MEG実験用低物質量ドリフトチェンバーの実機製作

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他 MEG Collaboration

JPS meeting, '12-I5/Sep./2005, @ Osaka City University

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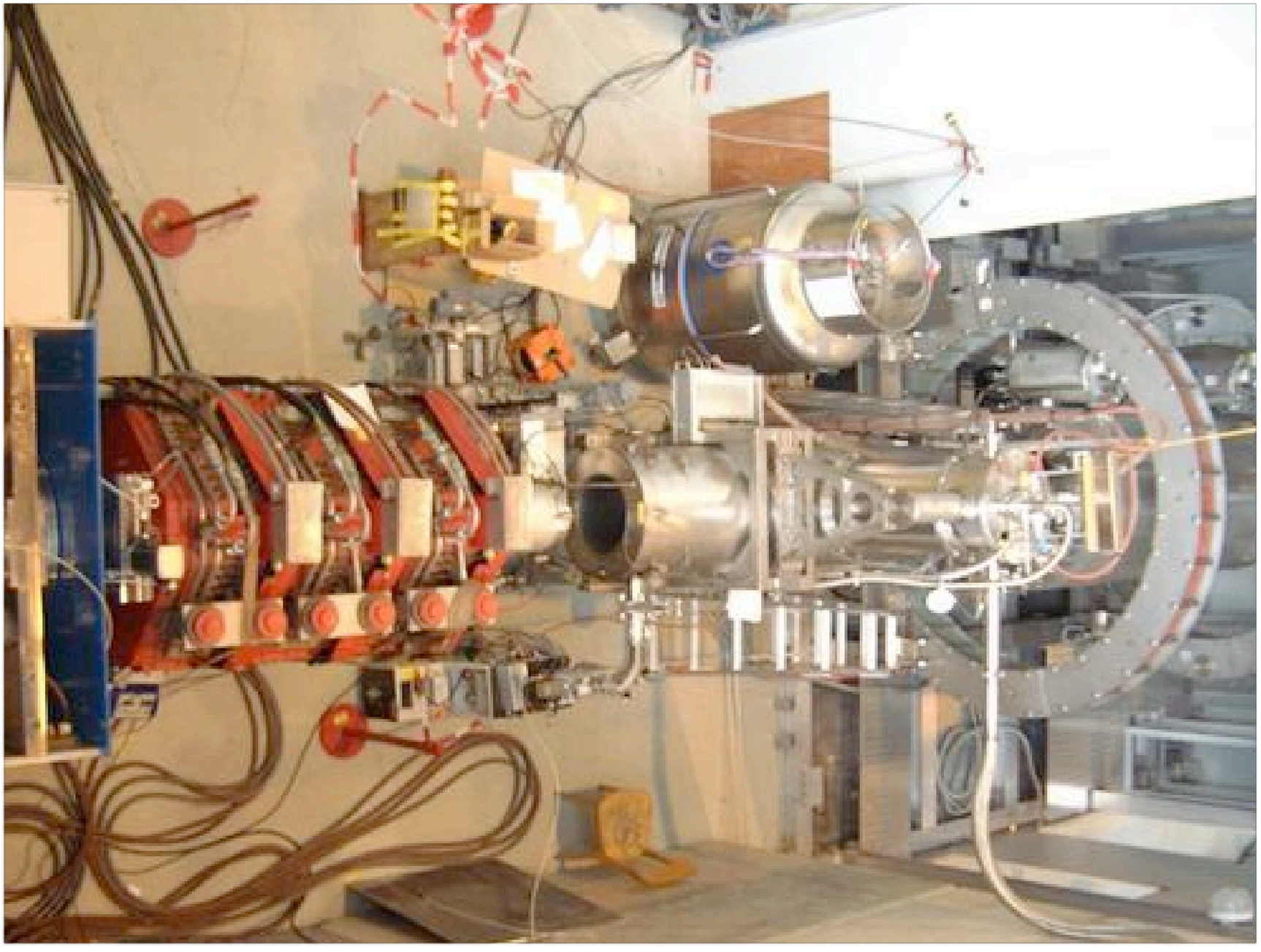
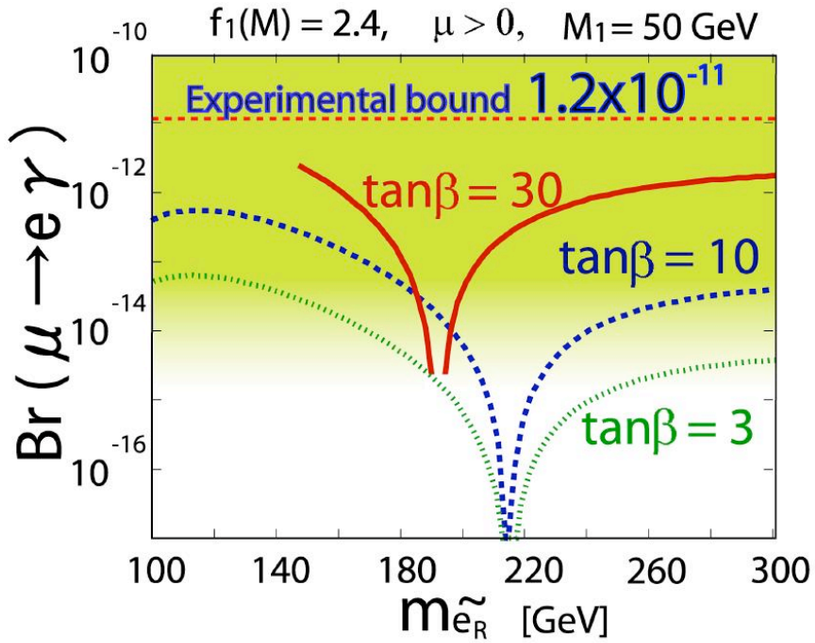


MEG experiment

MEG experiment

- Search experiment for $\mu^+ \rightarrow e^+\gamma$
  - "μ→evν" ~ 100% (Normal μ decay in SM)
  - "μ→eγ" violates Lepton Flavor Conservation
  - SUSY-GUT models predict higher branching ratio Br(μ→eγ) = 10^{-11}~10^{-15}
  - **Sensitive to physics beyond the SM !!**

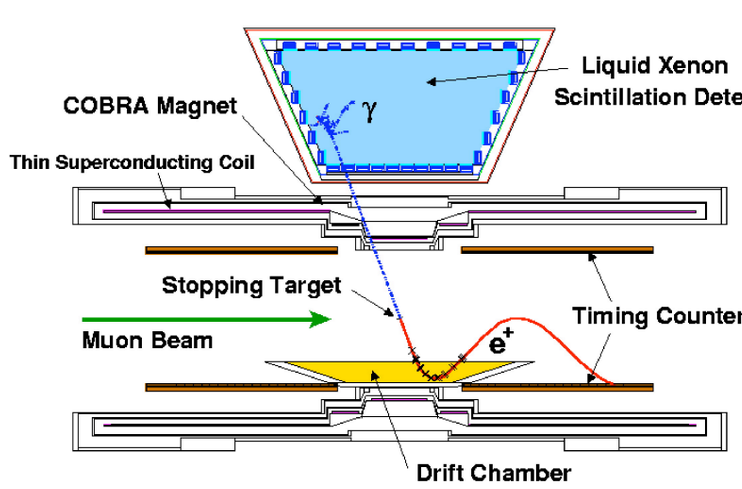


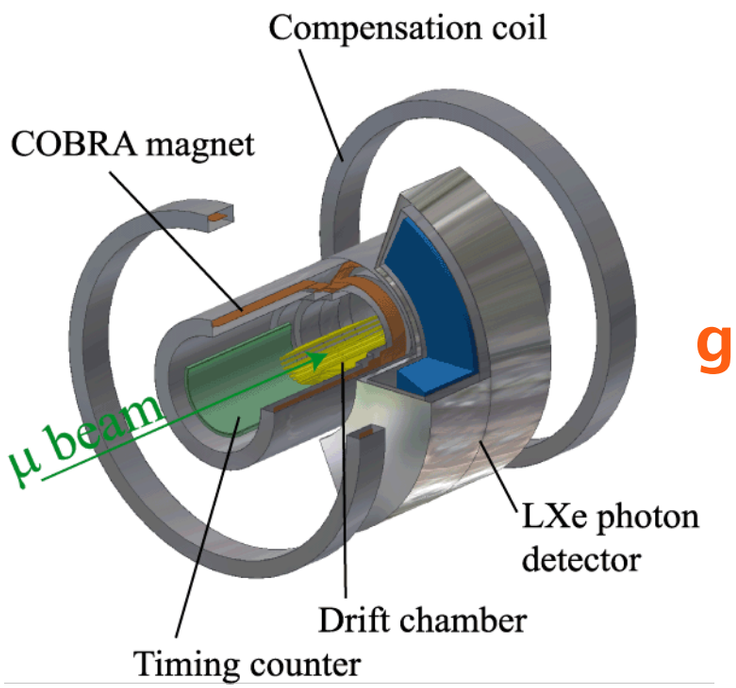
- New experiment with a sensitivity of Br : 10^{-13}~10^{-14} planned at Paul Scherrer Institut (PSI)
- Construction is progressing now, and related physics analysis study is also undergoing.

