

PaNDa Backward Electromagnetic Calorimeter Studies with BaBar-like framework and PandaROOT

María Carmen Mora Espí
Dmitry Khanefc

Institut für Kernphysik, Johannes Gutenberg Universität, Mainz
and
GSI, Darmstadt

March, 10th - 2010



Outline

1 Geometry

- STT dead material simulation
- MVD dead material simulation

2 Analysis

3 Results

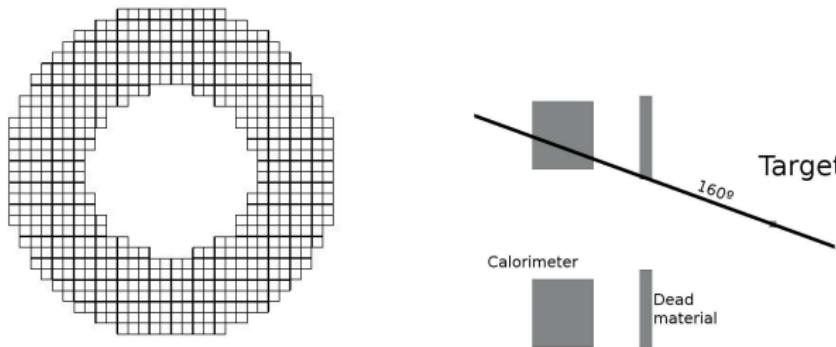
- STT
- MVD

4 Conclusions



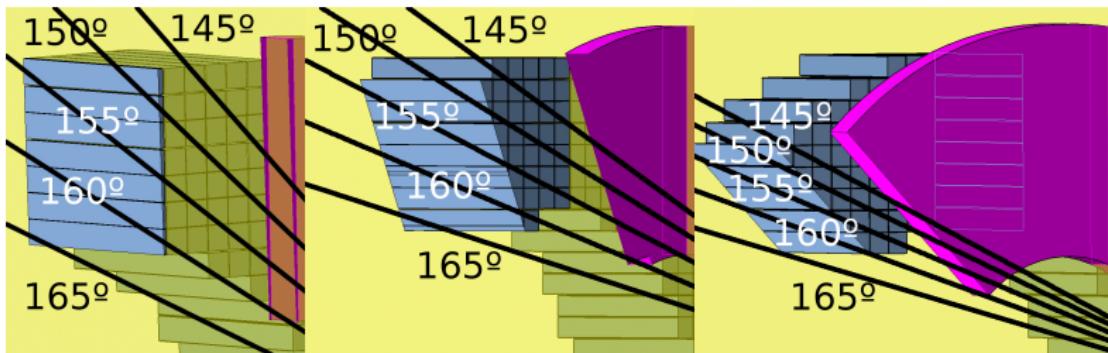
Geometry characteristics:

- **Calorimeter:** 20 cm long crystals ($2.44\text{ cm} \times 2.44\text{ cm}$), $r_{min} = 182\text{ mm}$, $r_{max} = 406\text{ mm}$, at $z = -594\text{ mm}$.
Full angular range: 145.65° , 167.09° .
- **Dead material of STT:**
 - **Nothing.**
 - **2 cm Al** $r_{min} = 150\text{ mm}$, $r_{max} = 418\text{ mm}$, at $z = -400\text{ mm}$ from the target. Behind STT.
 - **4 cm Al** $r_{min} = 150\text{ mm}$, $r_{max} = 418\text{ mm}$, at $z = -400\text{ mm}$ from the target. Behind STT.
- **Dead material of MVD:** Blocks at certain ϕ and θ angles (+ 2 cm Al for STT). See next slides.



Simulation characteristics: STT Dead material study

- Single gamma.
- Energies: 0.03, 0.1, 0.25, 0.5 and 0.7 GeV
- Angles:
 - θ : 145°, 150°, 155°, 160° and 165°
 - ϕ : 1°, 22.5° and 45°

