Portable Device based on RPCs for Muons Tomography

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LIP
LABORATÓRIO DE INSTRUMENTAÇÃO
E FÍSICA EXPERIMENTAL DE PARTÍCULAS

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DEPARTAMENTO DE FÍSICA
FACULDADE DE CIÊNCIAS E TECNOLOGIA
UNIVERSIDADE DE COIMBRA

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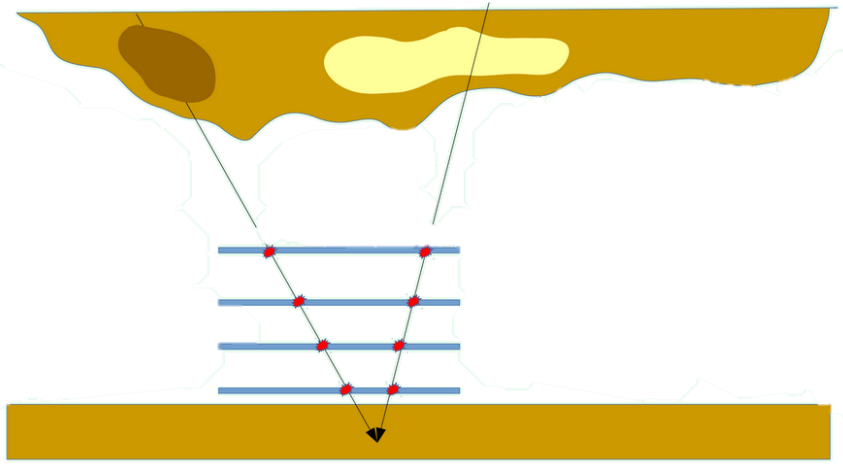
Mobile Muon RPC´s Tomograph

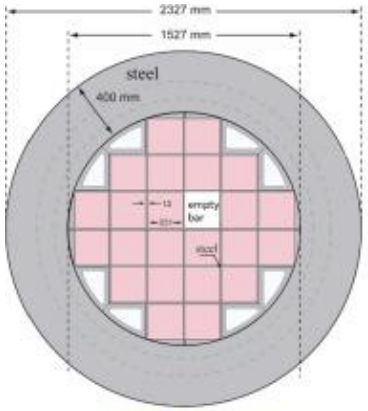
Physics Departments, Universidade de Coimbra

We'll use the data acquired in the Detector Lab to construct a muography of the Physics Department of the University of Coimbra, allowing us to test and calibrate the full chain of data analysis.

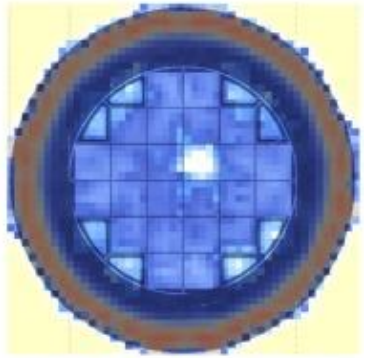
The symmetry of the building can be explored to create preliminary 3D images, reflecting the depth of the walls, floors and other objects crossed by the muons in each direction. Noise and uncertainties of the open-air muon flux due to space-weather or local variations will be studied and applied at a later step.



