Status report of simulations for $\bar{\text{P}}$ANDA by Mainz group

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Outline

1. **Study of Efficiency and Energy Resolution of the Backward End Cap Calorimeter with Babar-like framework**
   - Characteristics of simulation
   - Analysis done
   - Results

2. **Study of physics channel $\bar{p}p \to e^+e^-$ with Panda Root**

3. **Study of physics channel $\bar{p}p \to e^+e^-\pi^0$ with Babar-like framework**

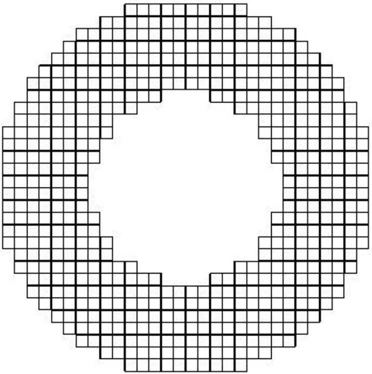
4. **Conclusions and Outlook**

BACKWARD EMC STUDIES WITH BABAR-LIKE FRAMEWORK

Geometry for simulation

CALORIMETER:

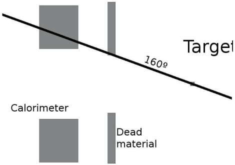
- 20 cm long crystals with a front face $(24.4 \times 24.4)\,\mathrm{mm}^2$.
- $R_{min} = 182\,\mathrm{mm}$, $R_{max} = 406\,\mathrm{mm}$, $z = -594\,\mathrm{mm}$ from target position (0, 0, 0).
- Angular range covered: 146°-167°.



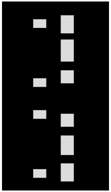
Geometry for simulation

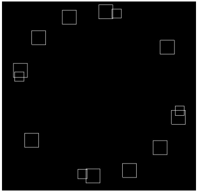
DEAD MATERIAL:

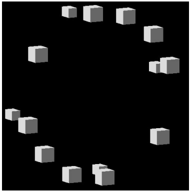
- STT: 2 cm thick Al plate with $R_{min} = 150$ mm, $R_{max} = 418$ mm and $z = -400$ mm from target $\sim 0.5 \cdot X_0$



- MVD: Estimation done based in the results for dead material by T. Würschig (Dec 09 PANDA Collaboration meeting):
  - 4 Cu boxes: $(14.5 \times 14.5 \times 22)\,\mathrm{mm}^3 \sim 1.8 \cdot X_0$
  - 10 Cu boxes: $(21.73 \times 21.73 \times 22)\,\mathrm{mm}^3 \sim 1.8 \cdot X_0$
  - Thin Cu cylinder $\sim 0.5 \cdot X_0$

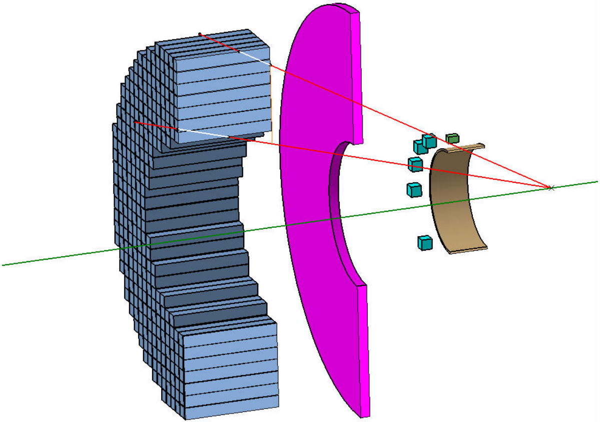






For more information look at my talk in the PANDA Collaboration meeting in March 2010.

