Muon Tomography

Muography at the University of Coimbra and at the Lousal Mine

9th July 2022, Jornadas Científicas LIP

Magda Duarte on behalf of the LouMu collaboration

LABORATÓRIO DE INSTRUMENTAÇÃO E FÍSICA EXPERIMENTAL DE PARTÍCULAS
partículas e tecnologia
LIP

UNIVERSIDADE DE ÉVORA

Centro Ciência Viva do Lousal
Mina de Ciência

ICT · Instituto de Ciências da Terra · Institute of Earth Sciences

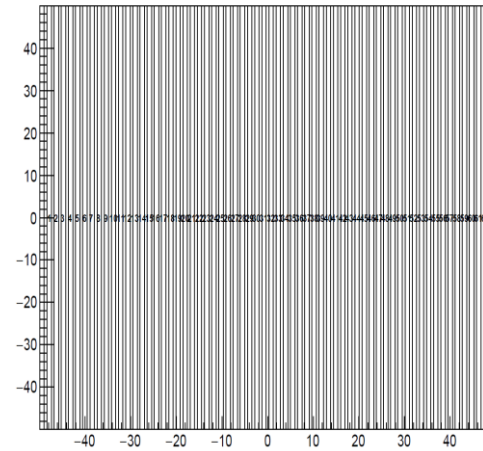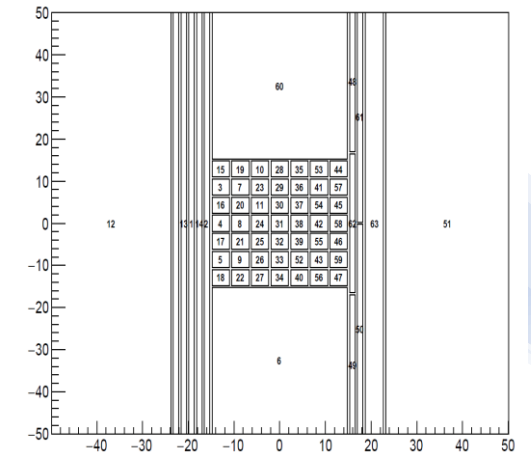LNEG

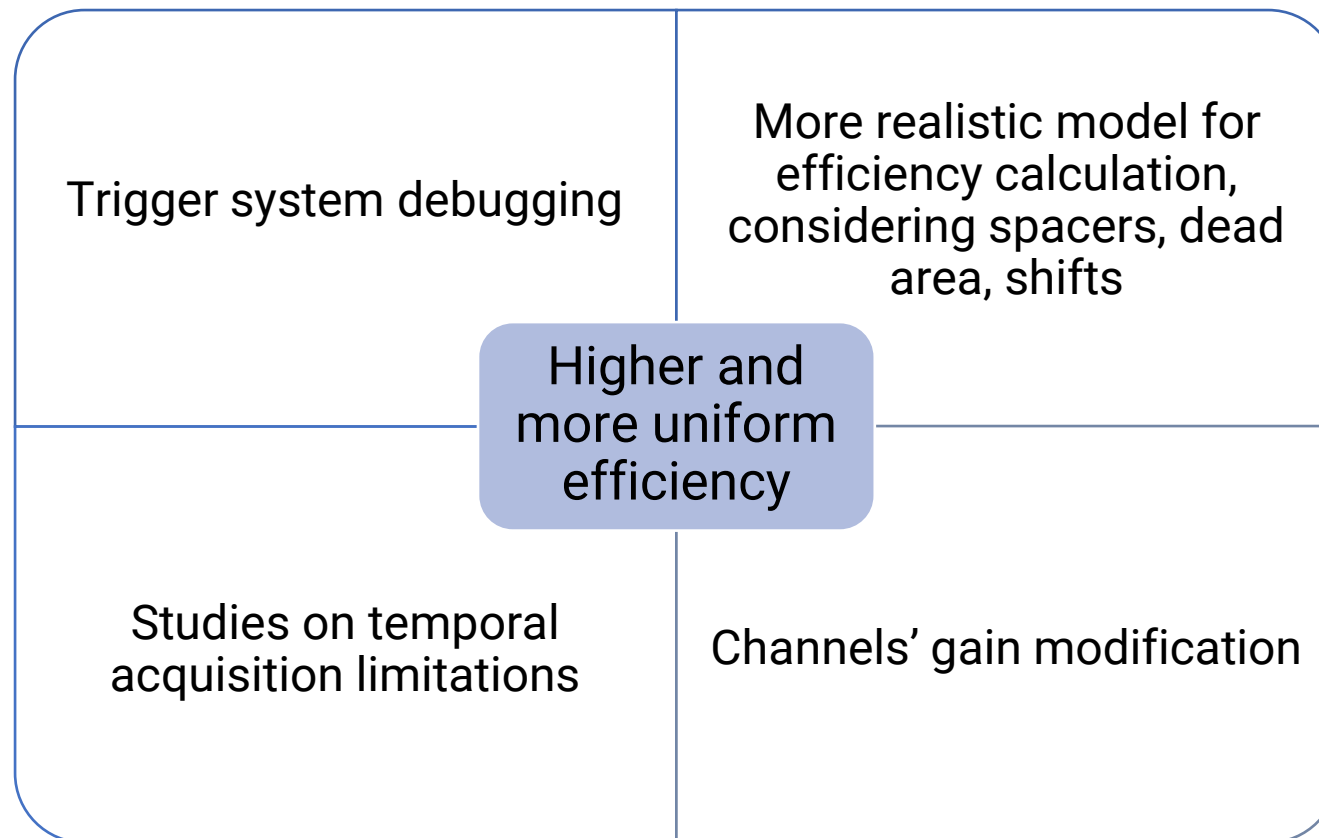FCT Fundação para a Ciência e a Tecnologia

REPÚBLICA PORTUGUESA

Detector

Plane 0

Planes 1, 2 e 3

Detector
Developments

Trigger system debugging

More realistic model for efficiency calculation, considering spacers, dead area, shifts

Higher and more uniform efficiency

Studies on temporal acquisition limitations
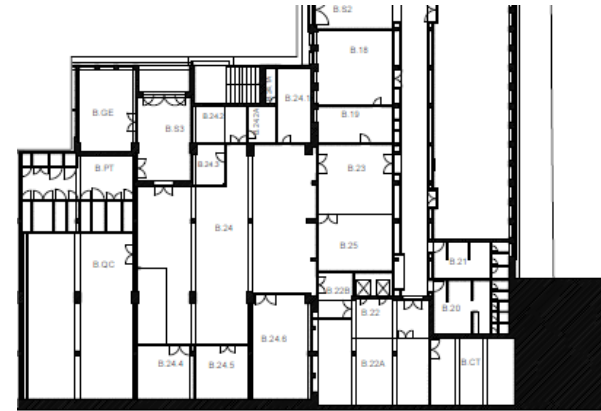
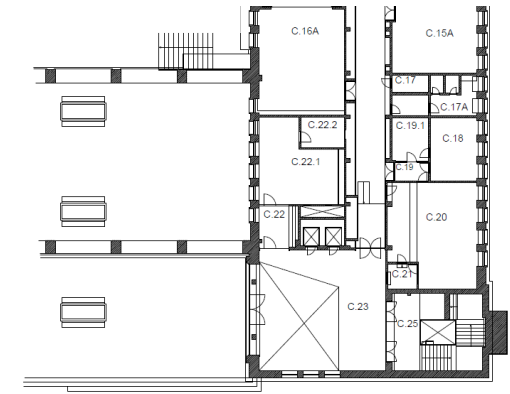Channels' gain modification