Detector in mina da Argemela



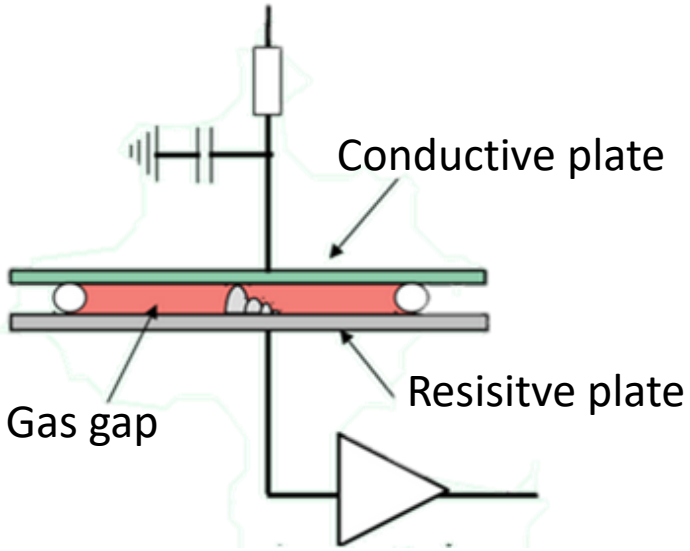
CASTOR V/21 model



Scattering Tomography Reconstruction

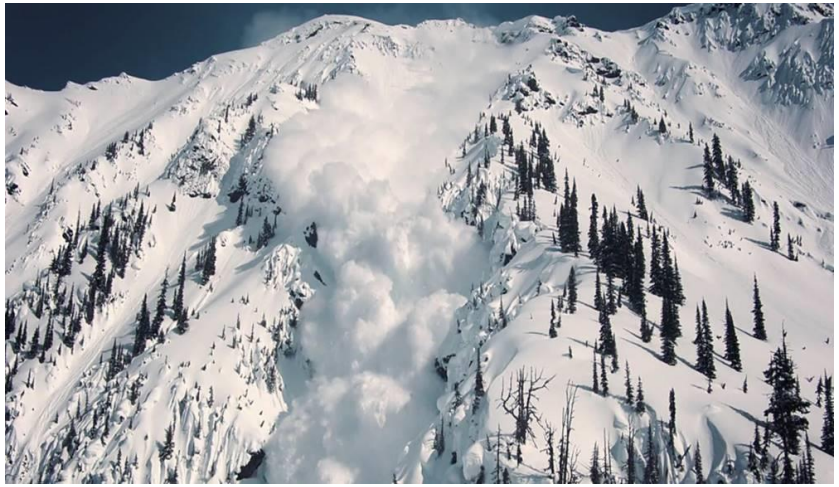
Results of this project will be applied mainly in underground mines but can be suited to a variety of subjects such as volcanology, security (cargo scanning), archaeology, nuclear waste and reactors, monitoring of historical buildings, etc.

Mobile Muon RPC´s Tomograph



RPC Resistive Plate Chamber

RPC were choosen due to it´s high versatibility and excellent cost per area, having high spacial and time resolution (<1mm and <1ns accordingly). This type of detectors have a very high efficiency of detection ~100%, it´s cheap to produce and has low cost high performance.



Main RPC´s pros:

- Versatibility
- Hight spatial and time resolution
- Low cost high performance
- Easiness to produce

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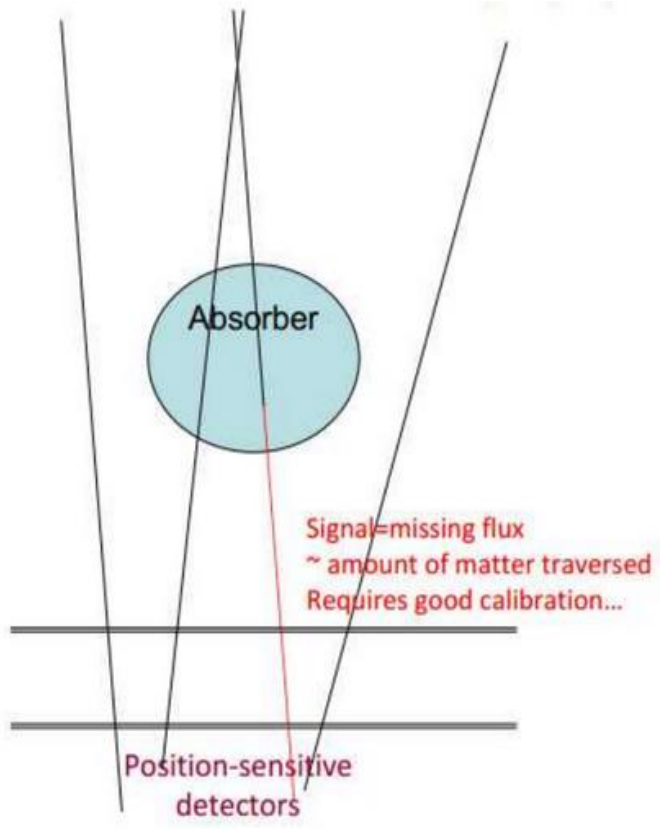
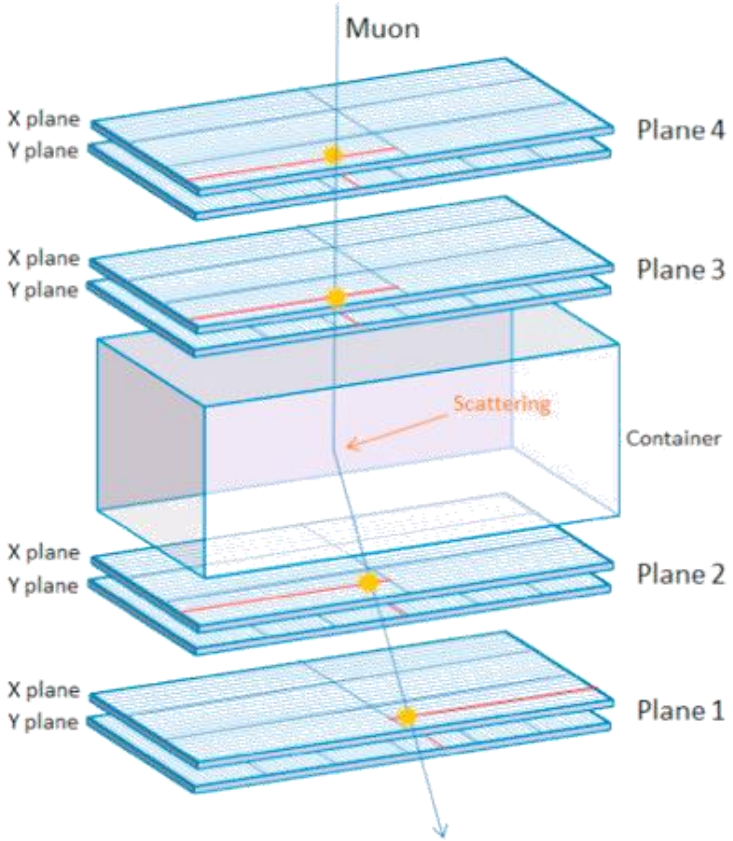
Mobile Muon RPC´s Tomograph