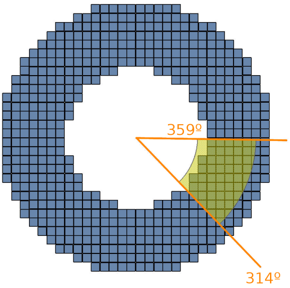
Geometry for simulation

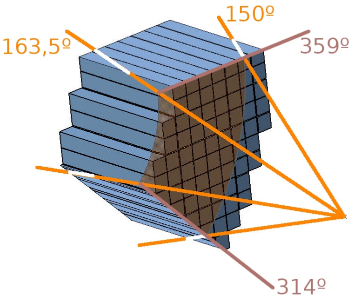


Simulated cases

- E: 30 MeV, 100 MeV, 250 MeV, 500 MeV, 700 MeV
- ϕ: 314°, 319°, 324°, 329°, 334°, 339°, 344°, 349°, 354°, 359°.
- θ: 150°, 151.5°, 153°, 154.5°, 156°, 157.5°, 159°, 160.5°, 162°, 163.5°.

50.000 events each





Simulation done in the new computer cluster in Mainz

Event selection

CUTS:

- Bump with highest energy per event

Fit function

NOVOSIBIRSK FUNCTION + CONSTANT:

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

with

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

Energy resolution and efficiency definitions

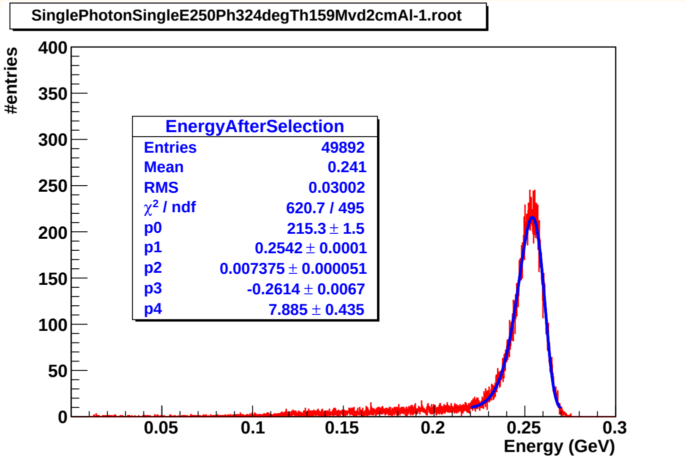
- Energy resolution of the backward end cap:

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

- Efficiency of the backward end cap:

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

Typical spectrum: E=250 MeV, $\phi = 324°$, $\theta = 159°$



Novosibirsk function plus constant gives better χ^2 results.
Fixed fit range for each energy.

panda

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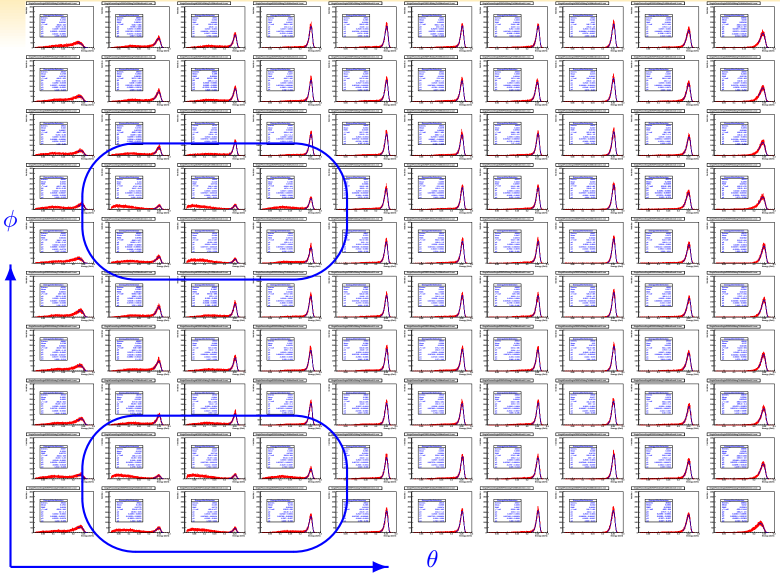
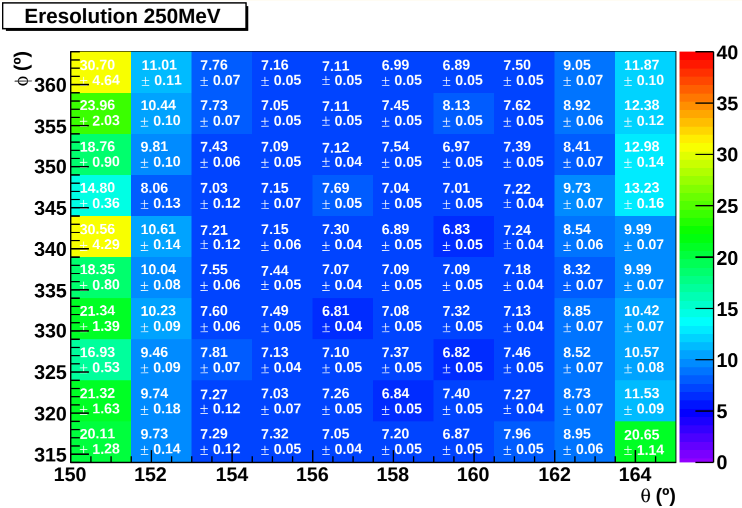
250 MeV