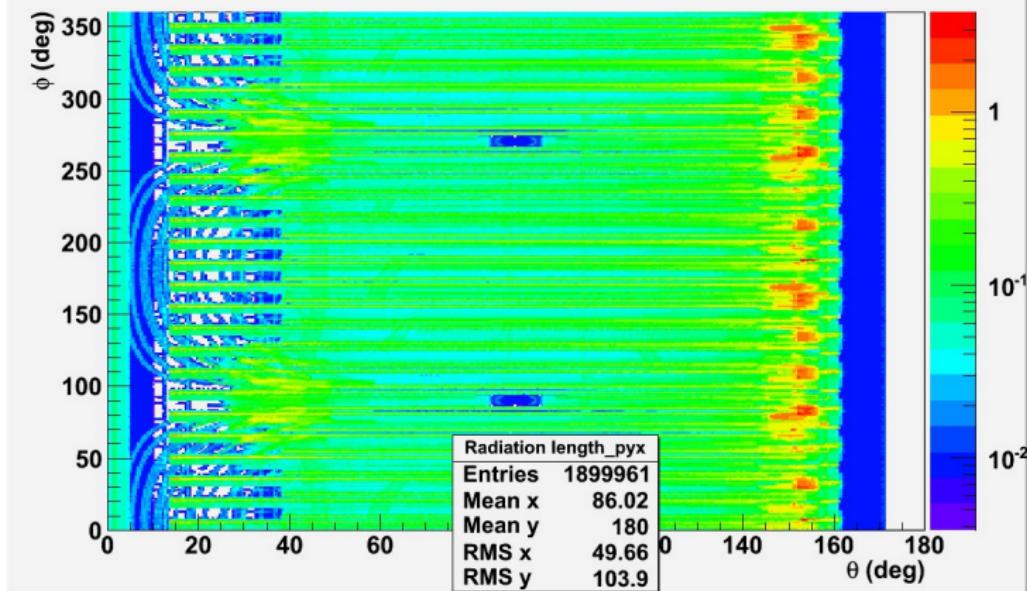


For more details look into our talks of last collaboration meeting:
M. C. Mora Espí (BaBar framework) and D. Khanefz (PandaROOT framework),
EMC and EMP sesions.



Estimation dead material for MVD

Full - # of radiation lengths

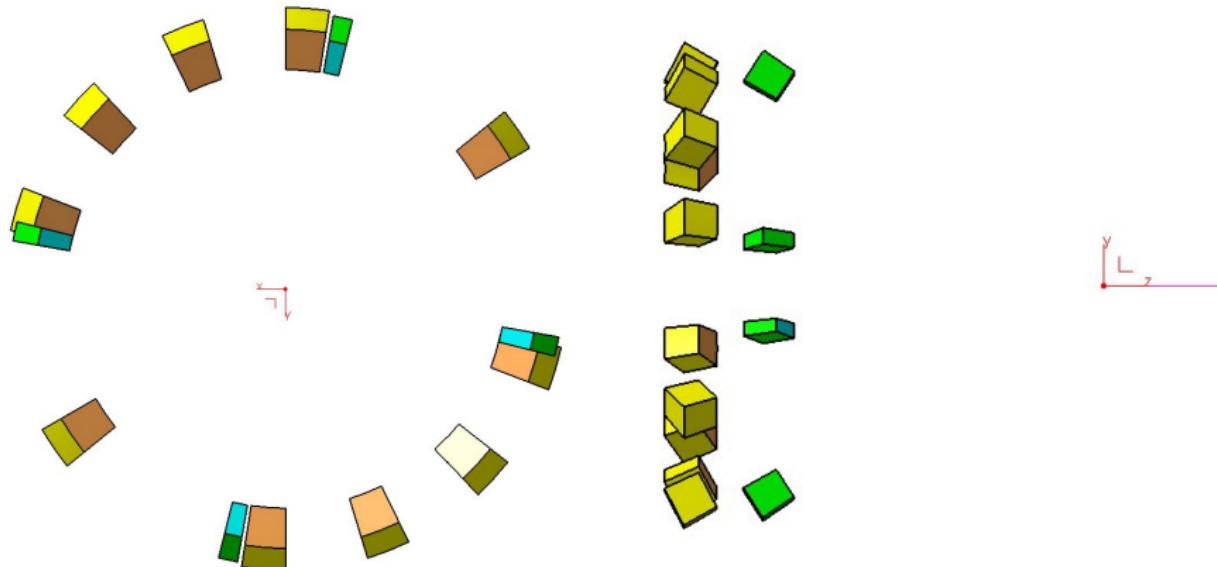


Thomas Würschig - Collaboration Meeting December 2009.



Estimation dead material for MVD

Geometry deduced from the plot by Th. Würschig.

