



Brazilian Group Overview **CYGNO**

Prepared by Rafael A Nóbrega and Herman Lima Jr

CYGNO international meeting, 17 June 2020

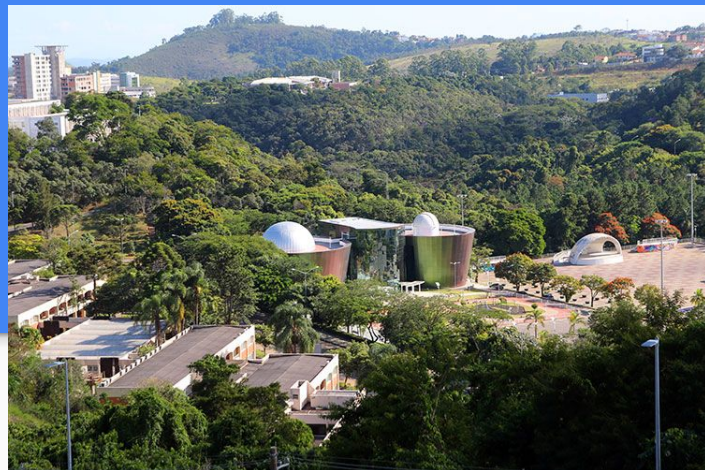
Institutions and people

- **Federal University of Juiz de Fora (UFJF)** since 2018
 - Rafael Antunes Nóbrega (Professor/Researcher)
 - Igor Abritta Costa (PhD student)
 - Guilherme Lopes (Master student)
 - Mariana Migliorini (Master student)
 - Igor Pains (Graduate student)
- **Brazilian Center for Physics Research (CBPF)** since Jan 2020
 - Herman Pessoa Lima Jr. (Researcher)
 - Danilo Cardoso (Master student)
 - Tiago Oliveira (Master student)



UFJF Scientific structure

City: Juiz de Fora - MG



Related to our group

- **Graduation program**
 - Electronics and Signal Processing
- **Post-Graduation program (Master and PhD)**
 - Signal Processing, Machine/Statistical Learning, Pattern Recognition, Electronics (Analog and Digital) and Data analysis.
- **Laboratory for sensors characterization and electronics development**
- **Computing for data processing**

<https://www2.ufjf.br>

CBPF Scientific structure

City: Rio de Janeiro - RJ



- **Post-Graduation program (Master and PhD)**
 - Physics (biophysics, high-energy, nanotechnology, RMN) and **Instrumentation for Physics**.
- **Laboratories for particle detectors and electronics development**
- **Laboratory for Nanoscience and Nanotechnology (LABNANO)**
- **Computing for data processing**

<http://www.cbpf.br/>

Exchange structure

- **PhD students can be sent abroad with expenses paid by our institutions for one year** (*like with Igor Abritta during 2018-2019*)
- **Foreigner PhD students can come to UFJF with expenses paid by our institutions for one year**
- **We can send and bring professors/researches for short period of time** (*like Giovanni's visit in 2019*)
- **We have a position for professors/researchers to come to work for one/two years at UFJF for scientific collaborations**

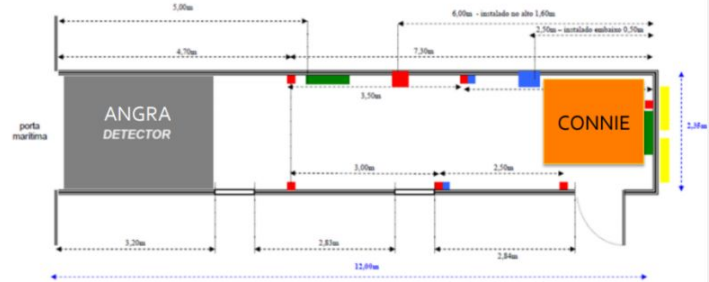
Nuclear reactor neutrinos facility

UFJF, CBPF, UNICAMP, and other four Universities

Anti-neutrino flux = $1.21 \times 10^{20} \text{ s}^{-1}$

Lab. 25 m far from de reactor core

In our detector ($\sim 1\text{m}^3$) we expect 5000 interactions/day



Our know-how

- Readout, acquisition and trigger electronics
- Estimation / Classification algorithms
- Digital Signal Processing
- Machine learning algorithms
- Data analysis in general

*The involved researchers have been working with particle physics experiments for more than 20 years dedicated mostly to **instrumentation** projects*

