LAWSCHEP 2019

Ciudad de México

November 20-23

Brazilian contribution to HEP software and computing

Leandro de Paula

leandro.de.paula@cern.ch

Instituto de Física

Universidade Federal do Rio de Janeiro

Summary

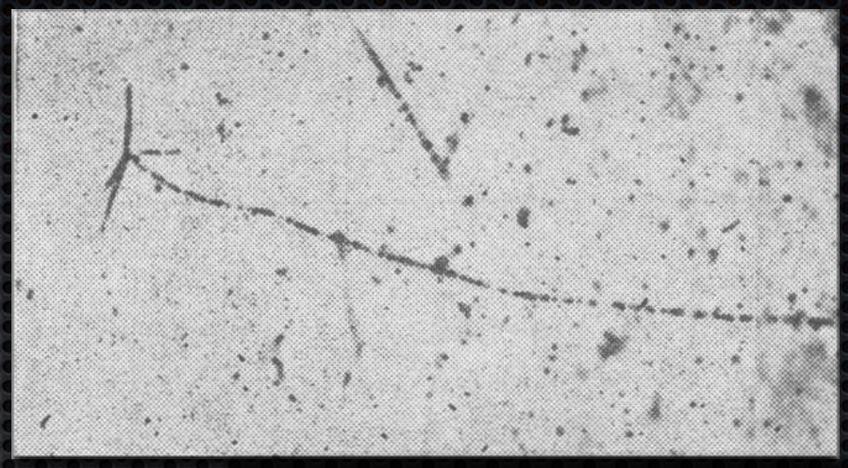
- A brief historical overview
- Snapshot of Brazil@HEP
  - Examples of Software & Computing contributions
- Conclusion

Early years

- **Gleb Wataghin** @ São Paulo (1934-1949)

- **Giuseppe Occhialini** @ São Paulo (1937-1944)

- **Cesar Lattes**
  - Pic du Midi, France and Chacaltaya, Bolivia
  - Bristol, UK (1947 - C. Powell, G. Occhialini & H. Muirhead, Nature - Cosmic rays)
  - Berkeley, US (1948 - E. Gardner, Science - 308 MeV α + C)
  - CBPF, USP, UFRJ, UNICAMP (1948-1986)



NATURE May 24, 1947 Vol. 159

PROCESSES INVOLVING CHARGED MESONS

By Dr. C. M. G. LATTES, H. MUIRHEAD, Dr. G. P. S. OCCHIALINI and Dr. C. F. POWELL

H. H. Wills Physical Laboratory, University of Bristol

No. 4066 October 4, 1947 NATURE

OBSERVATIONS ON THE TRACKS OF SLOW MESONS IN PHOTOGRAPHIC EMULSIONS*

By C. M. G. LATTES, Dr. G. P. S. OCCHIALINI and Dr. C. F. POWELL

H. H. Wills Physical Laboratory, University of Bristol

SCIENCE, March 12, 1948, Vol. 107

Production of Mesons by the 184-Inch Berkeley Cyclotron

EUGENE GARDNER and C. M. G. LATTES

University of California, Berkeley

Intermezzo

First CBPF publication: 1950
Berkeley cyclotron data

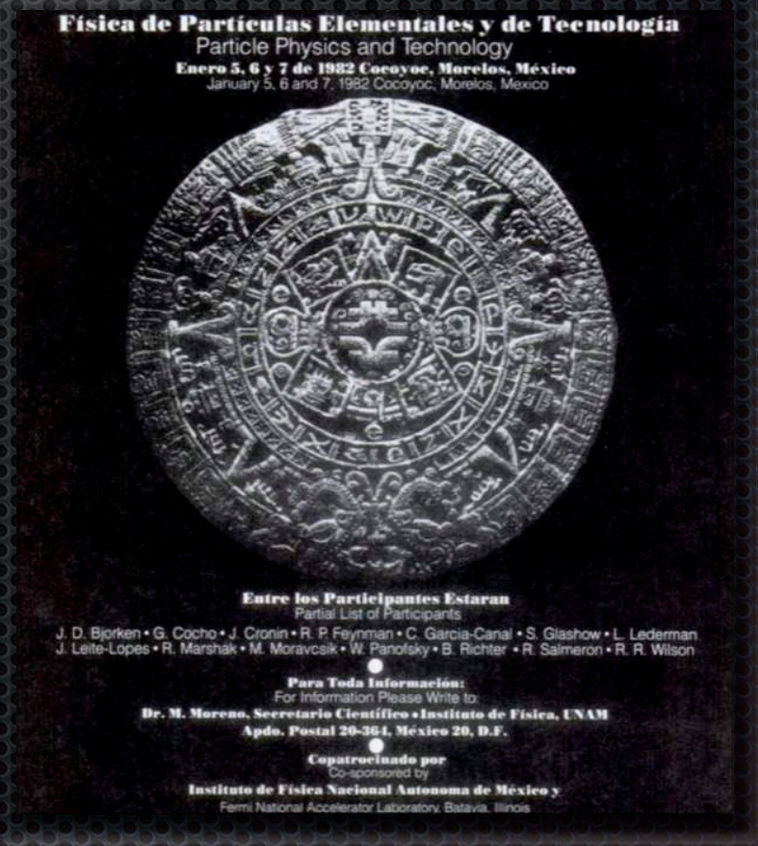
E. Frota-Pessôa

N. Amato

- 1949 - CBPF - Centro Brasileiro de Pesquisas Físicas
- **1951 - CNPq - Conselho Nacional de Pesquisas → Conselho de Desenvolvimento Científico e Tecnológico**
- **1951 - Chacaltaya Laboratory, Bolivia - 5,200 m**
- **1962 -1988: Brazil-Japan collaboration in Cosmic Rays (Yukawa's proposal)**

Brazil@Particle.Accelerators

- 1982: 1st Pan American Symposium on High Energy Physics and Technology - Cocoyoc, Mexico. “about 50 attendees with strong representation from the US, Brazil and Mexico.”
  - Fermilab (L. Lederman) invites Latin American (J. Tiomno) researchers to Fermilab



- 1983: 2nd Pan American Symposium on High Energy Physics and Technology - Rio de Janeiro, Brazil.

- 1984: CBPF (J. dos Angos, A. Santoro & M. Souza) and USP (C. Escobar) joined E691@Fermilab

- 1987: 3rd Pan American Symposium on High Energy Physics and Technology - Rio de Janeiro, Brazil.
  - CERN (C. Rubia) invites Brazilian groups

- 1989: CBPF (M.E. Pol), PUC-RJ (R. Shellard) and UFRJ (J.M. Seixas & C. Maindantchi) start activities @ CERN via LIP
  - DELPHI and R&D (SPACAL, Silicon detector …)

