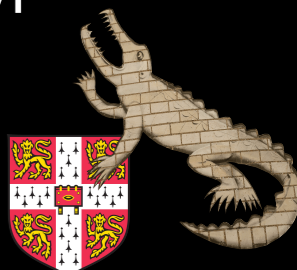


ANUBIS

AN Underground Belayed In-Shaft search experiment

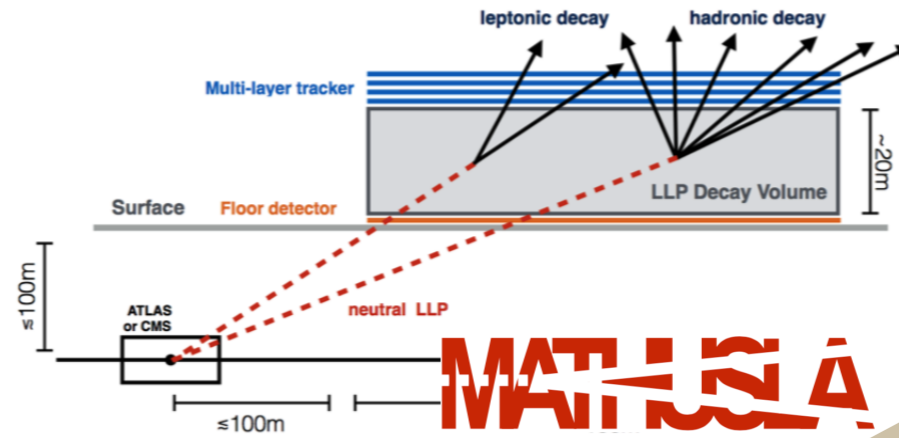
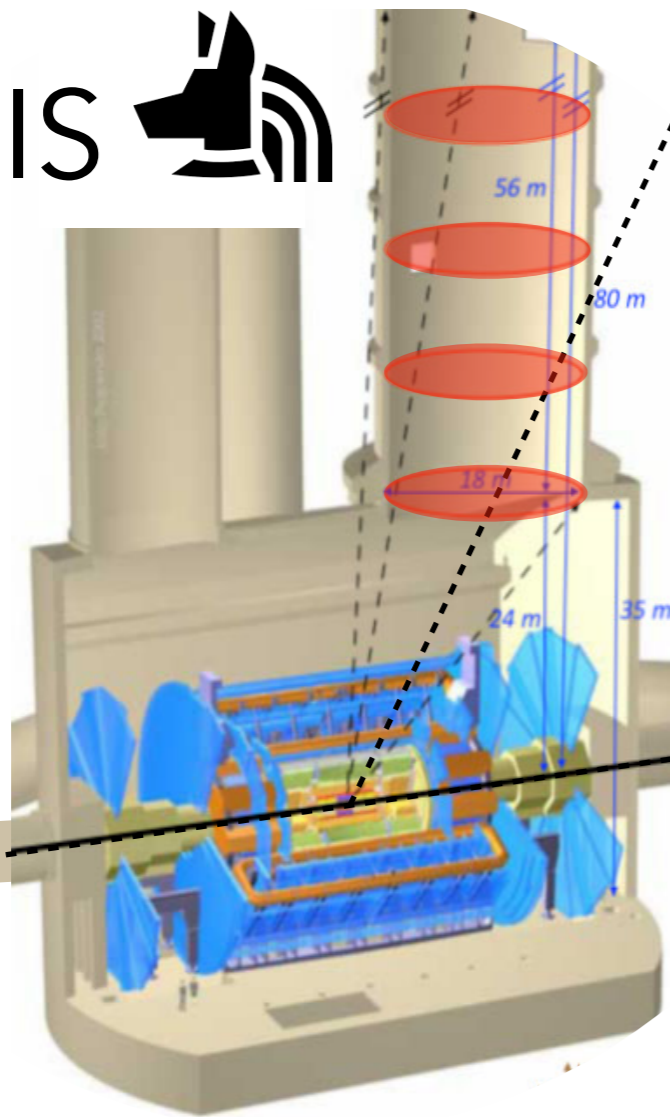
Martin Bauer • Oleg Brandt • Lawrence Lee • Christian Ohm • Bálint Szepefalvi

PicoTDC Users' meeting, 25.5.2020



Where to look for long-lived particles?

