JPS meeting, '27–30/Sep./2004, @ Kochi University

MEG 実験のための陽電子飛跡検出用 低物質量ドリフトチェンバーの研究開発

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他 MEG Collaboration

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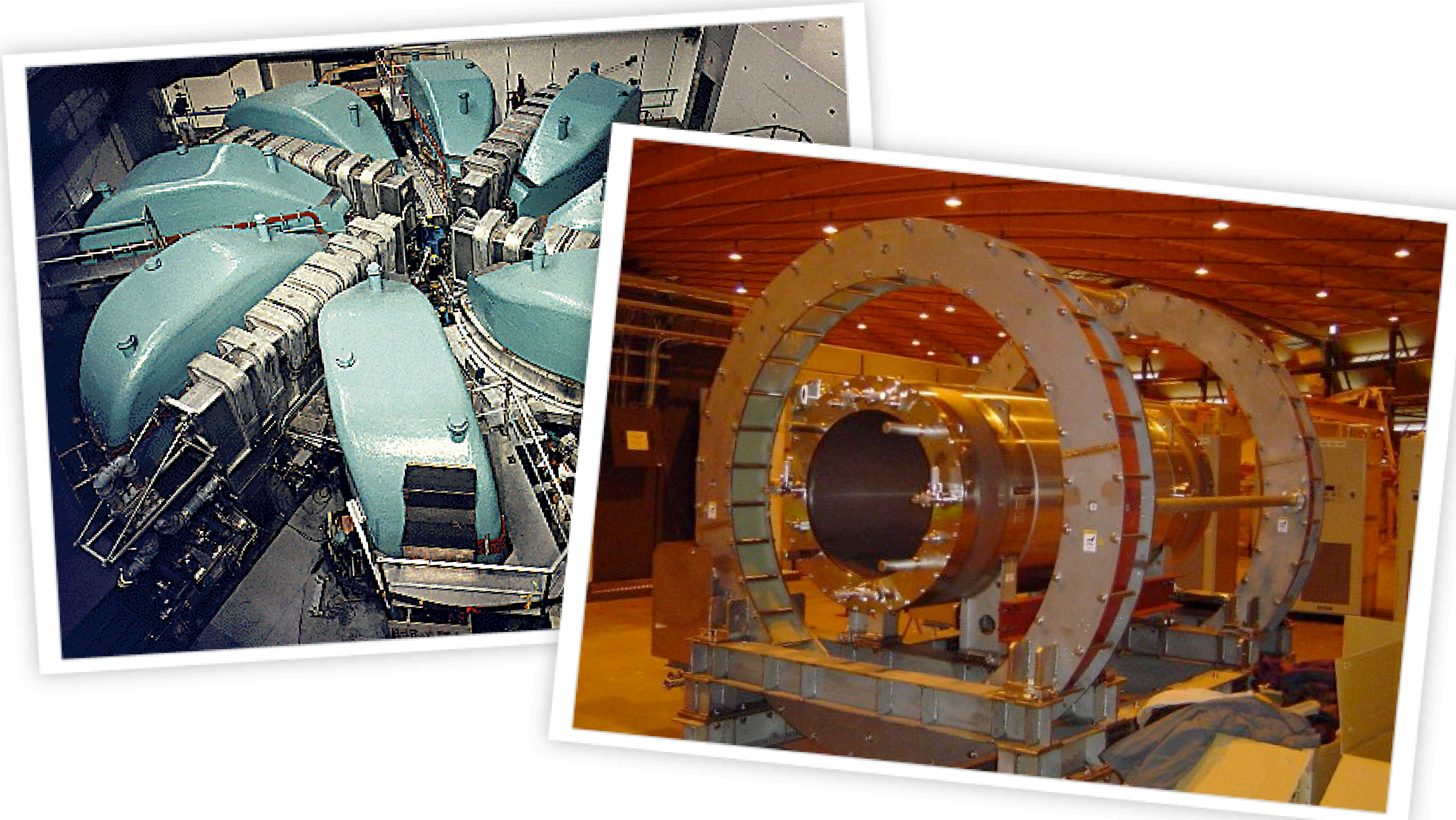
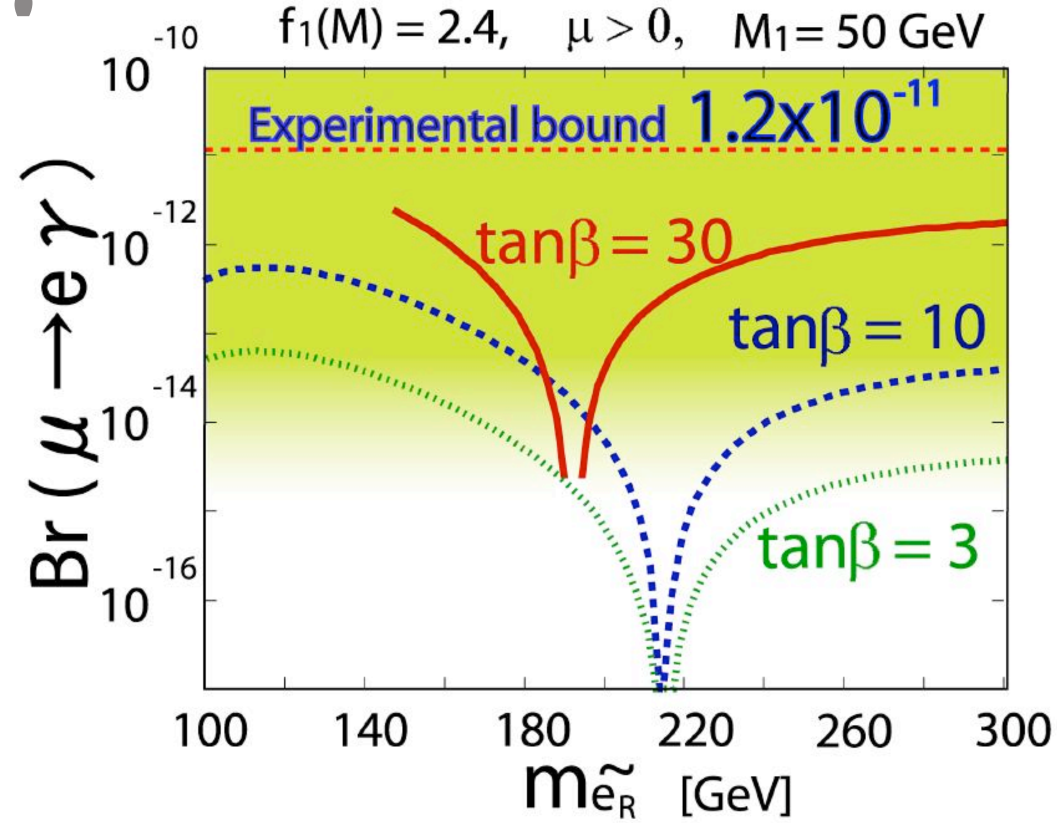


MEG experiment

MEG experiment

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



- New experiment with a sensitivity of Br : $10^{-13} \sim 10^{-14}$ planned at Paul Scherrer Institut (PSI)

MEG Collaboration

4 countries
10 institutions

ICEPP, University of Tokyo
KEK
Waseda University

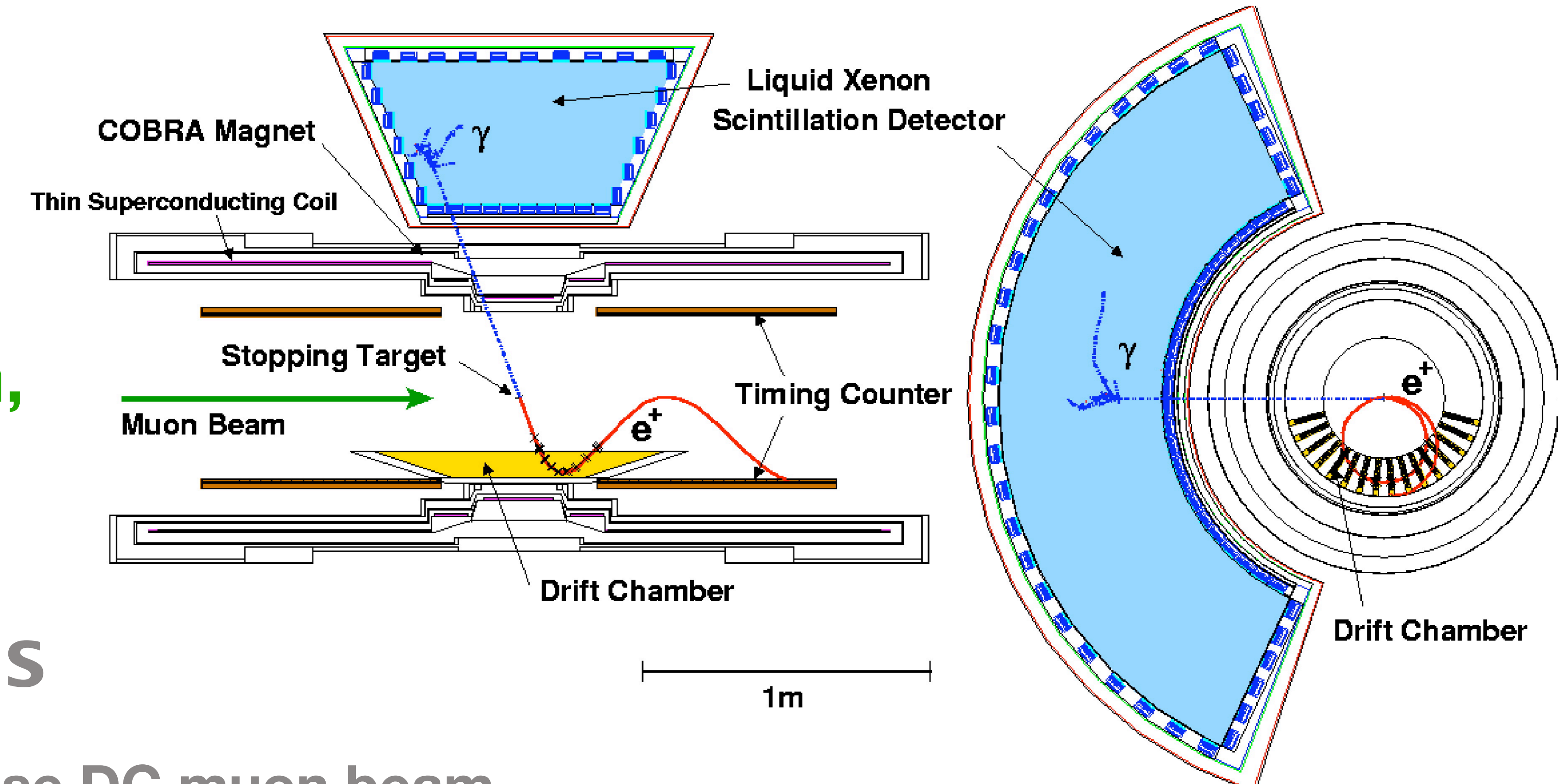
Paul Scherrer Institut
ETH-Zurich

INFN & Genova University
INFN & Lecce University
INFN & Pavia University
INFN & Pisa University