Energy resolution 250 MeV



Efficiency 250 MeV

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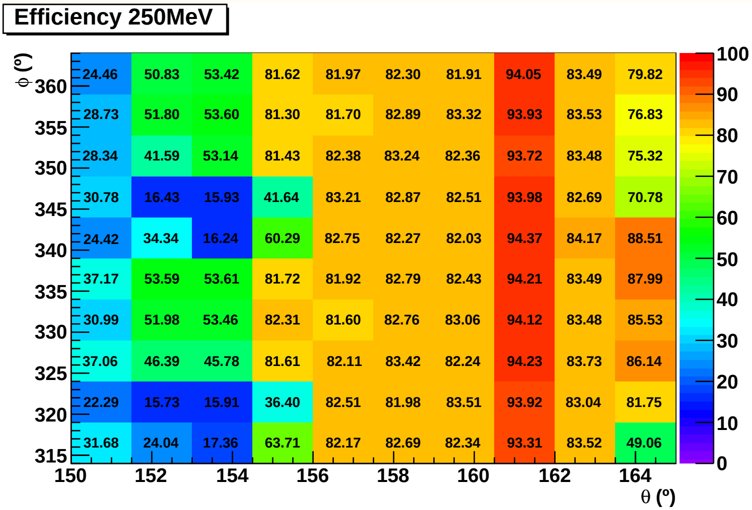
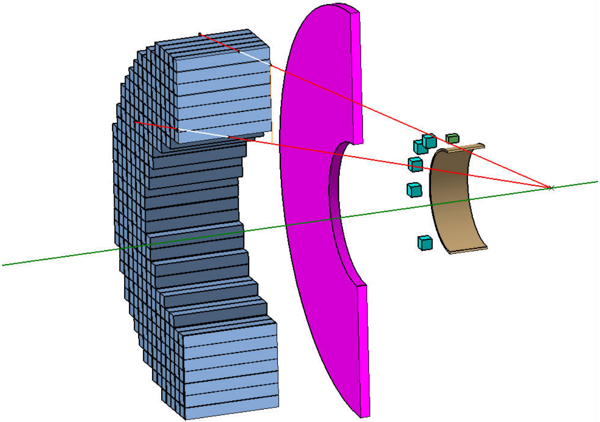


