Symmetric Møller/Bhabha Luminosity Monitor for the OLYMPUS experiment

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OLYMPUS

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Outline

- Symmetric Møller/Bhabha Luminosity Monitor
  - Expected rate (Møller, Bhabha, Annihilation)
  - Analysis method of ADC spectra
  - Rate vs. beam current
    (Check of linearity)
  - Check trigger efficiency
  - Beam position scan
  - Beam position vs. beam current
  - Elastic scattering
  - SYMB alignment
  - Summary

Symmetric Møller/Bhabha Luminosity Monitor

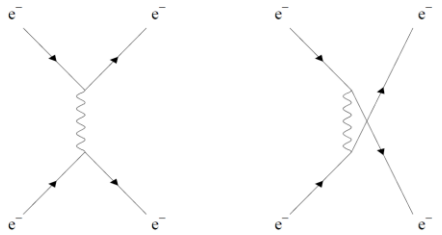
- **Møller Cross Section**

$$\left(\frac{d\sigma}{d\Omega_{CM}}\right)_{M\phi ller} = \frac{\alpha^2}{2s}\cdot\left(\frac{t^2+tu+u^2}{tu}\right)^2$$

$$\left(\frac{d\sigma}{d\Omega_{LAB}}\right)(\theta_{LAB}) = 88,944\,\mathrm{mbarn/sr}$$

Single arm rate

➡ 6.23KHz

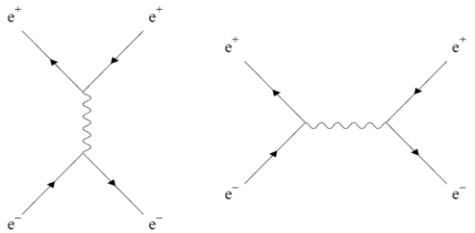


- **Bhabha Cross Section**

$$\left(\frac{d\sigma}{d\Omega_{CM}}\right)_{Bhabha} = \frac{\alpha^2}{2s}\cdot\left(\frac{t^2+ts+s^2}{ts}\right)^2$$

$$\left(\frac{d\sigma}{d\Omega_{LAB}}\right)(\theta_{LAB}) = 22,192\,\mathrm{mbarn/sr}$$

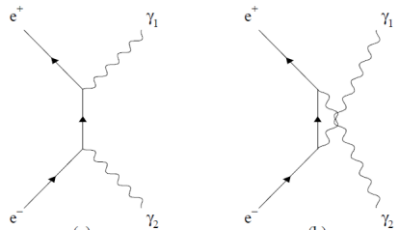
➡ 2.94KHz



- **Annihilation Cross Section**

$$\left(\frac{d\sigma}{d\Omega_{CM}}\right)_{Paarvernichtung} = \frac{\alpha^2}{2s}\cdot\left(\frac{u}{t}+\frac{t}{u}\right)$$

$$\left(\frac{d\sigma}{d\Omega_{LAB}}\right)_{Paarvernichtung}(\theta_{LAB}) = 19,768\,\mathrm{mbarn/sr}$$



