MEG実験における
ビームチューニング

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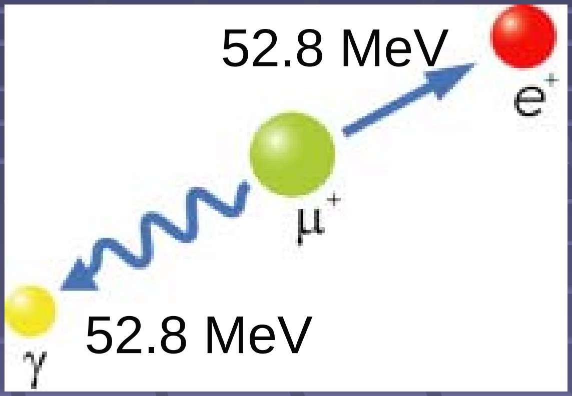
MEG Experiment

- Observe the decay
  $\mu^{+} \rightarrow e^{+} + \gamma$
- Search for the faint sign of SUSY
- LFV → beyond Standard Model



Rare decay

Experiment:
current upper limit $Br(\mu^{+} \rightarrow e^{+}\gamma) \leqq 1.2 \times 10^{-11}$ *

Theory:
$10^{-15} \leqq Br(\mu^{+} \rightarrow e^{+}\gamma) \leqq 10^{-11}$ (SUSY-GUTs)

Strong beam intensity is needed

* M.L.Brooks et al., Phys. Rev. Lett. 83, 1521 (1999)

Motivation for Beam tuning

Aim at ~10^8 stopping μ^+/s in a $\sigma x \sim \sigma y \sim$ 1cm spot

Beam tuning is essential for MEG Experiment

PSI (Paul Scherrer Institut) in Switzerland possesses the most intense DC proton accelerator in the world.

