Time optimization of the CYGNO reconstruction algorithm for the Trigger system

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

17/02/2021

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

Engenharia - UFJF

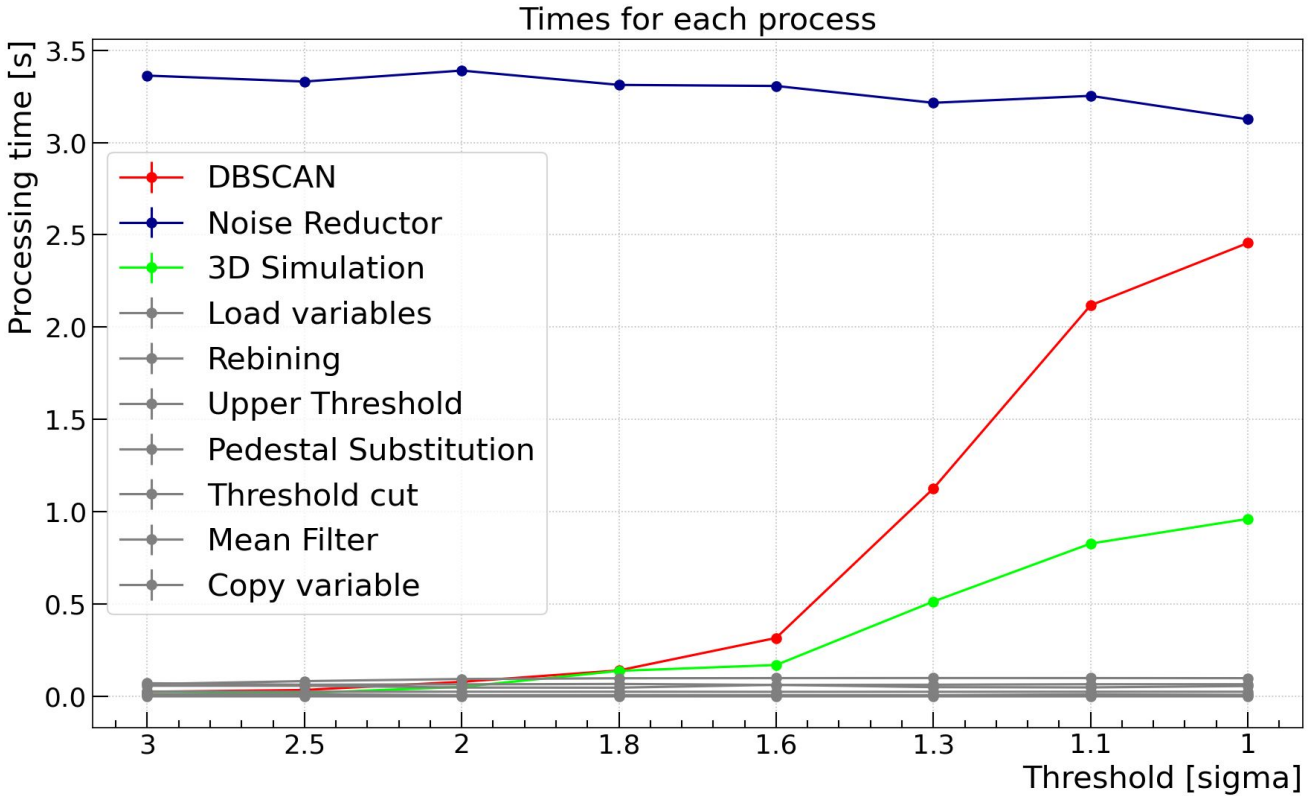
UNIVERSIDADE FEDERAL DE JUIZ DE FORA

Motivation

- Trigger system would need to run fast algorithms to take a decision about the events of interest;
    - As a first objective, we proposed to investigate about techniques that could be used to speed up the existing algorithms;
    - We've decided to time each process in order to find bottlenecks to work for reducing their processing time;

All tests were made rebinning the image by a factor of 4.

