Time analysis of the CYGNO reconstruction algorithm for number of clusters

Amaro Jr., Rafael A. N. and Igor Abritta

28/06/2021

Universidade Federal de Juiz de Fora (UFJF)
Juiz de Fora, MG

Engenharia - UFJF

UNIVERSIDADE FEDERAL DE JUIZ DE FORA

History

UNIVERSIDADE FEDERAL DE JUIZ DE FORA

- Overview in GPU programming;
    - Choosing a card, comparing speed with matrix calculus;
- New approach to the noise reducer algorithm, using convolution instead of concatenated fors to search for noise pixels;
- Timing the preprocessing steps in the reconstruction searching for optimization candidates;
    - Noise reducer, 3d simulation and DBSCAN were the slowest;
- Searched for a better way of optimizing DBSCAN;
    - GPU accelerated Rapids was a good and simple alternative;

History

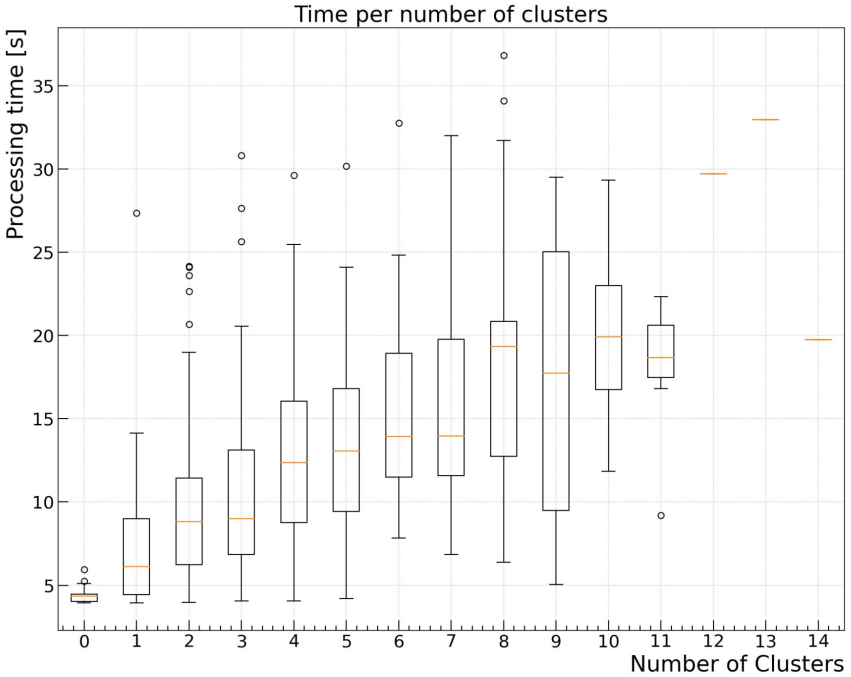
UNIVERSIDADE FEDERAL DE JUIZ DE FORA

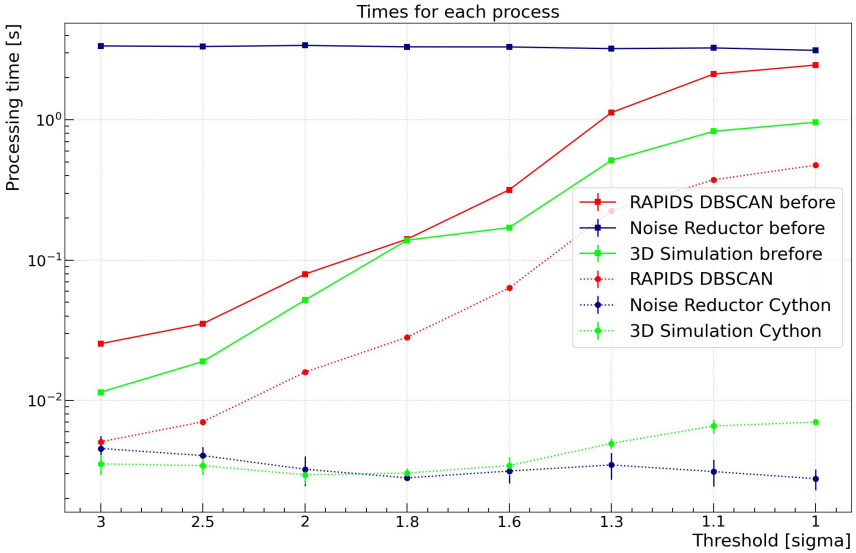
- Optimized the next two functions (Noise reducer, 3dsimulator) using Cython;
- Tested whether or not the optimizations could be used in reconstruction with real data from ^{55}Fe;
- Tested timings for the ^{55}Fe, checking how long the reconstruction algorithm would take with optimizations;
- Tested timings for number of points and number of clusters in the reconstruction algorithm inquiring weather some of it could be used in the trigger system.