Goal

Actions

Muography at the university

Basement

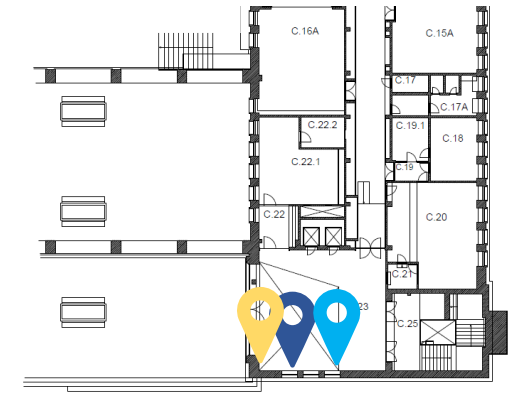Ground floor

4

Muography at the university

Basement
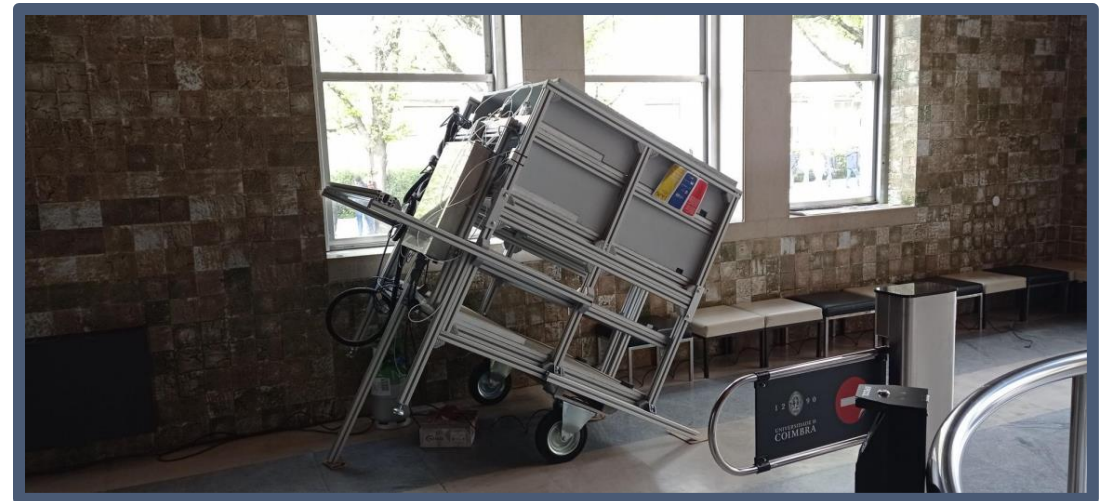

Ground floor

5

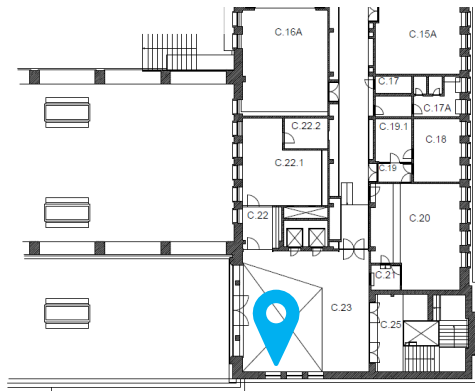# Muography at the university

Tilted by 15°

Tilted by 28.5°

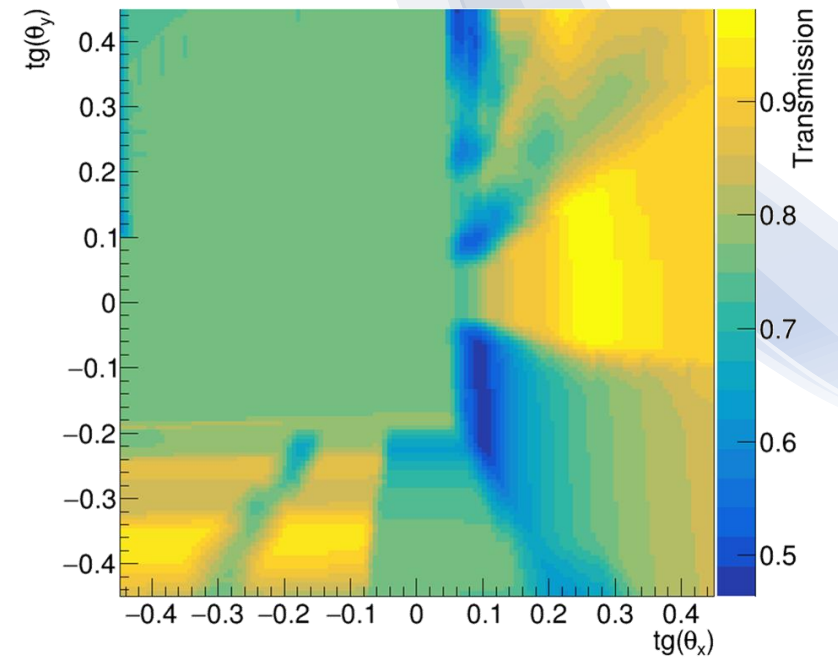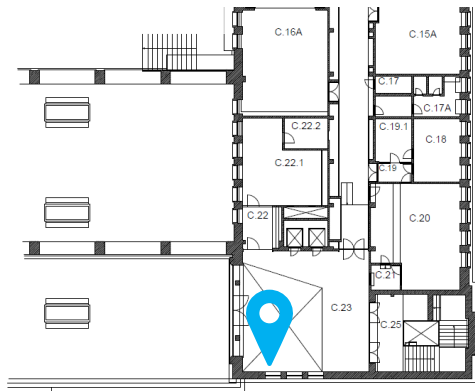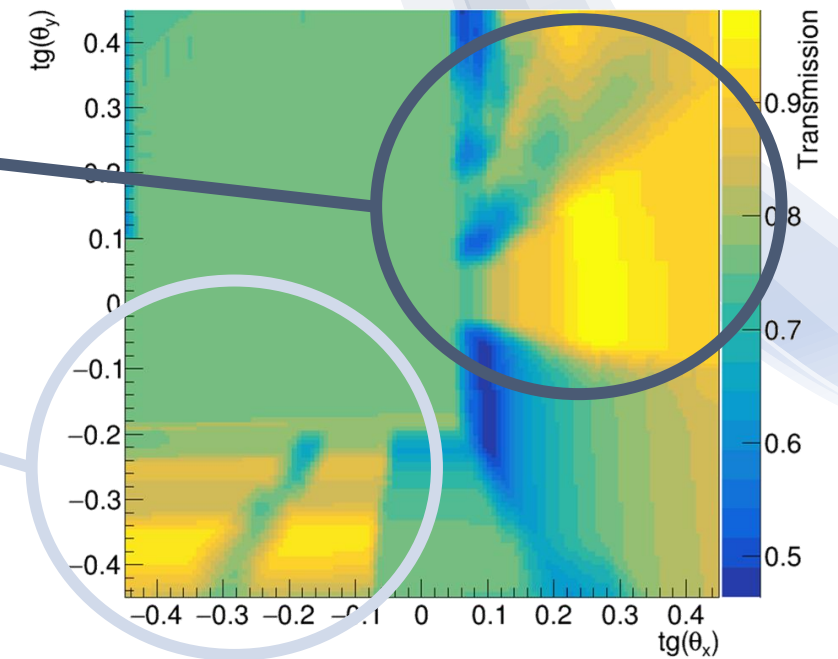# Muography at the university
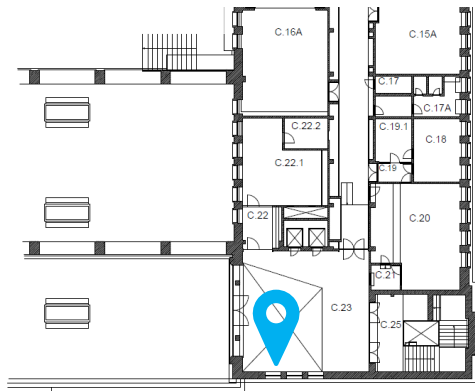## Simulation

