TOMAR:

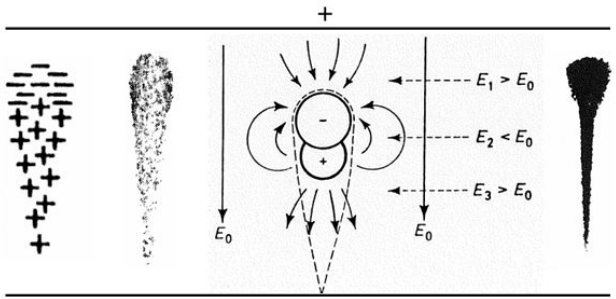
High Resolution RPC-based Muon Tomography

Alberto Blanco, Luis Lopes, Lidia Lappo, Jan Michel, Georgy Kornakov

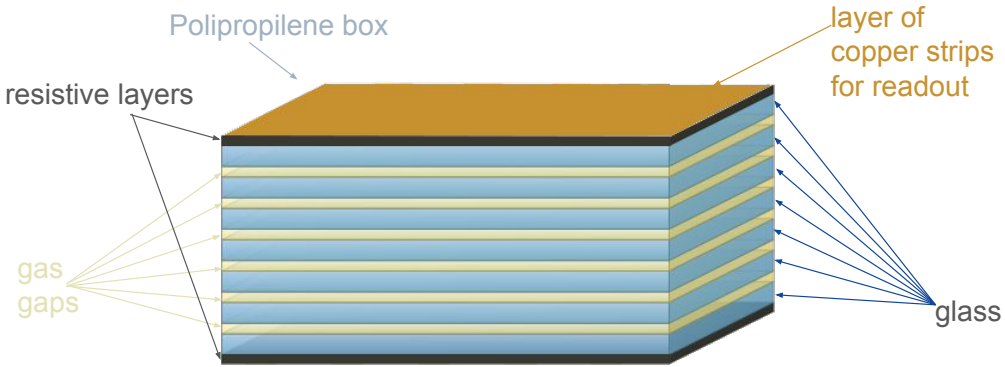
- What is RPC?
- RPC for muon tomography
  - Outdoor operation of RPC
  - Transmission tomography
  - Muon scattering tomography
- Read out
  - Position
  - Timing
- Proof of concept
  - 30x30
  - 130×90 cm
- TOMAR
- Future

Resistive Plate Chamber

- cost effective
- good timing
- position resolution dependent on readout strips



H. Raether. Electron Avalanches and Breakdown in Gases. London Butterworth, 1964. 38, 39, 40, 44



Resistive Plate Chamber

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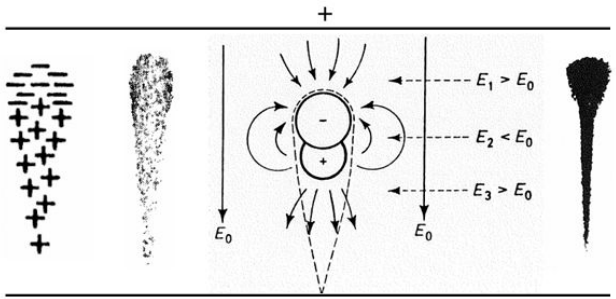

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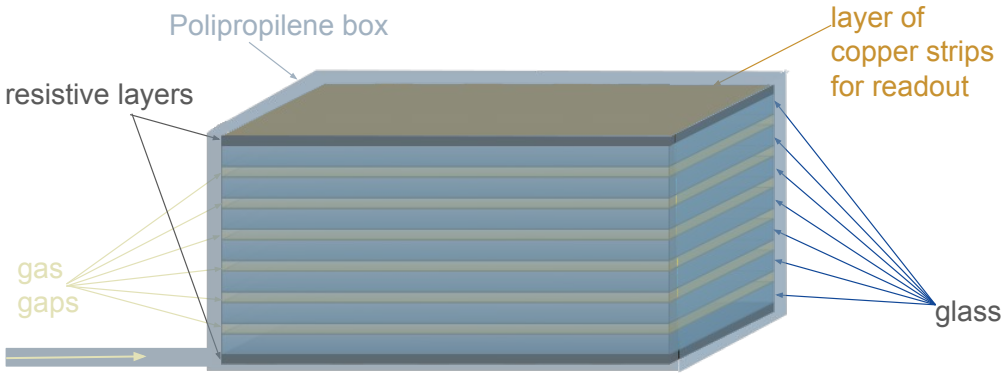


Outdoor operation of RPC MARTA in Pierre Auger array

Muon Array with RPCs for Tagging Air showers (MARTA)

R. Sarmento*, *P. Abreu, S. Andringa Dias, P. Assis, A. Blanco Castro, P. Brogueira,* et al. (click to show)

Studies on the response of a water-Cherenkov detector of the Pierre Auger Observatory to atmospheric muons using an RPC hodoscope

A. Aab, P. Abreu, M. Aglietta, J.M. Albury, I. Allekotte, A. Almela, J. Alvarez Castillo, J. Alvarez-Muñiz, R. Alves Batista, G.A. Anastasi ▾ Show full author list

Outdoor Field Experience with Autonomous RPC Based Stations

L. Lopes[b,*], P. Assis[a], A. Blanco[b], N. Carolino[b], M. A. Cerda[c,e], R. Conceição[a], O. Cunha[b], M. Ferreira[a], P. Fonte[b,d], R. Luz[a], L. Mendes[a], A. Pereira[b], M. Pimenta[a], R. Sarmento[f] and B. Tomé[a]

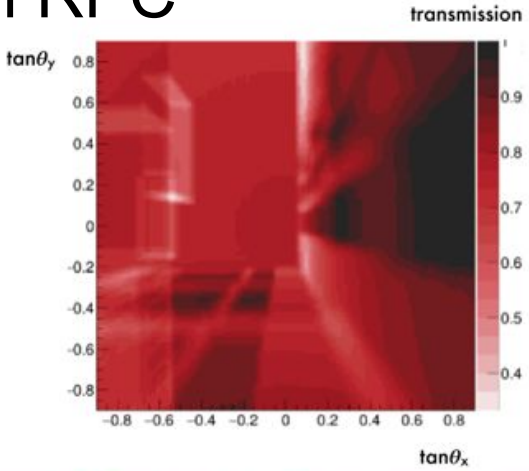
Outdoor Systems Performance and Upgrade

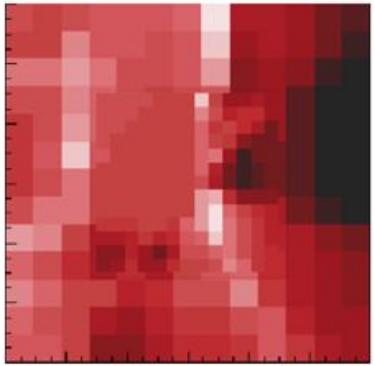
L. Lopes[a], S. Andringa[b], P. Assis[b,c], A. Blanco[a], N. Carolino[a], M. A. Cerda[g], F. Clemêncio[d], R. Conceição[b,c], O. Cunha[a], C. Dobrigkeit[f], M. Ferreira[b], C. Loureiro[e], L. Mendes[b], J. C. Nogueira[b], A. Pereira[a], M. Pimenta[b,c], J. Saraiva[a], R. Sarmento[b], P. Teixeira[h], B. Tomé[b,c]

