | 10,664,000 | 0xFFFFFFFF | 0xF4440 | 0xF5440 | 0xC0 | | USER_mp_ |
| USER_mp_GET_A5D_B_RESCALING | 30 | 37 | 0.811 | 0.05% | 0.05% | 79,980,000 | 98,642,000 | 0xFFFFFFFF | 0x10B1B0 | 0x10C1B0 | 0x4370 | | USER_mp_ |
| for_write_seq_fmt_xmit | 29 | 36 | 0.806 | 0.05% | 0.05% | 77,314,000 | 95,976,000 | 0xFFFFFFFF | 0x1446F0 | 0x1456F0 | 0x24B0 | | for_write_s |
| for__interp_fmt | 28 | 37 | 0.757 | 0.05% | 0.05% | 74,648,000 | 98,642,000 | 0xFFFFFFFF | 0x16B560 | 0x16C560 | 0xD80 | | for__interp_ |
| cvt_ieee_t_to_text_ex | 27 | 45 | 0.600 | 0.05% | 0.06% | 71,982,000 | 119,970,000 | 0xFFFFFFFF | 0x181420 | 0x182420 | 0x13E0 | | cvt_ieee_t_ |

**Figura 12 Antes da Otimização**

| Name | CPU_ sampl | INST_R samples | Clocks per... | CPU_CL % | INST_R % | CPU_CLK_UNH events | INST_RETIRED events | Segment | Offset | RVA | Size | Class | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| MSI2D9_mp_FB2D9 | 9,175 | 14,418 | 0.636 | 16.11% | 20.37% | 24,460,550,000 | 38,438,388,000 | 0xFFFFFFFF | 0x59F80 | 0x5AF80 | 0xC860 | | MSI2D9_m |
| MSI2D5_mp_FB2D5 | 8,335 | 14,386 | 0.579 | 14.64% | 20.33% | 22,221,110,000 | 38,353,076,000 | 0xFFFFFFFF | 0x3F7C0 | 0x407C0 | 0x9130 | | MSI2D5_m |
| COEFFICIENTS_mp_GET_VELOCITIES_AT_FACES | 8,284 | 7,919 | 1.046 | 14.55% | 11.19% | 22,085,144,000 | 21,112,054,000 | 0xFFFFFFFF | 0xDC290 | 0xDD290 | 0xEFB0 | | COEFFICIE |
| MSI2D9_mp_LU2D9 | 6,120 | 7,573 | 0.808 | 10.75% | 10.70% | 16,315,920,000 | 20,189,618,000 | 0xFFFFFFFF | 0x667E0 | 0x677E0 | 0xAB60 | | MSI2D9_m |
| MSI2D5_mp_LU2D5 | 3,008 | 3,086 | 0.975 | 5.28% | 4.36% | 8,019,328,000 | 8,227,276,000 | 0xFFFFFFFF | 0x488F0 | 0x498F0 | 0x4BF0 | | MSI2D5_m |
| COEFFICIENTS_mp_GET_T_COEFFICIENTS_AND_SOURCE | 2,606 | 2,701 | 0.965 | 4.58% | 3.82% | 6,947,596,000 | 7,200,866,000 | 0xFFFFFFFF | 0xB8C30 | 0xB9C30 | 0xCBA0 | | COEFFICIE |
| SOLVERS_mp_NORM_L1_9D | 1,815 | 2,778 | 0.653 | 3.19% | 3.93% | 4,838,790,000 | 7,406,148,000 | 0xFFFFFFFF | 0xF9B50 | 0xFAB50 | 0xD50 | | SOLVERS_ |
| COEFFICIENTS_mp_GET_INTERNAL_SIMPLEC_COEFFICIENTS | 1,777 | 1,926 | 0.923 | 3.12% | 2.72% | 4,737,482,000 | 5,134,716,000 | 0xFFFFFFFF | 0xF3B80 | 0xF4B80 | 0x2440 | | COEFFICIE |
| COEFFICIENTS_mp_GET_U_V_AT_REAL_NODES_WITH_PL | 1,724 | 1,405 | 1.227 | 3.03% | 1.93% | 4,596,184,000 | 3,745,730,000 | 0xFFFFFFFF | 0xF6310 | 0xF7310 | 0x1C00 | | COEFFICIE |
| COEFFICIENTS_mp_GET_U_SOURCE | 1,564 | 1,581 | 0.989 | 2.75% | 2.23% | 4,169,624,000 | 4,214,946,000 | 0xFFFFFFFF | 0x87FC0 | 0x88FC0 | 0x97B0 | | COEFFICIE |
| COEFFICIENTS_mp_GET_V_SOURCE | 1,555 | 1,595 | 0.975 | 2.73% | 2.25% | 4,145,630,000 | 4,252,270,000 | 0xFFFFFFFF | 0xA8AD0 | 0xA9AD0 | 0x8060 | | COEFFICIE |
| COEFFICIENTS_mp_GET_P_SOURCE | 1,431 | 2,344 | 0.610 | 2.51% | 3.31% | 3,815,046,000 | 6,249,104,000 | 0xFFFFFFFF | 0xD7200 | 0xD8200 | 0x2800 | | COEFFICIE |
| _intel_new_memset | 1,237 | 265 | 4.668 | 2.17% | 0.37% | 3,297,842,000 | 706,490,000 | 0xFFFFFFFF | 0x222080 | 0x223080 | 0x1560 | | _intel_new_ |
| COEFFICIENTS_mp_GET_P_COEFFICIENTS | 1,232 | 2,048 | 0.602 | 2.16% | 2.89% | 3,284,512,000 | 5,459,968,000 | 0xFFFFFFFF | 0xD2900 | 0xD3900 | 0x2380 | | COEFFICIE |
| COEFFICIENTS_mp_GET_U_COEFFICIENTS | 1,030 | 1,109 | 0.929 | 1.81% | 1.57% | 2,745,980,000 | 2,956,594,000 | 0xFFFFFFFF | 0x7A840 | 0x7B840 | 0x6B00 | | COEFFICIE |
| COEFFICIENTS_mp_GET_V_COEFFICIENTS | 902 | 1,158 | 0.779 | 1.58% | 1.64% | 2,404,732,000 | 3,087,228,000 | 0xFFFFFFFF | 0x9AFB0 | 0x9BFB0 | 0x6CD0 | | COEFFICIE |
| _intel_new_memcpy | 797 | 126 | 6.325 | 1.40% | 0.18% | 2,124,802,000 | 335,916,000 | 0xFFFFFFFF | 0x2235E0 | 0x2245E0 | 0x23D0 | | _intel_new_ |
| memset | 797 | 378 | 2.108 | 1.40% | 0.53% | 2,124,802,000 | 1,007,748,000 | 0xFFFFFFFF | 0x1CCE90 | 0x1CDE90 | 0xF0 | | memset |
| COEFFICIENTS_mp_GET_VELOCITIES_AT_INTERNAL_FACES_WITH_PL | 778 | 742 | 1.049 | 1.37% | 1.05% | 2,074,148,000 | 1,978,172,000 | 0xFFFFFFFF | 0xF7F10 | 0xF8F10 | 0x1450 | | COEFFICIE |
| COEFFICIENTS_mp_GET_DENSITY_AT_FACES | 570 | 1,162 | 0.491 | 1.00% | 1.64% | 1,519,620,000 | 3,097,892,000 | 0xFFFFFFFF | 0x79E90 | 0x7AE90 | 0x9B0 | | COEFFICIE |
| USER_mp_GET_LAMINAR_VISCOSITY_AT_FACES | 424 | 441 | 0.961 | 0.74% | 0.62% | 1,130,384,000 | 1,175,706,000 | 0xFFFFFFFF | 0xFACA0 | 0xFBCA0 | 0x720 | | USER_mp_ |
| USER_mp_GET_THERMAL_CONDUCTIVITY_AT_FACES | 420 | 487 | 0.862 | 0.74% | 0.69% | 1,119,720,000 | 1,298,342,000 | 0xFFFFFFFF | 0xFB3C0 | 0xFC3C0 | 0x720 | | USER_mp_ |
| SOLVERS_mp_NORM_L1_5D | 308 | 481 | 0.640 | 0.54% | 0.68% | 821,128,000 | 1,282,346,000 | 0xFFFFFFFF | 0xF9370 | 0xFA370 | 0x7E0 | | SOLVERS_ |
| MAIN_ip_GET_NUMERICAL_SOLUTION | 117 | 25 | 4.680 | 0.21% | 0.04% | 311,922,000 | 66,650,000 | 0xFFFFFFFF | 0x1284A0 | 0x1294A0 | 0x5455 | | MAIN_ip_G |
| COEFFICIENTS_mp_GET_DENSITY_AT_NODES | 112 | 35 | 3.200 | 0.20% | 0.05% | 298,592,000 | 93,310,000 | 0xFFFFFFFF | 0x79C60 | 0x7AC60 | 0x230 | | COEFFICIE |
| COEFFICIENTS_mp_GET_PRESSURE_DENSITY_CORRECTION_WITH_PL | 100 | 40 | 2.500 | 0.18% | 0.06% | 266,600,000 | 106,640,000 | 0xFFFFFFFF | 0xF5FC0 | 0xF6FC0 | 0x350 | | COEFFICIE |
| cvtas_t_to_a | 81 | 190 | 0.426 | 0.14% | 0.27% | 215,946,000 | 506,540,000 | 0xFFFFFFFF | 0x19F5E0 | 0x1A05E0 | 0x4320 | | cvtas_t_to_ |
| USER_mp_SET_CP_AND_GAMMA | 78 | 5 | 15.600 | 0.14% | 0.01% | 207,948,000 | 13,330,000 | 0xFFFFFFFF | 0xFA970 | 0xFB970 | 0x1B0 | | USER_mp_ |
| USER_mp_SET_LAMINAR_VISCOSITY_AT_NODES | 56 | 4 | 14.000 | 0.10% | 0.01% | 149,296,000 | 10,664,000 | 0xFFFFFFFF | 0xFAB20 | 0xFBB20 | 0xC0 | | USER_mp_ |
| USER_mp_GET_A9D_B_RESCALING | 51 | 67 | 0.761 | 0.09% | 0.09% | 135,966,000 | 178,622,000 | 0xFFFFFFFF | 0x115CC0 | 0x116CC0 | 0x5830 | | USER_mp_ |
| cvt_ieee_t_to_text_ex | 50 | 43 | 1.163 | 0.09% | 0.06% | 133,300,000 | 114,638,000 | 0xFFFFFFFF | 0x187BC0 | 0x188BC0 | 0x13E0 | | cvt_ieee_t_ |
| USER_mp_SET_BCP | 43 | 25 | 1.720 | 0.08% | 0.04% | 114,638,000 | 66,650,000 | 0xFFFFFFFF | 0x1070C0 | 0x1080C0 | 0x2D20 | | USER_mp_ |
| USER_mp_SET_BCU | 43 | 10 | 4.300 | 0.08% | 0.01% | 114,638,000 | 26,660,000 | 0xFFFFFFFF | 0xFBAE0 | 0xFCAE0 | 0x3C10 | | USER_mp_ |
| USER_mp_SET_THERMAL_CONDUCTIVITY_AT_NODES | 34 | 4 | 8.500 | 0.06% | 0.01% | 90,644,000 | 10,664,000 | 0xFFFFFFFF | 0xFABE0 | 0xFBBE0 | 0xC0 | | USER_mp_ |
| for_write_seq_fmt_xmit | 31 | 30 | 1.033 | 0.05% | 0.04% | 82,646,000 | 79,980,000 | 0xFFFFFFFF | 0x14AE90 | 0x14BE90 | 0x24B0 | | for_write_s |
| USER_mp_SET_BCV | 30 | 10 | 3.000 | 0.05% | 0.01% | 79,980,000 | 26,660,000 | 0xFFFFFFFF | 0xFF6F0 | 0x1006F0 | 0x3C00 | | USER_mp_ |
| USER_mp_GET_A5D_B_RESCALING | 25 | 28 | 0.893 | 0.04% | 0.04% | 66,650,000 | 74,648,000 | 0xFFFFFFFF | 0x111950 | 0x112950 | 0x4370 | | USER_mp_ |