The accelerator routinely achieves a 1.1MW DC proton beam of 1.85mA

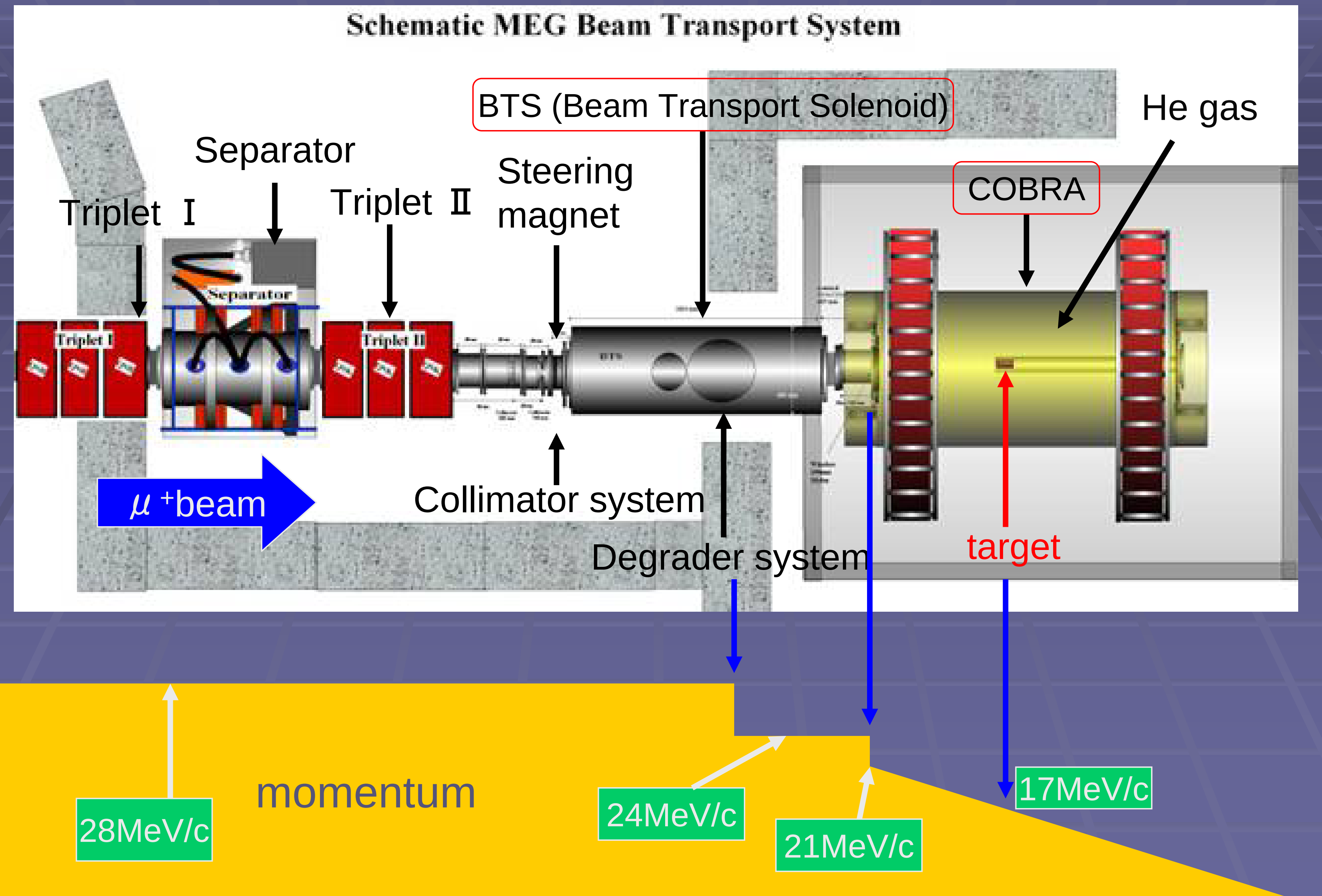
Purpose

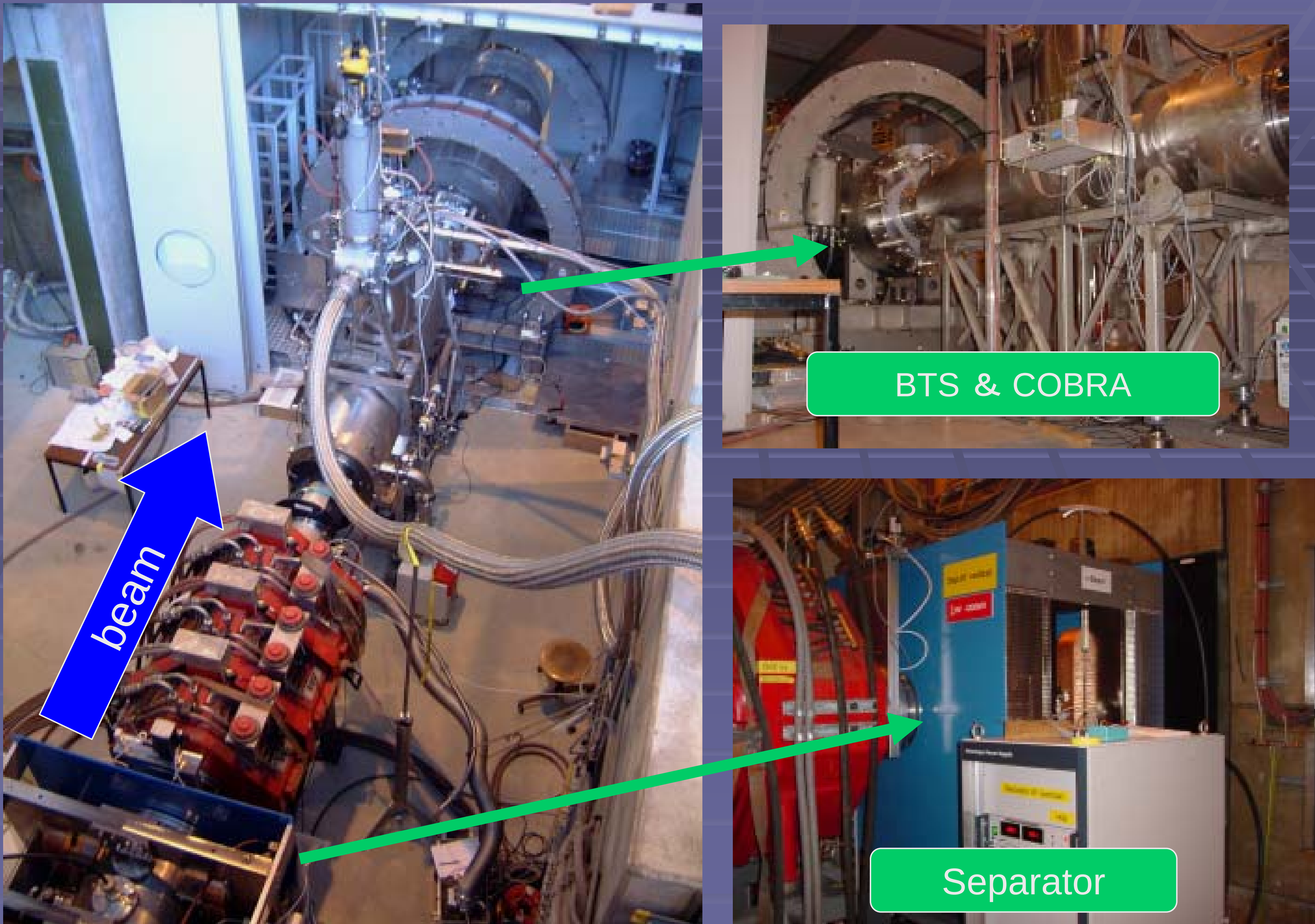
10^8 muon rate at target point
