

# Compton polarimeter simulations

PEPPo collaboration meeting

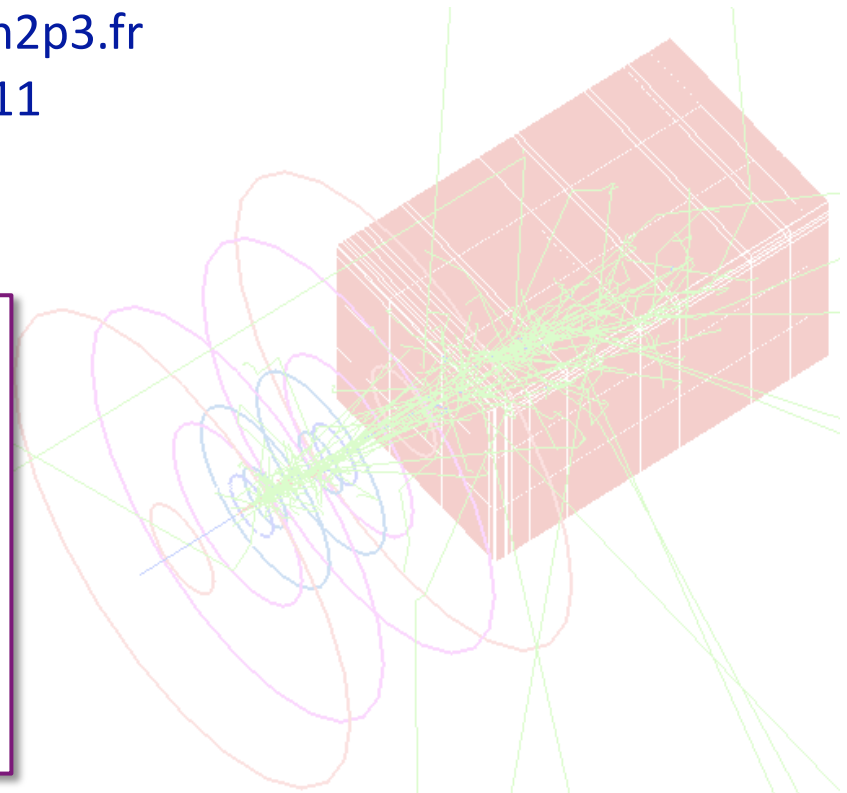
O. Dadoun, LAL Orsay & E. Voutier, LPSC

[dadoun@lal.in2p3.fr](mailto:dadoun@lal.in2p3.fr)

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## Outline

1. Experimental setup
2. E166 Asymmetry simulation
3. Asymmetry results
4. Conclusion/prospects



# Polarization e-/e+ measurement

The e- and the e+ polarization measurement is done via 2 step

- Circular polarized photon conversion (T2)
- Compton diffusion into polarized target iron magnet ( $P^{Fe}$ )

The e-/e+ polarization is deduced from the measurement asymmetry  $\delta_{e+/e-}$

$$P_{e^\pm} = \frac{\delta_{e^\pm}}{A_{e^\pm} P_{e^-}^{Fe}} \rightarrow 7\%$$

Analysing power determined by simulation

1. Integrated
2. Semi- Integrated

# Analyzing power : integrated and semi-integrated methods

## 1. Integrated energy

The electron/positron polarization is derived from the asymmetry  
For the crystal  $i$

$$A_i = (E_i^+ - E_i^-) / (E_i^+ + E_i^-)$$
$$(\delta A_i)^2 = \frac{2\mathbf{E}_i^- \mathbf{E}_i^+}{(\mathbf{E}_i^- + \mathbf{E}_i^+)^2} \sqrt{\left(\frac{\delta \mathbf{E}_i^+}{\mathbf{E}_i^+}\right)^2 + \left(\frac{\delta \mathbf{E}_i^-}{\mathbf{E}_i^-}\right)^2}$$

## 2. Semi integrated for a crystal $i$ in the energy bin $j$

$$A_i = \left[ \sum_j A_{ij} / (\delta A_{ij})^2 \right] / \left[ \sum_j 1 / (\delta A_{ij})^2 \right]$$
$$(\delta A_i)^2 = \left[ \sum_j 1 / (\delta A_{ij})^2 \right]^{-1}$$