- **15aSB-9** :モンテカルロシミュレーションを用いたMEG実験におけるmuon radiative decay の考察、久松康子他

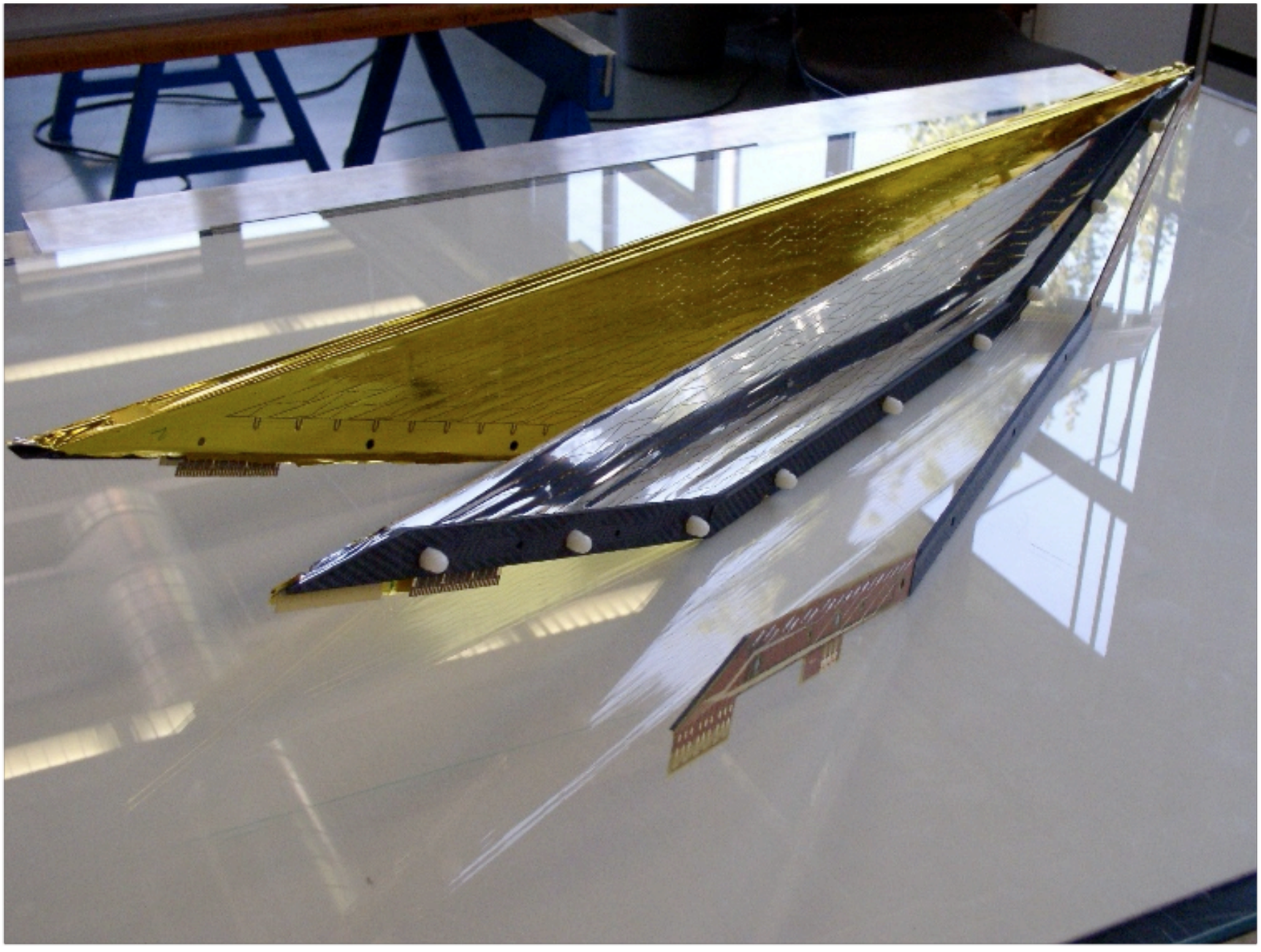
MEG detector

- Features
  - The most intense DC muon beam
  - Liquid Xenon photon detector
  - Positron spectrometer with gradient magnetic field
  - Thin super conducting magnet
  - Thin drift chamber and timing counter for positron tracking
  - Engineering run will start in early 2006