Muon absortion method



Muon scattering method

In this project was used technics of ***Tomography,*** imaging by sections or sectioning, using methods based on the absorption or scattering of atmospheric muons, collectively named under the neologism “muography”.

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Mobile Muon RPC´s Tomograph

LIP´s RPC Detector

LIP´s detetor is able to be moved easily, having an effective low cost high resolution ~10 mm. Both detetor and acquisition system were made in Portugal in LIP facilities.

We'll use the data acquired in the Detector Lab to construct a tomography of the Dep. Of Physics building, allowing us to test the full chain of data analysis methods and to measure systematic uncertainties that can affect the image reconstruction

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Mobile Muon RPC´s Tomograph

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Mobile Muon RPC´s Tomograph

Efficiency

```
function eff = eficiencia(save)

load(('.\HV_Scan\' + save))

I = find(Q1 > 0); M1 = Q1*0; M1(I) = 1; EventM1 = sum(M1');
I = find(Q2 > 0); M2 = Q2*0; M2(I) = 1; EventM2 = sum(M2');
I = find(Q3 > 0); M3 = Q3*0; M3(I) = 1; EventM3 = sum(M3');
I = find(Q4 > 0); M4 = Q4*0; M4(I) = 1; EventM4 = sum(M4');

 I = find(EventM1 > 1 & EventM4 > 1 & EventM2 > 1;


 eff = length(find(EventM3(I)))/length(I);

 end
```