Nominal Luminosity at 50mA in Olympus

Nominal Luminosity 2×10^{33}

Coincidence rate about 1.5 times less due to solid angle

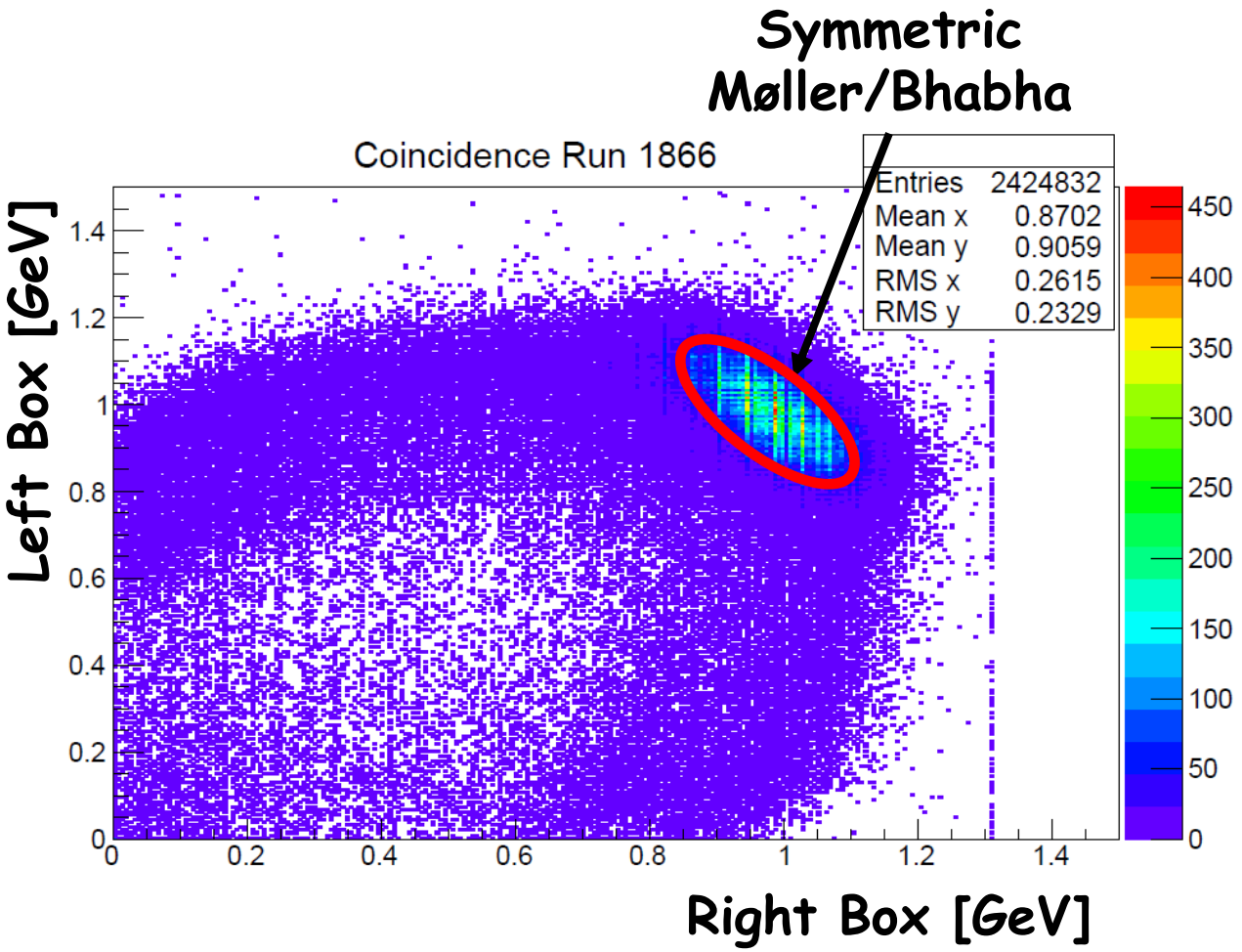
ADC Spectra

Elliptical cut on the Møller Bhabha signal peak

Problem:

This cut changes with

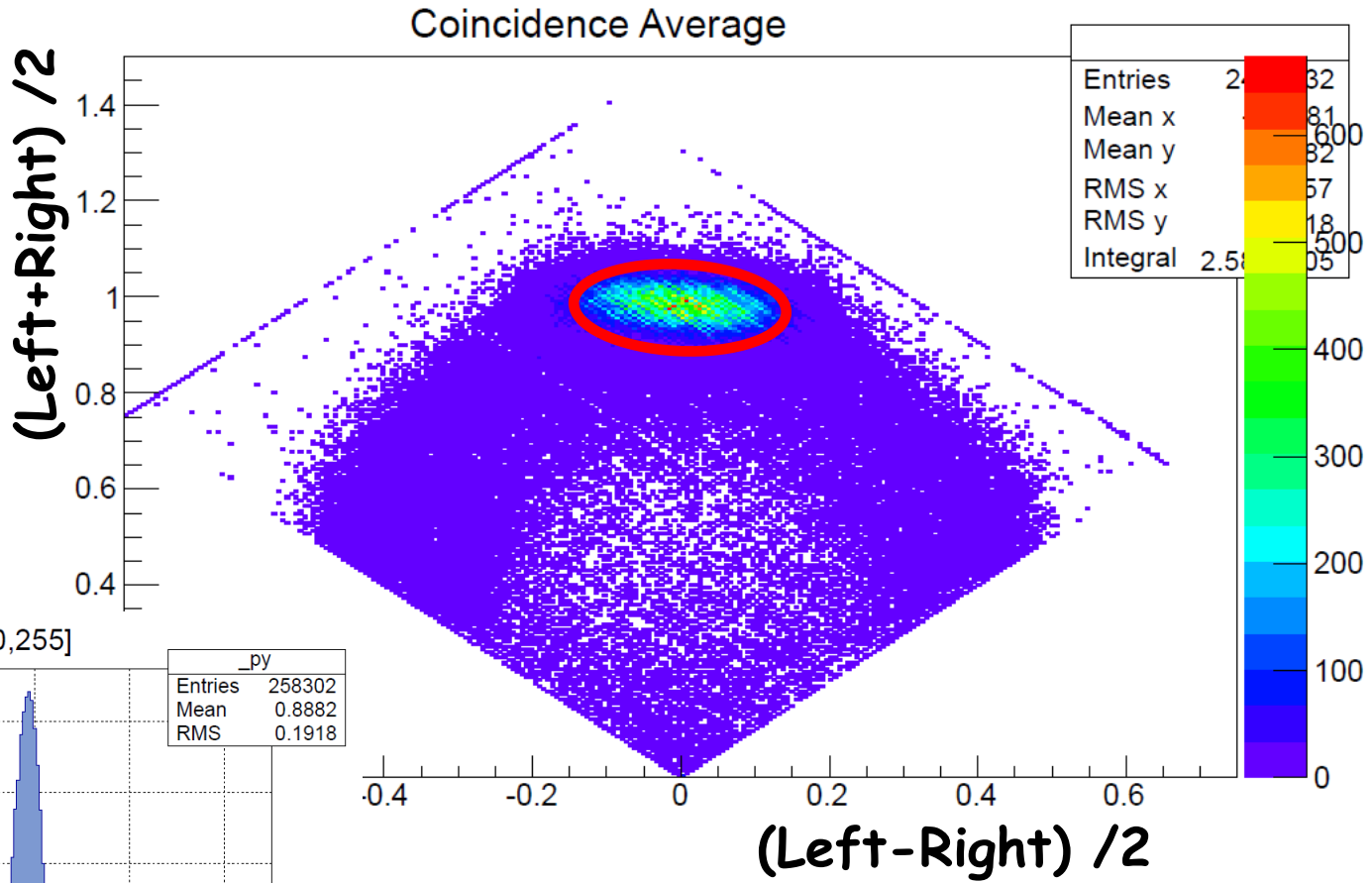
- beam species
- magnet polarity



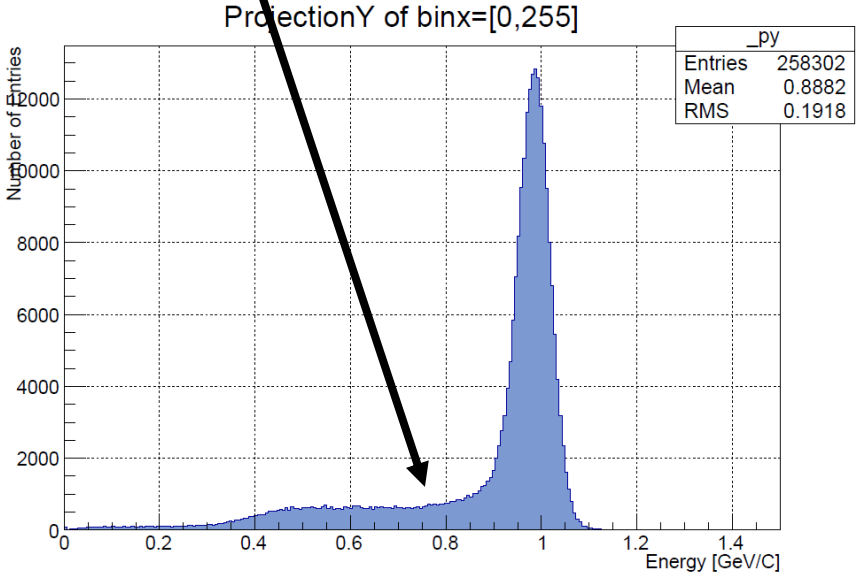
Normalize ADC axis

Analysis method

Elliptical cut on the Møller Bhabha signal peak is now stable

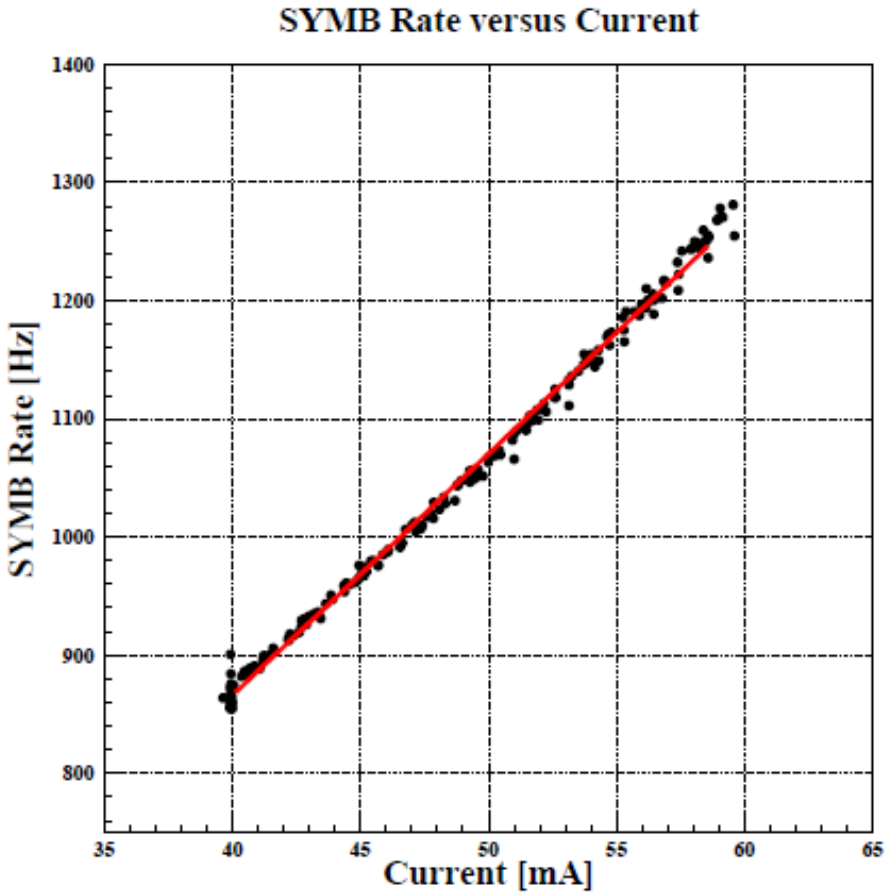


Small portion of background is removed by this elliptical cut