Ground floor

Theoretical transmission

Muography at the university
Simulation

Ground floor

Theoretical transmission

Muography at the university
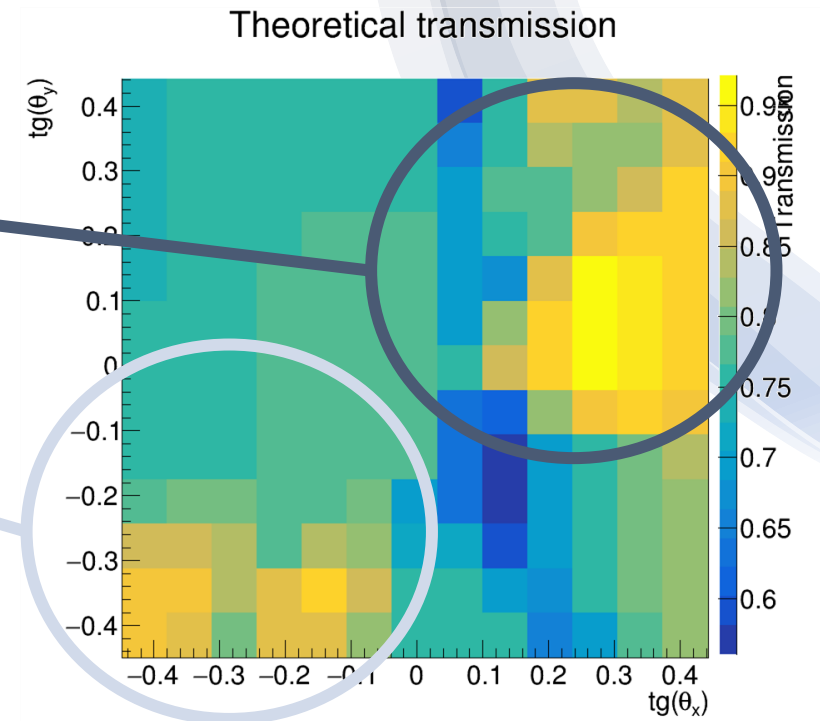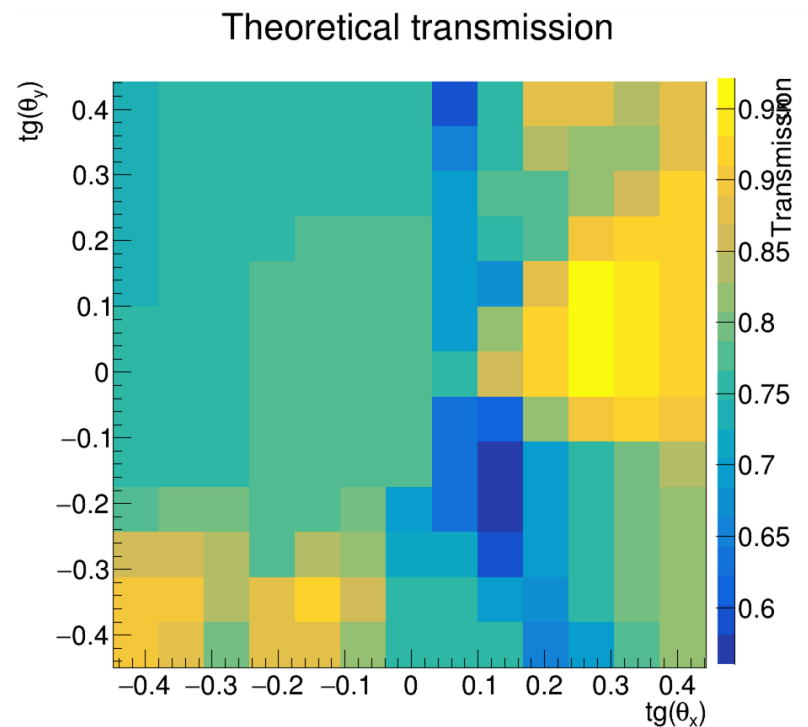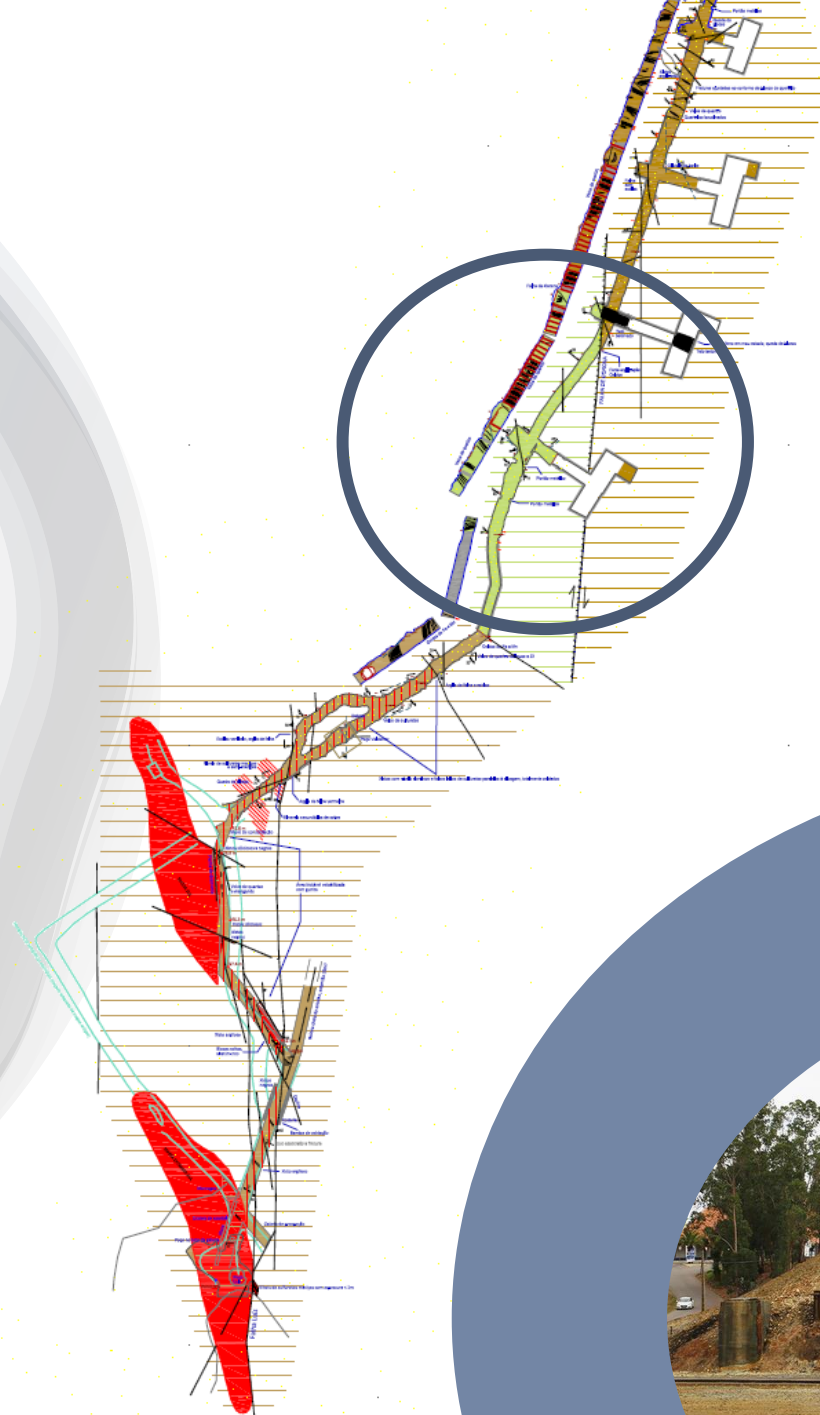## Simulation

