Relatório 3 para a reunião 04 do grupo de otimização do mach2D

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Data: **17 a 18/10/12**

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A - OTIMIZAÇÃO DAS SUBROTINAS DO MACH2D USANDO O PROGRAMA 'Intel(R) VTune(TM) Performance Analyzer 9.1 - parte 2'

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 (se ela é lenta, apenas o CPI (Clock per instruction) pode mostrar, se este valor é alto significa que a subrotina é lenta computacionalmente).

- 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 RELATÓRIO ANTERIOR, simulação: `SEN03_0013`

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	8,800	12,862	0.684	16.40%	20.15%	23,460,800,000	34,290,092,000	0xFFFFFFFF	0x5A6F0	0x5B6F0	0xBD50		MSI2D9_m
MSI2D5_mp_FB2D5	8,433	12,466	0.676	15.72%	19.53%	22,482,378,000	33,234,356,000	0xFFFFFFFF	0x408C0	0x418C0	0x87C0		MSI2D5_m
MSI2D9_mp_LU2D9	6,056	7,543	0.803	11.29%	11.82%	16,145,296,000	20,109,638,000	0xFFFFFFFF	0x66440	0x67440	0xAB60		MSI2D9_m
COEFFICIENTS_mp_GET_VELOCITIES_AT_FACES	5,275	4,788	1.102	9.83%	7.50%	14,063,150,000	12,764,808,000	0xFFFFFFFF	0xDBEF0	0xDCEF0	0x8730		COEFFICIE
MSI2D5_mp_LU2D5	3,022	3,081	0.981	5.63%	4.83%	8,056,652,000	8,213,946,000	0xFFFFFFFF	0x49080	0x4A080	0x4BF0		MSI2D5_m
COEFFICIENTS_mp_GET_T_COEFFICIENTS_AND_SOURCE	2,534	2,744	0.923	4.72%	4.30%	6,755,644,000	7,315,504,000	0xFFFFFFFF	0xB8890	0xB9890	0xCBA0		COEFFICIE
SOLVERS_mp_NORM_L1_9D	1,895	2,820	0.672	3.53%	4.42%	5,052,070,000	7,518,120,000	0xFFFFFFFF	0x11B7B0	0x11C7B0	0xD50		SOLVERS_
COEFFICIENTS_mp_GET_INTERNAL_SIMPLEC_COEFFICIENTS	1,794	1,546	1.160	3.34%	2.42%	4,782,804,000	4,121,636,000	0xFFFFFFFF	0xECF60	0xEDF60	0x2350		COEFFICIE
COEFFICIENTS_mp_GET_U_V_AT_REAL_NODES_WITH_PL	1,738	1,389	1.251	3.24%	2.18%	4,633,508,000	3,703,074,000	0xFFFFFFFF	0xEF600	0xF0600	0x1C00		COEFFICIE
COEFFICIENTS_mp_GET_U_SOURCE	1,593	1,573	1.013	2.97%	2.46%	4,246,938,000	4,193,618,000	0xFFFFFFFF	0x87C20	0x88C20	0x97B0		COEFFICIE
COEFFICIENTS_mp_GET_V_SOURCE	1,513	1,641	0.922	2.82%	2.57%	4,033,658,000	4,374,906,000	0xFFFFFFFF	0xA8730	0xA9730	0x8060		COEFFICIE
COEFFICIENTS_mp_GET_P_SOURCE	1,442	2,344	0.615	2.69%	3.67%	3,844,372,000	6,249,104,000	0xFFFFFFFF	0xD6E60	0xD7E60	0x2800		COEFFICIE
COEFFICIENTS_mp_GET_P_COEFFICIENTS	1,231	2,072	0.594	2.29%	3.25%	3,281,846,000	5,523,952,000	0xFFFFFFFF	0xD2560	0xD3560	0x2380		COEFFICIE
_intel_new_memset	1,206	224	5.384	2.25%	0.35%	3,215,196,000	597,184,000	0xFFFFFFFF	0x21BFF0	0x21CFF0	0x1560		_intel_new_
COEFFICIENTS_mp_GET_U_COEFFICIENTS	989	1,121	0.882	1.84%	1.76%	2,636,674,000	2,988,586,000	0xFFFFFFFF	0x7A4A0	0x7B4A0	0x6B00		COEFFICIE
memset	906	362	2.503	1.69%	0.57%	2,415,396,000	965,092,000	0xFFFFFFFF	0x1C6E00	0x1C7E00	0xF0		memset
COEFFICIENTS_mp_GET_V_COEFFICIENTS	892	1,127	0.791	1.66%	1.77%	2,378,072,000	3,004,582,000	0xFFFFFFFF	0x9AC10	0x9BC10	0x6CD0		COEFFICIE
_intel_new_memcpy	816	124	6.581	1.52%	0.19%	2,175,456,000	330,584,000	0xFFFFFFFF	0x21D550	0x21E550	0x23D0		_intel_new_
COEFFICIENTS_mp_GET_VELOCITIES_AT_INTERNAL_FACES_WITH_PL	764	747	1.023	1.42%	1.17%	2,036,824,000	1,991,502,000	0xFFFFFFFF	0xF1200	0xF2200	0x1450		COEFFICIE
COEFFICIENTS_mp_GET_DENSITY_AT_FACES	526	1,124	0.468	0.98%	1.76%	1,402,316,000	2,996,584,000	0xFFFFFFFF	0x79AF0	0x7AAF0	0x9B0		COEFFICIE
USER_mp_GET_LAMINAR_VISCOSITY_AT_FACES	437	455	0.960	0.81%	0.71%	1,165,042,000	1,213,030,000	0xFFFFFFFF	0xF2A50	0xF3A50	0x720		USER_mp_
USER_mp_GET_THERMAL_CONDUCTIVITY_AT_FACES	409	469	0.872	0.76%	0.73%	1,090,394,000	1,250,354,000	0xFFFFFFFF	0xF3170	0xF4170	0x720		USER_mp_
SOLVERS_mp_NORM_L1_5D	316	493	0.641	0.59%	0.77%	842,456,000	1,314,338,000	0xFFFFFFFF	0x11AFD0	0x11BFD0	0x7E0		SOLVERS_
MAIN_ip_GET_NUMERICAL_SOLUTION	132	15	8.800	0.25%	0.02%	351,912,000	39,990,000	0xFFFFFFFF	0x122620	0x123620	0x60B0		MAIN_ip_G
COEFFICIENTS_mp_GET_DENSITY_AT_NODES	120	30	4.000	0.22%	0.05%	319,920,000	79,980,000	0xFFFFFFFF	0x798C0	0x7A8C0	0x230		COEFFICIE
COEFFICIENTS_mp_GET_PRESSURE_DENSITY_CORRECTION_WITH_PL	98	40	2.450	0.18%	0.06%	261,268,000	106,640,000	0xFFFFFFFF	0xEF2B0	0xF02B0	0x350		COEFFICIE
USER_mp_SET_CP_AND_GAMMA	79	11	7.182	0.15%	0.02%	210,614,000	29,326,000	0xFFFFFFFF	0xF2720	0xF3720	0x1B0		USER_mp_
cvtas_t_to_a	77	204	0.377	0.14%	0.32%	205,282,000	543,864,000	0xFFFFFFFF	0x1995A0	0x19A5A0	0x4320		cvtas_t_to_
USER_mp_GET_A9D_B_RESCALING	67	74	0.905	0.12%	0.12%	178,622,000	197,284,000	0xFFFFFFFF	0x10F5A0	0x1105A0	0x5830		USER_mp_
USER_mp_SET_THERMAL_CONDUCTIVITY_AT_NODES	51	6	8.500	0.10%	0.01%	135,966,000	15,996,000	0xFFFFFFFF	0xF2990	0xF3990	0xC0		USER_mp_
USER_mp_SET_LAMINAR_VISCOSITY_AT_NODES	49	1	49.000	0.09%	0.00%	130,634,000	2,666,000	0xFFFFFFFF	0xF28D0	0xF38D0	0xC0		USER_mp_
USER_mp_SET_BCP	41	22	1.864	0.08%	0.03%	109,306,000	58,652,000	0xFFFFFFFF	0xFEE70	0xFFE70	0x2D20		USER_mp_
for__interp_fmt	38	39	0.974	0.07%	0.06%	101,308,000	103,974,000	0xFFFFFFFF	0x16BCC0	0x16CCC0	0xD80		for__interp_
cvt_ieee_t_to_text_ex	35	33	1.061	0.07%	0.05%	93,310,000	87,978,000	0xFFFFFFFF	0x181B80	0x182B80	0x13E0		cvt_ieee_t_
USER_mp_SET_BCV	33	13	2.538	0.06%	0.02%	87,978,000	34,658,000	0xFFFFFFFF	0xF74A0	0xF84A0	0x3C00		USER_mp_
USER_mp_SET_BCT	27	12	2.250	0.05%	0.02%	71,982,000	31,992,000	0xFFFFFFFF	0xFB0A0	0xFC0A0	0x3DD0		USER_mp_
USER_mp_SET_BCU	25	14	1.786	0.05%	0.02%	66,650,000	37,324,000	0xFFFFFFFF	0xF3890	0xF4890	0x3C10		USER_mp_

Figura 1 Versão ANTERIOR

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*** 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
    9.991643701326544E-01 = characterist velocity
    9.669190986681354E-01 = velocity of efective ejection at sea level
    9.746311246511808E-01 = velocity of efective ejection in the vacuum
    9.669190986681355E-01 = specific impulse at sea level
    9.746311246511810E-01 = specific impulse at vacuum


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

2)SUBROTINA: MSI2D9_mp_LU2D9: `SEN03_0014`

Ao invés de um if, foi feito dois ciclos e casos especiais nos volumes fictícios para alpha = 0.

Houve uma redução de **16,145,296,000** ciclos de clock para **15,558,776,000**. A rotina que utilizava **11,29%** do tempo total, agora utiliza **10,91%.**

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	8,800	12,862	0.684	16.40%	20.15%	23,460,800,000	34,290,092,000	0xFFFFFFFF	0x5A6F0	0x5B6F0	0xBD50		MSI2D9_m
MSI2D5_mp_FB2D5	8,433	12,466	0.676	15.72%	19.53%	22,482,378,000	33,234,356,000	0xFFFFFFFF	0x408C0	0x418C0	0x87C0		MSI2D5_m
MSI2D9_mp_LU2D9	6,056	7,543	0.803	11.29%	11.82%	16,145,296,000	20,109,638,000	0xFFFFFFFF	0x66440	0x67440	0xAB60		MSI2D9_m
COEFFICIENTS_mp_GET_VELOCITIES_AT_FACES	5,275	4,788	1.102	9.83%	7.50%	14,063,150,000	12,764,808,000	0xFFFFFFFF	0xDBEF0	0xDCEF0	0x8730		COEFFICIE
MSI2D5_mp_LU2D5	3,022	3,081	0.981	5.63%	4.83%	8,056,652,000	8,213,946,000	0xFFFFFFFF	0x49080	0x4A080	0x4BF0		MSI2D5_m
COEFFICIENTS_mp_GET_T_COEFFICIENTS_AND_SOURCE	2,534	2,744	0.923	4.72%	4.30%	6,755,644,000	7,315,504,000	0xFFFFFFFF	0xB8890	0xB9890	0xCBA0		COEFFICIE
SOLVERS_mp_NORM_L1_9D	1,895	2,820	0.672	3.53%	4.42%	5,052,070,000	7,518,120,000	0xFFFFFFFF	0x11B7B0	0x11C7B0	0xD50		SOLVERS_
COEFFICIENTS_mp_GET_INTERNAL_SIMPLEC_COEFFICIENTS	1,794	1,546	1.160	3.34%	2.42%	4,782,804,000	4,121,636,000	0xFFFFFFFF	0xECF60	0xEDF60	0x2350		COEFFICIE
COEFFICIENTS_mp_GET_U_V_AT_REAL_NODES_WITH_PL	1,738	1,389	1.251	3.24%	2.18%	4,633,508,000	3,703,074,000	0xFFFFFFFF	0xEF600	0xF0600	0x1C00		COEFFICIE
COEFFICIENTS_mp_GET_U_SOURCE	1,593	1,573	1.013	2.97%	2.46%	4,246,938,000	4,193,618,000	0xFFFFFFFF	0x87C20	0x88C20	0x97B0		COEFFICIE
COEFFICIENTS_mp_GET_V_SOURCE	1,513	1,641	0.922	2.82%	2.57%	4,033,658,000	4,374,906,000	0xFFFFFFFF	0xA8730	0xA9730	0x8060		COEFFICIE
COEFFICIENTS_mp_GET_P_SOURCE	1,442	2,344	0.615	2.69%	3.67%	3,844,372,000	6,249,104,000	0xFFFFFFFF	0xD6E60	0xD7E60	0x2800		COEFFICIE
COEFFICIENTS_mp_GET_P_COEFFICIENTS	1,231	2,072	0.594	2.29%	3.25%	3,281,846,000	5,523,952,000	0xFFFFFFFF	0xD2560	0xD3560	0x2380		COEFFICIE
_intel_new_memset	1,206	224	5.384	2.25%	0.35%	3,215,196,000	597,184,000	0xFFFFFFFF	0x21BFF0	0x21CFF0	0x1560		_intel_new_
COEFFICIENTS_mp_GET_U_COEFFICIENTS	989	1,121	0.882	1.84%	1.76%	2,636,674,000	2,988,586,000	0xFFFFFFFF	0x7A4A0	0x7B4A0	0x6B00		COEFFICIE
memset	906	362	2.503	1.69%	0.57%	2,415,396,000	965,092,000	0xFFFFFFFF	0x1C6E00	0x1C7E00	0xF0		memset
COEFFICIENTS_mp_GET_V_COEFFICIENTS	892	1,127	0.791	1.66%	1.77%	2,378,072,000	3,004,582,000	0xFFFFFFFF	0x9AC10	0x9BC10	0x6CD0		COEFFICIE
_intel_new_memcpy	816	124	6.581	1.52%	0.19%	2,175,456,000	330,584,000	0xFFFFFFFF	0x21D550	0x21E550	0x23D0		_intel_new_
COEFFICIENTS_mp_GET_VELOCITIES_AT_INTERNAL_FACES_WITH_PL	764	747	1.023	1.42%	1.17%	2,036,824,000	1,991,502,000	0xFFFFFFFF	0xF1200	0xF2200	0x1450		COEFFICIE
COEFFICIENTS_mp_GET_DENSITY_AT_FACES	526	1,124	0.468	0.98%	1.76%	1,402,316,000	2,996,584,000	0xFFFFFFFF	0x79AF0	0x7AAF0	0x9B0		COEFFICIE
USER_mp_GET_LAMINAR_VISCOSITY_AT_FACES	437	455	0.960	0.81%	0.71%	1,165,042,000	1,213,030,000	0xFFFFFFFF	0xF2A50	0xF3A50	0x720		USER_mp_
USER_mp_GET_THERMAL_CONDUCTIVITY_AT_FACES	409	469	0.872	0.76%	0.73%	1,090,394,000	1,250,354,000	0xFFFFFFFF	0xF3170	0xF4170	0x720		USER_mp_
SOLVERS_mp_NORM_L1_5D	316	493	0.641	0.59%	0.77%	842,456,000	1,314,338,000	0xFFFFFFFF	0x11AFD0	0x11BFD0	0x7E0		SOLVERS_
MAIN_ip_GET_NUMERICAL_SOLUTION	132	15	8.800	0.25%	0.02%	351,912,000	39,990,000	0xFFFFFFFF	0x122620	0x123620	0x60B0		MAIN_ip_G
COEFFICIENTS_mp_GET_DENSITY_AT_NODES	120	30	4.000	0.22%	0.05%	319,920,000	79,980,000	0xFFFFFFFF	0x798C0	0x7A8C0	0x230		COEFFICIE
COEFFICIENTS_mp_GET_PRESSURE_DENSITY_CORRECTION_WITH_PL	98	40	2.450	0.18%	0.06%	261,268,000	106,640,000	0xFFFFFFFF	0xEF2B0	0xF02B0	0x350		COEFFICIE
USER_mp_SET_CP_AND_GAMMA	79	11	7.182	0.15%	0.02%	210,614,000	29,326,000	0xFFFFFFFF	0xF2720	0xF3720	0x1B0		USER_mp_
cvtas_t_to_a	77	204	0.377	0.14%	0.32%	205,282,000	543,864,000	0xFFFFFFFF	0x1995A0	0x19A5A0	0x4320		cvtas_t_to_
USER_mp_GET_A9D_B_RESCALING	67	74	0.905	0.12%	0.12%	178,622,000	197,284,000	0xFFFFFFFF	0x10F5A0	0x1105A0	0x5830		USER_mp_
USER_mp_SET_THERMAL_CONDUCTIVITY_AT_NODES	51	6	8.500	0.10%	0.01%	135,966,000	15,996,000	0xFFFFFFFF	0xF2990	0xF3990	0xC0		USER_mp_
USER_mp_SET_LAMINAR_VISCOSITY_AT_NODES	49	1	49.000	0.09%	0.00%	130,634,000	2,666,000	0xFFFFFFFF	0xF28D0	0xF38D0	0xC0		USER_mp_
USER_mp_SET_BCP	41	22	1.864	0.08%	0.03%	109,306,000	58,652,000	0xFFFFFFFF	0xFEE70	0xFFE70	0x2D20		USER_mp_
for__interp_fmt	38	39	0.974	0.07%	0.06%	101,308,000	103,974,000	0xFFFFFFFF	0x16BCC0	0x16CCC0	0xD80		for__interp_
cvt_ieee_t_to_text_ex	35	33	1.061	0.07%	0.05%	93,310,000	87,978,000	0xFFFFFFFF	0x181B80	0x182B80	0x13E0		cvt_ieee_t_
USER_mp_SET_BCV	33	13	2.538	0.06%	0.02%	87,978,000	34,658,000	0xFFFFFFFF	0xF74A0	0xF84A0	0x3C00		USER_mp_
USER_mp_SET_BCT	27	12	2.250	0.05%	0.02%	71,982,000	31,992,000	0xFFFFFFFF	0xFB0A0	0xFC0A0	0x3DD0		USER_mp_
USER_mp_SET_BCU	25	14	1.786	0.05%	0.02%	66,650,000	37,324,000	0xFFFFFFFF	0xF3890	0xF4890	0x3C10		USER_mp_