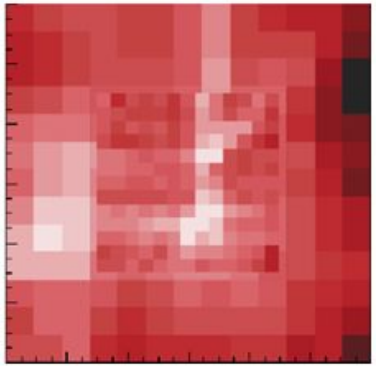
Long term experience in Autonomous Stations and production quality control

L. Lopes,[b,1] A.B. Alves,[f] P. Assis,[a,h] A. Blanco,[b] N. Carolino,[b] M.A. Cerda,[c,e] R. Conceição,[a,h] O. Cunha,[b] C. Dobrigkeit,[g] M. Ferreira,[a] P. Fonte,[b,d] L. de Almeida,[f] R. Luz,[a,h] V.B. Martins,[f] L. Mendes,[a] J.C. Nogueira,[a] A. Pereira,[b] M. Pimenta,[a,h] R. Sarmento,[a] V. de Souza[f] and B. Tomé[a,h]

Transmission tomography with RPC







Muon tomography with Resistive Plate Chambers for geological characterization

Raul Sarmento [a,*], Alberto Blanco Castro [c], Bento Caldeira [g], Bernardo Tomé [b], Custódio Loureiro [f], Filomena Clemêncio [e], Isabel Alexandre [b], João Costa [i], João Matos [h], João Saraiva [c], Jorge Silva [c], José Borges [g], Lorenzo Cazon [d], Luis Afonso [b], Luís Lopes [c], Magda Duarte [a], Marco Pinto [b], Mário Pimenta [b], Mourad Bezzeghoud [g], Paolo Dobrilla [c], Pedro Assis [b], Pedro Teixeira [g], Rui Oliveira [g], Sofia Andringa [b], Vanessa Pais [i]

Muon scattering tomography with RPC

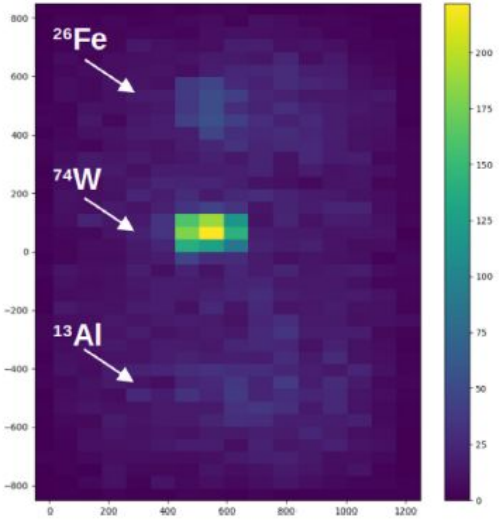


Table 1
Four-plane telescope properties.

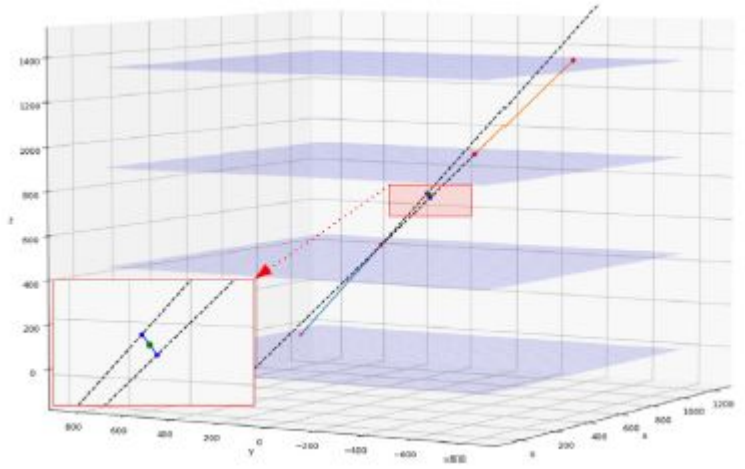
Time resolution (σ_t)	300 ps < σ_t < 400 ps
Spatial Resolution ($\sigma_{x,y}$)	σ_x: 0.85 cm, σ_y: 1.6 cm
Angular Resolution ($\sigma_{\theta_x,\theta_y}$)	σ_{θ_x}: 1.5°, σ_{θ_y}: 2.9°
Angular Acceptance (Ω)	0.5π sr < Ω < 0.7π sr
Efficiency (ϵ)[a]	ϵ > 98%

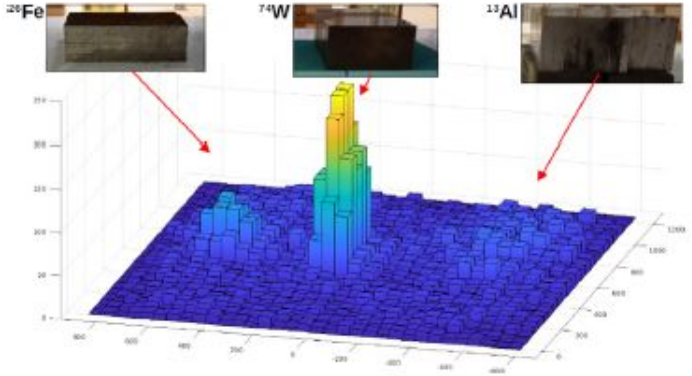
[a]With a Reduced electric field of 235 Td.