# Analyzing power : integrated and semi-integrated methods

## 1. Integrated energy

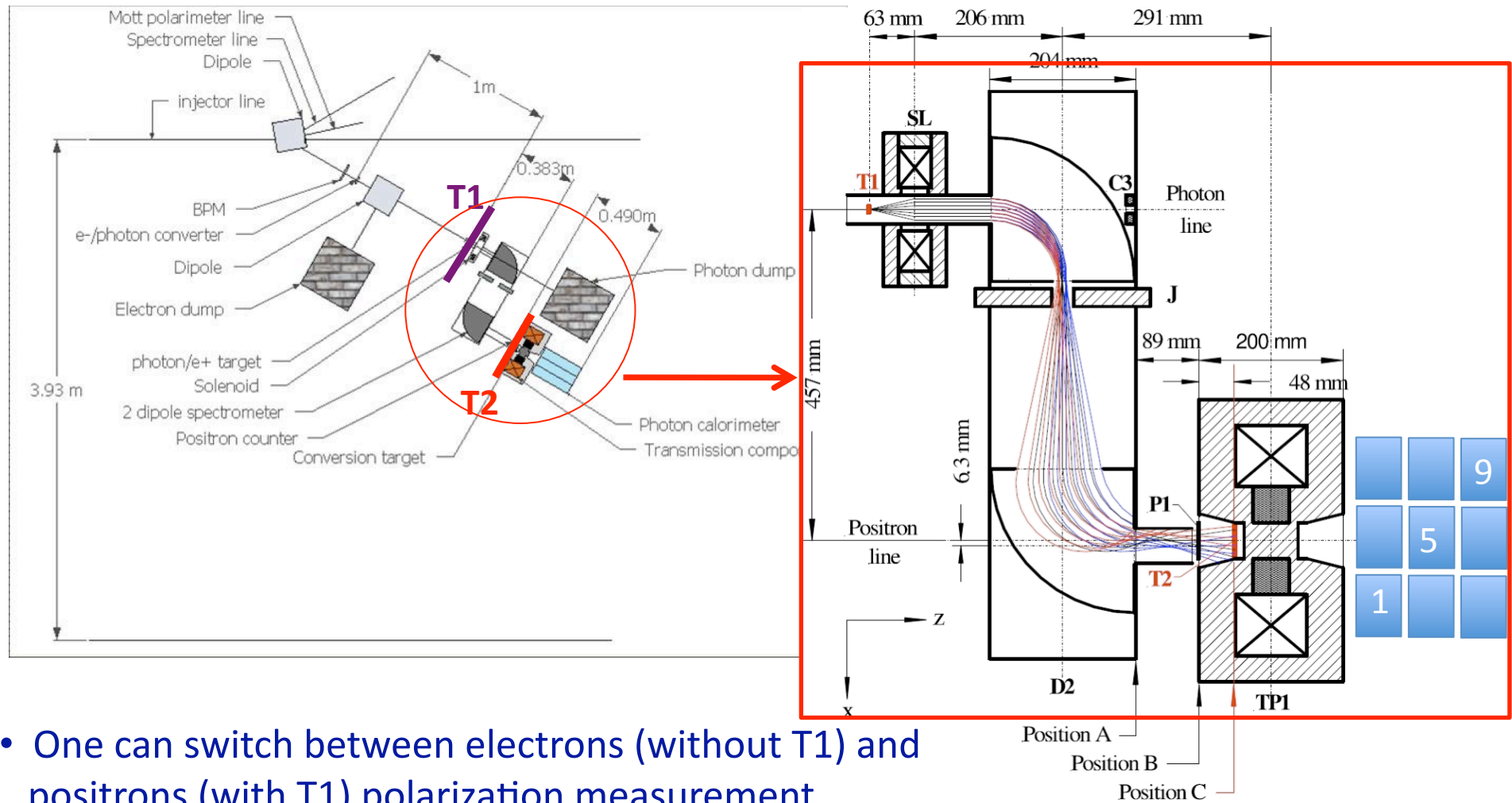
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