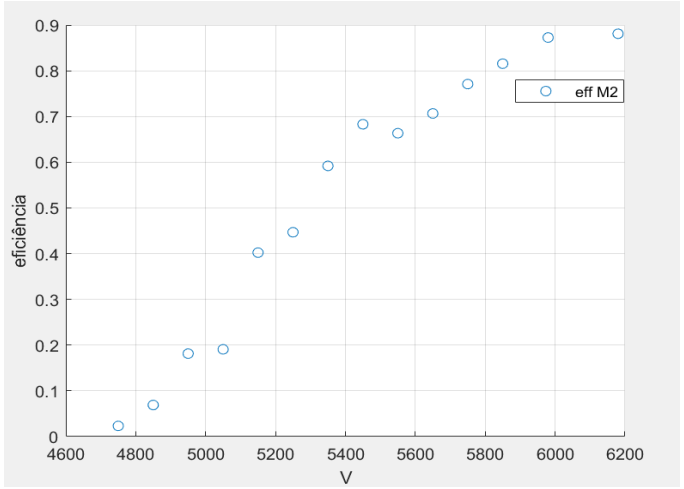
Plotting and Data Visualization

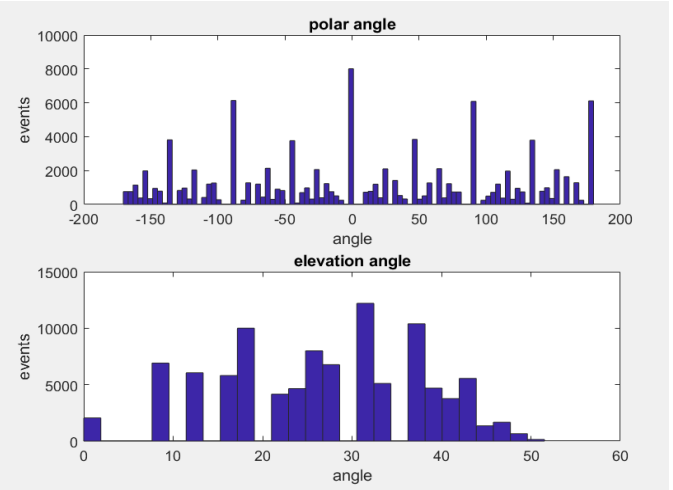
```
for i in y:
    phi.append(float(i)+3.14)


elevation = []
for i in theta:
    elevation.append(abs((math.sin(i))))
r = []
for i in range(len(elevation)):
    r.append(float(1))

x = []
 y = []
 z=[]
 for num1, num2 in zip(phi, theta):
          x.append(math.cos(num1)*math.sin(num2))
         y.append(math.sin(num1)*math.sin(num2))