after beam tuning

1st beam injection to target point

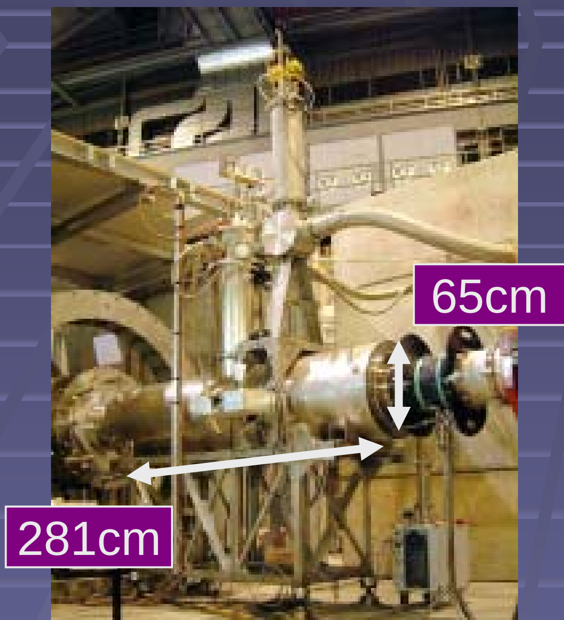
No degrader system → The situation is slight different from that of physics run.