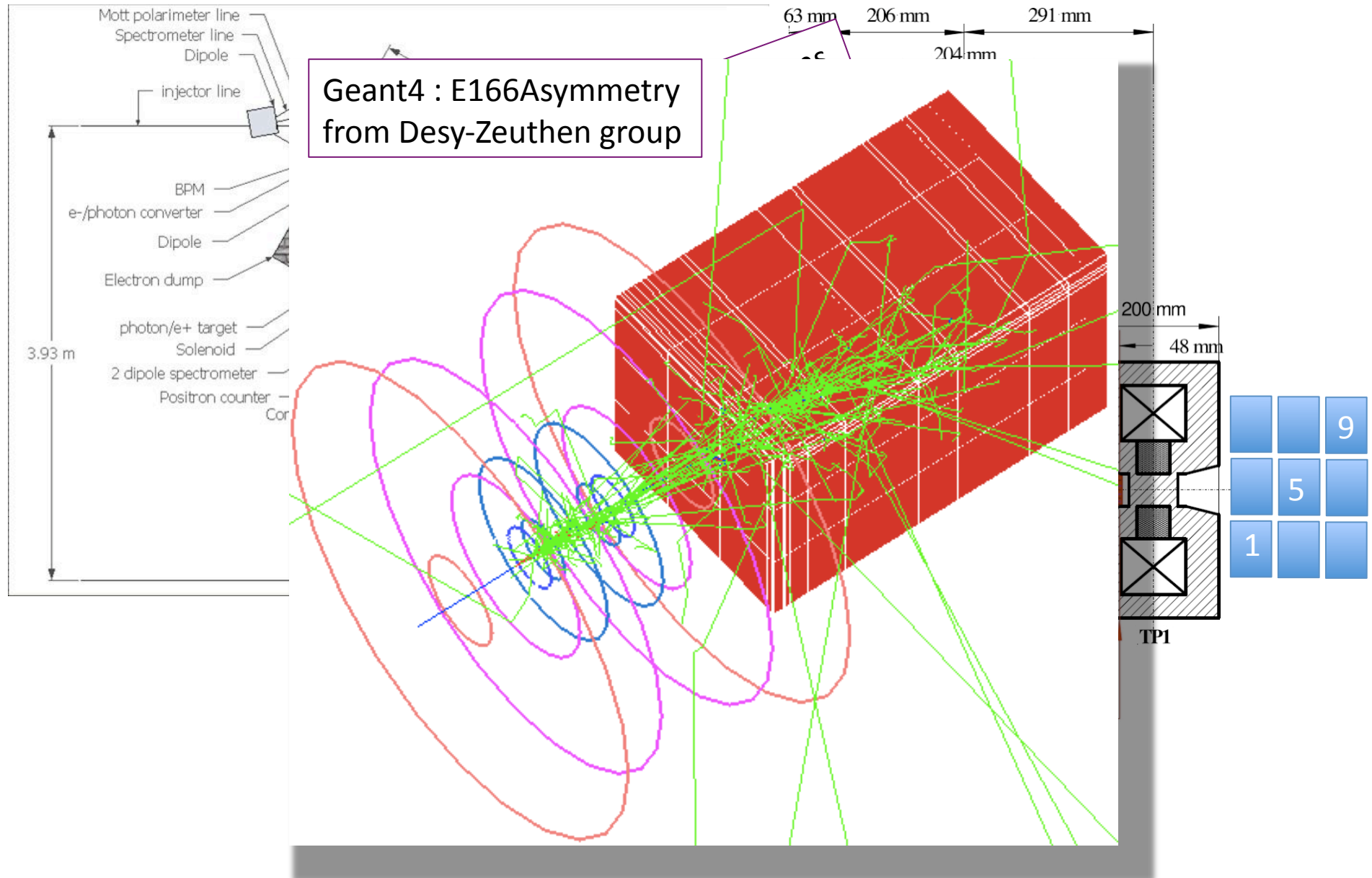
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# Schematics of the $e^+/e^-$ polarization analysis