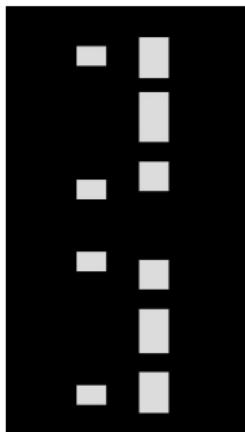


Drawings by D. Rodríguez

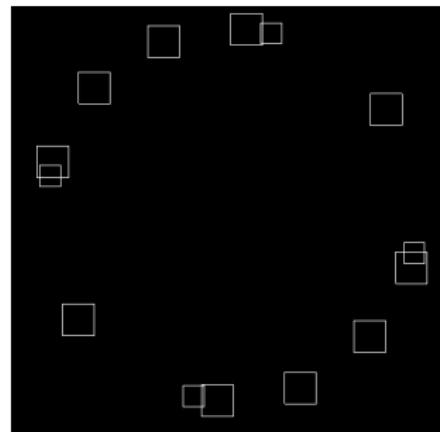


Estimation dead material for MVD

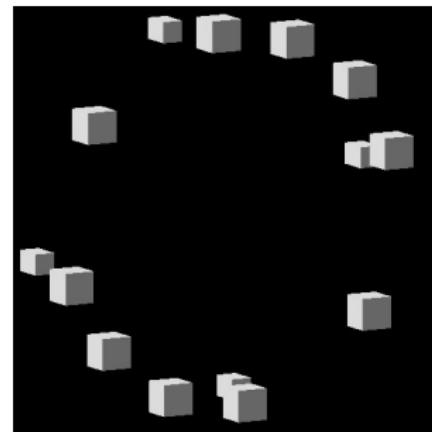
Simplified geometry for simulation in BaBar and PandaROOT frameworks.



4 Boxes type 1: $(14.5 \times 14.5 \times 22) \text{ mm}^3$



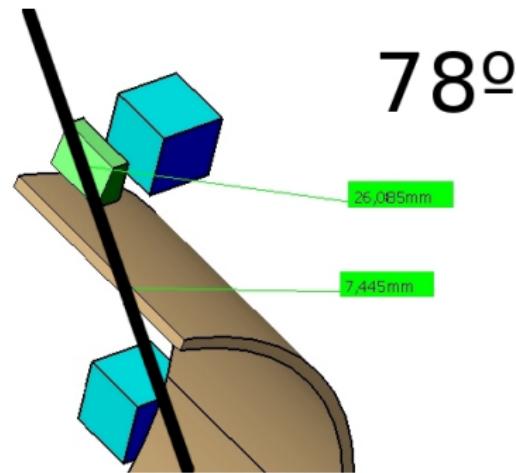
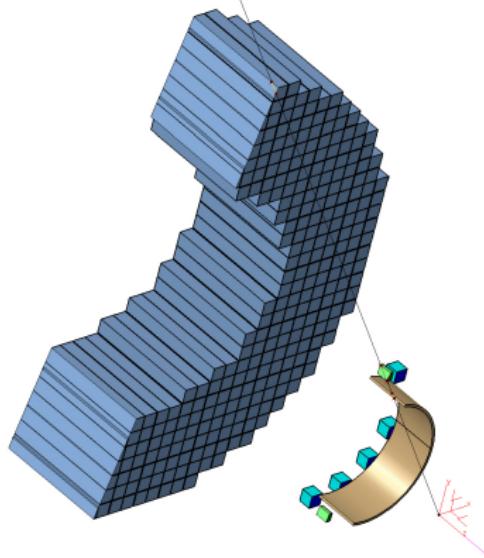
10 Boxes type 2: $(24.73 \times 21.73 \times 22) \text{ mm}^3$





Simulation Characteristics: MVD dead material studies

$\theta = 147.5^\circ$, $\phi = 78^\circ$, E= 30 MeV, 250 MeV and 700 MeV



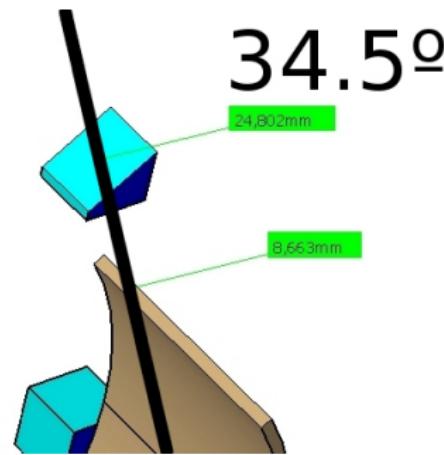
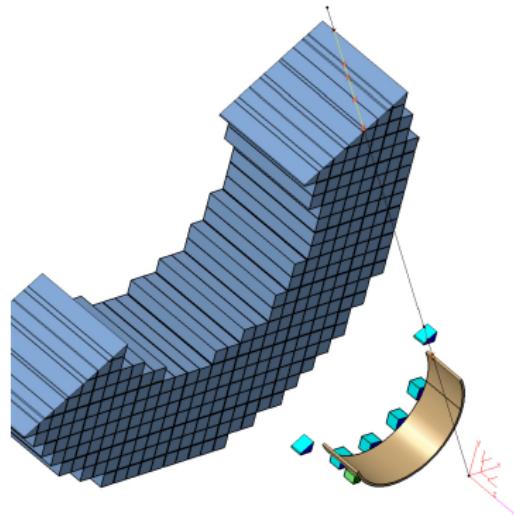
$X_0 \text{ Cu} = 14.3 \text{ mm}$:
 $26.085 \text{ mm} \rightarrow 1.82 X_0$
 $7.445 \text{ mm} \rightarrow 0.52 X_0$