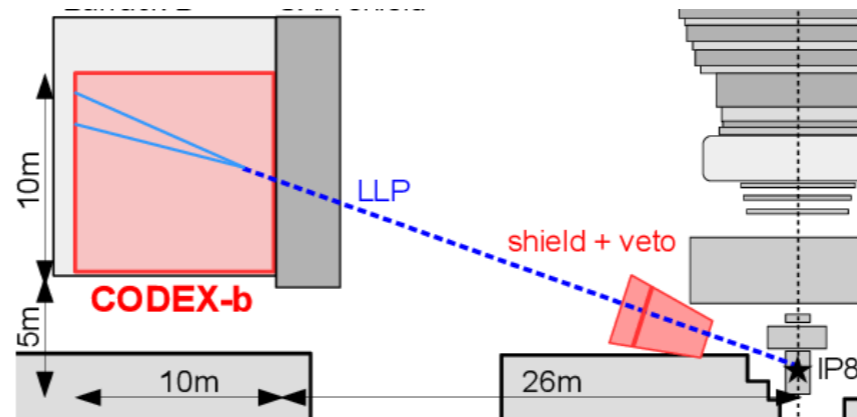
ANUBIS 



Chou et al 1606.06298

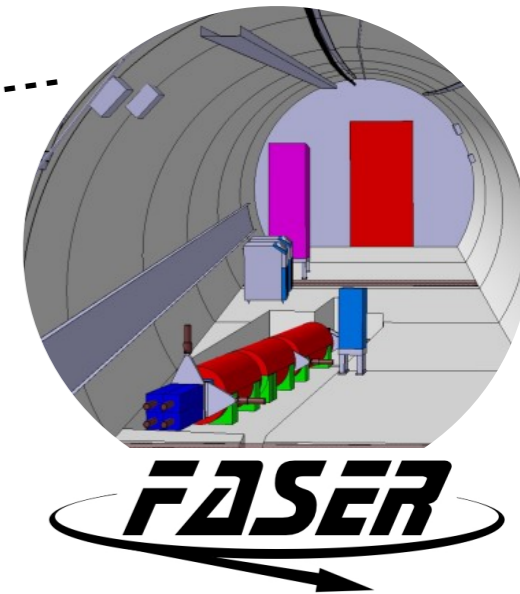
We propose to instrument the ATLAS service shaft