A large-area MRPC detector for muon scattering tomography

J. Saraiva[a,*], C. Alemparte[b], D. Belver[b], A. Blanco[a], J. Callón[b], J. Collazo[b], A. Iglesias[b], L. Lopes[a]

[a] LIP - Laboratory of Instrumentation and Experimental Particle Physics, 3004-516 Coimbra, Portugal
[b] Hidronav Technologies SL, 36202 Vigo, Pontevedra, Spain





Fine position

- Thin strips
- Pitch - 2.54 mm
- 30cm x 30cm
- 120 strips

Signal Merging PCB

- Thin strips
- Pitch - 2.54 mm
- 30cm x 30cm
- 120 strips
- Grouped by 24
- 24 FEE channels

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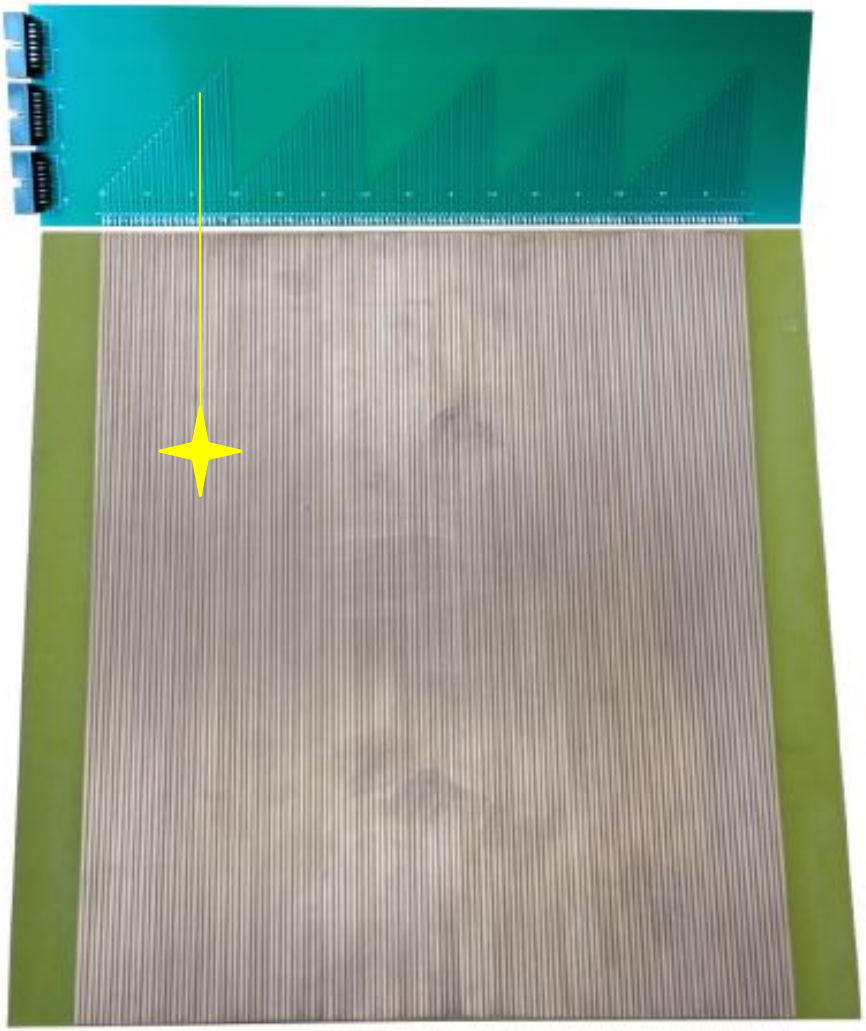


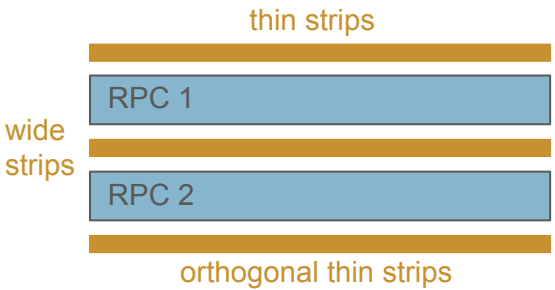
Signal Merging PCB

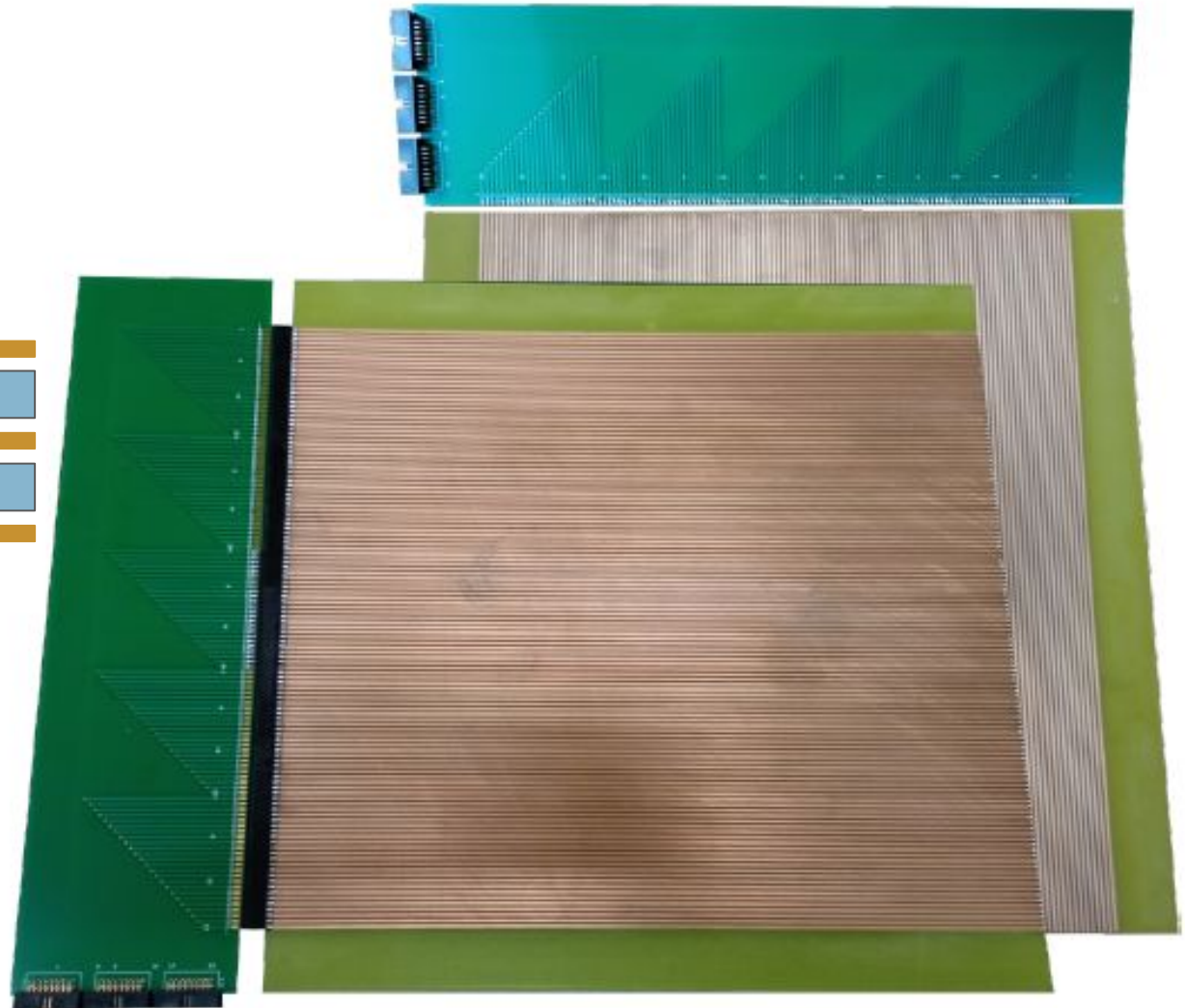
- Thin strips
- Pitch - 2.54 mm
- 30cm x 30cm
- 120 strips
- Grouped by 24
- 24 FEE channels

