

Current Status of the ALPACA experiment in 2023

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The ALPACA (Andes Large area PArticle detector for Cosmic ray physics and Astronomy) collaboration is a joint research between Bolivia, Mexico and Japan since 2016, and the ALPACA experiment is a project to observe sub-TeV gamma rays in the southern hemisphere, consisting of a large air shower (AS) array and a water Cherenkov-type underground muon detector array on the Chacaltaya Plateau (4740 m above sea level) in Bolivia. In 2023, a prototype AS array named ALPAQUITA (1/4 scale of ALPACA) [1] started its pre-operation in the center of the ALPACA site. The ALPAQUITA AS array consists of 97 scintillation detectors, each with an area of 1 m², deployed with 15 m spacing. Based on 83 live-day observation of the AS array, the cosmic-ray Moon shadow is successfully observed with 6.7 σ statistical significance, and an angular resolution of 0.9° is estimated from this observation.

1. ALPAQUITA and ALPACA

Site

- 16°23'S, 68°08'W, 4740 m a.s.l.

AS Detector

- 1.0 m² each
- with 0.5 cm thick Pb plate
- 5 cm thick plastic scintillator
- 2 inch diameter PMT

Muon Detector (MD)

- 56 m² each
- 2.5 m thick soil absorption layer
- 1.5 m deep water
- 20 inch diameter PMT

ALPAQUITA (ALPACA) Array

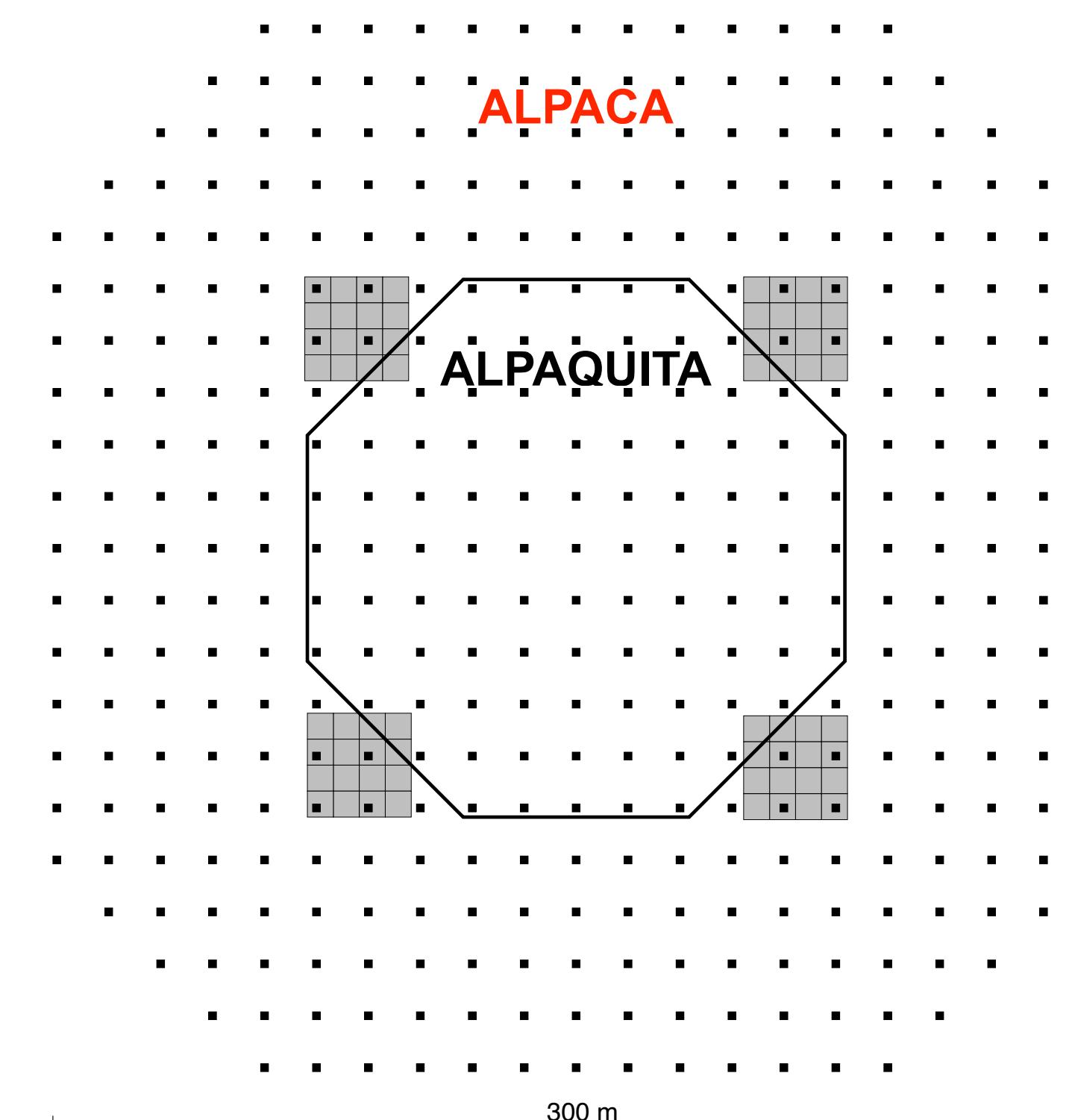
- 97 (401) AS detectors + 16 (64) MDs
- AS spacing 15 m
- AS array area 18,450 (82,800) m²
- MD total area 900 (3,600) m²