Rate vs. beam Current, check of linearity

$$\text{Rate} = \frac{\text{SYMB Count and DAQ UP}}{\text{Clock and DAQ UP}}$$

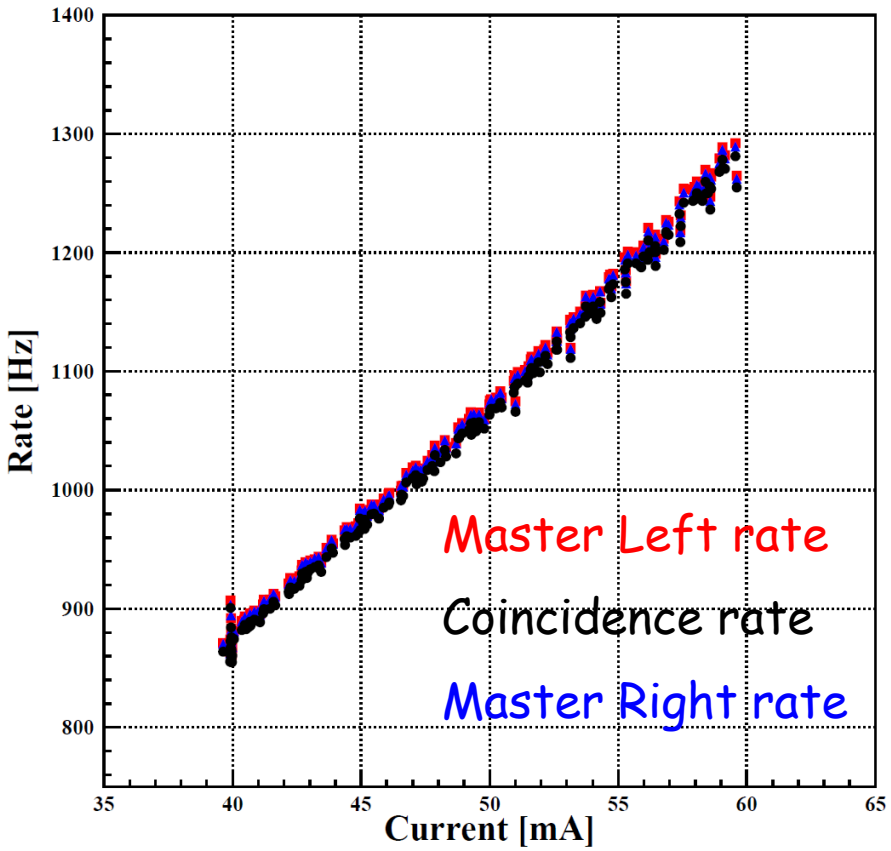


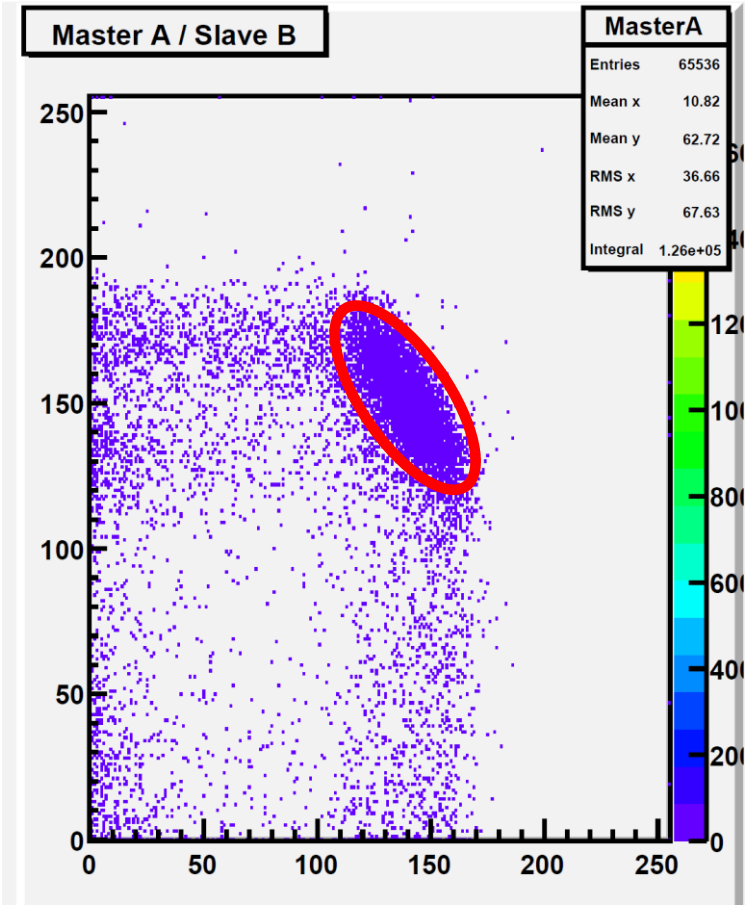
Coincidence rate
Linear fit

Electrons, negative magnet polarity (12/02/2012)