Beam line in the Experimental area

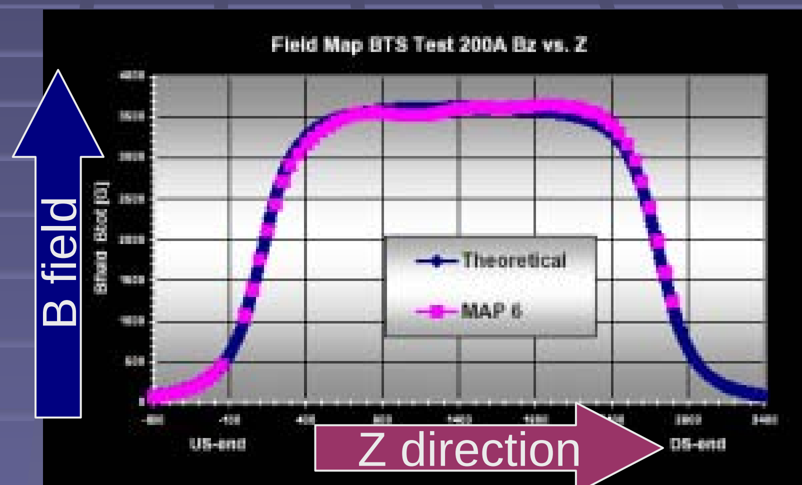



beam
BTS & COBRA
Separator

BTS (Beam Transport Solenoid)

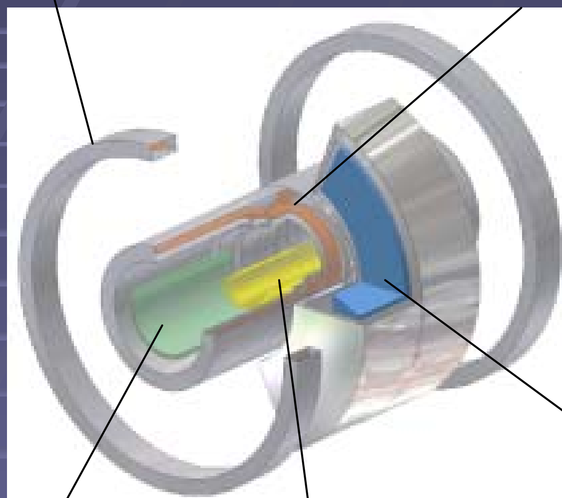


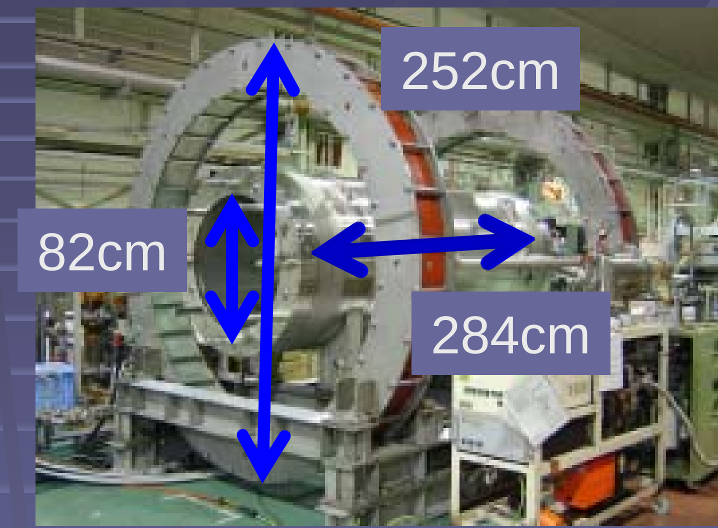
- Superconducting
- Solenoidal magnetic field (3.55kG)
- Double focus @center for momentum degrader system (480 μ CH_2)

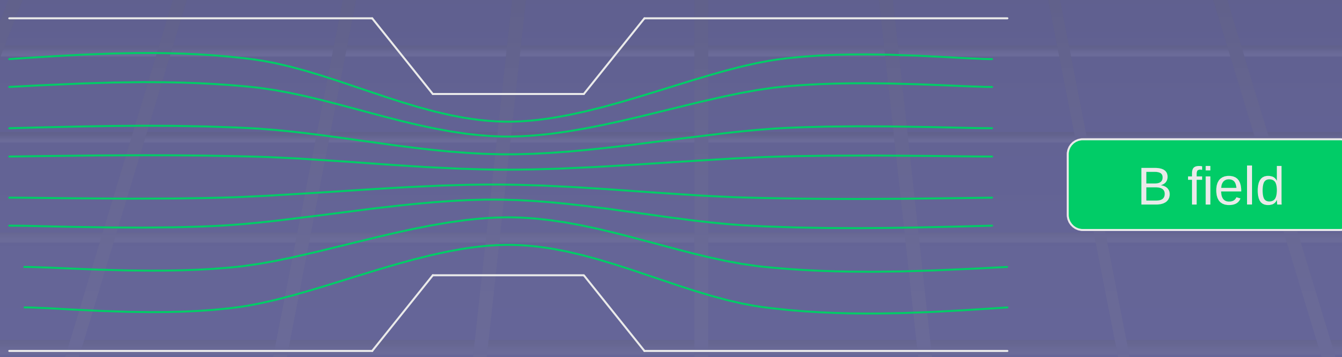


COBRA Spectrometer (filled with He)