ALPAQUITA Trigger

- Trigger condition 0.7 particles Any 4
- Trigger rate ~280 events/s

ALPACA Performance

- Angular resolution ~0.2° @ 100 TeV gamma
- Energy resolution ~20% @ 100 TeV gamma
- FOV ~2 sr
- BG CR rejection power >99.9% @ 100 TeV



Schematic ground view of ALPAQUITA and ALPACA
 Small open square : AS detector
 Large gray square : muon detector

The ALPACA Collaboration

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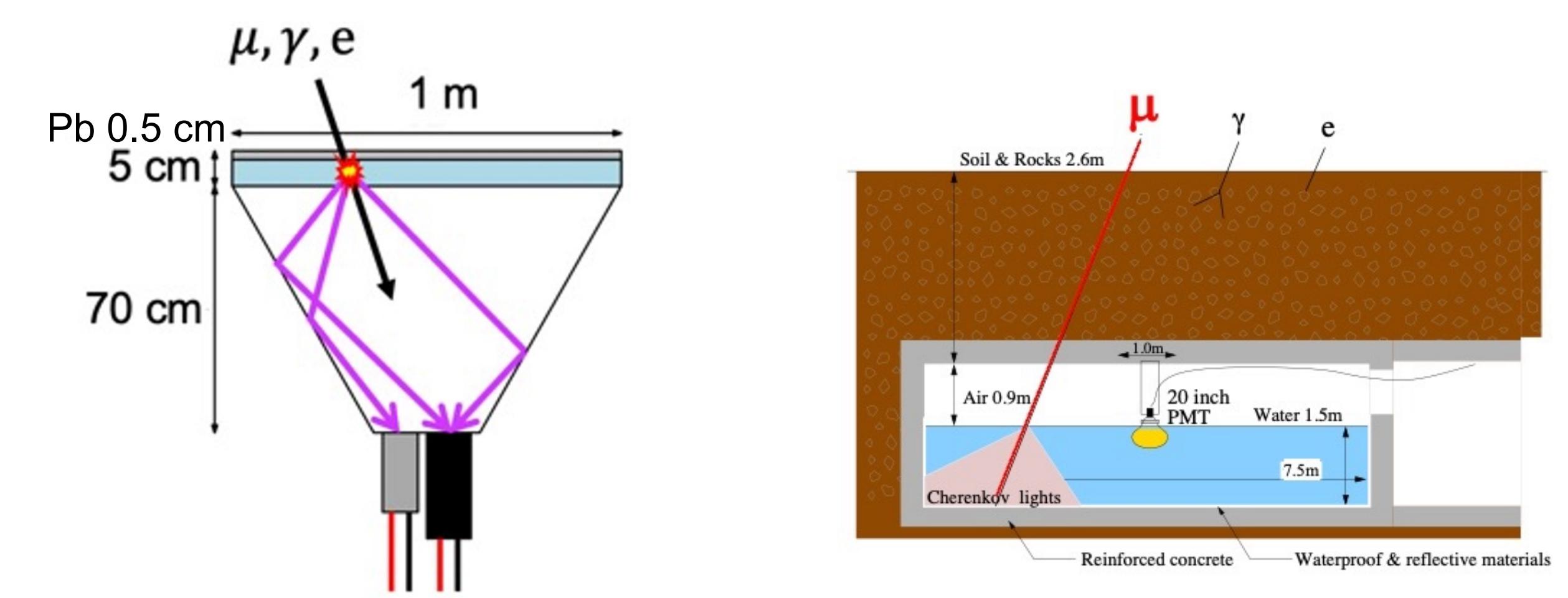
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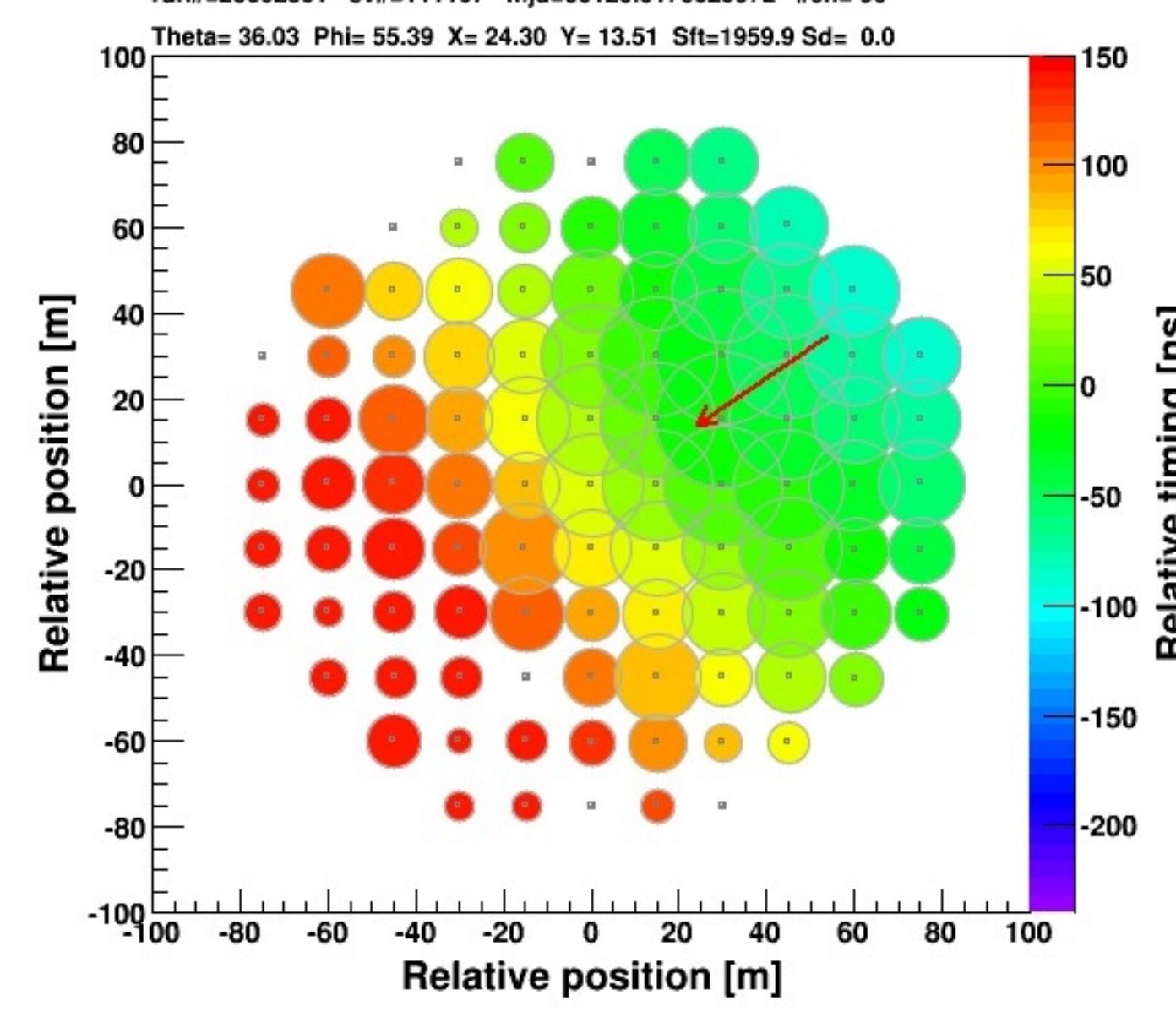
²³Japan Atomic Energy Agency, Tokai-mura 319-1195, Japan.