LHCb, ATLAS, Double Chooz, Neutrinos Angra, and now CYGNO



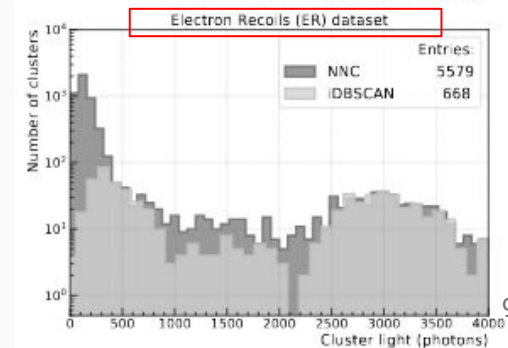
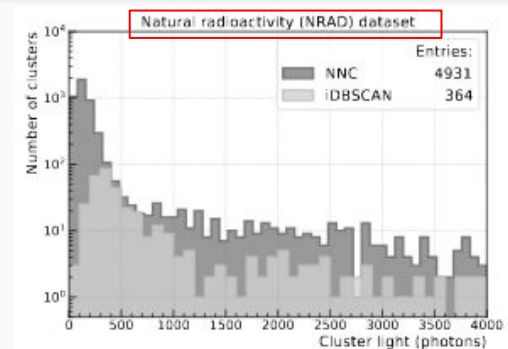
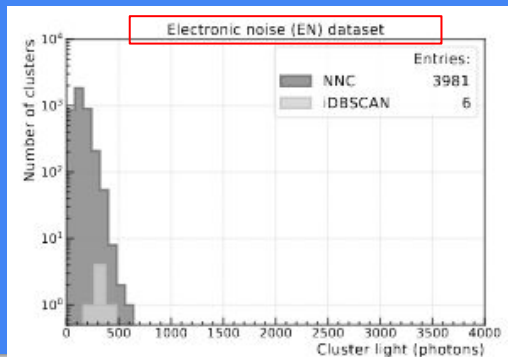
Activities we are involved in CYGNO

in collaboration with INFN groups

- **Development of clustering algorithms**
- **Study and simulation of noise based on CYGNO's images**
- **Study of different image sensors**
- **Image filtering studies**
- **Simulation of PMT signal**
- **Development of DAQ Electronics**

Clustering algorithm

- **Development of a DBSCAN algorithm adapted to CYGNO and comparison with the previous NNC algorithm**
 - iDBSCAN has reduced considerably fake events due to Electronic Noise and Natural Radioactivity in the low energy region
- **Part of the PhD work of Igor Abritta** (final stage)
- **Igor stayed in Rome for 1 year and a half**
- **A paper is being written for JINST**



Study of different image sensors

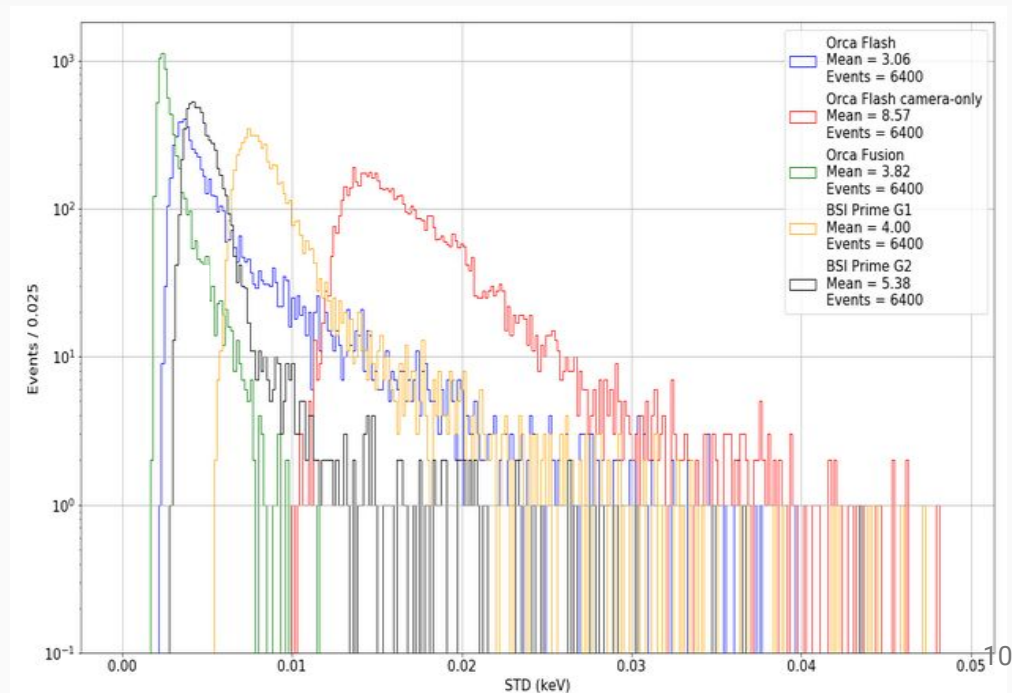
- **Four sensors being compared**

- ORCA FLASH
- ORCA FUSION
- BSI-1
- BSI-2

- **Parameters being measured**

- Sensor sensitivity
- Sensor noise level
- Telegraph noise (~spikes)