Efficiency



PANDA

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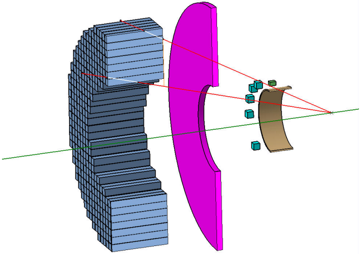
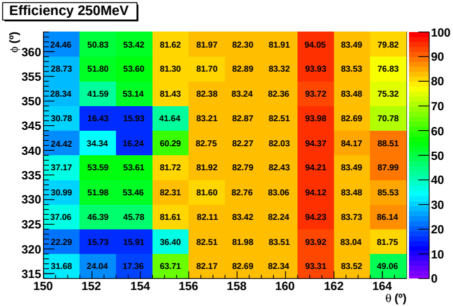
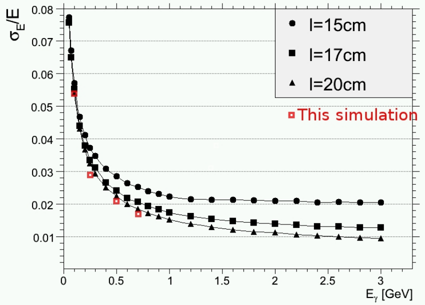
Results

E (MeV)	E Res	Best Eff	Worst Eff	Mean Eff
30	25%	94%	30%	85%
100	12%	93%	20%	83%
250	7%	94%	15%	82%
500	5%	94%	15%	84%
700	4%	92%	13%	82%





Expected values from simulation



[1]

Energy (GeV)	$\frac{\sigma}{E}\Big\|_{MySim}$	$\frac{\sigma}{E}\Big\|_{EMC-TDR}$
0.03	0.110	?
0.10	0.051	0.054
0.25	0.029	0.032
0.50	0.021	0.022
0.70	0.017	0.018

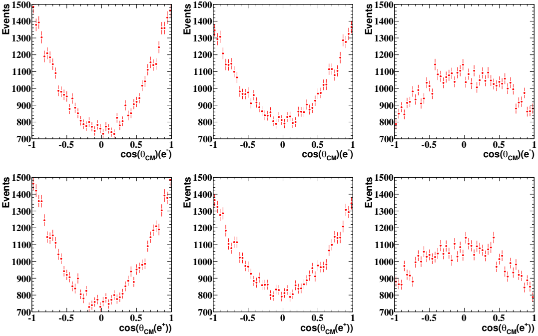
[1] Plot 9.4 from EMC - TDR

STATUS OF SIMULATIONS ON $\bar{p}p \rightarrow e^+e^-$

$\bar{p}p \to e^+e^-$ with Panda-Root (by D. Khaneft)

- Already analysed with the old Babar-like framework[2].
- Event generator fully developed for PandaRoot.
- First simulation done.
- Analysis under development.

SOME PLOTS: Angular distribution in CMS at true level for e^+ and e^- for $R = \frac{G_e}{G_m} = 0$, 1 or 3.



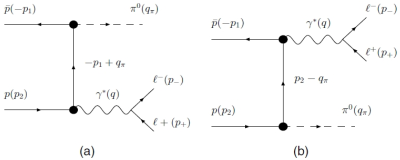
[2] M. Sudoł et al., Eur. Phys. J. A 44, 373-384 (2010)

STATUS OF SIMULATIONS ON $\bar{p}p \rightarrow e^+e^-\pi^0$

Physical processes

COMPTON-LIKE FEYNMANN AMPLITUDES[3]:

[3]C. Adamuščín et al., Physical Review C75, 045205 (2007)

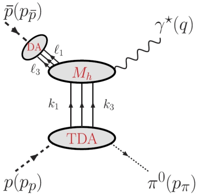


- Study FF's in the unphysical region.
- We are mainly interested in simulations at low energies.
- Event generator[5] ready but still not integrated in the frameworks.

[5]See M. Zambrana's talk

TDA'S APPROACH[4]:

[4]J. P. Lansberg et al., Physical Review C76, 111502(R) (2007)



- Study the validity of TDA's.
- Approach valid at high energies.
- Event generator developed for Babar-like framework.

