

LABORATÓRIO DE INSTRUMENTAÇÃO E FÍSICA EXPERIMENTAL DE PARTÍCULAS partículas e tecnologia 25 Abril

1974-2019

MARTA engineering array

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Muon Array with RPC for Tagging Air showers

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Regular Article - Experimental Physics

MARTA: a high-energy cosmic-ray detector concept for high-accuracy muon measurement

4 15 16 The implortance of measuring muons 17

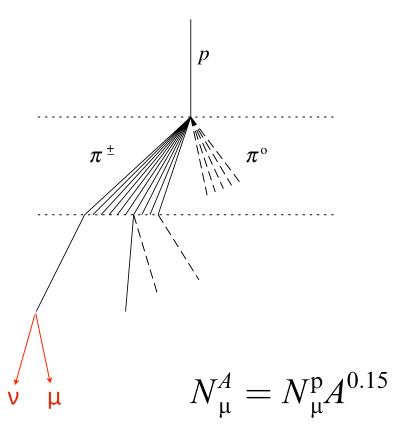
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•Simple model for development of extensive air showers

•Muons carry information on the primary composition (also on properties of first hadronic interactions, F. Riehn talk)

•Photon showers are poor in muons

Astroparticle Physics 22 (2005) 387–397

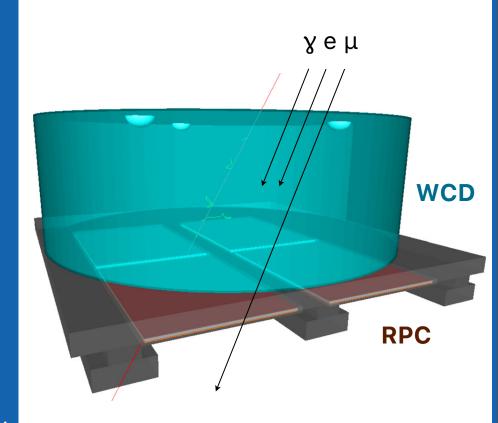


proton vs atomic mass A

Concept

•Original proposal for the Auger upgrade

•WCD shields the electromagnetic component; accurate muon measurement in RPC below



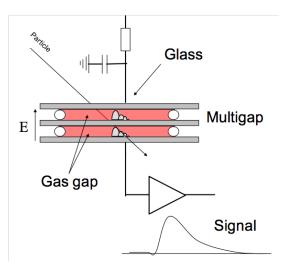
The RPC modules

PoS(ICRC2017)379

•Resistive Plate Chambers

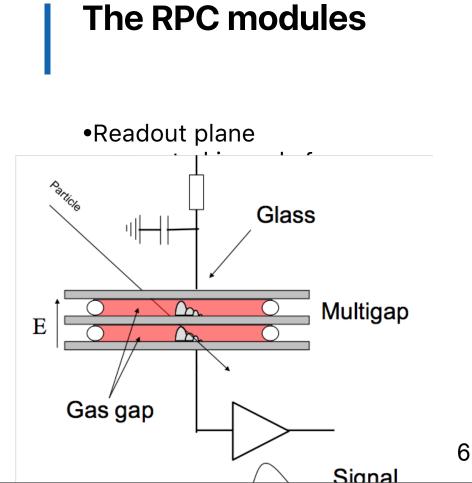
•Gaseous detector with **very good time resolution**

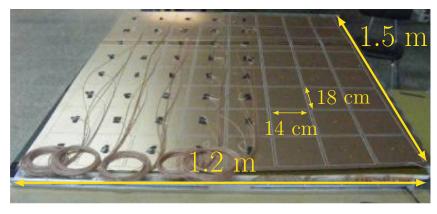
•Extensive R&D on autonomous stations in LIP-Coimbra (L. Lopes talk)





