MUON PROFILE DETECTORS

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INTRODUCTION

Beam Diagnostics in future High Energy Accelerators will require

* long lived Instrumentation in
* highly hostile radiation environment.

Detectors capable of

- withstand extreme radiation levels
- requiring no human intervention
- operate at frontiers of radiation-resistant technology

are at a prime for applications in environmental-hostile situations.

A research program aiming at

- individuating new solutions and technologies
- testing them under extreme operational conditions

has been launched at CERN in the framework of LHC developments.

Preliminary Ideas are presented for possible applications
in Muon Beams Diagnostics for future Neutrino Factories.

2 -A semi-invasive CdTe-based μ–profile monitor

MIP's create charges in CdTe and other semiconductors

PARAMETER			DETECTOR			
			CdTe	GaAs	Si	C (Diamond)
Thickness	τ	μm	300	300	300	300
Atomic number	Z		48/50	31/33	14	6
Density	ρ	$\mathrm{g\,cm^{-3}}$	5.83	5.32	2.33	2.88
Rad. thickness	$\rho\tau$	$\mathrm{g\,cm^{-2}}$	0.176	0.160	0.070	0.086
Energy loss rate	$-(dE/dx)_{min}$	$\mathrm{MeV\,g^{-1}\,cm^2}$	1.26	1.40	1.66	1.78
Energy loss	ΔE	MeV	0.222	0.224	0.116	0.153
Ionization potential	I_o	eV	4.43	4.20	3.61	13.0
Charges/MIP inside Det.(*)	$N_q = \Delta E/I_o$	$\times 10^3$	50	53	32.2	11.85

(*) See later for Collection Efficiency

2 - A semi-invasive CdTe-based $\mu-$profile monitor / Basic Idea

- **Array of 10×10 CdTe elements ($2\,\mathrm{cm}^2 \times 50$-$200\,\mu\mathrm{m}$)**
- **A 0.3 mm Al_2O_3 support (3.3×10^{-3} r.l.) covering 20×20 cm^2 $\mu-$beam section**
- **Remotely controlled to be inserted in beam**
- **Provides 2D profile measurements via charge collection on each CdTe element**
- **From (3) expect a charge per element proportional to a $\mu-$flux**

$$\langle \Delta N_\mu \rangle \simeq 2 \times 10^9 \ \mu/\mathrm{burst/element}$$

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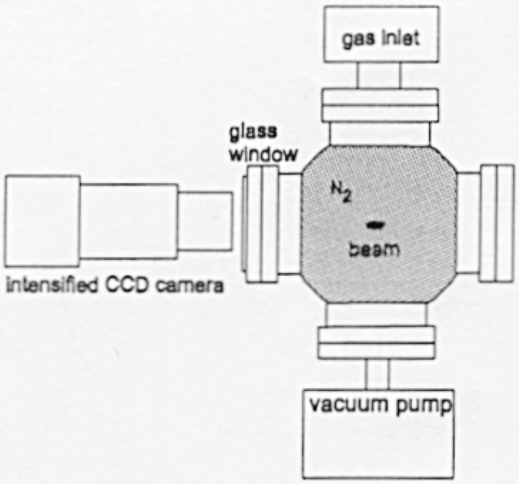
- CERN will complement LETI's expertise in technical realization of CdTe elements, deposit techniques, bonding on adequate supports, etc.

- Prototypes will be tested at CERN/SPS H4 450 GeV proton beam mid-2001 for
  1. charge collection efficiency and comparison with predictions,
  2. cross-talk detection between adjacent CdTe elements,
  3. front-end electronics requirements and performance.

- Performance tests after irradiation in high neutron and proton fluxes are planned.