low energy, good resolution, high intensity

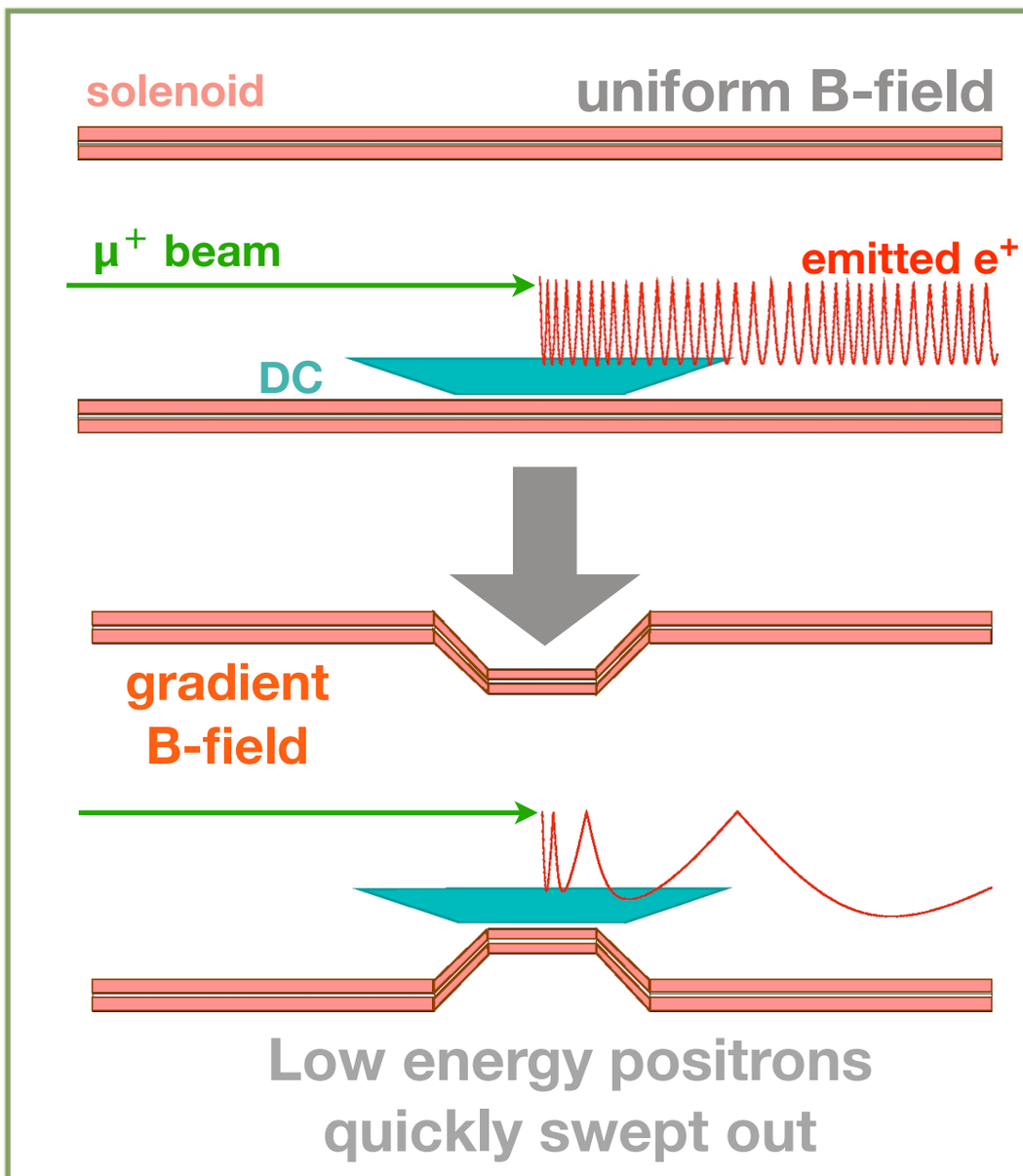


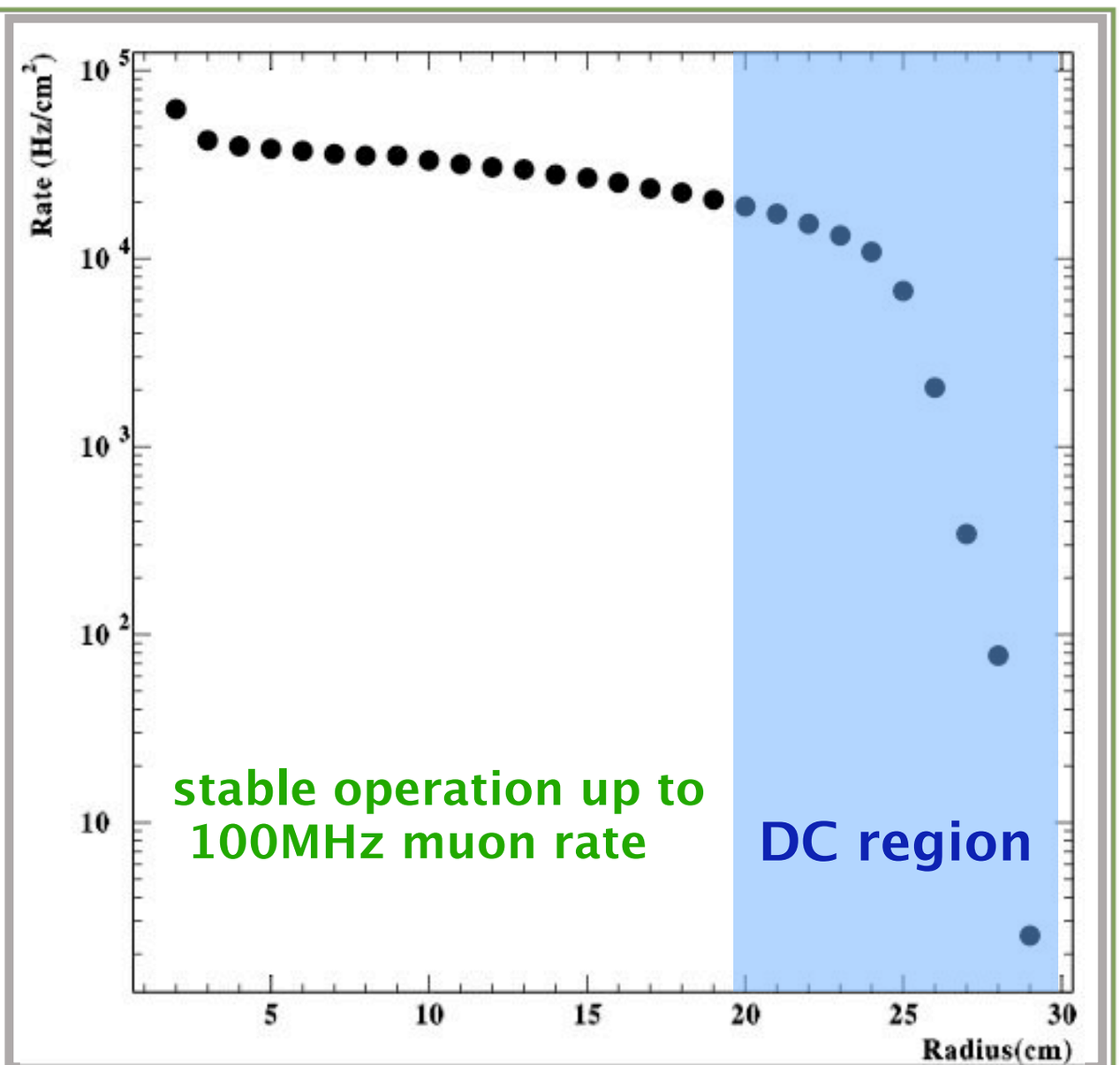
MEG Drift Chamber

Requirements for the Drift Chamber

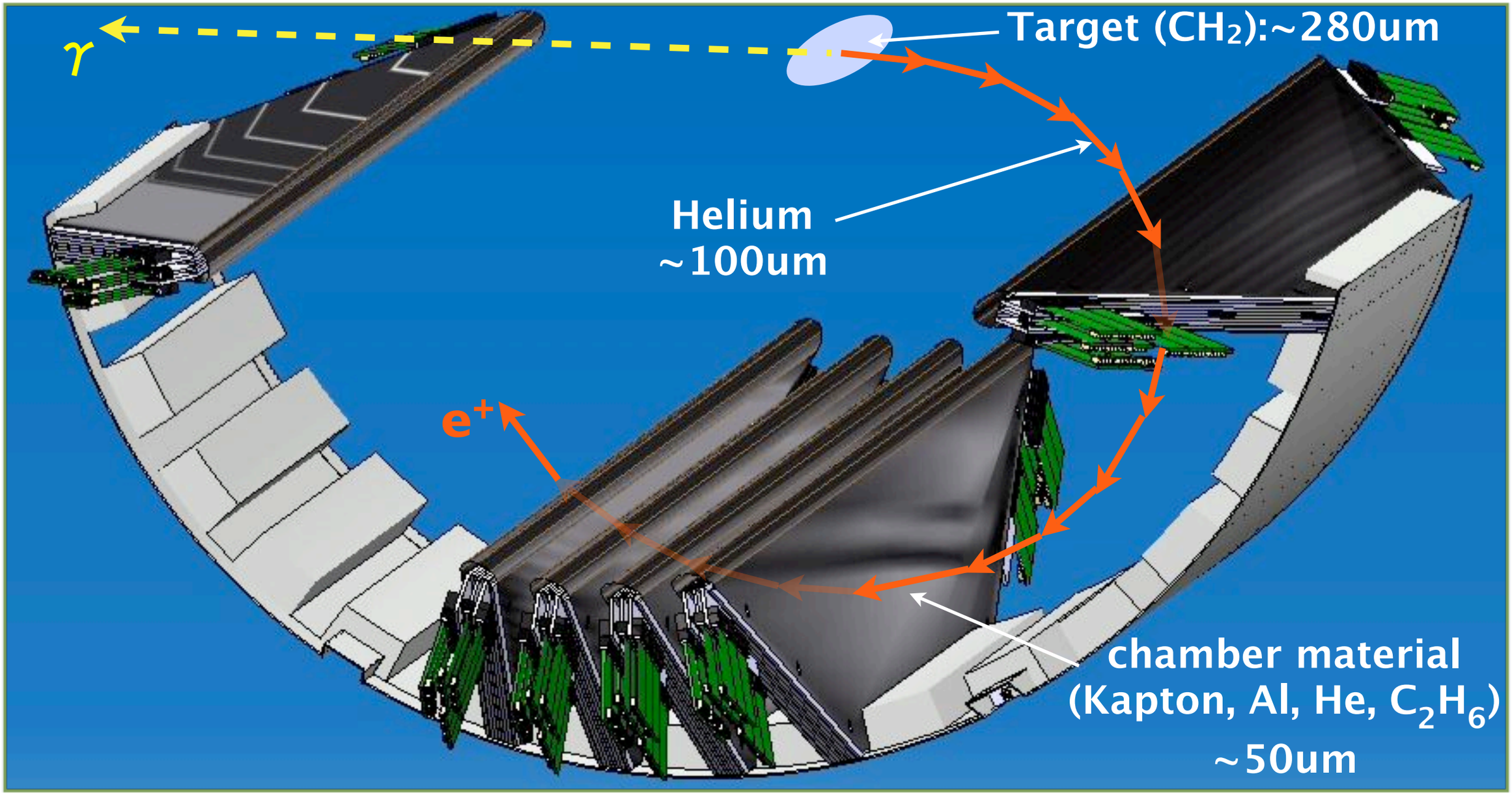
- High rate
  - the most intense DC muon beam
  - muon stopping rate : $2.5\times10^{7} \sim 10^{8}$ muon/sec
  - COBRA magnet and segmented modular chamber
- High Resolution
  - very excellent sensitivity
  - good position resolution (300μm) is required for both direction (r,z)
  - vernier pad system for z-position measurement
  - low material (multiple scattering suppression)

COBRA spectrometer (COnstant Bending RAdius)





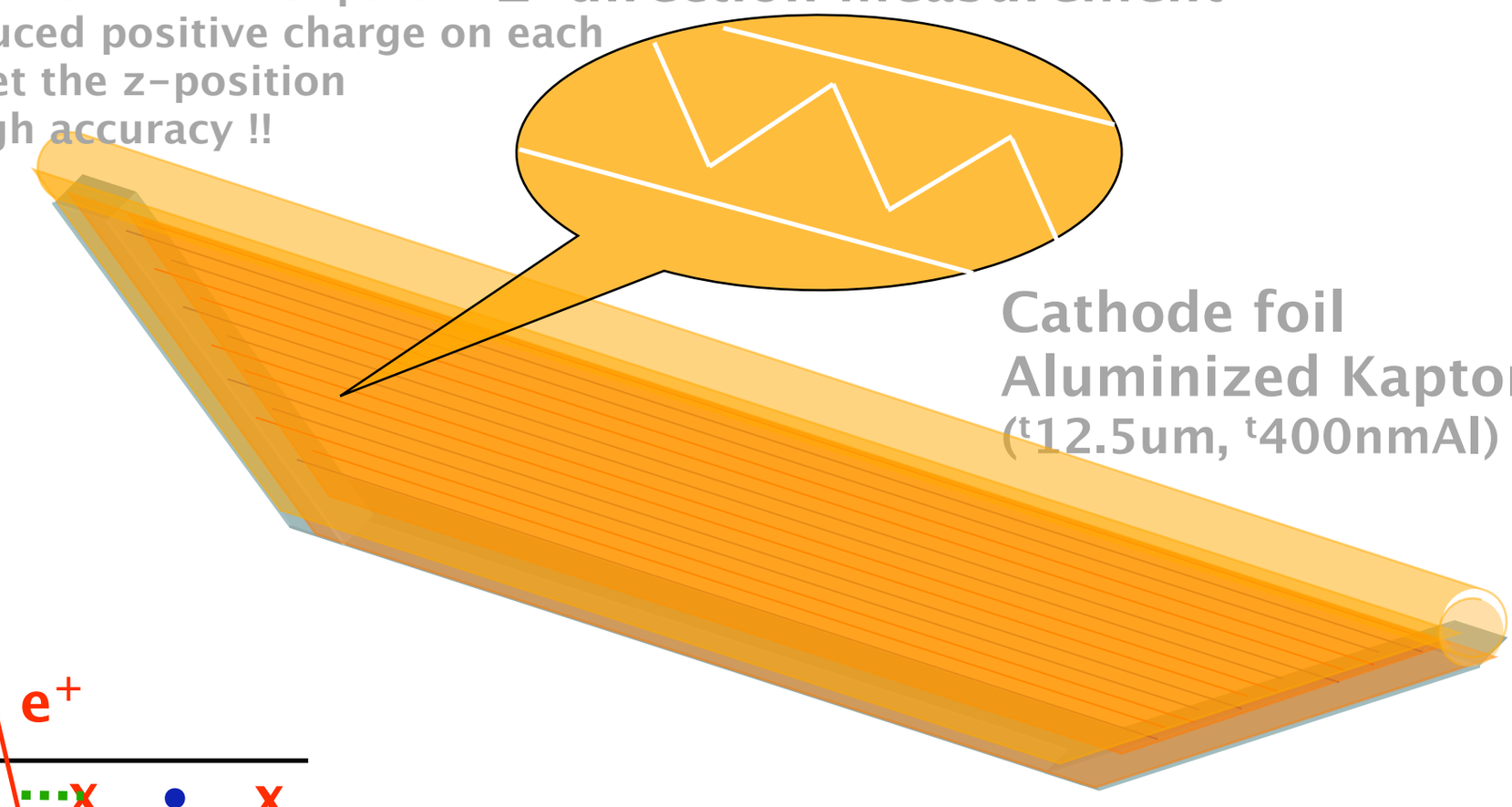
Multiple scattering in the spectrometer



Chamber structure

Vernier pattern is printed on cathode plane.
Using the ratio of induced positive charge on each vernier pad, we can get the z-position measurement with high accuracy !!

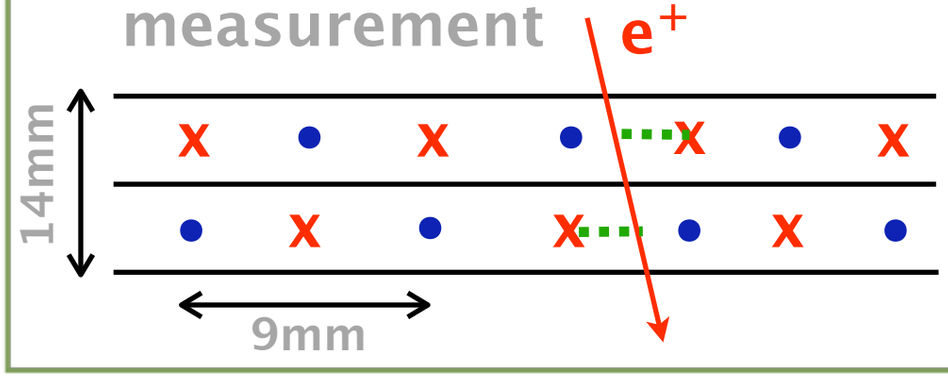
Z-direction measurement



opened-frame
(Carbon fiber)