Ground floor

Theoretical transmission

Muography at the university
Results

Theoretical transmission

Experimental transmission
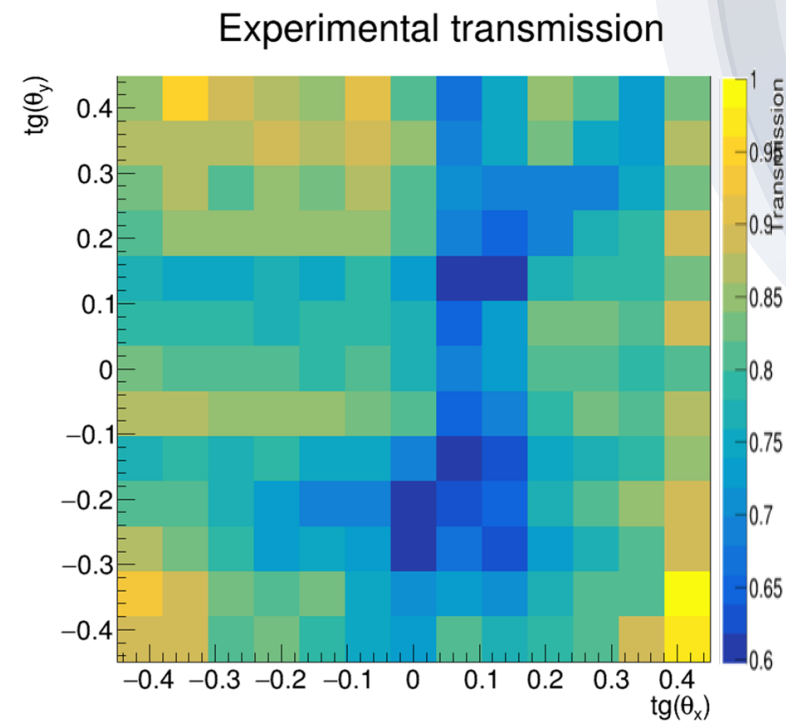
More muographies of the university can be found in the poster

Muography at the Lousal Mine

Muography
at the
Lousal Mine

Muography at the Lousal Mine
Field work

- LIDAR scans

- Photogrammetry

- Rock sampling

- Differential GPS

- Seismic refraction

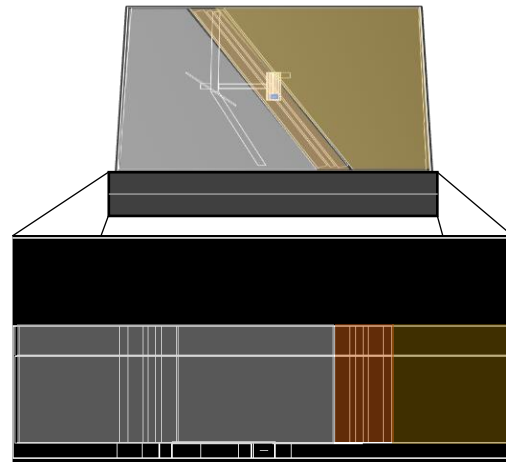- Ground penetrating radar

Muography at the Lousal Mine
Field work

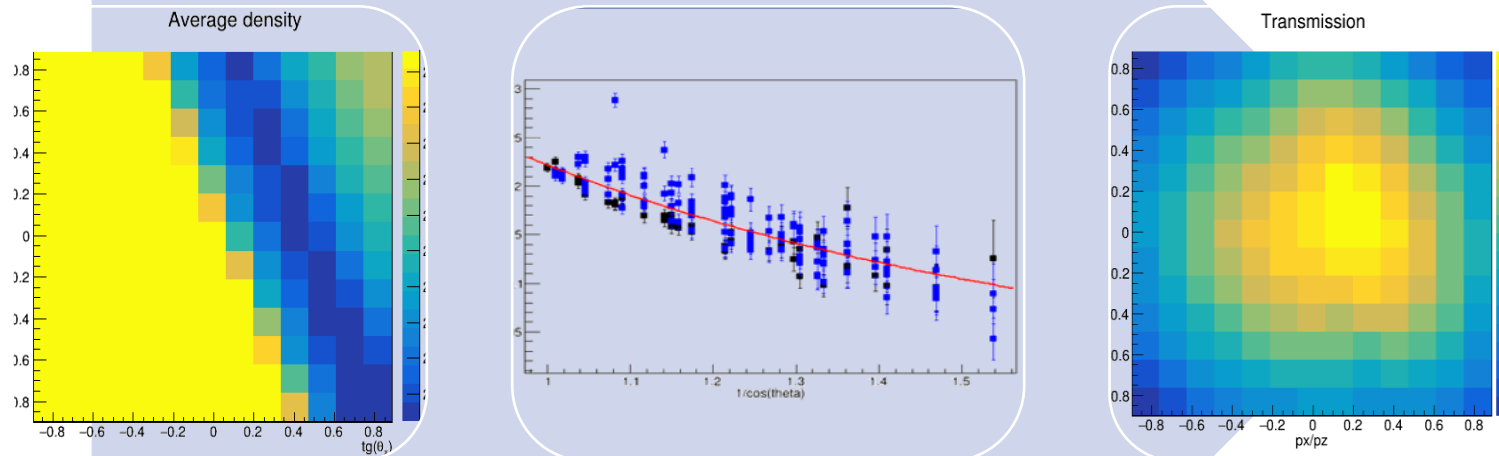# Muography at the Lousal Mine
Changes in strategy