Bauer, OB, Lee, Ohm 1909.13022



CODEX-b

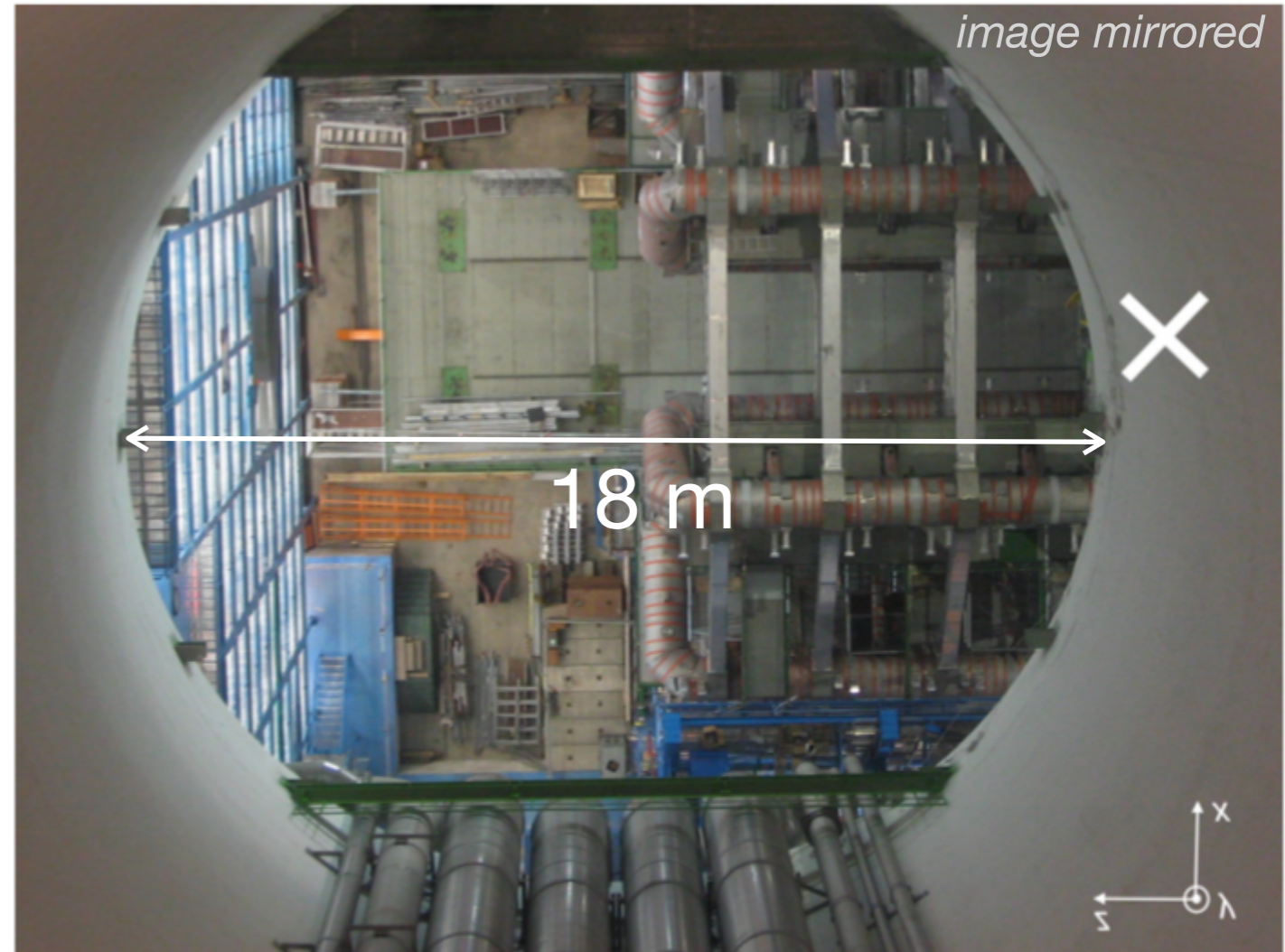