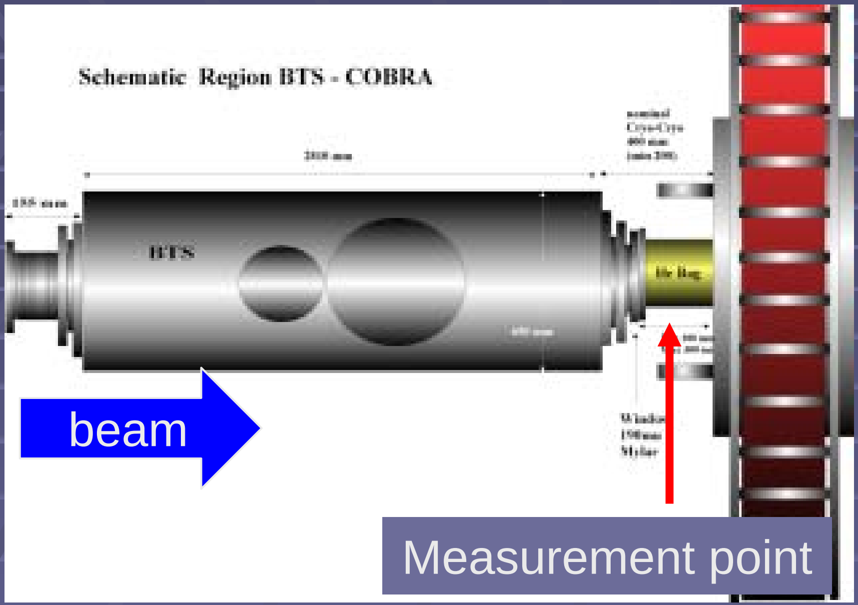
COnstant-Bending-RAdius spectrometer



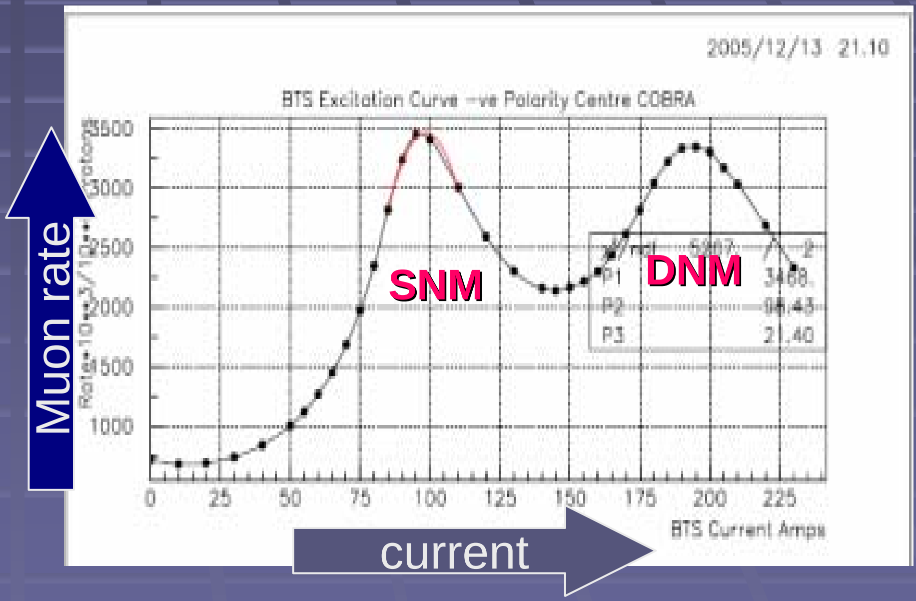


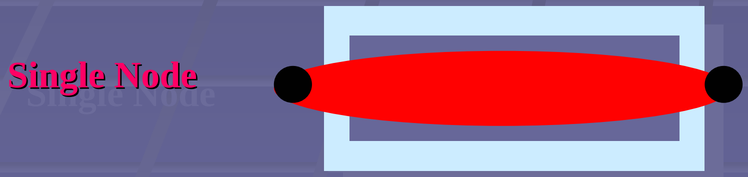


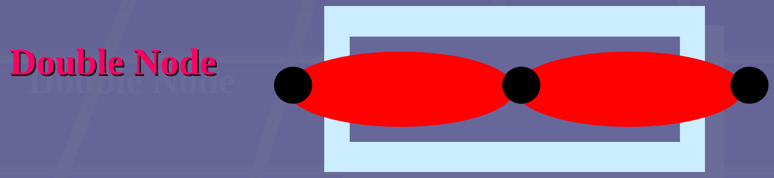
Beam tuning in BTS



- Tunes until muon rate maximum

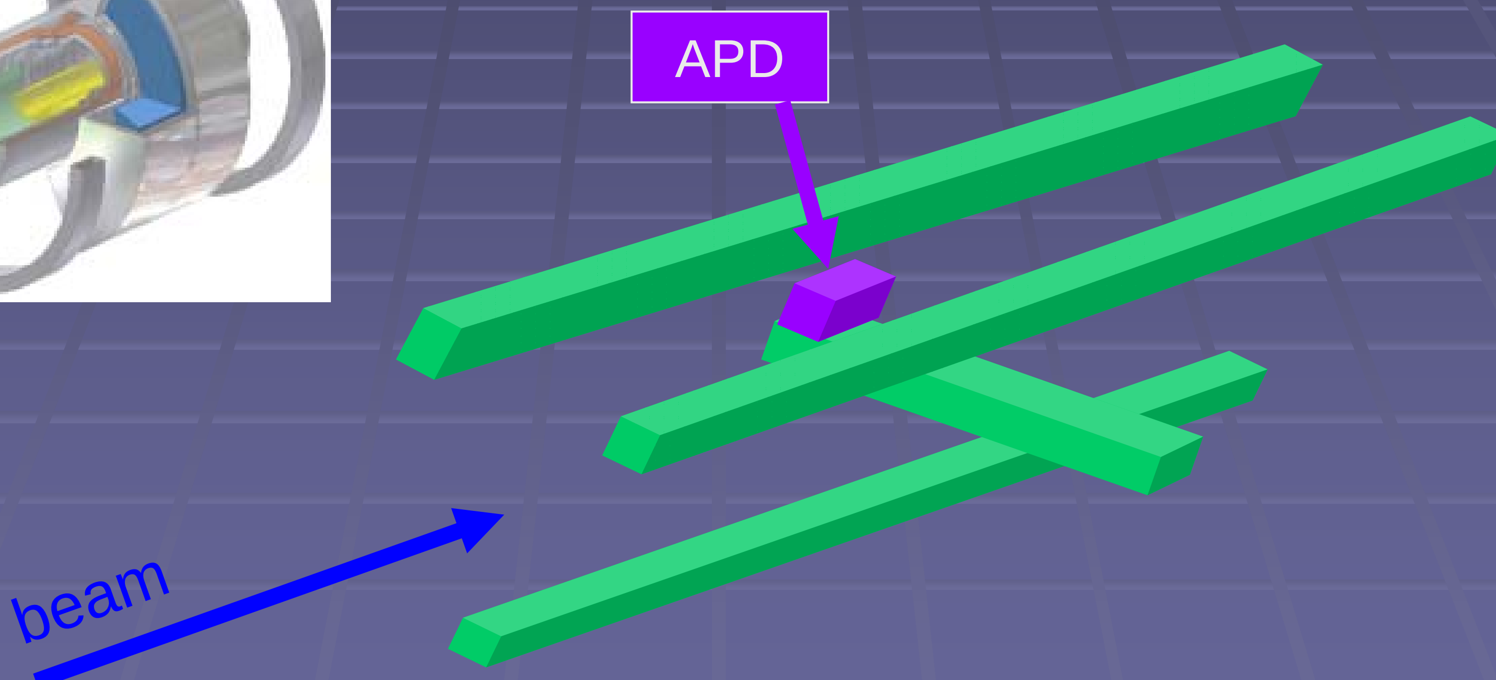






Method to examine tuning