- One can switch between electrons (without T1) and positrons (with T1) polarization measurement
- In both case the photon conversion target T2 needed for the analyzing magnet
- Initial electron polarization can be flipped
- Target polarization can be also flipped

# Schematics of the $e^+/e^-$ polarization analysis

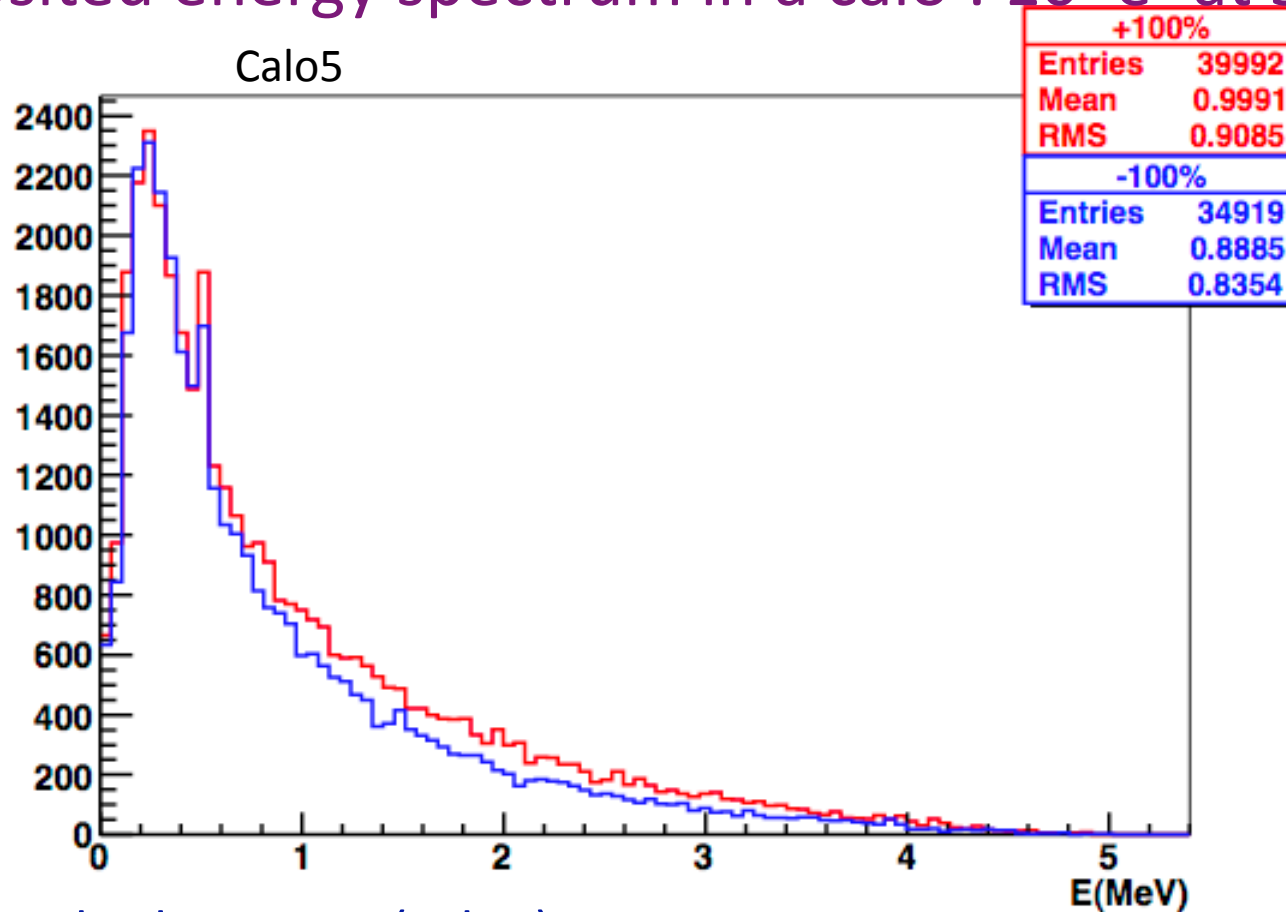


## E166Asymmetry a Geant4 simulation based

- Geant4 description of the E166Asymmetry's Compton transmission calorimeter :
  - Target reconversion T2 :  $0.5 X_0[W]=1.75$  mm
  - Iron core 75 mm, to improve the statistical significance 100% is taken
  - 9 CsI calorimeter crystals of 60mm × 60mm × 300mm
- Comments:
  - The real target is 2mm of Densimet D17K, which has a nominal composition of 90.5% W, 7% Ni, and 2.5% Cu (see E166 Nim paper)
    - Calliper to confirm
  - Real target polarization around 7%