Budker Institute

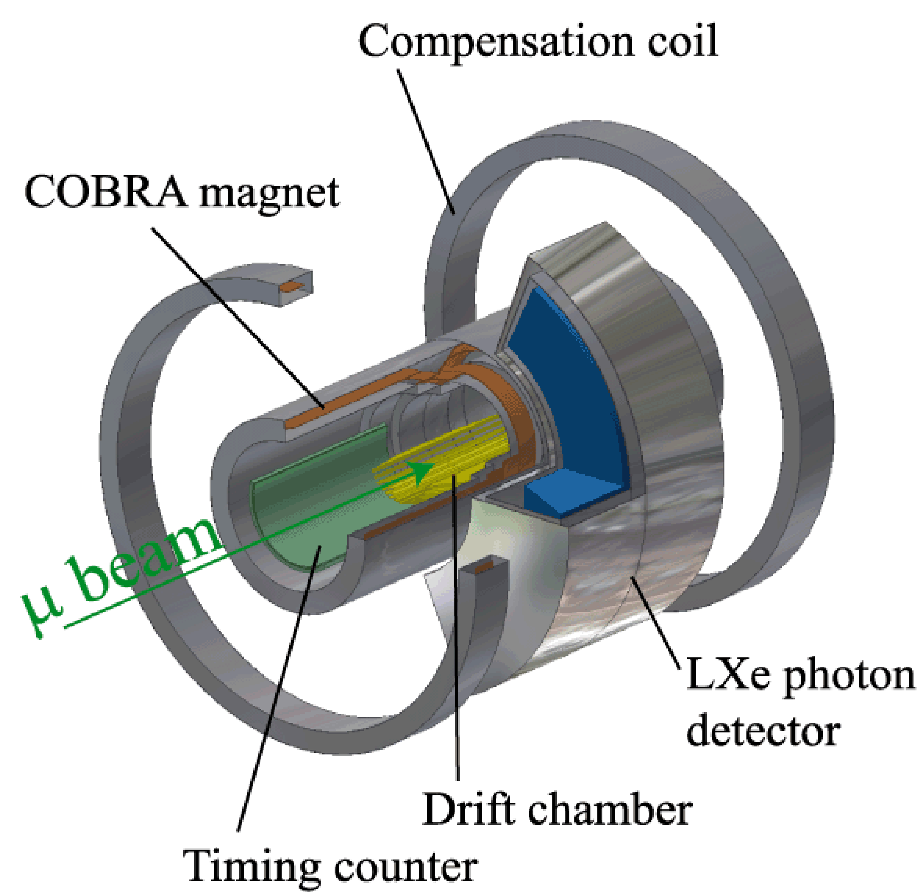
MEG detector

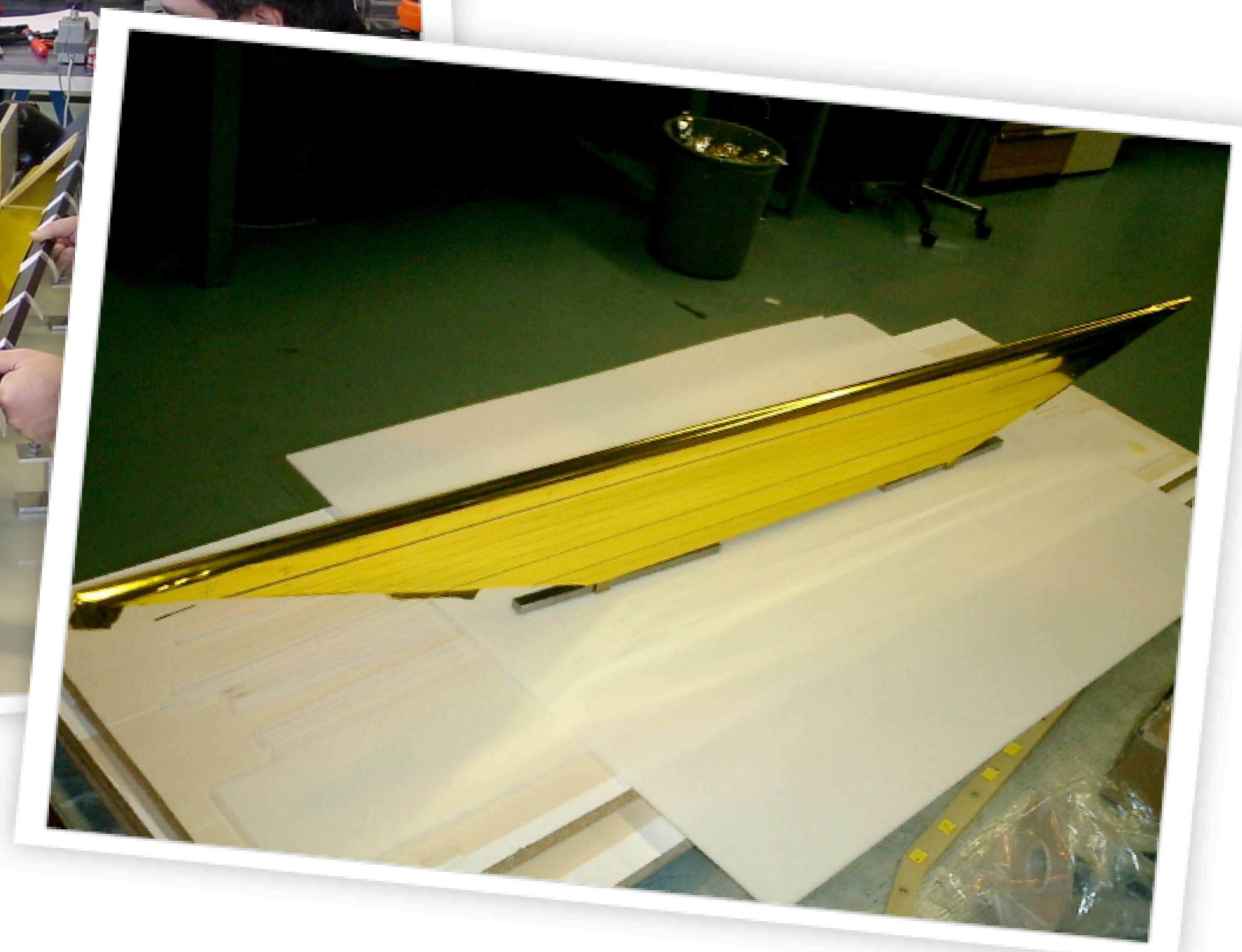
low energy,
good resolution,
high intensity



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 2005
- Physics run will start in early 2006



