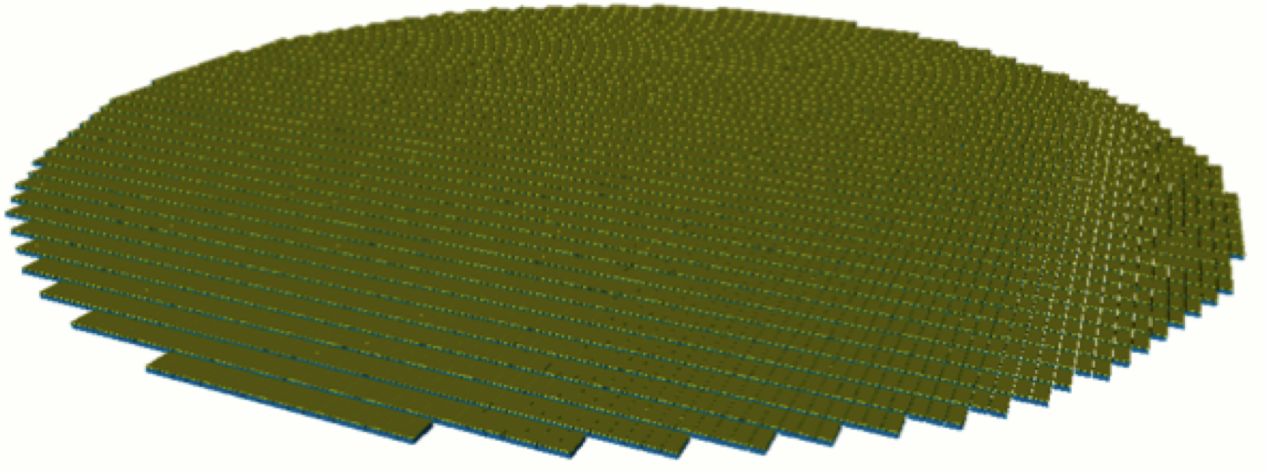
7th LATTES meeting
Coimbra, September 2018



https://www.lip.pt/experiments/lattes/

LIP

TÉCNICO LISBOA

FCT Fundação para a Ciência e a Tecnologia
MINISTÉRIO DA EDUCAÇÃO E CIÊNCIA

REPÚBLICA PORTUGUESA

Mário Pimenta

Main Goals

- News
- Progress reports on the several tasks
- Preparation for Heidelberg meeting

News

- Granada meeting
- meeting with HAWC : Heidelberg 8/9/10 October
- Emails exchanged with ALTO coordinator

Granada meeting

https://indico.lip.pt/event/473/

Discussion on the use of deep learning methods in LATTES analysis :

- g/h separation
- Energy calibration

Positive outcome:

- Granada is in !
- A Master thesis will be offered in Granada

LATTES Group

- Brazil – CBPF
- ITALY - Padova and Rome
- Portugal : LIP
- Czech Republic : Institute Physics of the Academy of Sciences
- Spain: Granada
- (China: Tsinghua University)

Yi Wang will visit Lx/Coimbra on the 4/5 October

TASK 1 - Detector R&D

1.1 Adapt the RPC design to operate at a much-reduced atmospheric pressure, to achieve a gas flux of 1 cc/min, and to make sure the requirements for remote, high-altitude operations are met. A revised design will be produced. Prototypes will be built and tested.
1.2 Develop a detailed thermal simulation of the detector for several insulations (passive and active) scenarios. The goal is to predict the operation temperature of each detector component as a function of time (daily and seasonal variations). Particularly relevant is the study of water freezing in the WCDs.
1.3 Study the evolution of the freezing point and of the optical properties of sterilized water samples as a function of different solvent concentrations. Experts from ITQB — Instituto de Tecnologia Química e Biológica collaborate in the project. The possibility to use the irradiation facilities at CTN - Centro de Tecnologia Nuclear to study the stability of the solution with sterilization by radiation will be investigated.

- RPCs – talk: Alberto/Luis Lopes
- Freezing point – talk: Fernando
- Thermal simulations: Luis Filipe looking for a master student

TASK 2 - Simulation and analysis

2.1 Design optimization:

- Study different detector configurations. Although the LATTES baseline detector concept is performing well, there are new ideas to be explored, for instance, to use the WCD as an active converter, instead of having a passive lead plate on top of the RPCs to convert the secondary photons. If feasible, this would not only reduce the detector cost but also offer additional mechanical/temperature protection to the RPCs. Other detector parameters will also be optimized for the final detector concept, such as the PMT position, WCD tank height, WCD inner layer properties and RPC pad size. The optimization of such parameters is linked both to the detector performance and to reconstruction analysis requirements.
- Study the possibility to add an external sparse array of detector units. Such sparse array would extend the reach to the highest energies (10-100 TeV) and allow us to remove an important background, namely high-energy hadronic showers that fall outside of the central core array but are reconstructed as having a low energy.