Time plots

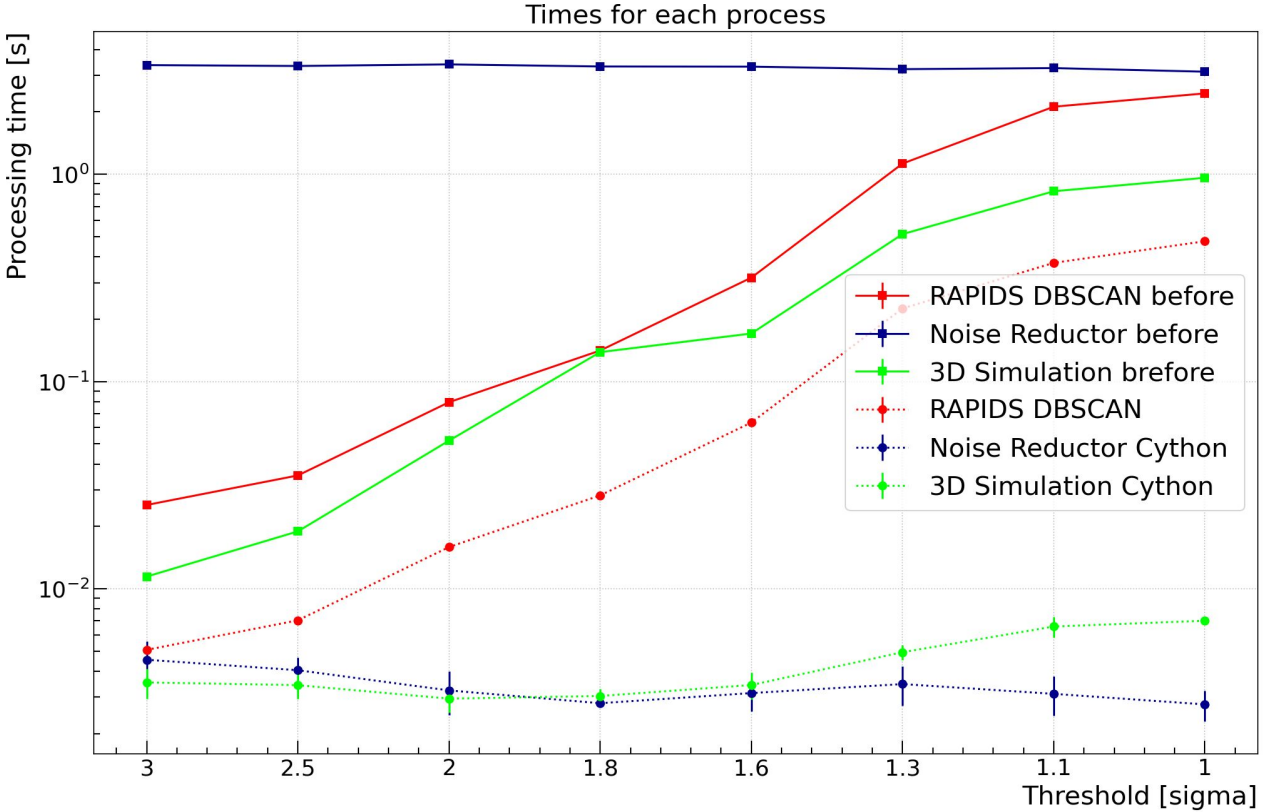

Times for each process
Processing time [s]
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
DBSCAN
Noise Reductor
3D Simulation
Load variables
Rebining
Upper Threshold
Pedestal Substitution
Threshold cut
Mean Filter
Copy variable
3
2.5
2
1.8
1.6
1.3
1.1
1
Threshold [sigma]

Optimization

UNIVERSIDADE FEDERAL DE JUIZ DE FORA

- DBSCAN time can be reduced by using GPU
- In order to optimize both ‘3D Simulation’ and ‘Noise Reduction’ steps they were re-written in Cython
  - Cython is a compiled version of Python that translate python calls to C/C++, then makes a compiled version with gcc
  - Results in a much faster deployment of the same code just for skipping the interpretation step of python

Optimization - Time comparison



The improvements using Cython could already be used by the collaboration to speed up the CYGNO on-going studies.

Optimization processes available

UNIVERSIDADE FEDERAL DE JUIZ DE FORA

Cython

- DBSCAN ✓
- Noise Reductor ✓
- 3D Simulation ✓
- Rebinning
- Upper Threshold
- Mean Filter
- Pedestal Substitution

CuPy

- Load Variables
- Rebinning
- Copy Variables
- Threshold Cut

CUDA

- DBSCAN ✓
- Upper Threshold
- Mean Filter
- Pedestal Substitution
- Threshold Cut

Conclusion

UNIVERSIDADE FEDERAL DE JUIZ DE FORA

- Our current reconstruction algorithm can be further optimized:
  - some improvements have already been tested as shown in this presentation;
  - other possibilities are under study;
- The idea is also to gain experience with the tools that can help in the timing optimization of the trigger algorithms;
  - speed gains can also make it possible to analyze images at full resolution;
- Other paradigms could also be explored as going further in C/C++ programming and porting the whole analysis to Cython;
- We'd like input for how to move forward from now on.