**Figura 13 Depois da otimização**

```
*** Efficiency: numerical solution 2D / analytic Q1D (dimensionless) ***

    1.000836328728610E+00 = discharge coefficient
    9.691914048072184E-01 = dynamic thrust
    9.752768908404300E-01 = pressure thrust at sea level (p = 101325 Pa)
```

```
1.080533092655724E+00 = pressure thrust in the vacuum
9.677277608885931E-01 = total thrust at sea level
9.754462366605240E-01 = total thrust in the vacuum
9.677277608885931E-01 = thrust coefficient at sea level
9.754462366605239E-01 = thrust coefficient in the vacuum
9.991643701326540E-01 = characterist velocity
9.669190986681350E-01 = velocity of efective ejection at sea level
9.746311246511803E-01 = velocity of efective ejection in the vacuum
9.669190986681351E-01 = specific impulse at sea level
9.746311246511804E-01 = specific impulse at vacuum


     0.000 = tcpuo: acumulated CPU time (s) (before interuption)
    59.281 = dtcpu: CPU time (s) (after interuption)
    59.281 = tcpu:  total CPU time (s)
```

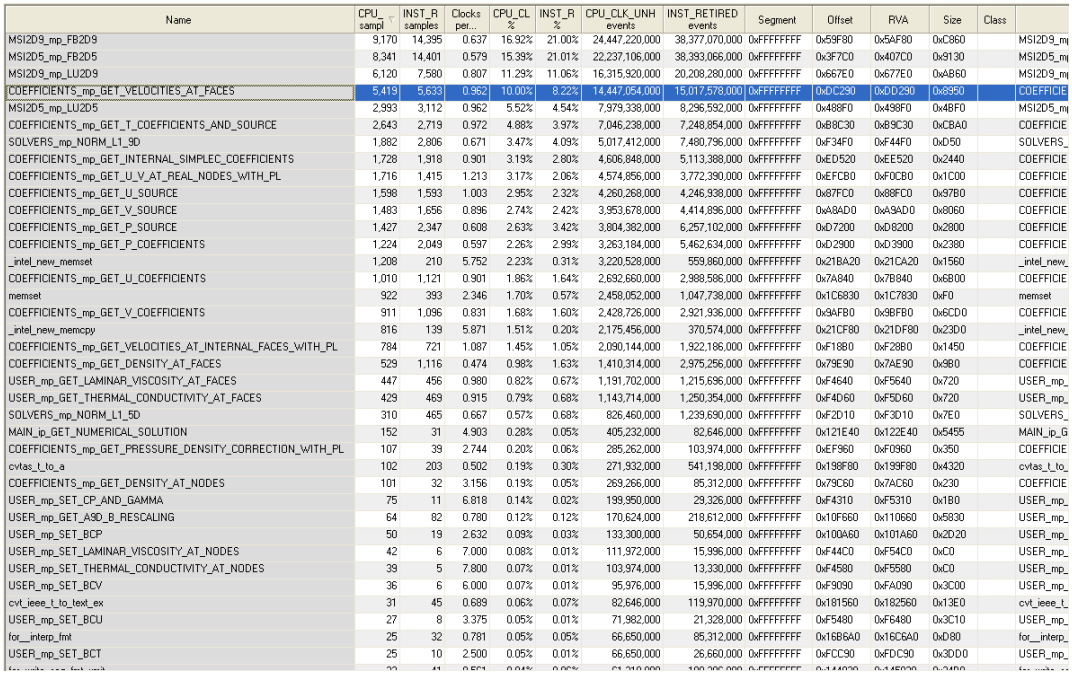
**9)SUBROTINA:** COEFFICIENTS_mp_GET_VELOCITIES_AT_FACES: SEN03_0009

Foi indexado sumup e sumvp.

Houve uma redução de **22,085,144,000** ciclos de clock para **14,447,054,000 .** A rotina que utilizava **14,55%.**do tempo total, agora utiliza **10,00%.**