2.2 Development of improved analyses methods for shower reconstruction and background rejection, combining the measurement of different detector unit components, in particular for low energy showers.

2.3 Development of strategies to evaluate and control systematic uncertainties both at detector and shower physics level.

- Analysed methods : talks Ruben and Bernardo
- Different detector configurations: talk – Jakub

TASK 3 – Phenomenology

3.1 Gamma-ray physics

- Study of flares and transient sources. The sensitivity of LATTES to these variable phenomena will be assessed and its connection with other current and future experiments evaluated. Its capability to trigger measurements providing alerts to IACTs, such as CTA, will be studied.
- Identification and study of extended photon sources, such as the Fermi bubbles, and evaluation of the detector sensitivity to these sources (also to put limits).
- Assessment of the sensitivity of LATTES to indirect dark matter (DM) searches. LATTES' wide FoV and large duty cycle make it a strong candidate to find gamma-rays produced in the annihilation of pairs of DM particles, or to put strong limits on their velocity-averaged annihilation cross section. Its privileged location allows to survey the galactic center region, where DM is expected to be more abundant. Since the astrophysical background in this region is high, LATTES will also contribute to the understanding of gamma-ray sources near the galactic center, providing information useful to other detectors.

TASK 3 – Phenomenology

3.2 Cosmic-ray physics

- Evaluation of LATTES' sensitivity to study the nature of cosmic rays up to the first "knee" energy region.
- Develop the LIP team expertise on air shower physics to study charged cosmic rays and their connection with accelerator measurements. For instance, we plan to use LATTES measurements to put constraints on hadronic interaction physics of difficult access to human-made accelerator experiments, such as proton-air diffraction. This is an extremely important parameter for higher energy cosmic ray experiments, such as the Pierre Auger Observatory.

3.3 – Multi-Messenger (astro)physics

- A multi-messenger (MM) approach is planned focused on the electromagnetic counterparts of different observations, in particular of extreme energy phenomena such as the Gravitational Waves and of possible neutrino bursts. One can expect that in these cases both the time interval from the alerts to the electromagnetic emission and the accuracy of localization are not appropriate to allow pointing instruments to localize and observe the target, while a large-FoV instrument as LATTES can do it.
- Organize a workshop dedicated to MM observations and interpretation of data, joining experts of different fields. This workshop will help to enhance the physics opportunities and impact of the LATTES results.

  - GRBs: talk Giovanni
  - BHs and NS merger: talk – Filipe

TASK 4 – Outreach

4.1. Develop materials for the exploration for educational purposes of gamma rays, messengers from outer space, and key to the most mysterious and energetic phenomena in the Universe:

- Talks to be given in schools and other contexts, such as public sessions in science centers and special events: European researcher's night, LIP Open days, sessions for university students, etc.
- Activity guides to be used in high school projects, with the support of researchers in the project. These will explore concepts in astrophysics and particle physics, making use of real or simulated data whenever possible, and proposing simple analysis tasks. This will allow us to convey not only the results of science but also its methods and procedures.
- LIP has been participating in Agencia Ciência Viva's internship program for high school students for over a decade, and this project will host a few students every Summer.
- The project web page will contain a section targeting a general audience, which will be developed in steps along the project.