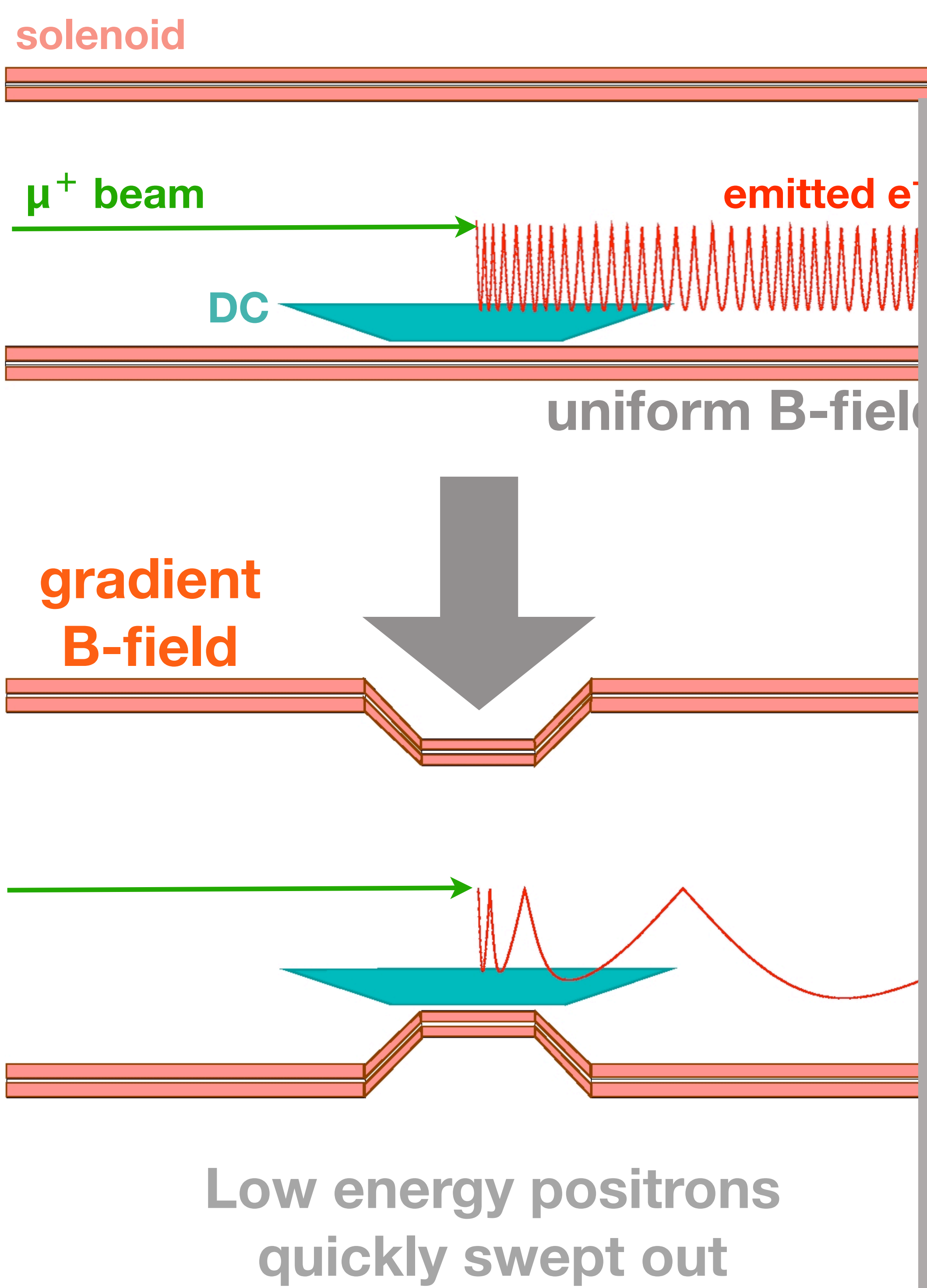


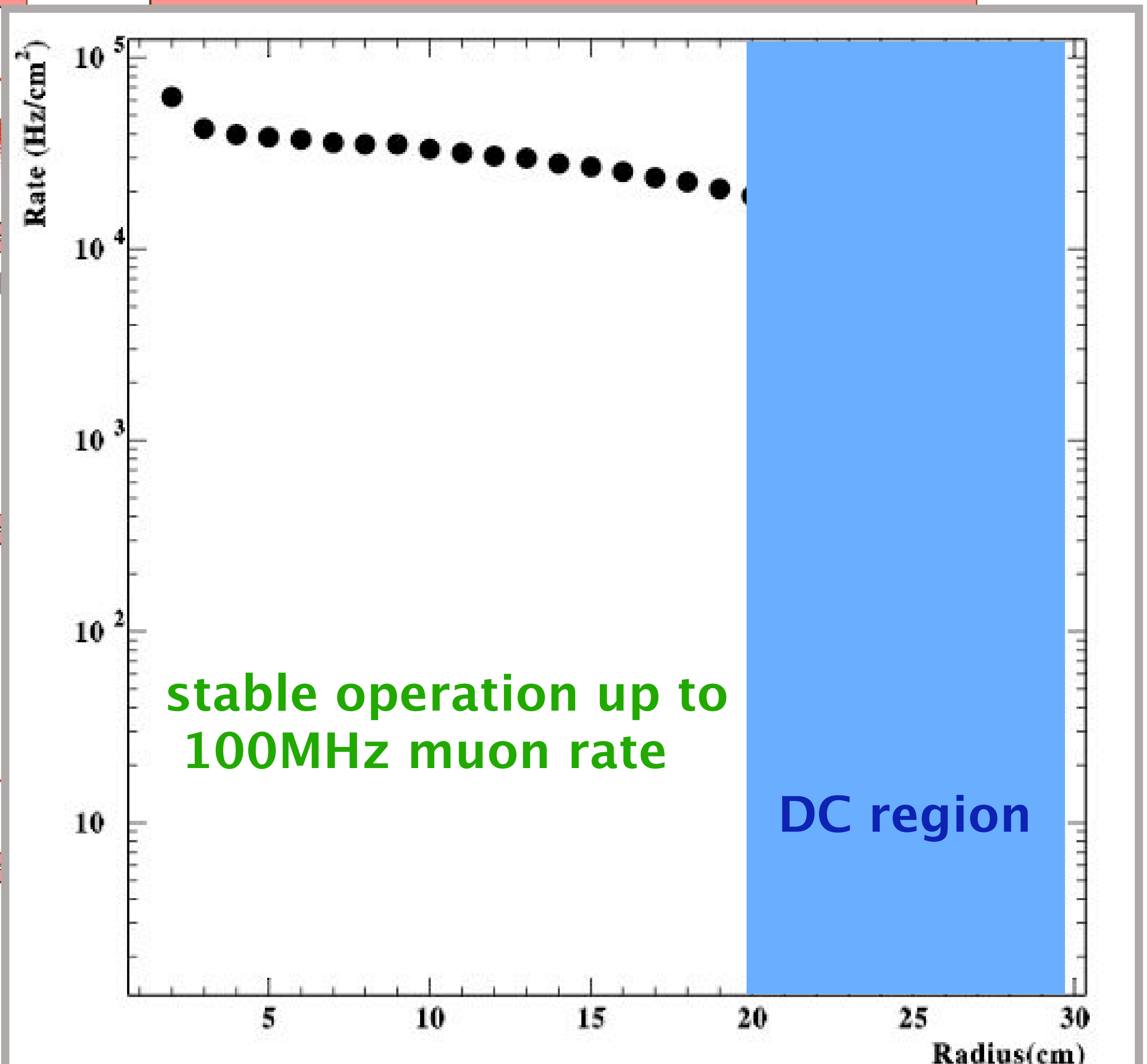
MEG drift chamber

Requirements for the Drift Chamber

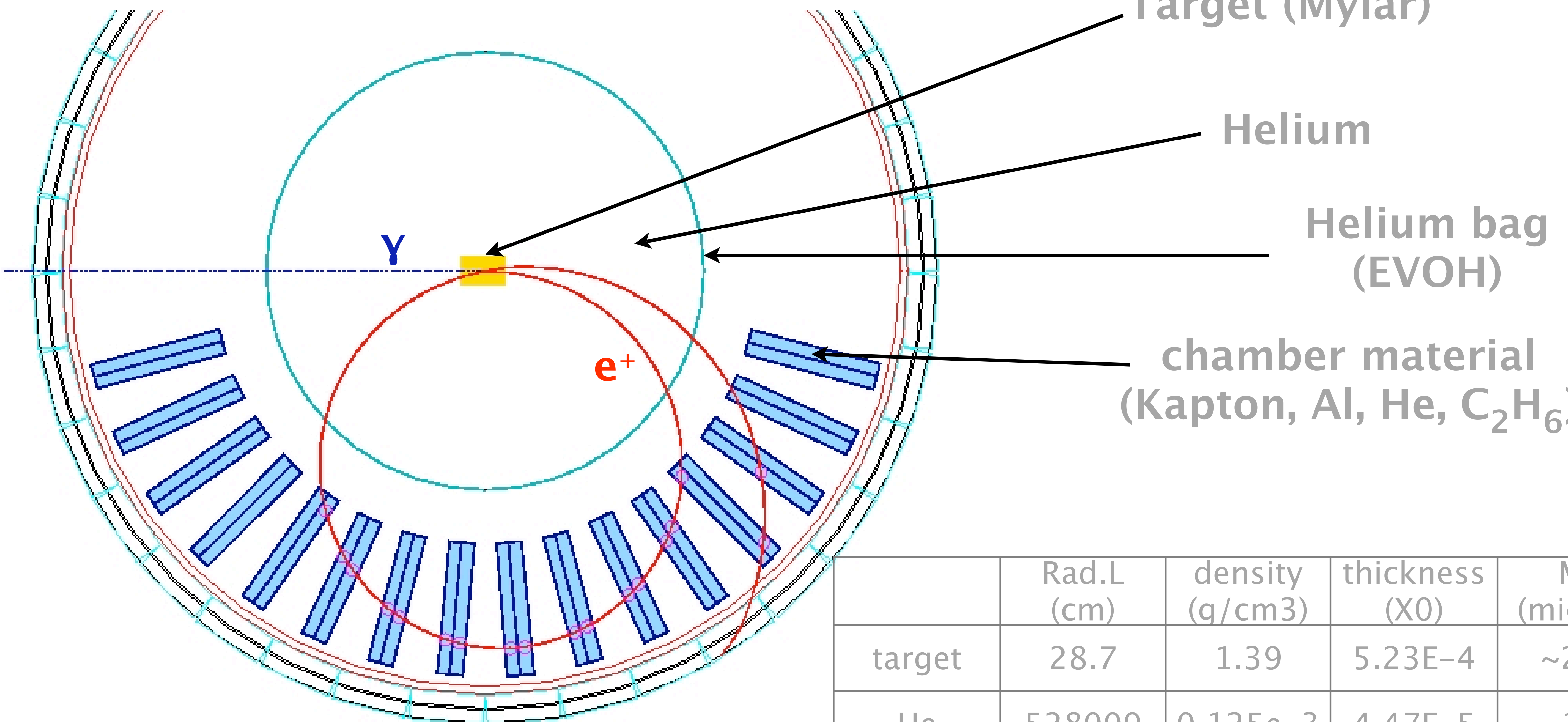
- High rate
  - the most intense DC muon beam
  - muon stopping rate : ~ 2.5×10^7 muon/sec
  - >> COBRA magnet and small chamber
- High Resolution
  - very excellent sensitivity
  - good position resolution (300μm) is required for both direction (r,z)
  - >> vernier pad system for z-position measurement
  - >> low material (multiple scattering suppression)

COBRA spectrometer
(COnstant Bending RAdius)





Multiple Scattering in the spectrometer

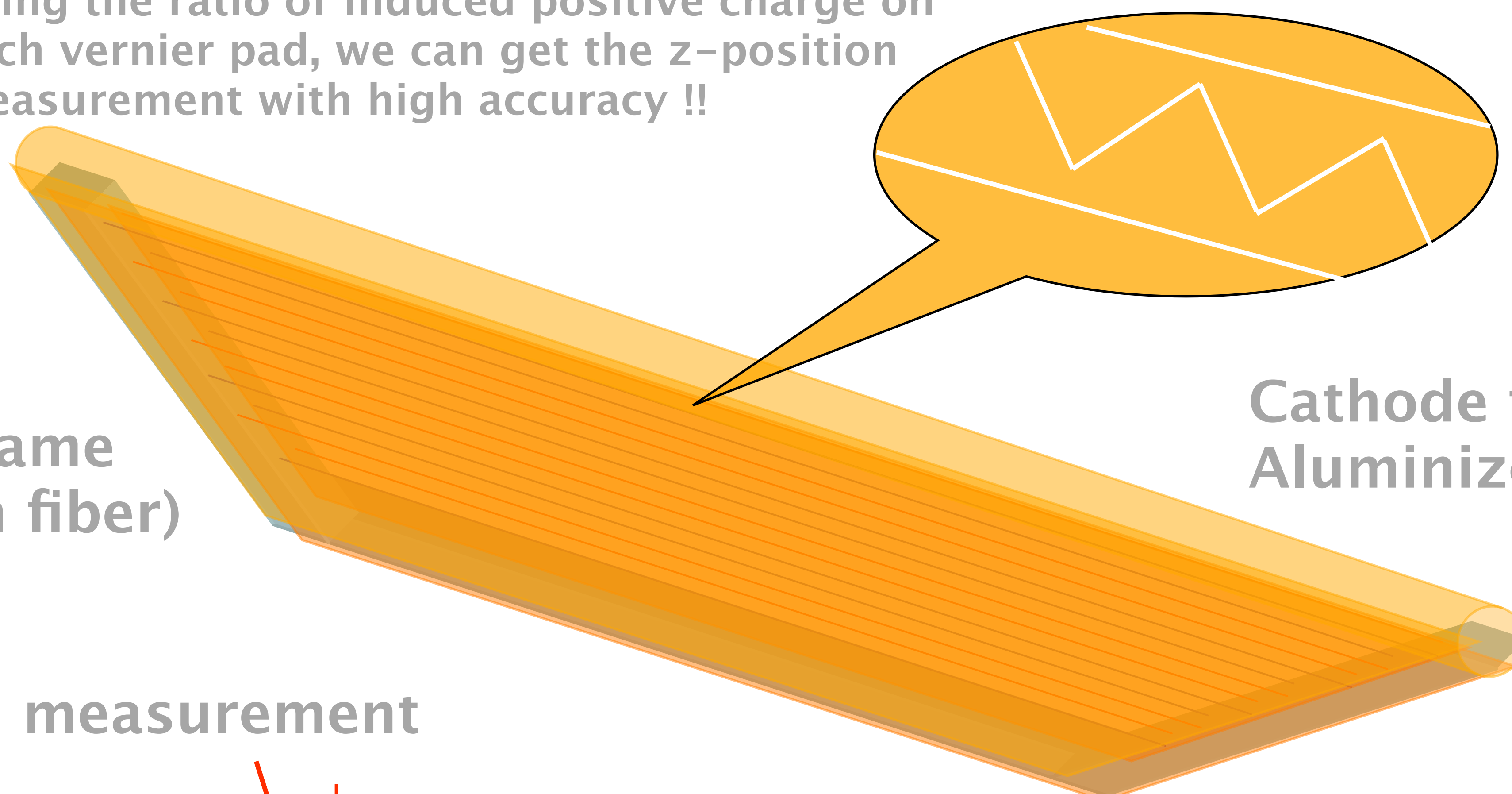


	Rad.L (cm)	density (g/cm3)	thickness (X0)	MS (micron)
target	28.7	1.39	5.23E-4	~280
He	528000	0.125e-3	4.47E-5	~100
Bag	34.3	1.19	2.92E-4	~200
DC wall	28.6	1.42	4.37E-5	~50
DC gas	65000	1.52e-3	7.69E-6	