- **Planning a journal publication**



Simulation of noise based on CYGNO's images

- The performed study has led us to use non-parametric noise estimation
- By now proposing to use Empirical CDF to simulate noise
- A code to generate noise is in the final stage of implementation

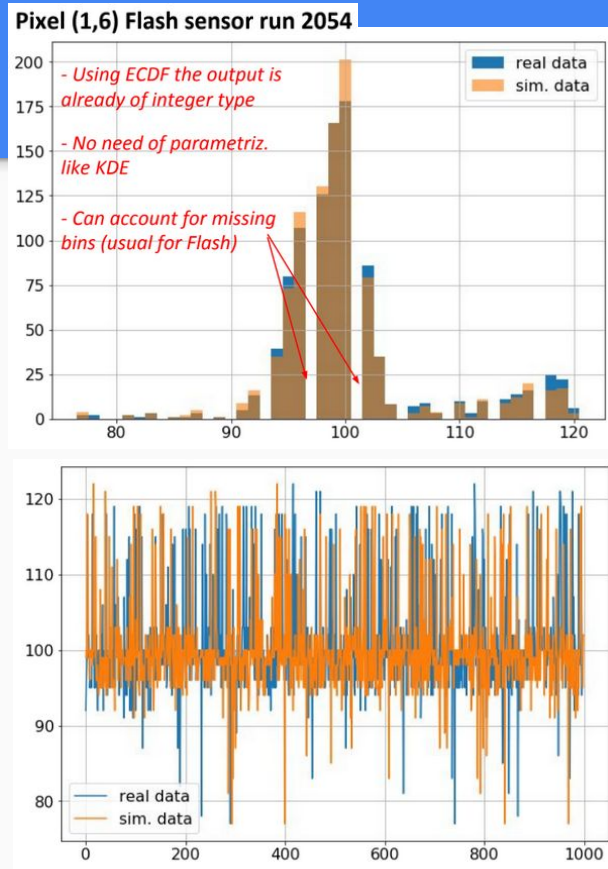
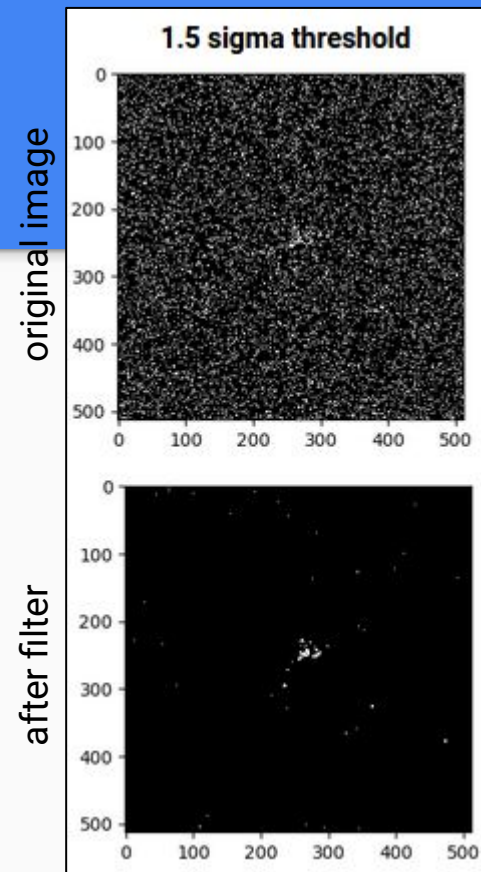