         z.append(math.cos(num2))


 plt.hist2d(x,y, bins=[np.arange(-1,1,0.015),np.arange(-1,1,0.05)])
 rcParams["figure.figsize"] = [8, 8]
 plt.show()

```

Mobile Muon RPC´s Tomograph

Results

- Efficiency
- Efficiency Progression with Eletric Field
- Spatial Resolution
- Azimutal and Polar Angles
- 3D Model





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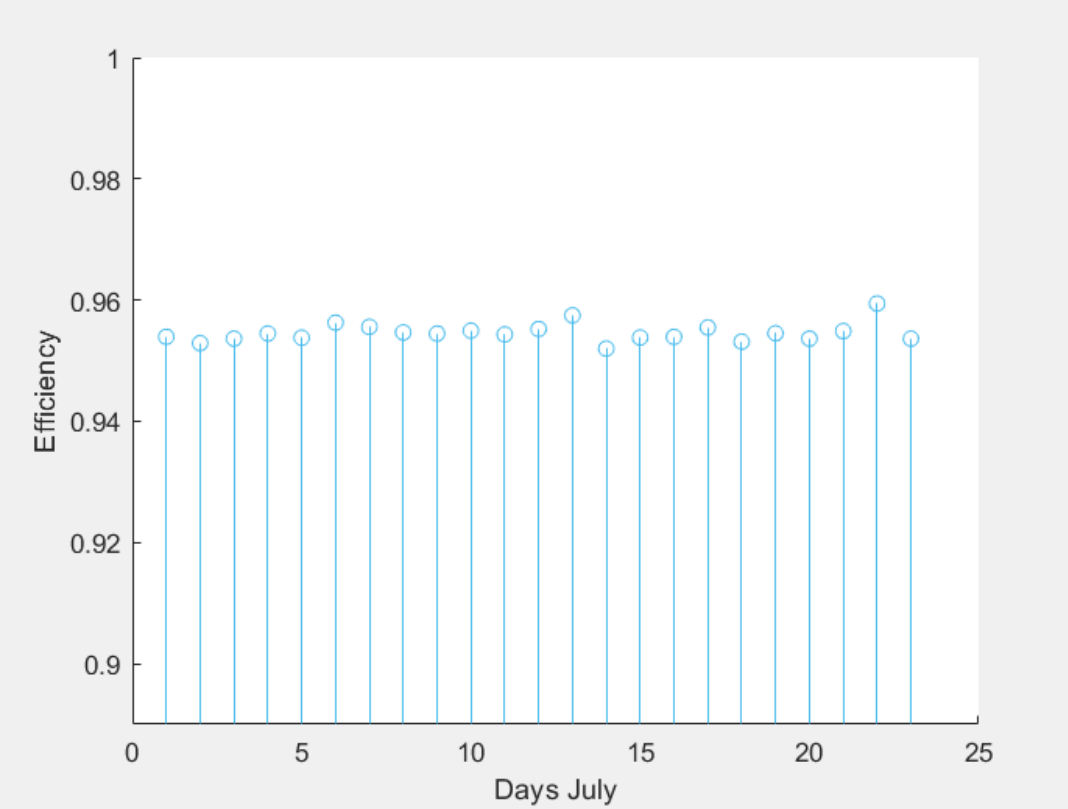
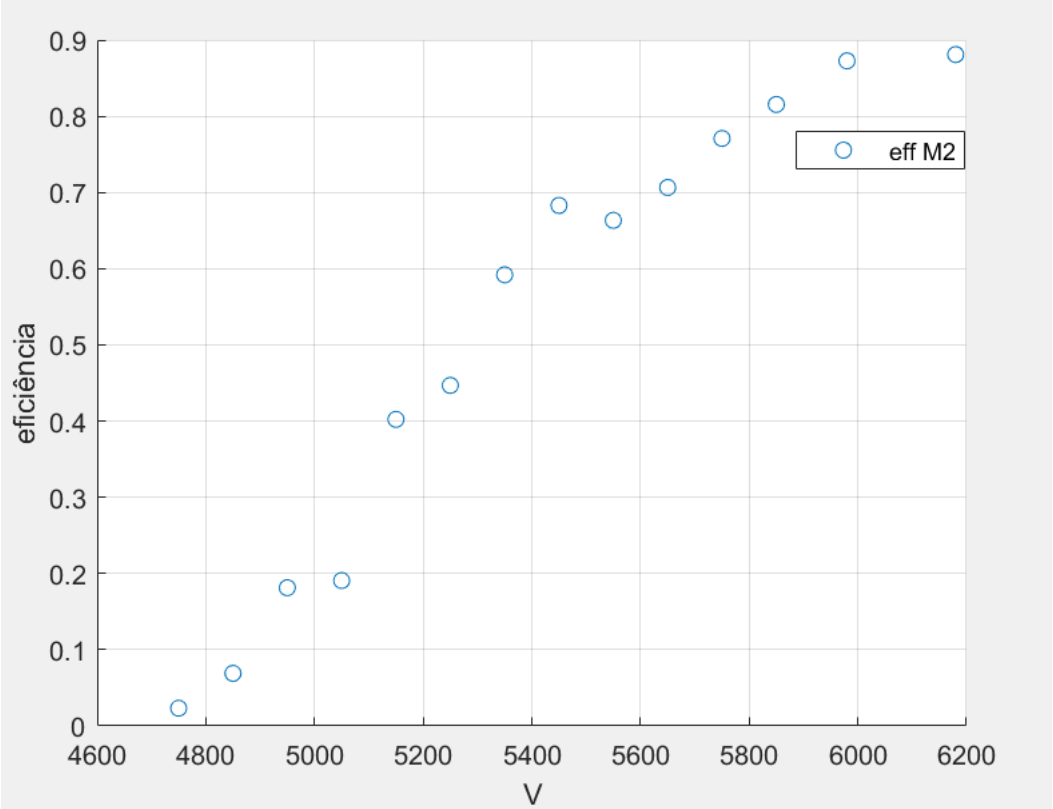
Efficiency