MEG drift chamber

Z-direction measurement

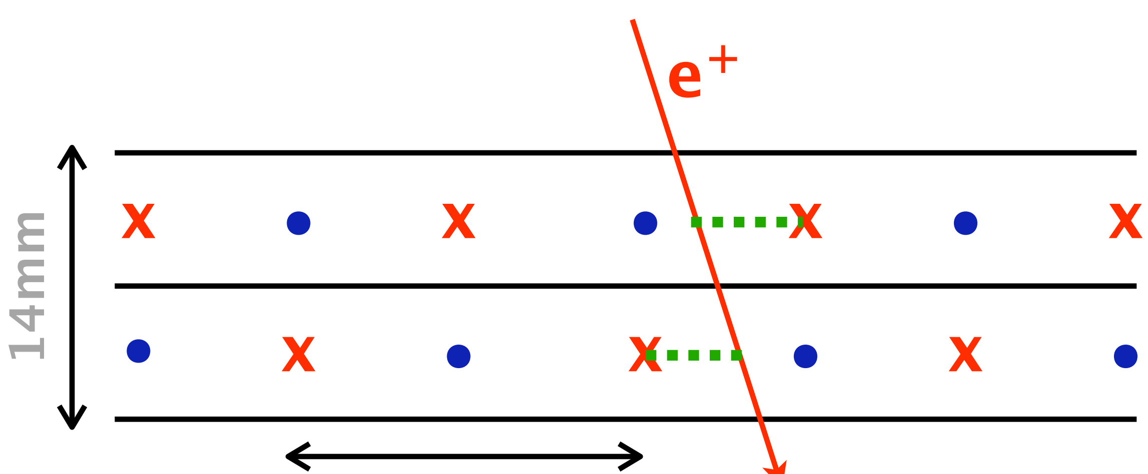
Vernier pattern is printed on cathode plane.
Using the ratio of induced positive charge on each vernier pad, we can get the z-position measurement with high accuracy !!



opened-frame
(G10/Carbon fiber)

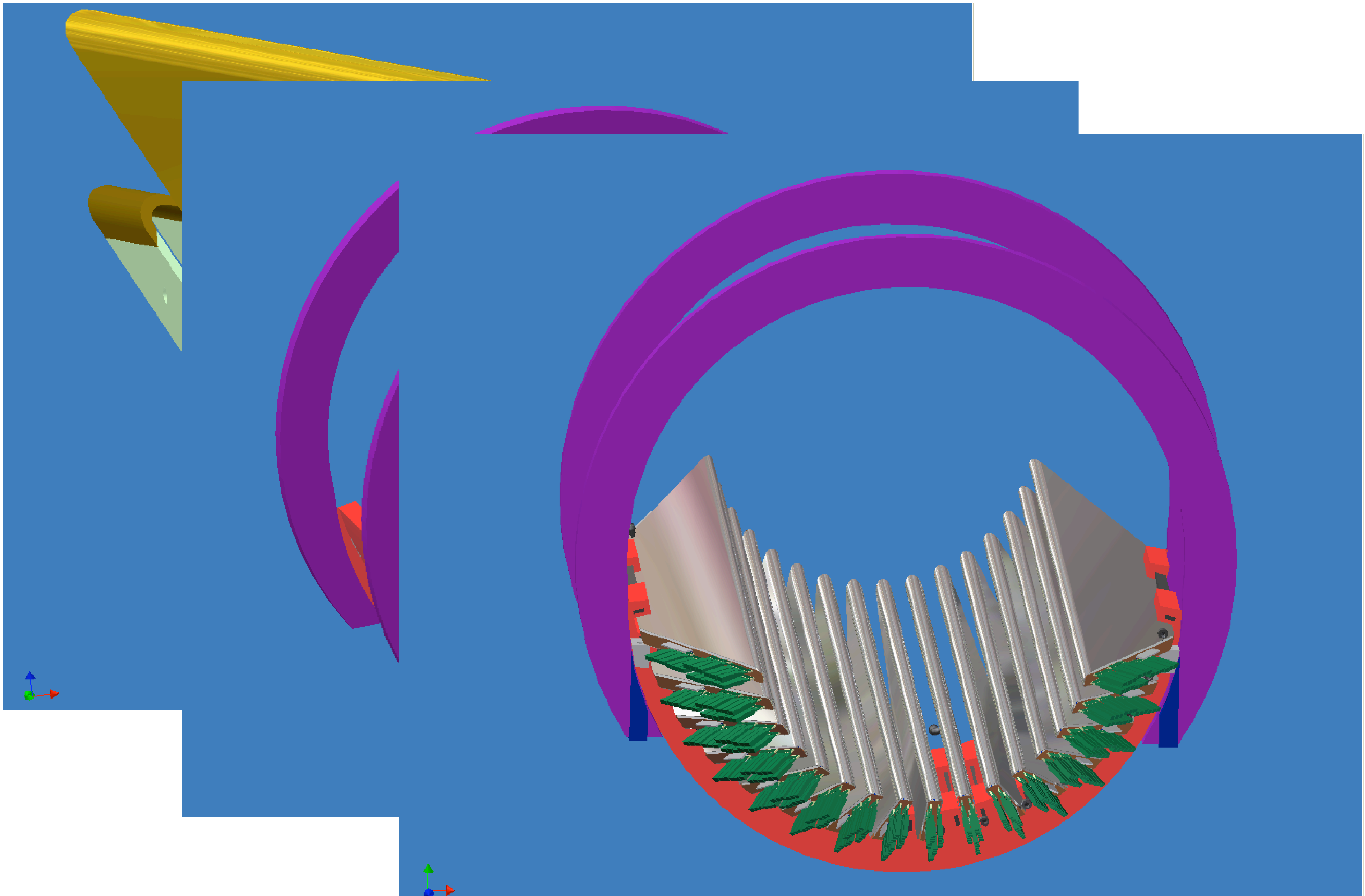
Cathode foil
Aluminized Kapton

R-direction measurement



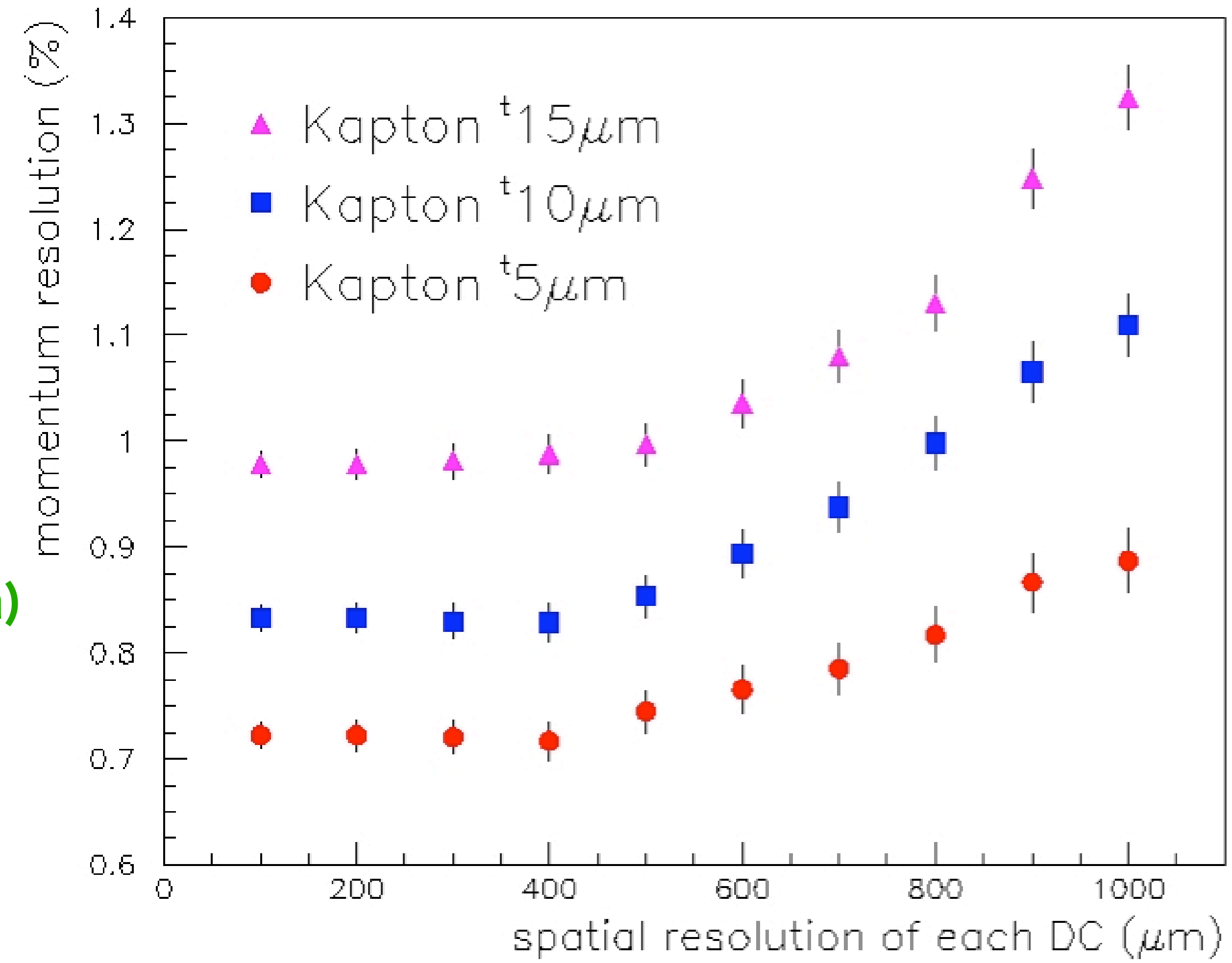
staggered 2-layer wires
sense (Ni/Cr, 25um, 0.5N)
potential (Be/Cu, 50um, 1.1N)

MEG drift chamber



Resolution & multiple scattering

MC results



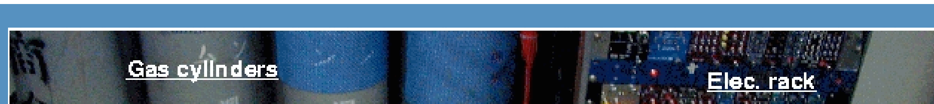
very low material

- chamber gas ;
  - He/C_2H_6 (50:50), long rad. length ~ 650m
- cathode foil ;
  - very thin polyimide (12.5μm) + Al (250nm)
  - with vernier pattern

High Resolution

- momentum resolution is determined by multiple scattering.
- for the z-direction accuracy, ~300μm spatial resolution(σ) is enough to achieve the required momentum resolution.