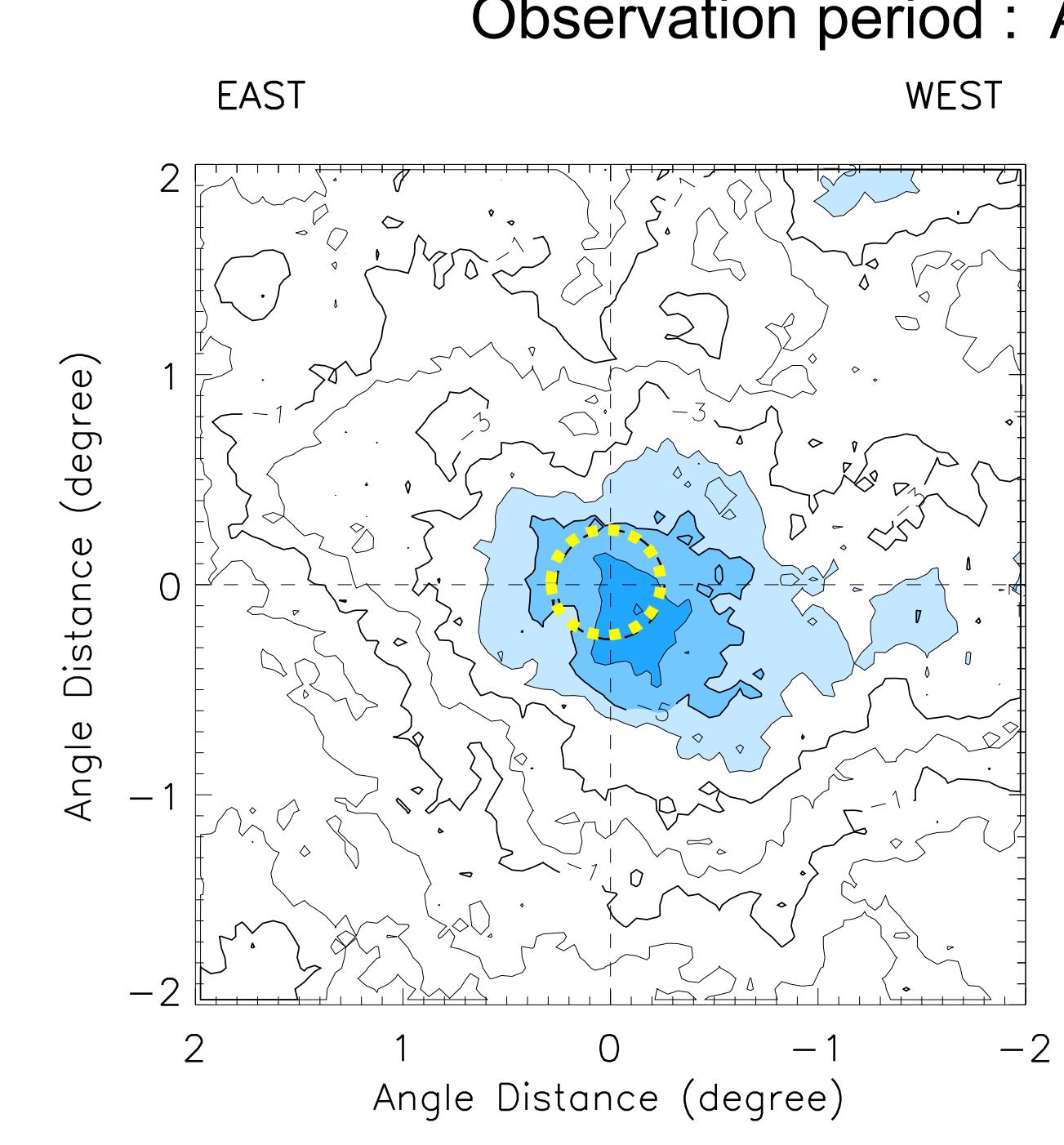
Side view of AS detector

Side view of muon detector (MD)