Efficiency Progression



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Efficiency

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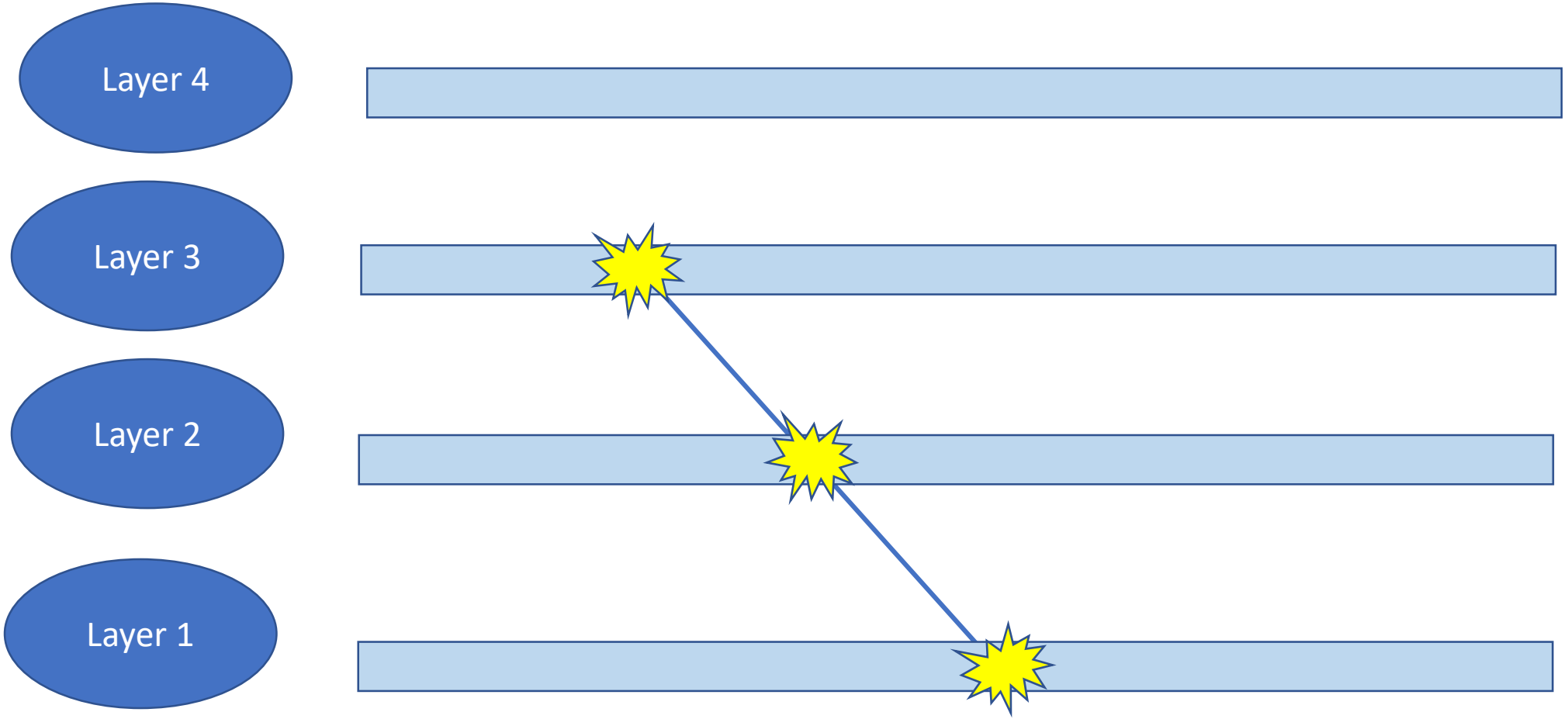
Mobile Muon RPC´s Tomograph

Efficiency



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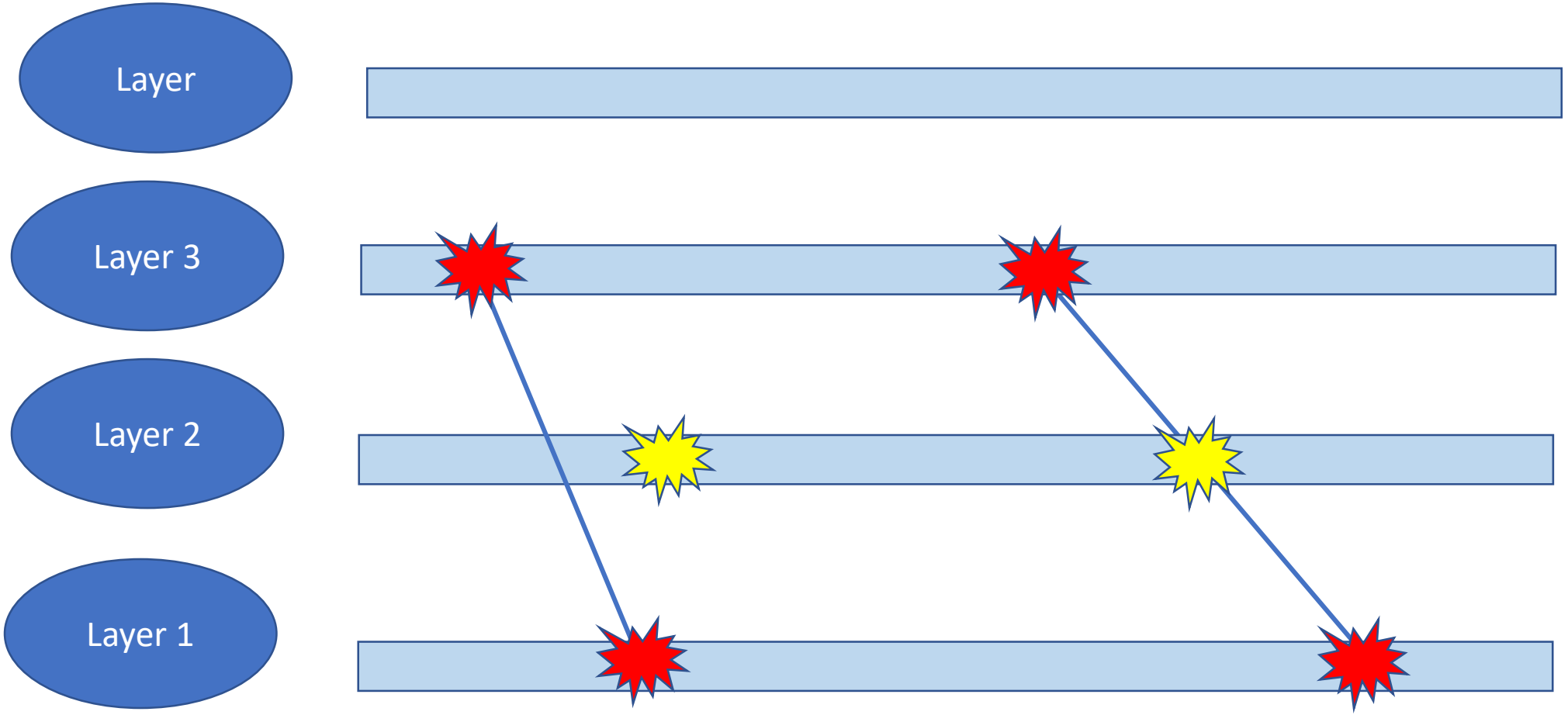
Spatial Resolution