| Name | CPU_ sampl | INST_R samples | Clocks per... | CPU_CL % | INST_R % | CPU_CLK_UNH events | INST_RETIRED events | Segment | Offset | RVA | Size | Class | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| MSI2D9_mp_FB2D9 | 9,175 | 14,418 | 0.636 | 16.11% | 20.37% | 24,460,550,000 | 38,438,388,000 | 0xFFFFFFFF | 0x59F80 | 0x5AF80 | 0xC860 | | MSI2D9_m |
| MSI2D5_mp_FB2D5 | 8,335 | 14,386 | 0.579 | 14.64% | 20.33% | 22,221,110,000 | 38,353,076,000 | 0xFFFFFFFF | 0x3F7C0 | 0x407C0 | 0x9130 | | MSI2D5_m |
| COEFFICIENTS_mp_GET_VELOCITIES_AT_FACES | 8,284 | 7,919 | 1.046 | 14.55% | 11.19% | 22,085,144,000 | 21,112,054,000 | 0xFFFFFFFF | 0xDC290 | 0xDD290 | 0xEFB0 | | COEFFICIE |
| MSI2D9_mp_LU2D9 | 6,120 | 7,573 | 0.808 | 10.75% | 10.70% | 16,315,920,000 | 20,189,618,000 | 0xFFFFFFFF | 0x667E0 | 0x677E0 | 0xAB60 | | MSI2D9_m |
| MSI2D5_mp_LU2D5 | 3,008 | 3,086 | 0.975 | 5.28% | 4.36% | 8,019,328,000 | 8,227,276,000 | 0xFFFFFFFF | 0x488F0 | 0x498F0 | 0x4BF0 | | MSI2D5_m |
| COEFFICIENTS_mp_GET_T_COEFFICIENTS_AND_SOURCE | 2,606 | 2,701 | 0.965 | 4.58% | 3.82% | 6,947,596,000 | 7,200,866,000 | 0xFFFFFFFF | 0xB8C30 | 0xB9C30 | 0xCBA0 | | COEFFICIE |
| SOLVERS_mp_NORM_L1_9D | 1,815 | 2,778 | 0.653 | 3.19% | 3.93% | 4,838,790,000 | 7,406,148,000 | 0xFFFFFFFF | 0xF9B50 | 0xFAB50 | 0xD50 | | SOLVERS_ |
| COEFFICIENTS_mp_GET_INTERNAL_SIMPLEC_COEFFICIENTS | 1,777 | 1,926 | 0.923 | 3.12% | 2.72% | 4,737,482,000 | 5,134,716,000 | 0xFFFFFFFF | 0xF3B80 | 0xF4B80 | 0x2440 | | COEFFICIE |
| COEFFICIENTS_mp_GET_U_V_AT_REAL_NODES_WITH_PL | 1,724 | 1,405 | 1.227 | 3.03% | 1.99% | 4,596,184,000 | 3,745,730,000 | 0xFFFFFFFF | 0xF6310 | 0xF7310 | 0x1C00 | | COEFFICIE |
| COEFFICIENTS_mp_GET_U_SOURCE | 1,564 | 1,581 | 0.989 | 2.75% | 2.23% | 4,169,624,000 | 4,214,946,000 | 0xFFFFFFFF | 0x87FC0 | 0x88FC0 | 0x97B0 | | COEFFICIE |
| COEFFICIENTS_mp_GET_V_SOURCE | 1,555 | 1,595 | 0.975 | 2.73% | 2.25% | 4,145,630,000 | 4,252,270,000 | 0xFFFFFFFF | 0xA8AD0 | 0xA9AD0 | 0x8060 | | COEFFICIE |
| COEFFICIENTS_mp_GET_P_SOURCE | 1,431 | 2,344 | 0.610 | 2.51% | 3.31% | 3,815,046,000 | 6,249,104,000 | 0xFFFFFFFF | 0xD7200 | 0xD8200 | 0x2800 | | COEFFICIE |
| _intel_new_memset | 1,237 | 265 | 4.668 | 2.17% | 0.37% | 3,297,842,000 | 706,490,000 | 0xFFFFFFFF | 0x222080 | 0x223080 | 0x1560 | | _intel_new |
| COEFFICIENTS_mp_GET_P_COEFFICIENTS | 1,232 | 2,048 | 0.602 | 2.16% | 2.89% | 3,284,512,000 | 5,459,968,000 | 0xFFFFFFFF | 0xD2900 | 0xD3900 | 0x2380 | | COEFFICIE |
| COEFFICIENTS_mp_GET_U_COEFFICIENTS | 1,030 | 1,109 | 0.929 | 1.81% | 1.57% | 2,745,980,000 | 2,956,594,000 | 0xFFFFFFFF | 0x7A840 | 0x7B840 | 0x6B00 | | COEFFICIE |
| COEFFICIENTS_mp_GET_V_COEFFICIENTS | 902 | 1,158 | 0.779 | 1.58% | 1.64% | 2,404,732,000 | 3,087,228,000 | 0xFFFFFFFF | 0x9AFB0 | 0x9BFB0 | 0x6CD0 | | COEFFICIE |
| _intel_new_memcpy | 797 | 126 | 6.325 | 1.40% | 0.18% | 2,124,802,000 | 335,916,000 | 0xFFFFFFFF | 0x2235E0 | 0x2245E0 | 0x23D0 | | _intel_new |
| memset | 797 | 378 | 2.108 | 1.40% | 0.53% | 2,124,802,000 | 1,007,748,000 | 0xFFFFFFFF | 0x1CCE90 | 0x1CDE90 | 0xF0 | | memset |
| COEFFICIENTS_mp_GET_VELOCITIES_AT_INTERNAL_FACES_WITH_PL | 778 | 742 | 1.049 | 1.37% | 1.05% | 2,074,148,000 | 1,978,172,000 | 0xFFFFFFFF | 0xF7F10 | 0xF8F10 | 0x1450 | | COEFFICIE |
| COEFFICIENTS_mp_GET_DENSITY_AT_FACES | 570 | 1,162 | 0.491 | 1.00% | 1.64% | 1,519,620,000 | 3,097,892,000 | 0xFFFFFFFF | 0x79E90 | 0x7AE90 | 0x9B0 | | COEFFICIE |
| USER_mp_GET_LAMINAR_VISCOSITY_AT_FACES | 424 | 441 | 0.961 | 0.74% | 0.62% | 1,130,384,000 | 1,175,706,000 | 0xFFFFFFFF | 0xFACA0 | 0xFBCA0 | 0x720 | | USER_mp_ |
| USER_mp_GET_THERMAL_CONDUCTIVITY_AT_FACES | 420 | 487 | 0.862 | 0.74% | 0.69% | 1,119,720,000 | 1,298,342,000 | 0xFFFFFFFF | 0xFB3C0 | 0xFC3C0 | 0x720 | | USER_mp_ |
| SOLVERS_mp_NORM_L1_5D | 308 | 481 | 0.640 | 0.54% | 0.68% | 821,128,000 | 1,282,346,000 | 0xFFFFFFFF | 0xF9370 | 0xFA370 | 0x7E0 | | SOLVERS_ |
| MAIN_ip_GET_NUMERICAL_SOLUTION | 117 | 25 | 4.680 | 0.21% | 0.04% | 311,922,000 | 66,650,000 | 0xFFFFFFFF | 0x1284A0 | 0x1294A0 | 0x5455 | | MAIN_ip_G |
| COEFFICIENTS_mp_GET_DENSITY_AT_NODES | 112 | 35 | 3.200 | 0.20% | 0.05% | 298,592,000 | 93,310,000 | 0xFFFFFFFF | 0x79C60 | 0x7AC60 | 0x230 | | COEFFICIE |
| COEFFICIENTS_mp_GET_PRESSURE_DENSITY_CORRECTION_WITH_PL | 100 | 40 | 2.500 | 0.18% | 0.06% | 266,600,000 | 106,640,000 | 0xFFFFFFFF | 0xF5FC0 | 0xF6FC0 | 0x350 | | COEFFICIE |
| cvtas_t_to_a | 81 | 190 | 0.426 | 0.14% | 0.27% | 215,946,000 | 506,540,000 | 0xFFFFFFFF | 0x19F5E0 | 0x1A05E0 | 0x4320 | | cvtas_t_to |
| USER_mp_SET_CP_AND_GAMMA | 78 | 5 | 15.600 | 0.14% | 0.01% | 207,948,000 | 13,330,000 | 0xFFFFFFFF | 0xFA970 | 0xFB970 | 0x1B0 | | USER_mp_ |
| USER_mp_SET_LAMINAR_VISCOSITY_AT_NODES | 56 | 4 | 14.000 | 0.10% | 0.01% | 149,296,000 | 10,664,000 | 0xFFFFFFFF | 0xFAB20 | 0xFBB20 | 0xC0 | | USER_mp_ |
| USER_mp_GET_A9D_B_RESCALING | 51 | 67 | 0.761 | 0.09% | 0.09% | 135,966,000 | 178,622,000 | 0xFFFFFFFF | 0x115CC0 | 0x116CC0 | 0x5830 | | USER_mp_ |
| cvt_ieee_t_to_text_ex | 50 | 43 | 1.163 | 0.09% | 0.06% | 133,300,000 | 114,638,000 | 0xFFFFFFFF | 0x187BC0 | 0x188BC0 | 0x13E0 | | cvt_ieee_t |
| USER_mp_SET_BCP | 43 | 25 | 1.720 | 0.08% | 0.04% | 114,638,000 | 66,650,000 | 0xFFFFFFFF | 0x1070C0 | 0x1080C0 | 0x2D20 | | USER_mp_ |
| USER_mp_SET_BCU | 43 | 10 | 4.300 | 0.08% | 0.01% | 114,638,000 | 26,660,000 | 0xFFFFFFFF | 0xFBAE0 | 0xFCAE0 | 0x3C10 | | USER_mp_ |
| USER_mp_SET_THERMAL_CONDUCTIVITY_AT_NODES | 34 | 4 | 8.500 | 0.06% | 0.01% | 90,644,000 | 10,664,000 | 0xFFFFFFFF | 0xFABE0 | 0xFBBE0 | 0xC0 | | USER_mp_ |
| for_write_seq_fmt_xmit | 31 | 30 | 1.033 | 0.05% | 0.04% | 82,646,000 | 79,980,000 | 0xFFFFFFFF | 0x14AE90 | 0x14BE90 | 0x24B0 | | for_write_s |
| USER_mp_SET_BCV | 30 | 10 | 3.000 | 0.05% | 0.01% | 79,980,000 | 26,660,000 | 0xFFFFFFFF | 0xFF6F0 | 0x1006F0 | 0x3C00 | | USER_mp_ |
| USER_mp_GET_A5D_B_RESCALING | 25 | 28 | 0.893 | 0.04% | 0.04% | 66,650,000 | 74,648,000 | 0xFFFFFFFF | 0x111950 | 0x112950 | 0x4370 | | USER_mp_ |