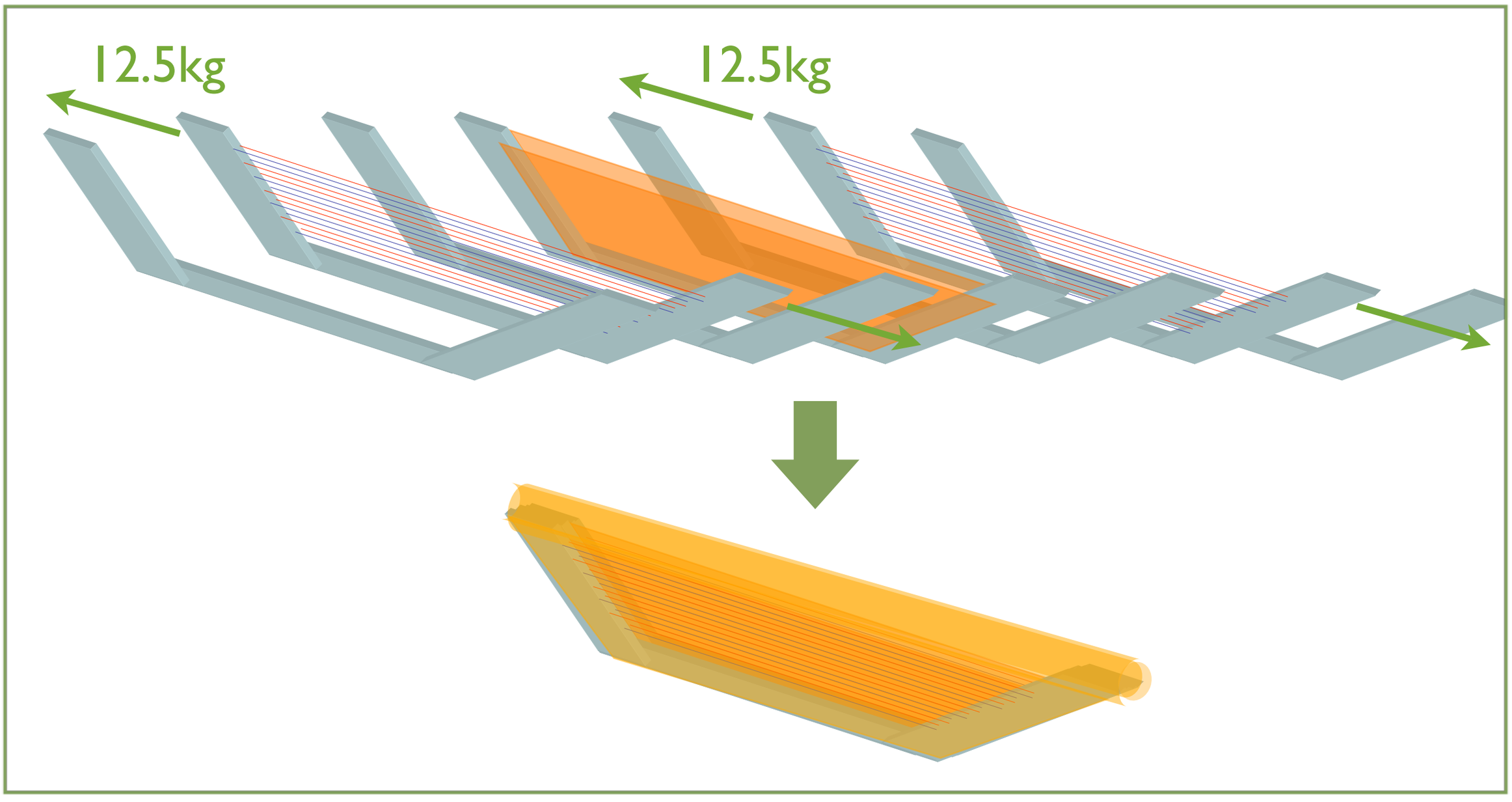
Cathode foil
Aluminized Kapton
(^{t}12.5um, ^{t}400nmAl)

R-direction measurement

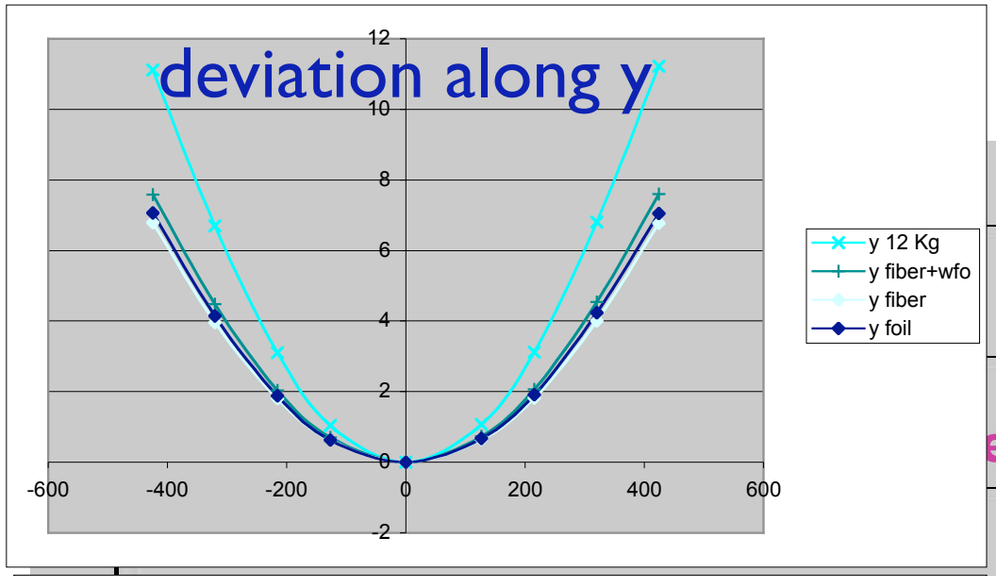


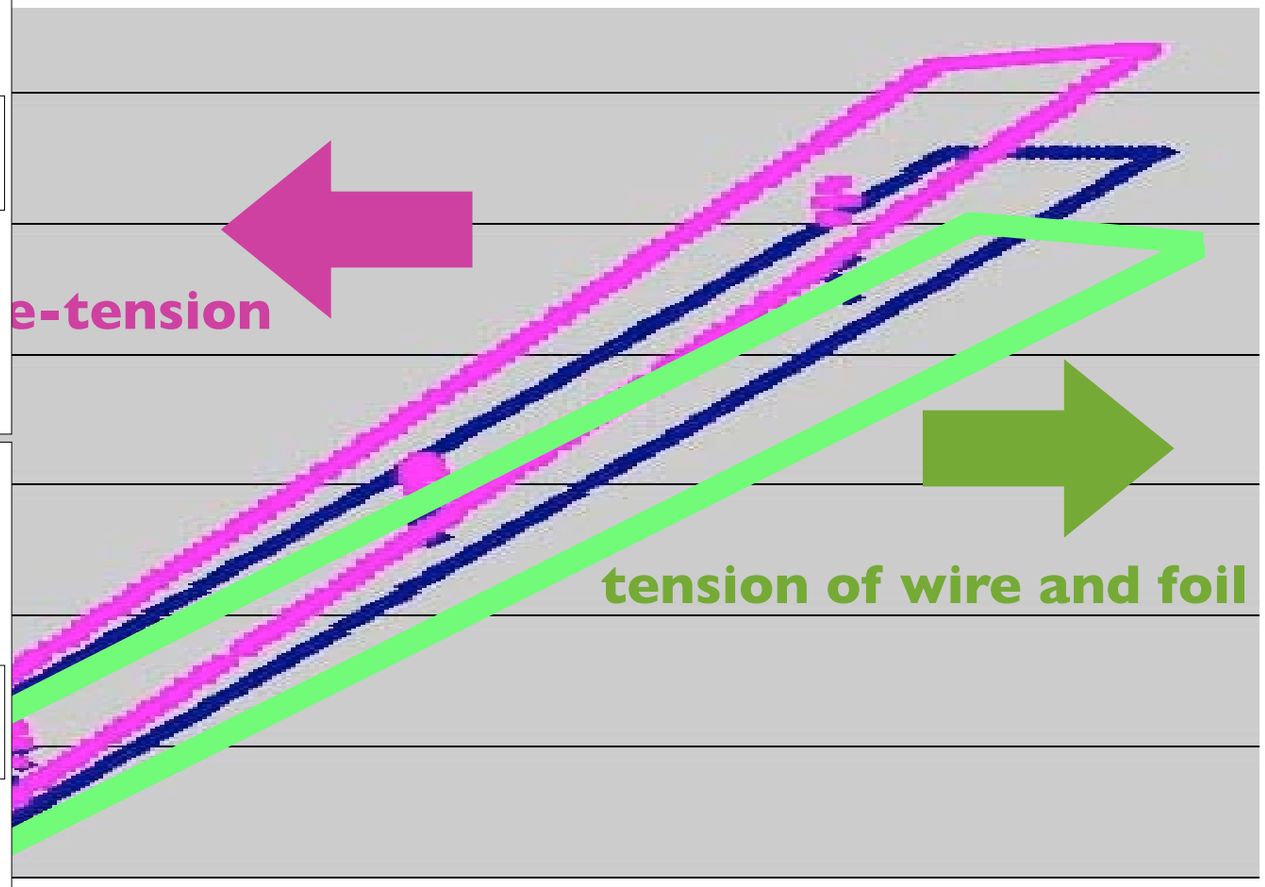
staggered 2-layer wires
sense (Ni/Cr, 25um, 0.5N)
potential (Be/Cu, 50um, 1.1N)

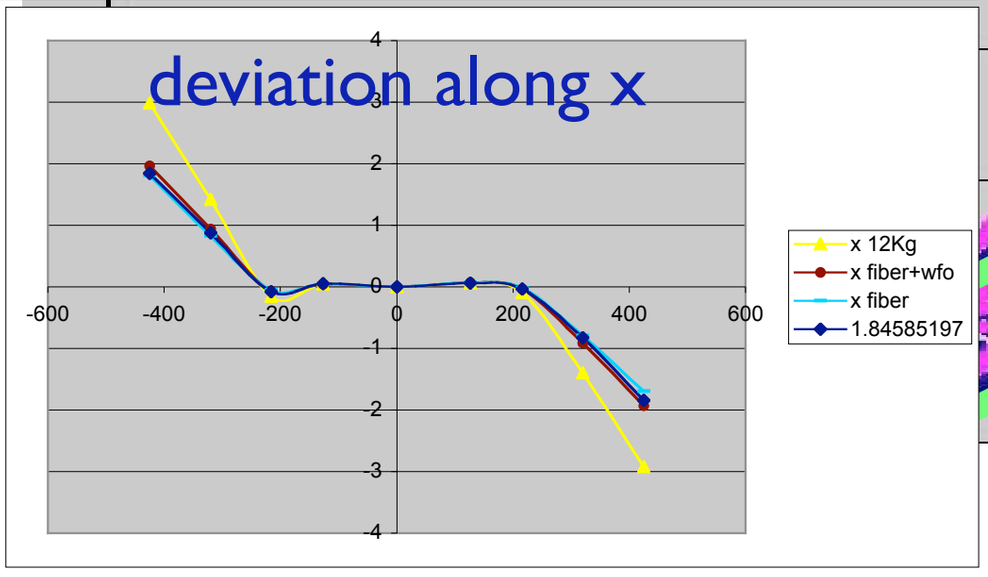
Making of MEG DC (1)