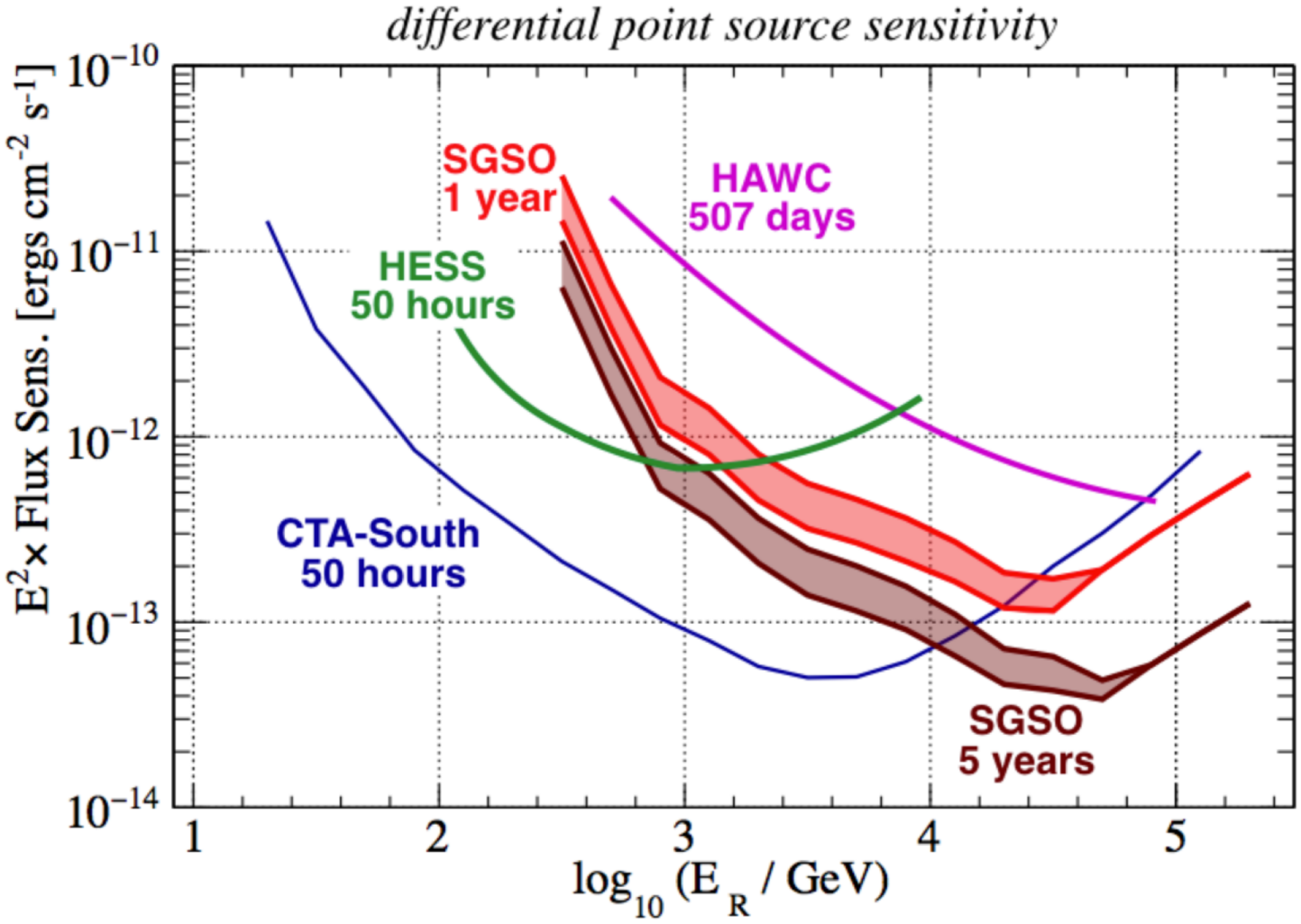
TASK 4 – Outreach

4.2 Development of detectors for educational purposes, to be used for demonstrations or installed for short periods in schools and science centers. Such detectors must be portable, easy to operate and relatively cheap. The required developments will stem from the main R&D lines of the project and from the Lab's previous experience. Two main technologies will be considered for the development of cosmic muon telescopes:

- RPCs — a simplified and smaller version of the autonomous and robust RPCs developed within this project would be well suited for this goal.
- Scintillators and optical fibers readout by silicon photomultipliers — a prototype version of such a portable "suitcase detector" has been built at LIP, inspired on the design of DESY's COSMO detector. Within this proposal, we have the ideal technical and human resources to take this project further.

- Muon tomography demonstrator to be installed in the Lousal Mine

SGSO – sensitivity curve



At 1 TeV ~ 5 (10) times better than HAWC !!!

Starts at 300 GeV !!!

How this happens?