GEANT4

More realistic detector model

Glass - 2mm	
Gas - 1mm	
Glass - 2mm	
Gas - 1mm	
Glass - 2mm	

Muography at the Lousal Mine
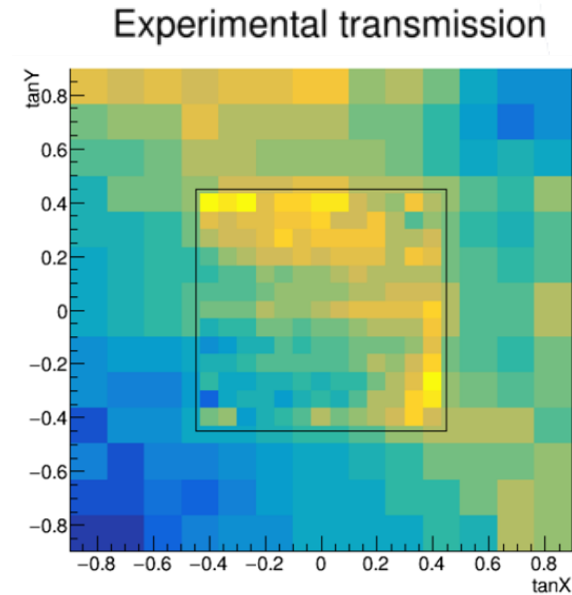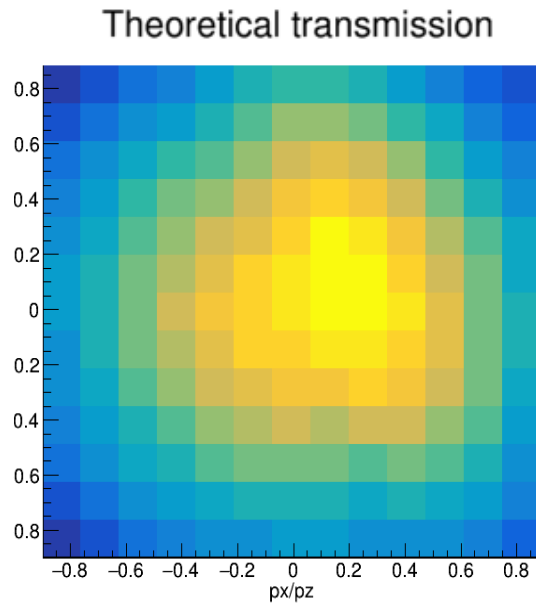## Changes in strategy

Transmission $\propto e^{-\frac{h}{\cos\theta}\times\frac{density}{\lambda}}$

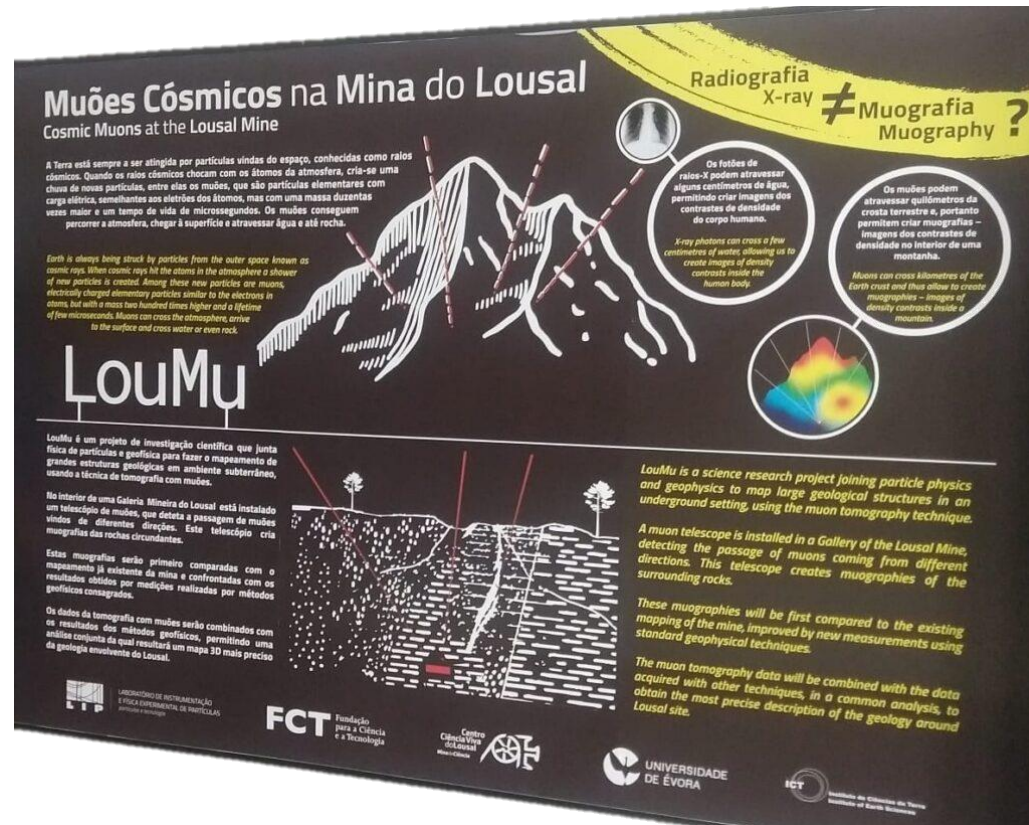# Muography at the Lousal Mine
First results

Theoretical transmission

Experimental transmission

Muography at the Lousal Mine
Outreach

Future work on…

Combining several muographies of different positions/perspectives for:

- 3D reconstruction
- Higher resolution

Understanding the Lousal mine results

- Work on the density to transmission model

Acknowledgements

Instrumentation and Particle Physics group:

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Outreach team:

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João Costa, Vanessa Pais

Collaborators:

Any questions?

Thank you

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https://pages.lip.pt/loumu/

Backup slides

Detector's efficiency

$$\epsilon_2\left[i\right] = \frac{N123\left[i\right]}{N13\left[i\right]}$$

Detector's efficiency

$$\epsilon_k [i] = \frac{N k l m [i]}{G_k N l m [i]}$$

Detector's efficiency

0.3 cm

3.8 cm

3.8 cm

0.1 cm

15	19	10	28	35	53	44
3	7	23	29	36	41	57
16	20	11	30	37	54	45
4	8	24	31	38	42	58
17	21	25	32	39	55	46
5	9	26	33	52	43	59
18	22	27	34	40	56	47