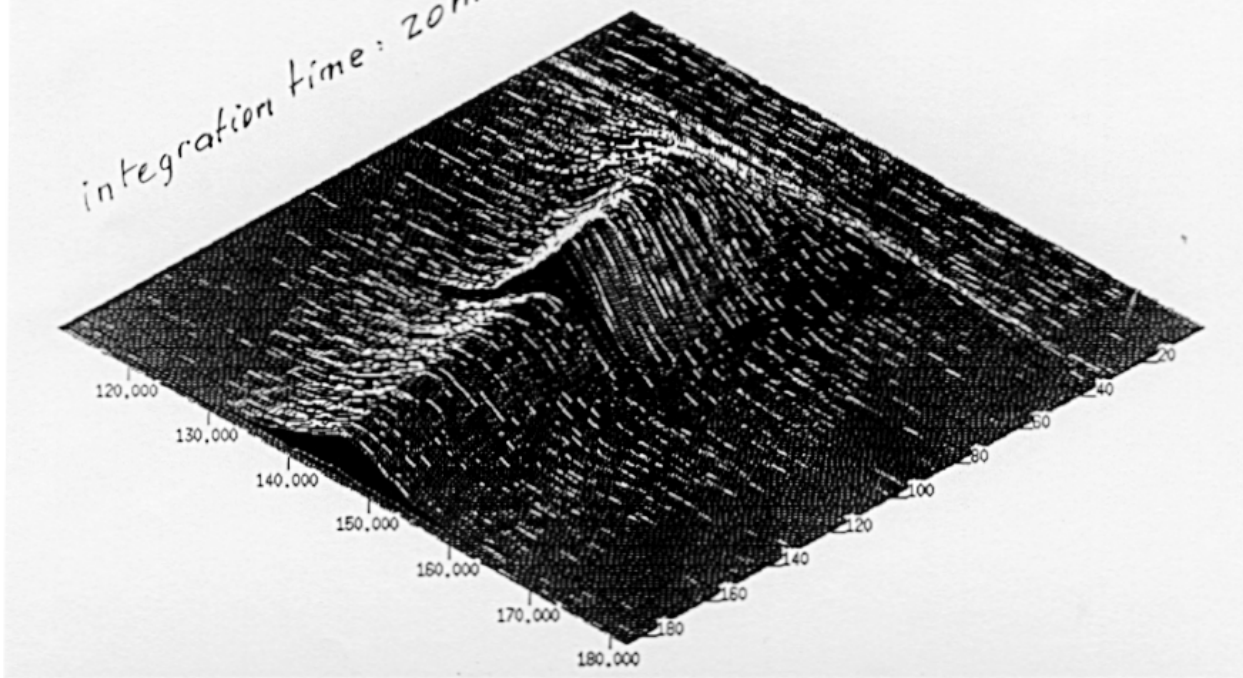
LSS4 Luminescence Gas Test Monitor

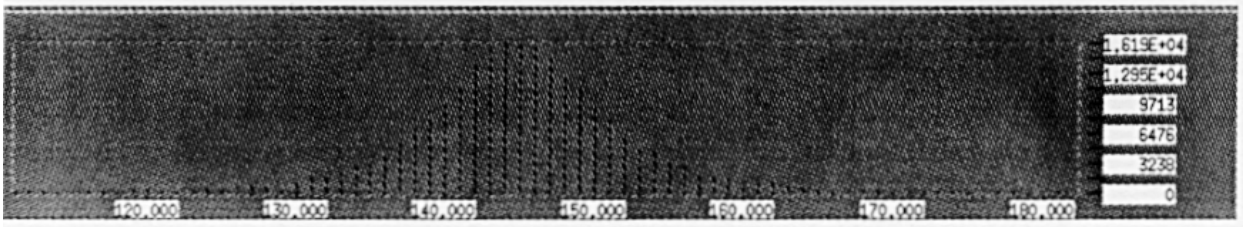
(60 n.s decay time)