Drawings by D. Rodríguez



Simulation: Characteristics: MVD dead material studies

$\theta = 152.5^\circ$, $\phi = 34.5^\circ$, E= 30 MeV, 250 MeV and 700 MeV



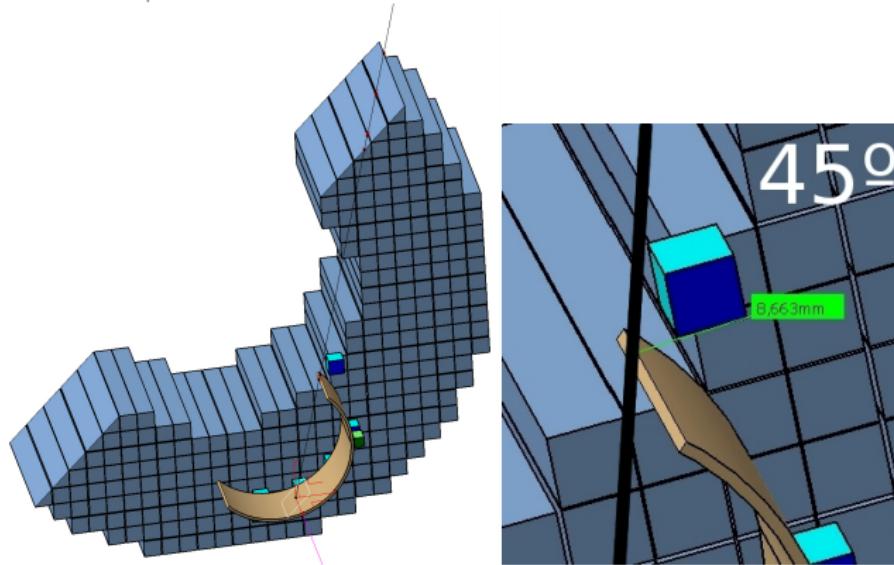
$$\begin{aligned}X_0 \text{ Cu} &= 14.3 \text{ mm:} \\24.802 \text{ mm} &\rightarrow 1.73 X_0 \\8.663 \text{ mm} &\rightarrow 0.61 X_0\end{aligned}$$

Drawings by D. Rodríguez



Simulation: Characteristics: MVD dead material studies

$\theta = 152.5^\circ$, $\phi = 45^\circ$, E= 30 MeV, 250 MeV and 700 MeV



X_0 Cu = 14.3 mm:
8.663 mm \rightarrow 0.61 X_0

Drawings by D. Rodríguez



Analysis

CUTS:

- Bump with highest energy per event

ANALYSIS:

- Energy resolution of the backward end cap:

$$E_{res} = \frac{2.35\sigma}{\mu}$$

σ and μ from Novosibirsk function, see next slide

- Efficiency of the backward end cap:

$$Eff = \frac{1}{50000} \int_{\mu-3\sigma}^{\mu+2\sigma} f(E) dE$$



Analysis

- Energy resolution:

NOVOSIBIRSK FUNCTION:

$$f(E) = A \exp \left\{ -\frac{1}{2} \left[\frac{\ln^2 [1 + \Lambda \tau(E - E_0)]}{\tau^2} + \tau^2 \right] \right\}$$