Modification in the code have been done to provide ROOT output file (more simple to handle and reduced disk space)
- Simulations:
  - For electrons and positrons  $100 \times 10^7 = 10^9$  particles  
With 100% of polarization (to improve the stat.)
  - No spatial extension have been taken into account

# Deposited energy spectrum in a calo : $10^7$ e<sup>-</sup> at 5MeV



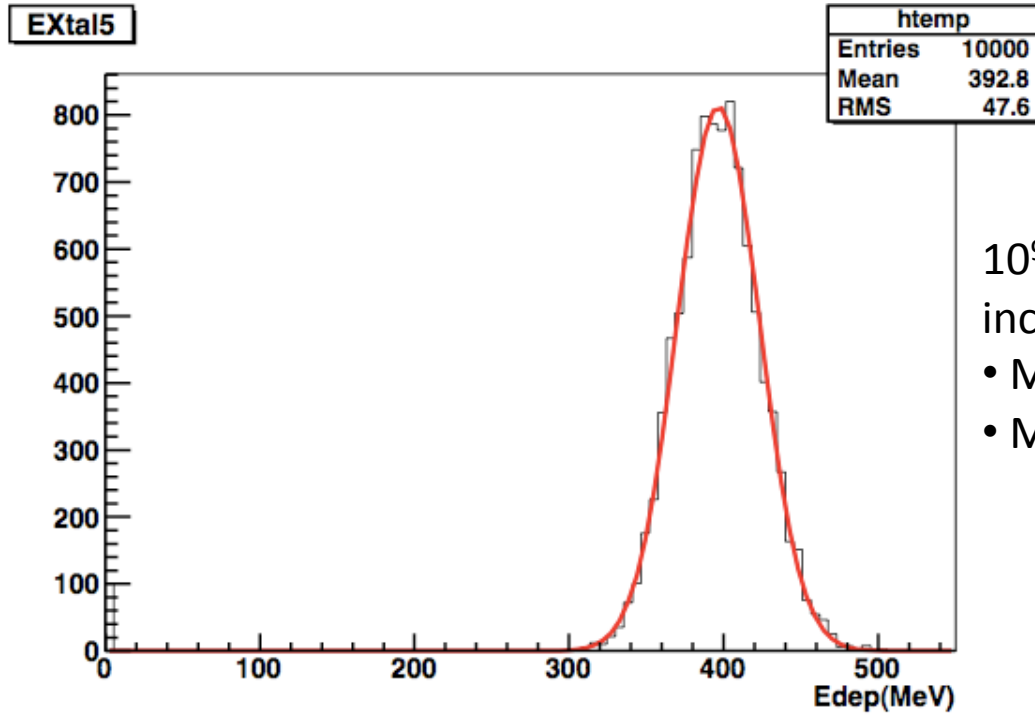
For the central calorimeter (calo5)

Mean energy deposited :  $\sim 1$ . MeV (0.08% of the incident energy e<sup>-</sup> beam)

Deposited energy distribution have been done and fitted

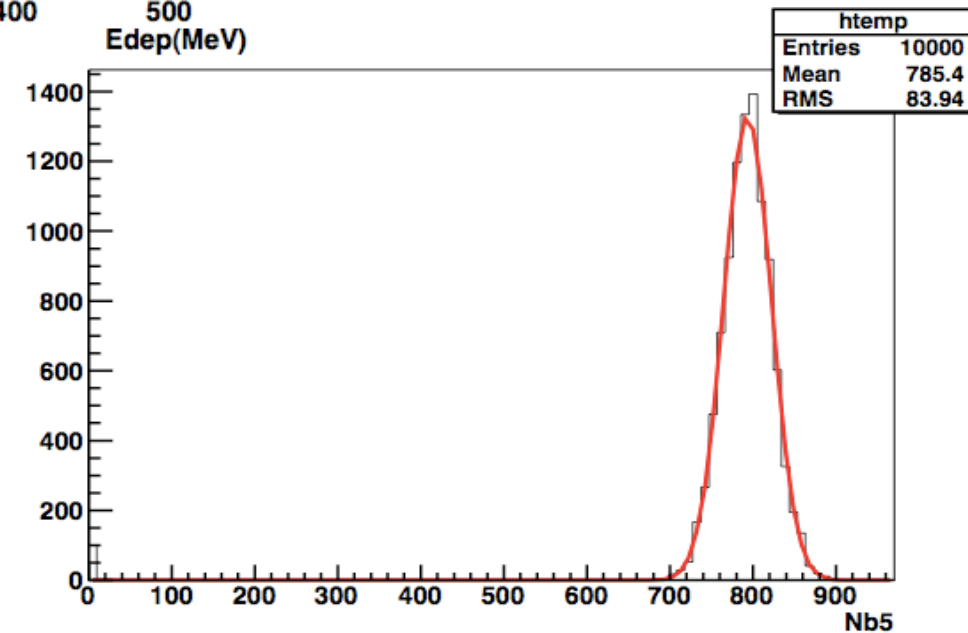
for both polarization, all the calo and all the energy (both e<sup>-</sup> and e<sup>+</sup>)