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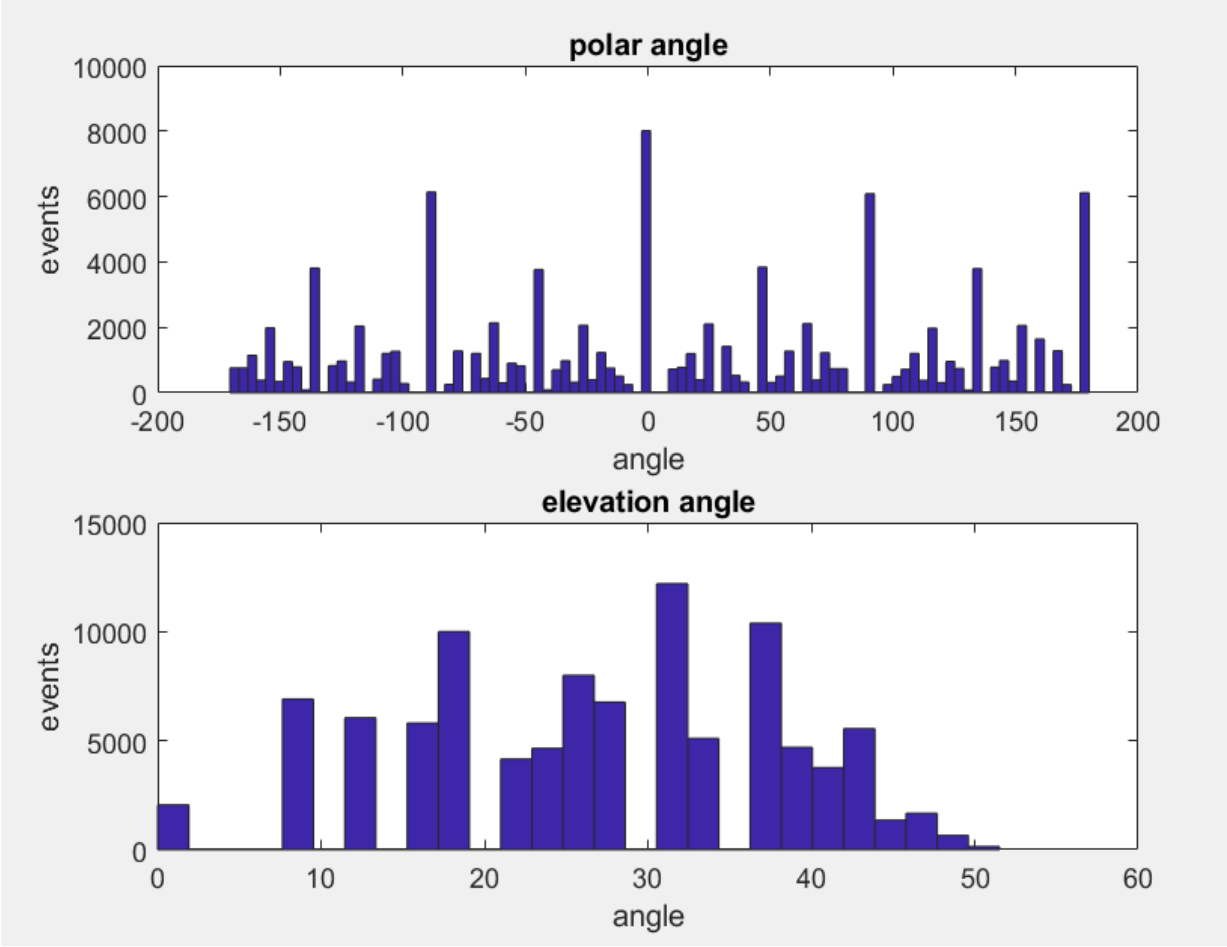
Simulation of expected values