Fermilab

E781 - SELEX

E691

E791

E769

E799

E831 - FOCUS

MINOS

E761

E832

MINERVA

D0

CERN

ALICE

CMS

R&D

ATLAS

LHCb

DELPHI

BROOKHAVEN NATIONAL LABORATORY

E864

STAR

E896

PHENIX

1985 1990 1995 2000 2005 2010

Fermilab

E781 - SELEX

E691

E791

E769

E799

E831 - FOCUS

MINOS

E761

E832

MINERVA

D0

CERN

ALICE

CMS

R&D

ATLAS

LHCb

DELPHI

BROOKHAVEN NATIONAL LABORATORY

E864

STAR

E896

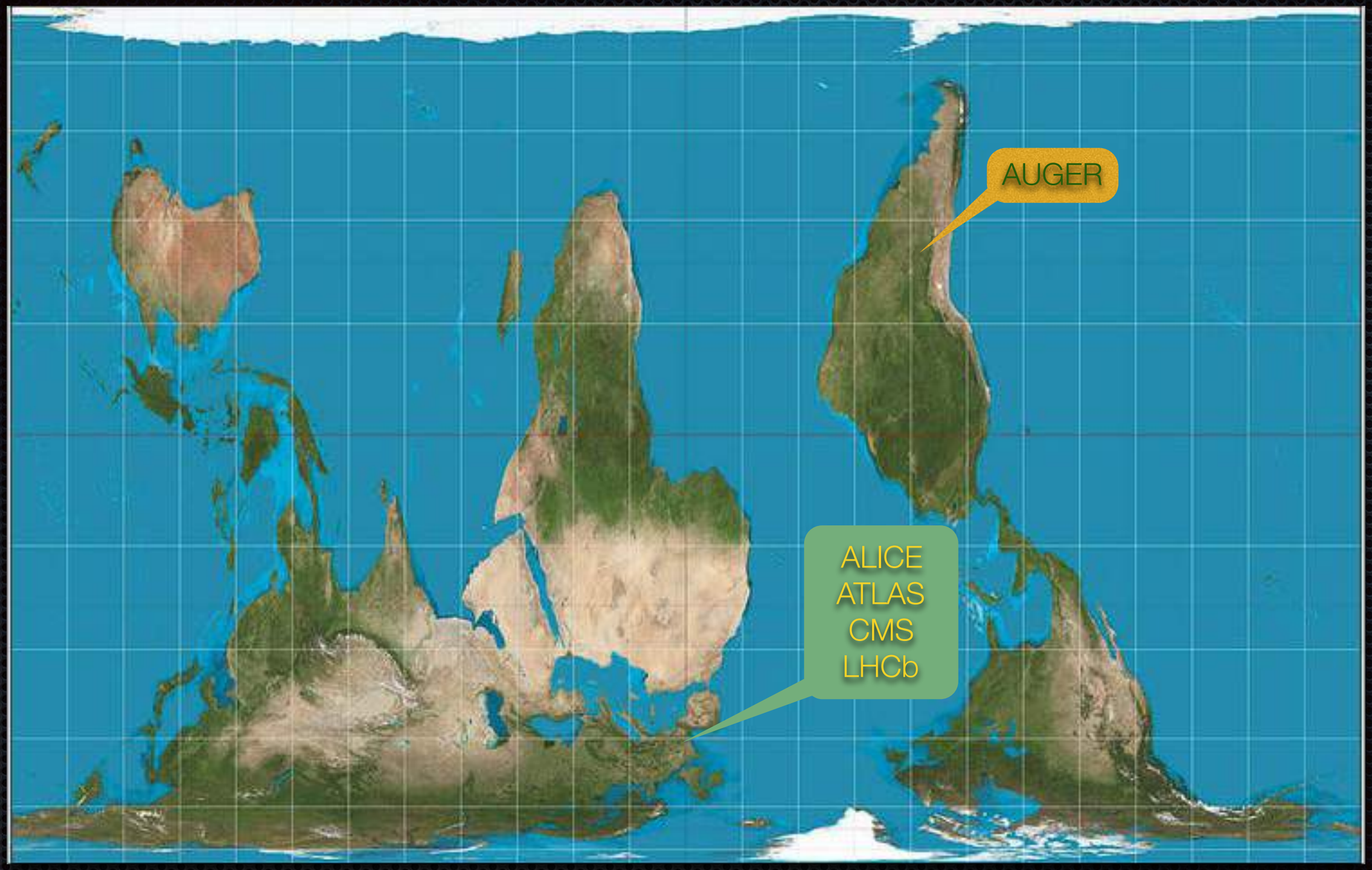
PHENIX

AUGER

1985 1990 1995 2000 2005 2010

Software & Computing Activities

- **Advanced Computer Project (ACP) - use of “farms" of parallel computers based upon commercially available processors”.**
  - **1st generation - Motorola 68020 processor**
  - **2nd generation - R3000 processor - developed under CBPF coordination**
    - **Reconstruction of $4x10^8$ events (E791)**
- **DELPHI: Online system manager from UFRJ (10 years)**
- **DAq, trigger, monitoring, reconstruction, data analysis**



Brazil@HEP

AUGER
Angra
CONNIE
CTA
JUNO
COSINE
DarkSide
ALICE
ATLAS
CMS
LHCb
ALPHA
DUNE
Minerva
Nova
DAMIC

Brazil@HEP

Brazilian HEP Community

- **~ 200 people (~120 registered at CERN)**
- **~ 15 international collaborations**
- **~ 20 institutes (7 States)**
- **The activities are coordinated (not funded) by RENAFAE - Rede Nacional de Física de Altas Energias**

RENAFAE

Created in 2008 by the Ministry of Science Technology and Innovation

- To promote the scientific and technological advances in the investigation of particle properties and their fundamental interactions
- To coordinate the activities of the high energy physics groups and, in particular, the activities associated with major international collaborations
- To consolidate and broaden research in high energy physics expanding national scientific and technical capacity
- To mobilize companies based in Brazil in order to develop instrumentation and software for international collaborations in the area

Brazil@HEP

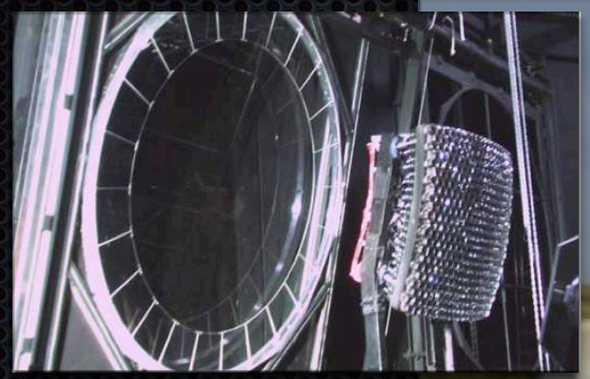
- c and b Physics
- CP violation
- Higgs
- Forward/diffractive Physics
- Eletroweak and QCD/Jets
- Neutrino
- Standard Model extensions
- Heavy ions
- High energy cosmic rays

- Physics Working Group coordination
- Editorial committee participation and coordination
- Speakers committee participation and coordination
- Collaboration board coordination
- Detector operation coordination
- Analysis proponent, software and detector development

Examples of Brazilian Hardware Contributions

ANGRA & CONNIE
Experiments

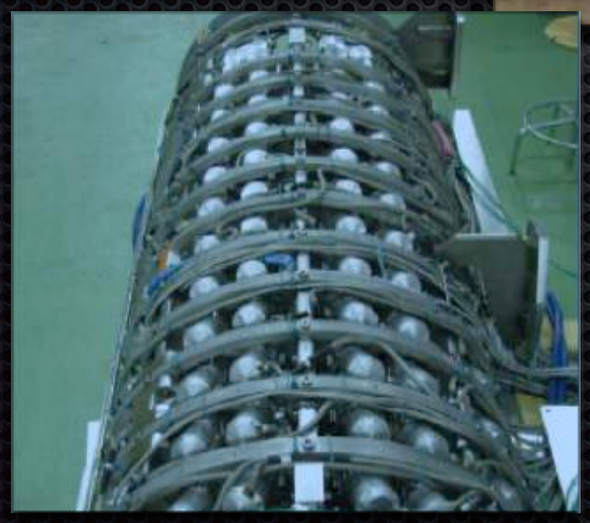
AUGER Fluorescence & Surface Detectors



SAMPA CHIP
ALICE & ...