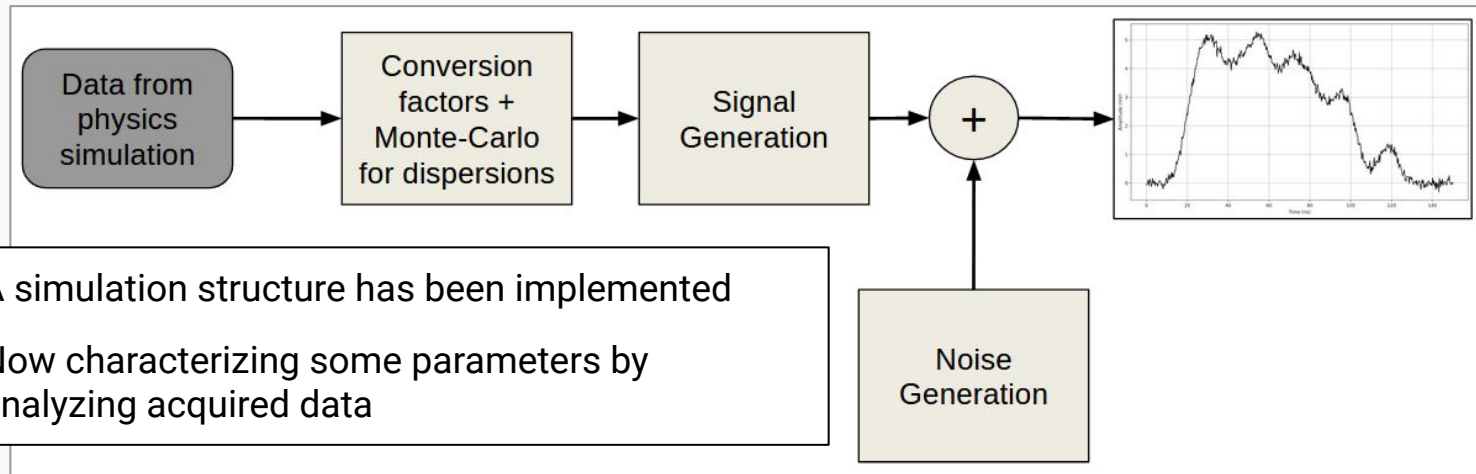
Image filtering studies

- **Study the impact of filters applied to CYGNO images**
 - Spatial domain filters: Mean, Median, Gaussian, Bilateral, Non Local Means
 - Transform domain: BM3D, Weiner
 - Dictionary learning based: FC-AIDE
- **Part of the Master's work of Guilherme Lopes** (final stage)



Simulation of PMT signal

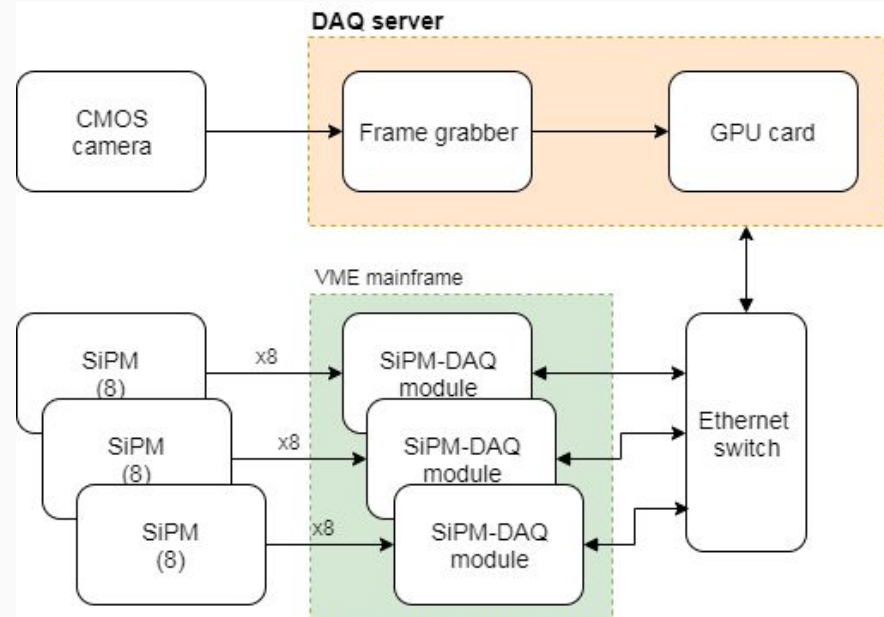
- **Characterization and simulation of PMT signal**
- **Part of the Master's work of Mariana Migliorini**



- A simulation structure has been implemented
- Now characterizing some parameters by analyzing acquired data

Development of DAQ electronics

- **Discussions with Andrea & Team are going on**
- **Initial proposal:**
 - **Commercial solution for cameras readout**
 - **Custom solution for PM readout (under study)**
- **Financing requested within the context of Brazil-Italy Collaboration (waiting results)**
- **Two Master students from CBPF getting involved with Herman**



Summary

- **Brazilian group is involved since mid of 2018**
- **UFJF and CBPF structure/know-how for instrumentation and computing**
- **Exchange visits are foreseen**
- **Current activities in CYGNO:**
 - Image processing, sensors' characterization/simulation, DAQ development