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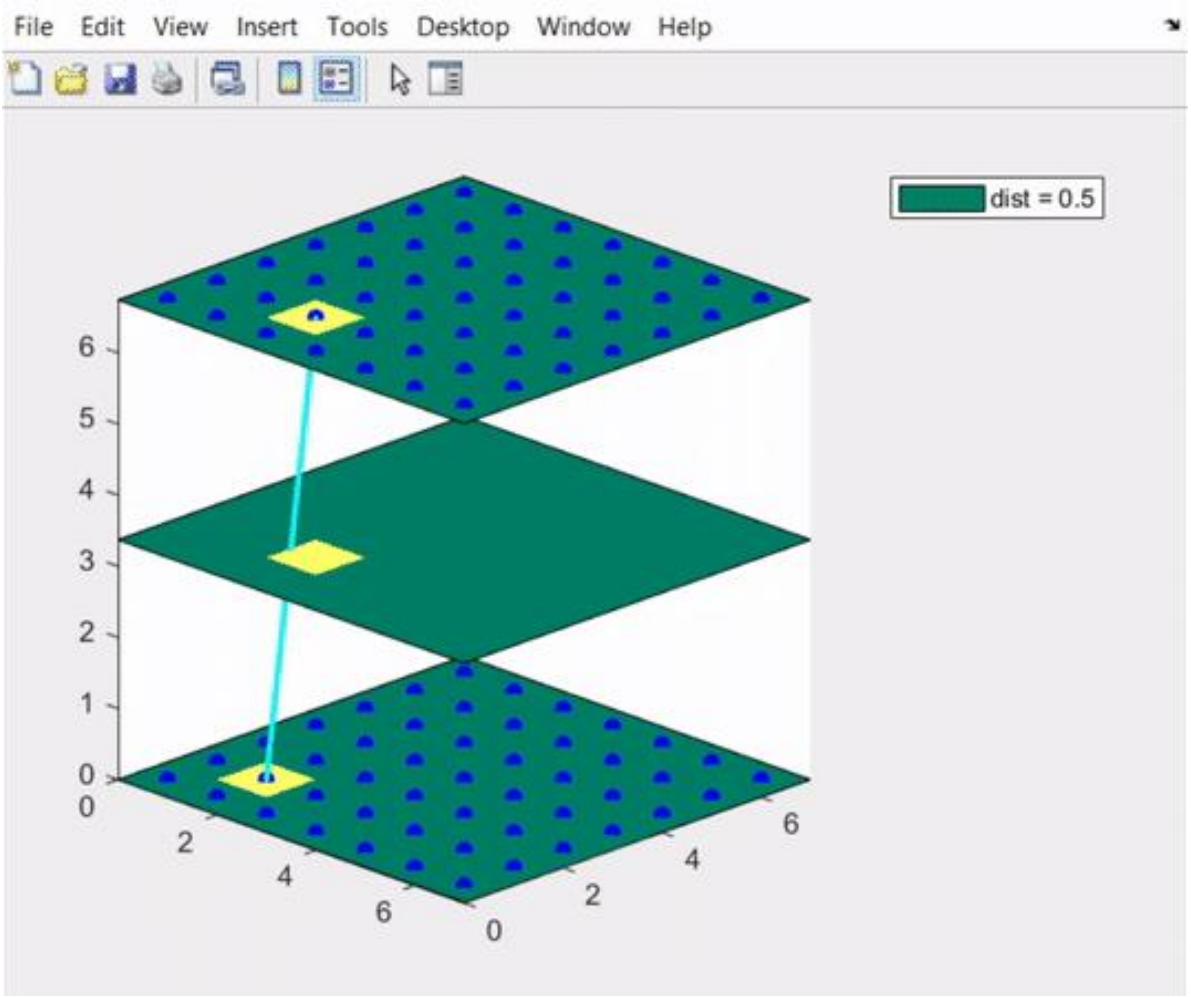
3D Model



Thank You!

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