R&D with prototypes



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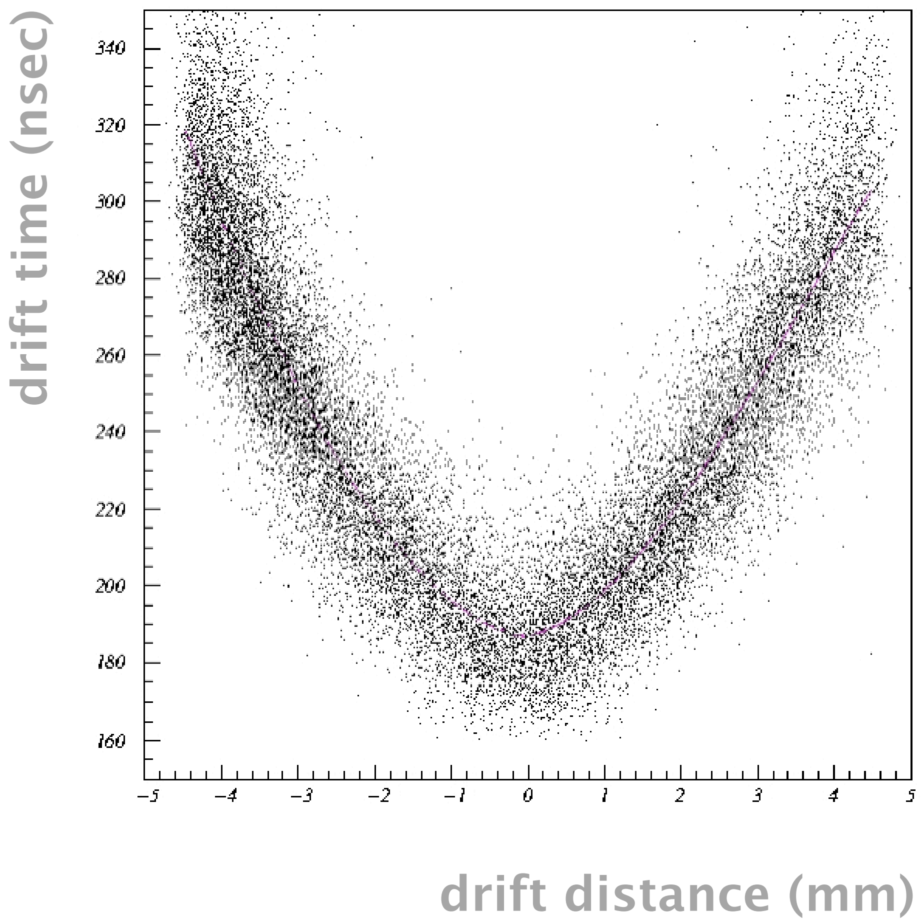
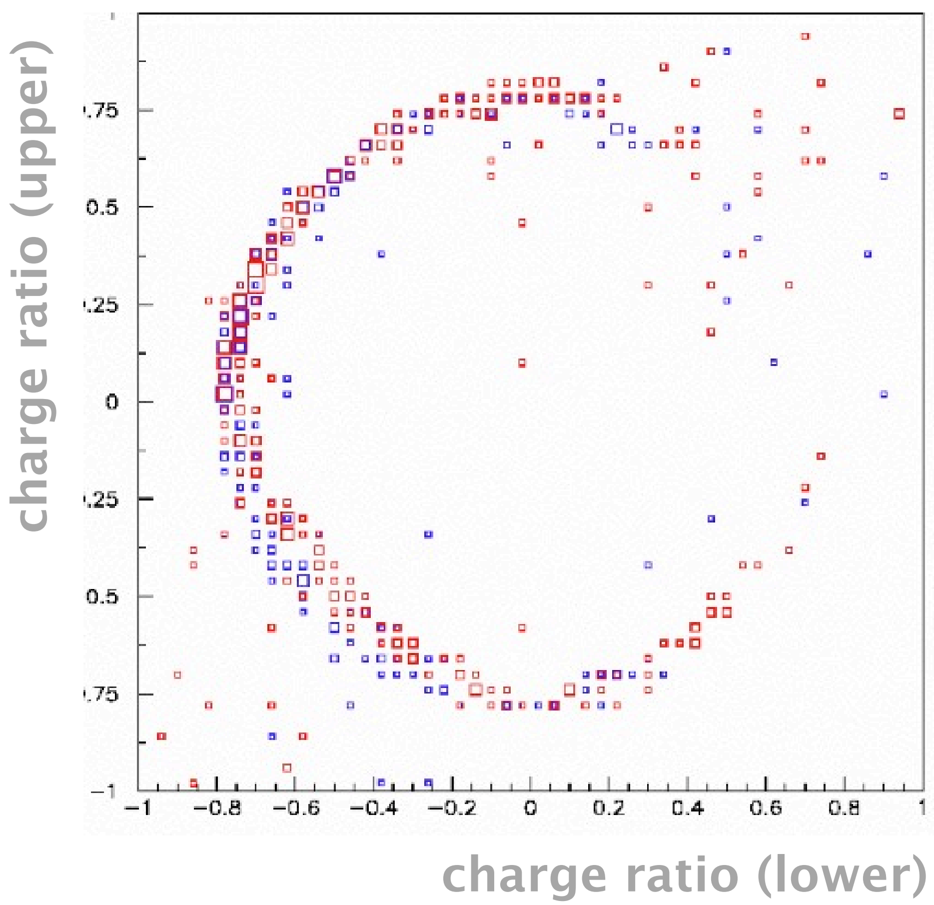
5th pro
1:1 Al-
electro
resolut
(w/o B

6th prototype (2004)
1:1 final test
mechanical test, construction study and final check

Results from prototypes



Spatial resolution (R-direction)
100~200 μm (σ)



Spatial resolution (Z-direction)
300~450 μm (σ)

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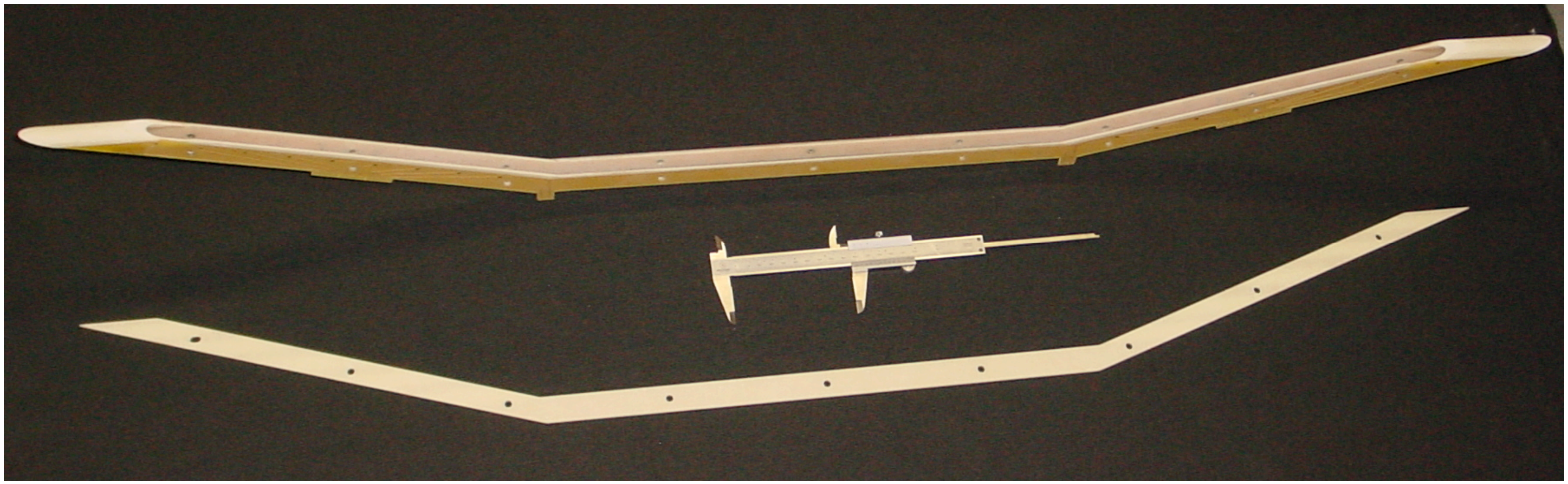
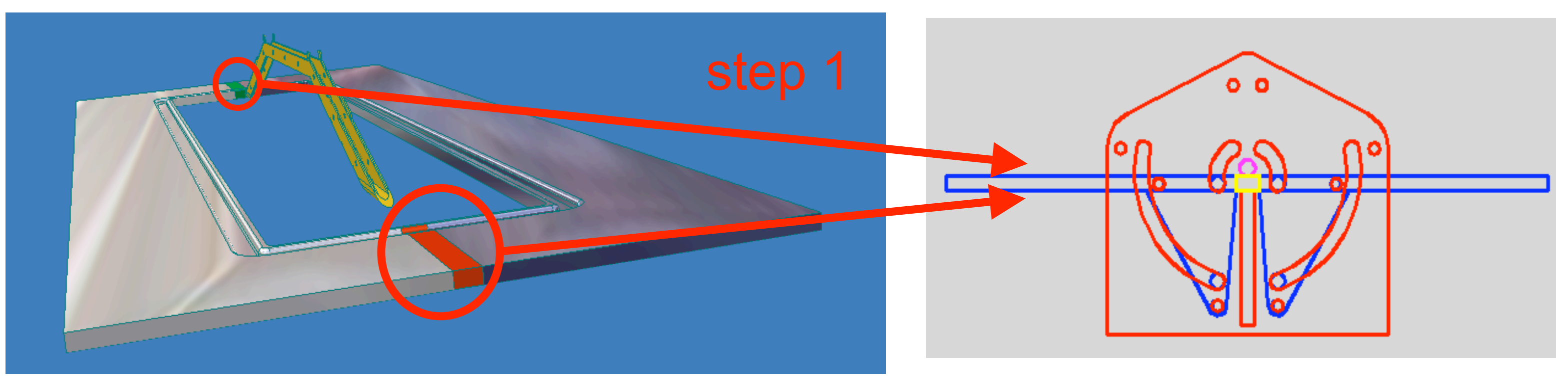
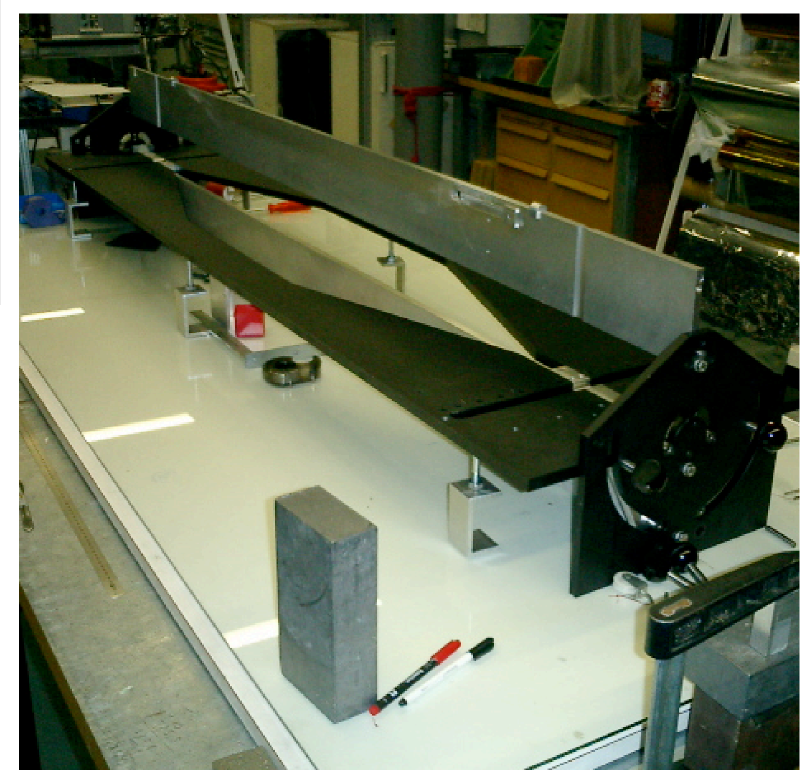
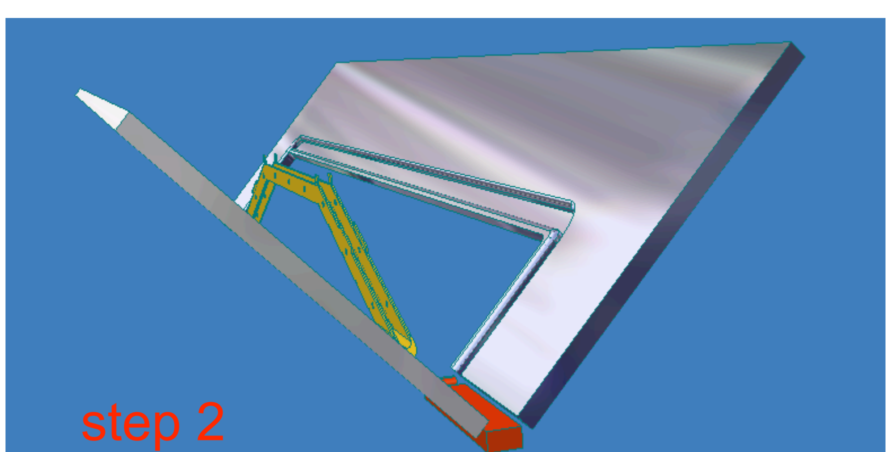
making of the drift chamber (1)