3-D phase space measured in COBRA volume



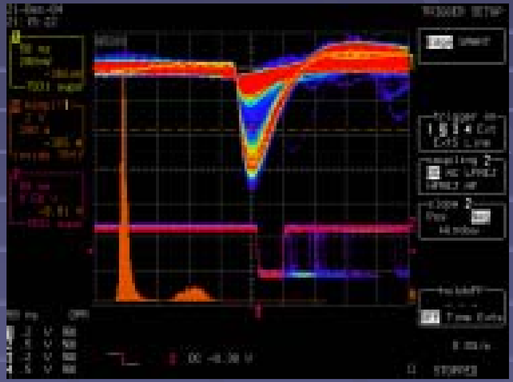
Filled with He in COBRA

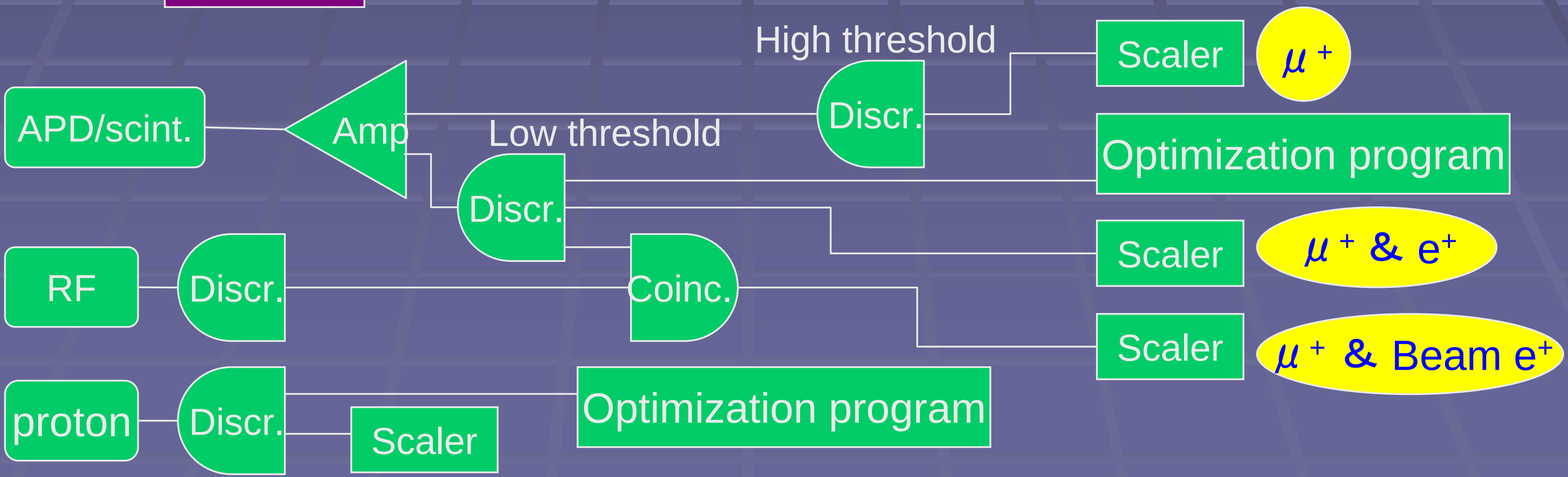
Tools to measure muon rate

- APD + scintillater

APD

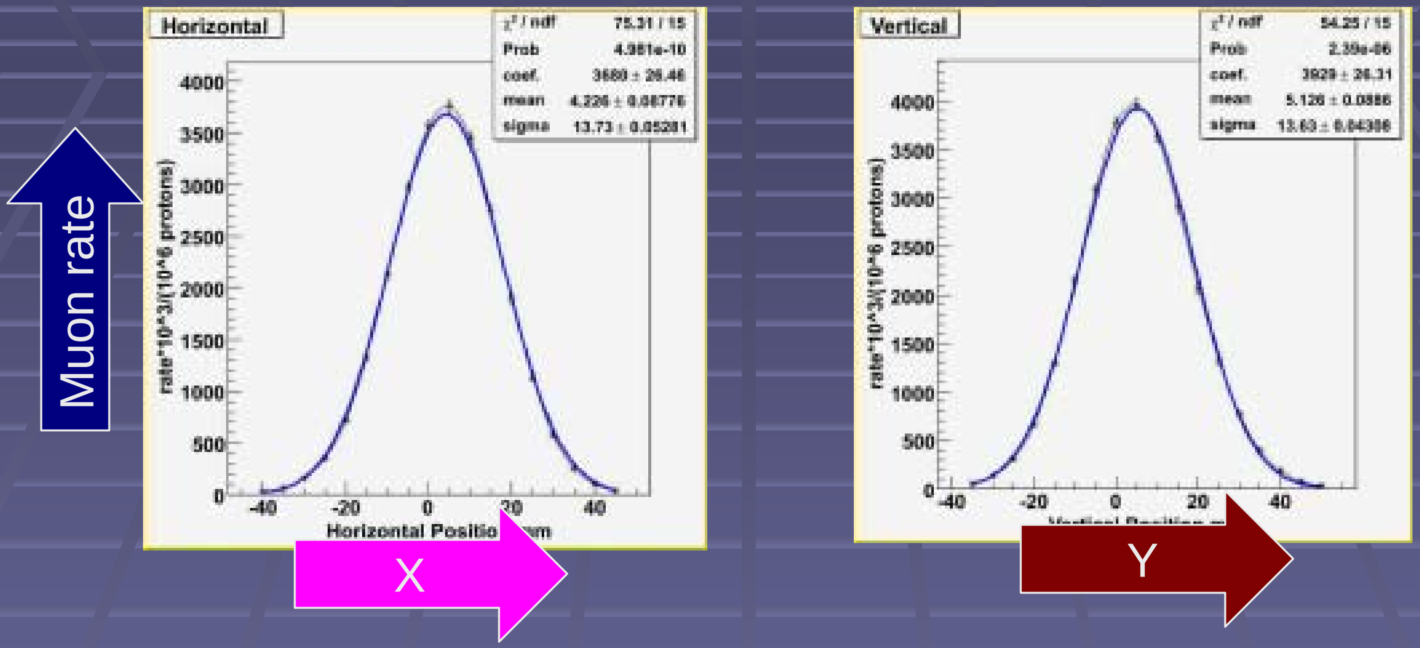
Sadygov-JINR
APD
- **micro-pixellated**
- **2.7x2.7 mm^2 act.**