$\bar{p}p \to e^+e^-\pi^0$ with Babar-like framework

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STUDY OF UNPHYSICAL REGION:

- The event generator has to be implemented for Babar-like framework.

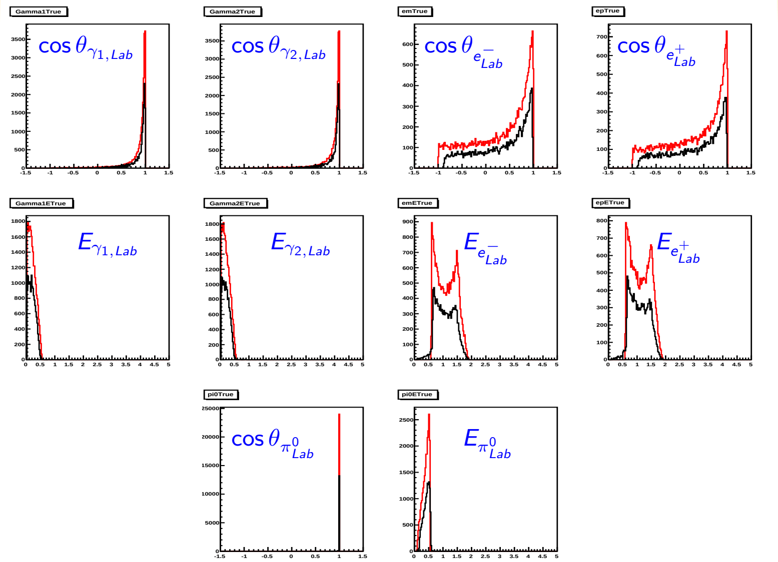
FEASIBILITY OF TDA'S STUDY WITH PANDA:

- First simulation for 4 specific scenarios done: Still under testing process.
  - $W^2 = 5\,\text{GeV}^2$, $10\,\text{GeV}^2$.
  - π^0 in forward or backward direction.

BACKGROND CHANNELS (Also for Panda-Root):

- Mainly $\bar{p}p \to \pi^+\pi^-\pi^0$.
- Angular distribution still to be determined.