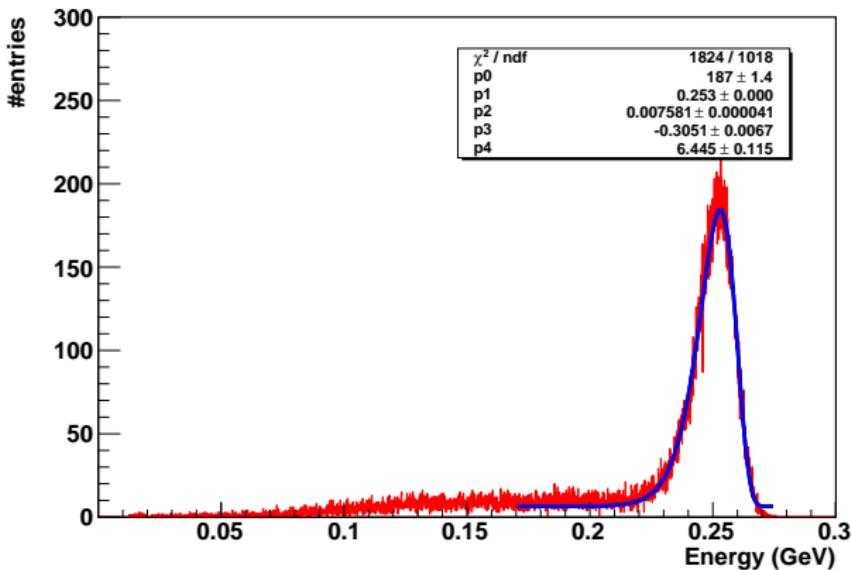
with

$$\Lambda = \frac{\sinh (\tau \sqrt{\ln(4)})}{\sigma \tau \sqrt{\ln(4)}}$$



Results: Dead material for STT

SinglePhotonSingleE250Ph22degTh1552cmAl-1.root



Example:
 $E = 250 \text{ MeV}$
 $\phi = 22.5^\circ$
 $\theta = 155^\circ$
2 cm Al

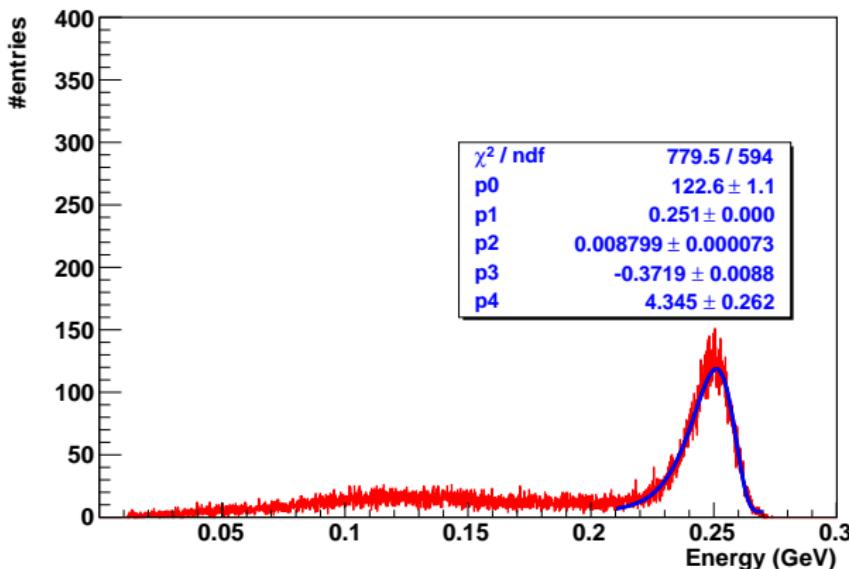
$R_E = 7\%$
 $Eff = 72\%$
BaBar-like
framework

For more details look into our talks of last collaboration meeting:
M. C. Mora Espí (BaBar framework) and D. Khanefi (PandaROOT framework),
EMC and EMP sesions.



Results: Dead material for MVD

TestMVDDeadEn250Ph45Th152Al2cm-1.root



Example:

$E = 250 \text{ MeV}$

$\phi = 45^\circ$

$\theta = 152.5^\circ$

2 cm Al for

STT

Thin cylinder

for MVD

$R_E = 8.2\%$

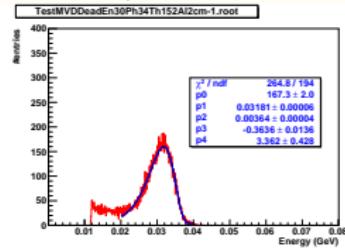
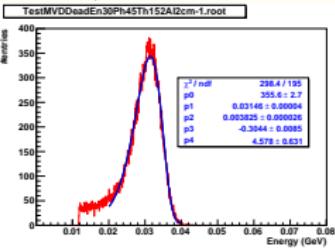
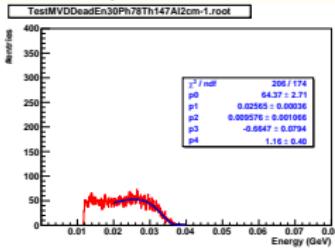
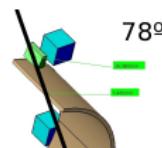
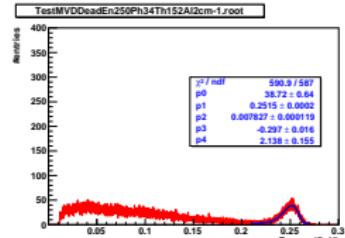
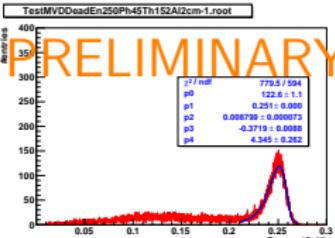
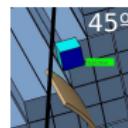
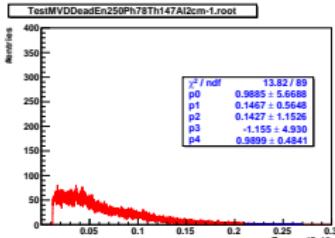
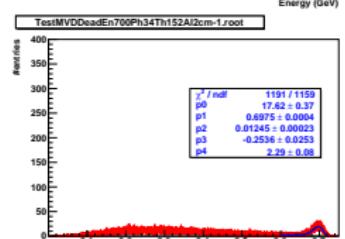
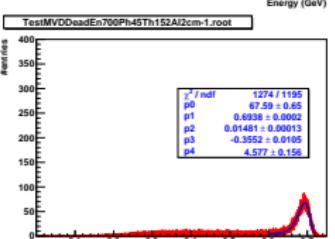
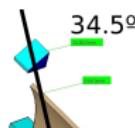
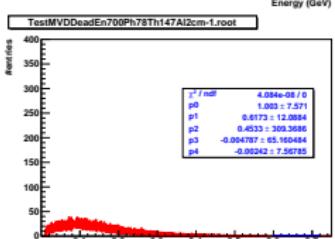
$Eff = 54\%$