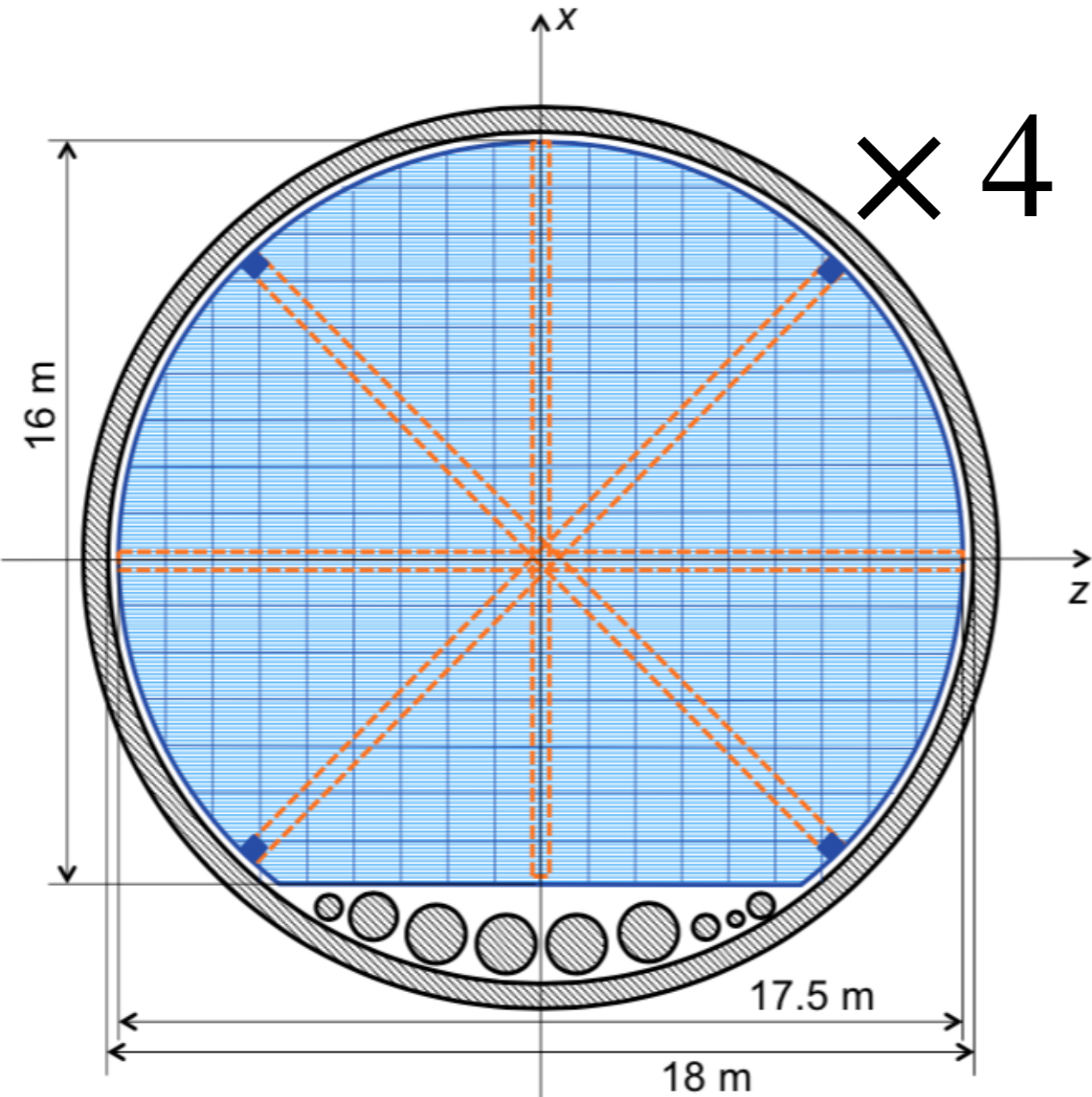
Gligorov et al 1708.09395