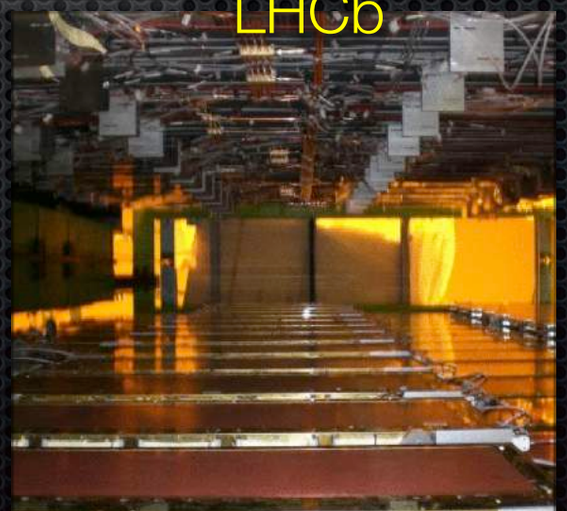
CARIOCA CHIP
LHCb

Optical Communication and Control - CMS

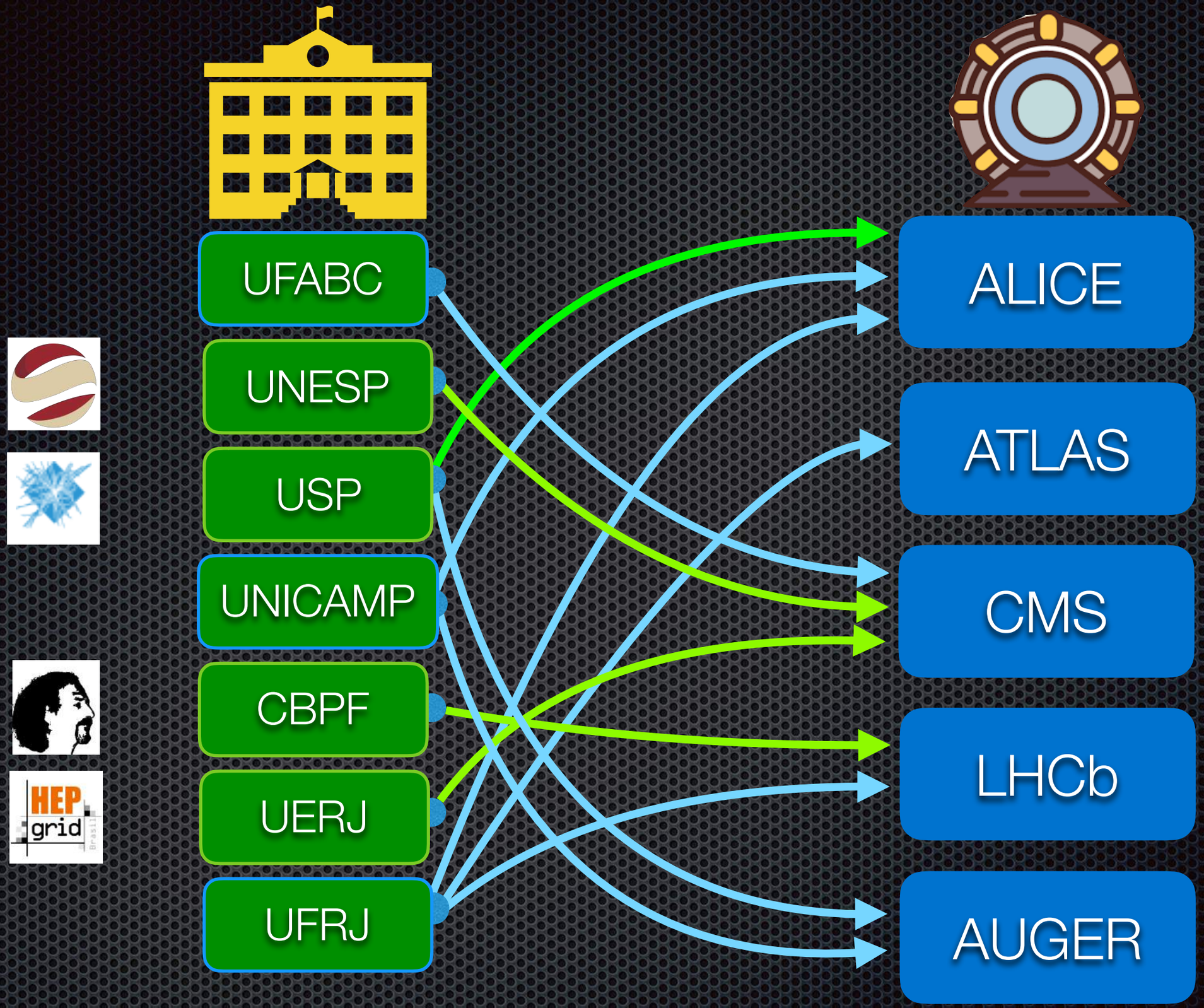


CASTOR
CMS

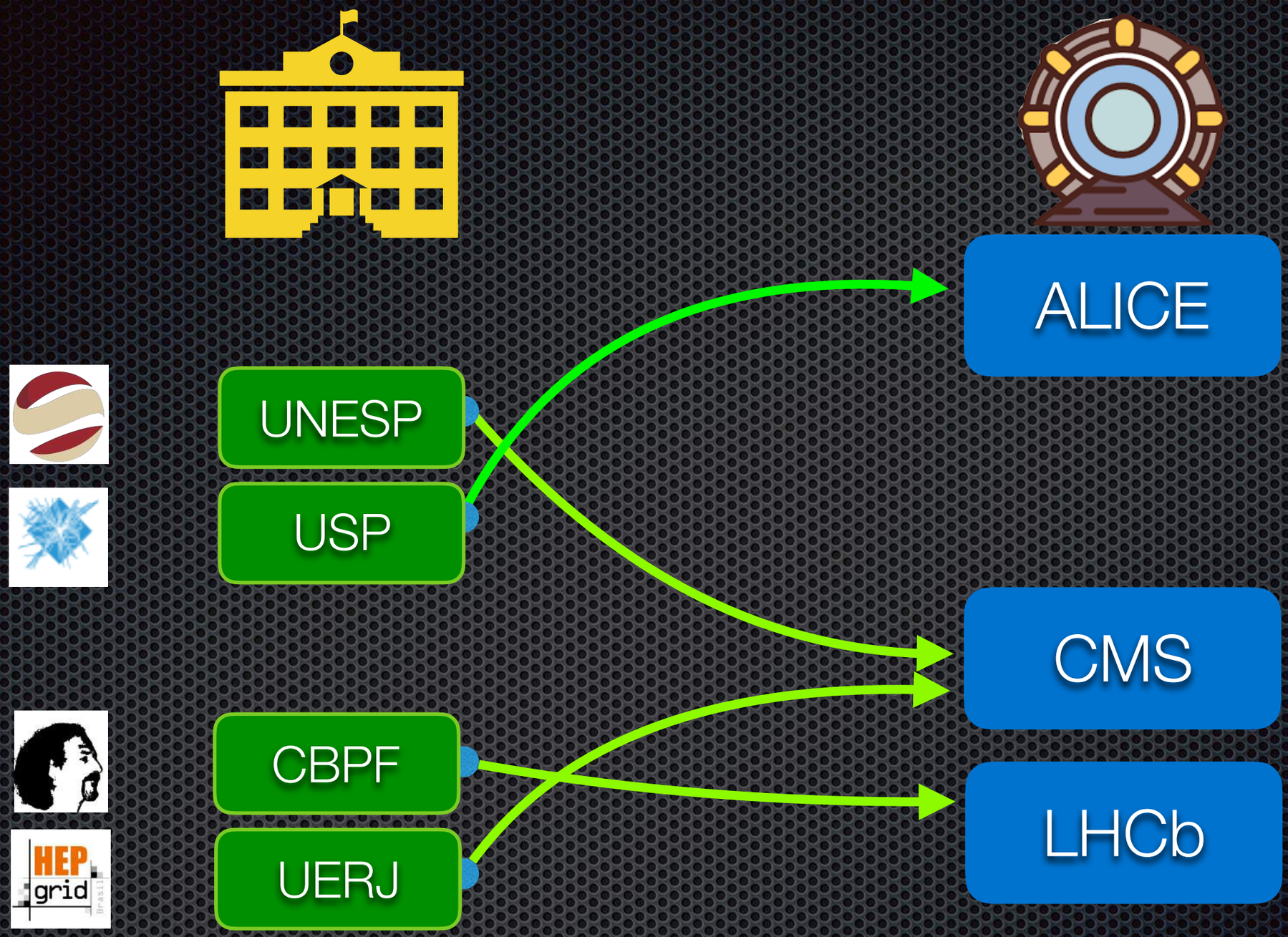
MWPC
LHCb



Brazilian S&C Contributions

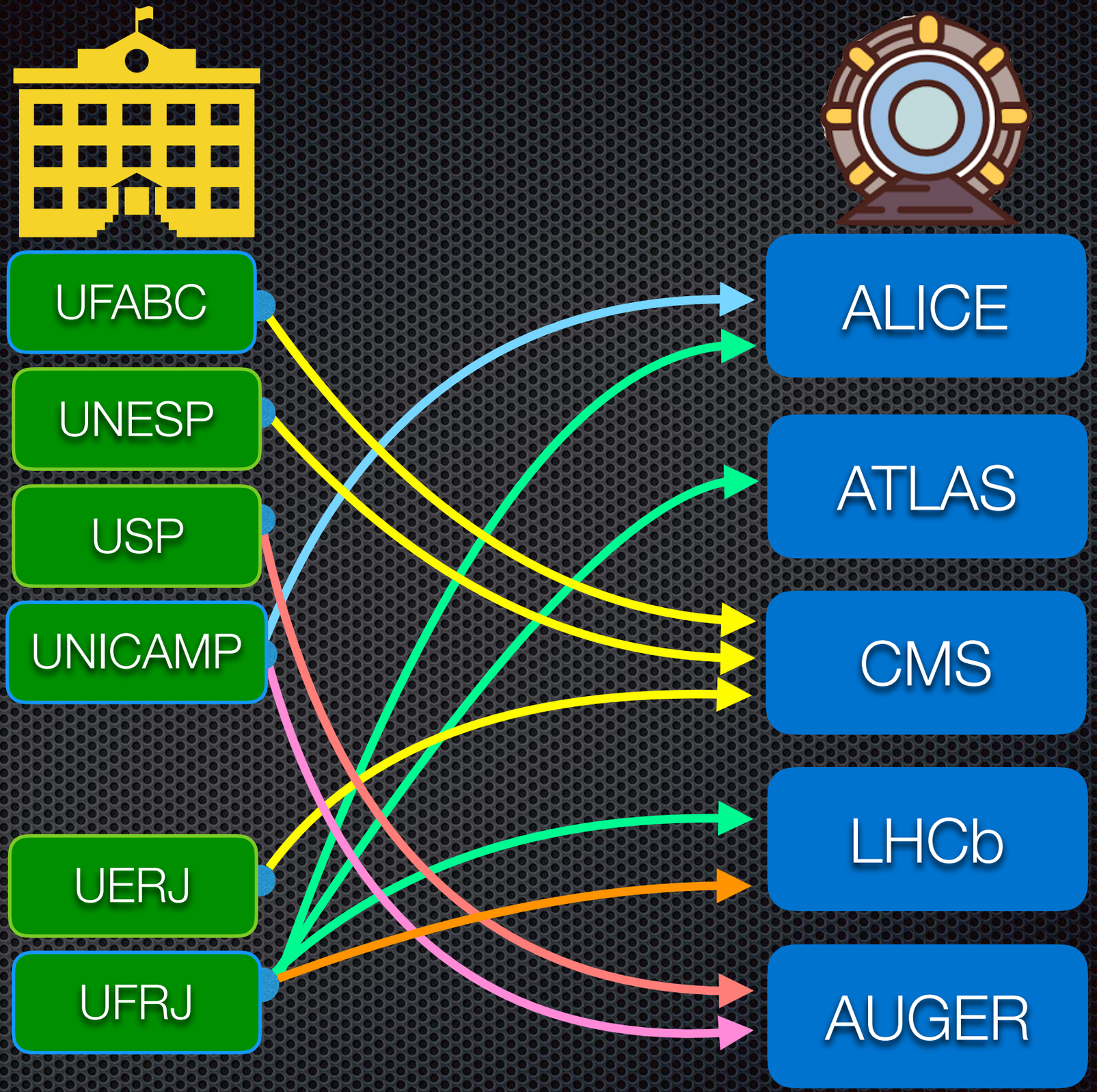


Brazilian S&C Contributions



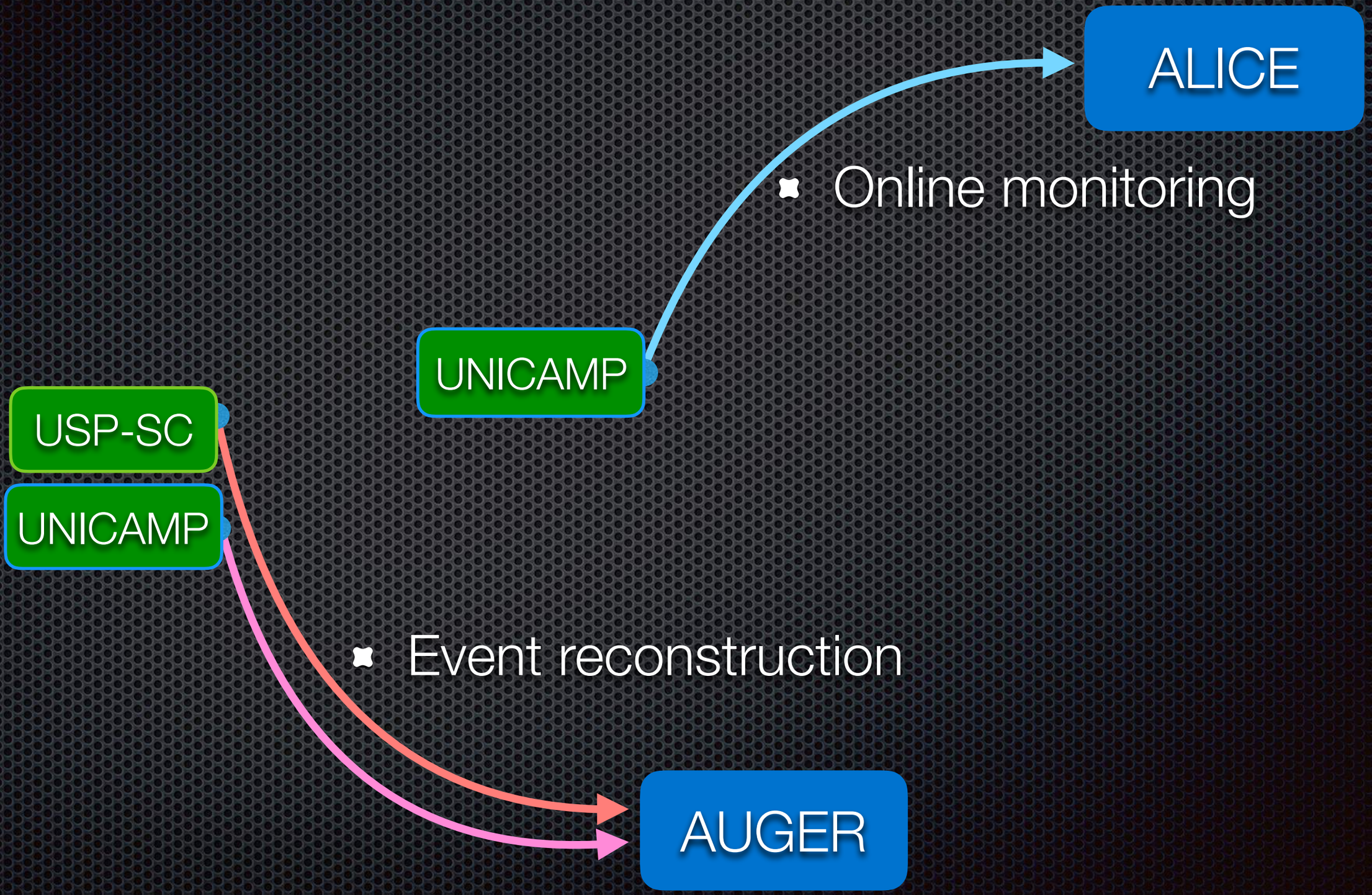
see R. Iope talk tomorrow

GRID Activities



Software Activities

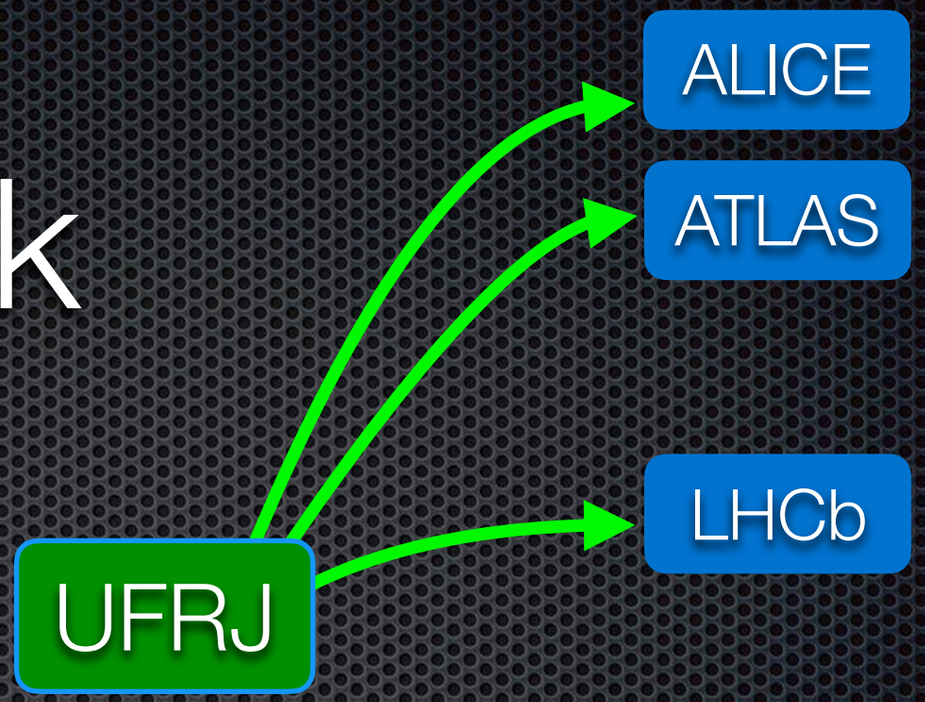
Software Contribution



LHCb Real Time Analysis Project

- LHCb luminosity: $4x10^{32}$ $cm^{-2}s^{-1}$ → $2x10^{33}$ $cm^{-2}s^{-1}$
  - Pileup x5
- Software trigger @ 30 MHz
  - Level 1 output: 100 kHz → 1 MHz
  - Disk buffer contigency: weeks → days
  - Level 2 output: 0.6 GB/s → 10 GB/s
- Major Software Upgrade
  - Jet software
  - Charm trigger lines

FENCE Framework



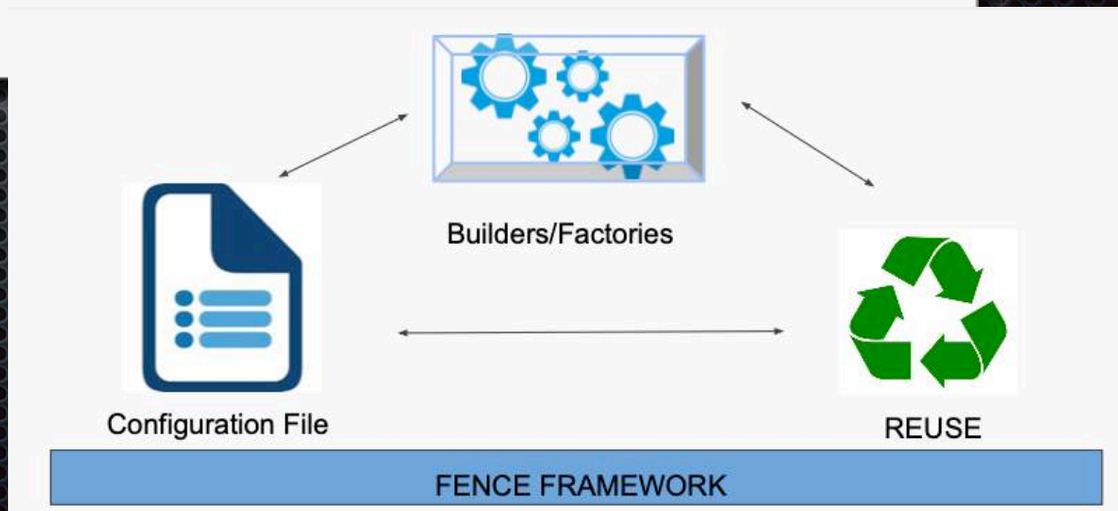
- Developed by a software engineering group of COPPE-UFRJ under the coordination of Carmen Maindantchik
- The goal is to access Database in a efficient way

The FENCE Framework

- A software framework:
  - is an environment that provides already implemented functionalities to be used as part of a system that is being developed.
  - provides a standard way to implement systems.
  - a framework (structure that serves as a support or guide) is wider than a library (building blocks that can be used anywhere).

- FENCE is an object oriented framework:
  - Gathers the required knowledge to develop systems that are suitable to CERN.
  - It is continuously being evolved by innovation.
  - Promotes reuse and gathers the concepts of inheritance.
  - Standardization on how to develop systems
  - Minimize the impacts of team turnover (less effort to be trained, understand requirements, etc)
  - Offers high level of configuration (heterogeneous users/needs).
  - Offers transition between:
    - Static relational and normalized BD x Dynamic and procedural system. (Glance ⇒ builders/factories)

from C. Maindantchik



Fence

Experiment

Welcome to FENCE!

Experiments

+ ATLAS

- ACES
- Apex TDAQ
- Analysis
- Appointment
- Cables
- Collaboration Board Meetings
- DSS Alarms Viewer
- Glance TDAQ
- Membership
- Muon Equipment
- Muon Spare
- MTF Database
- RackWizard
- SCAB
- Speakers Committee
- Survey
- TDAQ Speakers
- Thesis
- Traceability
- Upgrade Speakers

+ ALICE

- Membership
- SAMS

+ LHCb

- Cables
- Membership
- Traceability

20 systems

2 systems

3 systems

Versions

+ Production

- ATLAS
- ALICE
- LHCb

+ Stage

- ATLAS
- ALICE
- LHCb

+ Training

- ATLAS
- ALICE
- LHCb

Documentation

+ Experiments

- ATLAS
- ALICE
- CMS
- LHCb

+ Fast Access

+ FENCE Documentation

- FENCE Software Development Process
- FENCE Tutorial
- Fence Doc
- Jira Reports

+ FENCE Statistics

- May/2018

FENCE Framework

+ Monitoring

- FENCE Monitoring System

+ Publications

- CHEP 2015 text
- CHEP 2015 presentation
- FENCE + Upcoming Features
- FENCE overview, SuperSearch, Speakers 2.0
- FENCE - Front ENd ENgine for glaNCE
- Glance project for ATLAS, ALICE e LHCb

+ New Proposals

- Automated Test Plans
- Glance/FENCE Website Requirements
- LHCb FENCE Membership
- Rio Team Activities
- Test Plan Template
- Web Editor
- Google Analytics
- Control Panel