Check Trigger efficiency

$$\text{Rate} = \frac{\text{SYMB Count and DAQ UP}}{\text{Clock and DAQ UP}}$$





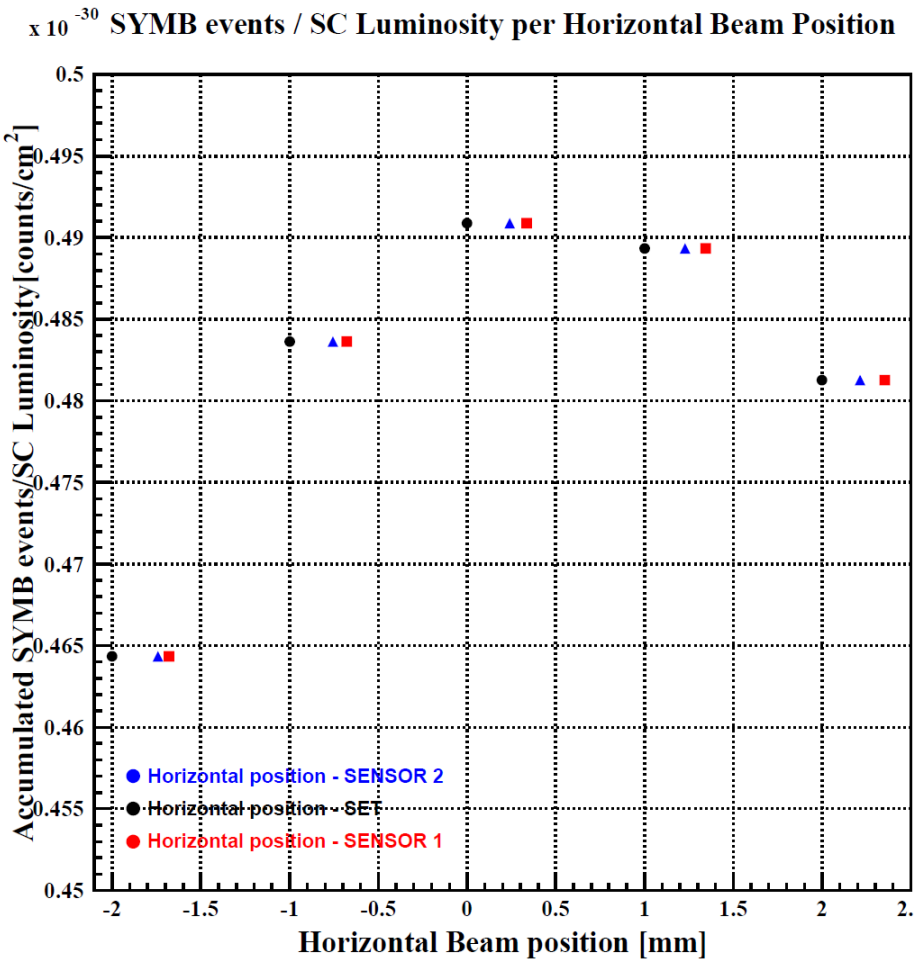
Trigger efficiency : 98 to 99 %

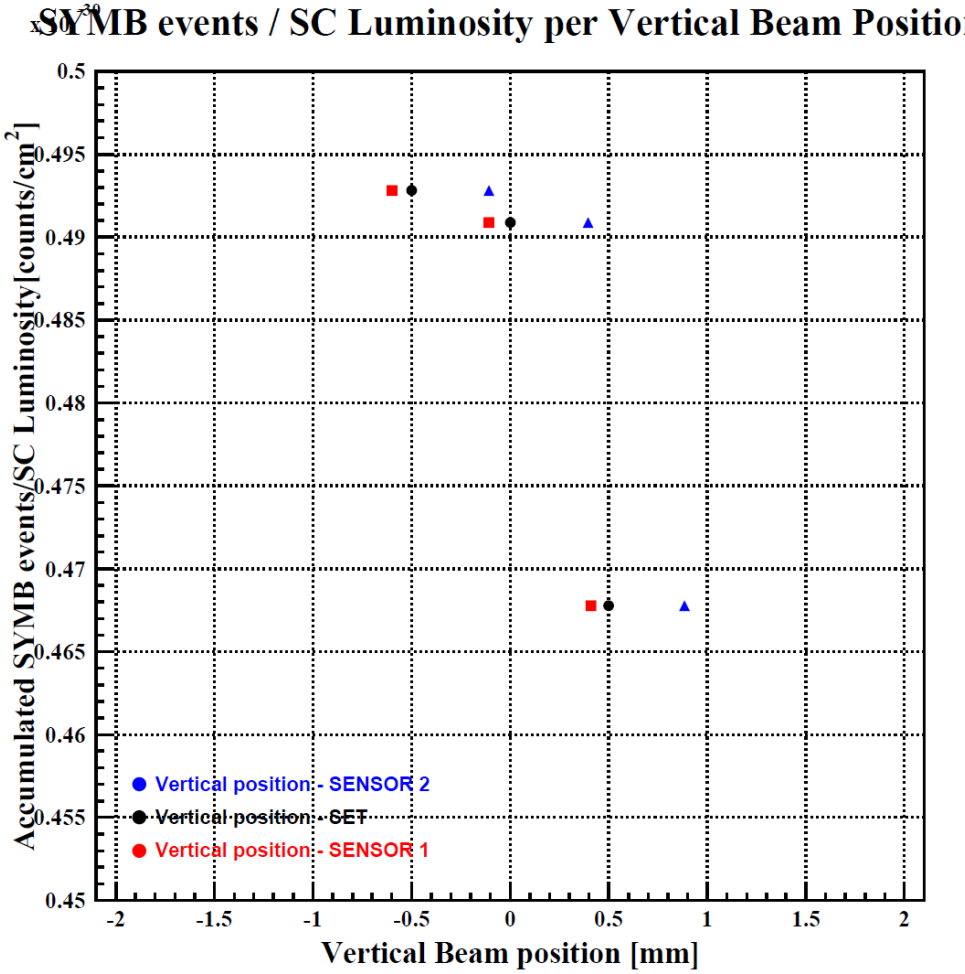
Electrons, negative magnet polarity (12/02/2012)