Feng, et al 1710.09387



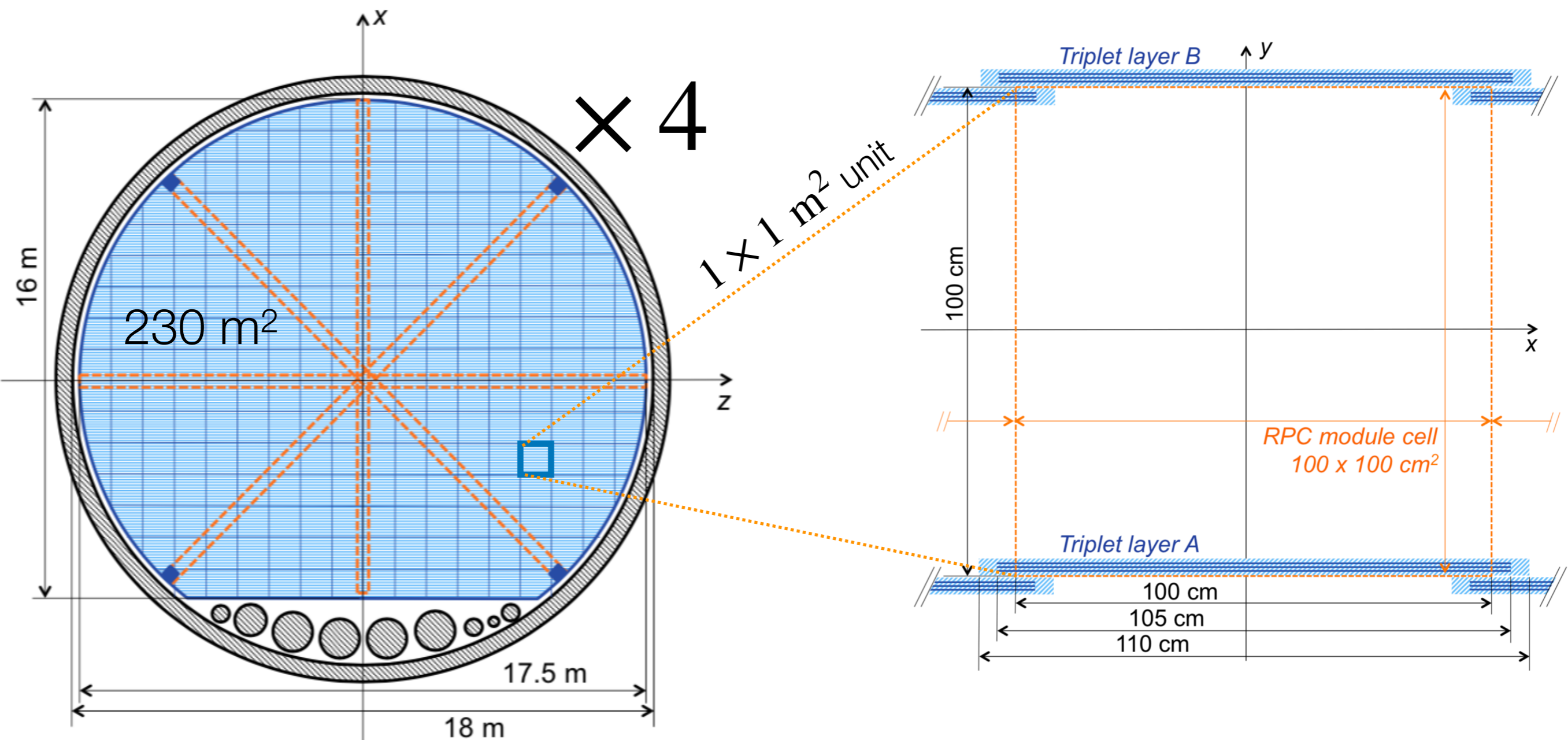
ANUBIS: idea



Current proposal:
Four evenly spaced tracking stations with
a **cross-sectional area** of 230 m² each