Coarse position

- Wide strips
- Pitch - 61.0 mm
- 5 strips
- 5 channels

XY position





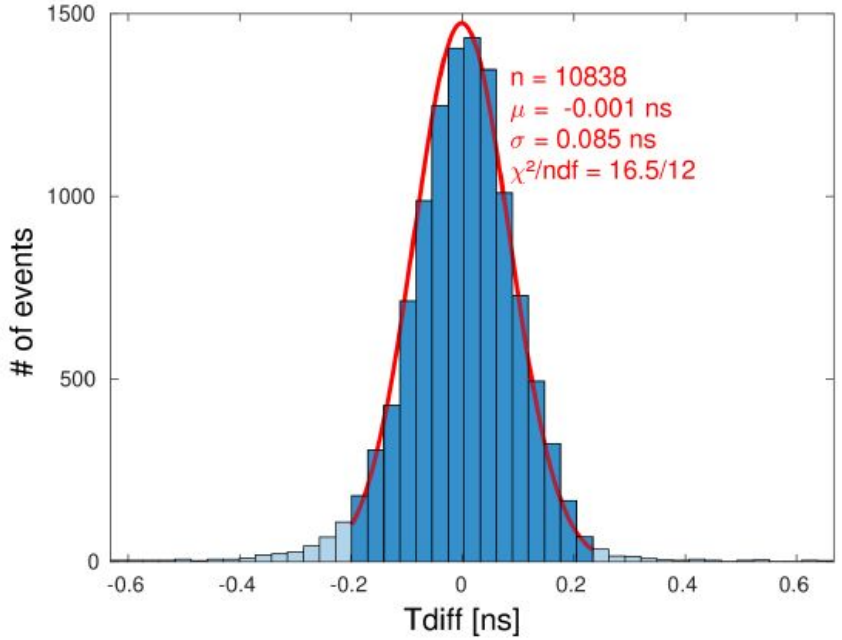
Position and Timing

New readout codification of large-area multi-gap timing RPCs for Muon Scattering Tomography

João Saraiva *, Alberto Blanco

LIP, Laboratory of Instrumentation and Experimental Particle Physics, Portugal

Timing



Position

New readout codification of large-area multi-gap timing RPCs for Muon Scattering Tomography

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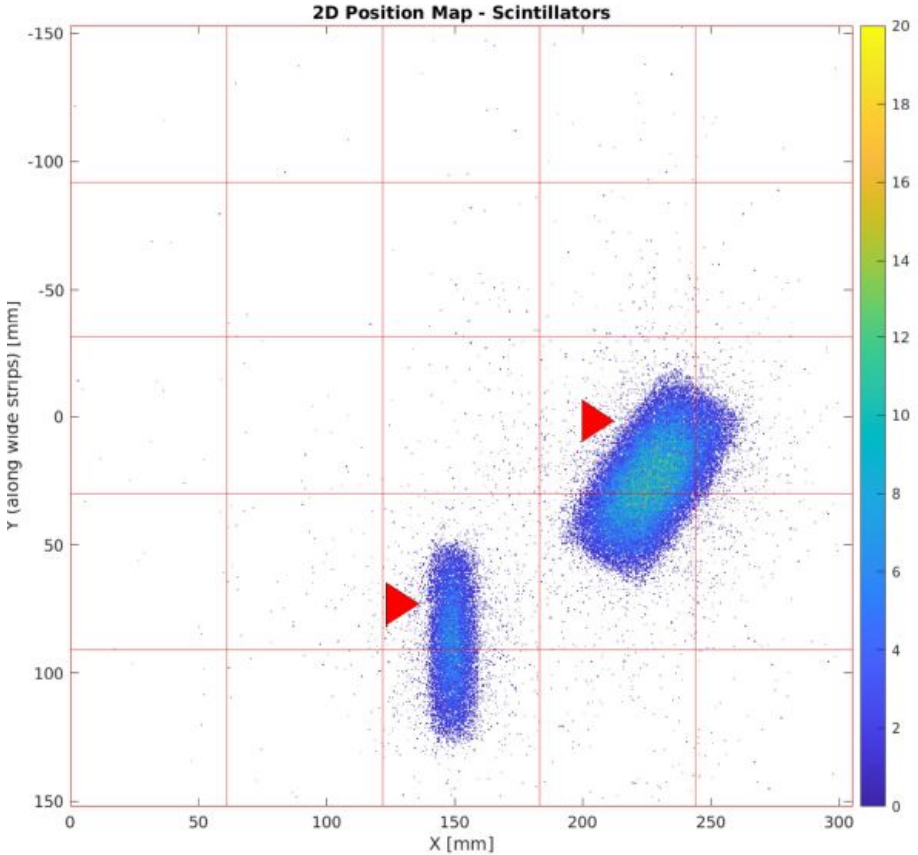
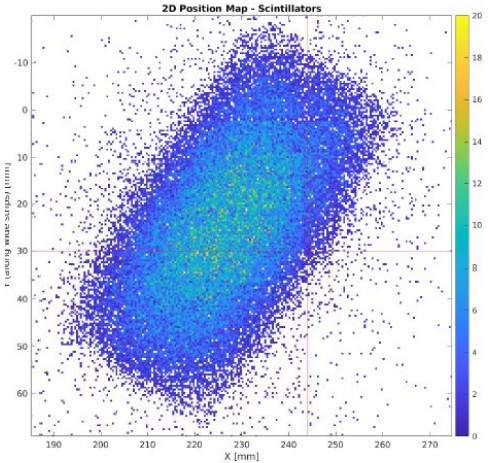
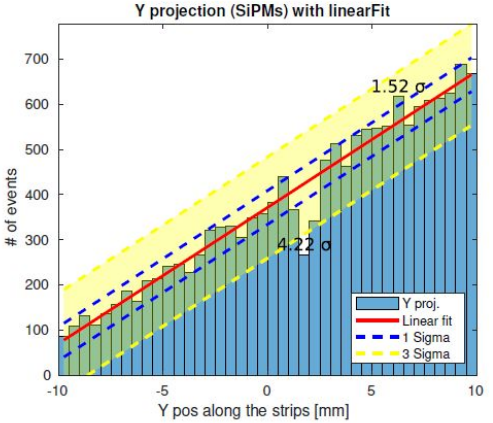