The same angular resolution in the conservative (0.75 better - optimistic)

An area 4 times larger

factor $\gtrsim 2$

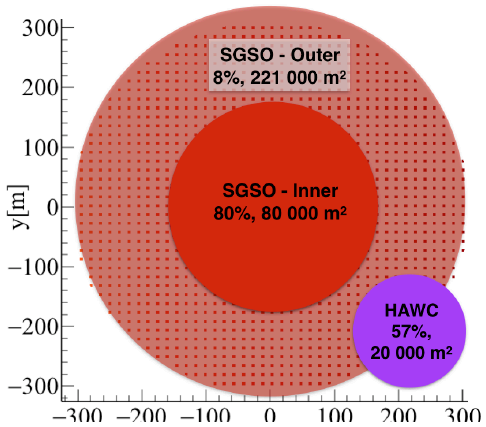
Higher coverage

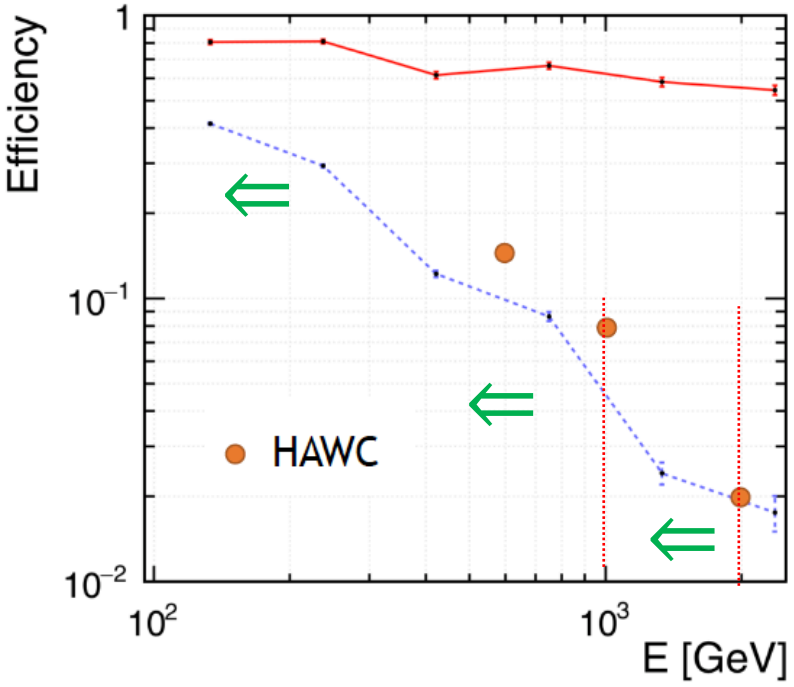
factor $\sqrt{(0.8/0.57)} = 1.18$

Take for grant that the g/h discrimination scales with the collect signal at ground!

for instances a factor 2 for an increase of 2 in the collected signal.

I am convinced that this is not true!





Agenda

10:30 - 11:00 - **LATTES: general remarks -** *Mário Pimenta*

11:00 - 11:20 - **LATTES station unit physics -** *Bernardo Tomé*
11:20 - 11:40 - **LATTES trigger and accidentals***Bernardo Tomé*
11:40 - 12:00 - **Comments on LATTES low energy reconstruction -** R*úben Conceição*