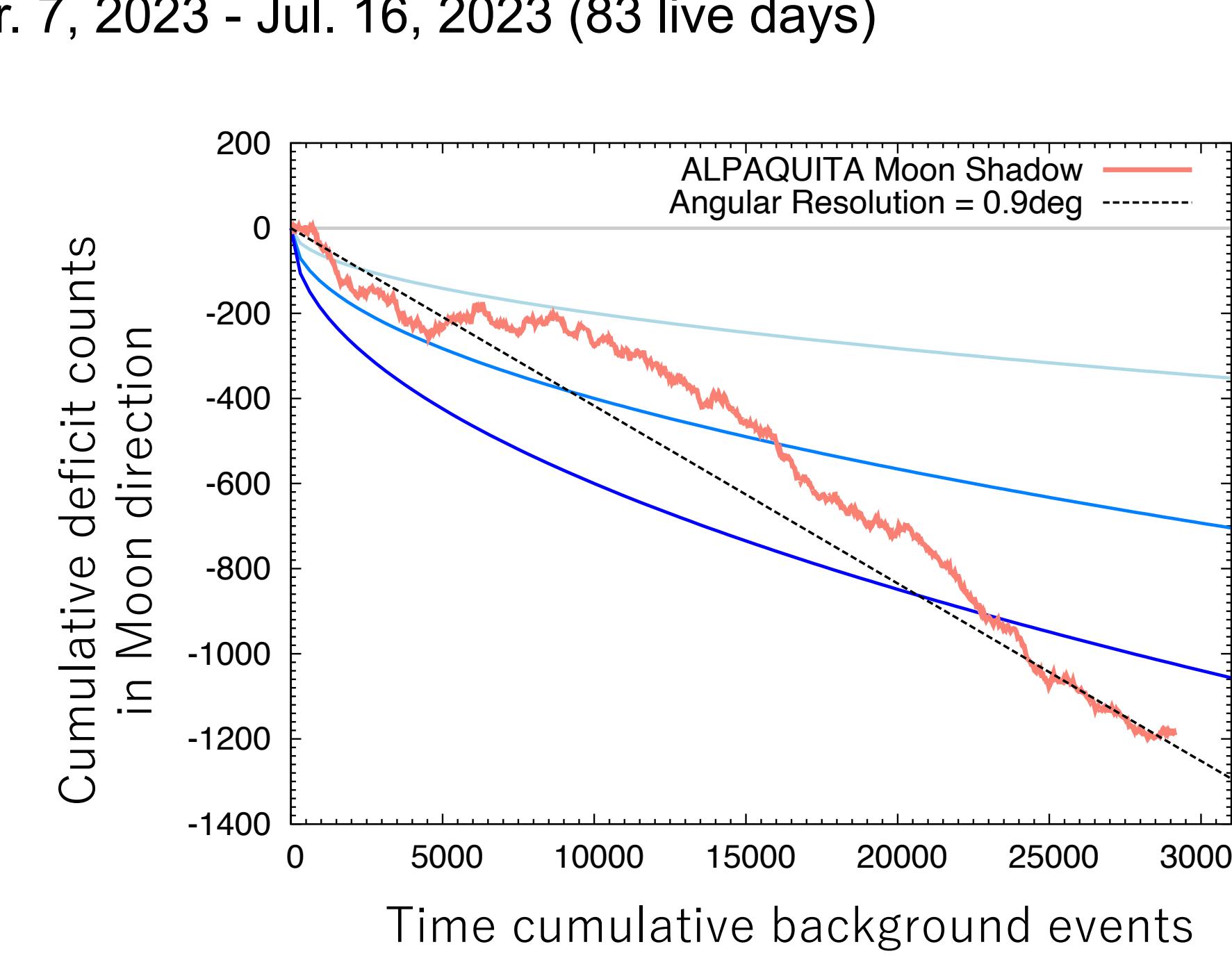
2. Initial events and Moon shadow by ALPAQUITA