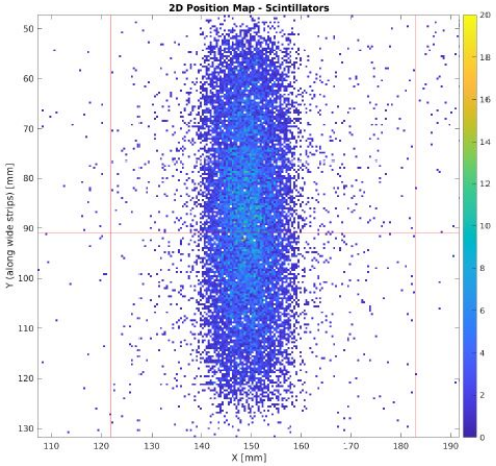
Position



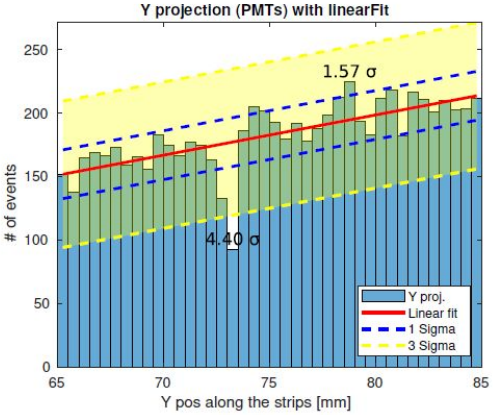
Close-up view of the 2D map



Projection onto the Y-axis

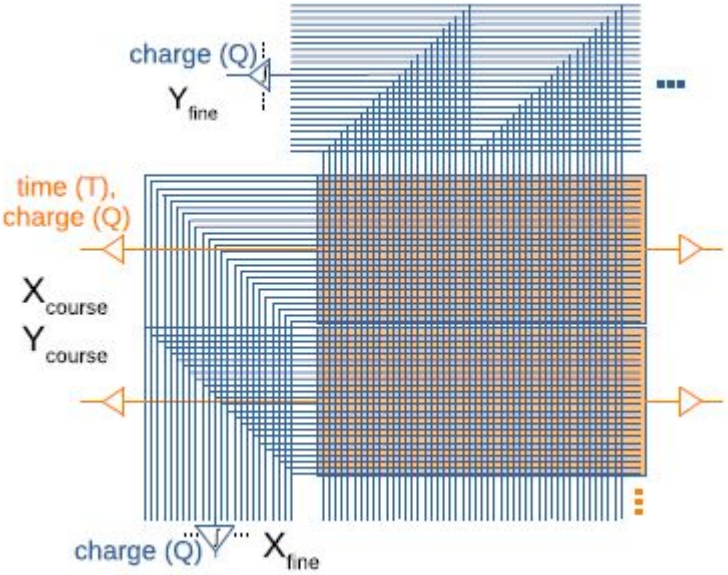


Close-up view of the 2D map



Projection onto the Y-axis

Scaling



New readout scheme for large area timing & position RPCs

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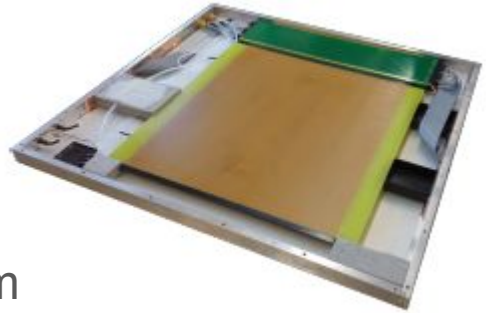
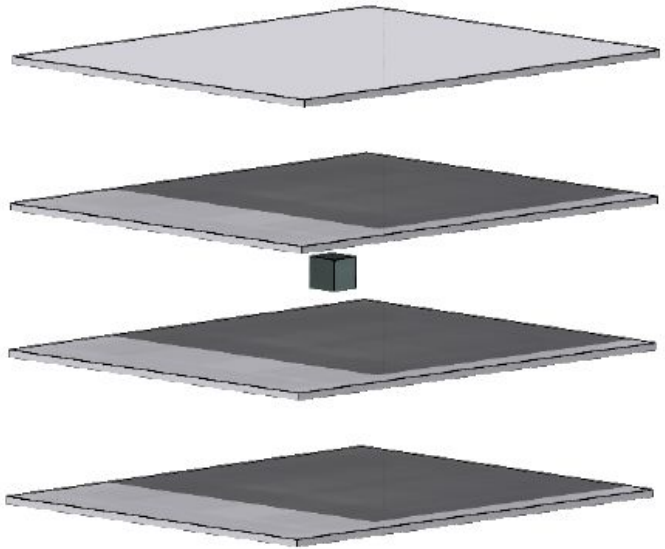
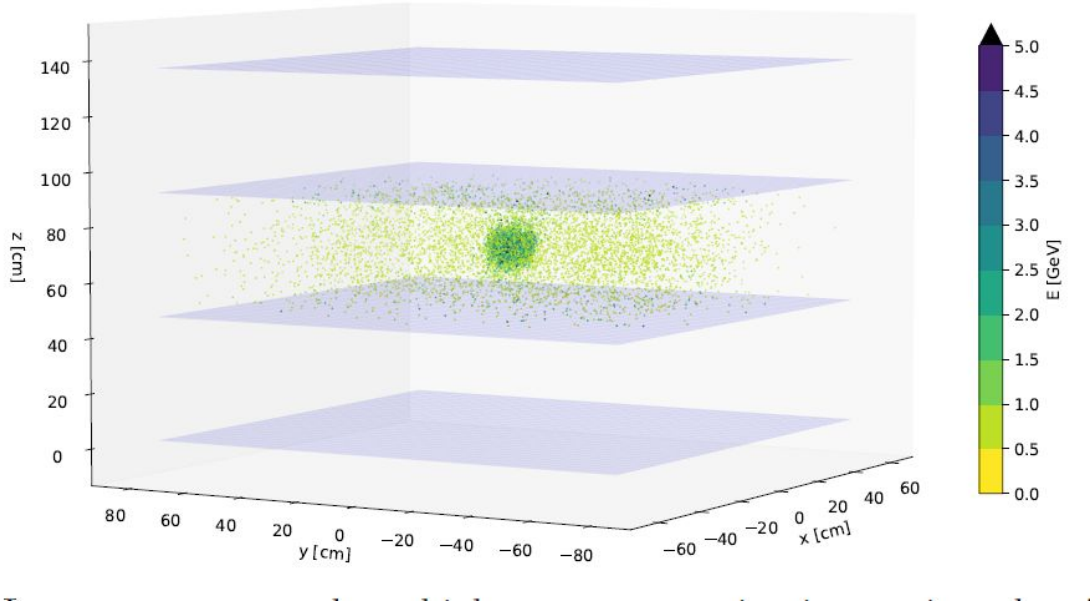