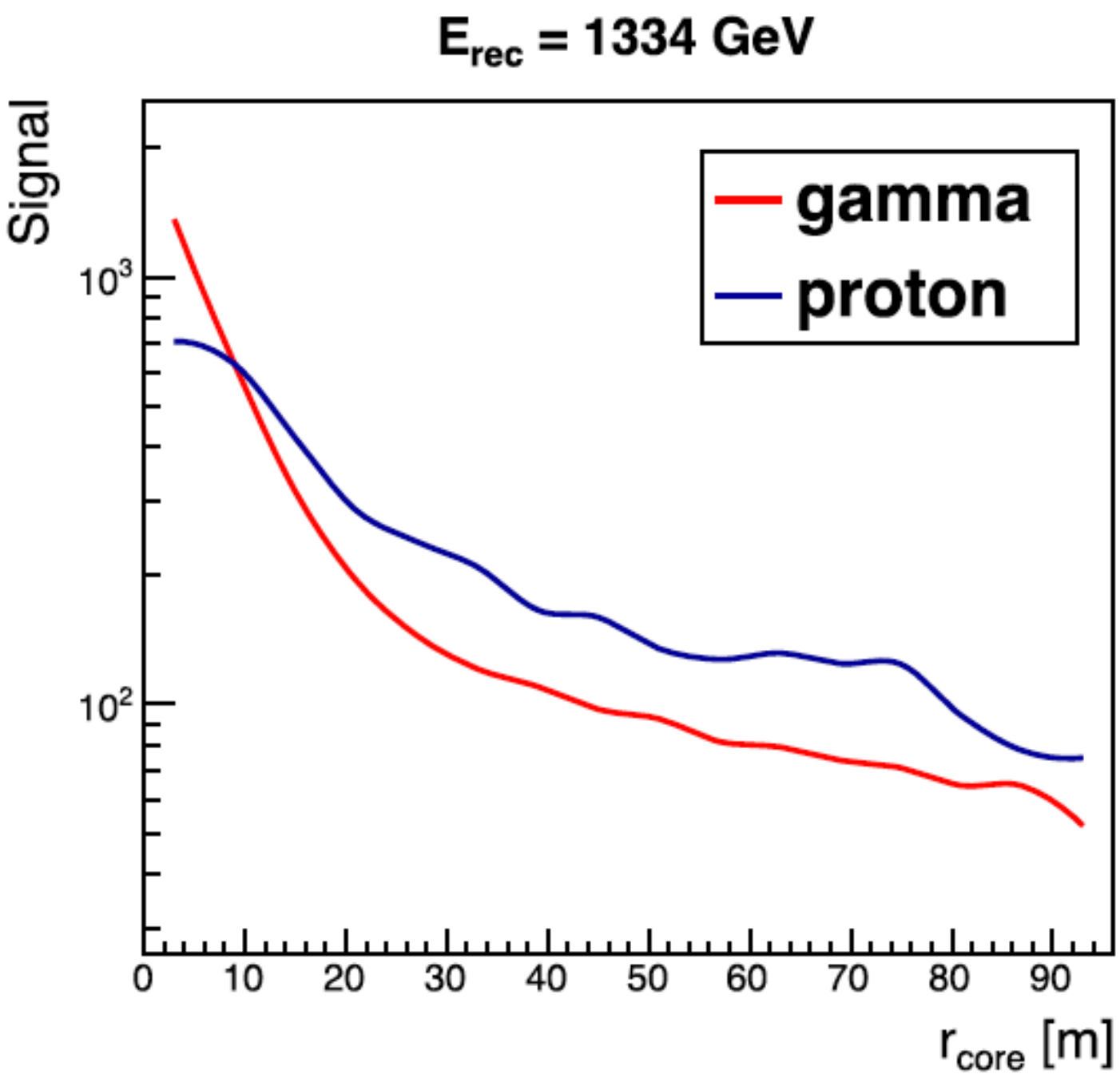
12:00 - 12:30 - **Discussion**

14:30 - 15:00 - **LATTES science case at low energies -** *Giovanni La Mura*
15:00 - 15:20 - **Dark matter searches in black hole mergers** *Filipe Salles*

15:20 - 15:50- **RPC R&D: status and news -** *Alberto Blanco et al.*
15:50 - 16:10 - **Water freezing in WCDs -** *Fernando Barão*

16:30 - 16:40 - **Brief report on the MARTA detector concept for LATTES -** *Rúben Conceição*
16:40 - 17:10 - **LATTESrec: analyses opportunities -** *Rúben Conceição*

17:10 - 18:00 – **Discussion**


E_{rec} = 1334 GeV
Signal
10^3
10^2
gamma
proton
0
10
20
30
40
50
60
70
80
90
r_{core} [m]

To Do list - Praga

R&D

- RPCs
  - Test of MARTA RPC at low pressure
  - Small prototypes optimized at 5000 meters
  - Cost review
  - RPC dedicated workshop
- Silicon PMTs
  - Layout design
- Trigger

Paulo/Alberto/Luís – RPCs ...

To Do list - Praga

Detector and Performance

- Sparse array
- Accidentals
- Explore RPC patterns
- Angular dependence
- MARTA/LATTES as a baseline ?

Ruben/Bernardo – Simulation Framework
Analysis methods

To Do list - Praga

Physics

- Sensitivity to transients
- Extended Sources: Fermi Bubles
- Multi-messenger GW : BH-NS
- Multi-messenger neutrinos : Galactic center
- Multi-messenger UHECRs : Pevatrons
- Cosmic-rays : Pulsars
- Multi-messenger workshop (Sep/Oct 2019)

Key Words

1- Towards a single collaboration - Heidelberg 8/10

2- Physics - physics case at low energies (100-500 GeV)

3- Detector and Performance - sparse array / Fortuitous / baseline vs "MARTA" concepts/ Deep learning

4- R&D – design, production and test of prototypes

5- Site - evaluation of sites (Chile, Argentina) and of the local support.