**Figura 14 Antes da Otimização**



| Name | CPU_ sampl | INST_R samples | Clocks per... | CPU_CL % | INST_R % | CPU_CLK_UNH events | INST_RETIRED events | Segment | Offset | RVA | Size | Class | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| MSI2D9_mp_FB2D9 | 9,170 | 14,395 | 0.637 | 16.92% | 21.00% | 24,447,220,000 | 38,377,070,000 | 0xFFFFFFFF | 0x59F80 | 0x5AF80 | 0xC860 | | MSI2D9_m |
| MSI2D5_mp_FB2D5 | 8,341 | 14,401 | 0.579 | 15.39% | 21.01% | 22,237,106,000 | 38,393,066,000 | 0xFFFFFFFF | 0x3F7C0 | 0x407C0 | 0x9130 | | MSI2D5_m |
| MSI2D9_mp_LU2D9 | 6,120 | 7,580 | 0.807 | 11.29% | 11.06% | 16,315,920,000 | 20,208,280,000 | 0xFFFFFFFF | 0x667E0 | 0x677E0 | 0xAB60 | | MSI2D9_m |
| COEFFICIENTS_mp_GET_VELOCITIES_AT_FACES | 5,419 | 5,633 | 0.962 | 10.00% | 8.22% | 14,447,054,000 | 15,017,578,000 | 0xFFFFFFFF | 0xDC290 | 0xDD290 | 0x8950 | | COEFFICIE |
| MSI2D5_mp_LU2D5 | 2,993 | 3,112 | 0.962 | 5.52% | 4.54% | 7,979,338,000 | 8,296,592,000 | 0xFFFFFFFF | 0x488F0 | 0x498F0 | 0x4BF0 | | MSI2D5_m |
| COEFFICIENTS_mp_GET_T_COEFFICIENTS_AND_SOURCE | 2,643 | 2,719 | 0.972 | 4.88% | 3.97% | 7,046,238,000 | 7,248,854,000 | 0xFFFFFFFF | 0xB8C30 | 0xB9C30 | 0xCBA0 | | COEFFICIE |
| SOLVERS_mp_NORM_L1_9D | 1,882 | 2,806 | 0.671 | 3.47% | 4.09% | 5,017,412,000 | 7,480,796,000 | 0xFFFFFFFF | 0xF34F0 | 0xF44F0 | 0xD50 | | SOLVERS_ |
| COEFFICIENTS_mp_GET_INTERNAL_SIMPLEC_COEFFICIENTS | 1,728 | 1,918 | 0.901 | 3.19% | 2.80% | 4,606,848,000 | 5,113,388,000 | 0xFFFFFFFF | 0xED520 | 0xEE520 | 0x2440 | | COEFFICIE |
| COEFFICIENTS_mp_GET_U_V_AT_REAL_NODES_WITH_PL | 1,716 | 1,415 | 1.213 | 3.17% | 2.06% | 4,574,856,000 | 3,772,390,000 | 0xFFFFFFFF | 0xEFCB0 | 0xF0CB0 | 0x1C00 | | COEFFICIE |
| COEFFICIENTS_mp_GET_U_SOURCE | 1,598 | 1,593 | 1.003 | 2.95% | 2.32% | 4,260,268,000 | 4,246,938,000 | 0xFFFFFFFF | 0x87FC0 | 0x88FC0 | 0x97B0 | | COEFFICIE |
| COEFFICIENTS_mp_GET_V_SOURCE | 1,483 | 1,656 | 0.896 | 2.74% | 2.42% | 3,953,678,000 | 4,414,896,000 | 0xFFFFFFFF | 0xA8AD0 | 0xA9AD0 | 0x8060 | | COEFFICIE |
| COEFFICIENTS_mp_GET_P_SOURCE | 1,427 | 2,347 | 0.608 | 2.63% | 3.42% | 3,804,382,000 | 6,257,102,000 | 0xFFFFFFFF | 0xD7200 | 0xD8200 | 0x2800 | | COEFFICIE |
| COEFFICIENTS_mp_GET_P_COEFFICIENTS | 1,224 | 2,049 | 0.597 | 2.26% | 2.99% | 3,263,184,000 | 5,462,634,000 | 0xFFFFFFFF | 0xD2900 | 0xD3900 | 0x2380 | | COEFFICIE |
| _intel_new_memset | 1,208 | 210 | 5.752 | 2.23% | 0.31% | 3,220,528,000 | 559,860,000 | 0xFFFFFFFF | 0x21BA20 | 0x21CA20 | 0x1560 | | _intel_new_ |
| COEFFICIENTS_mp_GET_U_COEFFICIENTS | 1,010 | 1,121 | 0.901 | 1.86% | 1.64% | 2,692,660,000 | 2,988,586,000 | 0xFFFFFFFF | 0x7A840 | 0x7B840 | 0x6B00 | | COEFFICIE |
| memset | 922 | 393 | 2.346 | 1.70% | 0.57% | 2,458,052,000 | 1,047,738,000 | 0xFFFFFFFF | 0x1C6830 | 0x1C7830 | 0xF0 | | memset |
| COEFFICIENTS_mp_GET_V_COEFFICIENTS | 911 | 1,096 | 0.831 | 1.68% | 1.60% | 2,428,726,000 | 2,921,936,000 | 0xFFFFFFFF | 0x9AFB0 | 0x9BFB0 | 0x6CD0 | | COEFFICIE |
| _intel_new_memcpy | 816 | 139 | 5.871 | 1.51% | 0.20% | 2,175,456,000 | 370,574,000 | 0xFFFFFFFF | 0x21CF80 | 0x21DF80 | 0x23D0 | | _intel_new_ |
| COEFFICIENTS_mp_GET_VELOCITIES_AT_INTERNAL_FACES_WITH_PL | 784 | 721 | 1.087 | 1.45% | 1.05% | 2,090,144,000 | 1,922,186,000 | 0xFFFFFFFF | 0xF1880 | 0xF2880 | 0x1450 | | COEFFICIE |
| COEFFICIENTS_mp_GET_DENSITY_AT_FACES | 529 | 1,116 | 0.474 | 0.98% | 1.63% | 1,410,314,000 | 2,975,256,000 | 0xFFFFFFFF | 0x79E90 | 0x7AE90 | 0x9B0 | | COEFFICIE |
| USER_mp_GET_LAMINAR_VISCOSITY_AT_FACES | 447 | 456 | 0.980 | 0.82% | 0.67% | 1,191,702,000 | 1,215,696,000 | 0xFFFFFFFF | 0xF4640 | 0xF5640 | 0x720 | | USER_mp_ |
| USER_mp_GET_THERMAL_CONDUCTIVITY_AT_FACES | 429 | 469 | 0.915 | 0.79% | 0.68% | 1,143,714,000 | 1,250,354,000 | 0xFFFFFFFF | 0xF4D60 | 0xF5D60 | 0x720 | | USER_mp_ |
| SOLVERS_mp_NORM_L1_5D | 310 | 465 | 0.667 | 0.57% | 0.68% | 826,460,000 | 1,239,690,000 | 0xFFFFFFFF | 0xF2D10 | 0xF3D10 | 0x7E0 | | SOLVERS_ |
| MAIN_ip_GET_NUMERICAL_SOLUTION | 152 | 31 | 4.903 | 0.28% | 0.05% | 405,232,000 | 82,646,000 | 0xFFFFFFFF | 0x121E40 | 0x122E40 | 0x5455 | | MAIN_ip_G |
| COEFFICIENTS_mp_GET_PRESSURE_DENSITY_CORRECTION_WITH_PL | 107 | 39 | 2.744 | 0.20% | 0.06% | 285,262,000 | 103,974,000 | 0xFFFFFFFF | 0xEF960 | 0xF0960 | 0x350 | | COEFFICIE |
| cvtas_t_to_a | 102 | 203 | 0.502 | 0.19% | 0.30% | 271,932,000 | 541,198,000 | 0xFFFFFFFF | 0x198F80 | 0x199F80 | 0x4320 | | cvtas_t_to_ |
| COEFFICIENTS_mp_GET_DENSITY_AT_NODES | 101 | 32 | 3.156 | 0.19% | 0.05% | 269,266,000 | 85,312,000 | 0xFFFFFFFF | 0x79C60 | 0x7AC60 | 0x230 | | COEFFICIE |
| USER_mp_SET_CP_AND_GAMMA | 75 | 11 | 6.818 | 0.14% | 0.02% | 199,950,000 | 29,326,000 | 0xFFFFFFFF | 0xF4310 | 0xF5310 | 0x1B0 | | USER_mp_ |
| USER_mp_GET_A9D_B_RESCALING | 64 | 82 | 0.780 | 0.12% | 0.12% | 170,624,000 | 218,612,000 | 0xFFFFFFFF | 0x10F660 | 0x110660 | 0x5830 | | USER_mp_ |
| USER_mp_SET_BCP | 50 | 19 | 2.632 | 0.09% | 0.03% | 133,300,000 | 50,654,000 | 0xFFFFFFFF | 0x100A60 | 0x101A60 | 0x2D20 | | USER_mp_ |
| USER_mp_SET_LAMINAR_VISCOSITY_AT_NODES | 42 | 6 | 7.000 | 0.08% | 0.01% | 111,972,000 | 15,996,000 | 0xFFFFFFFF | 0xF44C0 | 0xF54C0 | 0xC0 | | USER_mp_ |
| USER_mp_SET_THERMAL_CONDUCTIVITY_AT_NODES | 39 | 5 | 7.800 | 0.07% | 0.01% | 103,974,000 | 13,330,000 | 0xFFFFFFFF | 0xF4580 | 0xF5580 | 0xC0 | | USER_mp_ |
| USER_mp_SET_BCV | 36 | 6 | 6.000 | 0.07% | 0.01% | 95,976,000 | 15,996,000 | 0xFFFFFFFF | 0xF9090 | 0xFA090 | 0x3C00 | | USER_mp_ |
| cvt_ieee_t_to_text_ex | 31 | 45 | 0.689 | 0.06% | 0.07% | 82,646,000 | 119,970,000 | 0xFFFFFFFF | 0x181560 | 0x182560 | 0x13E0 | | cvt_ieee_t_ |
| USER_mp_SET_BCU | 27 | 8 | 3.375 | 0.05% | 0.01% | 71,982,000 | 21,328,000 | 0xFFFFFFFF | 0xF5480 | 0xF6480 | 0x3C10 | | USER_mp_ |
| for__interp_fmt | 25 | 32 | 0.781 | 0.05% | 0.05% | 66,650,000 | 85,312,000 | 0xFFFFFFFF | 0x16B6A0 | 0x16C6A0 | 0xD80 | | for__interp_ |
| USER_mp_SET_BCT | 25 | 10 | 2.500 | 0.05% | 0.01% | 66,650,000 | 26,660,000 | 0xFFFFFFFF | 0xFCC90 | 0xFDC90 | 0x3DD0 | | USER_mp_ |

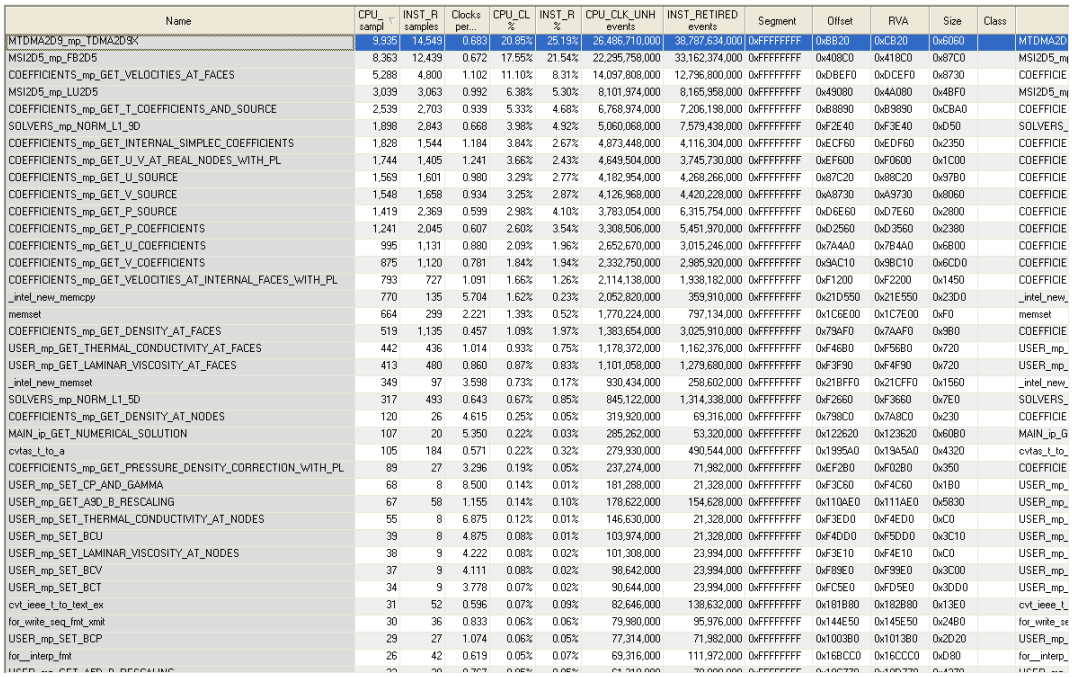
**Figura 15 Depois da otimização**

```
*** Efficiency: numerical solution 2D / analytic Q1D (dimensionless) ***

    1.000836328728610E+00 = discharge coefficient
    9.691914048072189E-01 = dynamic thrust
    9.752768908404302E-01 = pressure thrust at sea level (p = 101325 Pa)
    1.080533092655724E+00 = pressure thrust in the vacuum
    9.677277608885936E-01 = total thrust at sea level
    9.754462366605243E-01 = total thrust in the vacuum
    9.677277608885935E-01 = thrust coefficient at sea level
    9.754462366605243E-01 = thrust coefficient in the vacuum
    9.991643701326541E-01 = characterist velocity
    9.669190986681355E-01 = velocity of efective ejection at sea level
    9.746311246511808E-01 = velocity of efective ejection in the vacuum
    9.669190986681356E-01 = specific impulse at sea level
    9.746311246511810E-01 = specific impulse at vacuum


         0.000 = tcpuo: acumulated CPU time (s) (before interuption)
        56.281 = dtcpu: CPU time (s) (after interuption)
        56.281 = tcpu:  total CPU time (s)
```