# Total energy deposited in calo5 for pola +100% ( $10^9$ events)



$10^9$  Events e-(e+) with respect to the incident beam:

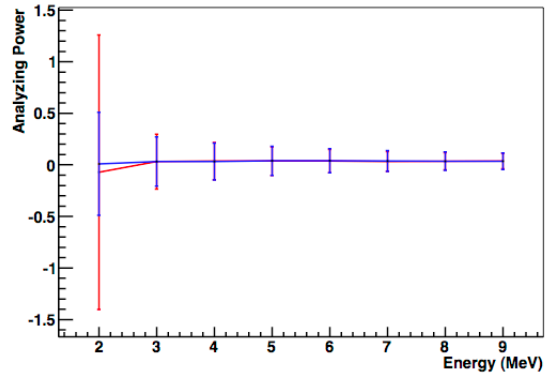
- Mean energy deposited :  $\sim 0.079\%$
- Mean hits : 0.8 %



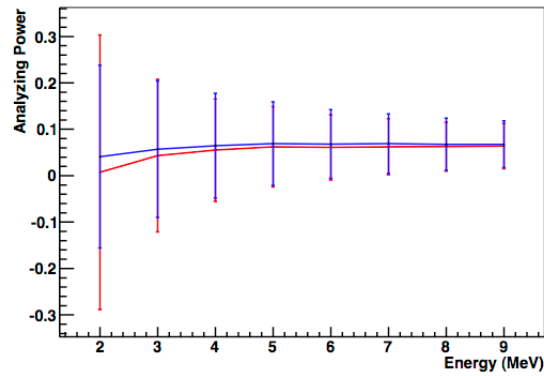
# Analysing power

Red curves are the electrons  
Blue curves are the positrons

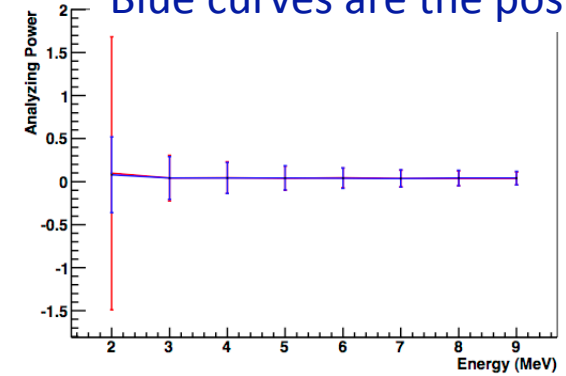
Crystal7



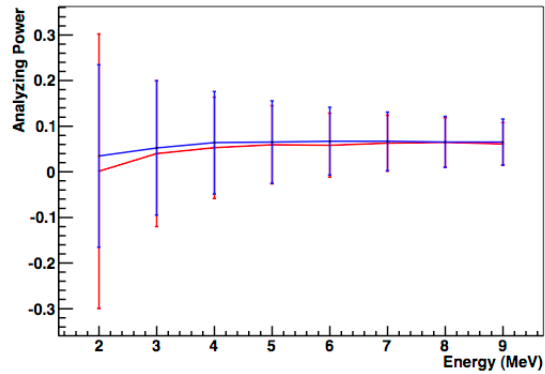
Crystal8



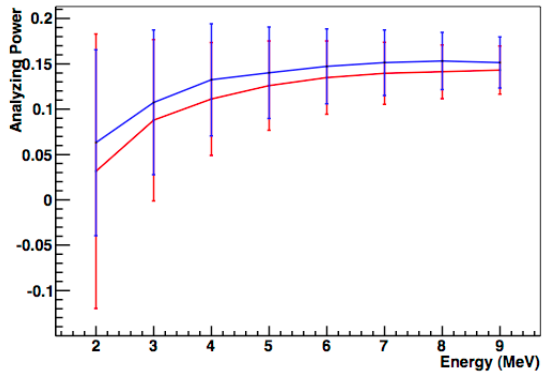