Reconstruction times table

	Sigma = 3	Sigma = 2.5	Sigma = 2	Sigma = 1.8	Sigma = 1.6	Sigma = 1.3	Sigma = 1.1	Sigma = 1
	Time (s)							
mean_dbscan	2.1854e-02	3.7062e-02	8.4079e-02	0.14387	0.32683	1.1203	2.0841	2.4486
std_dbscan	6.7958e-04	7.5364e-04	3.9864e-03	2.2151e-03	1.9935e-02	3.3674e-02	2.6931e-02	1.0592e-02
mean_load	5.6931e-03	5.9024e-03	6.2369e-03	5.6393e-03	5.5895e-03	5.7270e-03	5.7500e-03	5.7666e-03
std_load	8.6380e-04	6.1796e-04	7.1019e-04	5.6142e-04	5.0385e-04	5.9272e-04	3.6873e-04	4.7452e-04
mean_rebin	1.8305e-02	1.8242e-02	1.8395e-02	1.8175e-02	1.8140e-02	1.8329e-02	1.8102e-02	1.8120e-02
std_rebin	6.5495e-04	2.4434e-04	4.1557e-04	2.3167e-04	2.1020e-04	9.1019e-04	2.4225e-04	2.5176e-04
mean_uth	7.3634e-03	7.8201e-03	7.9374e-03	7.4549e-03	7.6428e-03	7.4781e-03	7.4367e-03	7.6640e-03
std_uth	4.0293e-04	7.0694e-04	5.8089e-04	3.4438e-04	7.1159e-04	5.0639e-04	4.2236e-04	3.3087e-04
mean_psub	4.7712e-02	4.7944e-02	4.7111e-02	4.6800e-02	4.6170e-02	4.7424e-02	4.7928e-02	4.7141e-02
std_psub	1.4338e-03	1.5309e-03	1.9215e-03	2.7330e-03	1.2971e-03	3.6355e-03	4.8695e-03	3.5013e-03
mean_thcut	6.1751e-02	6.3785e-02	6.3793e-02	6.1633e-02	6.2149e-02	6.3189e-02	6.6394e-02	6.8389e-02
std_thcut	2.6797e-03	2.5775e-03	2.6883e-03	2.4998e-03	3.8567e-03	1.9047e-03	3.6254e-03	4.3370e-03
mean_reb	2.0647e-02	2.0671e-02	2.1063e-02	2.0965e-02	2.0400e-02	2.0655e-02	2.0245e-02	2.0326e-02
std_reb	9.0925e-04	3.8821e-04	1.4599e-03	1.7583e-03	4.4116e-04	1.1710e-03	2.6805e-04	6.3286e-04
mean_mfilt	6.5621e-02	8.0667e-02	9.5930e-02	9.7644e-02	9.9625e-02	1.0119e-01	9.9528e-02	9.9881e-02
std_mfilt	1.2774e-03	1.3461e-03	1.4890e-03	5.9341e-04	1.2568e-03	1.4443e-03	4.4314e-04	6.2581e-04
mean_edcp	6.6312e-04	7.0242e-04	6.9184e-04	6.4577e-04	6.6984e-04	6.4573e-04	6.5563e-04	6.6206e-04
std_edcp	5.7478e-05	8.6818e-05	6.0360e-05	1.9030e-05	5.4356e-05	6.7814e-05	2.4438e-05	3.8483e-05
mean_nred	3.2365e+00	3.3114e+00	3.3649e+00	3.2600e+00	3.2591e+00	3.2192e+00	3.1527e+00	3.1844
std_nred	7.5369e-02	8.6263e-02	8.9451e-02	1.7693e-02	5.2286e-02	4.7929e-02	2.2917e-02	3.5562e-02
mean_3d	1.0089e-02	2.0046e-02	3.5034e-02	6.2560e-02	1.2597e-01	3.8810e-01	6.1269e-01	0.70450
std_3d	1.5120e-03	1.9225e-02	9.9733e-04	4.4683e-03	2.5842e-03	7.4356e-03	5.1608e-03	8.3139e-03

Some graphs


Time per number of clusters
Processing time [s]
Number of Clusters
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
5
10
15
20
25
30
35


Times for each process
Processing time [s]
Threshold [sigma]
RAPIDS DBSCAN before
Noise Reductor before
3D Simulation brefore
RAPIDS DBSCAN
Noise Reductor Cython
3D Simulation Cython
3
2.5
2
1.8
1.6
1.3
1.1
1

Goals so far

UNIVERSIDADE FEDERAL DE JUIZ DE FORA

- Our goal so far was to study the reconstruction algorithm timings and propose ways to optimize it to help to think about the CYGNO trigger system;
    - The most time consuming parts were identified;
    - The time per cluster measured;
    - The proposed optimizations would remove about 2s of processing;

- Now we'd like to trace a path we could follow that would be useful to the collaboration and the experiment and progress our work.