+ The Glance Project

+ Glance Wiki

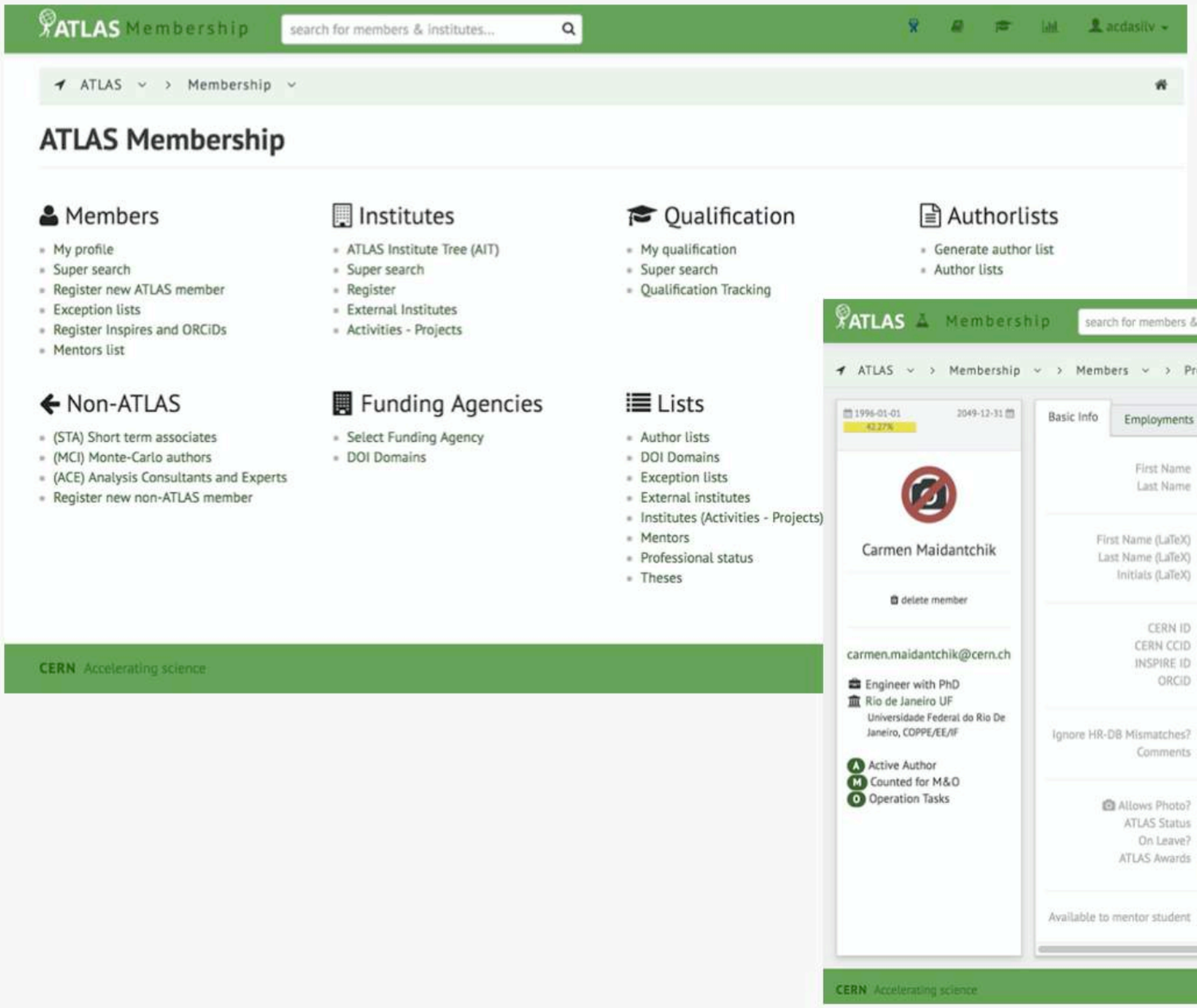
CERN Accelerating science

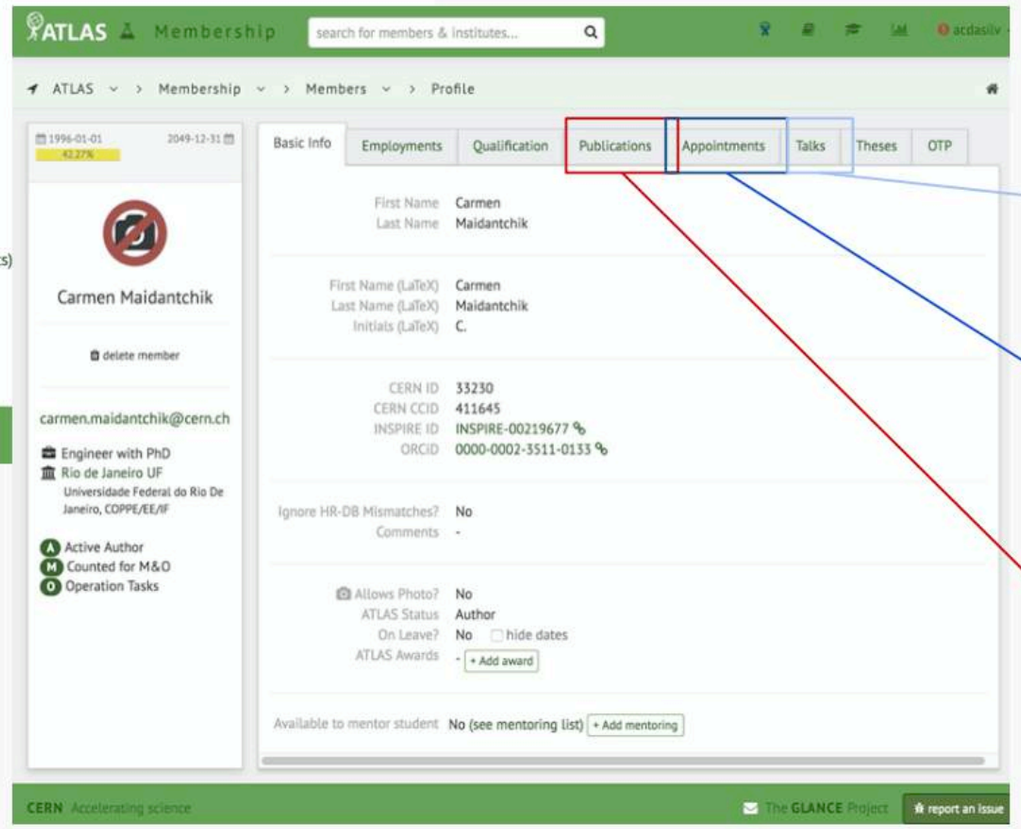
The GLANCE Project

report an issue

from C. Maindantchik

Membership





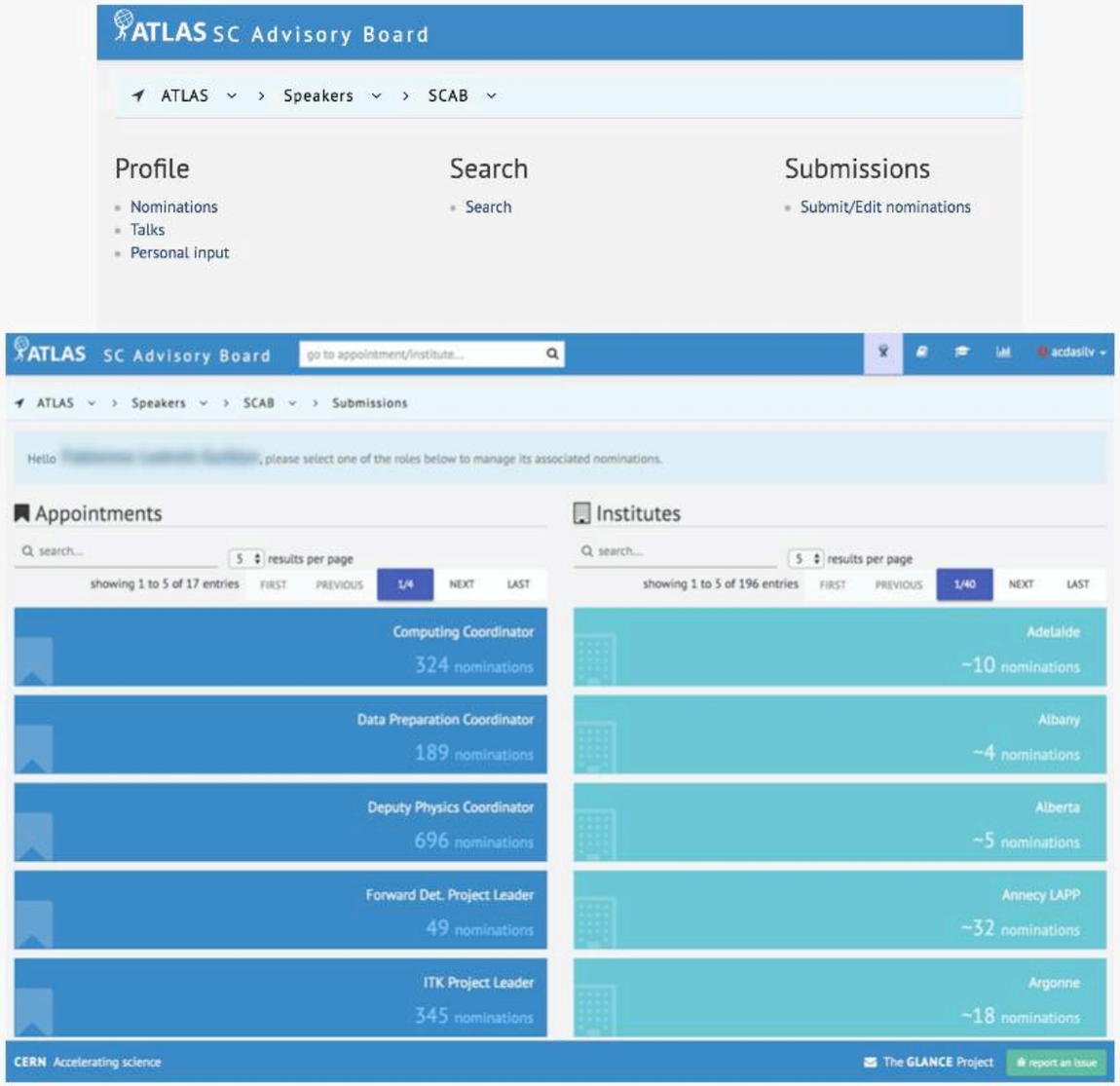
Speakers Committee

Appointment

Analysis

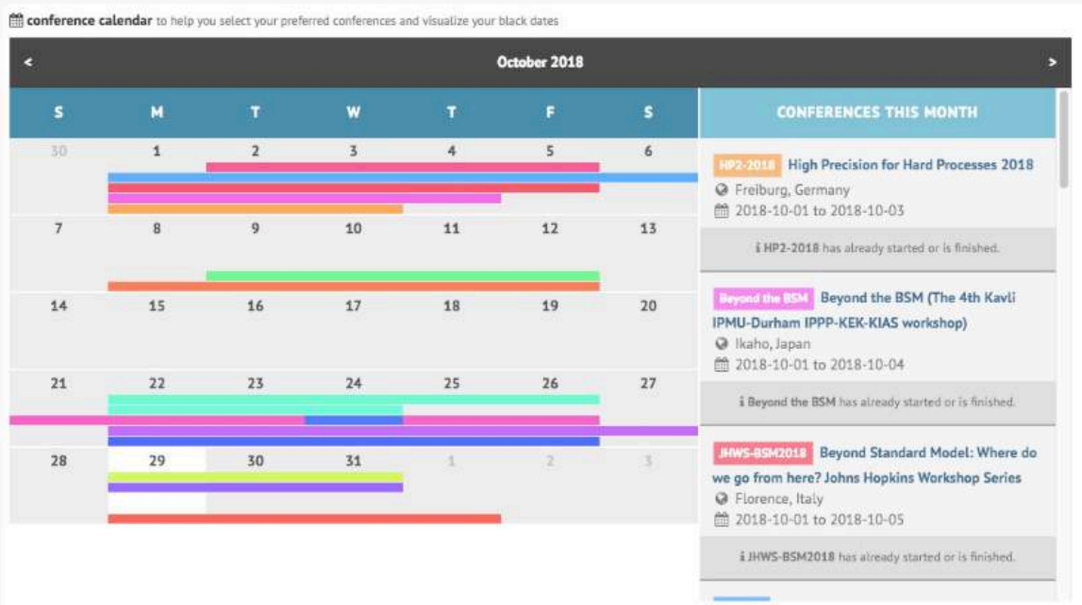
from C. Maindantchik

Speakers Committee Advisory Board (SCAB)



Management of speakers':

- Nominations
- Last talk given
- Nominations' priorities
- Rank (calculated by several criteria)