sensitive volume in acrylic box







The RPC modules



•MAROC based DAQ developed in LIP-Lisbon

•Annex for electronics and high voltage with reduced number of feedthroughs

•Connected and tested in São Carlos



produced in Malargue

•Less than one day to assemble one MARTA station



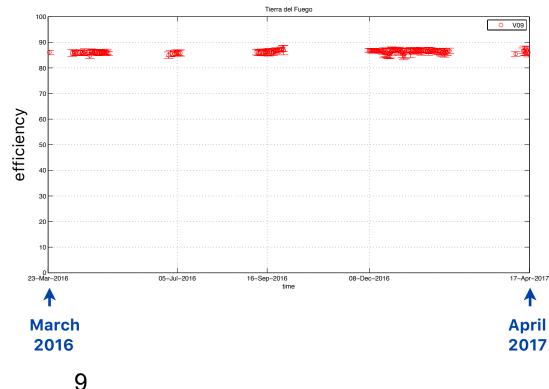
Field experience

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•Prototype RPC and electronics

•Stable, high muondetection efficiency achieved outdoors in the field

•Gas flux down to 1 cc/min

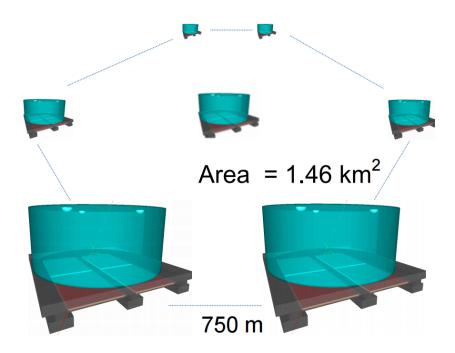


MARTA - EA

•Approved for installation on Auger hexagon: MARTA-Engineering Array

•7 stations → 28 RPC

 Maximize statistics with low energy showers → Infill region (750m station spacing)

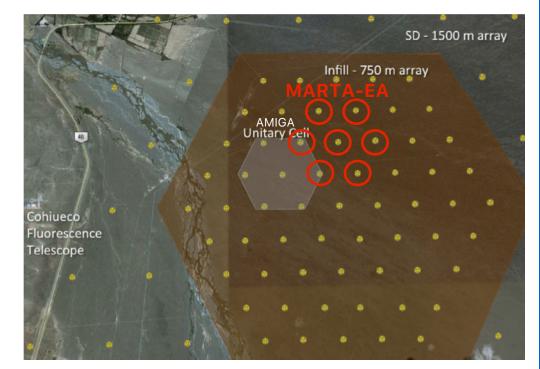


MARTA - EA: location

•Power, communications and synchronization provided by AMIGA

•Also at the site of the SSD-EA and AERALET

•Under the field of view of HEAT



MARTA - EA: status

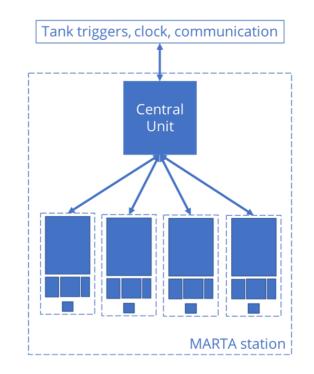
Sensitive RPC volumes: ✔

•DAQs + power supplies: 🗸

•Concrete precasts: ✔

•Assembled and arrived at Malargue: **22 RPC units**

•Installation in the field: expected in September •Under development: **central unit**, data analysis software framework