ANUBIS: detector concept



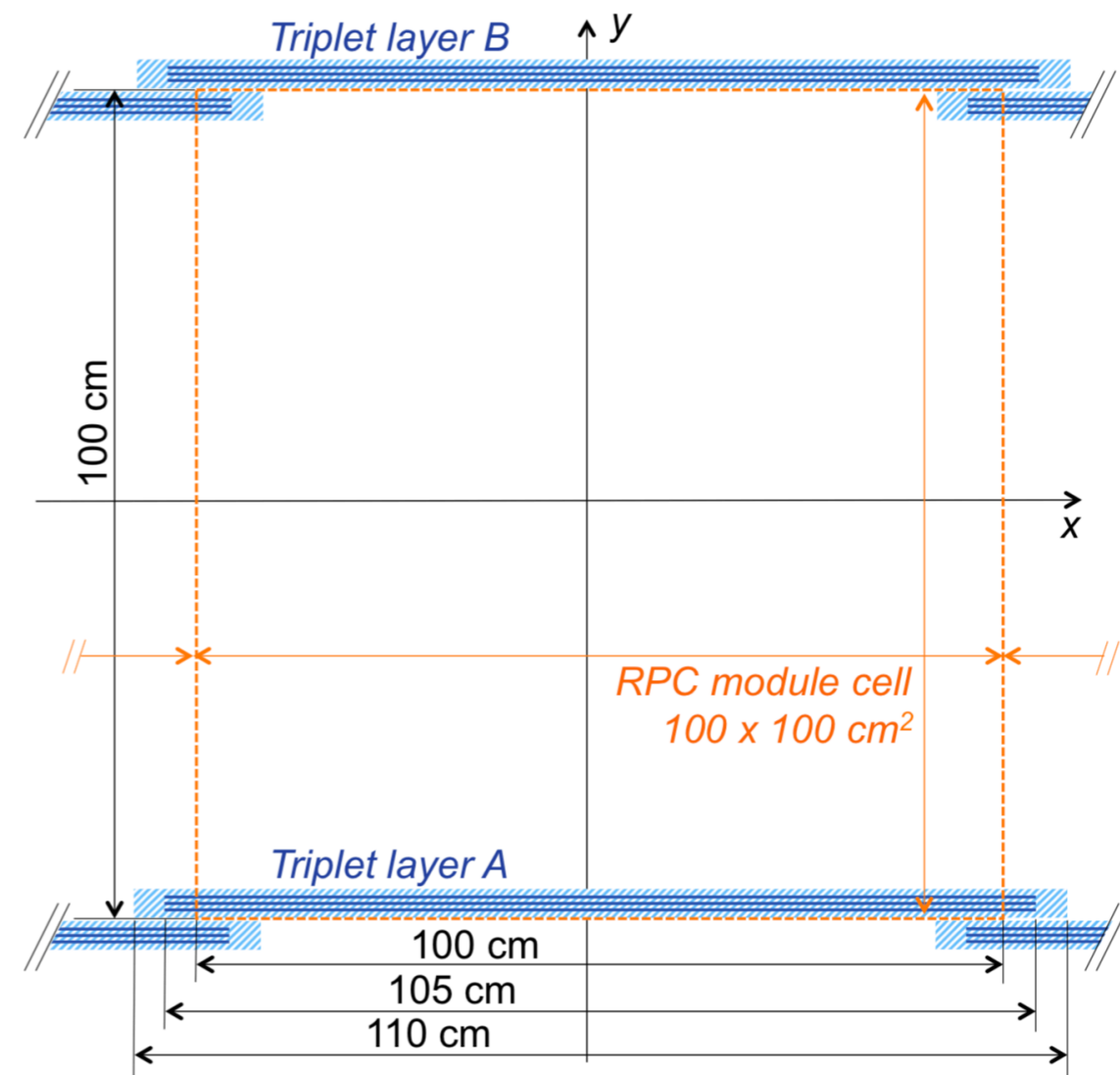
Modular design of tracking stations
from 1 x 1 m² modules

Parameter	Specification
Time resolution	$\delta t \lesssim 0.5 \text{ ns}$
Angular resolution	$\delta \alpha \lesssim 0.01 \text{ rad}$
Spatial resolution	$\delta x, \delta z \lesssim 0.5 \text{ cm}$
Per-layer hit efficiency	$\varepsilon \gtrsim 98\%$

ANUBIS: detector technology



- Resistive Plate Chamber technology; ANUBIS performance specifications met by ATLAS *BIS-7 prototype* (ongoing upgrade):
triplet of layers with 0.4 ns time resolution, 0.1 cm spatial resolution
- Future improvements may result in time resolution down to 100 ps
- Need a TDC with a per-channel time resolution of ~ 100 ps
- Cope with LHC data taking conditions, but low-ish occupancy up in the shaft
- Sensor electronics and amplifiers integrated into RPC sensor (Faraday cage)