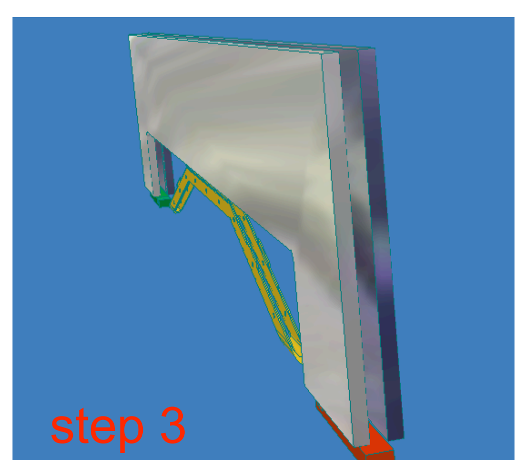
~ frame and construction procedure ~



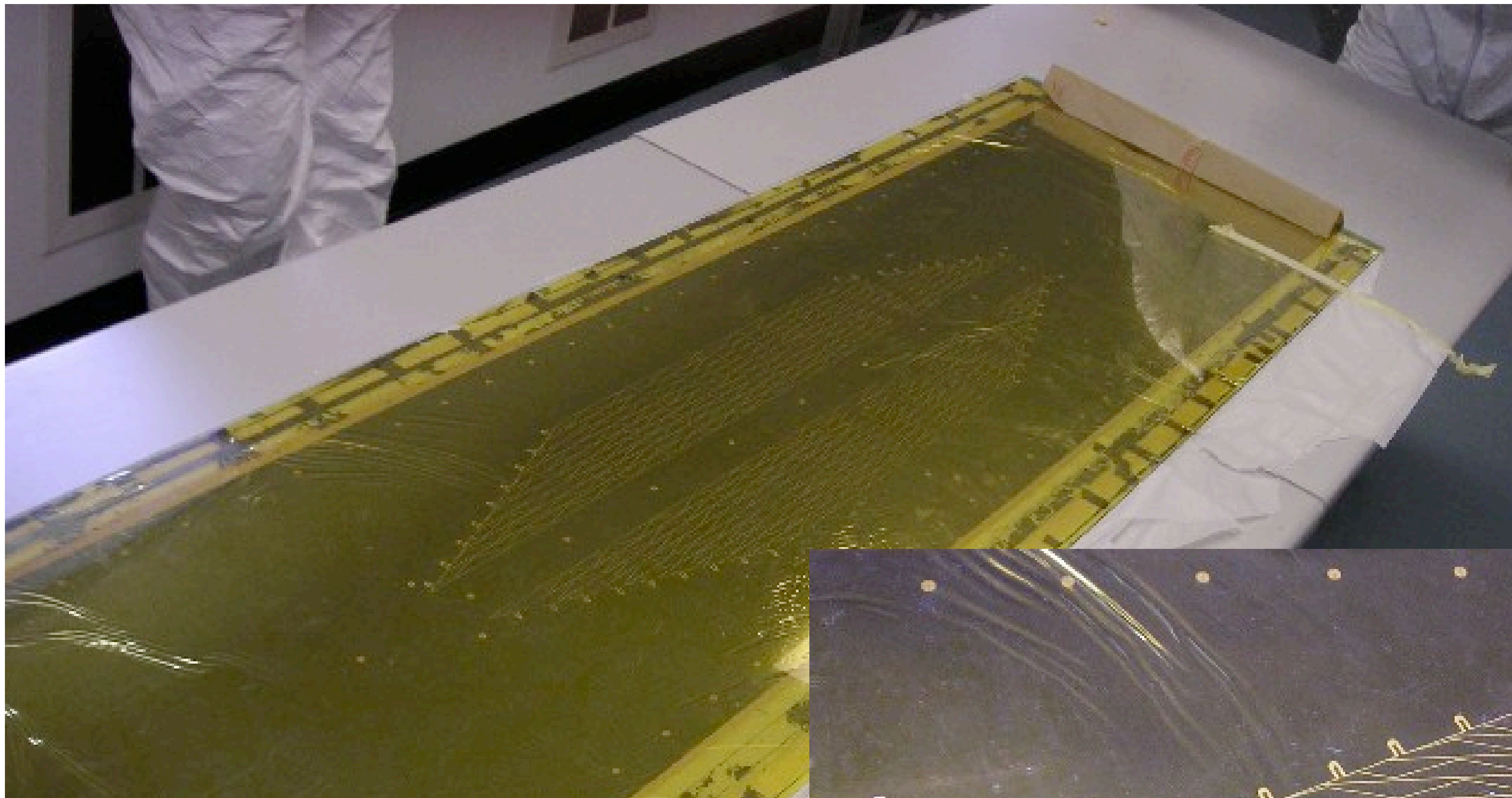




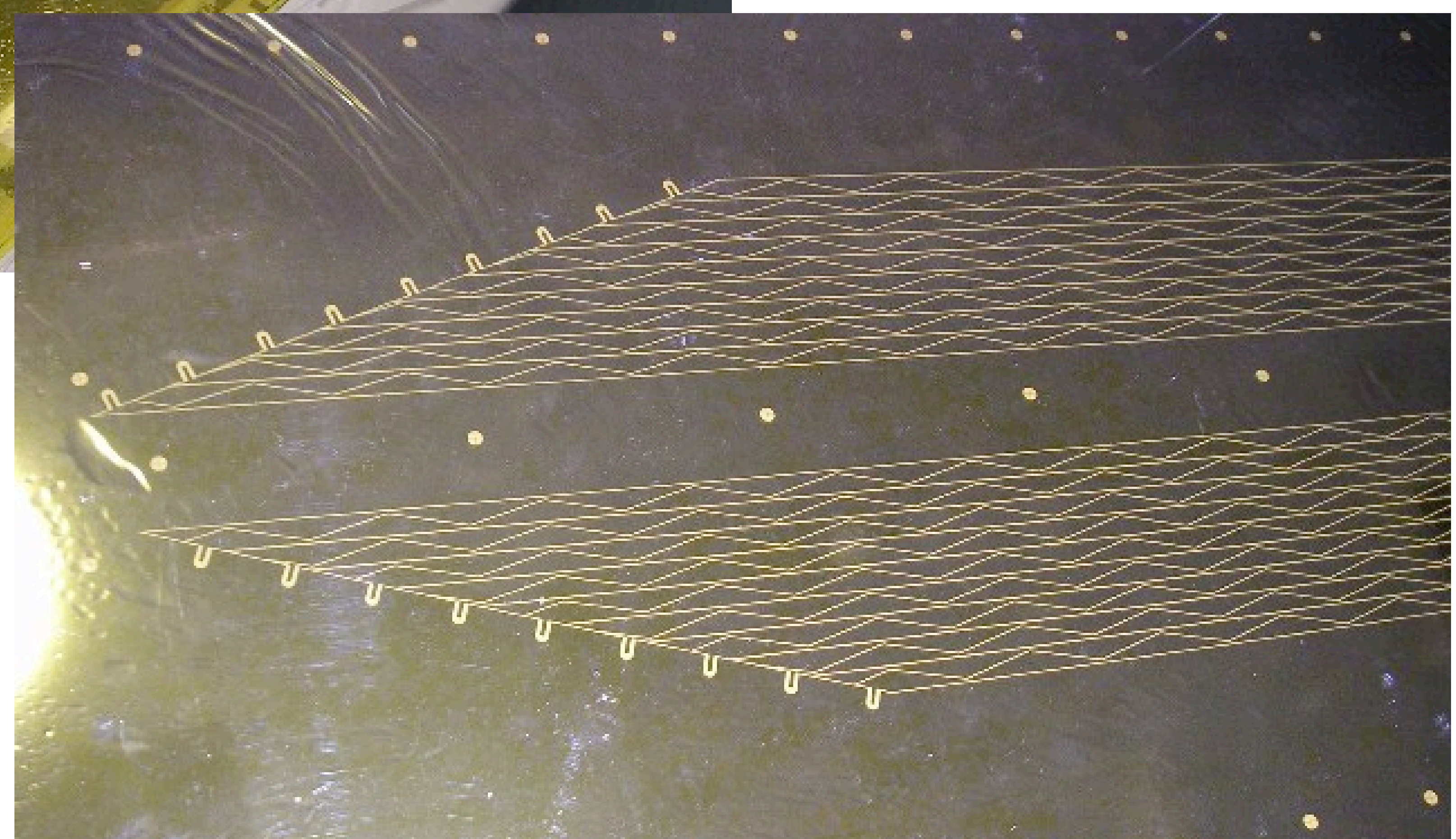




making of the drift chamber (2)
~ vernier pattern printed thin Kapton foil ~



joint development by PSI, REPIC, and Hirai-seimitsu co,Ltd.



