

DE LA RECHERCHE À L'INDUSTRIE

cea

SCAN
PYRAMIDS



HIP INSTITUTE
HERITAGE
INNOVATION
PRESERVATION

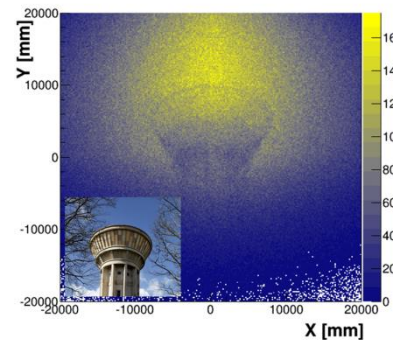


ARAB
REPUBLIC
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MINISTRY OF
ANTIQUITIES



FACULTY OF
ENGINEERING
CAIRO
UNIVERSITY

An exotic use of multiplexed Micromegas: muography of Egyptian pyramids

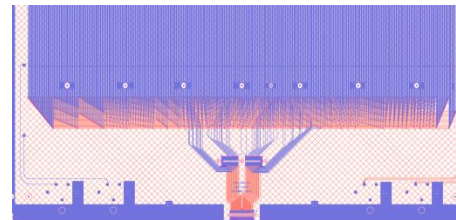


IRFU/SPhN: S. Procureur, S. Bouteille (PhD)

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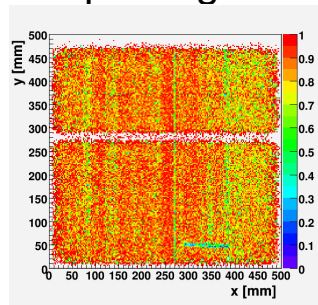
RD51, 07/06/2016

→ 2012: concept of genetic multiplexing



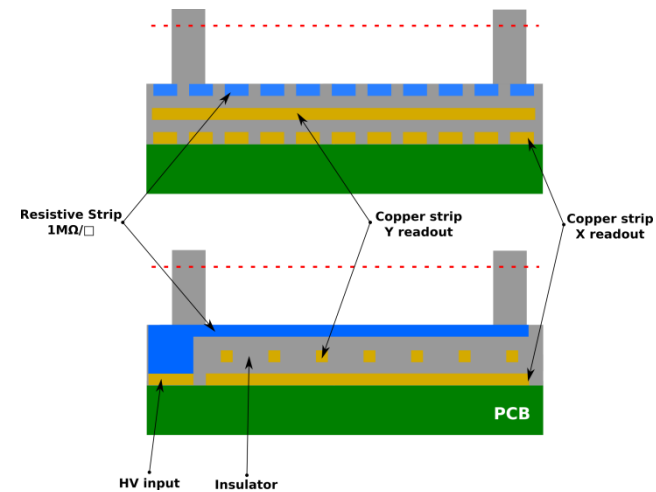
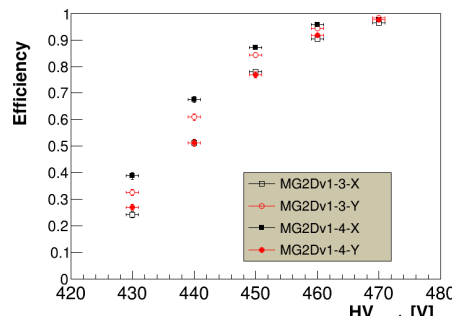
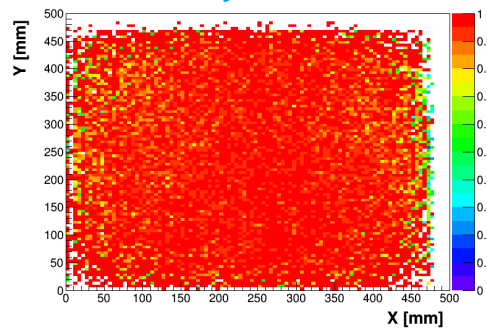
→ 2013: first, 1D prototype

- *T2K/AFTER electronics*
- *~90% efficiency in 1D*



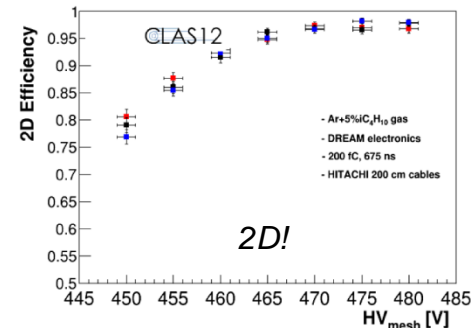
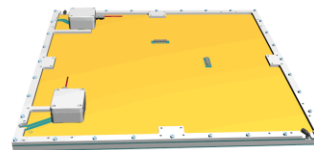
→ 2014: 2D, resistive detectors (MG2D-v1)

- *CLAS12/DREAM electronics*
- *~95% efficiency in 2D*



→ 2015: improved version (MG2D-v2)

- *CLAS12/DREAM electronics*
- *Better shielding (N~2600 e-, S/N~60-100)*
- *61x17=1037 channels*
- *1.5 cm drift gap (μ-TPC)*
- *~97% efficiency in 2D*
- *Longer plateau*