Figura 2 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	8,791	12,811	0.686	16.43%	20.15%	23,436,806,000	34,154,126,000	0xFFFFFFFF	0x5A6F0	0x5B6F0	0xBD50		MSI2D9_m
MSI2D5_mp_FB2D5	8,468	12,511	0.677	15.82%	19.68%	22,575,688,000	33,354,326,000	0xFFFFFFFF	0x408C0	0x418C0	0x87C0		MSI2D5_m
MSI2D9_mp_LU2D9	5,836	7,322	0.797	10.91%	11.52%	15,558,776,000	19,520,452,000	0xFFFFFFFF	0x66440	0x67440	0xACF0		MSI2D9_m
COEFFICIENTS_mp_GET_VELOCITIES_AT_FACES	5,336	4,832	1.104	9.97%	7.60%	14,225,776,000	12,882,112,000	0xFFFFFFFF	0xDC080	0xDD080	0x8730		COEFFICIE
MSI2D5_mp_LU2D5	2,985	3,037	0.983	5.58%	4.78%	7,958,010,000	8,096,642,000	0xFFFFFFFF	0x49080	0x4A080	0x4BF0		MSI2D5_m
COEFFICIENTS_mp_GET_T_COEFFICIENTS_AND_SOURCE	2,511	2,716	0.925	4.69%	4.27%	6,694,326,000	7,240,856,000	0xFFFFFFFF	0xB8A20	0xB9A20	0xCBA0		COEFFICIE
SOLVERS_mp_NORM_L1_9D	1,919	2,819	0.681	3.59%	4.43%	5,116,054,000	7,515,454,000	0xFFFFFFFF	0x11B940	0x11C940	0xD50		SOLVERS_
COEFFICIENTS_mp_GET_INTERNAL_SIMPLEC_COEFFICIENTS	1,797	1,530	1.175	3.36%	2.41%	4,790,802,000	4,078,980,000	0xFFFFFFFF	0xED0F0	0xEE0F0	0x2350		COEFFICIE
COEFFICIENTS_mp_GET_U_V_AT_REAL_NODES_WITH_PL	1,730	1,364	1.268	3.23%	2.15%	4,612,180,000	3,636,424,000	0xFFFFFFFF	0xEF790	0xF0790	0x1C00		COEFFICIE
COEFFICIENTS_mp_GET_V_SOURCE	1,546	1,626	0.951	2.89%	2.56%	4,121,636,000	4,334,916,000	0xFFFFFFFF	0xA88C0	0xA98C0	0x8060		COEFFICIE
COEFFICIENTS_mp_GET_U_SOURCE	1,546	1,589	0.973	2.89%	2.50%	4,121,636,000	4,236,274,000	0xFFFFFFFF	0x87DB0	0x88DB0	0x97B0		COEFFICIE
COEFFICIENTS_mp_GET_P_SOURCE	1,419	2,359	0.602	2.65%	3.71%	3,783,054,000	6,289,094,000	0xFFFFFFFF	0xD6FF0	0xD7FF0	0x2800		COEFFICIE
_intel_new_memset	1,260	222	5.676	2.35%	0.35%	3,359,160,000	591,852,000	0xFFFFFFFF	0x21C180	0x21D180	0x1560		_intel_new_
COEFFICIENTS_mp_GET_P_COEFFICIENTS	1,217	2,051	0.593	2.27%	3.23%	3,244,522,000	5,467,966,000	0xFFFFFFFF	0xD26F0	0xD36F0	0x2380		COEFFICIE
COEFFICIENTS_mp_GET_U_COEFFICIENTS	1,003	1,122	0.894	1.87%	1.77%	2,673,998,000	2,991,252,000	0xFFFFFFFF	0x7A630	0x7B630	0x6B00		COEFFICIE
COEFFICIENTS_mp_GET_V_COEFFICIENTS	867	1,140	0.761	1.62%	1.79%	2,311,422,000	3,039,240,000	0xFFFFFFFF	0x9ADA0	0x9BDA0	0x6CD0		COEFFICIE
memset	835	390	2.141	1.56%	0.61%	2,226,110,000	1,039,740,000	0xFFFFFFFF	0x1C6F90	0x1C7F90	0xF0		memset
_intel_new_memcpy	813	117	6.949	1.52%	0.18%	2,167,458,000	311,922,000	0xFFFFFFFF	0x21D6E0	0x21E6E0	0x23D0		_intel_new_
COEFFICIENTS_mp_GET_VELOCITIES_AT_INTERNAL_FACES_WITH_PL	774	759	1.020	1.45%	1.19%	2,063,484,000	2,023,494,000	0xFFFFFFFF	0xF1390	0xF2390	0x1450		COEFFICIE
COEFFICIENTS_mp_GET_DENSITY_AT_FACES	588	1,134	0.519	1.10%	1.78%	1,567,608,000	3,023,244,000	0xFFFFFFFF	0x79C80	0x7AC80	0x9B0		COEFFICIE
USER_mp_GET_THERMAL_CONDUCTIVITY_AT_FACES	457	478	0.956	0.85%	0.75%	1,218,362,000	1,274,348,000	0xFFFFFFFF	0xF3300	0xF4300	0x720		USER_mp_
USER_mp_GET_LAMINAR_VISCOSITY_AT_FACES	412	455	0.905	0.77%	0.72%	1,098,392,000	1,213,030,000	0xFFFFFFFF	0xF2BE0	0xF3BE0	0x720		USER_mp_
SOLVERS_mp_NORM_L1_5D	308	506	0.609	0.58%	0.80%	821,128,000	1,348,996,000	0xFFFFFFFF	0x11B160	0x11C160	0x7E0		SOLVERS_
MAIN_ip_GET_NUMERICAL_SOLUTION	125	18	6.944	0.23%	0.03%	333,250,000	47,988,000	0xFFFFFFFF	0x1227B0	0x1237B0	0x60B0		MAIN_ip_G
COEFFICIENTS_mp_GET_PRESSURE_DENSITY_CORRECTION_WITH_PL	116	41	2.829	0.22%	0.06%	309,256,000	109,306,000	0xFFFFFFFF	0xEF440	0xF0440	0x350		COEFFICIE
COEFFICIENTS_mp_GET_DENSITY_AT_NODES	98	25	3.920	0.18%	0.04%	261,268,000	66,650,000	0xFFFFFFFF	0x79A50	0x7AA50	0x230		COEFFICIE
cvtas_t_to_a	93	206	0.451	0.17%	0.32%	247,938,000	549,196,000	0xFFFFFFFF	0x199730	0x19A730	0x4320		cvtas_t_to_
USER_mp_SET_CP_AND_GAMMA	89	7	12.714	0.17%	0.01%	237,274,000	18,662,000	0xFFFFFFFF	0xF28B0	0xF38B0	0x1B0		USER_mp_
USER_mp_GET_A9D_B_RESCALING	75	66	1.136	0.14%	0.10%	199,950,000	175,956,000	0xFFFFFFFF	0x10F730	0x110730	0x5830		USER_mp_
USER_mp_SET_BCP	45	27	1.667	0.08%	0.04%	119,970,000	71,982,000	0xFFFFFFFF	0xFF000	0x100000	0x2D20		USER_mp_
USER_mp_SET_LAMINAR_VISCOSITY_AT_NODES	40	3	13.333	0.07%	0.00%	106,640,000	7,998,000	0xFFFFFFFF	0xF2A60	0xF3A60	0xC0		USER_mp_
USER_mp_SET_BCU	40	8	5.000	0.07%	0.01%	106,640,000	21,328,000	0xFFFFFFFF	0xF3A20	0xF4A20	0x3C10		USER_mp_
USER_mp_SET_THERMAL_CONDUCTIVITY_AT_NODES	39	4	9.750	0.07%	0.01%	103,974,000	10,664,000	0xFFFFFFFF	0xF2B20	0xF3B20	0xC0		USER_mp_
USER_mp_GET_A5D_B_RESCALING	33	31	1.065	0.06%	0.05%	87,978,000	82,646,000	0xFFFFFFFF	0x10B3C0	0x10C3C0	0x4370		USER_mp_
USER_mp_SET_BCV	31	7	4.429	0.06%	0.01%	82,646,000	18,662,000	0xFFFFFFFF	0xF7630	0xF8630	0x3C00		USER_mp_
USER_mp_SET_BCT	30	4	7.500	0.06%	0.01%	79,980,000	10,664,000	0xFFFFFFFF	0xFB230	0xFC230	0x3DD0		USER_mp_
cvt_ieee_t_to_text_ex	30	39	0.769	0.06%	0.06%	79,980,000	103,974,000	0xFFFFFFFF	0x181D10	0x182D10	0x13E0		cvt_ieee_t_

Figura 3 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
9.991643701326544E-01 = characterist velocity
9.669190986681354E-01 = velocity of efective ejection at sea level
9.746311246511808E-01 = velocity of efective ejection in the vacuum
9.669190986681355E-01 = specific impulse at sea level
9.746311246511810E-01 = specific impulse at vacuum


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

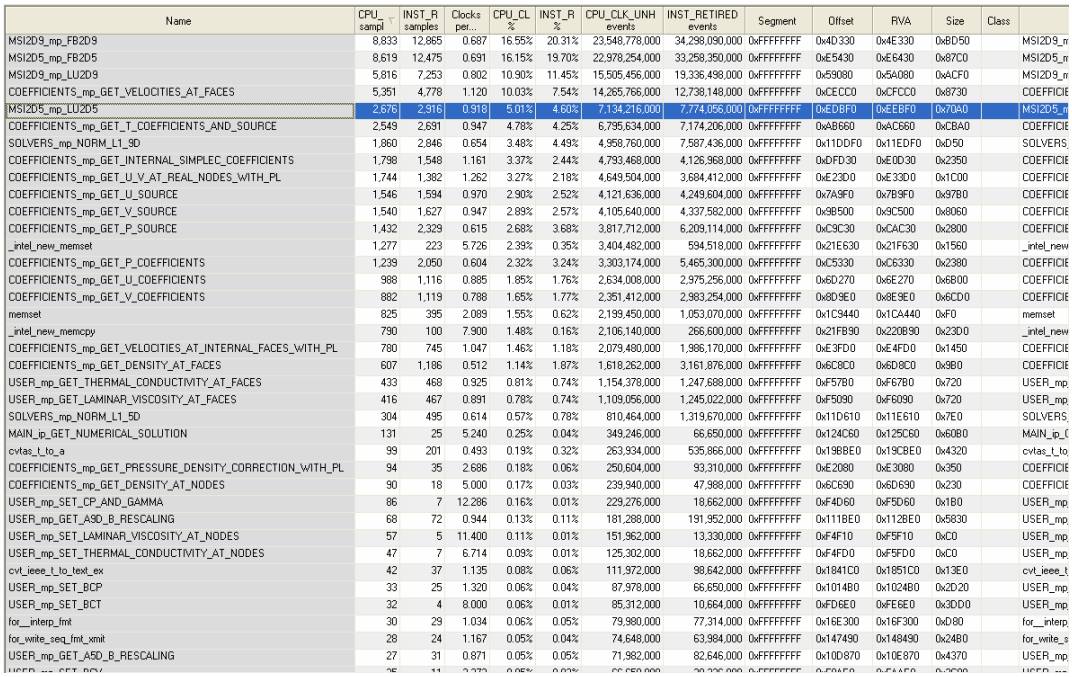
3)SUBROTINA: MSI2D5_mp_LU2D5: `SEN03_0015`

Ao invés de um if, foi feito dois ciclos e casos especiais nos volumes fictícios para alpha = 0.