Results

No degrader

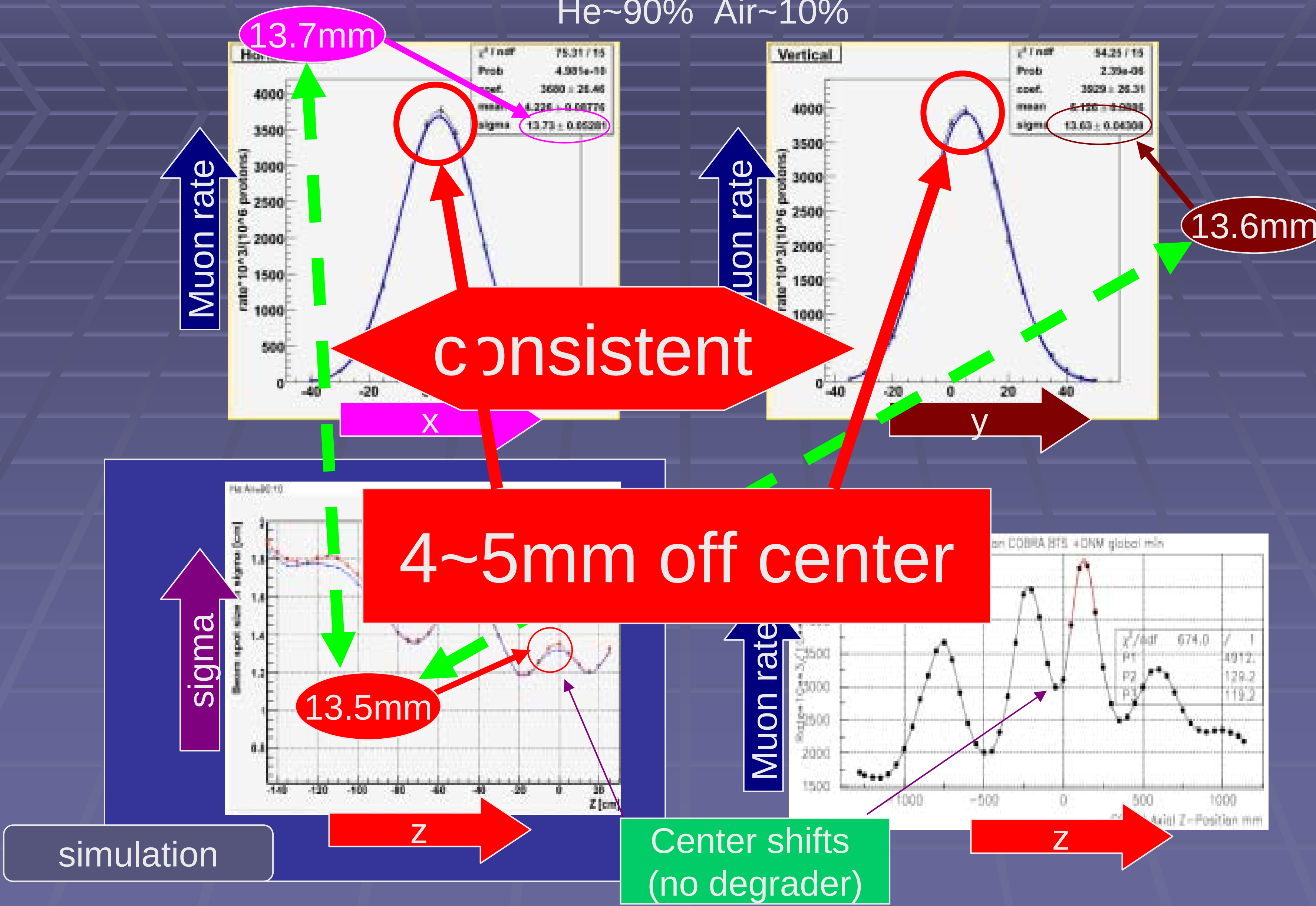


$$R_\mu = 2\sigma_x\sigma_y R_{APD}/r_{APD}\text{^}2$$
$$= 1.19\times 10^8 \mu^+ s^{-1} @ 1.8\text{mA}, 4\text{cm Target}$$

Satisfies the requirement ($\sim 10^8 \mu^+ s^{-1}$)

Results

He~90% Air~10%



Summary

- Muon rate satisfies the requirement

  $\sim 10^8 \mu^+ s^{-1}$

- Simulation well reconstructs the real measurements

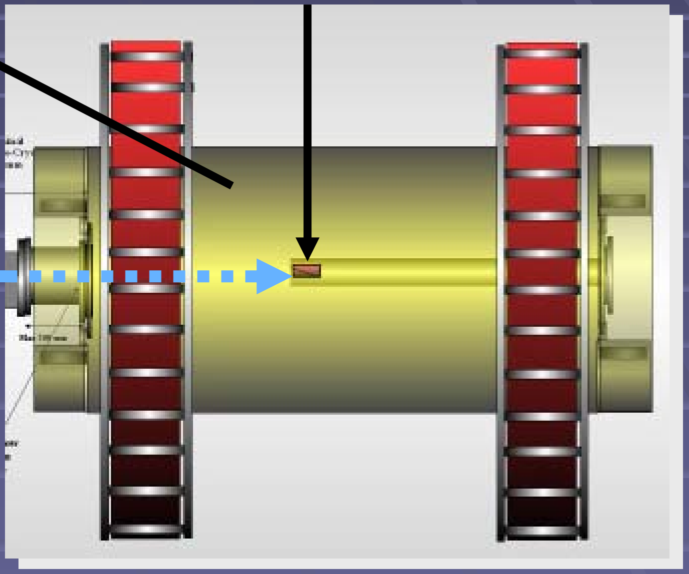
Future prospect

- Solve the problem:
  4~5mm beam shifts (of unknown cause)
- Measurements with Degrader System in BTS → April 6 – May 10
- MEG Pilot Run → Late 2006