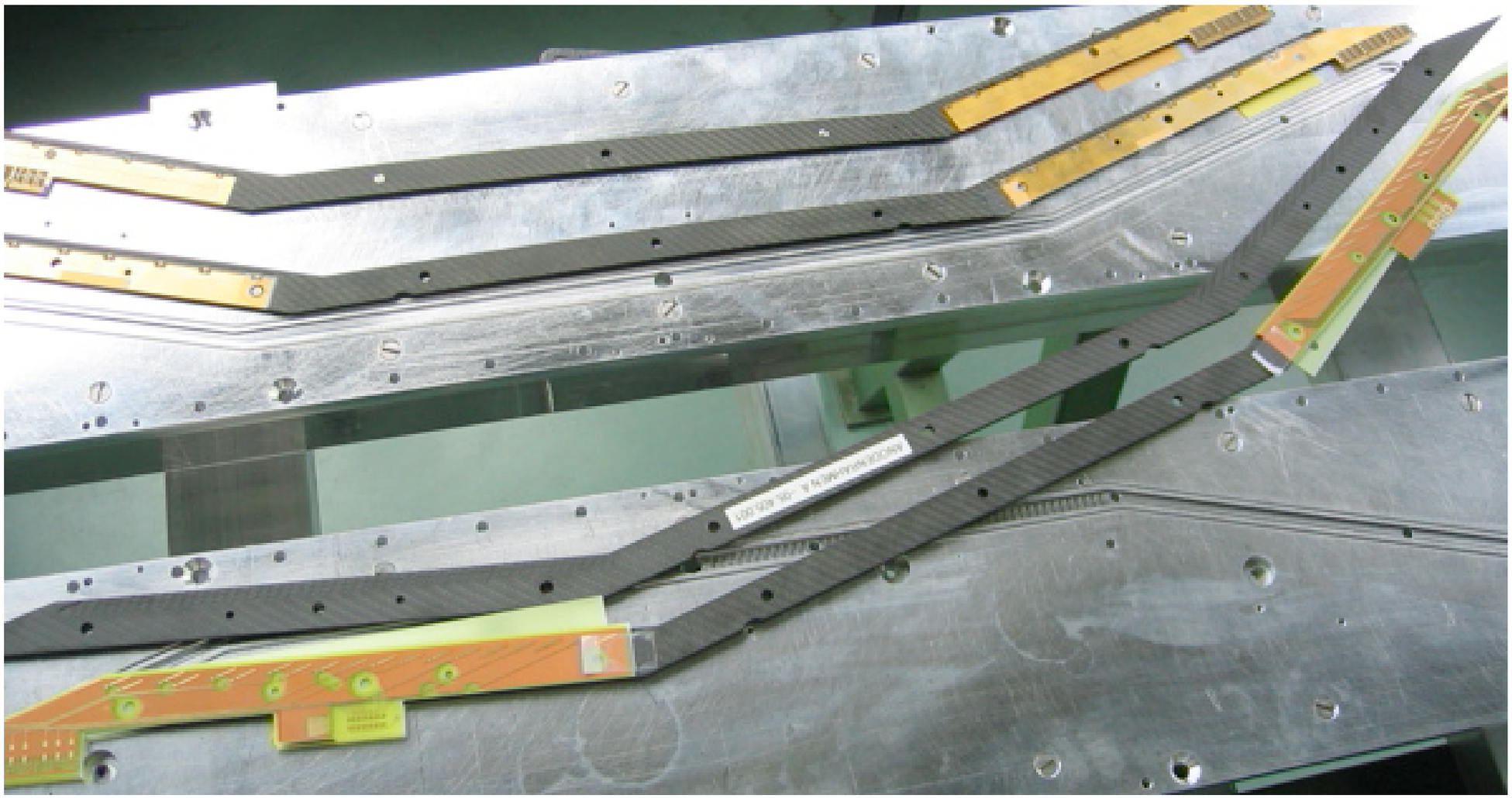
Making of MEG DC (2)