W^2=5 GeV^2; π^0 Forward direction



W^2=5 GeV^2; π^0 Backward direction

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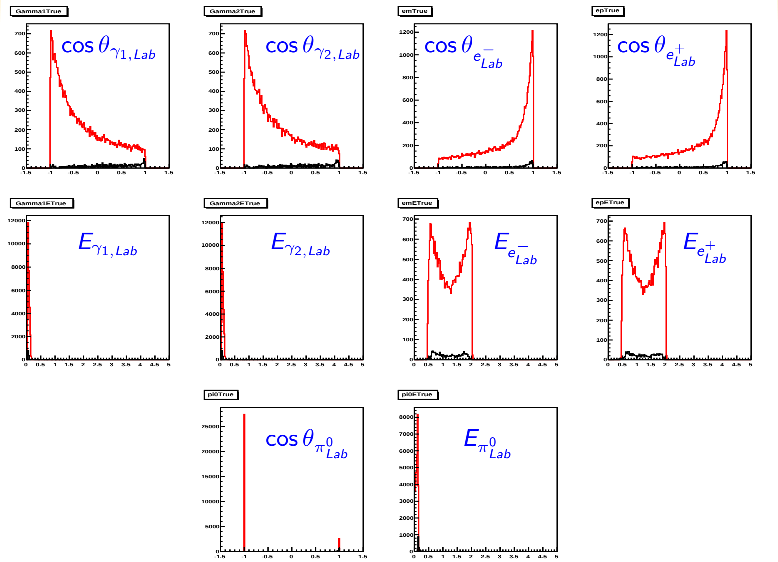
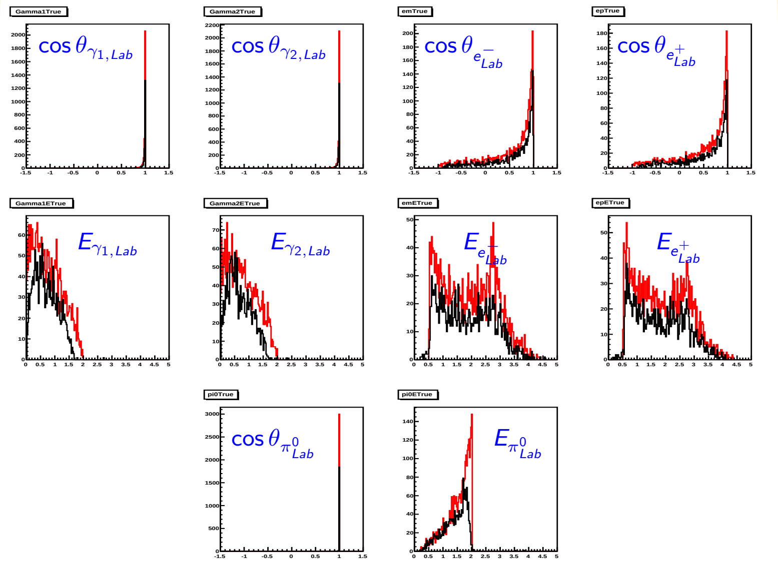
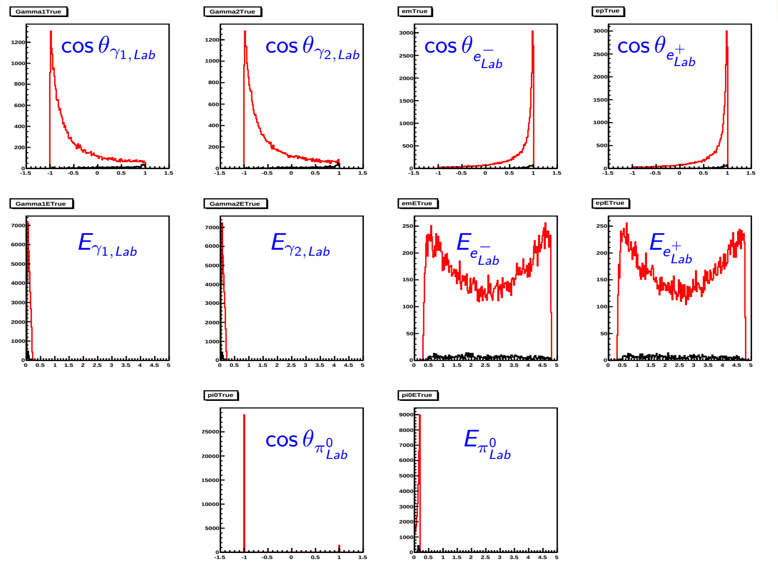


W^2=10 GeV^2; π^0 Forward direction



W^2=10 GeV^2; π^0 Backward direction



Conclusions and Outlook

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BACKWARD EMC STUDIES:

- Best approximation of MVD dead material to reality with Babar framework.
- Dead material structures of MVD and STT can be recognized in the Efficiency map.
- Good efficiency except for specific ϕ and θ angles.

EFFICIENCY AND ENERGY RESOLUTION ARE GOOD ENOUGH TO DO PHYSICS WITH THE BACKWARD END CAP CALORIMETER!!

SIMULATIONS ONGOING:

- $\bar{p}p \to e^+e^-$ ready for simulation and analysis in PandaRoot.
- $\bar{p}p \to e^+e^-\pi^0$ getting started to analyse the process in Babar-like framework.

Outlook:

- Background distribution is still unknown. We need it for develope the event generator for the simulation.

BACKUP

Q_{min}	Q_{max}	W^2	fw/bw	p($\bar{p}$)
1.9	2.3	5	1	1.45
1.9	2.3	5	0	1.45
2.4	3.2	10	1	4.29
2.4	3.2	10	0	4.29