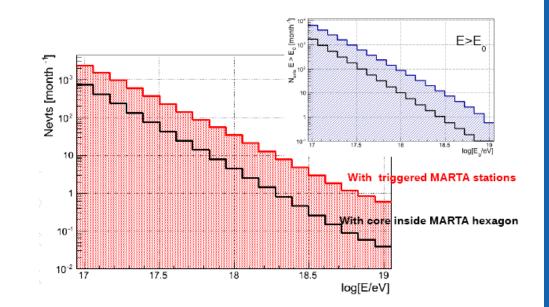


MARTA - EA: events

•Trigger provided by SD

•Data per pad will consist of: hit/no-hit per 12.5 ns

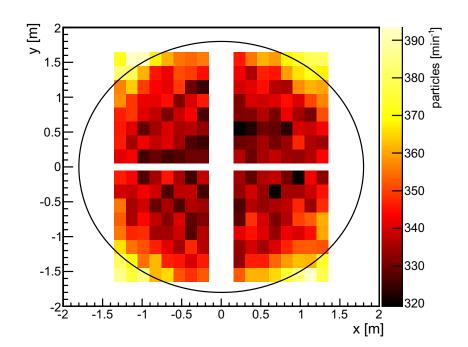
•About 1000 events per month at 10¹⁷ eV



Monitoring with atmospheric muons

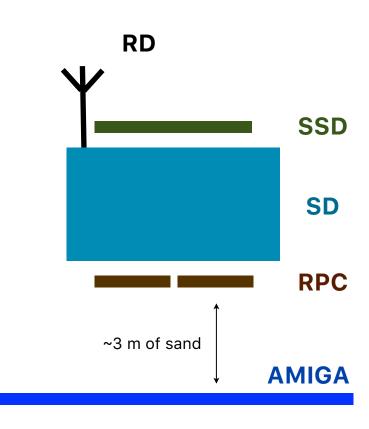
•Calibration of the efficiency of the pads with the atmospheric muon flux

•Statistical precision of 1% every half an hour



Detectors cross calibrations

•Possibility for systematics studies and cross calibrations with remaining detectors

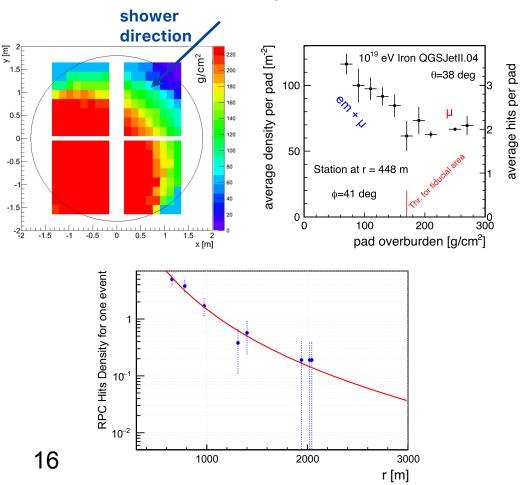


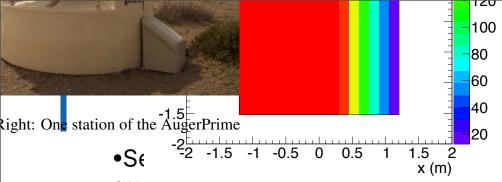
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Measurement of the number of muons

•Analyses validated with simulations at 10^{19} eV: fiducial area definition, LDF and N_µ evaluation

•10¹⁷ eV shower: equivalent proton first interaction center-ofmass energy ~14 TeV





QUALITY CONTROL n numbers [15, 16], fibre foreast mass crossed before reaching the MARTA RPCs under a 150 g/cm² vertical water equivalent mass, for incident oduction in extensive air showers. zenith angle.

(HV) electrodes are applied to these plates, creating an intense and uniform electric field. The passage nising particles through the detector creates avalanches ofic of the Pierre Augerous atom which induce signals in the readout electrodes. of the plates prevents electrical dish of the existing waterenkoy arges, which would affect all the detecto. ator Detector (S concerns and significant advantages with respect to more conventional detectors, as for example lators, partic-CD below it. Mary concerning cost and feasibility. Moreover, the segwo scintillator sub-montation (Come y i constrained essentially

The 3.8 m^2 scintillator planes are allows us to achieve high-voltage insulation and gas tighton top of the existing sycal with considerably the number of feed throughs. ill be collected with wavelength case is used to host the RPC, the Data

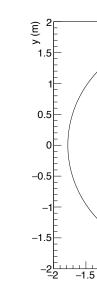
i National Accelerator Itale orendout. The signal piscup electrodes are physi-

Fig. 3. The MARTA implementation for the Pierre Auger Observatory: the RPCs (in brow ChSeltu Dttorstudey) a and trigger. The concrete suppor

muons mance and to further exploit t. teresting possibilities for comb



tectors (WCD). The WCD wo ing as shielding for the elect nent, and sitting on top of a the DDC medules. The meter





Thanks

Acknowledgements:







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