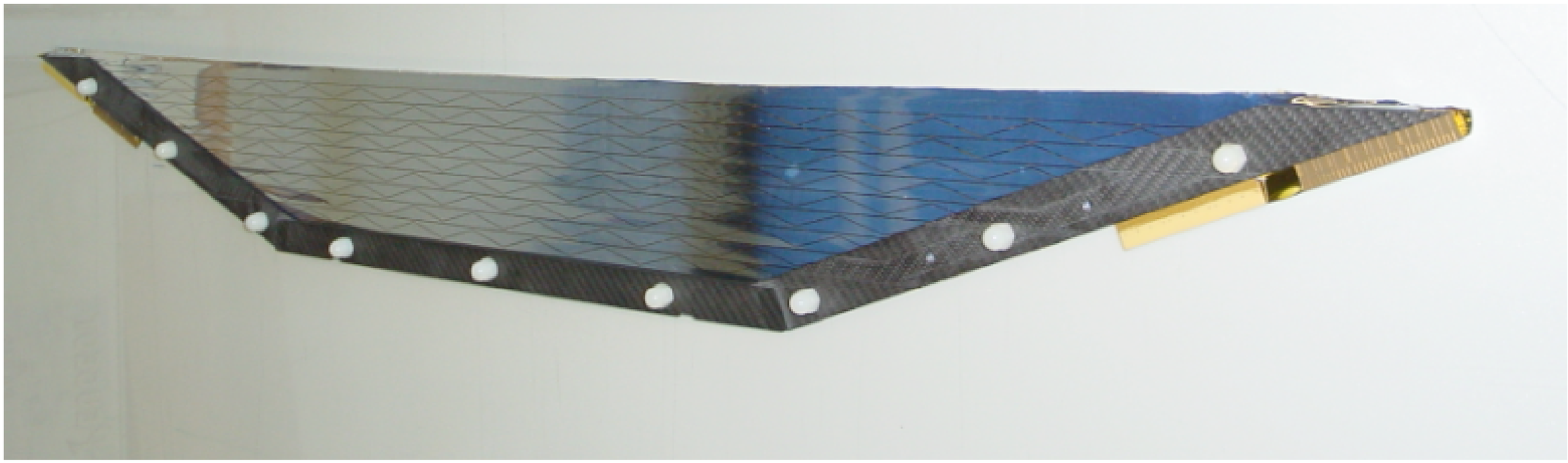




Making of MEG DC (3)
- inner cathode frame -

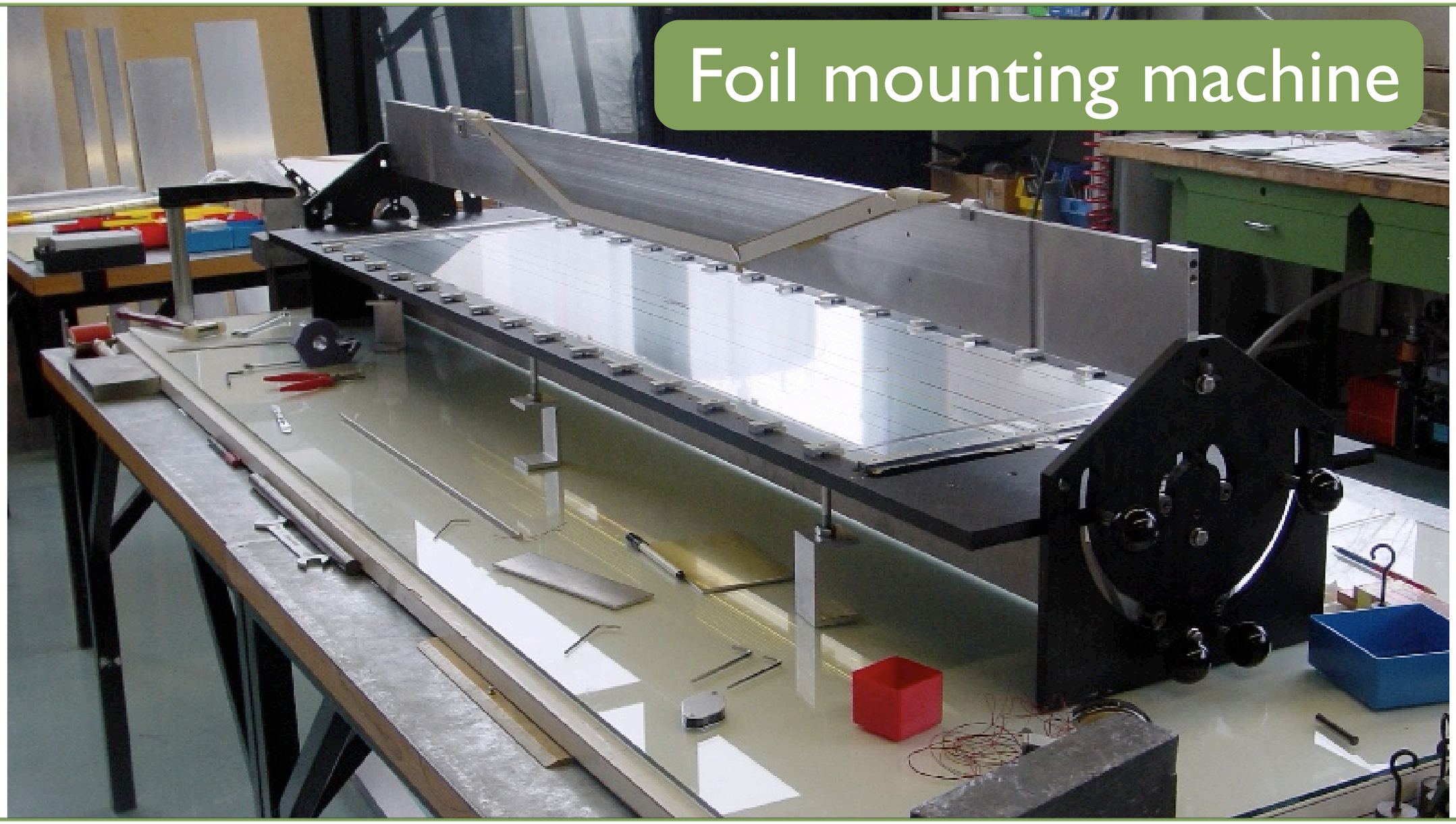


Making of MEG DC (4)
- inner cathode frame -

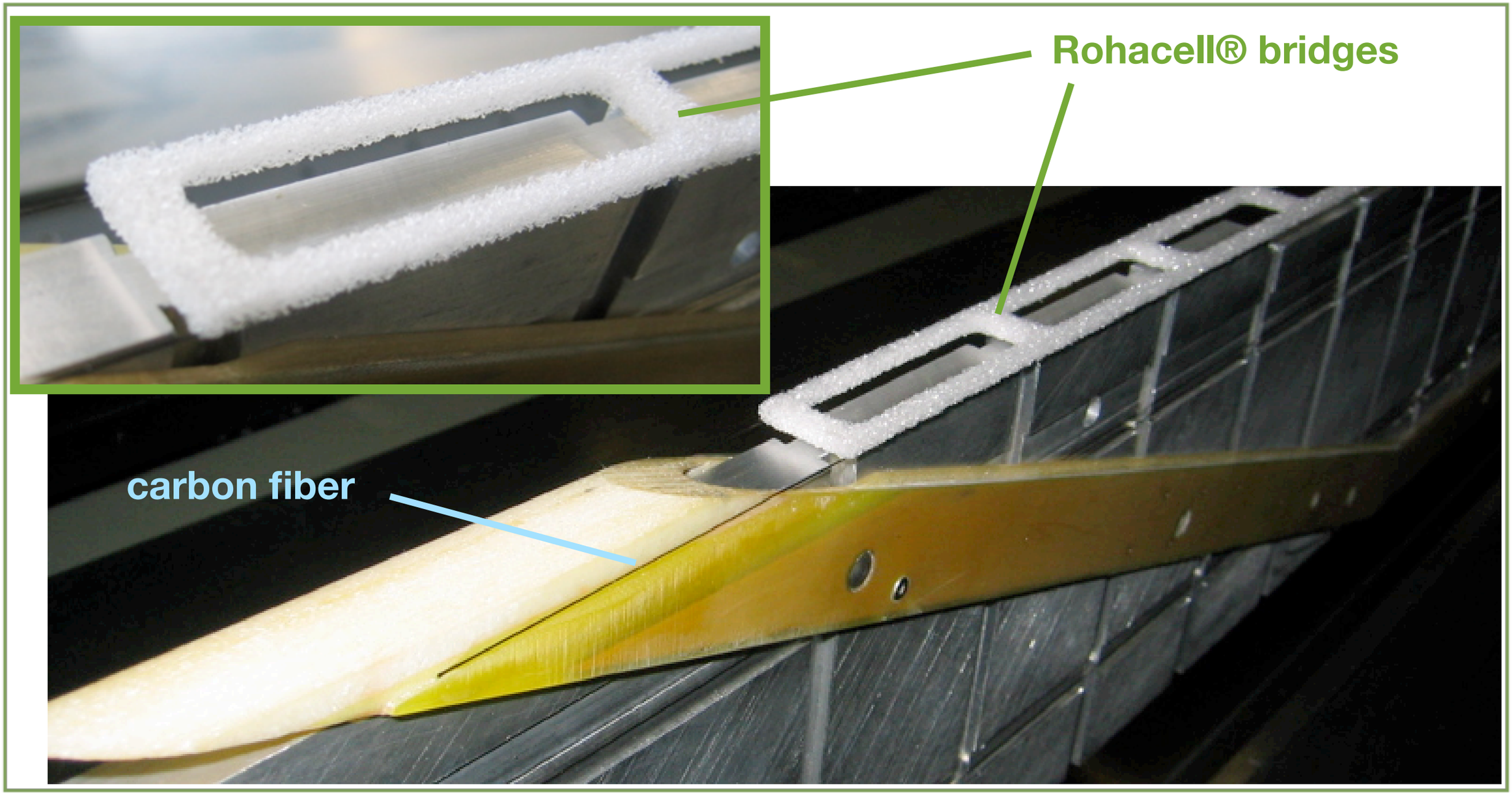


Inner cathode foil is mounted on the frame

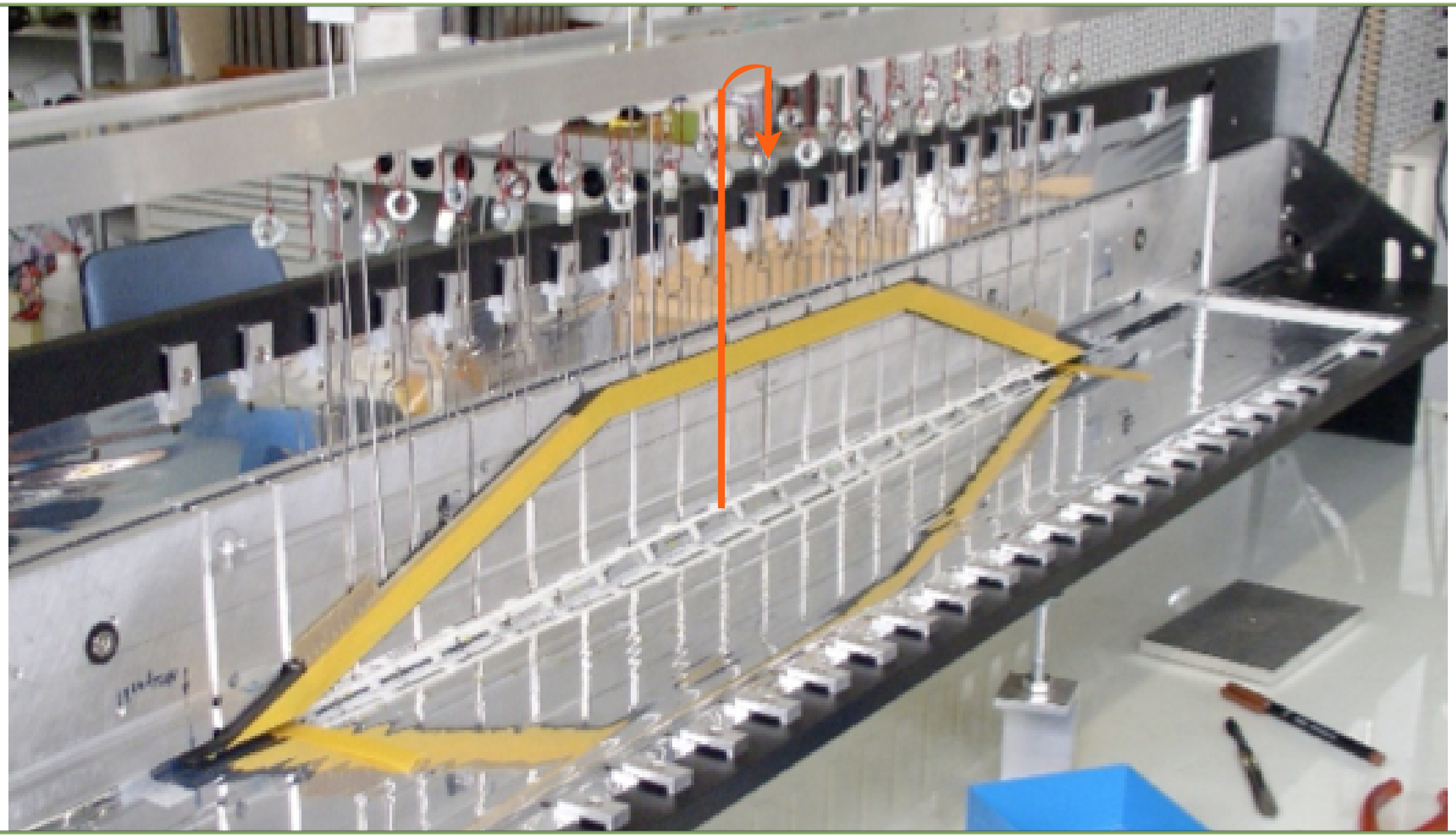
Making of MEG DC (5)
- cathode hood mount -