Crystal1



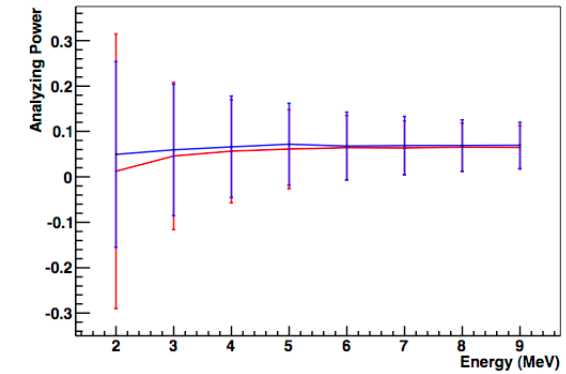
Crystal4



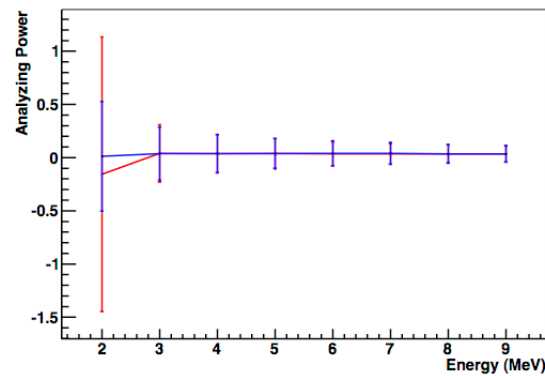
Crystal5



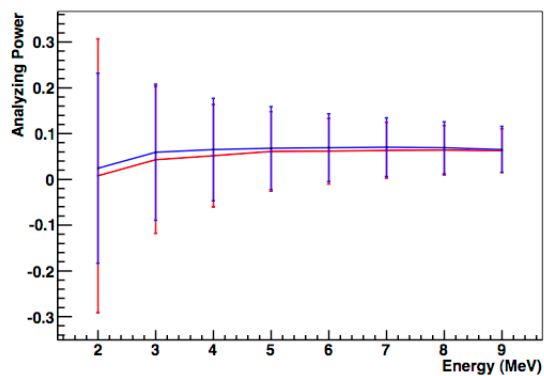
Crystal6



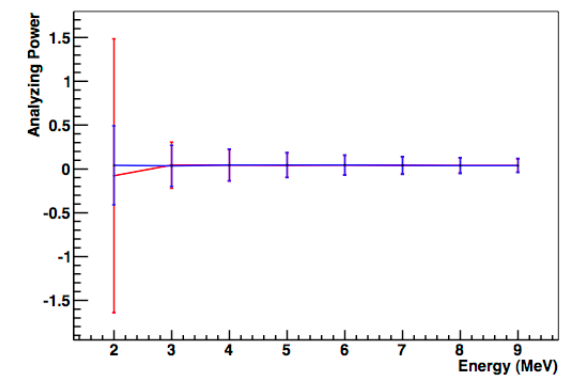
Crystal1



Crystal2

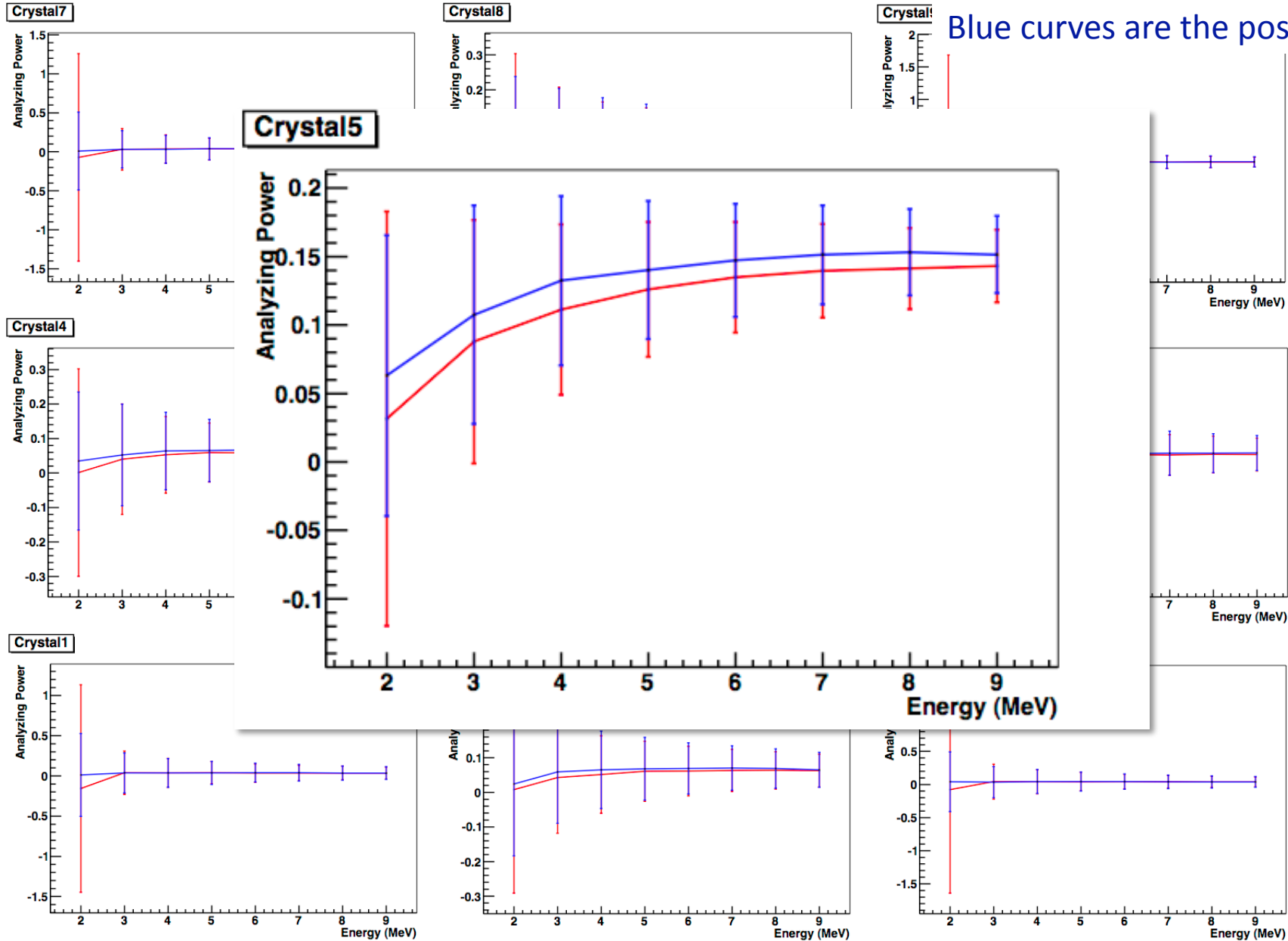


Crystal3



# Analysing power

Red curves are the electrons  
Blue curves are the positrons



## Conclusion & prospects

- Larger statics is required
  - Few days on CCIN2P3 Linux farm was needed to provide  $100 \times 10^7 \times 2$
  - Use the JLAB's Farm & Grid
  - All the post analysis is done need only time (or manpower) to do it ...
- Semi-integrated method currently under consideration
- Prospects:
  - What is the implication of the real field map ?
  - Phase distributions of the impinging e-/e+ (on T2)
- One can evaluate the "beam time" needed for the PEPPo experiment

$$t = e / (I \times \epsilon P_t^2 \times A_e^2 \times \delta P^2)$$

(See Eric' talk)

- Studying the possible misalignments of the calorimeter