Method to tune beam

COBRA is filled with helium

APD



BEAM

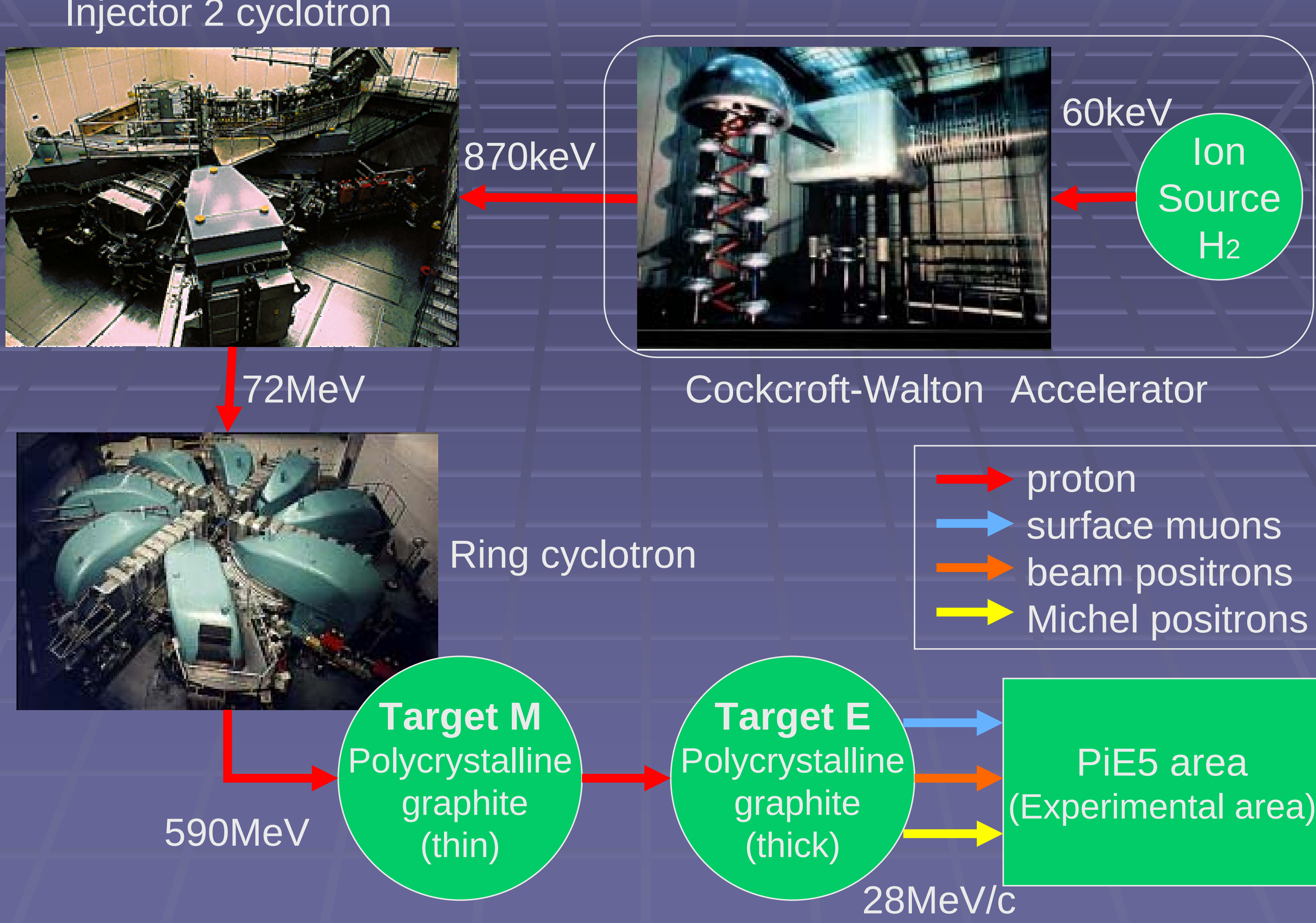
Motion	Deviation	Reproducibility
R	0.2mm	0.5mm
φ	0.35mm	0.5mm
Z†	0.7mm in R 1.5mm in φ	0.5mm in Z

† measured at radius ~ 30cm

Measured the beam intensity with tuning the beam line

Find out the place with the strongest intensity of the μ^+beam by moving APD 3-dimensionally

Beam Production



Triplet Ⅰ, Ⅱ

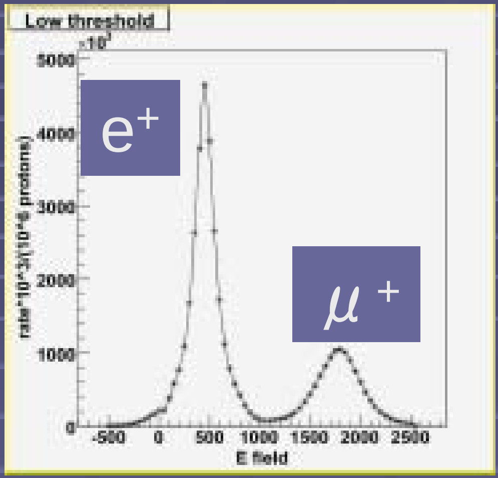
- Set of 3-quadrupole magnets
- Focusing elements
- Producing round spot

Steering magnet + collimator system

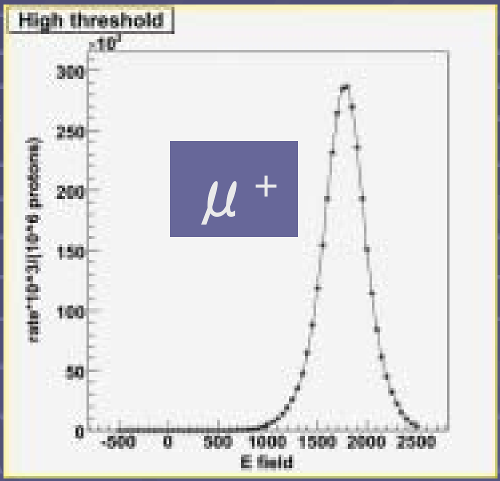
- Placed at double focus
- horizontal deflection
- Eliminate deflected beam-positrons from separator

Method to tune beam

- Build up beam line element-by-element, place detector at foci & optimize element by maximizing normalized μ^+ rate
- Optimization of particle separation — separator, collimators
- Optimize range, stopping distribution in target — degrader, target



Low threshold (90mV)



High threshold (850mV)