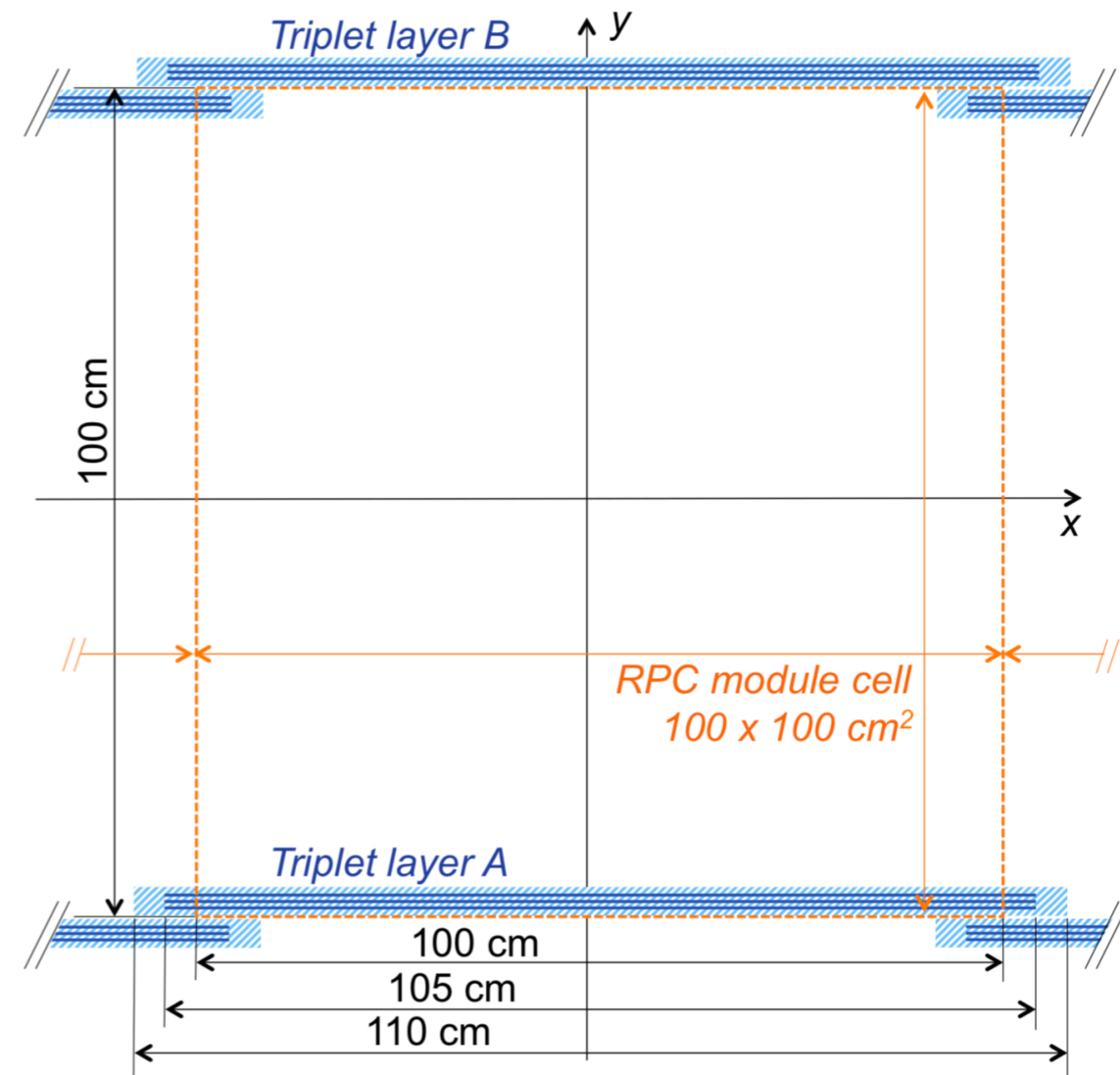


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ANUBIS: detector technology



- Pitch of RPC sensor: 1.6 cm
- 64 channels per RPC module cell
x 3 layers x 2 floors (np,oma;;_
- $2.3 \times 10^3 \text{ m}^2$ total instrumented area =
442k channels in total
-> need inexpensive solution for TDC
- PicoTDC can be a good solution for
ANUBIS, depending on the costs
- 442k channels = 6900 PicoTDCs (64ch)
design not finalised, may go up to 10k
- Looking at other options like FPGA-
based TDC (rad-hardness? stability?)