Detector's efficiency

Plane 2 efficiency
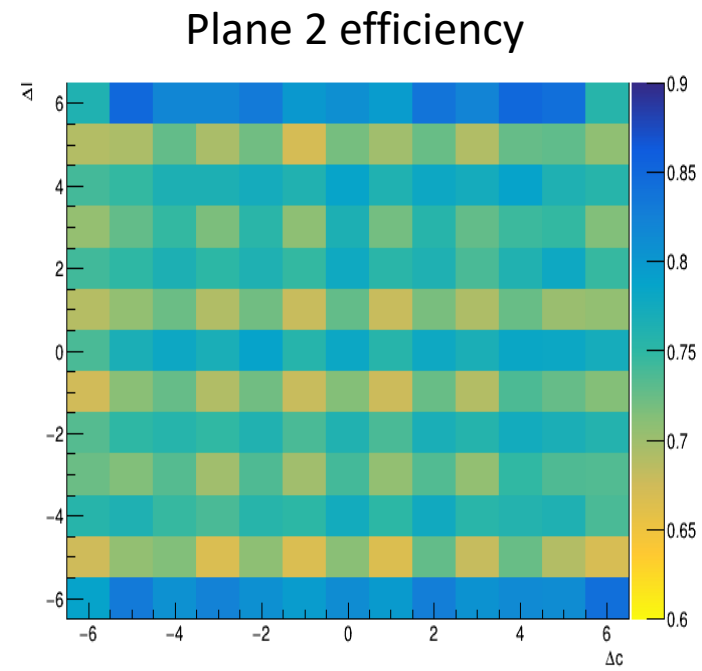
Dettector's efficiency
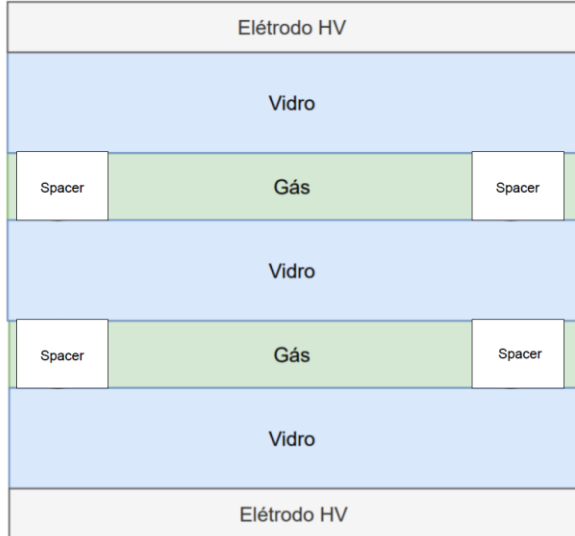
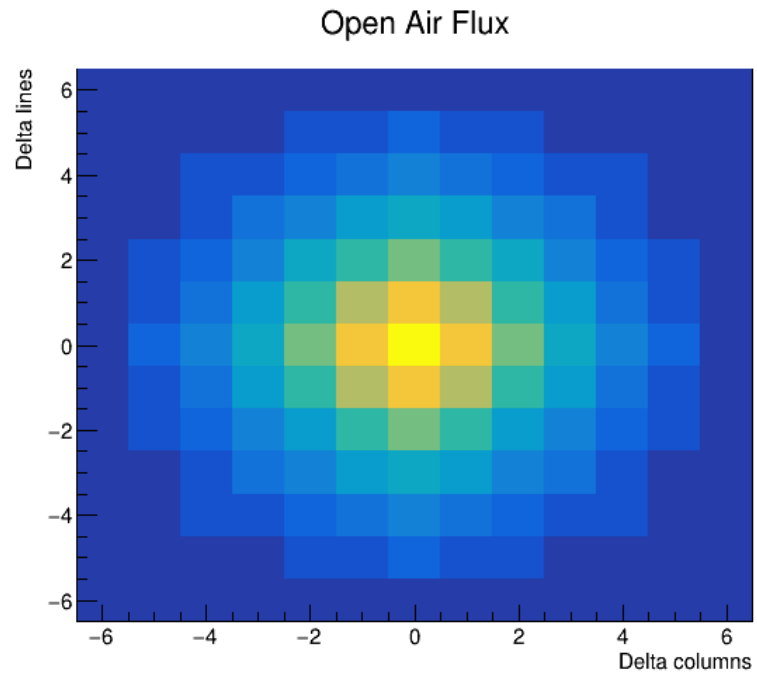Plane 2 efficiency (muons that travel between columns in plane 2)
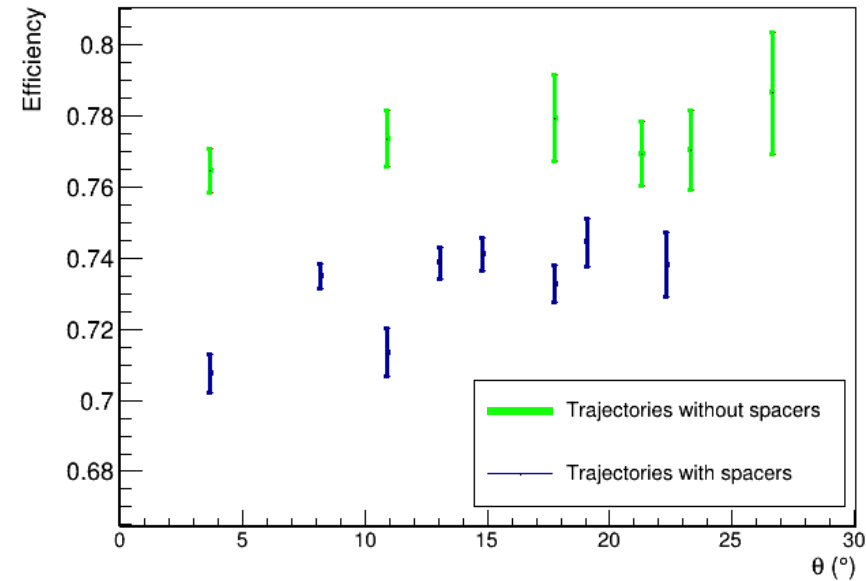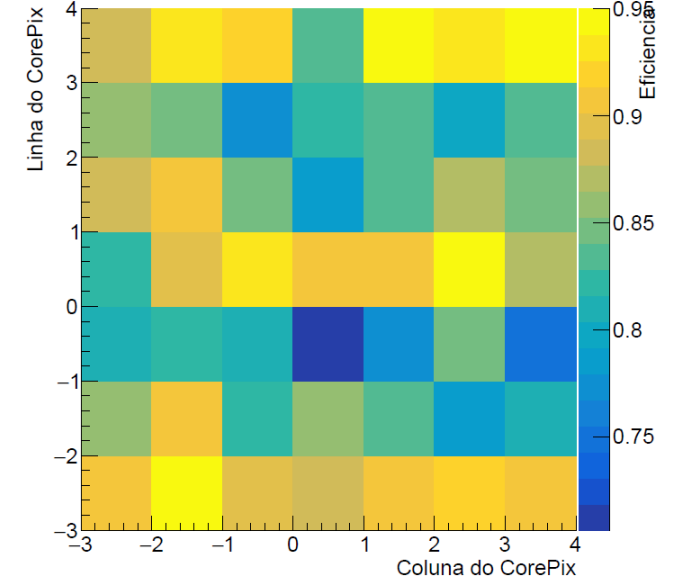