Small area - 30x30cm

Large area -130x90cm

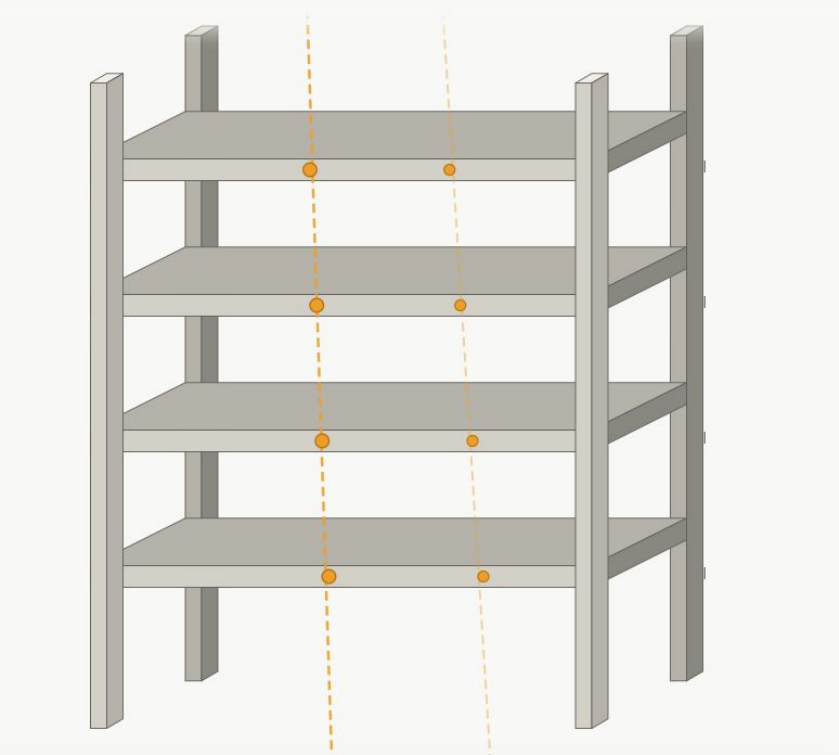
Simulation

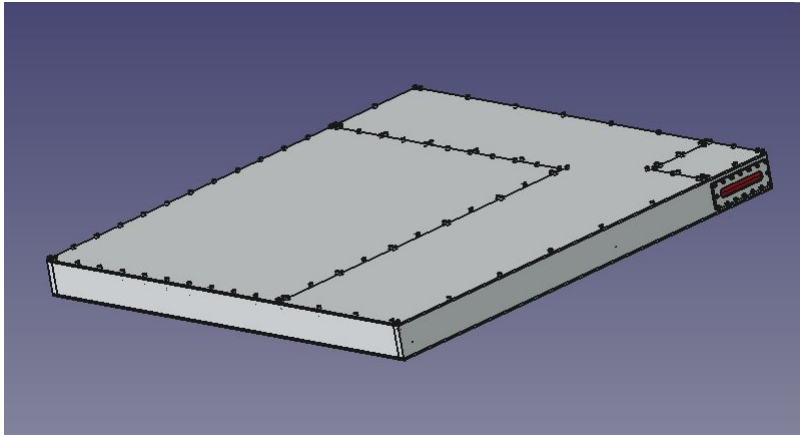



140
120
100
80
60
40
20
0
z [cm]
80
60
40
20
0
−20
−40
−60
−80
y [cm]
−60
−40
−20
0
20
40
60
x [cm]
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
E [GeV]