COMPARACAO com uso do esquema de MSI no ciclo da massa e TDMAX nos outros sem paralelização (uso da biblioteca -qopenmp no command line) e MSI PURO:



| Name | CPU_ sampl | INST_R samples | Clocks per... | CPU_CL % | INST_R % | CPU_CLK_UNH events | INST_RETIRED events | Segment | Offset | RVA | Size | Class | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| MTDMA2D9_mp_TDMA2D9K | 9,935 | 14,549 | 0.683 | 20.95% | 25.19% | 26,486,710,000 | 38,787,634,000 | 0xFFFFFFFF | 0x8B20 | 0xCB20 | 0x6060 | | MTDMA2D |
| MSI2D5_mp_FB2D5 | 8,363 | 12,439 | 0.672 | 17.55% | 21.54% | 22,295,758,000 | 33,162,374,000 | 0xFFFFFFFF | 0x408C0 | 0x418C0 | 0x87C0 | | MSI2D5_m |
| COEFFICIENTS_mp_GET_VELOCITIES_AT_FACES | 5,288 | 4,800 | 1.102 | 11.10% | 8.31% | 14,097,808,000 | 12,796,800,000 | 0xFFFFFFFF | 0xDBEF0 | 0xDCEF0 | 0x8730 | | COEFFICIE |
| MSI2D5_mp_LU2D5 | 3,039 | 3,063 | 0.992 | 6.38% | 5.30% | 8,101,974,000 | 8,165,958,000 | 0xFFFFFFFF | 0x49080 | 0x4A080 | 0x4BF0 | | MSI2D5_m |
| COEFFICIENTS_mp_GET_T_COEFFICIENTS_AND_SOURCE | 2,539 | 2,703 | 0.939 | 5.33% | 4.68% | 6,768,974,000 | 7,206,198,000 | 0xFFFFFFFF | 0xB8890 | 0xB9890 | 0xCBA0 | | COEFFICIE |
| SOLVERS_mp_NORM_L1_9D | 1,898 | 2,843 | 0.668 | 3.98% | 4.92% | 5,060,068,000 | 7,579,438,000 | 0xFFFFFFFF | 0xF2E40 | 0xF3E40 | 0xD50 | | SOLVERS_ |
| COEFFICIENTS_mp_GET_INTERNAL_SIMPLEC_COEFFICIENTS | 1,828 | 1,544 | 1.184 | 3.84% | 2.67% | 4,873,448,000 | 4,116,304,000 | 0xFFFFFFFF | 0xECF60 | 0xEDF60 | 0x2350 | | COEFFICIE |
| COEFFICIENTS_mp_GET_U_V_AT_REAL_NODES_WITH_PL | 1,744 | 1,405 | 1.241 | 3.66% | 2.43% | 4,649,504,000 | 3,745,730,000 | 0xFFFFFFFF | 0xEF600 | 0xF0600 | 0x1C00 | | COEFFICIE |
| COEFFICIENTS_mp_GET_U_SOURCE | 1,569 | 1,601 | 0.980 | 3.29% | 2.77% | 4,182,954,000 | 4,268,266,000 | 0xFFFFFFFF | 0x87C20 | 0x88C20 | 0x97B0 | | COEFFICIE |
| COEFFICIENTS_mp_GET_V_SOURCE | 1,548 | 1,658 | 0.934 | 3.25% | 2.87% | 4,126,968,000 | 4,420,228,000 | 0xFFFFFFFF | 0xA8730 | 0xA9730 | 0x8060 | | COEFFICIE |
| COEFFICIENTS_mp_GET_P_SOURCE | 1,419 | 2,369 | 0.599 | 2.98% | 4.10% | 3,783,054,000 | 6,315,754,000 | 0xFFFFFFFF | 0xD6E60 | 0xD7E60 | 0x2800 | | COEFFICIE |
| COEFFICIENTS_mp_GET_P_COEFFICIENTS | 1,241 | 2,045 | 0.607 | 2.60% | 3.54% | 3,308,506,000 | 5,451,970,000 | 0xFFFFFFFF | 0xD2560 | 0xD3560 | 0x2380 | | COEFFICIE |
| COEFFICIENTS_mp_GET_U_COEFFICIENTS | 995 | 1,131 | 0.880 | 2.09% | 1.96% | 2,652,670,000 | 3,015,246,000 | 0xFFFFFFFF | 0x7A4A0 | 0x7B4A0 | 0x6B00 | | COEFFICIE |
| COEFFICIENTS_mp_GET_V_COEFFICIENTS | 875 | 1,120 | 0.781 | 1.84% | 1.94% | 2,332,750,000 | 2,985,920,000 | 0xFFFFFFFF | 0x9AC10 | 0x9BC10 | 0x6CD0 | | COEFFICIE |
| COEFFICIENTS_mp_GET_VELOCITIES_AT_INTERNAL_FACES_WITH_PL | 793 | 727 | 1.091 | 1.66% | 1.26% | 2,114,138,000 | 1,938,182,000 | 0xFFFFFFFF | 0xF1200 | 0xF2200 | 0x1450 | | COEFFICIE |
| _intel_new_memcpy | 770 | 135 | 5.704 | 1.62% | 0.23% | 2,052,820,000 | 359,910,000 | 0xFFFFFFFF | 0x21D550 | 0x21E550 | 0x23D0 | | _intel_new_ |
| memset | 664 | 299 | 2.221 | 1.39% | 0.52% | 1,770,224,000 | 797,134,000 | 0xFFFFFFFF | 0x1C6E00 | 0x1C7E00 | 0xF0 | | memset |
| COEFFICIENTS_mp_GET_DENSITY_AT_FACES | 519 | 1,135 | 0.457 | 1.09% | 1.97% | 1,383,654,000 | 3,025,910,000 | 0xFFFFFFFF | 0x79AF0 | 0x7AAF0 | 0x9B0 | | COEFFICIE |
| USER_mp_GET_THERMAL_CONDUCTIVITY_AT_FACES | 442 | 436 | 1.014 | 0.93% | 0.75% | 1,178,372,000 | 1,162,376,000 | 0xFFFFFFFF | 0xF46B0 | 0xF56B0 | 0x720 | | USER_mp_ |
| USER_mp_GET_LAMINAR_VISCOSITY_AT_FACES | 413 | 480 | 0.860 | 0.87% | 0.83% | 1,101,058,000 | 1,279,680,000 | 0xFFFFFFFF | 0xF3F90 | 0xF4F90 | 0x720 | | USER_mp_ |
| _intel_new_memset | 349 | 97 | 3.598 | 0.73% | 0.17% | 930,434,000 | 258,602,000 | 0xFFFFFFFF | 0x21BFF0 | 0x21CFF0 | 0x1560 | | _intel_new_ |
| SOLVERS_mp_NORM_L1_5D | 317 | 493 | 0.643 | 0.67% | 0.85% | 845,122,000 | 1,314,338,000 | 0xFFFFFFFF | 0xF2660 | 0xF3660 | 0x7E0 | | SOLVERS_ |
| COEFFICIENTS_mp_GET_DENSITY_AT_NODES | 120 | 26 | 4.615 | 0.25% | 0.05% | 319,920,000 | 69,316,000 | 0xFFFFFFFF | 0x798C0 | 0x7A8C0 | 0x230 | | COEFFICIE |
| MAIN_ip_GET_NUMERICAL_SOLUTION | 107 | 20 | 5.350 | 0.22% | 0.03% | 285,262,000 | 53,320,000 | 0xFFFFFFFF | 0x122620 | 0x123620 | 0x60B0 | | MAIN_ip_G |
| cvtas_t_to_a | 105 | 184 | 0.571 | 0.22% | 0.32% | 279,930,000 | 490,544,000 | 0xFFFFFFFF | 0x1995A0 | 0x19A5A0 | 0x4320 | | cvtas_t_to_ |
| COEFFICIENTS_mp_GET_PRESSURE_DENSITY_CORRECTION_WITH_PL | 89 | 27 | 3.296 | 0.19% | 0.05% | 237,274,000 | 71,982,000 | 0xFFFFFFFF | 0xEF2B0 | 0xF02B0 | 0x350 | | COEFFICIE |
| USER_mp_SET_CP_AND_GAMMA | 68 | 8 | 8.500 | 0.14% | 0.01% | 181,288,000 | 21,328,000 | 0xFFFFFFFF | 0xF3C60 | 0xF4C60 | 0x1B0 | | USER_mp_ |
| USER_mp_GET_A9D_B_RESCALING | 67 | 58 | 1.155 | 0.14% | 0.10% | 178,622,000 | 154,628,000 | 0xFFFFFFFF | 0x110AE0 | 0x111AE0 | 0x5830 | | USER_mp_ |
| USER_mp_SET_THERMAL_CONDUCTIVITY_AT_NODES | 55 | 8 | 6.875 | 0.12% | 0.01% | 146,630,000 | 21,328,000 | 0xFFFFFFFF | 0xF3ED0 | 0xF4ED0 | 0xC0 | | USER_mp_ |
| USER_mp_SET_BCU | 39 | 8 | 4.875 | 0.08% | 0.01% | 103,974,000 | 21,328,000 | 0xFFFFFFFF | 0xF4DD0 | 0xF5DD0 | 0x3C10 | | USER_mp_ |
| USER_mp_SET_LAMINAR_VISCOSITY_AT_NODES | 38 | 9 | 4.222 | 0.08% | 0.02% | 101,308,000 | 23,994,000 | 0xFFFFFFFF | 0xF3E10 | 0xF4E10 | 0xC0 | | USER_mp_ |
| USER_mp_SET_BCV | 37 | 9 | 4.111 | 0.08% | 0.02% | 98,642,000 | 23,994,000 | 0xFFFFFFFF | 0xF89E0 | 0xF99E0 | 0x3C00 | | USER_mp_ |
| USER_mp_SET_BCT | 34 | 9 | 3.778 | 0.07% | 0.02% | 90,644,000 | 23,994,000 | 0xFFFFFFFF | 0xFC5E0 | 0xFD5E0 | 0x3DD0 | | USER_mp_ |
| cvt_ieee_t_to_text_ex | 31 | 52 | 0.596 | 0.07% | 0.09% | 82,646,000 | 138,632,000 | 0xFFFFFFFF | 0x181B80 | 0x182B80 | 0x13E0 | | cvt_ieee_t_ |
| for_write_seq_fmt_xmit | 30 | 36 | 0.833 | 0.06% | 0.06% | 79,980,000 | 95,976,000 | 0xFFFFFFFF | 0x144E50 | 0x145E50 | 0x24B0 | | for_write_se |
| USER_mp_SET_BCP | 29 | 27 | 1.074 | 0.06% | 0.05% | 77,314,000 | 71,982,000 | 0xFFFFFFFF | 0x1003B0 | 0x1013B0 | 0x2D20 | | USER_mp_ |
| for__interp_fmt | 26 | 42 | 0.619 | 0.05% | 0.07% | 69,316,000 | 111,972,000 | 0xFFFFFFFF | 0x16BCC0 | 0x16CCC0 | 0xD80 | | for__interp_ |