Houve uma redução de **7,958,010,000** ciclos de clock para **7,134,216,000**. A rotina que utilizava **5,58%** do tempo total, agora utiliza **5,01%.**

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	8,791	12,811	0.686	16.43%	20.15%	23,436,806,000	34,154,126,000	0xFFFFFFFF	0x5A6F0	0x5B6F0	0xBD50		MSI2D9_m
MSI2D5_mp_FB2D5	8,468	12,511	0.677	15.82%	19.68%	22,575,688,000	33,354,326,000	0xFFFFFFFF	0x408C0	0x418C0	0x87C0		MSI2D5_m
MSI2D9_mp_LU2D9	5,836	7,322	0.797	10.91%	11.52%	15,558,776,000	19,520,452,000	0xFFFFFFFF	0x66440	0x67440	0xACF0		MSI2D9_m
COEFFICIENTS_mp_GET_VELOCITIES_AT_FACES	5,336	4,832	1.104	9.97%	7.60%	14,225,776,000	12,882,112,000	0xFFFFFFFF	0xDC080	0xDD080	0x8730		COEFFICIE
MSI2D5_mp_LU2D5	2,985	3,037	0.983	5.58%	4.78%	7,958,010,000	8,096,642,000	0xFFFFFFFF	0x49080	0x4A080	0x48F0		MSI2D5_m
COEFFICIENTS_mp_GET_T_COEFFICIENTS_AND_SOURCE	2,511	2,716	0.925	4.69%	4.27%	6,694,326,000	7,240,856,000	0xFFFFFFFF	0xB8A20	0xB9A20	0xCBA0		COEFFICIE
SOLVERS_mp_NORM_L1_9D	1,919	2,819	0.681	3.59%	4.43%	5,116,054,000	7,515,454,000	0xFFFFFFFF	0x11B940	0x11C940	0xD50		SOLVERS_
COEFFICIENTS_mp_GET_INTERNAL_SIMPLEC_COEFFICIENTS	1,797	1,530	1.175	3.36%	2.41%	4,790,802,000	4,078,980,000	0xFFFFFFFF	0xED0F0	0xEE0F0	0x2350		COEFFICIE
COEFFICIENTS_mp_GET_U_V_AT_REAL_NODES_WITH_PL	1,730	1,364	1.268	3.23%	2.15%	4,612,180,000	3,636,424,000	0xFFFFFFFF	0xEF790	0xF0790	0x1C00		COEFFICIE
COEFFICIENTS_mp_GET_V_SOURCE	1,546	1,626	0.951	2.89%	2.56%	4,121,636,000	4,334,916,000	0xFFFFFFFF	0xA88C0	0xA98C0	0x8060		COEFFICIE
COEFFICIENTS_mp_GET_U_SOURCE	1,546	1,589	0.973	2.89%	2.50%	4,121,636,000	4,236,274,000	0xFFFFFFFF	0x87DB0	0x88DB0	0x97B0		COEFFICIE
COEFFICIENTS_mp_GET_P_SOURCE	1,419	2,359	0.602	2.65%	3.71%	3,783,054,000	6,289,094,000	0xFFFFFFFF	0xD6FF0	0xD7FF0	0x2800		COEFFICIE
_intel_new_memset	1,260	222	5.676	2.35%	0.35%	3,359,160,000	591,852,000	0xFFFFFFFF	0x21C180	0x21D180	0x1560		_intel_new_
COEFFICIENTS_mp_GET_P_COEFFICIENTS	1,217	2,051	0.593	2.27%	3.23%	3,244,522,000	5,467,966,000	0xFFFFFFFF	0xD26F0	0xD36F0	0x2380		COEFFICIE
COEFFICIENTS_mp_GET_U_COEFFICIENTS	1,003	1,122	0.894	1.87%	1.77%	2,673,998,000	2,991,252,000	0xFFFFFFFF	0x7A630	0x7B630	0x6B00		COEFFICIE
COEFFICIENTS_mp_GET_V_COEFFICIENTS	867	1,140	0.761	1.62%	1.79%	2,311,422,000	3,039,240,000	0xFFFFFFFF	0x9ADA0	0x9BDA0	0x6CD0		COEFFICIE
memset	835	390	2.141	1.56%	0.61%	2,226,110,000	1,039,740,000	0xFFFFFFFF	0x1C6F90	0x1C7F90	0xF0		memset
_intel_new_memcpy	813	117	6.949	1.52%	0.18%	2,167,458,000	311,922,000	0xFFFFFFFF	0x21D6E0	0x21E6E0	0x23D0		_intel_new_
COEFFICIENTS_mp_GET_VELOCITIES_AT_INTERNAL_FACES_WITH_PL	774	759	1.020	1.45%	1.19%	2,063,484,000	2,023,494,000	0xFFFFFFFF	0xF1390	0xF2390	0x1450		COEFFICIE
COEFFICIENTS_mp_GET_DENSITY_AT_FACES	588	1,134	0.519	1.10%	1.78%	1,567,608,000	3,023,244,000	0xFFFFFFFF	0x79C80	0x7AC80	0x9B0		COEFFICIE
USER_mp_GET_THERMAL_CONDUCTIVITY_AT_FACES	457	478	0.956	0.85%	0.75%	1,218,362,000	1,274,348,000	0xFFFFFFFF	0xF3300	0xF4300	0x720		USER_mp_
USER_mp_GET_LAMINAR_VISCOSITY_AT_FACES	412	455	0.905	0.77%	0.72%	1,098,392,000	1,213,030,000	0xFFFFFFFF	0xF2BE0	0xF3BE0	0x720		USER_mp_
SOLVERS_mp_NORM_L1_5D	308	506	0.609	0.58%	0.80%	821,128,000	1,348,996,000	0xFFFFFFFF	0x11B160	0x11C160	0x7E0		SOLVERS_
MAIN_ip_GET_NUMERICAL_SOLUTION	125	18	6.944	0.23%	0.03%	333,250,000	47,988,000	0xFFFFFFFF	0x1227B0	0x1237B0	0x60B0		MAIN_ip_G
COEFFICIENTS_mp_GET_PRESSURE_DENSITY_CORRECTION_WITH_PL	116	41	2.829	0.22%	0.06%	309,256,000	109,306,000	0xFFFFFFFF	0xEF440	0xF0440	0x350		COEFFICIE
COEFFICIENTS_mp_GET_DENSITY_AT_NODES	98	25	3.920	0.18%	0.04%	261,268,000	66,650,000	0xFFFFFFFF	0x79A50	0x7AA50	0x230		COEFFICIE
cvtas_t_to_a	93	206	0.451	0.17%	0.32%	247,938,000	549,196,000	0xFFFFFFFF	0x199730	0x19A730	0x4320		cvtas_t_to_
USER_mp_SET_CP_AND_GAMMA	89	7	12.714	0.17%	0.01%	237,274,000	18,662,000	0xFFFFFFFF	0xF28B0	0xF38B0	0x1B0		USER_mp_
USER_mp_GET_A9D_B_RESCALING	75	66	1.136	0.14%	0.10%	199,950,000	175,956,000	0xFFFFFFFF	0x10F730	0x110730	0x5830		USER_mp_
USER_mp_SET_BCP	45	27	1.667	0.08%	0.04%	119,970,000	71,982,000	0xFFFFFFFF	0xFF000	0x100000	0x2D20		USER_mp_
USER_mp_SET_LAMINAR_VISCOSITY_AT_NODES	40	3	13.333	0.07%	0.00%	106,640,000	7,998,000	0xFFFFFFFF	0xF2A60	0xF3A60	0xC0		USER_mp_
USER_mp_SET_BCU	40	8	5.000	0.07%	0.01%	106,640,000	21,328,000	0xFFFFFFFF	0xF3A20	0xF4A20	0x3C10		USER_mp_
USER_mp_SET_THERMAL_CONDUCTIVITY_AT_NODES	39	4	9.750	0.07%	0.01%	103,974,000	10,664,000	0xFFFFFFFF	0xF2B20	0xF3B20	0xC0		USER_mp_
USER_mp_GET_A5D_B_RESCALING	33	31	1.065	0.06%	0.05%	87,978,000	82,646,000	0xFFFFFFFF	0x10B3C0	0x10C3C0	0x4370		USER_mp_
USER_mp_SET_BCV	31	7	4.429	0.06%	0.01%	82,646,000	18,662,000	0xFFFFFFFF	0xF7630	0xF8630	0x3C00		USER_mp_
USER_mp_SET_BCT	30	4	7.500	0.06%	0.01%	79,980,000	10,664,000	0xFFFFFFFF	0xFB230	0xFC230	0x3DD0		USER_mp_
cvt_ieee_t_to_text_ex	30	39	0.769	0.06%	0.06%	79,980,000	103,974,000	0xFFFFFFFF	0x181D10	0x182D10	0x13E0		cvt_ieee_t_