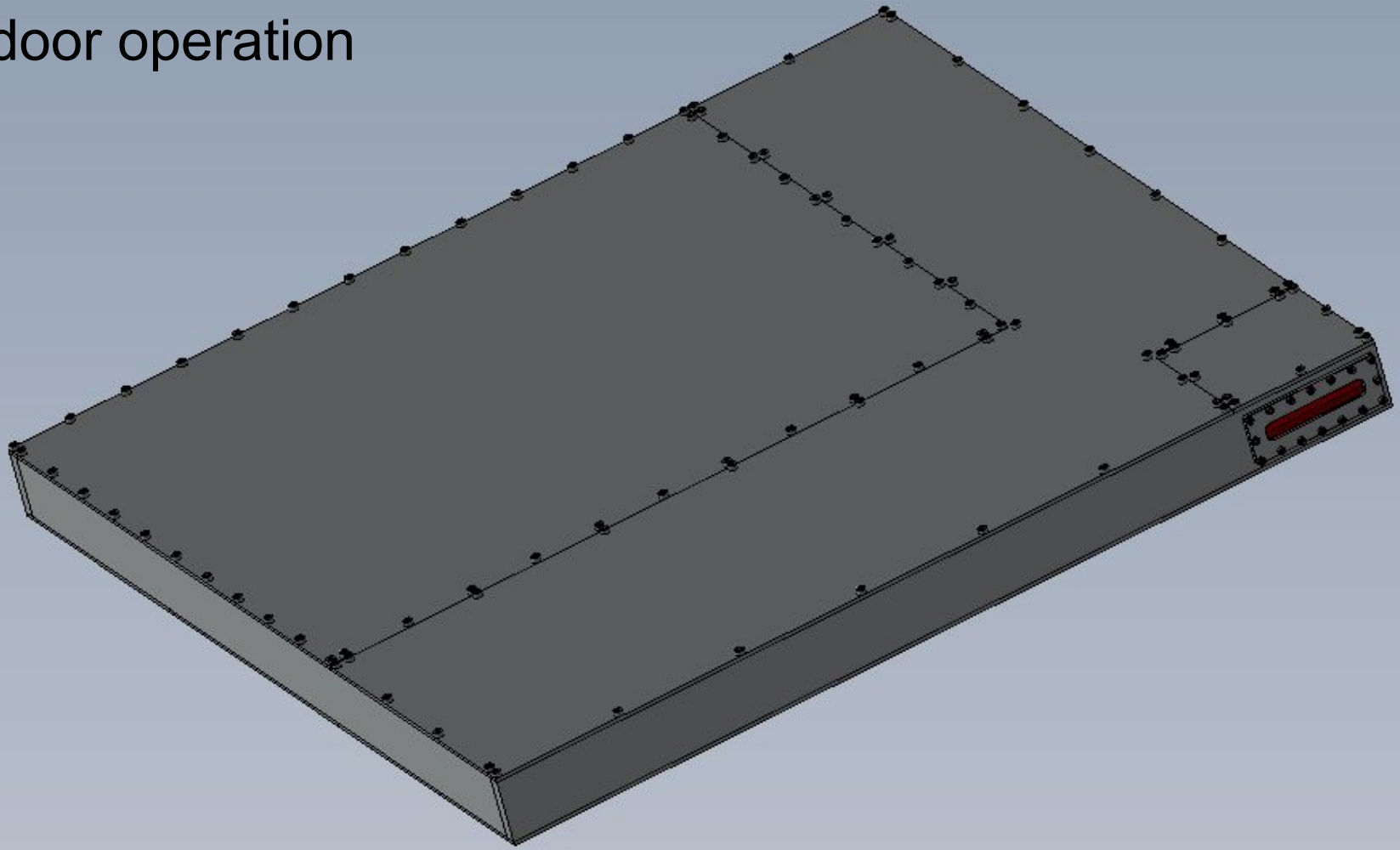
TOMografia Aplicada com RPCs

Applied Muon Tomography with RPCs

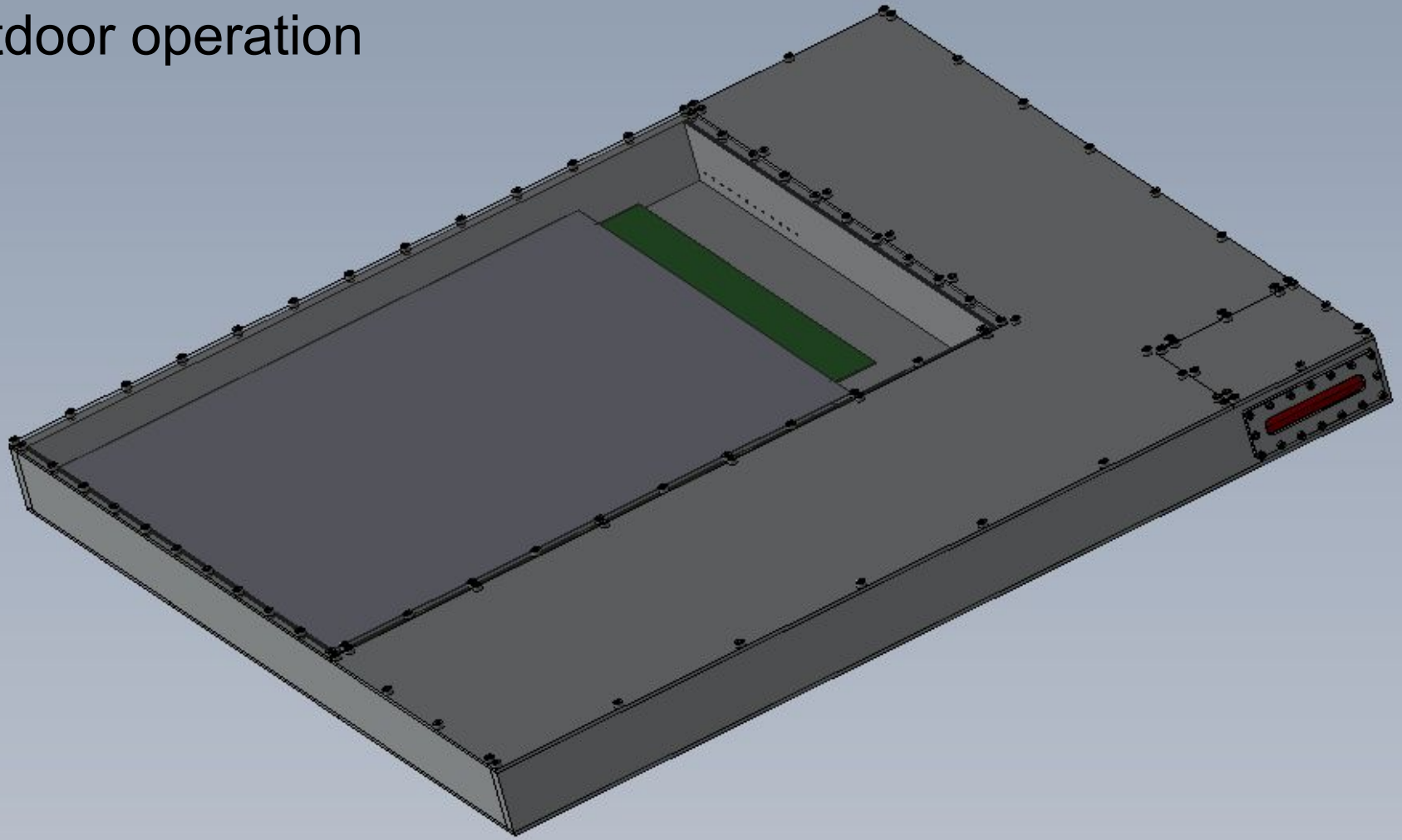




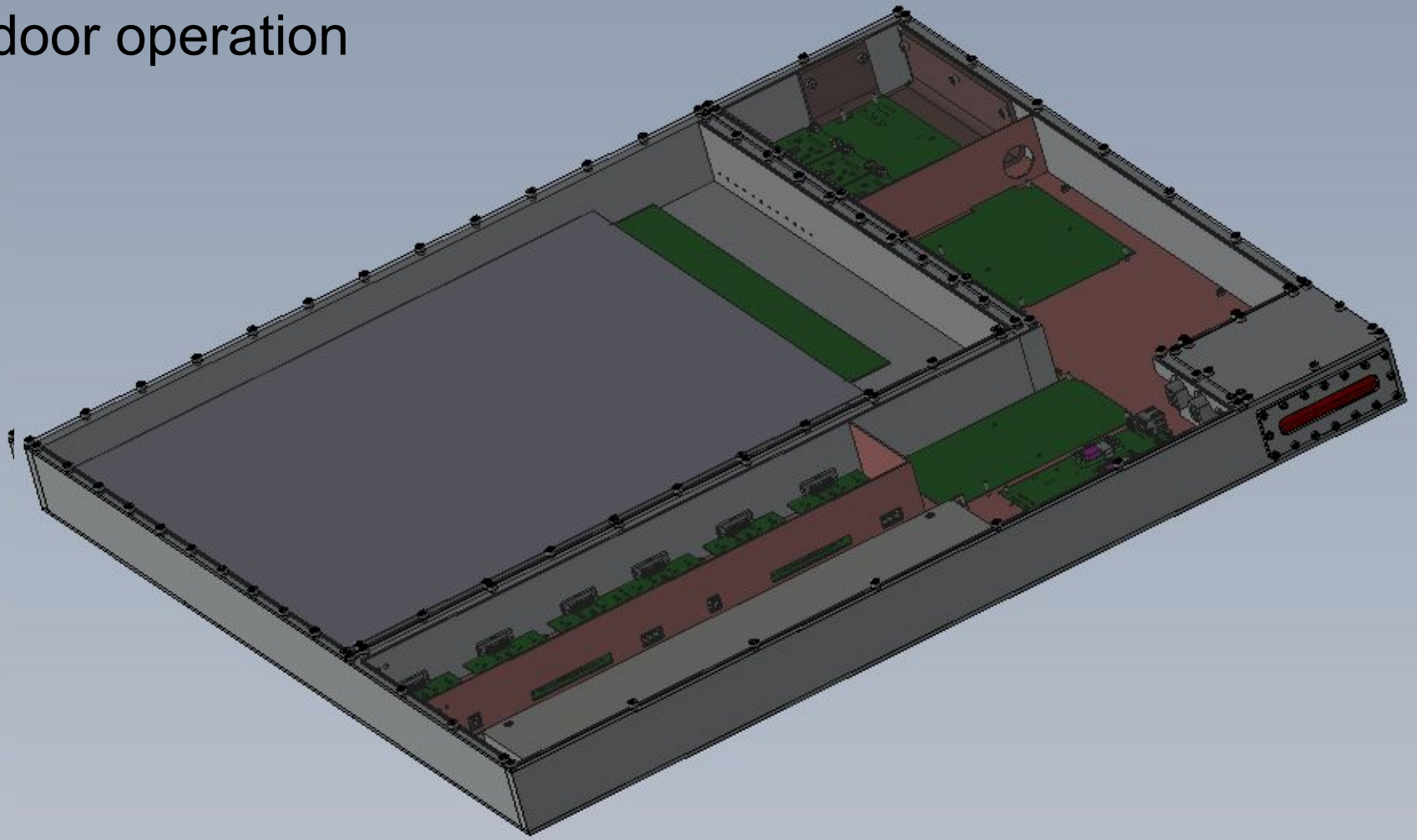