A big event (> 100 TeV)
 The arrow shows arrival direction and core position



Moon shadow detected with 6.7 σ



Cumulative deficit in Moon direction

→ ~0.9° angular resolution

3. Future project Mega ALPACA

AS Detector

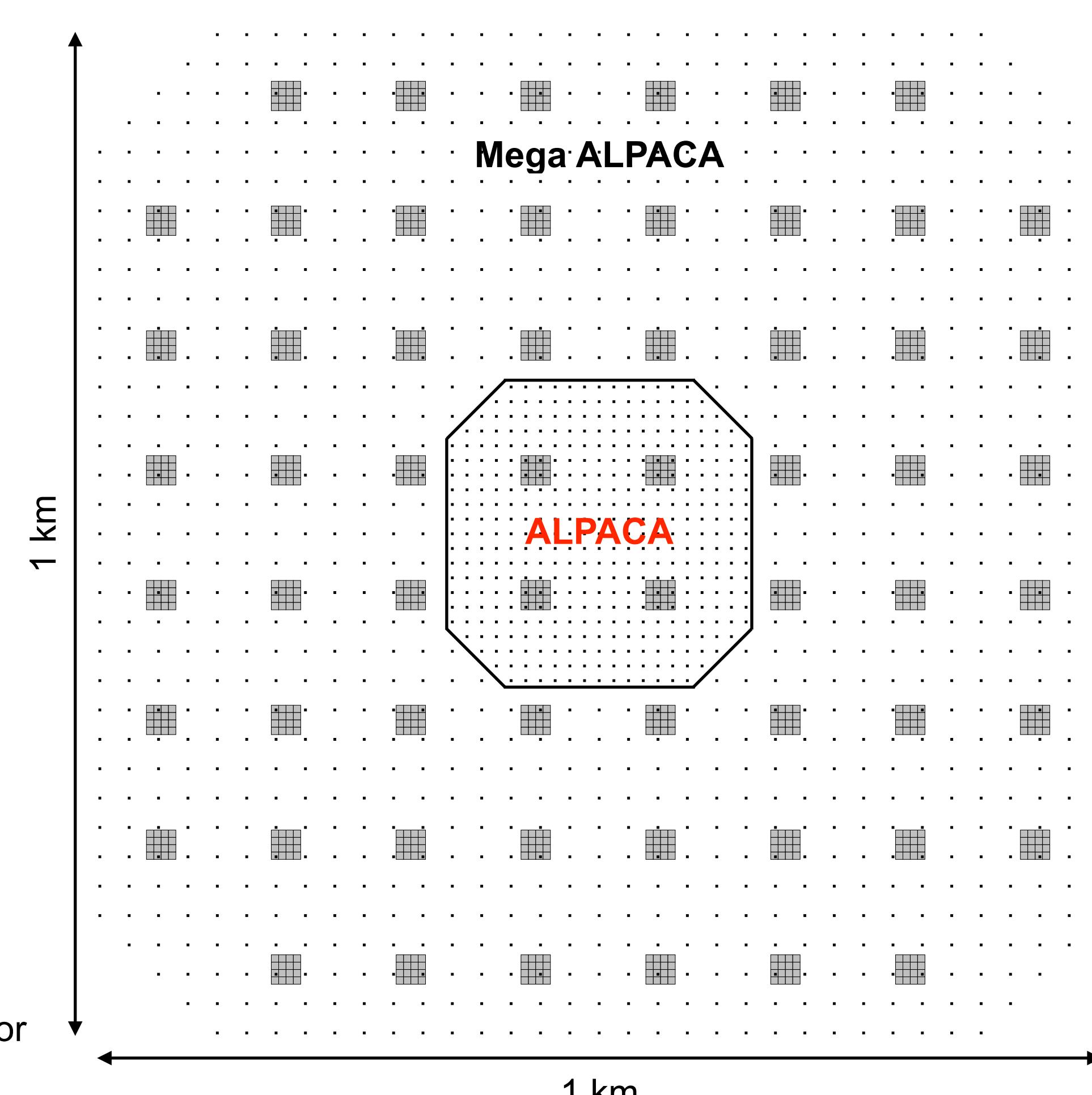
- 1.0 m² each

Muon Detector (MD)