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	
MSI2D9_mp_FB2D9	8,833	12,865	0.687	16.55%	20.31%	23,548,778,000	34,298,090,000	0xFFFFFFFF	0x4D330	0x4E330	0xBD50		MSI2D9_m
MSI2D5_mp_FB2D5	8,619	12,475	0.691	16.15%	19.70%	22,978,254,000	33,258,350,000	0xFFFFFFFF	0xE5430	0xE6430	0x87C0		MSI2D5_m
MSI2D9_mp_LU2D9	5,816	7,253	0.802	10.90%	11.45%	15,505,456,000	19,336,498,000	0xFFFFFFFF	0x59080	0x5A080	0xACF0		MSI2D9_m
COEFFICIENTS_mp_GET_VELOCITIES_AT_FACES	5,351	4,778	1.120	10.03%	7.54%	14,265,766,000	12,738,148,000	0xFFFFFFFF	0xCECC0	0xCFCC0	0x8730		COEFFICIE
MSI2D5_mp_LU2D5	2,676	2,916	0.918	5.01%	4.60%	7,134,216,000	7,774,056,000	0xFFFFFFFF	0xEDBF0	0xEEBF0	0x70A0		MSI2D5_m
COEFFICIENTS_mp_GET_T_COEFFICIENTS_AND_SOURCE	2,549	2,691	0.947	4.78%	4.25%	6,795,634,000	7,174,206,000	0xFFFFFFFF	0xAB660	0xAC660	0xCBA0		COEFFICIE
SOLVERS_mp_NORM_L1_9D	1,860	2,846	0.654	3.48%	4.49%	4,958,760,000	7,587,436,000	0xFFFFFFFF	0x11DDF0	0x11EDF0	0xD50		SOLVERS_
COEFFICIENTS_mp_GET_INTERNAL_SIMPLEC_COEFFICIENTS	1,798	1,548	1.161	3.37%	2.44%	4,793,468,000	4,126,968,000	0xFFFFFFFF	0xDFD30	0xE0D30	0x2350		COEFFICIE
COEFFICIENTS_mp_GET_U_V_AT_REAL_NODES_WITH_PL	1,744	1,382	1.262	3.27%	2.18%	4,649,504,000	3,684,412,000	0xFFFFFFFF	0xE23D0	0xE33D0	0x1C00		COEFFICIE
COEFFICIENTS_mp_GET_U_SOURCE	1,546	1,594	0.970	2.90%	2.52%	4,121,636,000	4,249,604,000	0xFFFFFFFF	0x7A9F0	0x7B9F0	0x97B0		COEFFICIE
COEFFICIENTS_mp_GET_V_SOURCE	1,540	1,627	0.947	2.89%	2.57%	4,105,640,000	4,337,582,000	0xFFFFFFFF	0x9B500	0x9C500	0x8060		COEFFICIE
COEFFICIENTS_mp_GET_P_SOURCE	1,432	2,329	0.615	2.68%	3.68%	3,817,712,000	6,209,114,000	0xFFFFFFFF	0xC9C30	0xCAC30	0x2800		COEFFICIE
_intel_new_memset	1,277	223	5.726	2.39%	0.35%	3,404,482,000	594,518,000	0xFFFFFFFF	0x21E630	0x21F630	0x1560		_intel_new
COEFFICIENTS_mp_GET_P_COEFFICIENTS	1,239	2,050	0.604	2.32%	3.24%	3,303,174,000	5,465,300,000	0xFFFFFFFF	0xC5330	0xC6330	0x2380		COEFFICIE
COEFFICIENTS_mp_GET_U_COEFFICIENTS	988	1,116	0.885	1.85%	1.76%	2,634,008,000	2,975,256,000	0xFFFFFFFF	0x6D270	0x6E270	0x6B00		COEFFICIE
COEFFICIENTS_mp_GET_V_COEFFICIENTS	882	1,119	0.788	1.65%	1.77%	2,351,412,000	2,983,254,000	0xFFFFFFFF	0x8D9E0	0x8E9E0	0x6CD0		COEFFICIE
memset	825	395	2.089	1.55%	0.62%	2,199,450,000	1,053,070,000	0xFFFFFFFF	0x1C9440	0x1CA440	0xF0		memset
_intel_new_memcpy	790	100	7.900	1.48%	0.16%	2,106,140,000	266,600,000	0xFFFFFFFF	0x21FB90	0x220B90	0x23D0		_intel_new
COEFFICIENTS_mp_GET_VELOCITIES_AT_INTERNAL_FACES_WITH_PL	780	745	1.047	1.46%	1.18%	2,079,480,000	1,986,170,000	0xFFFFFFFF	0xE3FD0	0xE4FD0	0x1450		COEFFICIE
COEFFICIENTS_mp_GET_DENSITY_AT_FACES	607	1,186	0.512	1.14%	1.87%	1,618,262,000	3,161,876,000	0xFFFFFFFF	0x6C8C0	0x6D8C0	0x9B0		COEFFICIE
USER_mp_GET_THERMAL_CONDUCTIVITY_AT_FACES	433	468	0.925	0.81%	0.74%	1,154,378,000	1,247,688,000	0xFFFFFFFF	0xF57B0	0xF67B0	0x720		USER_mp_
USER_mp_GET_LAMINAR_VISCOSITY_AT_FACES	416	467	0.891	0.78%	0.74%	1,109,056,000	1,245,022,000	0xFFFFFFFF	0xF5090	0xF6090	0x720		USER_mp_
SOLVERS_mp_NORM_L1_5D	304	495	0.614	0.57%	0.78%	810,464,000	1,319,670,000	0xFFFFFFFF	0x11D610	0x11E610	0x7E0		SOLVERS_
MAIN_ip_GET_NUMERICAL_SOLUTION	131	25	5.240	0.25%	0.04%	349,246,000	66,650,000	0xFFFFFFFF	0x124C60	0x125C60	0x60B0		MAIN_ip_(
cvtas_t_to_a	99	201	0.493	0.19%	0.32%	263,934,000	535,866,000	0xFFFFFFFF	0x19BBE0	0x19CBE0	0x4320		cvtas_t_to
COEFFICIENTS_mp_GET_PRESSURE_DENSITY_CORRECTION_WITH_PL	94	35	2.686	0.18%	0.06%	250,604,000	93,310,000	0xFFFFFFFF	0xE2080	0xE3080	0x350		COEFFICIE
COEFFICIENTS_mp_GET_DENSITY_AT_NODES	90	18	5.000	0.17%	0.03%	239,940,000	47,988,000	0xFFFFFFFF	0x6C690	0x6D690	0x230		COEFFICIE
USER_mp_SET_CP_AND_GAMMA	86	7	12.286	0.16%	0.01%	229,276,000	18,662,000	0xFFFFFFFF	0xF4D60	0xF5D60	0x1B0		USER_mp_
USER_mp_GET_A9D_B_RESCALING	68	72	0.944	0.13%	0.11%	181,288,000	191,952,000	0xFFFFFFFF	0x111BE0	0x112BE0	0x5830		USER_mp_
USER_mp_SET_LAMINAR_VISCOSITY_AT_NODES	57	5	11.400	0.11%	0.01%	151,962,000	13,330,000	0xFFFFFFFF	0xF4F10	0xF5F10	0xC0		USER_mp_
USER_mp_SET_THERMAL_CONDUCTIVITY_AT_NODES	47	7	6.714	0.09%	0.01%	125,302,000	18,662,000	0xFFFFFFFF	0xF4FD0	0xF5FD0	0xC0		USER_mp_
cvt_ieee_t_to_text_ex	42	37	1.135	0.08%	0.06%	111,972,000	98,642,000	0xFFFFFFFF	0x1841C0	0x1851C0	0x13E0		cvt_ieee_t
USER_mp_SET_BCP	33	25	1.320	0.06%	0.04%	87,978,000	66,650,000	0xFFFFFFFF	0x1014B0	0x1024B0	0x2D20		USER_mp_
USER_mp_SET_BCT	32	4	8.000	0.06%	0.01%	85,312,000	10,664,000	0xFFFFFFFF	0xFD6E0	0xFE6E0	0x3DD0		USER_mp_
for__interp_fmt	30	29	1.034	0.06%	0.05%	79,980,000	77,314,000	0xFFFFFFFF	0x16E300	0x16F300	0xD80		for__interp
for_write_seq_fmt_xmit	28	24	1.167	0.05%	0.04%	74,648,000	63,984,000	0xFFFFFFFF	0x147490	0x148490	0x24B0		for_write_s
USER_mp_GET_A5D_B_RESCALING	27	31	0.871	0.05%	0.05%	71,982,000	82,646,000	0xFFFFFFFF	0x10D870	0x10E870	0x4370		USER_mp_

Figura 5 Depois da otimização

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

    1.000836328728611E+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
    9.991643701326540E-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)
        55.234 = dtcpu: CPU time (s) (after interuption)
        55.234 = tcpu:  total CPU time (s)
```

4)SUBROTINA: MSI2D9_mp_FB2D9: `SEN03_0016`

Ao invés de um if, foi feito dois ciclos e casos especiais nos volumes fictícios para o cálculo do resíduo.

Houve uma redução de **23,548,778,000** ciclos de clock para **22,924,934,000**. A rotina que utilizava **16,55%** do tempo total, agora utiliza **16,27%.**

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	8,833	12,865	0.687	16.55%	20.31%	23,548,778,000	34,298,090,000	0xFFFFFFFF	0x4D330	0x4E330	0x8D50		MSI2D9_mp_FB2D9
MSI2D5_mp_FB2D5	8,619	12,475	0.691	16.15%	19.70%	22,978,254,000	33,258,350,000	0xFFFFFFFF	0xE5430	0xE6430	0x87C0		MSI2D5_mp_FB2D5
MSI2D9_mp_LU2D9	5,816	7,253	0.802	10.90%	11.45%	15,505,456,000	19,336,498,000	0xFFFFFFFF	0x59080	0x5A080	0xACF0		MSI2D9_mp_LU2D9
COEFFICIENTS_mp_GET_VELOCITIES_AT_FACES	5,351	4,778	1.120	10.03%	7.54%	14,265,766,000	12,738,148,000	0xFFFFFFFF	0xCECC0	0xCFCC0	0x8730		COEFFICIENTS_mp_GE
MSI2D5_mp_LU2D5	2,676	2,916	0.918	5.01%	4.60%	7,134,216,000	7,774,056,000	0xFFFFFFFF	0xEDBF0	0xEEBF0	0x70A0		MSI2D5_mp_LU2D5
COEFFICIENTS_mp_GET_T_COEFFICIENTS_AND_SOURCE	2,549	2,691	0.947	4.78%	4.25%	6,795,634,000	7,174,206,000	0xFFFFFFFF	0xAB660	0xAC660	0xCBA0		COEFFICIENTS_mp_GE
SOLVERS_mp_NORM_L1_9D	1,860	2,846	0.654	3.48%	4.49%	4,958,760,000	7,587,436,000	0xFFFFFFFF	0x11DDF0	0x11EDF0	0xD50		SOLVERS_mp_NORM_I
COEFFICIENTS_mp_GET_INTERNAL_SIMPLEC_COEFFICIENTS	1,798	1,548	1.161	3.37%	2.44%	4,793,468,000	4,126,968,000	0xFFFFFFFF	0xDFD30	0xE0D30	0x2350		COEFFICIENTS_mp_GE
COEFFICIENTS_mp_GET_U_V_AT_REAL_NODES_WITH_PL	1,744	1,382	1.262	3.27%	2.18%	4,649,504,000	3,684,412,000	0xFFFFFFFF	0xE23D0	0xE33D0	0x1C00		COEFFICIENTS_mp_GE
COEFFICIENTS_mp_GET_U_SOURCE	1,546	1,594	0.970	2.90%	2.52%	4,121,636,000	4,249,604,000	0xFFFFFFFF	0x7A9F0	0x7B9F0	0x97B0		COEFFICIENTS_mp_GE
COEFFICIENTS_mp_GET_V_SOURCE	1,540	1,627	0.947	2.89%	2.57%	4,105,640,000	4,337,582,000	0xFFFFFFFF	0x9B500	0x9C500	0x8060		COEFFICIENTS_mp_GE
COEFFICIENTS_mp_GET_P_SOURCE	1,432	2,329	0.615	2.68%	3.68%	3,817,712,000	6,209,114,000	0xFFFFFFFF	0xC9C30	0xCAC30	0x2800		COEFFICIENTS_mp_GE
_intel_new_memset	1,277	223	5.726	2.39%	0.35%	3,404,482,000	594,518,000	0xFFFFFFFF	0x21E630	0x21F630	0x1560		_intel_new_memset
COEFFICIENTS_mp_GET_P_COEFFICIENTS	1,239	2,050	0.604	2.32%	3.24%	3,303,174,000	5,465,300,000	0xFFFFFFFF	0xC5330	0xC6330	0x2380		COEFFICIENTS_mp_GE
COEFFICIENTS_mp_GET_U_COEFFICIENTS	988	1,116	0.885	1.85%	1.76%	2,634,008,000	2,975,256,000	0xFFFFFFFF	0x6D270	0x6E270	0x6B00		COEFFICIENTS_mp_GE
COEFFICIENTS_mp_GET_V_COEFFICIENTS	882	1,119	0.788	1.65%	1.77%	2,351,412,000	2,983,254,000	0xFFFFFFFF	0x8D9E0	0x8E9E0	0x6CD0		COEFFICIENTS_mp_GE
memset	825	395	2.089	1.55%	0.62%	2,199,450,000	1,053,070,000	0xFFFFFFFF	0x1C9440	0x1CA440	0xF0		memset
_intel_new_memcpy	790	100	7.900	1.48%	0.16%	2,106,140,000	266,600,000	0xFFFFFFFF	0x21FB90	0x220B90	0x23D0		_intel_new_memcpy
COEFFICIENTS_mp_GET_VELOCITIES_AT_INTERNAL_FAC...	780	745	1.047	1.46%	1.18%	2,079,480,000	1,986,170,000	0xFFFFFFFF	0xE3FD0	0xE4FD0	0x1450		COEFFICIENTS_mp_GE
COEFFICIENTS_mp_GET_DENSITY_AT_FACES	607	1,186	0.512	1.14%	1.87%	1,618,262,000	3,161,876,000	0xFFFFFFFF	0x6C8C0	0x6D8C0	0x9B0		COEFFICIENTS_mp_GE
USER_mp_GET_THERMAL_CONDUCTIVITY_AT_FACES	433	468	0.925	0.81%	0.74%	1,154,378,000	1,247,688,000	0xFFFFFFFF	0xF57B0	0xF67B0	0x720		USER_mp_GET_THERI
USER_mp_GET_LAMINAR_VISCOSITY_AT_FACES	416	467	0.891	0.78%	0.74%	1,109,056,000	1,245,022,000	0xFFFFFFFF	0xF5090	0xF6090	0x720		USER_mp_GET_LAMIN
SOLVERS_mp_NORM_L1_5D	304	495	0.614	0.57%	0.78%	810,464,000	1,319,670,000	0xFFFFFFFF	0x11D610	0x11E610	0x7E0		SOLVERS_mp_NORM_I
MAIN_ip_GET_NUMERICAL_SOLUTION	131	25	5.240	0.25%	0.04%	349,246,000	66,650,000	0xFFFFFFFF	0x124C60	0x125C60	0x60B0		MAIN_ip_GET_NUMERI
cvtas_t_to_a	99	201	0.493	0.19%	0.32%	263,934,000	535,866,000	0xFFFFFFFF	0x19BBE0	0x19CBE0	0x4320		cvtas_t_to_a
COEFFICIENTS_mp_GET_PRESSURE_DENSITY_CORRECT...	94	35	2.686	0.18%	0.06%	250,604,000	93,310,000	0xFFFFFFFF	0xE2080	0xE3080	0x350		COEFFICIENTS_mp_GE
COEFFICIENTS_mp_GET_DENSITY_AT_NODES	90	18	5.000	0.17%	0.03%	239,940,000	47,988,000	0xFFFFFFFF	0x6C690	0x6D690	0x230		COEFFICIENTS_mp_GE
USER_mp_SET_CP_AND_GAMMA	86	7	12.286	0.16%	0.01%	229,276,000	18,662,000	0xFFFFFFFF	0xF4D60	0xF5D60	0x1B0		USER_mp_SET_CP_AN
USER_mp_GET_A9D_B_RESCALING	68	72	0.944	0.13%	0.11%	181,288,000	191,952,000	0xFFFFFFFF	0x111BE0	0x112BE0	0x5830		USER_mp_GET_A9D_B
USER_mp_SET_LAMINAR_VISCOSITY_AT_NODES	57	5	11.400	0.11%	0.01%	151,962,000	13,330,000	0xFFFFFFFF	0xF4F10	0xF5F10	0xC0		USER_mp_SET_LAMIN
USER_mp_SET_THERMAL_CONDUCTIVITY_AT_NODES	47	7	6.714	0.09%	0.01%	125,302,000	18,662,000	0xFFFFFFFF	0xF4FD0	0xF5FD0	0xC0		USER_mp_SET_THERM
cvt_ieee_t_to_text_ex	42	37	1.135	0.08%	0.06%	111,972,000	98,642,000	0xFFFFFFFF	0x1841C0	0x1851C0	0x13E0		cvt_ieee_t_to_text_ex
USER_mp_SET_BCP	33	25	1.320	0.06%	0.04%	87,978,000	66,650,000	0xFFFFFFFF	0x1014B0	0x1024B0	0x2D20		USER_mp_SET_BCP
USER_mp_SET_BCT	32	4	8.000	0.06%	0.01%	85,312,000	10,664,000	0xFFFFFFFF	0xFD6E0	0xFE6E0	0x3DD0		USER_mp_SET_BCT
for__interp_fmt	30	29	1.034	0.06%	0.05%	79,980,000	77,314,000	0xFFFFFFFF	0x16E300	0x16F300	0xD80		for__interp_fmt
for_write_seq_fmt_xmit	28	24	1.167	0.05%	0.04%	74,648,000	63,984,000	0xFFFFFFFF	0x147490	0x148490	0x24B0		for_write_seq_fmt_xmit
USER_mp_GET_A5D_B_RESCALING	27	31	0.871	0.05%	0.05%	71,982,000	82,646,000	0xFFFFFFFF	0x10D870	0x10E870	0x4370		USER_mp_GET_A5D_B

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	
MSI2D9_mp_FB2D9	8,599	12,071	0.712	16.27%	19.29%	22,924,934,000	32,181,286,000	0xFFFFFFFF	0xDE250	0xDF250	0xBE70		MSI2D9_m
MSI2D5_mp_FB2D5	8,436	12,461	0.677	15.96%	19.91%	22,490,376,000	33,221,026,000	0xFFFFFFFF	0xCE9E0	0xCF9E0	0x87C0		MSI2D5_m
MSI2D9_mp_LU2D9	5,844	7,250	0.806	11.05%	11.58%	15,580,104,000	19,328,500,000	0xFFFFFFFF	0xEA0C0	0xEB0C0	0xACF0		MSI2D9_m
COEFFICIENTS_mp_GET_VELOCITIES_AT_FACES	5,302	4,795	1.106	10.03%	7.66%	14,135,132,000	12,783,470,000	0xFFFFFFFF	0xB8270	0xB9270	0x8730		COEFFICIE
MSI2D5_mp_LU2D5	2,670	2,901	0.920	5.05%	4.64%	7,118,220,000	7,734,066,000	0xFFFFFFFF	0xD71A0	0xD81A0	0x70A0		MSI2D5_m
COEFFICIENTS_mp_GET_T_COEFFICIENTS_AND_SOURCE	2,545	2,736	0.930	4.81%	4.37%	6,784,970,000	7,294,176,000	0xFFFFFFFF	0x94C10	0x95C10	0xCBA0		COEFFICIE
SOLVERS_mp_NORM_L1_9D	1,881	2,832	0.664	3.56%	4.53%	5,014,746,000	7,550,112,000	0xFFFFFFFF	0x11DF10	0x11EF10	0xD50		SOLVERS_
COEFFICIENTS_mp_GET_INTERNAL_SIMPLEC_COEFFICIENTS	1,798	1,536	1.171	3.40%	2.45%	4,793,468,000	4,094,976,000	0xFFFFFFFF	0xC92E0	0xCA2E0	0x2350		COEFFICIE
COEFFICIENTS_mp_GET_U_V_AT_REAL_NODES_WITH_PL	1,742	1,393	1.251	3.30%	2.23%	4,644,172,000	3,713,738,000	0xFFFFFFFF	0xCB980	0xCC980	0x1C00		COEFFICIE
COEFFICIENTS_mp_GET_U_SOURCE	1,555	1,584	0.982	2.94%	2.53%	4,145,630,000	4,222,944,000	0xFFFFFFFF	0x63FA0	0x64FA0	0x97B0		COEFFICIE
COEFFICIENTS_mp_GET_V_SOURCE	1,490	1,632	0.913	2.82%	2.61%	3,972,340,000	4,350,912,000	0xFFFFFFFF	0x84AB0	0x85AB0	0x8060		COEFFICIE
COEFFICIENTS_mp_GET_P_SOURCE	1,416	2,335	0.606	2.68%	3.73%	3,775,056,000	6,225,110,000	0xFFFFFFFF	0xB31E0	0xB41E0	0x2800		COEFFICIE
_intel_new_memset	1,246	232	5.371	2.36%	0.37%	3,321,836,000	618,512,000	0xFFFFFFFF	0x21E750	0x21F750	0x1560		_intel_new_
COEFFICIENTS_mp_GET_P_COEFFICIENTS	1,243	2,044	0.608	2.35%	3.27%	3,313,838,000	5,449,304,000	0xFFFFFFFF	0xAE8E0	0xAF8E0	0x2380		COEFFICIE
COEFFICIENTS_mp_GET_U_COEFFICIENTS	987	1,127	0.876	1.87%	1.80%	2,631,342,000	3,004,582,000	0xFFFFFFFF	0x56820	0x57820	0x6B00		COEFFICIE
COEFFICIENTS_mp_GET_V_COEFFICIENTS	875	1,136	0.770	1.66%	1.82%	2,332,750,000	3,028,576,000	0xFFFFFFFF	0x76F90	0x77F90	0x6CD0		COEFFICIE
memset	846	412	2.053	1.60%	0.66%	2,255,436,000	1,098,392,000	0xFFFFFFFF	0x1C9560	0x1CA560	0xF0		memset
_intel_new_memcpy	797	113	7.053	1.51%	0.18%	2,124,802,000	301,258,000	0xFFFFFFFF	0x21FCB0	0x220CB0	0x23D0		_intel_new_
COEFFICIENTS_mp_GET_VELOCITIES_AT_INTERNAL_FACES_WITH_PL	776	748	1.037	1.47%	1.20%	2,068,816,000	1,994,168,000	0xFFFFFFFF	0xCD580	0xCE580	0x1450		COEFFICIE
COEFFICIENTS_mp_GET_DENSITY_AT_FACES	547	1,149	0.476	1.03%	1.84%	1,458,302,000	3,063,234,000	0xFFFFFFFF	0x55E70	0x56E70	0x9B0		COEFFICIE
USER_mp_GET_LAMINAR_VISCOSITY_AT_FACES	431	449	0.960	0.82%	0.72%	1,149,046,000	1,197,034,000	0xFFFFFFFF	0xF51B0	0xF61B0	0x720		USER_mp_
USER_mp_GET_THERMAL_CONDUCTIVITY_AT_FACES	397	474	0.838	0.75%	0.76%	1,058,402,000	1,263,684,000	0xFFFFFFFF	0xF58D0	0xF68D0	0x720		USER_mp_
SOLVERS_mp_NORM_L1_5D	304	507	0.600	0.58%	0.81%	810,464,000	1,351,662,000	0xFFFFFFFF	0x11D730	0x11E730	0x7E0		SOLVERS_
MAIN_ip_GET_NUMERICAL_SOLUTION	148	17	8.706	0.28%	0.03%	394,568,000	45,322,000	0xFFFFFFFF	0x124D80	0x125D80	0x60B0		MAIN_ip_G
cvtas_t_to_a	104	200	0.520	0.20%	0.32%	277,264,000	533,200,000	0xFFFFFFFF	0x19BD00	0x19CD00	0x4320		cvtas_t_to_
USER_mp_SET_CP_AND_GAMMA	99	4	24.750	0.19%	0.01%	263,934,000	10,664,000	0xFFFFFFFF	0xF4E80	0xF5E80	0x1B0		USER_mp_
COEFFICIENTS_mp_GET_DENSITY_AT_NODES	97	21	4.619	0.18%	0.03%	258,602,000	55,986,000	0xFFFFFFFF	0x55C40	0x56C40	0x230		COEFFICIE
COEFFICIENTS_mp_GET_PRESSURE_DENSITY_CORRECTION_WITH_PL	91	38	2.395	0.17%	0.06%	242,606,000	101,308,000	0xFFFFFFFF	0xCB630	0xCC630	0x350		COEFFICIE
USER_mp_SET_THERMAL_CONDUCTIVITY_AT_NODES	64	8	8.000	0.12%	0.01%	170,624,000	21,328,000	0xFFFFFFFF	0xF50F0	0xF60F0	0xC0		USER_mp_
USER_mp_GET_A9D_B_RESCALING	62	67	0.925	0.12%	0.11%	165,292,000	178,622,000	0xFFFFFFFF	0x111D00	0x112D00	0x5830		USER_mp_
USER_mp_SET_LAMINAR_VISCOSITY_AT_NODES	47	6	7.833	0.09%	0.01%	125,302,000	15,996,000	0xFFFFFFFF	0xF5030	0xF6030	0xC0		USER_mp_
USER_mp_SET_BCU	36	13	2.769	0.07%	0.02%	95,976,000	34,658,000	0xFFFFFFFF	0xF5FF0	0xF6FF0	0x3C10		USER_mp_
cvt_ieee_t_to_text_ex	36	41	0.878	0.07%	0.07%	95,976,000	109,306,000	0xFFFFFFFF	0x1842E0	0x1852E0	0x13E0		cvt_ieee_t_
for_write_seq_fmt_xmit	35	33	1.061	0.07%	0.05%	93,310,000	87,978,000	0xFFFFFFFF	0x1475B0	0x1485B0	0x24B0		for_write_s
for__interp_fmt	33	29	1.138	0.06%	0.05%	87,978,000	77,314,000	0xFFFFFFFF	0x16E420	0x16F420	0xD80		for__interp_
USER_mp_SET_BCV	31	12	2.583	0.06%	0.02%	82,646,000	31,992,000	0xFFFFFFFF	0xF9C00	0xFAC00	0x3C00		USER_mp_
USER_mp_SET_BCP	31	17	1.824	0.06%	0.03%	82,646,000	45,322,000	0xFFFFFFFF	0x1015D0	0x1025D0	0x2D20		USER_mp_

Figura 7 Depois da otimização

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

    1.000836328728611E+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
    9.9916437013265 40E-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)
    54.829 = dtcpu: CPU time (s) (after interuption)
    54.829 = tcpu:  total CPU time (s)
```