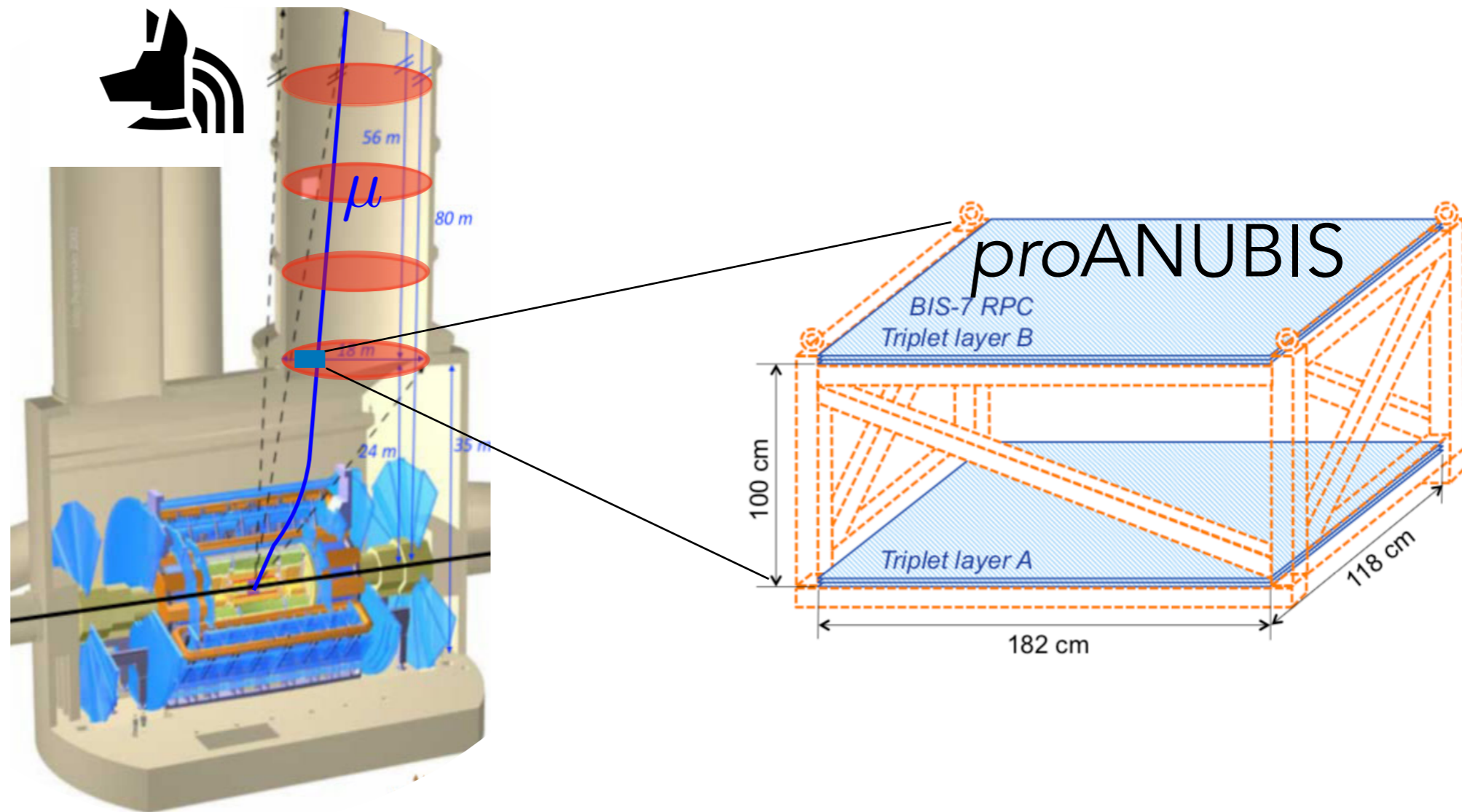


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Next Steps beyond proposal stage



- **proANUBIS:** two $1.8 \times 1.2 \times 1 \text{ m}^3$ prototypes:
 - **Measure fluxes** in PX14 shaft & **correlate** to ATLAS (Run 3)



Next Steps beyond proposal stage



- **proANUBIS:** two $1.8 \times 1.2 \times 1 \text{ m}^3$ prototypes:
 - **Measure fluxes** in PX14 shaft & **correlate** to ATLAS (Run 3)
 - R&D for **next RPC generation** for LLP search detectors
 - Eco-gas + ageing, reduced pitch, fully integrated R/O electronics (**PicoTDC?**), **improved timing & reduced costs!**

- **Detailed simulations**, full GEANT4 model
 - Correlate results with *proANUBIS*

- **Potential timeline for HL-LHC:**

- Pre-production in 4 years (one tracking station octant)
- Assembly, installation, commissioning in time for HL-LHC