**Figura 16 MSI no ciclo da massa e TDMAX nos outros : mach2d-SEN03_0011**

```
*** Efficiency: numerical solution 2D / analytic Q1D (dimensionless) ***

    1.000836328728610E+00 = discharge coefficient
    9.691914048072184E-01 = dynamic thrust
    9.752768908404300E-01 = pressure thrust at sea level (p = 101325 Pa)
    1.080533092655724E+00 = pressure thrust in the vacuum
    9.677277608885931E-01 = total thrust at sea level
    9.754462366605240E-01 = total thrust in the vacuum
    9.677277608885931E-01 = thrust coefficient at sea level
    9.754462366605239E-01 = thrust coefficient in the vacuum
    9.991643701326544E-01 = characterist velocity
    9.669190986681352E-01 = velocity of efective ejection at sea level
    9.746311246511806E-01 = velocity of efective ejection in the vacuum
    9.669190986681352E-01 = specific impulse at sea level
    9.746311246511807E-01 = specific impulse at vacuum


         0.000 = tcpuo: acumulated CPU time (s) (before interuption)
        49.390 = dtcpu: CPU time (s) (after interuption)
        49.390 = tcpu:  total CPU time (s)
```

| Name | CPU_ sampl | INST_R samples | Clocks per... | CPU_CL % | INST_R % | CPU_CLK_UNH events | INST_RETIRED events | Segment | Offset | RVA | Size | Class | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| MSI2D9_mp_FB2D9 | 8,787 | 12,889 | 0.682 | 16.34% | 20.20% | 23,426,142,000 | 34,362,074,000 | 0xFFFFFFFF | 0x5A6F0 | 0x5B6F0 | 0x8D50 | | MSI2D9_m |
| MSI2D5_mp_FB2D5 | 8,367 | 12,454 | 0.672 | 15.55% | 19.52% | 22,306,422,000 | 33,202,364,000 | 0xFFFFFFFF | 0x408C0 | 0x418C0 | 0x87C0 | | MSI2D5_m |
| MSI2D9_mp_LU2D9 | 6,058 | 7,510 | 0.807 | 11.26% | 11.77% | 16,150,628,000 | 20,021,660,000 | 0xFFFFFFFF | 0x66440 | 0x67440 | 0xAB60 | | MSI2D9_m |
| COEFFICIENTS_mp_GET_VELOCITIES_AT_FACES | 5,312 | 4,795 | 1.108 | 9.88% | 7.52% | 14,161,792,000 | 12,783,470,000 | 0xFFFFFFFF | 0xDBEF0 | 0xDCEF0 | 0x8730 | | COEFFICIE |
| MSI2D5_mp_LU2D5 | 3,000 | 3,076 | 0.975 | 5.58% | 4.82% | 7,998,000,000 | 8,200,616,000 | 0xFFFFFFFF | 0x49080 | 0x4A080 | 0x4BF0 | | MSI2D5_m |
| COEFFICIENTS_mp_GET_T_COEFFICIENTS_AND_SOURCE | 2,541 | 2,726 | 0.932 | 4.72% | 4.27% | 6,774,306,000 | 7,267,516,000 | 0xFFFFFFFF | 0xB8890 | 0xB9890 | 0xCBA0 | | COEFFICIE |
| SOLVERS_mp_NORM_L1_9D | 1,905 | 2,824 | 0.675 | 3.54% | 4.43% | 5,078,730,000 | 7,528,784,000 | 0xFFFFFFFF | 0xF2E40 | 0xF3E40 | 0xD50 | | SOLVERS_ |
| COEFFICIENTS_mp_GET_INTERNAL_SIMPLEC_COEFFICIENTS | 1,832 | 1,548 | 1.183 | 3.41% | 2.43% | 4,884,112,000 | 4,126,968,000 | 0xFFFFFFFF | 0xECF60 | 0xEDF60 | 0x2350 | | COEFFICIE |
| COEFFICIENTS_mp_GET_U_V_AT_REAL_NODES_WITH_PL | 1,733 | 1,372 | 1.263 | 3.22% | 2.15% | 4,620,178,000 | 3,657,752,000 | 0xFFFFFFFF | 0xEF600 | 0xF0600 | 0x1C00 | | COEFFICIE |
| COEFFICIENTS_mp_GET_U_SOURCE | 1,553 | 1,594 | 0.974 | 2.89% | 2.50% | 4,140,298,000 | 4,249,604,000 | 0xFFFFFFFF | 0x87C20 | 0x88C20 | 0x97B0 | | COEFFICIE |
| COEFFICIENTS_mp_GET_V_SOURCE | 1,547 | 1,657 | 0.934 | 2.88% | 2.60% | 4,124,302,000 | 4,417,562,000 | 0xFFFFFFFF | 0xA8730 | 0xA9730 | 0x8060 | | COEFFICIE |
| COEFFICIENTS_mp_GET_P_SOURCE | 1,464 | 2,352 | 0.622 | 2.72% | 3.69% | 3,903,024,000 | 6,270,432,000 | 0xFFFFFFFF | 0xD6E60 | 0xD7E60 | 0x2800 | | COEFFICIE |
| _intel_new_memset | 1,290 | 223 | 5.785 | 2.40% | 0.35% | 3,439,140,000 | 594,518,000 | 0xFFFFFFFF | 0x21BFF0 | 0x21CFF0 | 0x1560 | | _intel_new_ |
| COEFFICIENTS_mp_GET_P_COEFFICIENTS | 1,235 | 2,053 | 0.602 | 2.30% | 3.22% | 3,292,510,000 | 5,473,298,000 | 0xFFFFFFFF | 0xD2560 | 0xD3560 | 0x2380 | | COEFFICIE |
| COEFFICIENTS_mp_GET_U_COEFFICIENTS | 1,001 | 1,130 | 0.886 | 1.86% | 1.77% | 2,668,666,000 | 3,012,580,000 | 0xFFFFFFFF | 0x7A4A0 | 0x7B4A0 | 0x6B00 | | COEFFICIE |
| memset | 896 | 401 | 2.234 | 1.67% | 0.63% | 2,388,736,000 | 1,069,066,000 | 0xFFFFFFFF | 0x1C6E00 | 0x1C7E00 | 0xF0 | | memset |
| COEFFICIENTS_mp_GET_V_COEFFICIENTS | 882 | 1,112 | 0.793 | 1.64% | 1.74% | 2,351,412,000 | 2,964,592,000 | 0xFFFFFFFF | 0x9AC10 | 0x9BC10 | 0x6CD0 | | COEFFICIE |
| _intel_new_memcpy | 796 | 130 | 6.123 | 1.48% | 0.20% | 2,122,136,000 | 346,580,000 | 0xFFFFFFFF | 0x21D550 | 0x21E550 | 0x23D0 | | _intel_new_ |
| COEFFICIENTS_mp_GET_VELOCITIES_AT_INTERNAL_FACES_WITH_PL | 775 | 749 | 1.035 | 1.44% | 1.17% | 2,066,150,000 | 1,996,834,000 | 0xFFFFFFFF | 0xF1200 | 0xF2200 | 0x1450 | | COEFFICIE |
| COEFFICIENTS_mp_GET_DENSITY_AT_FACES | 552 | 1,128 | 0.489 | 1.03% | 1.77% | 1,471,632,000 | 3,007,248,000 | 0xFFFFFFFF | 0x79AF0 | 0x7AAF0 | 0x9B0 | | COEFFICIE |
| USER_mp_GET_THERMAL_CONDUCTIVITY_AT_FACES | 442 | 454 | 0.974 | 0.82% | 0.71% | 1,178,372,000 | 1,210,364,000 | 0xFFFFFFFF | 0xF46B0 | 0xF56B0 | 0x720 | | USER_mp_ |
| USER_mp_GET_LAMINAR_VISCOSITY_AT_FACES | 404 | 472 | 0.856 | 0.75% | 0.74% | 1,077,064,000 | 1,258,352,000 | 0xFFFFFFFF | 0xF3F90 | 0xF4F90 | 0x720 | | USER_mp_ |
| SOLVERS_mp_NORM_L1_5D | 312 | 495 | 0.630 | 0.58% | 0.78% | 831,792,000 | 1,319,670,000 | 0xFFFFFFFF | 0xF2660 | 0xF3660 | 0x7E0 | | SOLVERS_ |
| cvtas_t_to_a | 120 | 210 | 0.571 | 0.22% | 0.33% | 319,920,000 | 559,860,000 | 0xFFFFFFFF | 0x1995A0 | 0x19A5A0 | 0x4320 | | cvtas_t_to_ |
| MAIN_ip_GET_NUMERICAL_SOLUTION | 115 | 22 | 5.227 | 0.21% | 0.03% | 306,590,000 | 58,652,000 | 0xFFFFFFFF | 0x122620 | 0x123620 | 0x60B0 | | MAIN_ip_G |
| COEFFICIENTS_mp_GET_PRESSURE_DENSITY_CORRECTION_WITH_PL | 113 | 44 | 2.568 | 0.21% | 0.07% | 301,258,000 | 117,304,000 | 0xFFFFFFFF | 0xEF2B0 | 0xF02B0 | 0x350 | | COEFFICIE |
| COEFFICIENTS_mp_GET_DENSITY_AT_NODES | 95 | 22 | 4.318 | 0.18% | 0.03% | 253,270,000 | 58,652,000 | 0xFFFFFFFF | 0x798C0 | 0x7A8C0 | 0x230 | | COEFFICIE |
| USER_mp_SET_CP_AND_GAMMA | 93 | 6 | 15.500 | 0.17% | 0.01% | 247,938,000 | 15,996,000 | 0xFFFFFFFF | 0xF3C60 | 0xF4C60 | 0x1B0 | | USER_mp_ |
| USER_mp_GET_A9D_B_RESCALING | 67 | 62 | 1.081 | 0.12% | 0.10% | 178,622,000 | 165,292,000 | 0xFFFFFFFF | 0x110AE0 | 0x111AE0 | 0x5830 | | USER_mp_ |
| USER_mp_SET_THERMAL_CONDUCTIVITY_AT_NODES | 48 | 7 | 6.857 | 0.09% | 0.01% | 127,968,000 | 18,662,000 | 0xFFFFFFFF | 0xF3ED0 | 0xF4ED0 | 0xC0 | | USER_mp_ |
| USER_mp_SET_LAMINAR_VISCOSITY_AT_NODES | 47 | 6 | 7.833 | 0.09% | 0.01% | 125,302,000 | 15,996,000 | 0xFFFFFFFF | 0xF3E10 | 0xF4E10 | 0xC0 | | USER_mp_ |
| cvt_ieee_t_to_text_ex | 38 | 30 | 1.267 | 0.07% | 0.05% | 101,308,000 | 79,980,000 | 0xFFFFFFFF | 0x181B80 | 0x182B80 | 0x13E0 | | cvt_ieee_t_ |
| USER_mp_SET_BCP | 34 | 21 | 1.619 | 0.06% | 0.03% | 90,644,000 | 55,986,000 | 0xFFFFFFFF | 0x1003B0 | 0x1013B0 | 0x2D20 | | USER_mp_ |
| USER_mp_SET_BCT | 33 | 13 | 2.538 | 0.06% | 0.02% | 87,978,000 | 34,658,000 | 0xFFFFFFFF | 0xFC5E0 | 0xFD5E0 | 0x3DD0 | | USER_mp_ |
| for_write_seq_fmt_xmit | 30 | 30 | 1.000 | 0.06% | 0.05% | 79,980,000 | 79,980,000 | 0xFFFFFFFF | 0x144E50 | 0x145E50 | 0x24B0 | | for_write_se |
| USER_mp_SET_BCU | 28 | 6 | 4.667 | 0.05% | 0.01% | 74,648,000 | 15,996,000 | 0xFFFFFFFF | 0xF4DD0 | 0xF5DD0 | 0x3C10 | | USER_mp_ |
| USER_mp_SET_BCV | 27 | 1 | 27.000 | 0.05% | 0.00% | 71,982,000 | 2,666,000 | 0xFFFFFFFF | 0xF89E0 | 0xF99E0 | 0x3C00 | | USER_mp_ |
| USER_mp_GET_A9D_B_RESCALING | 25 | 21 | 1.190 | 0.05% | 0.03% | 66,650,000 | 55,986,000 | 0xFFFFFFFF | 0x19C770 | 0x19D770 | 0x4270 | | USER_mp_ |