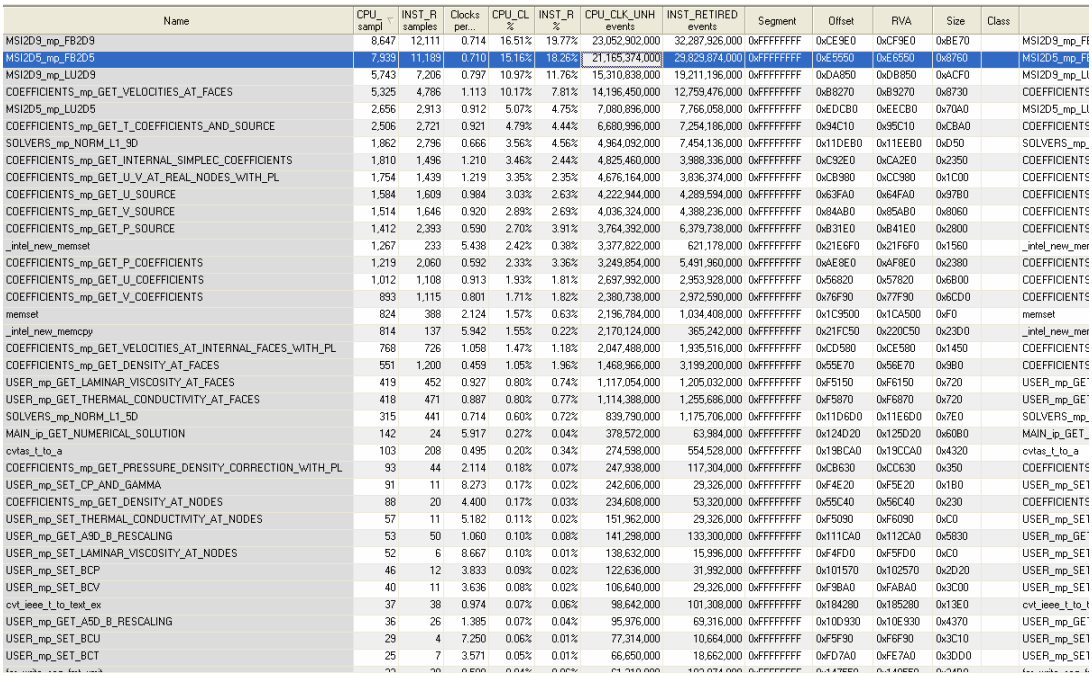
5)SUBROTINA: MSI2D5_mp_FB2D5: `SEN03_0017`

Ao invés de um if, foi feito dois ciclos e casos especiais nos volumes fictícios para o cálculo do resíduo.

Houve uma redução de **22,490,376,000** ciclos de clock para **21,165,374,000**. A rotina que utilizava **15,96%** do tempo total, agora utiliza **15,16%.**