BaBar-like

framework



Results: Dead material for MVD - BaBar-like framework

 $\phi = 34.5^\circ$

 $\phi = 45^\circ$

 $\phi = 78^\circ$

 $E = 30 \text{ MeV}$

 $E = 250 \text{ MeV}$

 $E = 250 \text{ MeV}$

 $E = 250 \text{ MeV}$

 $E = 250 \text{ MeV}$
 $E = 700 \text{ MeV}$

 $E = 700 \text{ MeV}$

 $E = 700 \text{ MeV}$

 $E = 700 \text{ MeV}$

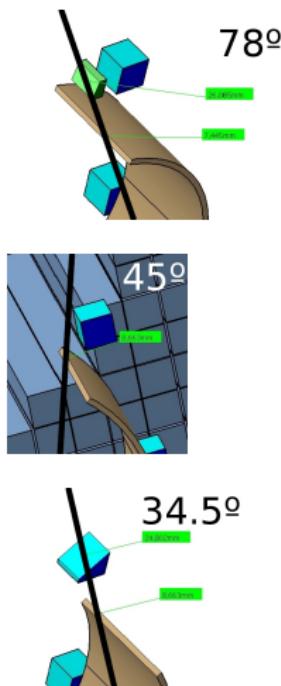
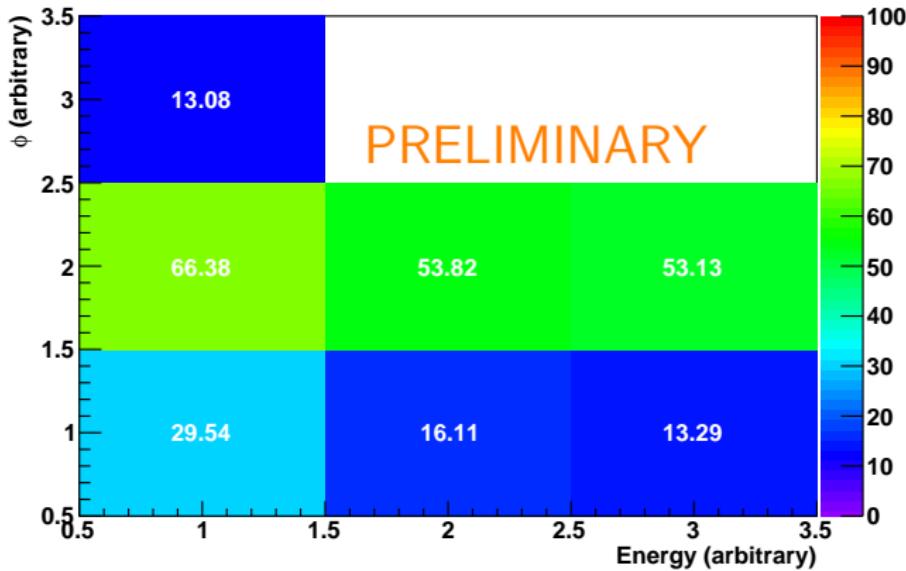