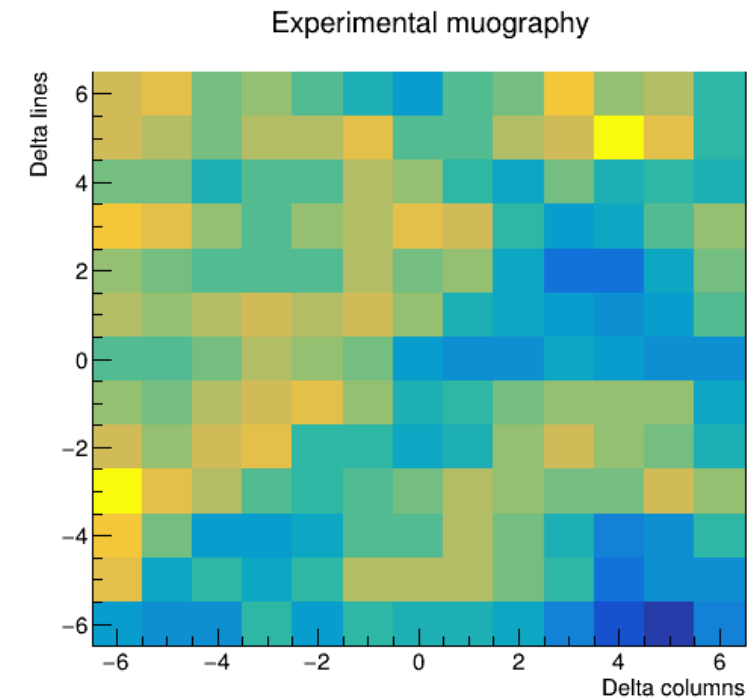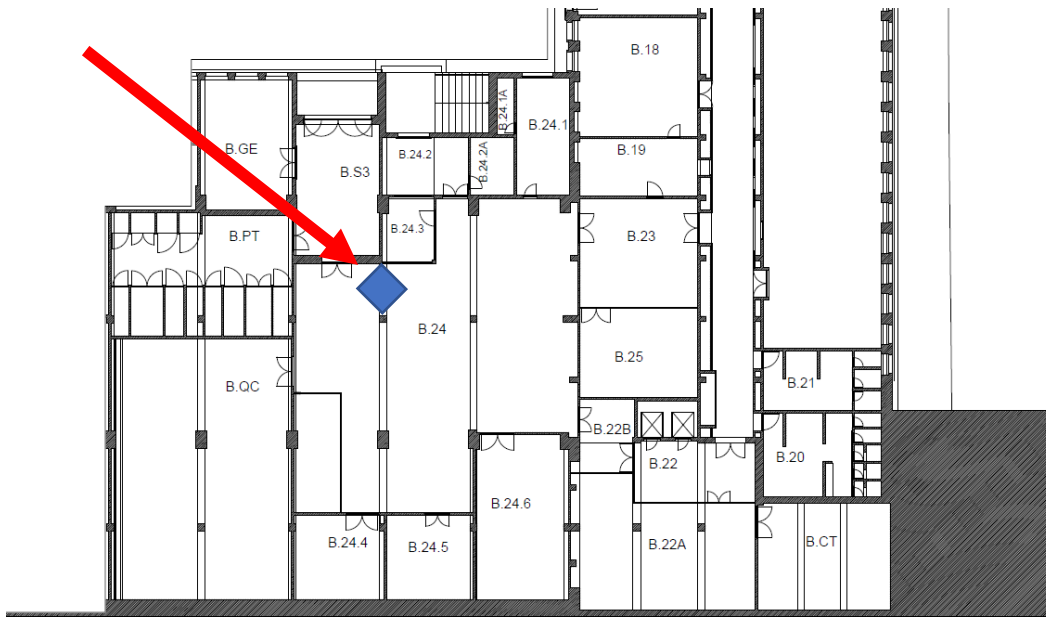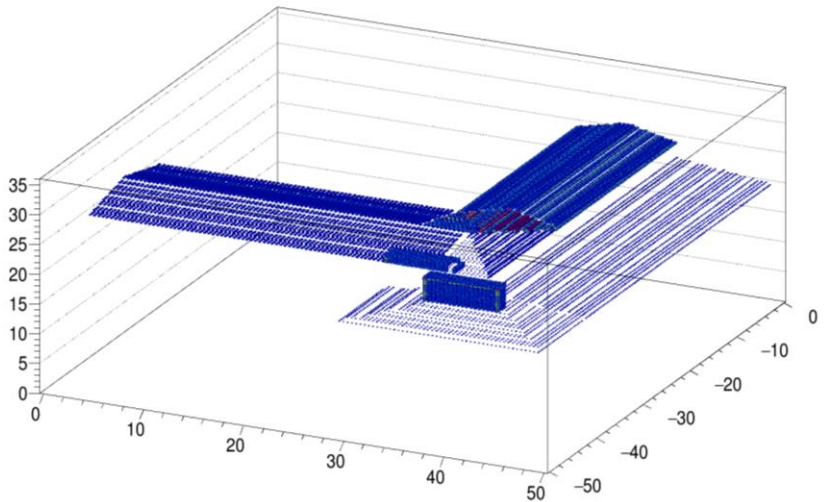
Simulation
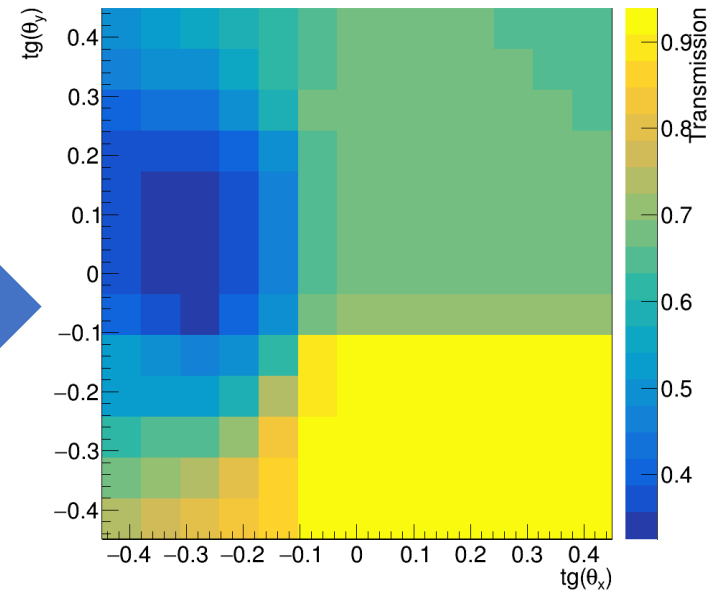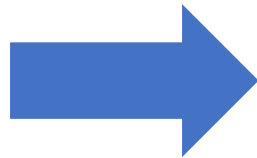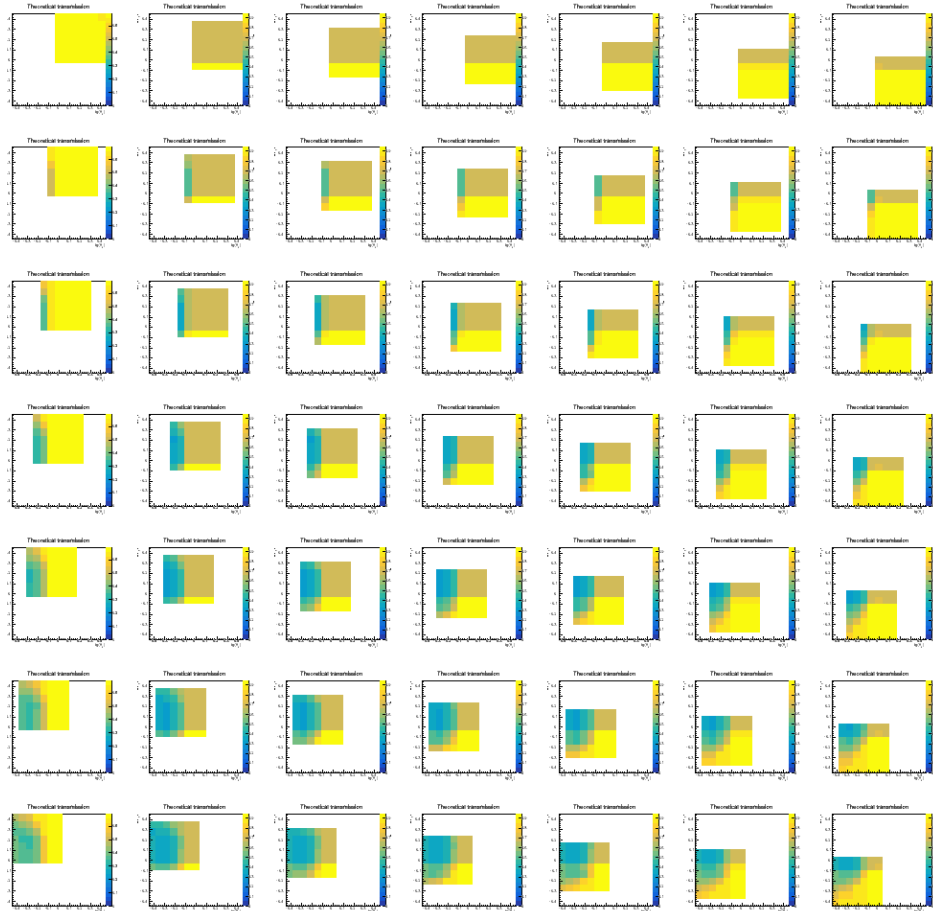
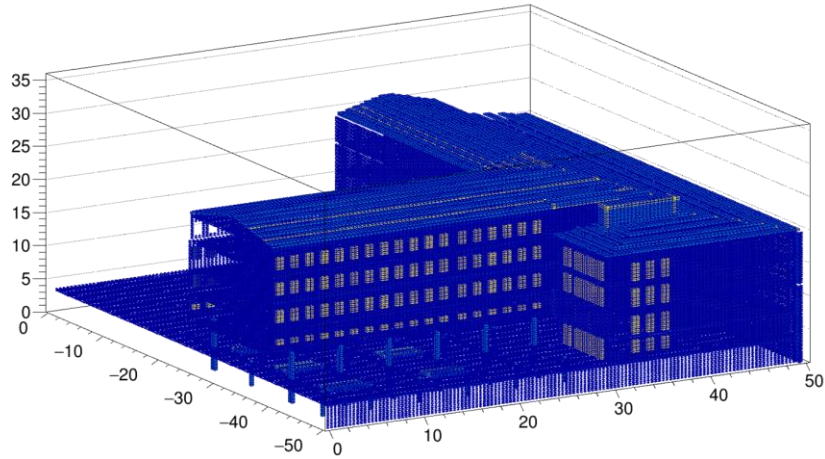# Data treatment