- 56 m² each

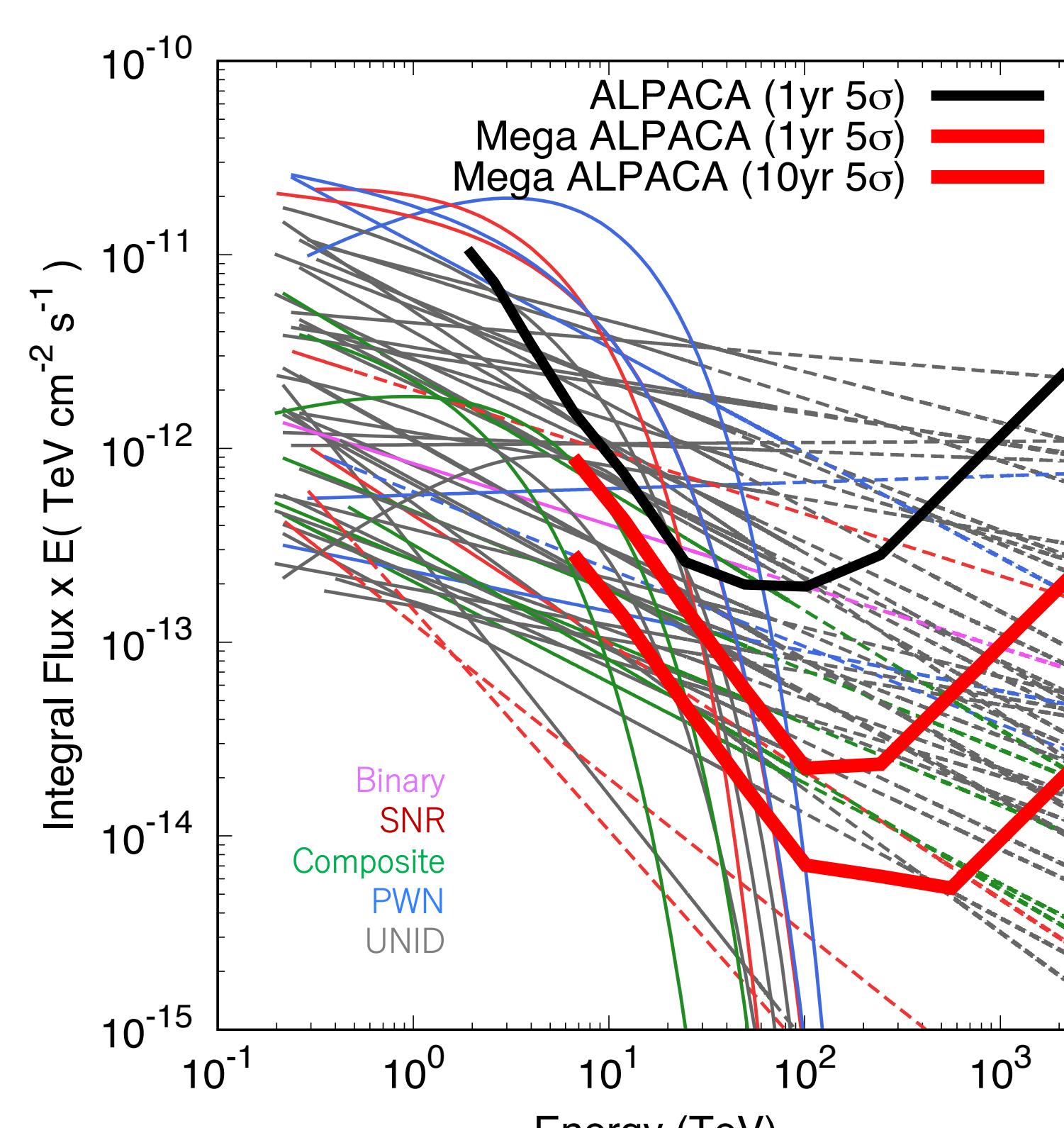
Mega ALPACA Array

- 1185 AS detectors + 960 MDs
- AS spacing 30 m
- AS array area ~1,000,000 m²
- MD total area ~54,000 m²



Schematic ground view of Mega ALPACA array

Small open square : AS detector
 Large gray square : muon detector