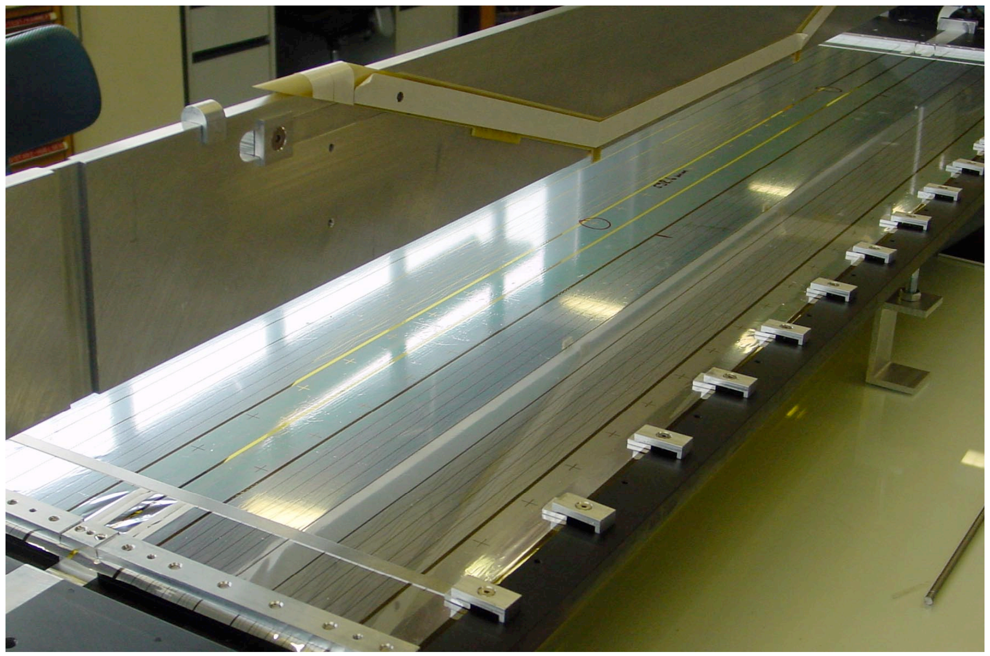
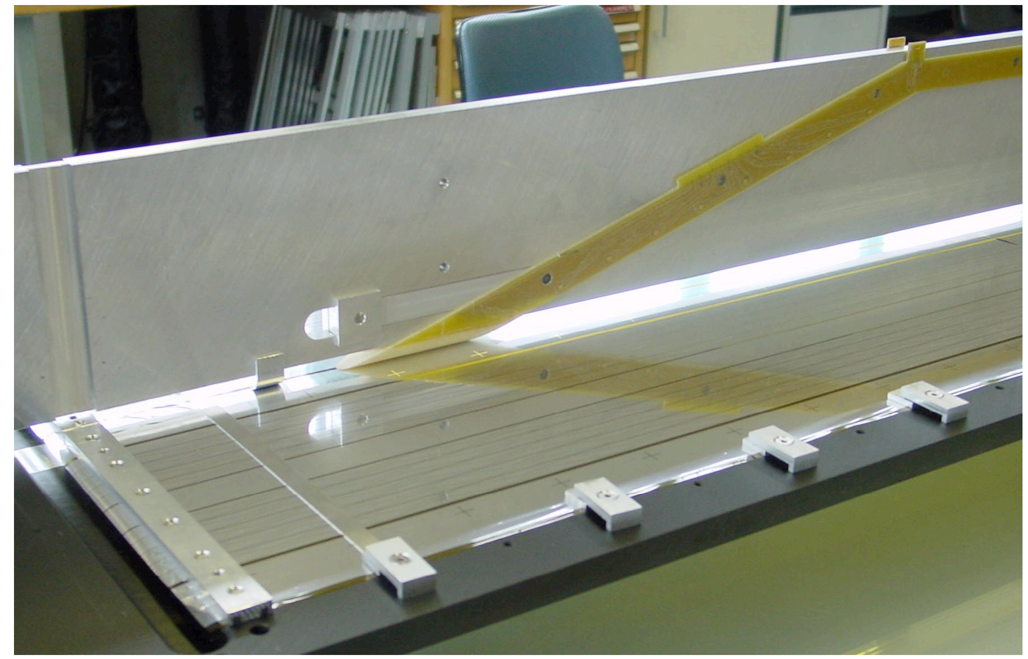
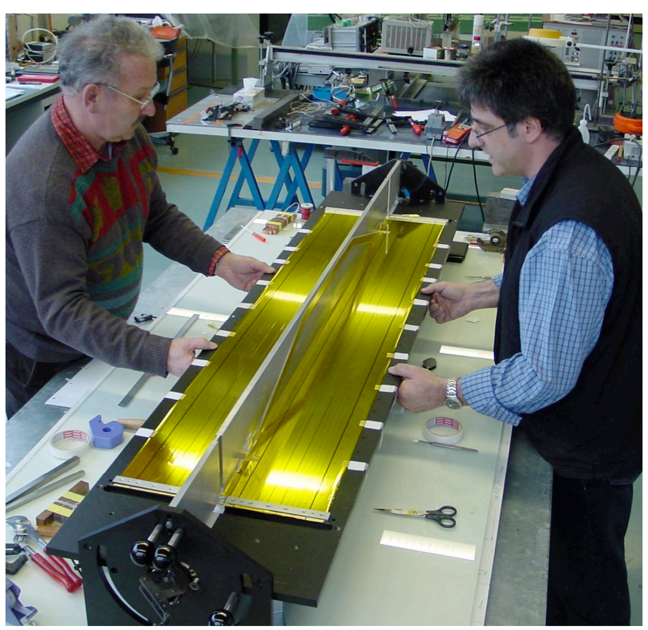
30aSB7

アルミを使用した低物質量カプトンフィルムの開発とその応用

理研[A]，林栄[B]　延與秀人[A]，竹谷篤[A]，○近野和夫[B]

making of the drift chamber (3)

~ construction ~

Conclusion

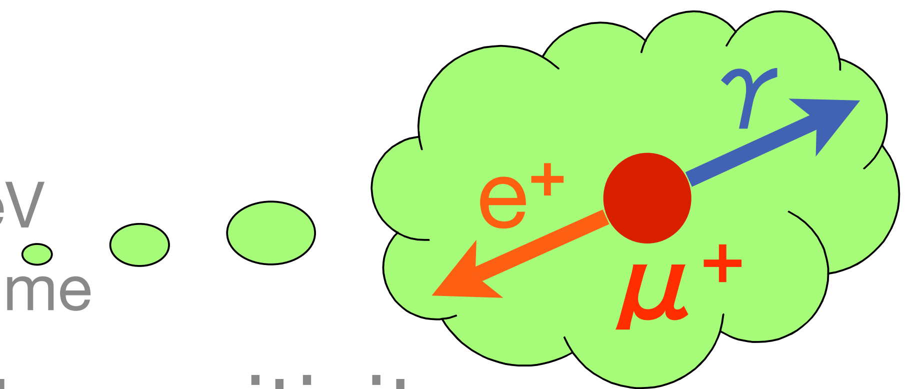
- MEG experiment will run @ PSI, engineering run will start in next year, and physics run will start in early 2006.
- MEG drift chamber must be satisfied with some requirements, operation in high rate, resolution, low material and so on.
- Drift chamber R&D for the MEG experiment has been carried out and completed more or less.
- Our prototype reached expected performances.
- Final mass-production will start soon !!

Appendix

Additional transparencies

Signal & Background

- Signal
  - $E_e = E_\gamma = 52.8$ MeV
  - Back to back, in time

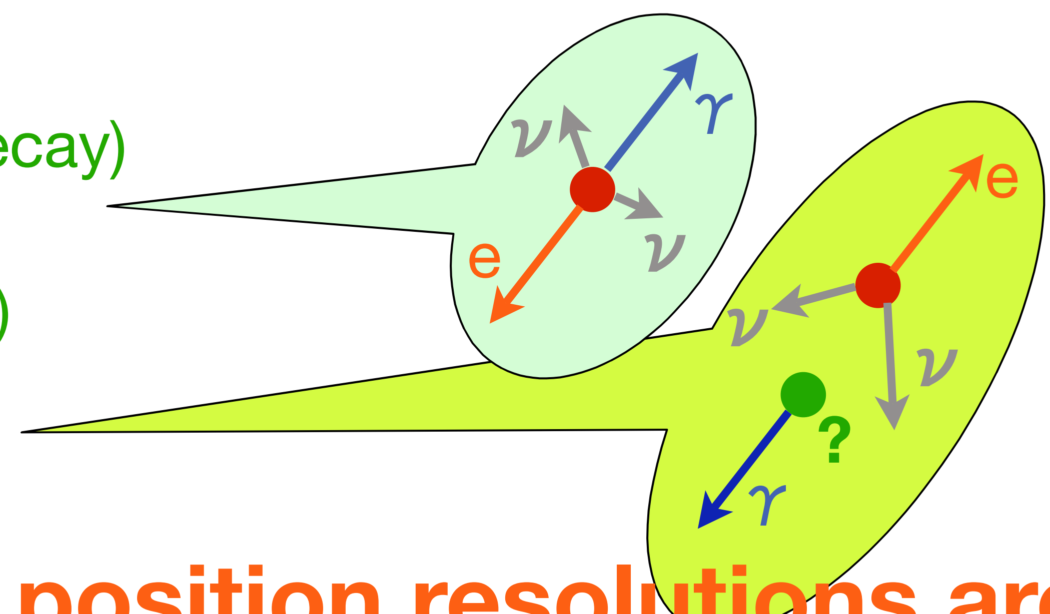


- Single event sensitivity
  - $N_\mu=2.5\times10^7$/s, T~4×10^7s, $\Omega/4\pi=0.09$, $\varepsilon_e=0.9$, $\varepsilon_\gamma=0.6$
  - **Sensitivity ~ 4.5×10^{-14}**

Expected detecter resolution (FWHM)

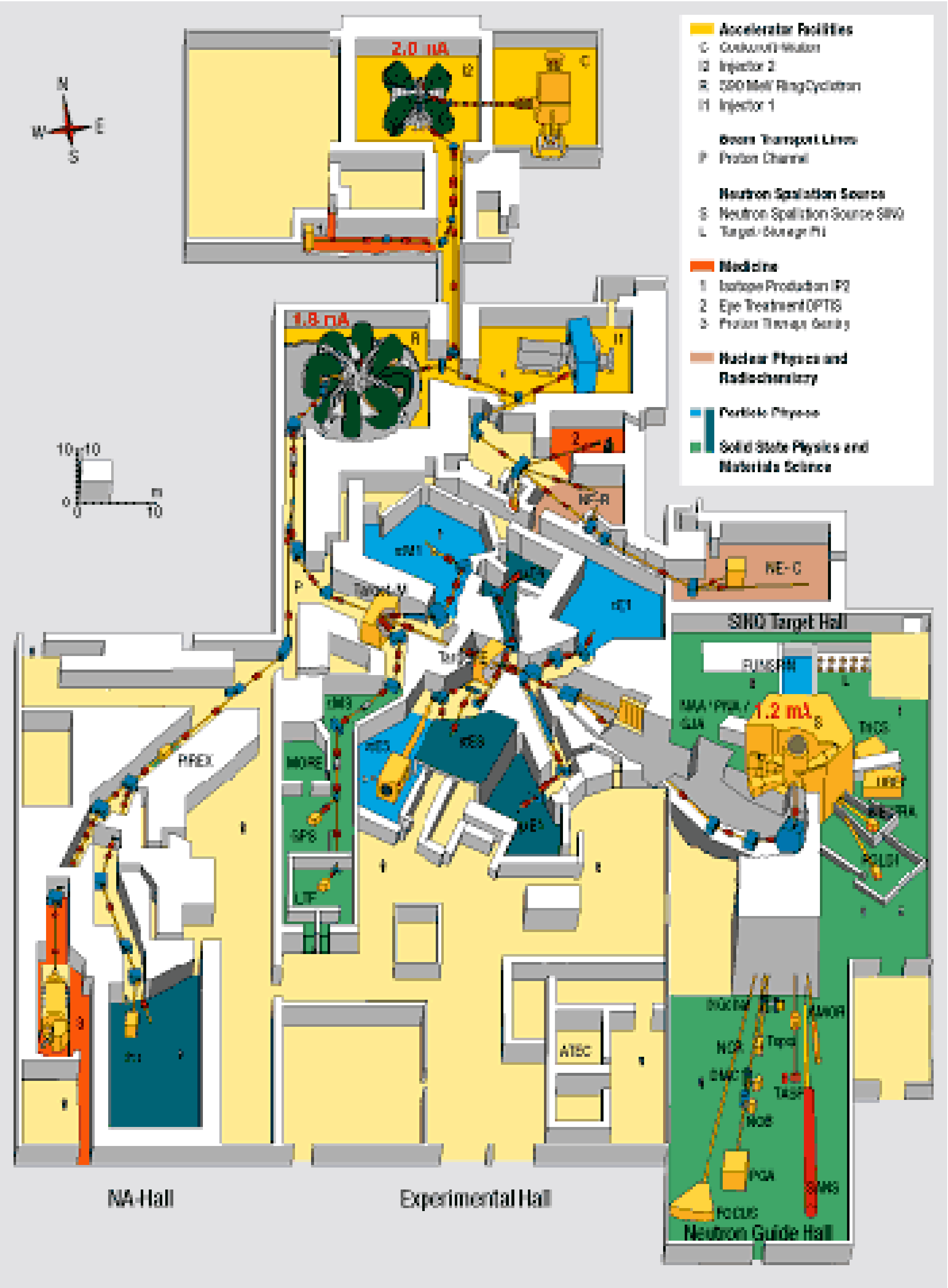
γ energy ΔE_γ	4.5 %
e^+ momentum Δp_e	0.8 %
angular $\Delta\theta_{e\gamma}$	10 mrad
timing $\Delta t_{e\gamma}$	141 psec