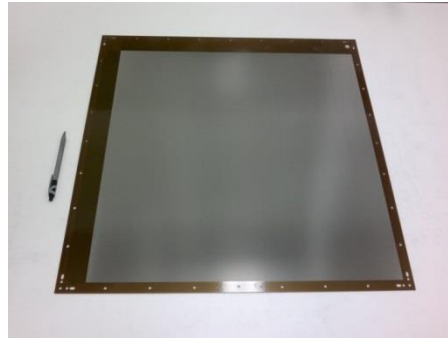
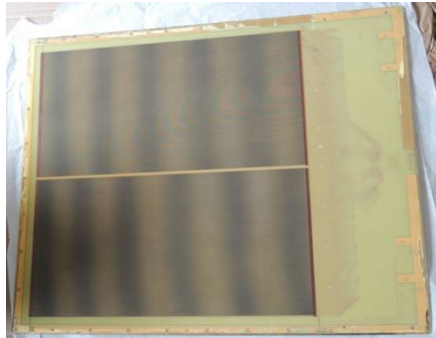


→ From the beginning, collaboration with ELVIA for know-how transfer

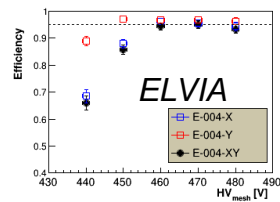
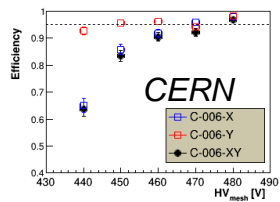
2013

End 2015

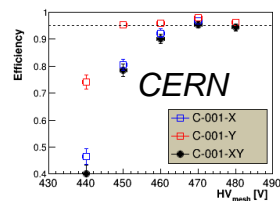
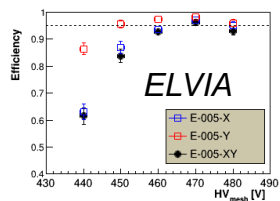
March 2016



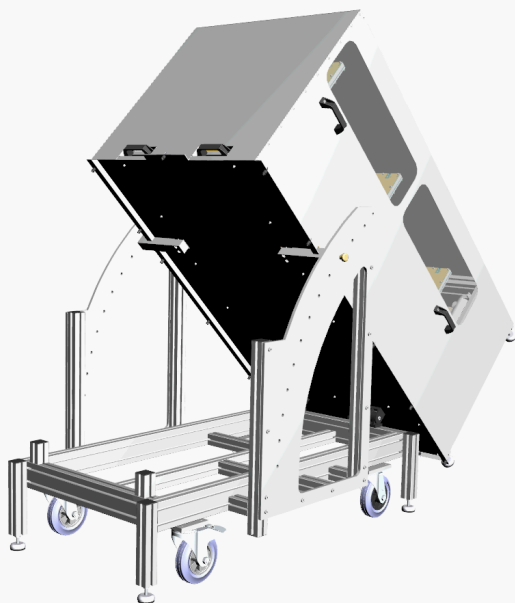
- ⇒ Slow progress, but more involvement since ~6 months
- ⇒ First operational prototype in November 2015, now received 8



⇒ Same performance level than CERN detectors



1st muon telescope with multiplexed Micromegas (2015)



→ 1st use of MM tracker outdoors

- Temperature fluctuations from 11 to 43°C
- Online feedback on T (P)

→ FEU from Clas12

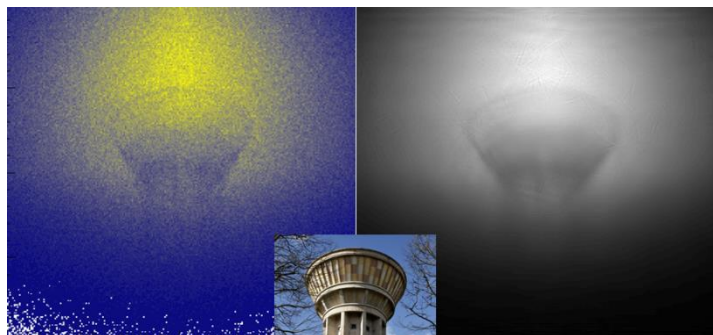
→ Self-trigger mode

→ Compact electronic system

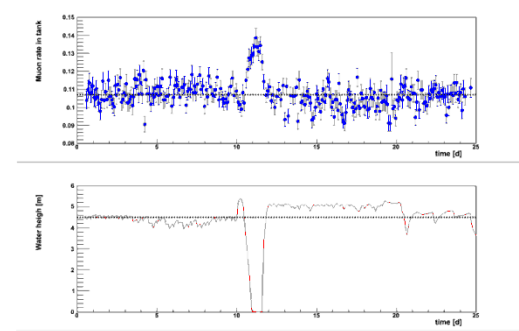
→ 30 W of consumption



static



dynamic



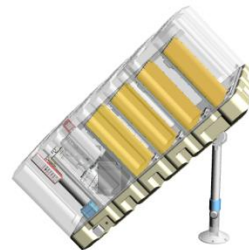
Applications of muon detection for the imaging of pyramids

→ Complement Japanese instruments (Nagoya + KEK)

- *Emulsions & scintillators*
- *So far only inside pyramids*

→ Construction of 3 telescopes of new generation

- *Thermal protection*
- *Waterproof*
- *Improved components => less noise*
- *3G connection*
- *Online data analysis (nano-PC)*
- *Simulation to optimize the sensitivity*



→ Were deployed last week around Kheops (2 on the East side, 1 on the North)



⇒ **Results in a few weeks/months ☺**

- *Collected already more than 1 million of cosmic*
- *Excellent trigger purity (>95%)*
- *Very good trigger efficiency (>90%, still under optimization)*
- *Very high temperatures but working fine so far!*