Making of MEG DC (6)
- cathode hood mount -

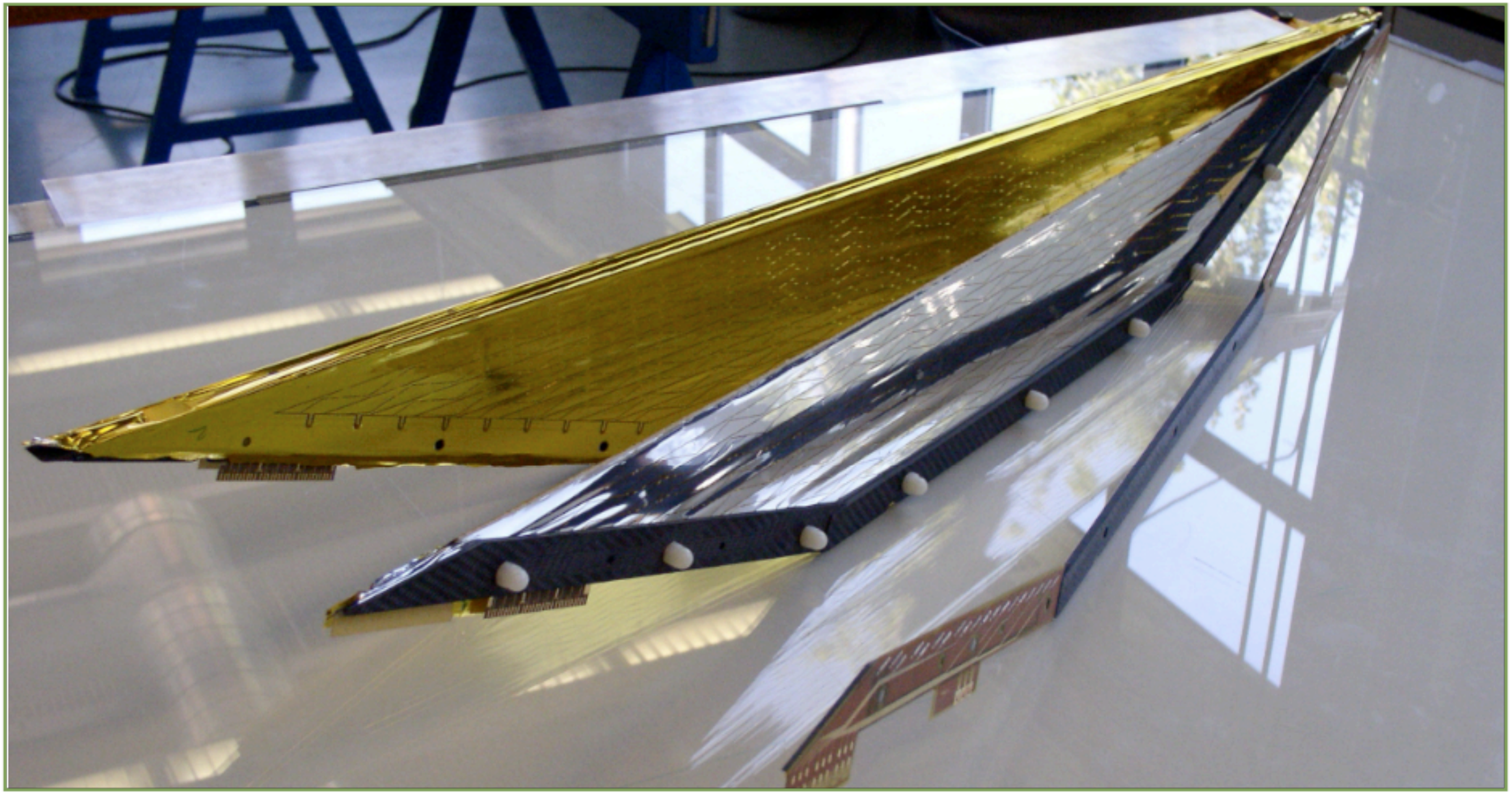


Making of MEG DC (7)



Making of MEG DC (8)
- cathode hood mount -

Making of MEG DC (9)
- final 3 parts -



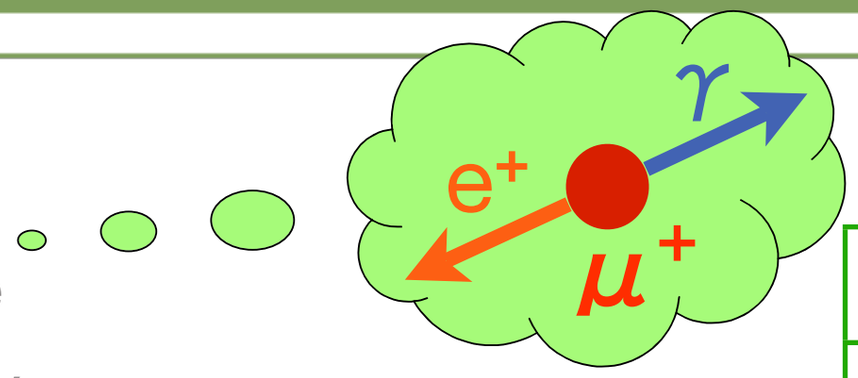
Conclusion

- MEG will start early 2006
- DC prototype study completed, we will start mass-production soon.
- Mass-production will be completed in 2005.
- Tracking algorithm study is undergoing in parallel.
- We've already gotten ~0.5% momentum resolution by the conservative LS method and KF both.
- Some other techniques is developing now.

extra transparencies

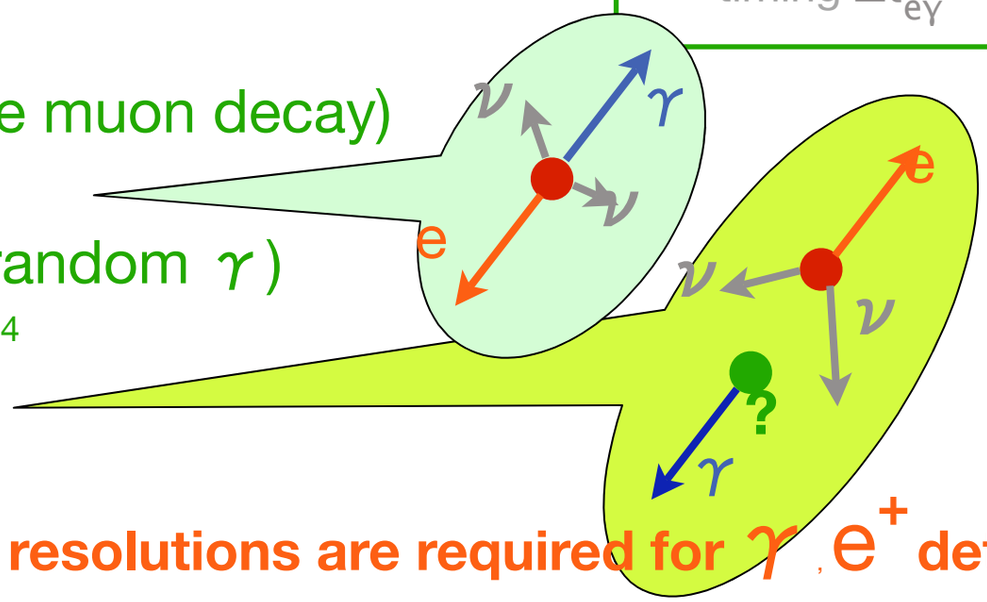
Signal sensitivity & Background

- Signal
  - $E_e = E_\gamma = 52.8$ MeV
  - Back to back, in time
- Single event sensitivity
  - $N_\mu = 2.5 \times 10^7$/s, $T \sim 4 \times 10^7$s, $\Omega/4\pi = 0.09$, $\varepsilon_e = 0.9$, $\varepsilon_\gamma = 0.6$
  - **Sensitivity ~ 4.5 x 10^{-14}**
- Backgrounds
  - Prompt background (Radiative muon decay)
  - background rate : < 10^{-14}
  - Accidental : (Michel decay + random γ)
  - background rate : 2~4 x 10^{-14}
  - accidental events : 0.6



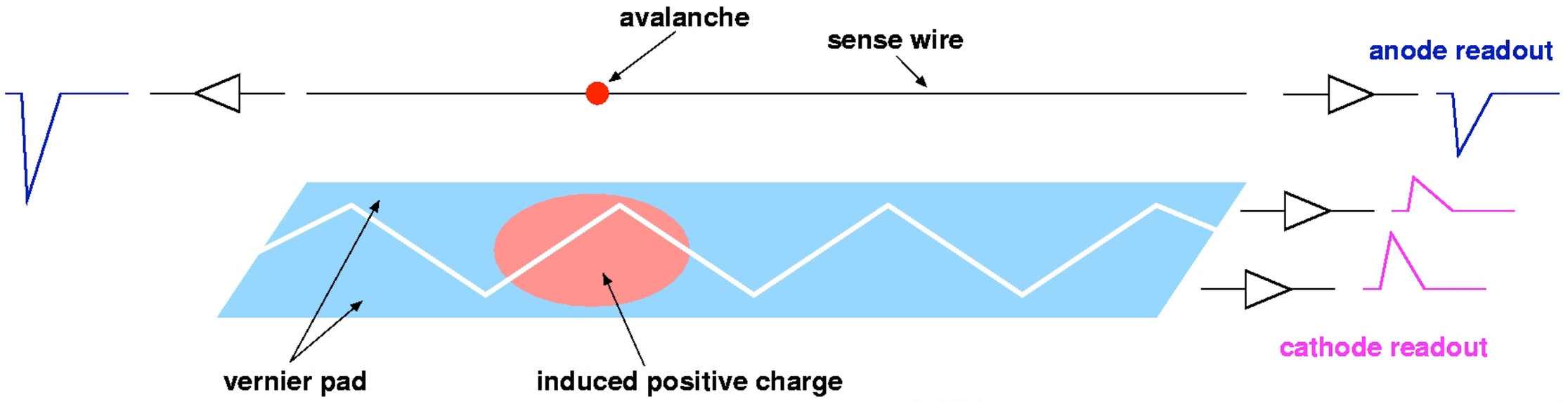
Expected detecter resolution (FWHM)

γ energy ΔE_γ	4.5 %
e^+ momentum Δp_e	0.8 %
angular $\Delta\theta_{e\gamma}$	10 mrad
timing $\Delta t_{e\gamma}$	140 psec



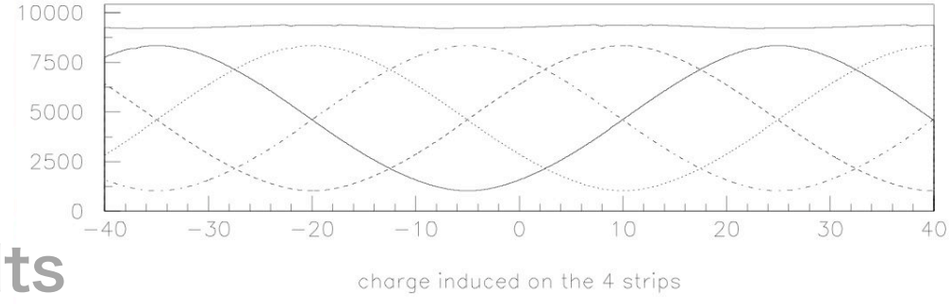
- **Good energy, timing and position resolutions are required for γ, e^+ detector !**

cathode pads with vernier pattern

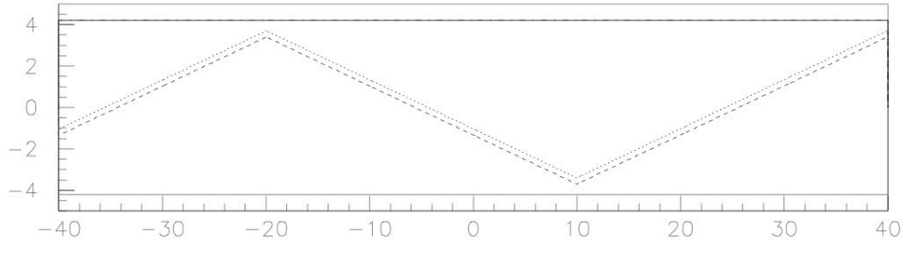


- rough estimation by charge division method (~ 1cm)
- using the ratio of induced charge on each 4 strips (~ 300 μm)
- drop-off in readout channel and electronics