Beam position scan

Run taken especially to study the influence of the beam position on the rate

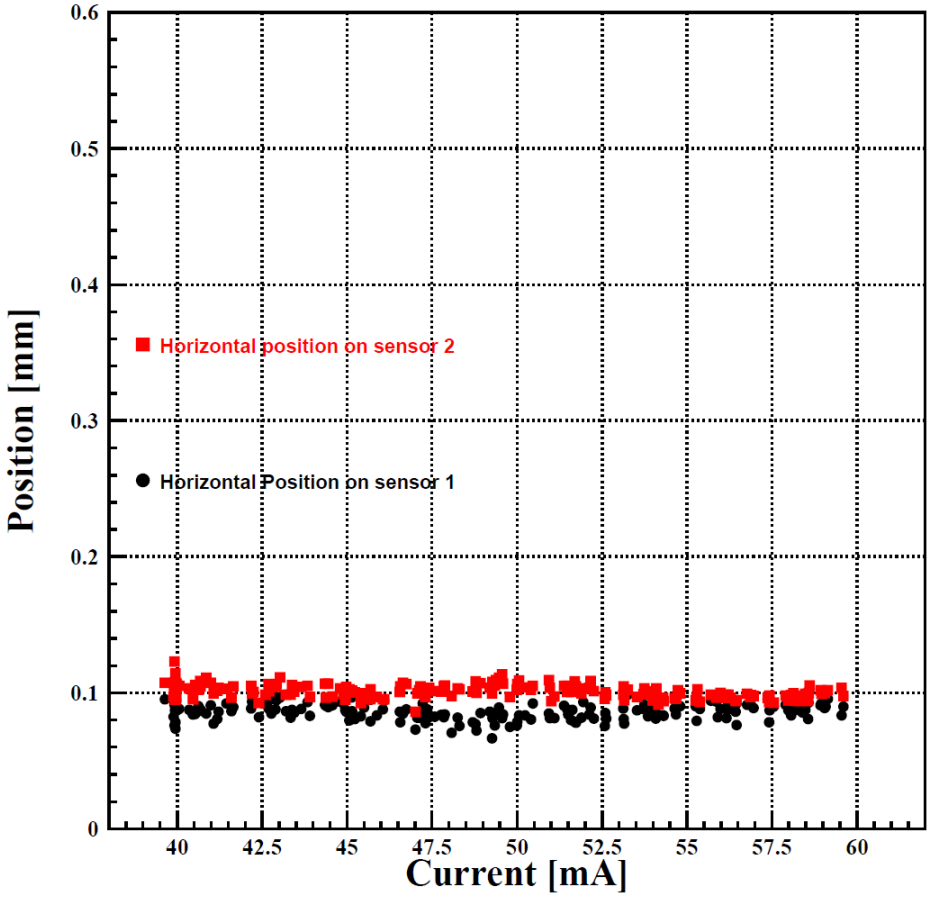
Rate change : 5%

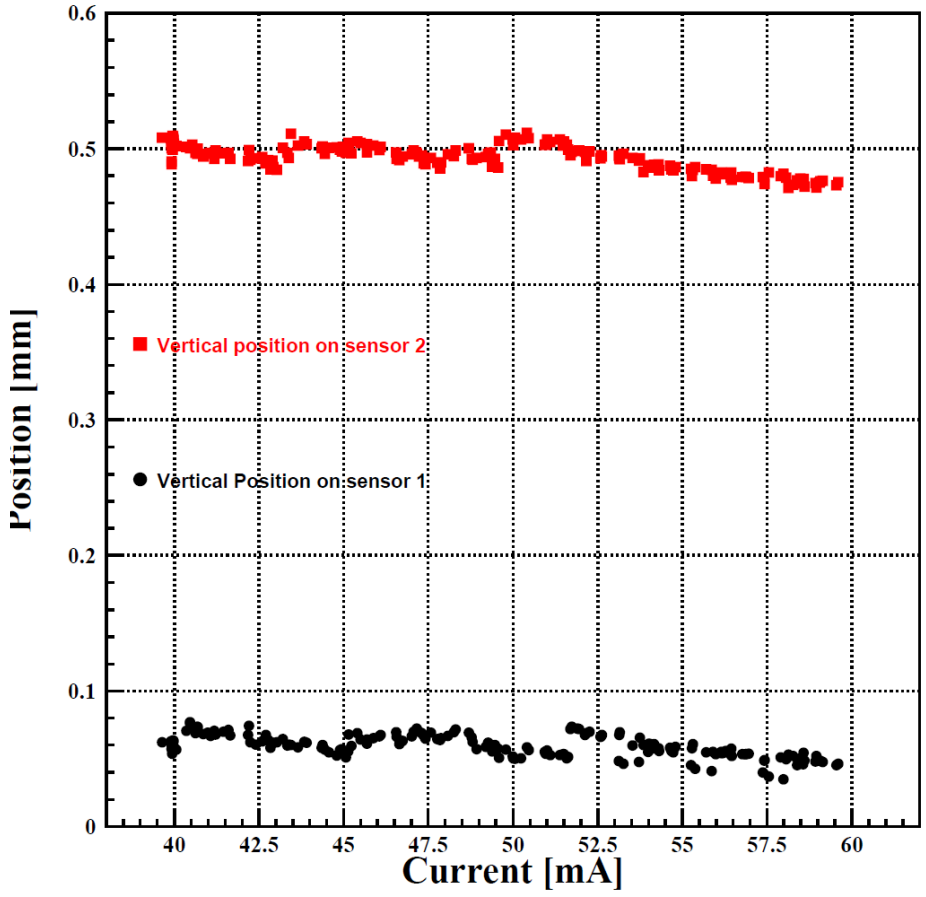




Beam position vs. beam current

Slight position change during run may cause rate changes



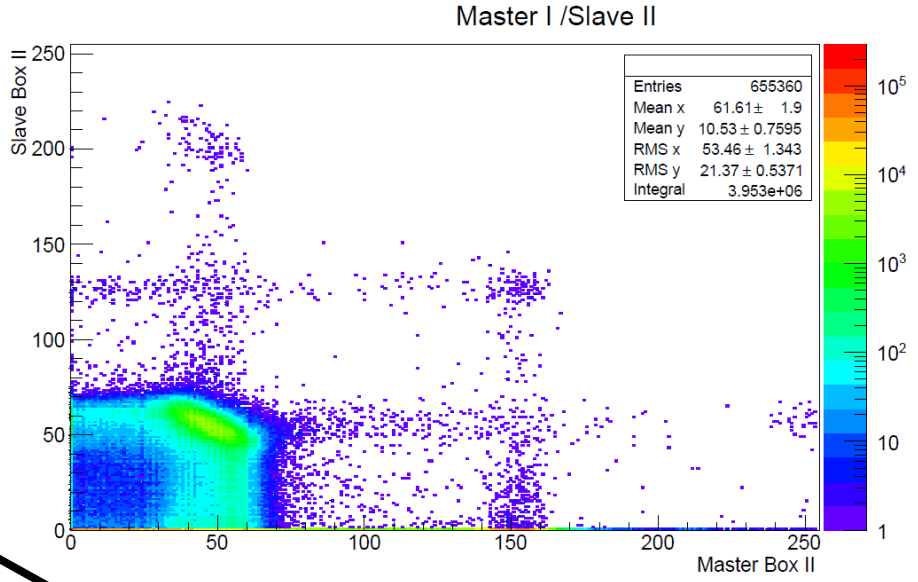


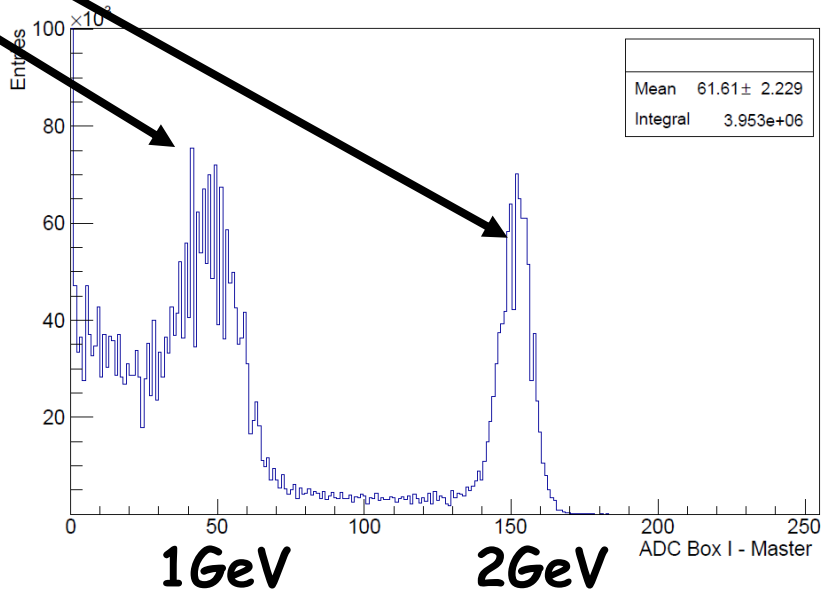
Electrons, negative magnet polarity (12/02/2012)

Elastic Scattering - Quick and Dirty

Elastic electron proton

Symmetric Møller/Bhabha



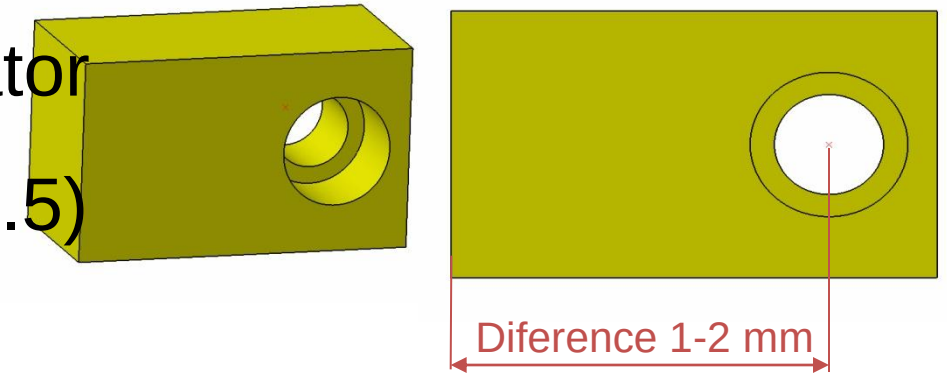


Pedestal at -25 ADC Channel

HV was not optimized
150V lower than calibrated
to see elastic scattering

Alignment of SYMB-collimator

(search for missing factor 3.5)



Rough measurement of **position of the channel/hole** of the left collimator (badly accessible now): possible offset of 1-2 mm wrt lead body

Investigation and discussion with Martin Noak (MEA2 group):

- Survey of collim. hole wrt. 6 SYMB reference “nests”: 0.20 mm acc.
- SYMB moved to “in beam” (by use of end switches)

  (reproducibility needs to be checked, assume for now) 0.30 mm acc.
- Alignment to DORIS/Olympus reference system: 0.30 mm acc.
- Alignment of **collimator exit hole center and collimator surface**

  wrt Doris ref. system (possible misalignm. channel axis by 0.08°)

  0.15 mm acc.