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	8,599	12,071	0.712	16.27%	19.29%	22,924,934,000	32,181,286,000	0xFFFFFFFF	0xDE250	0xDF250	0xBE70		MSI2D9_m
MSI2D5_mp_FB2D5	8,436	12,461	0.677	15.96%	19.91%	22,490,376,000	33,221,026,000	0xFFFFFFFF	0xCE9E0	0xCF9E0	0x87C0		MSI2D5_m
MSI2D9_mp_LU2D9	5,844	7,250	0.806	11.05%	11.58%	15,580,104,000	19,328,500,000	0xFFFFFFFF	0xEA0C0	0xEB0C0	0xACF0		MSI2D9_m
COEFFICIENTS_mp_GET_VELOCITIES_AT_FACES	5,302	4,795	1.106	10.03%	7.66%	14,135,132,000	12,783,470,000	0xFFFFFFFF	0xB8270	0xB9270	0x8730		COEFFICIE
MSI2D5_mp_LU2D5	2,670	2,901	0.920	5.05%	4.64%	7,118,220,000	7,734,066,000	0xFFFFFFFF	0xD71A0	0xD81A0	0x70A0		MSI2D5_m
COEFFICIENTS_mp_GET_T_COEFFICIENTS_AND_SOURCE	2,545	2,736	0.930	4.81%	4.37%	6,784,970,000	7,294,176,000	0xFFFFFFFF	0x94C10	0x95C10	0xCBA0		COEFFICIE
SOLVERS_mp_NORM_L1_9D	1,881	2,832	0.664	3.56%	4.53%	5,014,746,000	7,550,112,000	0xFFFFFFFF	0x11DF10	0x11EF10	0xD50		SOLVERS_
COEFFICIENTS_mp_GET_INTERNAL_SIMPLEC_COEFFICIENTS	1,798	1,536	1.171	3.40%	2.45%	4,793,468,000	4,094,976,000	0xFFFFFFFF	0xC92E0	0xCA2E0	0x2350		COEFFICIE
COEFFICIENTS_mp_GET_U_V_AT_REAL_NODES_WITH_PL	1,742	1,393	1.251	3.30%	2.23%	4,644,172,000	3,713,738,000	0xFFFFFFFF	0xCB980	0xCC980	0x1C00		COEFFICIE
COEFFICIENTS_mp_GET_U_SOURCE	1,555	1,584	0.982	2.94%	2.53%	4,145,630,000	4,222,944,000	0xFFFFFFFF	0x63FA0	0x64FA0	0x97B0		COEFFICIE
COEFFICIENTS_mp_GET_V_SOURCE	1,490	1,632	0.913	2.82%	2.61%	3,972,340,000	4,350,912,000	0xFFFFFFFF	0x84AB0	0x85AB0	0x8060		COEFFICIE
COEFFICIENTS_mp_GET_P_SOURCE	1,416	2,335	0.606	2.68%	3.73%	3,775,056,000	6,225,110,000	0xFFFFFFFF	0xB31E0	0xB41E0	0x2800		COEFFICIE
_intel_new_memset	1,246	232	5.371	2.36%	0.37%	3,321,836,000	618,512,000	0xFFFFFFFF	0x21E750	0x21F750	0x1560		_intel_new_
COEFFICIENTS_mp_GET_P_COEFFICIENTS	1,243	2,044	0.608	2.35%	3.27%	3,313,838,000	5,449,304,000	0xFFFFFFFF	0xAE8E0	0xAF8E0	0x2380		COEFFICIE
COEFFICIENTS_mp_GET_U_COEFFICIENTS	987	1,127	0.876	1.87%	1.80%	2,631,342,000	3,004,582,000	0xFFFFFFFF	0x56820	0x57820	0x6B00		COEFFICIE
COEFFICIENTS_mp_GET_V_COEFFICIENTS	875	1,136	0.770	1.66%	1.82%	2,332,750,000	3,028,576,000	0xFFFFFFFF	0x76F90	0x77F90	0x6CD0		COEFFICIE
memset	846	412	2.053	1.60%	0.66%	2,255,436,000	1,098,392,000	0xFFFFFFFF	0x1C9560	0x1CA560	0xF0		memset
_intel_new_memcpy	797	113	7.053	1.51%	0.18%	2,124,802,000	301,258,000	0xFFFFFFFF	0x21FCB0	0x220CB0	0x23D0		_intel_new_
COEFFICIENTS_mp_GET_VELOCITIES_AT_INTERNAL_FACES_WITH_PL	776	748	1.037	1.47%	1.20%	2,068,816,000	1,994,168,000	0xFFFFFFFF	0xCD580	0xCE580	0x1450		COEFFICIE
COEFFICIENTS_mp_GET_DENSITY_AT_FACES	547	1,149	0.476	1.03%	1.84%	1,458,302,000	3,063,234,000	0xFFFFFFFF	0x55E70	0x56E70	0x9B0		COEFFICIE
USER_mp_GET_LAMINAR_VISCOSITY_AT_FACES	431	449	0.960	0.82%	0.72%	1,149,046,000	1,197,034,000	0xFFFFFFFF	0xF51B0	0xF61B0	0x720		USER_mp_
USER_mp_GET_THERMAL_CONDUCTIVITY_AT_FACES	397	474	0.838	0.75%	0.76%	1,058,402,000	1,263,684,000	0xFFFFFFFF	0xF58D0	0xF68D0	0x720		USER_mp_
SOLVERS_mp_NORM_L1_5D	304	507	0.600	0.58%	0.81%	810,464,000	1,351,662,000	0xFFFFFFFF	0x11D730	0x11E730	0x7E0		SOLVERS_
MAIN_ip_GET_NUMERICAL_SOLUTION	148	17	8.706	0.28%	0.03%	394,568,000	45,322,000	0xFFFFFFFF	0x124D80	0x125D80	0x60B0		MAIN_ip_G
cvtas_t_to_a	104	200	0.520	0.20%	0.32%	277,264,000	533,200,000	0xFFFFFFFF	0x19BD00	0x19CD00	0x4320		cvtas_t_to_
USER_mp_SET_CP_AND_GAMMA	99	4	24.750	0.19%	0.01%	263,934,000	10,664,000	0xFFFFFFFF	0xF4E80	0xF5E80	0x1B0		USER_mp_
COEFFICIENTS_mp_GET_DENSITY_AT_NODES	97	21	4.619	0.18%	0.03%	258,602,000	55,986,000	0xFFFFFFFF	0x55C40	0x56C40	0x230		COEFFICIE
COEFFICIENTS_mp_GET_PRESSURE_DENSITY_CORRECTION_WITH_PL	91	38	2.395	0.17%	0.06%	242,606,000	101,308,000	0xFFFFFFFF	0xCB630	0xCC630	0x350		COEFFICIE
USER_mp_SET_THERMAL_CONDUCTIVITY_AT_NODES	64	8	8.000	0.12%	0.01%	170,624,000	21,328,000	0xFFFFFFFF	0xF50F0	0xF60F0	0xC0		USER_mp_
USER_mp_GET_A9D_B_RESCALING	62	67	0.925	0.12%	0.11%	165,292,000	178,622,000	0xFFFFFFFF	0x111D00	0x112D00	0x5830		USER_mp_
USER_mp_SET_LAMINAR_VISCOSITY_AT_NODES	47	6	7.833	0.09%	0.01%	125,302,000	15,996,000	0xFFFFFFFF	0xF5030	0xF6030	0xC0		USER_mp_
USER_mp_SET_BCU	36	13	2.769	0.07%	0.02%	95,976,000	34,658,000	0xFFFFFFFF	0xF5FF0	0xF6FF0	0x3C10		USER_mp_
cvt_ieee_t_to_text_ex	36	41	0.878	0.07%	0.07%	95,976,000	109,306,000	0xFFFFFFFF	0x1842E0	0x1852E0	0x13E0		cvt_ieee_t_
for_write_seq_fmt_xmit	35	33	1.061	0.07%	0.05%	93,310,000	87,978,000	0xFFFFFFFF	0x1475B0	0x1485B0	0x24B0		for_write_s
for__interp_fmt	33	29	1.138	0.06%	0.05%	87,978,000	77,314,000	0xFFFFFFFF	0x16E420	0x16F420	0xD80		for__interp_
USER_mp_SET_BCV	31	12	2.583	0.06%	0.02%	82,646,000	31,992,000	0xFFFFFFFF	0xF9C00	0xFAC00	0x3C00		USER_mp_
USER_mp_SET_BCP	31	17	1.824	0.06%	0.03%	82,646,000	45,322,000	0xFFFFFFFF	0x1015D0	0x1025D0	0x2D20		USER_mp_
[illegible]	27	21	0.971	0.06%	0.05%	71,982,000	82,646,000	0xFFFFFFFF	0x180000	0x190000	0x4230		[illegible]

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	
MSI2D9_mp_FB2D9	8,647	12,111	0.714	16.51%	19.77%	23,052,902,000	32,287,926,000	0xFFFFFFFF	0xCE9E0	0xCF9E0	0xBE70		MSI2D9_mp_FB
MSI2D5_mp_FB2D5	7,939	11,189	0.710	15.16%	18.26%	21,165,374,000	29,829,874,000	0xFFFFFFFF	0xE5550	0xE6550	0x8760		MSI2D5_mp_FB
MSI2D9_mp_LU2D9	5,743	7,206	0.797	10.97%	11.76%	15,310,838,000	19,211,196,000	0xFFFFFFFF	0xDA850	0xDB850	0xACF0		MSI2D9_mp_LU
COEFFICIENTS_mp_GET_VELOCITIES_AT_FACES	5,325	4,786	1.113	10.17%	7.81%	14,196,450,000	12,759,476,000	0xFFFFFFFF	0xB8270	0xB9270	0x8730		COEFFICIENTS
MSI2D5_mp_LU2D5	2,656	2,913	0.912	5.07%	4.75%	7,080,896,000	7,766,058,000	0xFFFFFFFF	0xEDCB0	0xEECB0	0x70A0		MSI2D5_mp_LU
COEFFICIENTS_mp_GET_T_COEFFICIENTS_AND_SOURCE	2,506	2,721	0.921	4.79%	4.44%	6,680,996,000	7,254,186,000	0xFFFFFFFF	0x94C10	0x95C10	0xCBA0		COEFFICIENTS
SOLVERS_mp_NORM_L1_9D	1,862	2,796	0.666	3.56%	4.56%	4,964,092,000	7,454,136,000	0xFFFFFFFF	0x11DEB0	0x11EEB0	0xD50		SOLVERS_mp_
COEFFICIENTS_mp_GET_INTERNAL_SIMPLEC_COEFFICIENTS	1,810	1,496	1.210	3.46%	2.44%	4,825,460,000	3,988,336,000	0xFFFFFFFF	0xC92E0	0xCA2E0	0x2350		COEFFICIENTS
COEFFICIENTS_mp_GET_U_V_AT_REAL_NODES_WITH_PL	1,754	1,439	1.219	3.35%	2.35%	4,676,164,000	3,836,374,000	0xFFFFFFFF	0xCB980	0xCC980	0x1C00		COEFFICIENTS
COEFFICIENTS_mp_GET_U_SOURCE	1,584	1,609	0.984	3.03%	2.63%	4,222,944,000	4,289,594,000	0xFFFFFFFF	0x63FA0	0x64FA0	0x97B0		COEFFICIENTS
COEFFICIENTS_mp_GET_V_SOURCE	1,514	1,646	0.920	2.89%	2.69%	4,036,324,000	4,388,236,000	0xFFFFFFFF	0x84AB0	0x85AB0	0x8060		COEFFICIENTS
COEFFICIENTS_mp_GET_P_SOURCE	1,412	2,393	0.590	2.70%	3.91%	3,764,392,000	6,379,738,000	0xFFFFFFFF	0xB31E0	0xB41E0	0x2800		COEFFICIENTS
_intel_new_memset	1,267	233	5.438	2.42%	0.38%	3,377,822,000	621,178,000	0xFFFFFFFF	0x21E6F0	0x21F6F0	0x1560		_intel_new_mer
COEFFICIENTS_mp_GET_P_COEFFICIENTS	1,219	2,060	0.592	2.33%	3.36%	3,249,854,000	5,491,960,000	0xFFFFFFFF	0xAE8E0	0xAF8E0	0x2380		COEFFICIENTS
COEFFICIENTS_mp_GET_U_COEFFICIENTS	1,012	1,108	0.913	1.93%	1.81%	2,697,992,000	2,953,928,000	0xFFFFFFFF	0x56820	0x57820	0x6B00		COEFFICIENTS
COEFFICIENTS_mp_GET_V_COEFFICIENTS	893	1,115	0.801	1.71%	1.82%	2,380,738,000	2,972,590,000	0xFFFFFFFF	0x76F90	0x77F90	0x6CD0		COEFFICIENTS
memset	824	388	2.124	1.57%	0.63%	2,196,784,000	1,034,408,000	0xFFFFFFFF	0x1C9500	0x1CA500	0xF0		memset
_intel_new_memcpy	814	137	5.942	1.55%	0.22%	2,170,124,000	365,242,000	0xFFFFFFFF	0x21FC50	0x220C50	0x23D0		_intel_new_mer
COEFFICIENTS_mp_GET_VELOCITIES_AT_INTERNAL_FACES_WITH_PL	768	726	1.058	1.47%	1.18%	2,047,488,000	1,935,516,000	0xFFFFFFFF	0xCD580	0xCE580	0x1450		COEFFICIENTS
COEFFICIENTS_mp_GET_DENSITY_AT_FACES	551	1,200	0.459	1.05%	1.96%	1,468,966,000	3,199,200,000	0xFFFFFFFF	0x55E70	0x56E70	0x9B0		COEFFICIENTS
USER_mp_GET_LAMINAR_VISCOSITY_AT_FACES	419	452	0.927	0.80%	0.74%	1,117,054,000	1,205,032,000	0xFFFFFFFF	0xF5150	0xF6150	0x720		USER_mp_GE
USER_mp_GET_THERMAL_CONDUCTIVITY_AT_FACES	418	471	0.887	0.80%	0.77%	1,114,388,000	1,255,686,000	0xFFFFFFFF	0xF5870	0xF6870	0x720		USER_mp_GE
SOLVERS_mp_NORM_L1_5D	315	441	0.714	0.60%	0.72%	839,790,000	1,175,706,000	0xFFFFFFFF	0x11D6D0	0x11E6D0	0x7E0		SOLVERS_mp_
MAIN_ip_GET_NUMERICAL_SOLUTION	142	24	5.917	0.27%	0.04%	378,572,000	63,984,000	0xFFFFFFFF	0x124D20	0x125D20	0x60B0		MAIN_ip_GET_
cvtas_t_to_a	103	208	0.495	0.20%	0.34%	274,598,000	554,528,000	0xFFFFFFFF	0x19BCA0	0x19CCA0	0x4320		cvtas_t_to_a
COEFFICIENTS_mp_GET_PRESSURE_DENSITY_CORRECTION_WITH_PL	93	44	2.114	0.18%	0.07%	247,938,000	117,304,000	0xFFFFFFFF	0xCB630	0xCC630	0x350		COEFFICIENTS
USER_mp_SET_CP_AND_GAMMA	91	11	8.273	0.17%	0.02%	242,606,000	29,326,000	0xFFFFFFFF	0xF4E20	0xF5E20	0x1B0		USER_mp_SE1
COEFFICIENTS_mp_GET_DENSITY_AT_NODES	88	20	4.400	0.17%	0.03%	234,608,000	53,320,000	0xFFFFFFFF	0x55C40	0x56C40	0x230		COEFFICIENTS
USER_mp_SET_THERMAL_CONDUCTIVITY_AT_NODES	57	11	5.182	0.11%	0.02%	151,962,000	29,326,000	0xFFFFFFFF	0xF5090	0xF6090	0xC0		USER_mp_SE1
USER_mp_GET_A9D_B_RESCALING	53	50	1.060	0.10%	0.08%	141,298,000	133,300,000	0xFFFFFFFF	0x111CA0	0x112CA0	0x5830		USER_mp_GE
USER_mp_SET_LAMINAR_VISCOSITY_AT_NODES	52	6	8.667	0.10%	0.01%	138,632,000	15,996,000	0xFFFFFFFF	0xF4FD0	0xF5FD0	0xC0		USER_mp_SE1
USER_mp_SET_BCP	46	12	3.833	0.09%	0.02%	122,636,000	31,992,000	0xFFFFFFFF	0x101570	0x102570	0x2D20		USER_mp_SE1
USER_mp_SET_BCV	40	11	3.636	0.08%	0.02%	106,640,000	29,326,000	0xFFFFFFFF	0xF9BA0	0xFABA0	0x3C00		USER_mp_SE1
cvt_ieee_t_to_text_ex	37	38	0.974	0.07%	0.06%	98,642,000	101,308,000	0xFFFFFFFF	0x184280	0x185280	0x13E0		cvt_ieee_t_to_t
USER_mp_GET_A5D_B_RESCALING	36	26	1.385	0.07%	0.04%	95,976,000	69,316,000	0xFFFFFFFF	0x10D930	0x10E930	0x4370		USER_mp_GE
USER_mp_SET_BCU	29	4	7.250	0.06%	0.01%	77,314,000	10,664,000	0xFFFFFFFF	0xF5F90	0xF6F90	0x3C10		USER_mp_SE1
USER_mp_SET_BCT	25	7	3.571	0.05%	0.01%	66,650,000	18,662,000	0xFFFFFFFF	0xFD7A0	0xFE7A0	0x3DD0		USER_mp_SE1