MC results

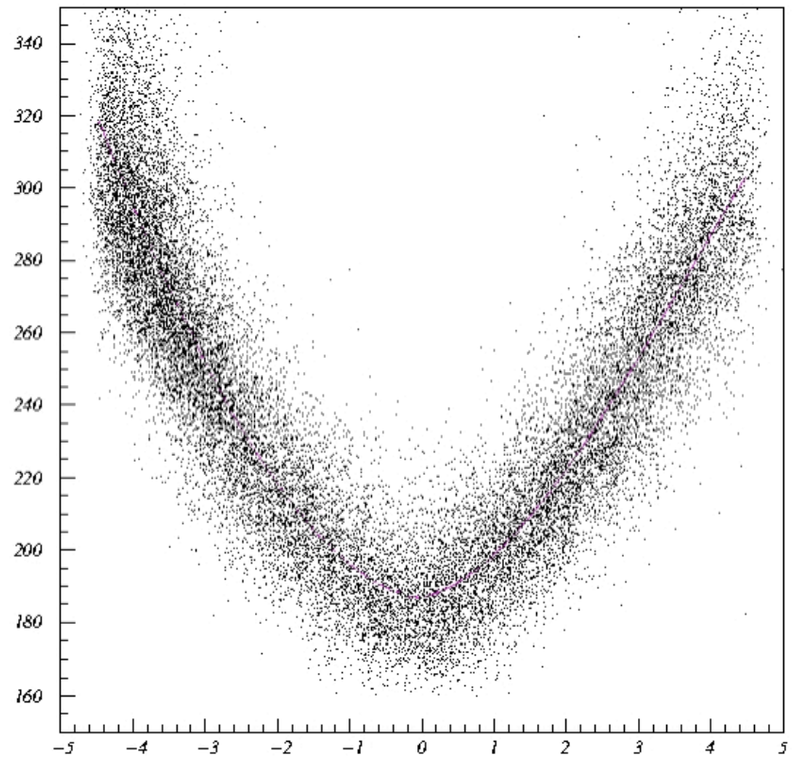


charge induced on the 4 strips



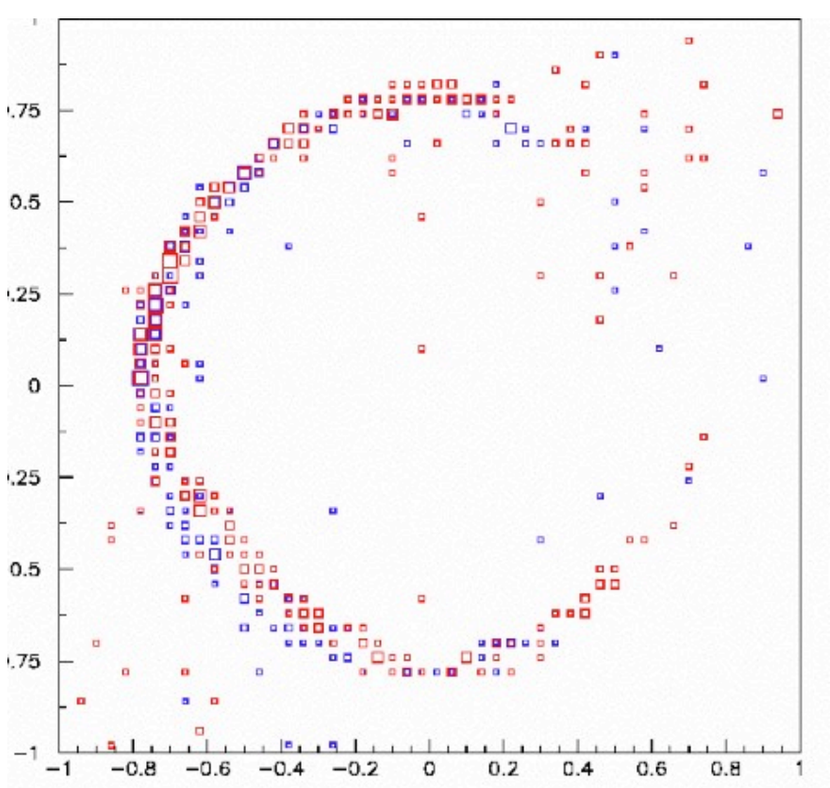
double strip cathode shape

Results from prototypes



Spatial resolution (R-direction)

100~200 μm (σ)

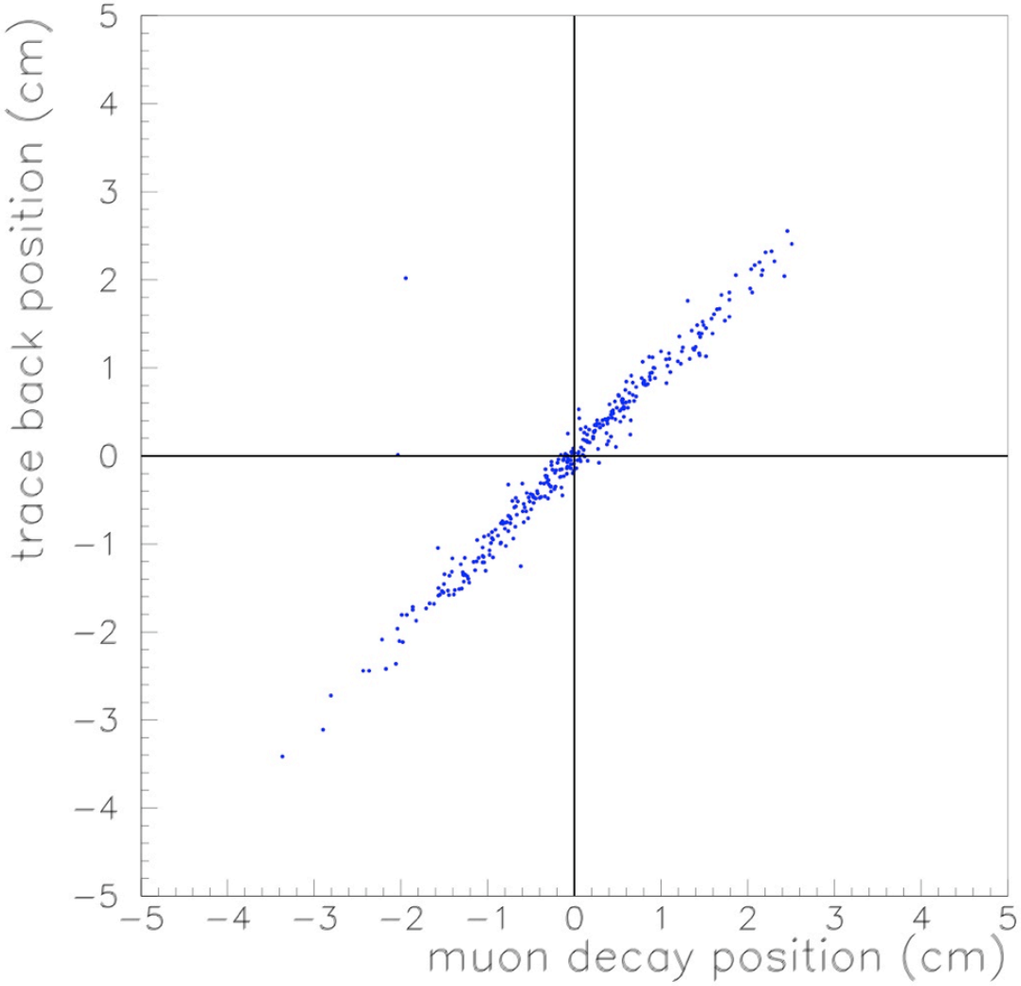


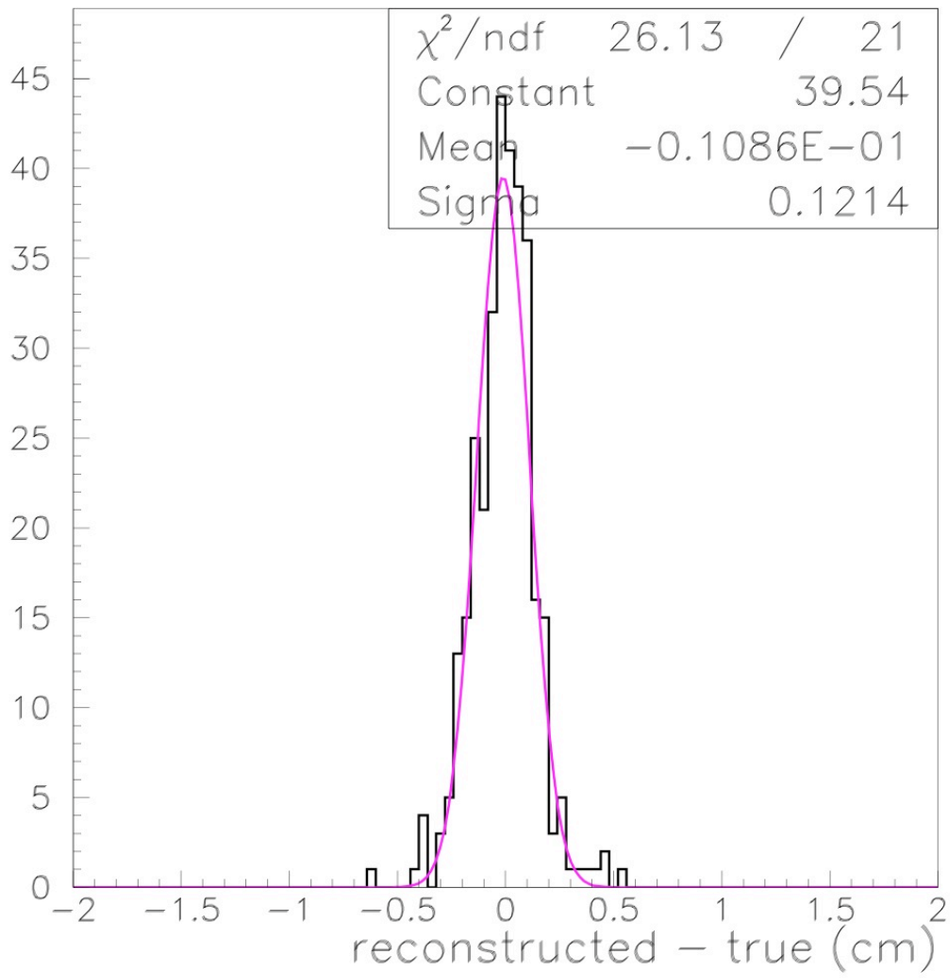
Spatial resolution (Z-direction)

300~450 μm (σ)

Trace back performance

- trace back (initial muon decay vertex) , ~1.2 mm accuracy





Momentum reconstruction of Michel positron

- Momentum reconstruction @ Michel positron