Open Air Flux

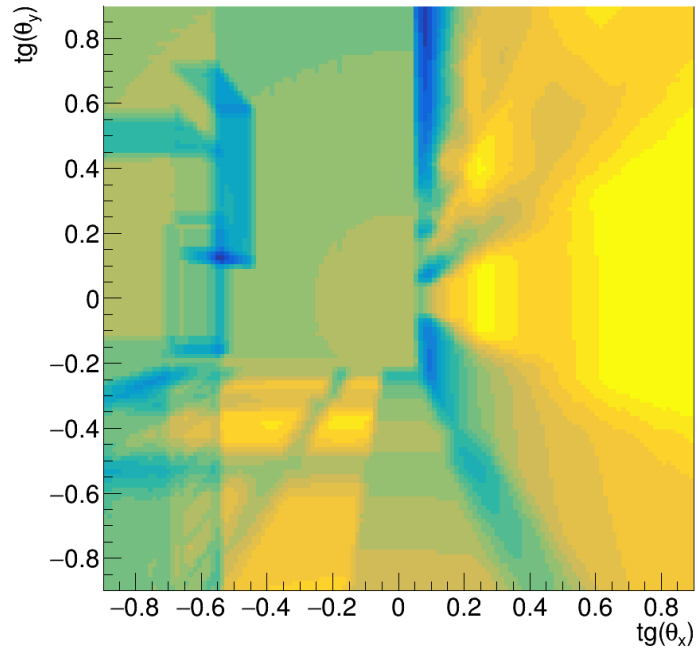Transmission = measured muon rate x efficiency correction / open air flux

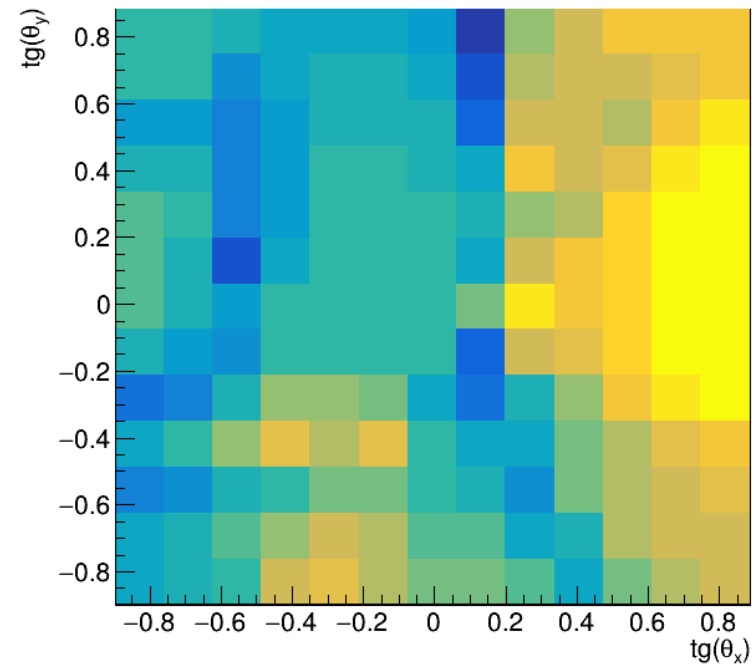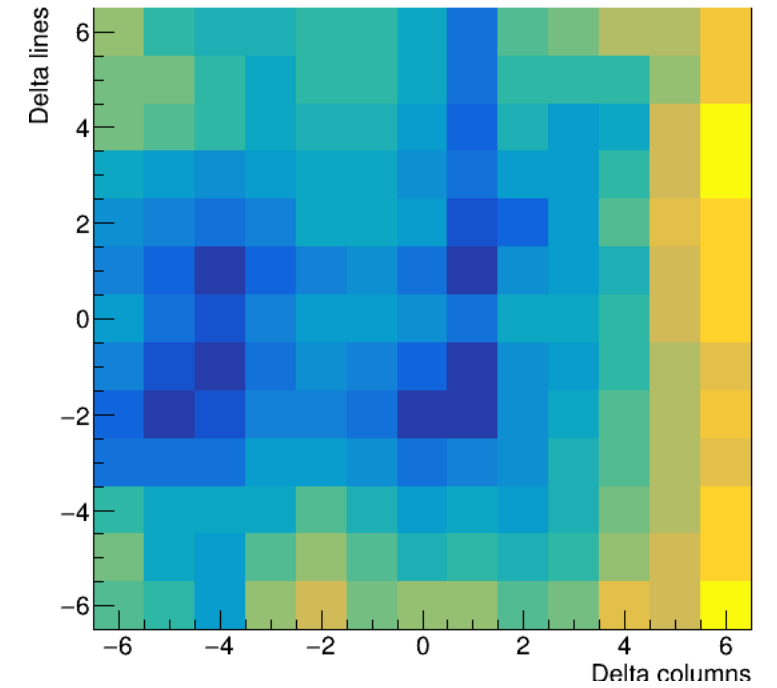# More results

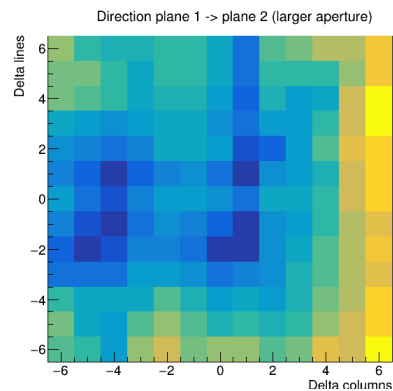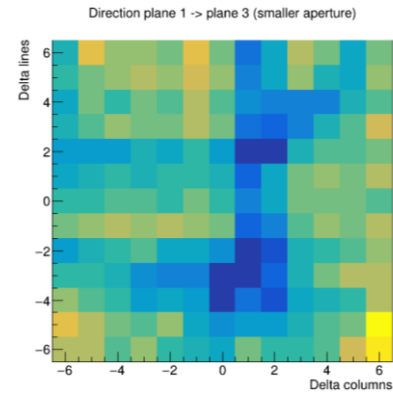# More results

More results

Theoretical transmission

Theoretical transmission

Direction plane 1 -> plane 2 (larger aperture)

Higher resolution

Direction plane 1 -> plane 3 (smaller aperture)

Direction plane 1 -> plane 2 (larger aperture)

Super map