Efficiency - BaBar-like framework

E: 1 → 30 MeV; 2 → 250 MeV; 3 → 700 MeV

Φ: 1 → 34.5° ; 2 → 45° ; 3 → 78°

Efficiency



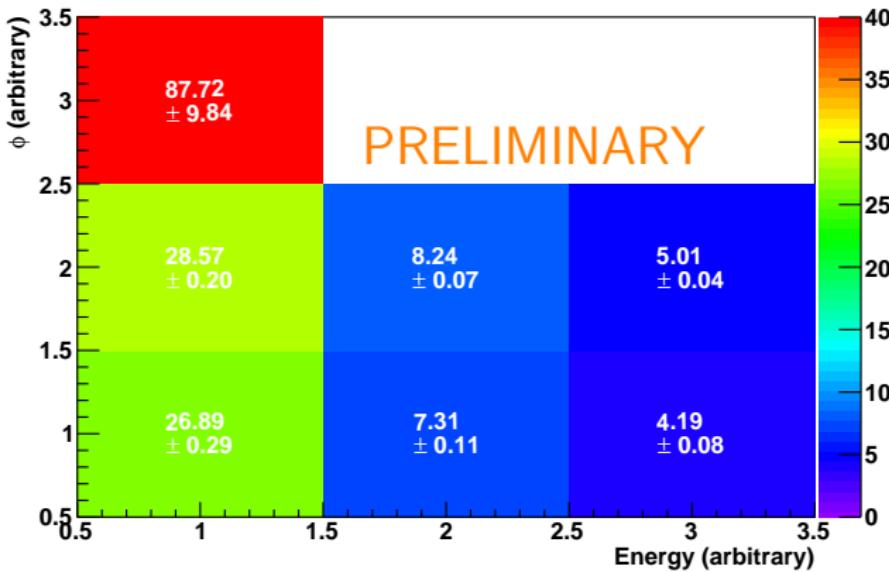


Energy resolution - BaBar-like framework

E: 1 → 30 MeV; 2 → 250 MeV; 3 → 700 MeV

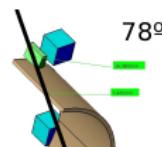
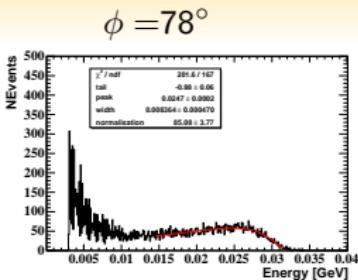
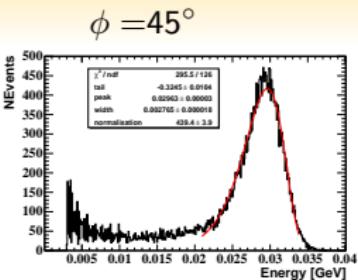
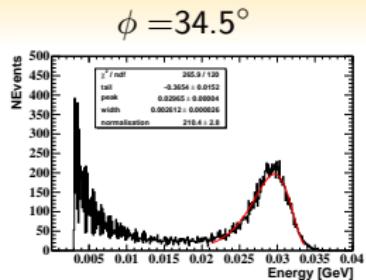
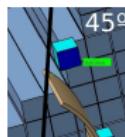
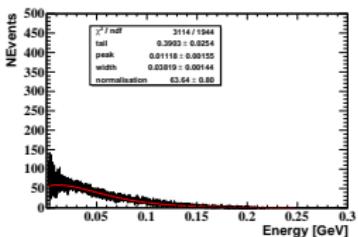
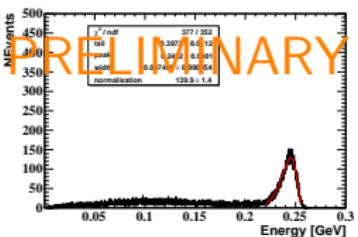
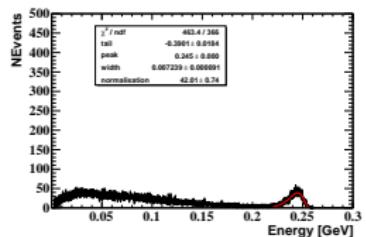
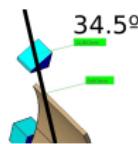
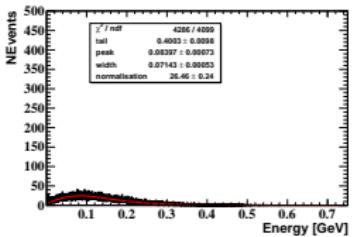
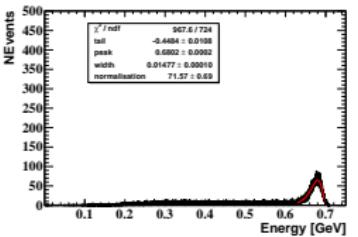
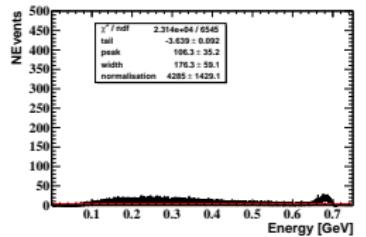
Φ: 1 → 34.5° ; 2 → 45° ; 3 → 78°