Figura 9 Depois da otimização

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

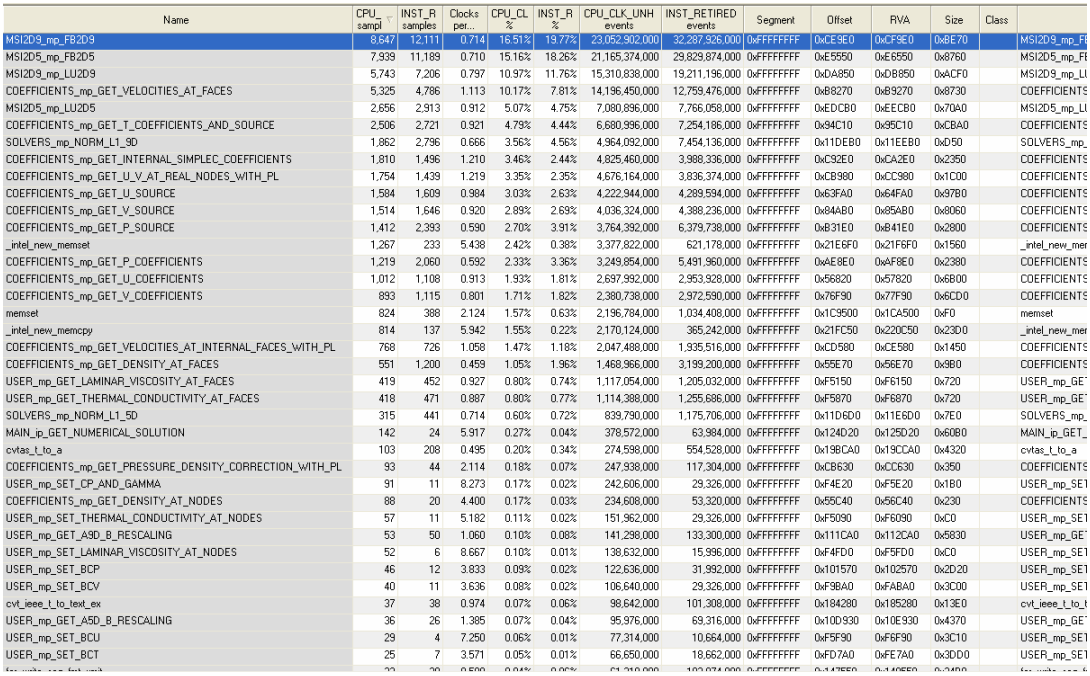
    1.000836328728611E+00 = discharge coefficient
    9.691914048072191E-01 = dynamic thrust
    9.752768908404300E-01 = pressure thrust at sea level (p = 101325 Pa)
    1.080533092655724E+00 = pressure thrust in the vacuum
    9.677277608885939E-01 = total thrust at sea level
    9.754462366605247E-01 = total thrust in the vacuum
    9.677277608885938E-01 = thrust coefficient at sea level
    9.754462366605245E-01 = thrust coefficient in the vacuum
    9.991643701326540E-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)
    54.329 = dtcpu: CPU time (s) (after interuption)
    54.329 = tcpu:  total CPU time (s)
```

6)SUBROTINA: MSI2D9_mp_FB2D9: `SEN03_0018`

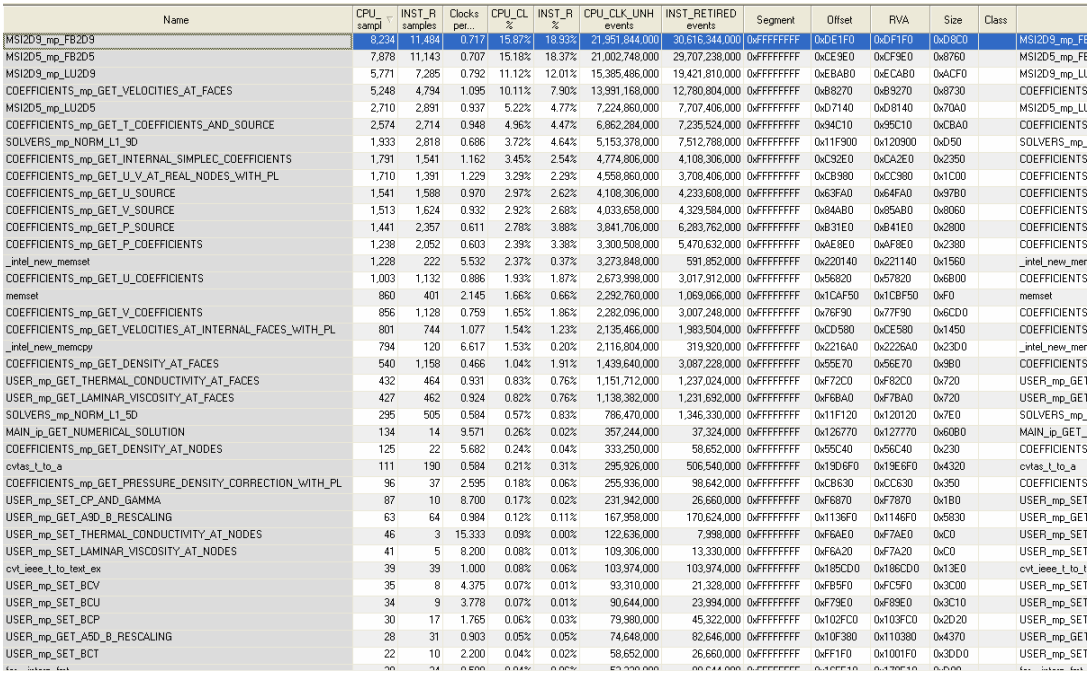
Foi aplicado a técnica de loop unrolling no cálculo do resíduo, ao invés de um cálculo de resíduo com ip variando de um em um, foi feito de dois em dois. ATENÇÃO: ESTA TÉCNICA SÓ FUNCIONA PARA NÚMEROS PARES DE VOLUMES REAIS NA DIREÇÃO AXIAL

Houve uma redução de **23,059,902,000** ciclos de clock para **21,951,844,000**. A rotina que utilizava **16,51%** do tempo total, agora utiliza **15,87%.**



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	8,647	12,111	0.714	16.51%	19.77%	23,052,902,000	32,287,926,000	0xFFFFFFFF	0xCE9E0	0xCF9E0	0x8E70		MSI2D9_mp_FB
MSI2D5_mp_FB2D5	7,939	11,189	0.710	15.16%	18.26%	21,165,374,000	29,829,874,000	0xFFFFFFFF	0xE5550	0xE6550	0x8760		MSI2D5_mp_FB
MSI2D9_mp_LU2D9	5,743	7,206	0.797	10.97%	11.76%	15,310,838,000	19,211,196,000	0xFFFFFFFF	0xDA850	0xDB850	0xACF0		MSI2D9_mp_LU
COEFFICIENTS_mp_GET_VELOCITIES_AT_FACES	5,325	4,786	1.113	10.17%	7.81%	14,196,450,000	12,759,476,000	0xFFFFFFFF	0xB8270	0xB9270	0x8730		COEFFICIENTS
MSI2D5_mp_LU2D5	2,656	2,913	0.912	5.07%	4.75%	7,080,896,000	7,766,058,000	0xFFFFFFFF	0xEDCB0	0xEECB0	0x70A0		MSI2D5_mp_LU
COEFFICIENTS_mp_GET_T_COEFFICIENTS_AND_SOURCE	2,506	2,721	0.921	4.79%	4.44%	6,680,996,000	7,254,186,000	0xFFFFFFFF	0x94C10	0x95C10	0xCBA0		COEFFICIENTS
SOLVERS_mp_NORM_L1_9D	1,862	2,796	0.666	3.56%	4.56%	4,964,092,000	7,454,136,000	0xFFFFFFFF	0x11DEB0	0x11EEB0	0xD50		SOLVERS_mp_
COEFFICIENTS_mp_GET_INTERNAL_SIMPLEC_COEFFICIENTS	1,810	1,496	1.210	3.46%	2.44%	4,825,460,000	3,988,336,000	0xFFFFFFFF	0xC92E0	0xCA2E0	0x2350		COEFFICIENTS
COEFFICIENTS_mp_GET_U_V_AT_REAL_NODES_WITH_PL	1,754	1,439	1.219	3.35%	2.35%	4,676,164,000	3,836,374,000	0xFFFFFFFF	0xCB980	0xCC980	0x1C00		COEFFICIENTS
COEFFICIENTS_mp_GET_U_SOURCE	1,584	1,609	0.984	3.03%	2.63%	4,222,944,000	4,289,594,000	0xFFFFFFFF	0x63FA0	0x64FA0	0x97B0		COEFFICIENTS
COEFFICIENTS_mp_GET_V_SOURCE	1,514	1,646	0.920	2.89%	2.69%	4,036,324,000	4,388,236,000	0xFFFFFFFF	0x84AB0	0x85AB0	0x8060		COEFFICIENTS
COEFFICIENTS_mp_GET_P_SOURCE	1,412	2,393	0.590	2.70%	3.91%	3,764,392,000	6,379,738,000	0xFFFFFFFF	0xB31E0	0xB41E0	0x2800		COEFFICIENTS
_intel_new_memset	1,267	233	5.438	2.42%	0.38%	3,377,822,000	621,178,000	0xFFFFFFFF	0x21E6F0	0x21F6F0	0x1560		_intel_new_mer
COEFFICIENTS_mp_GET_P_COEFFICIENTS	1,219	2,060	0.592	2.33%	3.36%	3,249,854,000	5,491,960,000	0xFFFFFFFF	0xAE8E0	0xAF8E0	0x2380		COEFFICIENTS
COEFFICIENTS_mp_GET_U_COEFFICIENTS	1,012	1,108	0.913	1.93%	1.81%	2,697,992,000	2,953,928,000	0xFFFFFFFF	0x56820	0x57820	0x6B00		COEFFICIENTS
COEFFICIENTS_mp_GET_V_COEFFICIENTS	893	1,115	0.801	1.71%	1.82%	2,380,738,000	2,972,590,000	0xFFFFFFFF	0x76F90	0x77F90	0x6CD0		COEFFICIENTS
memset	824	388	2.124	1.57%	0.63%	2,196,784,000	1,034,408,000	0xFFFFFFFF	0x1C9500	0x1CA500	0xF0		memset
_intel_new_memcpy	814	137	5.942	1.55%	0.22%	2,170,124,000	365,242,000	0xFFFFFFFF	0x21FC50	0x220C50	0x23D0		_intel_new_mer
COEFFICIENTS_mp_GET_VELOCITIES_AT_INTERNAL_FACES_WITH_PL	768	726	1.058	1.47%	1.18%	2,047,488,000	1,935,516,000	0xFFFFFFFF	0xCD580	0xCE580	0x1450		COEFFICIENTS
COEFFICIENTS_mp_GET_DENSITY_AT_FACES	551	1,200	0.459	1.05%	1.96%	1,468,966,000	3,199,200,000	0xFFFFFFFF	0x55E70	0x56E70	0x9B0		COEFFICIENTS
USER_mp_GET_LAMINAR_VISCOSITY_AT_FACES	419	452	0.927	0.80%	0.74%	1,117,054,000	1,205,032,000	0xFFFFFFFF	0xF5150	0xF6150	0x720		USER_mp_GE
USER_mp_GET_THERMAL_CONDUCTIVITY_AT_FACES	418	471	0.887	0.80%	0.77%	1,114,388,000	1,255,686,000	0xFFFFFFFF	0xF5870	0xF6870	0x720		USER_mp_GE
SOLVERS_mp_NORM_L1_5D	315	441	0.714	0.60%	0.72%	839,790,000	1,175,706,000	0xFFFFFFFF	0x11D6D0	0x11E6D0	0x7E0		SOLVERS_mp_
MAIN_ip_GET_NUMERICAL_SOLUTION	142	24	5.917	0.27%	0.04%	378,572,000	63,984,000	0xFFFFFFFF	0x124D20	0x125D20	0x60B0		MAIN_ip_GET_
cvtas_t_to_a	103	208	0.495	0.20%	0.34%	274,598,000	554,528,000	0xFFFFFFFF	0x19BCA0	0x19CCA0	0x4320		cvtas_t_to_a
COEFFICIENTS_mp_GET_PRESSURE_DENSITY_CORRECTION_WITH_PL	93	44	2.114	0.18%	0.07%	247,938,000	117,304,000	0xFFFFFFFF	0xCB630	0xCC630	0x350		COEFFICIENTS
USER_mp_SET_CP_AND_GAMMA	91	11	8.273	0.17%	0.02%	242,606,000	29,326,000	0xFFFFFFFF	0xF4E20	0xF5E20	0x1B0		USER_mp_SET
COEFFICIENTS_mp_GET_DENSITY_AT_NODES	88	20	4.400	0.17%	0.03%	234,608,000	53,320,000	0xFFFFFFFF	0x55C40	0x56C40	0x230		COEFFICIENTS
USER_mp_SET_THERMAL_CONDUCTIVITY_AT_NODES	57	11	5.182	0.11%	0.02%	151,962,000	29,326,000	0xFFFFFFFF	0xF5090	0xF6090	0xC0		USER_mp_SET
USER_mp_GET_A9D_B_RESCALING	53	50	1.060	0.10%	0.08%	141,298,000	133,300,000	0xFFFFFFFF	0x111CA0	0x112CA0	0x5830		USER_mp_GE
USER_mp_SET_LAMINAR_VISCOSITY_AT_NODES	52	6	8.667	0.10%	0.01%	138,632,000	15,996,000	0xFFFFFFFF	0xF4FD0	0xF5FD0	0xC0		USER_mp_SET
USER_mp_SET_BCP	46	12	3.833	0.09%	0.02%	122,636,000	31,992,000	0xFFFFFFFF	0x101570	0x102570	0x2D20		USER_mp_SET
USER_mp_SET_BCV	40	11	3.636	0.08%	0.02%	106,640,000	29,326,000	0xFFFFFFFF	0xF9BA0	0xFABA0	0x3C00		USER_mp_SET
cvt_ieee_t_to_text_ex	37	38	0.974	0.07%	0.06%	98,642,000	101,308,000	0xFFFFFFFF	0x184280	0x185280	0x13E0		cvt_ieee_t_to_t
USER_mp_GET_A5D_B_RESCALING	36	26	1.385	0.07%	0.04%	95,976,000	69,316,000	0xFFFFFFFF	0x10D930	0x10E930	0x4370		USER_mp_GE
USER_mp_SET_BCU	29	4	7.250	0.06%	0.01%	77,314,000	10,664,000	0xFFFFFFFF	0xF5F90	0xF6F90	0x3C10		USER_mp_SET
USER_mp_SET_BCT	25	7	3.571	0.05%	0.01%	66,650,000	18,662,000	0xFFFFFFFF	0xFD7A0	0xFE7A0	0x3DD0		USER_mp_SET

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	8,234	11,484	0.717	15.87%	18.93%	21,951,844,000	30,616,344,000	0xFFFFFFFF	0xDE1F0	0xDF1F0	0xD8C0		MSI2D9_mp_FB
MSI2D5_mp_FB2D5	7,878	11,143	0.707	15.18%	18.37%	21,002,748,000	29,707,238,000	0xFFFFFFFF	0xCE9E0	0xCF9E0	0x8760		MSI2D5_mp_FB
MSI2D9_mp_LU2D9	5,771	7,285	0.792	11.12%	12.01%	15,385,486,000	19,421,810,000	0xFFFFFFFF	0xEBAB0	0xECAB0	0xACF0		MSI2D9_mp_LU
COEFFICIENTS_mp_GET_VELOCITIES_AT_FACES	5,248	4,794	1.095	10.11%	7.90%	13,991,168,000	12,780,804,000	0xFFFFFFFF	0xB8270	0xB9270	0x8730		COEFFICIENTS
MSI2D5_mp_LU2D5	2,710	2,891	0.937	5.22%	4.77%	7,224,860,000	7,707,406,000	0xFFFFFFFF	0xD7140	0xD8140	0x70A0		MSI2D5_mp_LU
COEFFICIENTS_mp_GET_T_COEFFICIENTS_AND_SOURCE	2,574	2,714	0.948	4.96%	4.47%	6,862,284,000	7,235,524,000	0xFFFFFFFF	0x94C10	0x95C10	0xCBA0		COEFFICIENTS
SOLVERS_mp_NORM_L1_9D	1,933	2,818	0.686	3.72%	4.64%	5,153,378,000	7,512,788,000	0xFFFFFFFF	0x11F900	0x120900	0xD50		SOLVERS_mp_
COEFFICIENTS_mp_GET_INTERNAL_SIMPLEC_COEFFICIENTS	1,791	1,541	1.162	3.45%	2.54%	4,774,806,000	4,108,306,000	0xFFFFFFFF	0xC92E0	0xCA2E0	0x2350		COEFFICIENTS
COEFFICIENTS_mp_GET_U_V_AT_REAL_NODES_WITH_PL	1,710	1,391	1.229	3.29%	2.29%	4,558,860,000	3,708,406,000	0xFFFFFFFF	0xCB980	0xCC980	0x1C00		COEFFICIENTS
COEFFICIENTS_mp_GET_U_SOURCE	1,541	1,588	0.970	2.97%	2.62%	4,108,306,000	4,233,608,000	0xFFFFFFFF	0x63FA0	0x64FA0	0x97B0		COEFFICIENTS
COEFFICIENTS_mp_GET_V_SOURCE	1,513	1,624	0.932	2.92%	2.68%	4,033,658,000	4,329,584,000	0xFFFFFFFF	0x84AB0	0x85AB0	0x8060		COEFFICIENTS
COEFFICIENTS_mp_GET_P_SOURCE	1,441	2,357	0.611	2.78%	3.88%	3,841,706,000	6,283,762,000	0xFFFFFFFF	0xB31E0	0xB41E0	0x2800		COEFFICIENTS
COEFFICIENTS_mp_GET_P_COEFFICIENTS	1,238	2,052	0.603	2.39%	3.38%	3,300,508,000	5,470,632,000	0xFFFFFFFF	0xAE8E0	0xAF8E0	0x2380		COEFFICIENTS
_intel_new_memset	1,228	222	5.532	2.37%	0.37%	3,273,848,000	591,852,000	0xFFFFFFFF	0x220140	0x221140	0x1560		_intel_new_mer
COEFFICIENTS_mp_GET_U_COEFFICIENTS	1,003	1,132	0.886	1.93%	1.87%	2,673,998,000	3,017,912,000	0xFFFFFFFF	0x56820	0x57820	0x6B00		COEFFICIENTS
memset	860	401	2.145	1.66%	0.66%	2,292,760,000	1,069,066,000	0xFFFFFFFF	0x1CAF50	0x1CBF50	0xF0		memset
COEFFICIENTS_mp_GET_V_COEFFICIENTS	856	1,128	0.759	1.65%	1.86%	2,282,096,000	3,007,248,000	0xFFFFFFFF	0x76F90	0x77F90	0x6CD0		COEFFICIENTS
COEFFICIENTS_mp_GET_VELOCITIES_AT_INTERNAL_FACES_WITH_PL	801	744	1.077	1.54%	1.23%	2,135,466,000	1,983,504,000	0xFFFFFFFF	0xCD580	0xCE580	0x1450		COEFFICIENTS
_intel_new_memcpy	794	120	6.617	1.53%	0.20%	2,116,804,000	319,920,000	0xFFFFFFFF	0x2216A0	0x2226A0	0x23D0		_intel_new_mer
COEFFICIENTS_mp_GET_DENSITY_AT_FACES	540	1,158	0.466	1.04%	1.91%	1,439,640,000	3,087,228,000	0xFFFFFFFF	0x55E70	0x56E70	0x9B0		COEFFICIENTS
USER_mp_GET_THERMAL_CONDUCTIVITY_AT_FACES	432	464	0.931	0.83%	0.76%	1,151,712,000	1,237,024,000	0xFFFFFFFF	0xF72C0	0xF82C0	0x720		USER_mp_GE1
USER_mp_GET_LAMINAR_VISCOSITY_AT_FACES	427	462	0.924	0.82%	0.76%	1,138,382,000	1,231,692,000	0xFFFFFFFF	0xF6BA0	0xF7BA0	0x720		USER_mp_GE1
SOLVERS_mp_NORM_L1_5D	295	505	0.584	0.57%	0.83%	786,470,000	1,346,330,000	0xFFFFFFFF	0x11F120	0x120120	0x7E0		SOLVERS_mp_
MAIN_ip_GET_NUMERICAL_SOLUTION	134	14	9.571	0.26%	0.02%	357,244,000	37,324,000	0xFFFFFFFF	0x126770	0x127770	0x60B0		MAIN_ip_GET_
COEFFICIENTS_mp_GET_DENSITY_AT_NODES	125	22	5.682	0.24%	0.04%	333,250,000	58,652,000	0xFFFFFFFF	0x55C40	0x56C40	0x230		COEFFICIENTS
cvtas_t_to_a	111	190	0.584	0.21%	0.31%	295,926,000	506,540,000	0xFFFFFFFF	0x19D6F0	0x19E6F0	0x4320		cvtas_t_to_a
COEFFICIENTS_mp_GET_PRESSURE_DENSITY_CORRECTION_WITH_PL	96	37	2.595	0.18%	0.06%	255,936,000	98,642,000	0xFFFFFFFF	0xCB630	0xCC630	0x350		COEFFICIENTS
USER_mp_SET_CP_AND_GAMMA	87	10	8.700	0.17%	0.02%	231,942,000	26,660,000	0xFFFFFFFF	0xF6870	0xF7870	0x1B0		USER_mp_SET
USER_mp_GET_A9D_B_RESCALING	63	64	0.984	0.12%	0.11%	167,958,000	170,624,000	0xFFFFFFFF	0x1136F0	0x1146F0	0x5830		USER_mp_GE1
USER_mp_SET_THERMAL_CONDUCTIVITY_AT_NODES	46	3	15.333	0.09%	0.00%	122,636,000	7,998,000	0xFFFFFFFF	0xF6AE0	0xF7AE0	0xC0		USER_mp_SET
USER_mp_SET_LAMINAR_VISCOSITY_AT_NODES	41	5	8.200	0.08%	0.01%	109,306,000	13,330,000	0xFFFFFFFF	0xF6A20	0xF7A20	0xC0		USER_mp_SET
cvt_ieee_t_to_text_ex	39	39	1.000	0.08%	0.06%	103,974,000	103,974,000	0xFFFFFFFF	0x185CD0	0x186CD0	0x13E0		cvt_ieee_t_to_t
USER_mp_SET_BCV	35	8	4.375	0.07%	0.01%	93,310,000	21,328,000	0xFFFFFFFF	0xFB5F0	0xFC5F0	0x3C00		USER_mp_SET
USER_mp_SET_BCU	34	9	3.778	0.07%	0.01%	90,644,000	23,994,000	0xFFFFFFFF	0xF79E0	0xF89E0	0x3C10		USER_mp_SET
USER_mp_SET_BCP	30	17	1.765	0.06%	0.03%	79,980,000	45,322,000	0xFFFFFFFF	0x102FC0	0x103FC0	0x2D20		USER_mp_SET
USER_mp_GET_A5D_B_RESCALING	28	31	0.903	0.05%	0.05%	74,648,000	82,646,000	0xFFFFFFFF	0x10F380	0x110380	0x4370		USER_mp_GE1
USER_mp_SET_BCT	22	10	2.200	0.04%	0.02%	58,652,000	26,660,000	0xFFFFFFFF	0xFF1F0	0x1001F0	0x3DD0		USER_mp_SET

Figura 11 Depois da otimização