- Preferred topics
- Preferred conferences
- Black dates (periods for which he/she should not be considered to give talks)

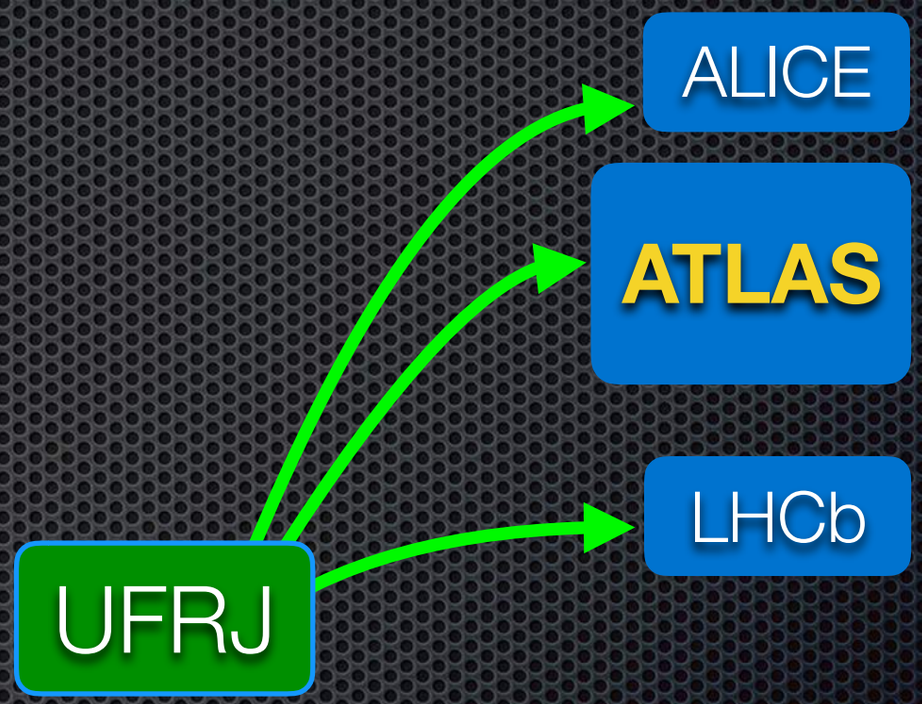


from C. Maindantchik

COPPE/Poli/UFRJ

Laboratório de Processamento de Sinais
Inteligência Computacional. Inovação

- FENCE/GLANCE systems
- Trigger
- Hadronic Calorimeter
  - Spinoff → 5 companies



SPRACE

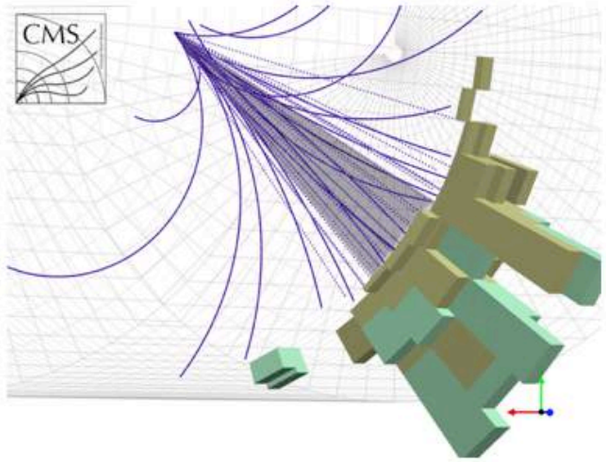
Boosted Jet Classification

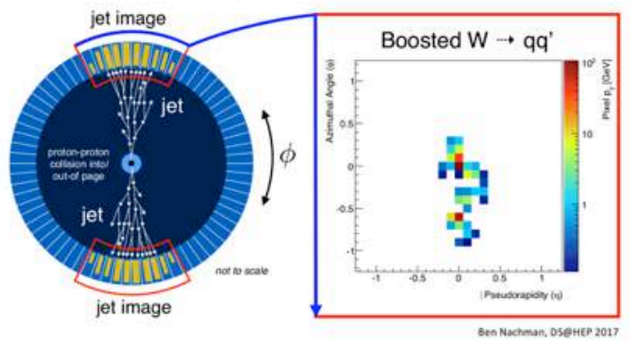
Jets coming from high energy parent are superimposed:

- **Signal**: Jets from W/Z processes
- **Back**: Jets coming from QCD

Machine Learning

- Train a classifier that could distinguish
  - Logistic regression
  - Multilayer perceptron
  - Convolutional Neural Net
- Model evaluation
  - Cross validation
  - Training set (70 %)
  - Test set (30 %)





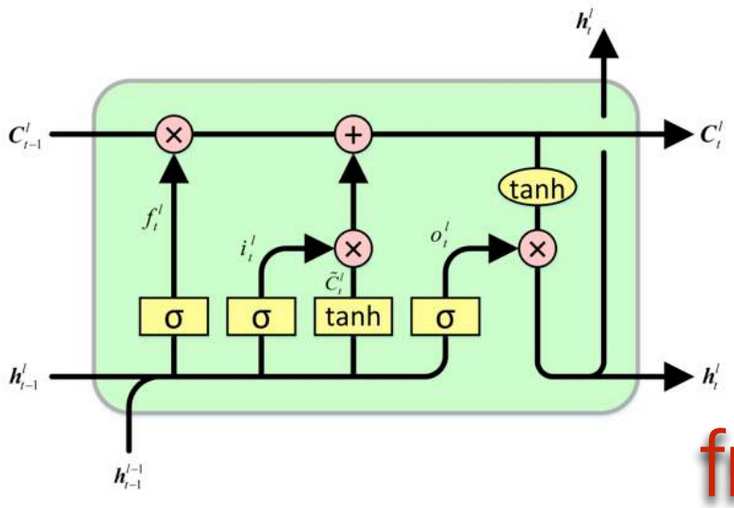
from S. Novaes

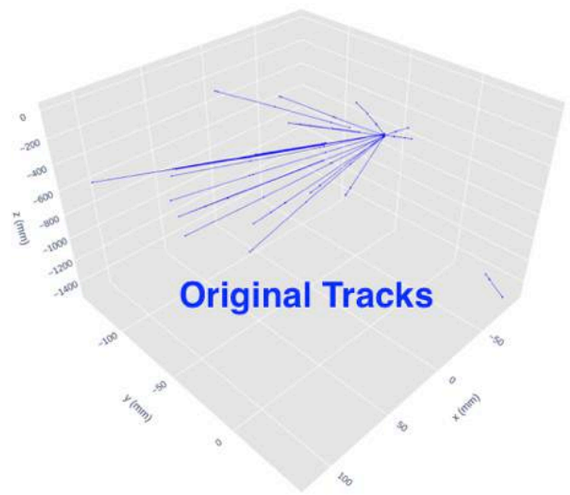
AI@SPRACE

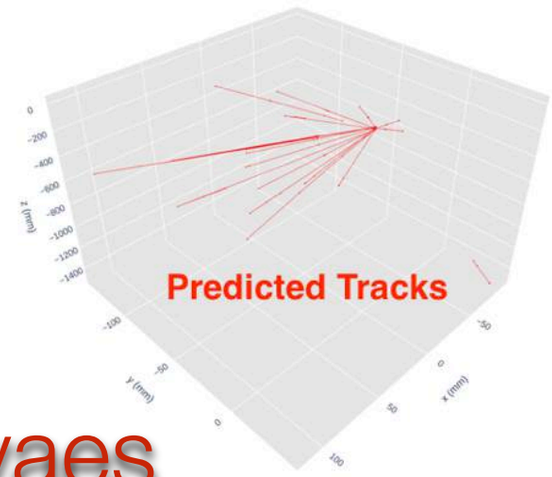
Tracking with Machine Learning

NN architectures:

- Multilayer perceptron
- Long short-term memory network
- Graph network







from S. Novaes

AI2

advancedinstitute.ai

twitter.com/AdvInstAI

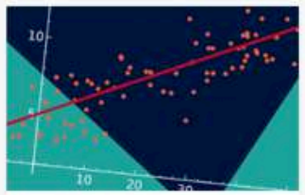
LinkedIn

company/advanced-institute-for-artificial-intelligence/

from S. Novaes

Training and Education Program

High School Courses



Artificial-Intelligence

Aprendizagem estatística – EM

APPLY NOW ›

Artificial-Intelligence

Visualização de Dados – EM

APPLY NOW ›

Artificial-Intelligence

Python para Datascience – EM

APPLY NOW ›

Artificial-Intelligence

Introdução a Estatística – EM

APPLY NOW ›

Artificial-Intelligence

Programação em R – EM

APPLY NOW ›

Artificial-Intelligence

Introdução a Programação em Python – EM

APPLY NOW ›

Regular Courses

Computer-Vision

Aplicações em processamento de imagens

APPLY NOW ›

Computer-Vision

Introdução ao processamento de imagem

APPLY NOW ›

Artificial-Intelligence

Projetos Aplicados de Machine Learning

APPLY NOW ›

Data-Science

Redes Neurais Avançadas

APPLY NOW ›

Data-Science

Redes Neurais

APPLY NOW ›

Data-Science

Introdução à Inteligência Artificial

APPLY NOW ›

from S. Novaes

Conclusions

- BR@High.Energy.Physics
  - has a long tradition
  - is a very active field
  - has a large and diverse community
- Software and computing
  - relevant contributions
  - spinoff
- Opportunities for collaboration

Contacts

- ALICE
  - UFGRS: Beatriz Gay - gay@if.ufrgs.br
  - UNICAMP: Jun Takahashi - jun@ifi.unicamp.br
  - USP: Marcelo Munhoz - munhoz@if.usp.br
- ATLAS
  - UFRJ: José Manoel Seixas - seixas@lps.ufrj.br
  - USP: Marco Leite - marco.leite@cern.ch
- CMS
  - CBPF: Gilvan Alves - gilvan@cbpf.br
  - UERJ: Luiz Mundim - luiz.mundim@cern.ch
  - UFABC: Eduardo Gregores - eduardo.gregores@cern.ch
  - UNESP: Sergio Novaes - novaes@sprace.org.br
- LHCb
  - CBPF: Ignacio Bediaga - bediaga@cbpf.br
  - UFRJ: Leandro de Paula - leandro.de.paula@cern.ch
- ALPHA
  - UFRJ: Claudio Lenz - lenz@if.ufrj.br
- AUGER
  - CBPF: Ronald Shellard - shellard@cbpf.br
  - UFABC - USP: Marcelo Leigui - leigui@ufabc.edu.br
  - UNICAMP: Carola Dobrigkeit - carola@ifi.unicamp.br
- CTA
  - CBPF: Ulisses Barres - ulisses@cbpf.br
  - USP/SC - UFABC: Luiz Vitor de Souza - vitor@ifsc.usp.br
  - USP/SP - IAG: Elisabete dal Pino - dalpino@iag.usp.br
- ANGRA
  - CBPF: Herman Lima - hlima@cbpf.br
- DUNE
  - UNICAMP: Ettore Segreto - segreto@ifi.unicamp.br
- JUNO
  - UEL: Pietro Chimenti - pietro.chimenti@gmail.com
- MINERVA
  - CBPF: Helio da Motta - helio@fnal.gov
- NOVA
  - UFG: Ricardo Gomes - ragomes@ufg.br
- CONNIE
  - UFRJ: Carla Bonifazi - bonifazi@if.uvrj.br
- COSINE
  - USP: Nelson Carlin - carlin@if.usp.br
- DAMIC
  - UFRJ: João Torres - jtmn@if.ufrj.br
- DARKSIDE
  - USP: Ivonne Freire - ifreire@if.usp.br

Muchas Gracias