Eresolution





Results: Dead material for MVD - PandaROOT

 $E=30 \text{ MeV}$  $E=250 \text{ MeV}$  $E=700 \text{ MeV}$ 



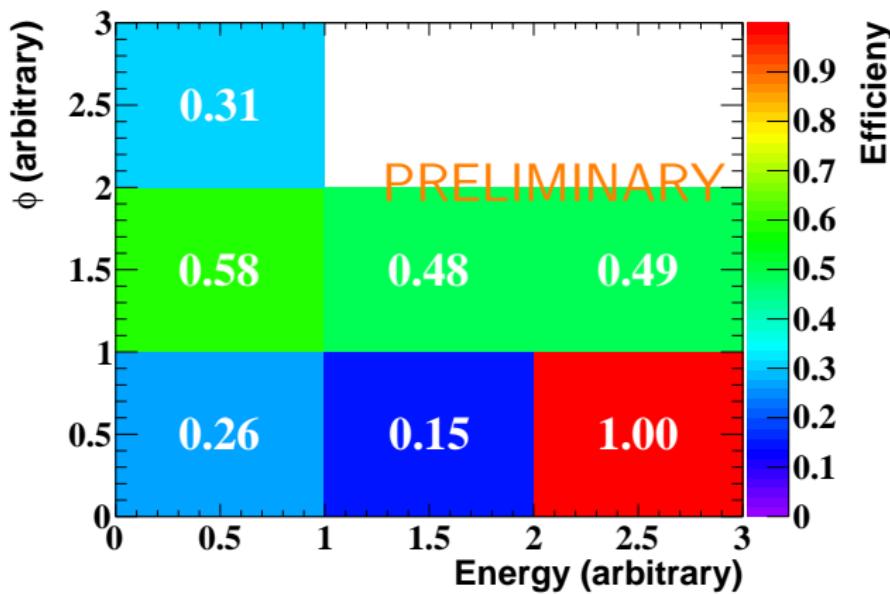
Efficiency - PandaROOT



JOHANNES GUTENBERG
UNIVERSITÄT MAINZ

E: $0.5 \rightarrow 30 \text{ MeV}$; $1.5 \rightarrow 250 \text{ MeV}$; $2.5 \rightarrow 700 \text{ MeV}$

Φ : $0.5 \rightarrow 34.5^\circ$; $1.5 \rightarrow 45^\circ$; $2.5 \rightarrow 78^\circ$

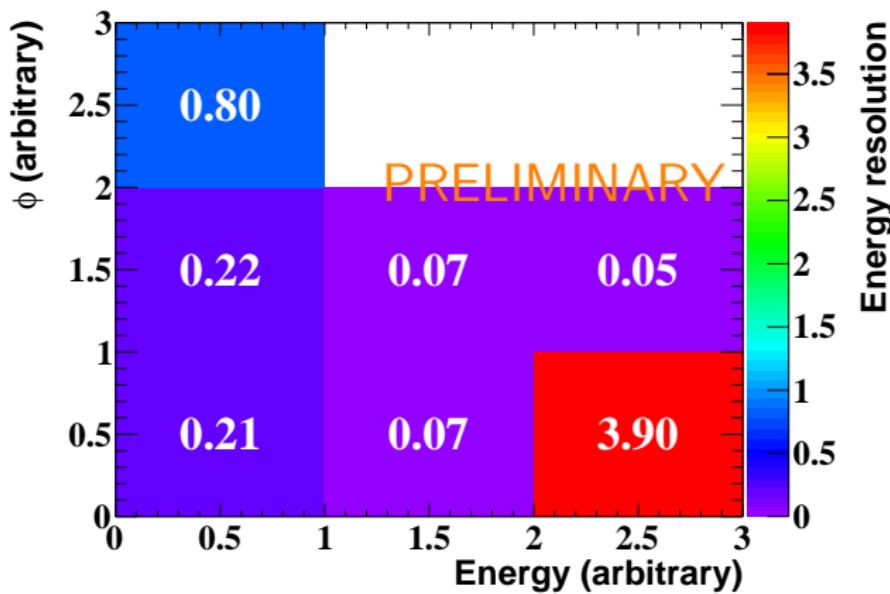




Energy resolution - PandaROOT

E: 0.5 → 30 MeV; 1.5 → 250 MeV; 2.5 → 700 MeV

Φ: 0.5 → 34.5°; 1.5 → 45°; 2.5 → 78°





Conclusions



JOHANNES GUTENBERG
UNIVERSITÄT MAINZ

- First studies of the effect of the dead material of STT on the energy resolution and efficiency of the Backward end cap were presented in the last collaboration meeting (December 2009 at GSI).
 - Preliminary results of the same studies including dead material of MVD have been presented in this talk.
-
- Better modeling of the dead material for MVD is needed.
 - The efficiency strongly depends on the dead material.
 - Good results for energy resolution are achieved even in unfavorable cases.