Outdoor operation



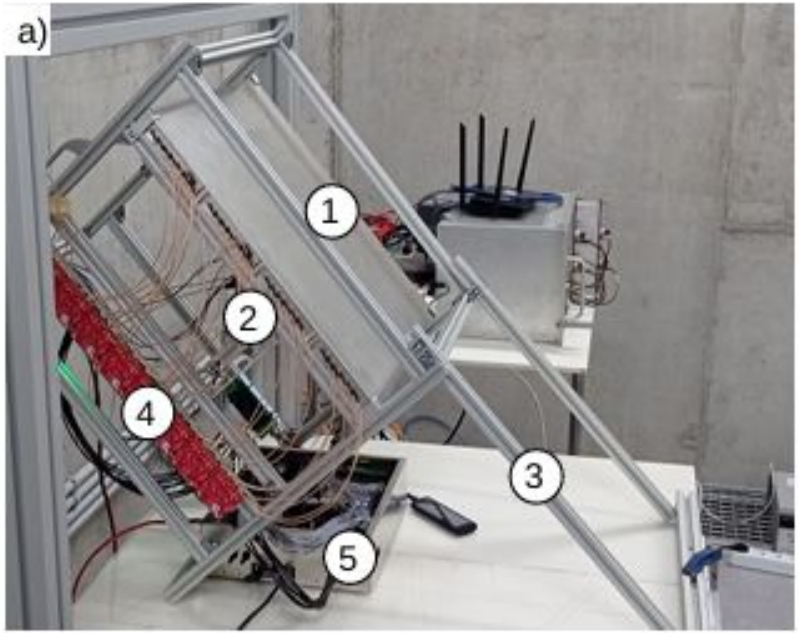
Outdoor operation

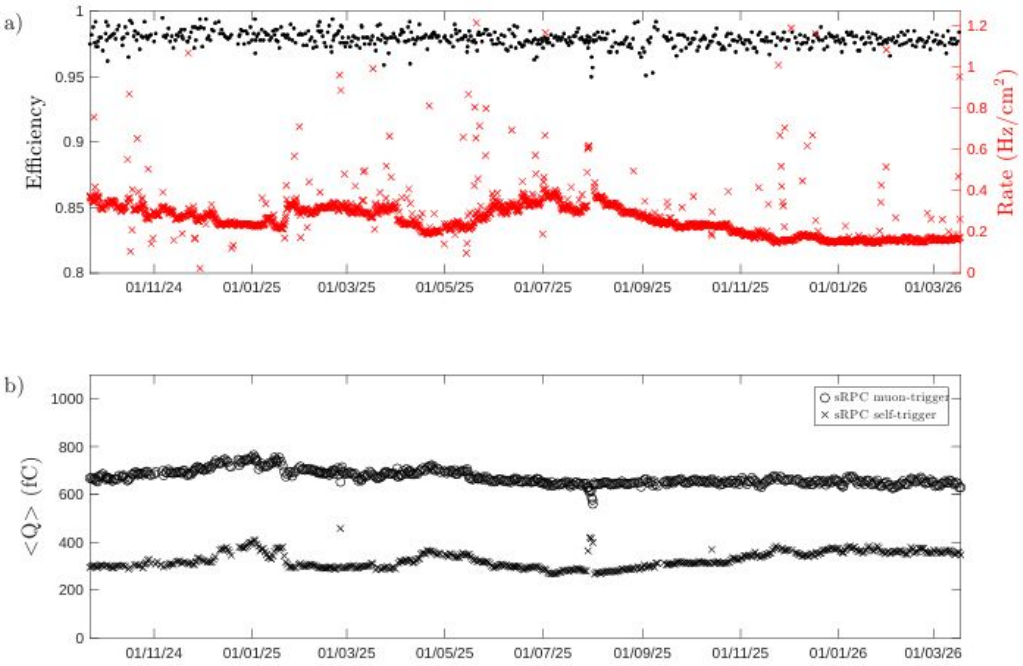


Outdoor operation



Outdoor operation - sealed RPC?





Thank you for your attention!