Worst, worst case: **channels in collimator off by 1mm (0.3 mrad= 0.02°)** (regardless of position wrt lead brick)

But: possible offset of PbF_2-calorimeter of 1-2 mm (no effect, 10% of R_M)

Possible misalignment by 1 mm not explanation for missing factor 3.5

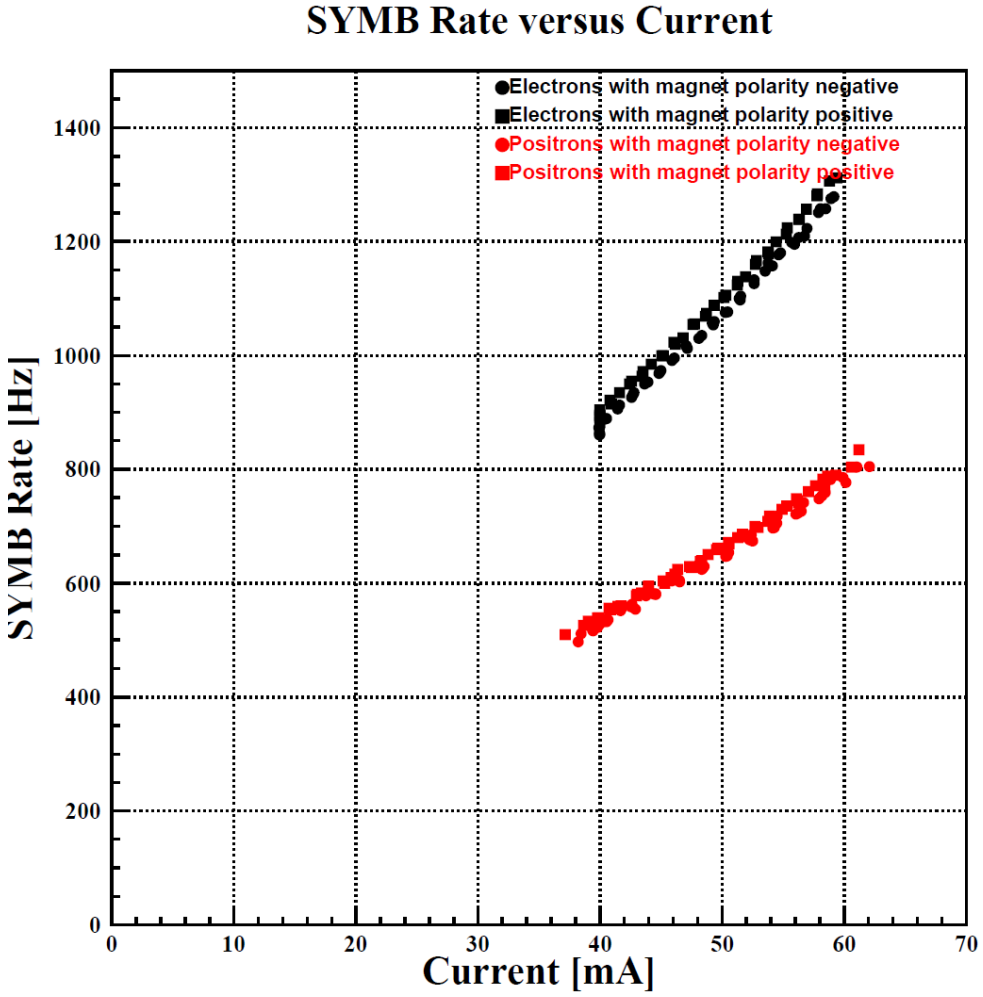
Next steps in SYMB alignment

- **Verify present alignment** with respect to DORIS/Olympus at current position
- Verify **reproducibility of end switches** at “in beam”-position
  (goal get reproducability accuracy to much better than 0.3 mm)
- **Resurvey and realign the detector**
  (Improve precision of channels angle, get rid of 0.15mm uncertainty)
- For this purpose we need to **dismount** cables, crystals and boxes
- Scheduled for **June, 4-11** access (confirmation pending from MEA2)

Final goal: alignment accuracy: 0.5 mm (at present 1mm)

Summary

- We observe a factor of about 3.5 missing in all rates
- Check of electron – positron ratio correct
- Check of linearity of rate vs. current
- Check of trigger efficiency : 98 to 99%
- Check of linearity of analog signal (Moeller vs. elastic)
- SYMB seem to work correctly, target density missing?
- Continue analysis of data
  (include position and angles corrections)


SYMB Rate versus Current
Electrons with magnet polarity negative
Electrons with magnet polarity positive
Positrons with magnet polarity negative
Positrons with magnet polarity positive
SYMB Rate [Hz]
Current [mA]
0
200
400
600
800
1000
1200
1400
0
10
20
30
40
50
60
70