Sensitivities of Mega ALPACA and ALPACA

Thin curves: fluxes of known gamma-ray sources
 Solid lines: measured fluxes
 Dashed lines: extrapolations of the fitting

4. Gallery



ALPAQUITA AS array



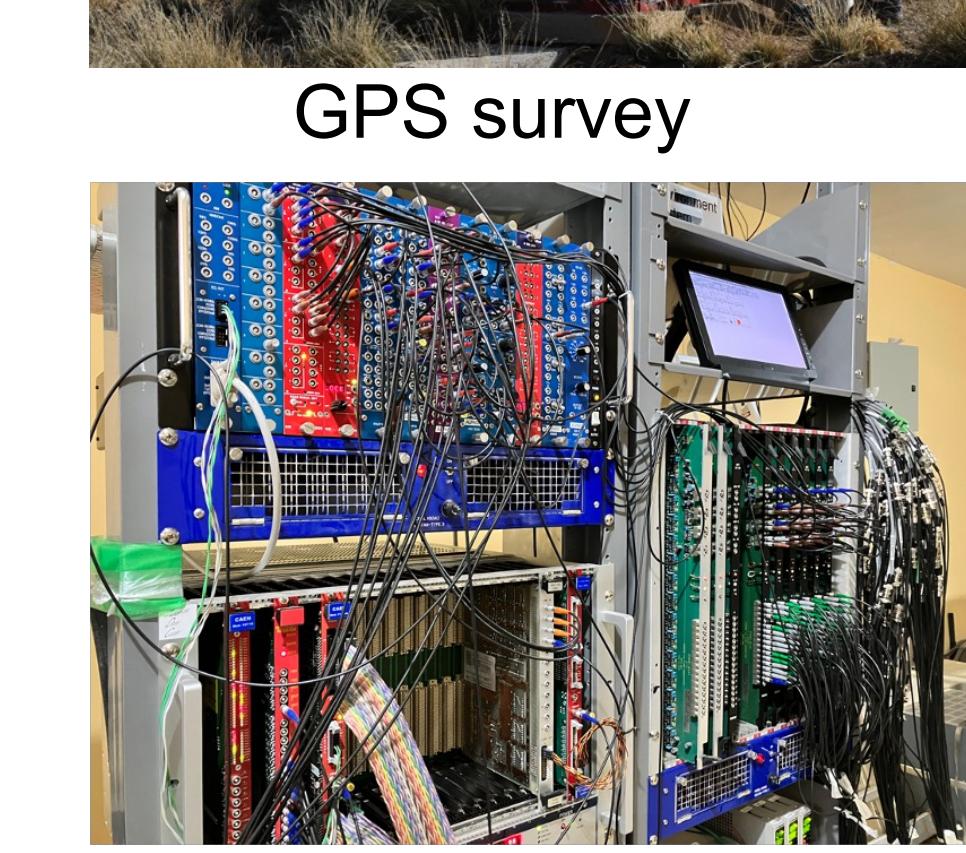
ALPAQUITA AS detector



Cable trench and installation of cables



GPS survey



DAQ system