```
*** 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
```

```
    9.991643701326540E-01 = characterist velocity
    9.669190986681357E-01 = velocity of efective ejection at sea level
    9.746311246511811E-01 = velocity of efective ejection in the vacuum
    9.669190986681356E-01 = specific impulse at sea level
    9.746311246511811E-01 = specific impulse at vacuum


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

B - CONCLUSÕES

- Neste relatório foi possível otimizar o solver MSI 5 diagonais e MSI 9 diagonais, fazendo com que o programa que utilizava 55,641 s de tempo computacional, agora utiliza 53,828 s de tempo computacional. Gerando os mesmos resultados.

- Houve otimizações que foram realizadas no intel i5 que realmente diminuiram o tempo computacional, mas no computador CFD6 não geraram melhora significativa:
- Na subrotina get_velocities_at_faces, o cálculo da indexação de mpa, sumup e sumvp foi feito de 2 em 2 e depois de 4 em 4 (da mesma forma que no passo 6)), gerando melhora no tempo computacional de 20,064 s para 19,676 s (com o cálculo de 2 em 2), e de 19,676 s para 19,660 (com o cálculo de 4 em 4).
- Nas subrotinas de resolução do MSI (fb2d5 e fb2d9), foi indexado uma variável auxiliar 'inv_dl1' para não realizar a divisão por dl(ip,1) que era feita em muitos cálculos, também a abolição dos if's como foi feito nos passos 2),3),4) e 5) deste relatório.
O tempo computacional final, com todas estas otimizações citadas no intel i5, foi de 17,983 s.

- Ou seja, a partir de um certo nível, as otimizações dependem de cada computador utilizado, pois no CFD6, as mesmas otimizações até aumentavam o tempo computacional.

- OBS: O uso do VTUNE é feito na versão debug do fortran. Isto pode fazer a diferença, na comparação entre o CFD6 (debug) e o intel i5 (release).

- Há a possibilidade de que uma otimização não apareça na versão debug mas apareça na versão release do fortran.

- Quadro geral de otimizações:

(VERSÃO DEBUG) (REDUÇÃO DE 12,2 %)
- PROGRAMA Bertoldo - 61,329 s (RELATÓRIO ANTERIOR)

```
*** 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)
```

- PROGRAMA Atual - 53,828 s

```
*** 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
    9.991643701326540E-01 = characterist velocity
    9.669190986681357E-01 = velocity of efective ejection at sea level
    9.746311246511811E-01 = velocity of efective ejection in the vacuum
    9.669190986681356E-01 = specific impulse at sea level
    9.746311246511811E-01 = specific impulse at vacuum


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

(VERSÃO RELEASE) (REDUÇÃO DE 17,6 %)

- PROGRAMA Bertoldo - 35,859 s

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

    1.000836328728610E+00 = discharge coefficient
    9.691914048072180E-01 = dynamic thrust
    9.752768908404300E-01 = pressure thrust at sea level (p = 101325 Pa)
    1.080533092655724E+00 = pressure thrust in the vacuum
    9.677277608885928E-01 = total thrust at sea level
    9.754462366605237E-01 = total thrust in the vacuum
    9.677277608885928E-01 = thrust coefficient at sea level
    9.754462366605237E-01 = thrust coefficient in the vacuum
    9.991643701326548E-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)
        35.859 = dtcpu: CPU time (s) (after interuption)
        35.859 = tcpu:  total CPU time (s)
```

- PROGRAMA Atual - 29,532 s

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

    1.000836328728610E+00 = discharge coefficient
    9.691914048072179E-01 = dynamic thrust
    9.752768908404299E-01 = pressure thrust at sea level (p = 101325 Pa)
    1.080533092655724E+00 = pressure thrust in the vacuum
    9.677277608885926E-01 = total thrust at sea level
    9.754462366605234E-01 = total thrust in the vacuum
    9.677277608885926E-01 = thrust coefficient at sea level
    9.754462366605234E-01 = thrust coefficient in the vacuum
    9.991643701326548E-01 = characterist velocity
    9.669190986681351E-01 = velocity of efective ejection at sea level
    9.746311246511805E-01 = velocity of efective ejection in the vacuum
    9.669190986681352E-01 = specific impulse at sea level
    9.746311246511805E-01 = specific impulse at vacuum


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