- 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

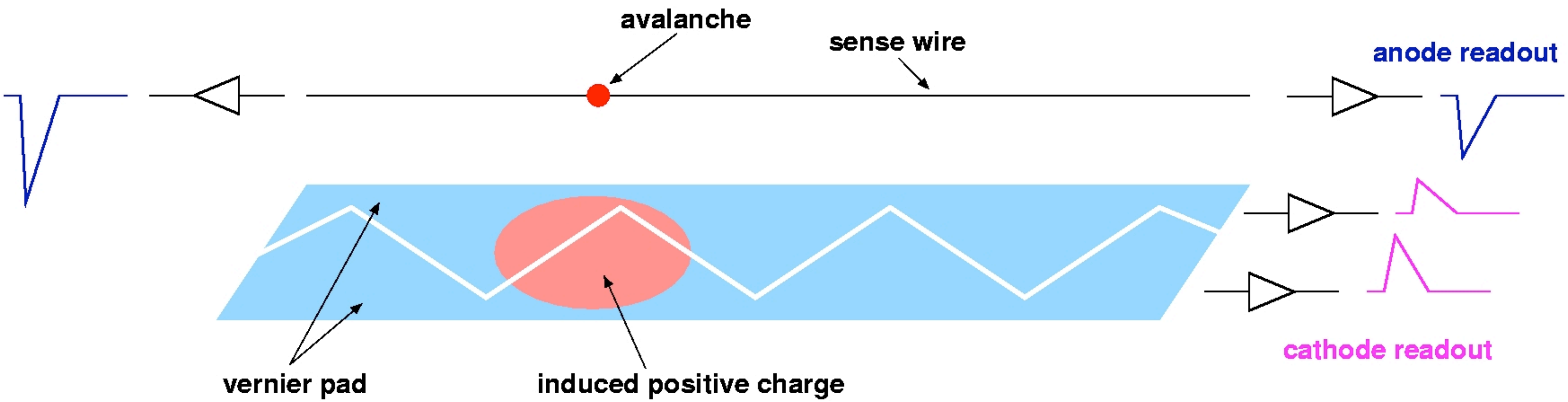


- **Good energy, timing and position resolutions are required for γ , e^+ detector !**

Paul Scherrer Institut

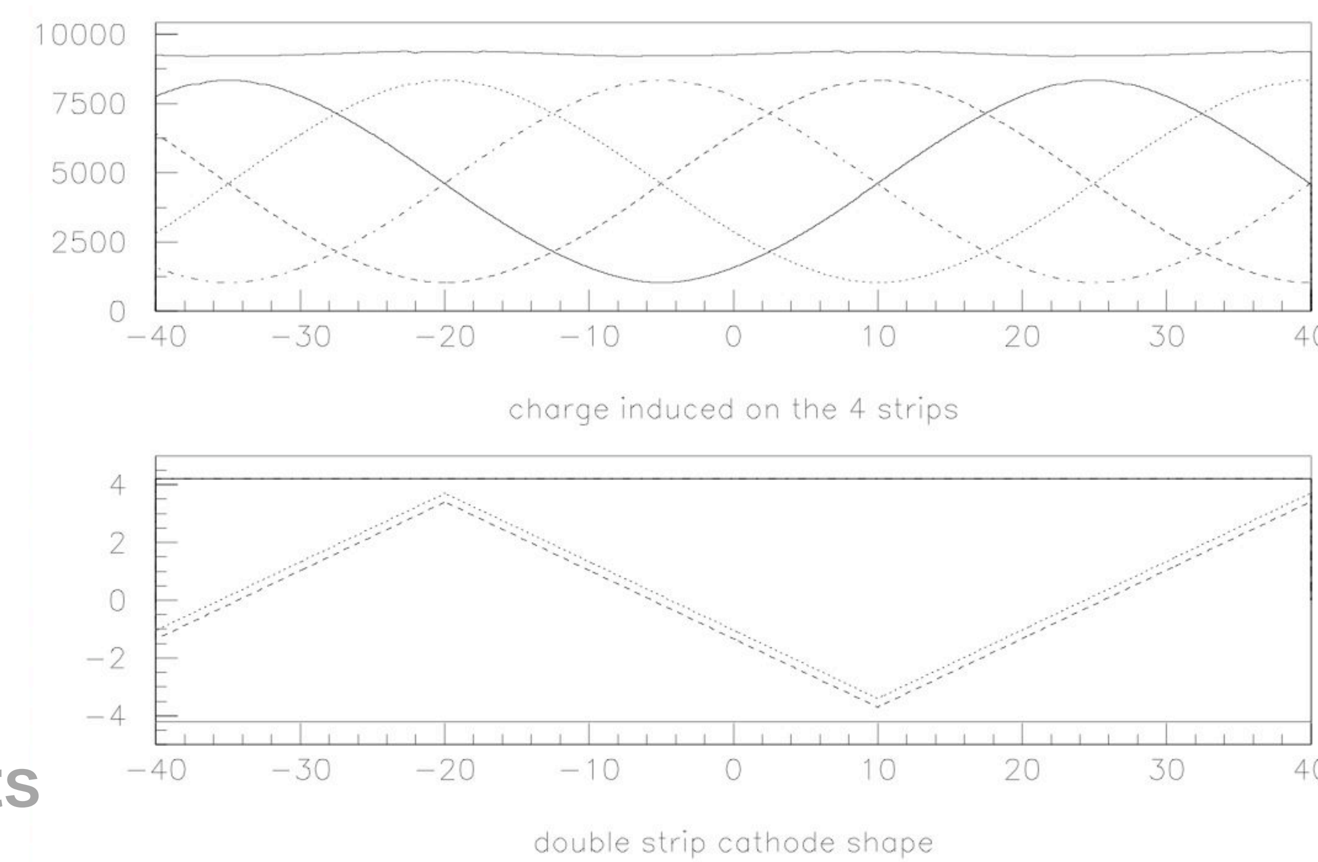


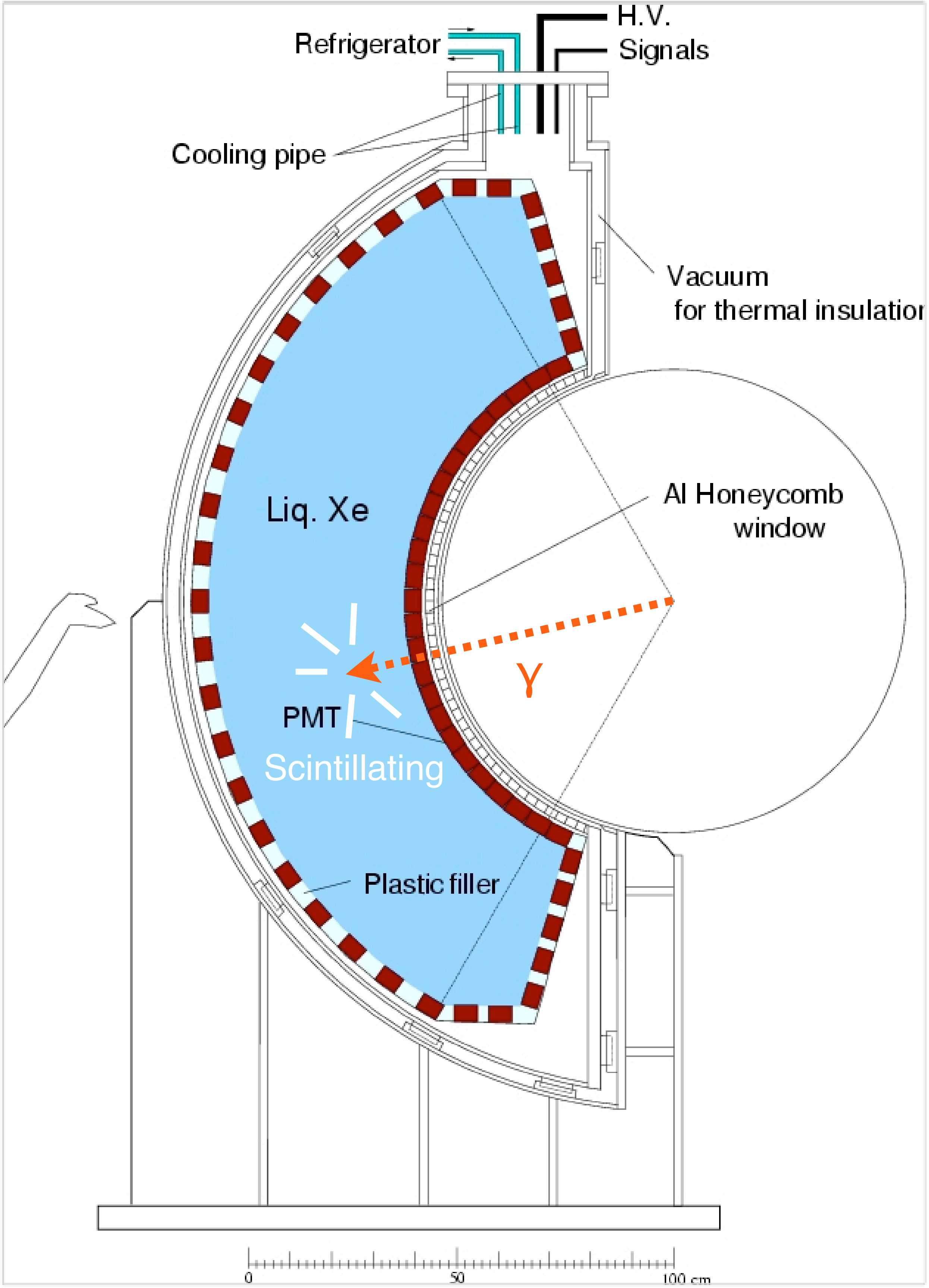
cathode pads with vernier pattern



- 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





Liquid Xenon Photon detector

Features

- High light yield (75% of NaI)
  - Good resolutions
- Fast signal (4.2nsec decay time)
  - Reduce pileups
- Liquid (good uniformity)
  - No need segmentation

Design

- Active volume of LXe ~ 800L
- 830 PMTs immersed in LXe