**Figura 17 MSI puro : mach2d-SEN03_0012**

```
*** Efficiency: numerical solution 2D / analytic Q1D (dimensionless) ***

    1.000836328728610E+00 = discharge coefficient
    9.691914048072191E-01 = dynamic thrust
    9.752768908404300E-01 = pressure thrust at sea level (p = 101325 Pa)
    1.080533092655724E+00 = pressure thrust in the vacuum
    9.677277608885939E-01 = total thrust at sea level
    9.754462366605247E-01 = total thrust in the vacuum
    9.677277608885938E-01 = thrust coefficient at sea level
    9.754462366605245E-01 = thrust coefficient in the vacuum
    9.991643701326544E-01 = characterist velocity
    9.669190986681360E-01 = velocity of efective ejection at sea level
    9.746311246511813E-01 = velocity of efective ejection in the vacuum
    9.669190986681360E-01 = specific impulse at sea level
    9.746311246511813E-01 = specific impulse at vacuum


         0.000 = tcpuo: acumulated CPU time (s) (before interuption)
        55.813 = dtcpu: CPU time (s) (after interuption)
        55.813 = tcpu:  total CPU time (s)
```

# C - RESUMO DAS MODIFICAÇÕES em relação a versão do mach2D recebida pelo Guilherme Bertoldo:

1) **Foi retirada a linha de declaração da variável 'g' no 'main.f90', senão o programa nem rodava.**
2) **Criou-se uma pasta com os arquivos do gnuplot na raiz do mach2D, assim a subrotina 'postp.f90' usa a variável character *gnuplot* = ".\gnuplot\gnuplot ".**
3) **Em todas as subrotinas que utilizavam um ciclo em 'j' e outro em 'i', foi criado uma variável auxiliar 'aux_i' para receber parte do índice:**
   **aux_i = (j-1) * nx**
   **índice = aux_i + i**
4) **Em todas as subrotinas que faziam a divisão de um número constante, foi feito uma multiplicação por um número constante, por exemplo:**

**- ao invés de '1/4', utilizou-se '0.25d0'.**
**- Fez-se ao invés de '1/3', '3.333333333333333d-1', mas o professor Manoel de Computação de Alto Desempenho não aprovou esta mudança, diz ele que pode acrescentar erros de arredondamento á solução numérica.**

**Pelas otimizações acima, notou-se que a divisão por 'dt' também consome muito tempo computacional, então criar uma variável auxiliar 'inv_dt' é uma recomendação minha que pode economizar um tempo computacional considerável.**

5) **Adicionou-se a opção de 5 esquemas de solver:**
   **0) Msi puro;**
   **1)TDMA-XY;**
   **2) TDMA-X;**
   **3) MSI em p' e TDMAX em u, v e T ;**
   **4) MSI em p' e Gauss-Siedel em u, v e T.**
   **Bastando apenas alterar uma variável no arquivo de entrada de dados (utilizou-se 'select case' para escolher entre elas.**
6) **Alterou-se a posição de algumas linhas de código do 'main.f90', como a escrita do cabeçalho para fora do ciclo externo do programa.**
7) **As rotinas do solver TDMA foram otimizadas para tirar os if's do programa, tendo casos especiais, ao invés de if's**
8) **Na subrotina get_T_coefficients_and_source, foi criado uma variável inv_dt para armazenar a inversa de dt**
9) **Na subrotina get_internal_simplec_coefficients, foi indexado soma_au e soma_av**
10) **Na subrotina get_velocities_at_faces foi criado uma variável para armazenar a inversa de dt, foi indexado mpa, sumup e sumvp além de agrupar os dois ciclos em apenas um com casos especiais.**

## D – REFINO PG

**- Fazer refino PG no mach2D é mais fácil do que se pensava, basta fazer o seguinte:**

**Por exemplo num refino 2 nas duas direções, o primeiro volume será dividido por 2 (na direção transversal), ou seja, na malha refinada basta utilizar um 'a1 grosso' dividido por 2, que obter-se-á o refino PG**

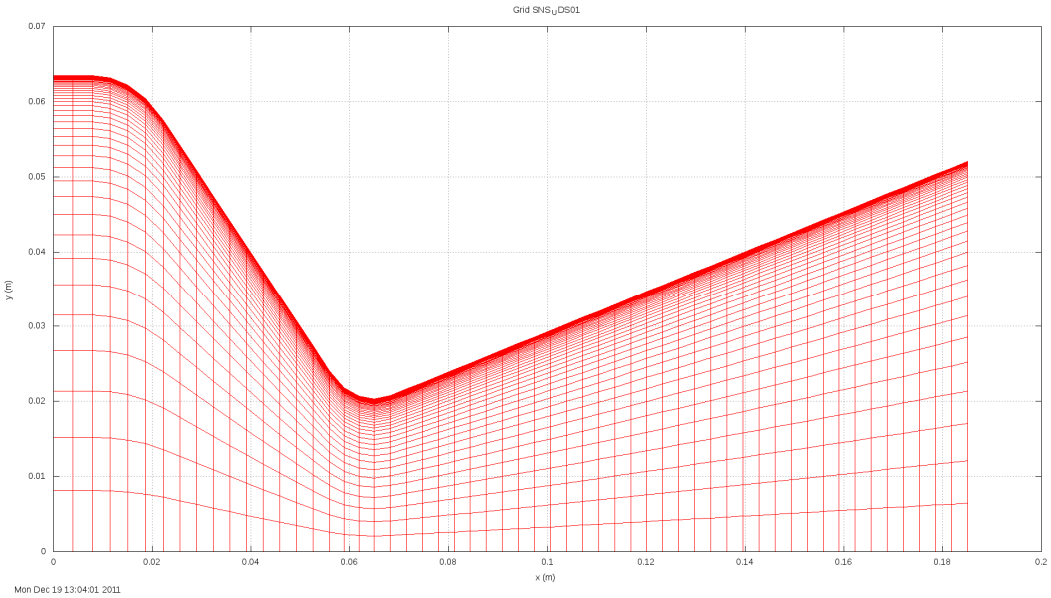



**Figura 18 Malha – base do refino PG de 19/12/11**

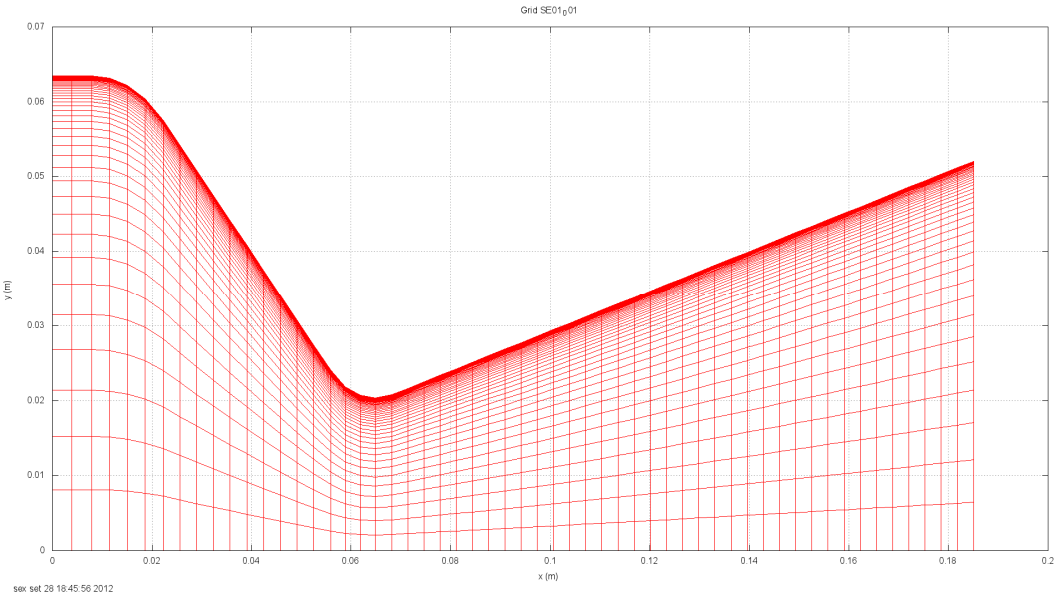



**Figura 19 Malha – base do refino PG 'NOVO'**

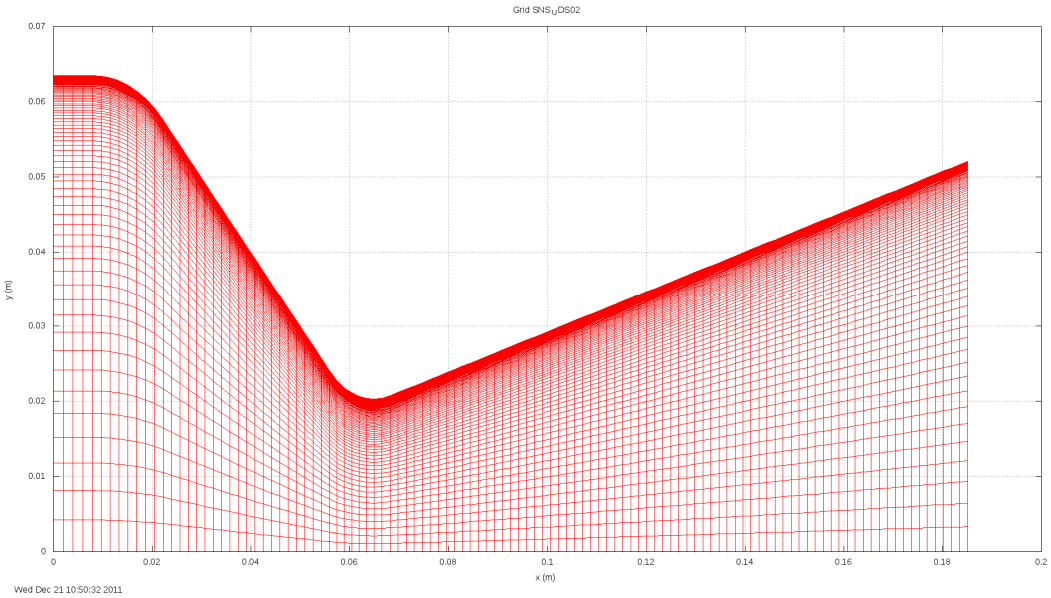



**Figura 20 Malha - base * 2 do refino PG de 21/12/11**

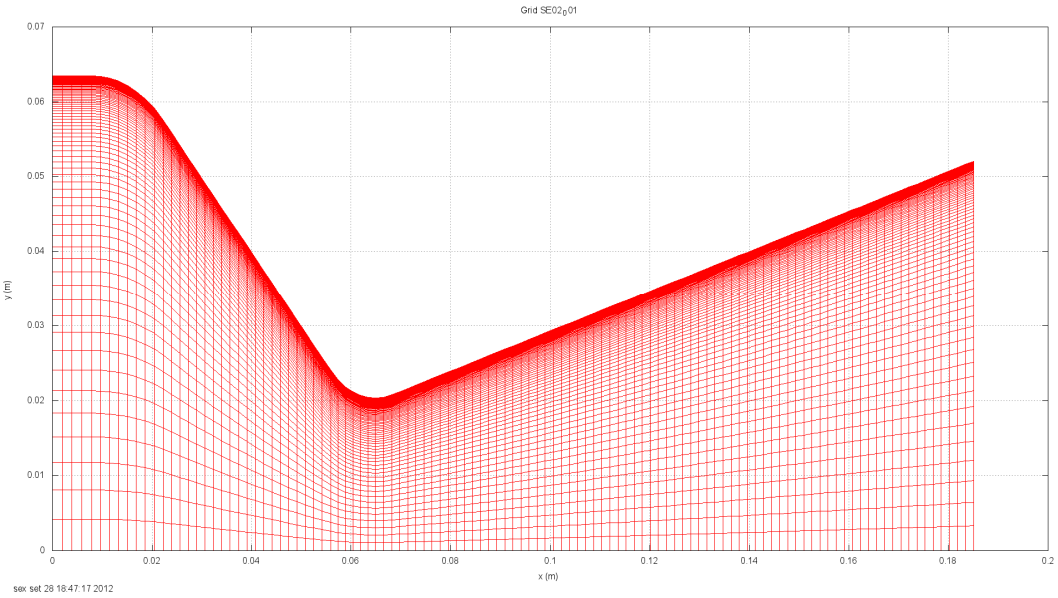



**Figura 21 Malha - base * 2 do refino PG 'NOVO'**

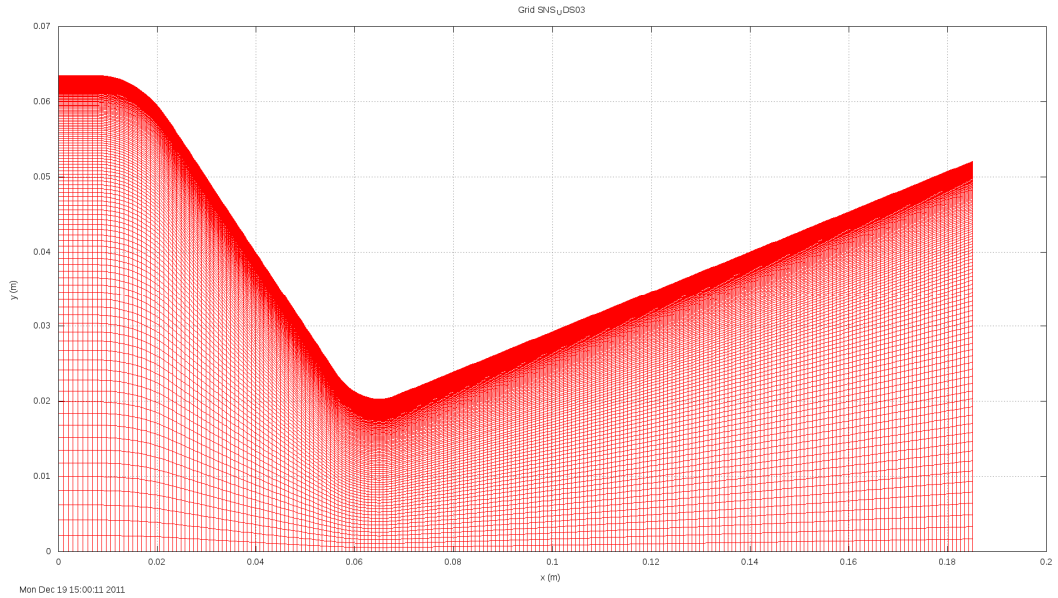



**Figura 22 Malha - base * 4 do refino PG de 19/12/11**

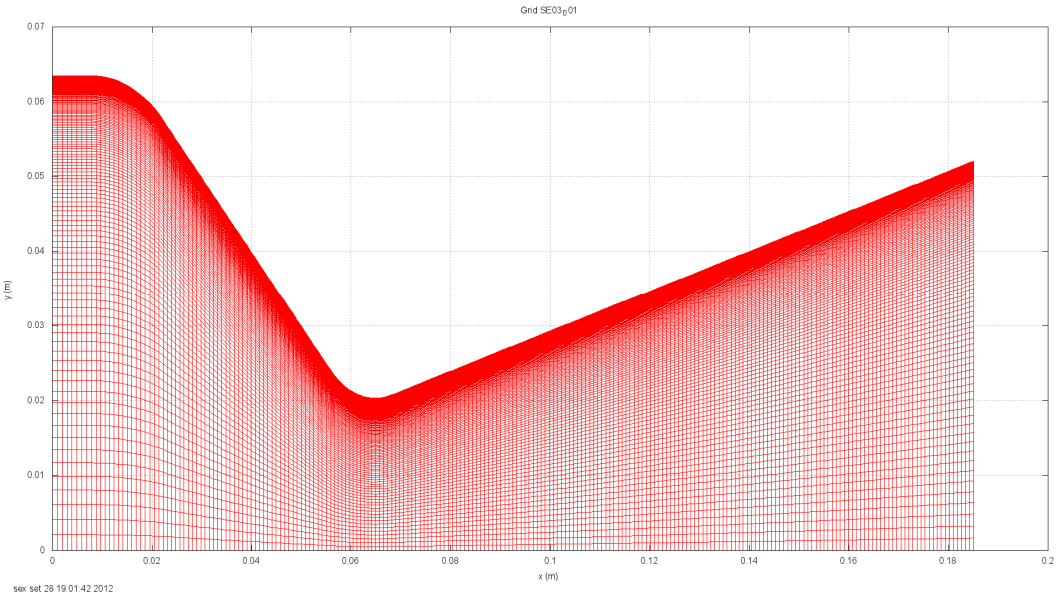



**Figura 23 Malha - base * 4 do refino PG 'NOVO'**

## E - CONCLUSÕES

**- Nesta versão do mach2D, realmente não há efeito 'dt' na solução, utilizando-se um dt maior ou menor. O mesmo foi verificado para o uso de diferentes solvers.**

**- O uso do fator E não funciona para 'u' e 'v', apenas para p' e T.**
**Tendo como base um dt fixo para todas as variáveis, é possível encontrar um fator E para p' e T que diminua o tempo computacional, mantendo-se fixo um dt para 'u' e 'v'.**

**- O Esquema com MSI em p' e TDMAX em u, v e T é o melhor esquema de solver para o mach2D-Euler, mas ao simular-se mach2D-Navier_Stokes notou-se que MSI puro é o melhor esquema.**

**Anteriormente, concluiu-se que o esquema com MSI em p' e Gauss-Seidel em u, v e T era mais rápido, mas na versão atual retirou-se o cálculo do resíduo do solver TDMAX, o que diminuiu o tempo computacional o suficiente para tornar o esquema com MSI e TDMAX o mais rápido.**

**- Com o Vtune é possível analisar o tempo computacional subrotina por subrotina, o que é muito importante no mach2D que possui muitas subrotinas.**

**Algumas delas consomem pouquíssimo tempo computacional e outras, surpreendentemente, consumiam maior tempo computacional que o próprio solver.**

**Isto é importantíssimo para a otimização, pois uma pequena alteração na rotina que mais consome tempo de CPU pode melhorar muito o programa. Basta ver a idéia de utilizar uma variável auxiliar para armazenar a inversa de dt (strength reduction), o que diminuiu em quase 1 bilhão e 700 milhões de ciclos de clock da subrotina get_velocities_at_faces.**

**- Otimizou-se várias subrotinas com o Vtune, sendo a mais importante a subrotina get_velocities_at_faces.**
**Foi possível partir de um tempo computacional de 61,329 s para 56,281 s (MSI puro com a biblioteca -Qopenmp habilitada)**

**Isto numa malha de 224x80 nós, numa malha mais fina, será possível observar melhor o ganho computacional.**

**Também, num computador melhor, o programa será mais rápido, no Intel i5, a mesma malha com os mesmos parâmetros consumia 22,887 s (antes das otimizações), agora utilizou 20,200 s (após as otimizações).**

**- Para fazer refino PG, basta utilizar um 'a1 refinado' = 'a1 grosso' / 2**