$I_b = 2 \times 10^{13}$ p

integration time: 20ms

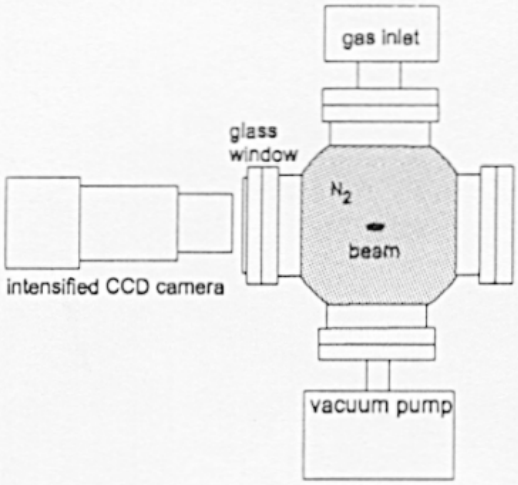




$\sigma = 860 \mu m$

Preliminary results with Nitrogen at 10^{-5} to 10^{-6} Torr

LSS4 Luminescence Gas Test Monitor



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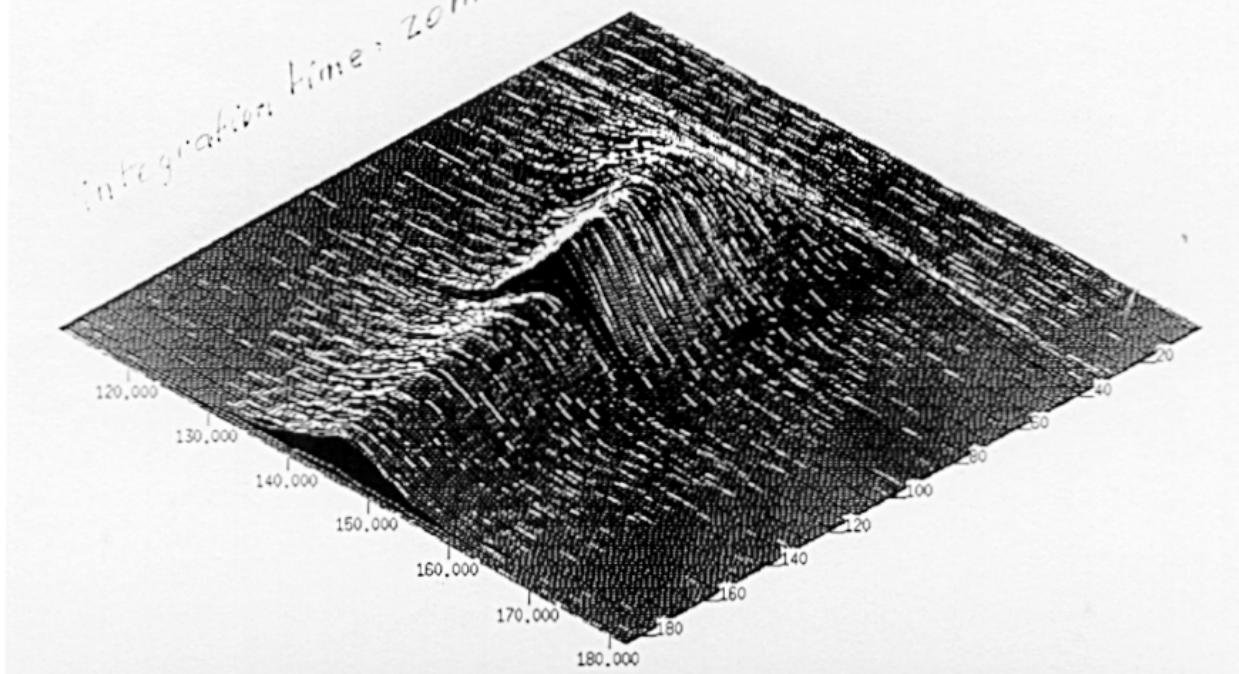
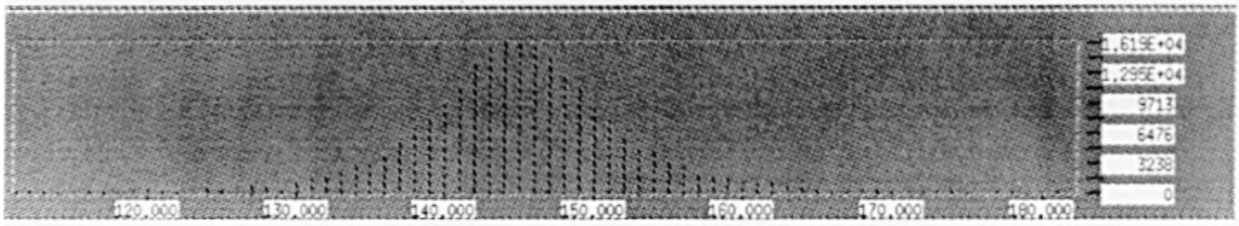
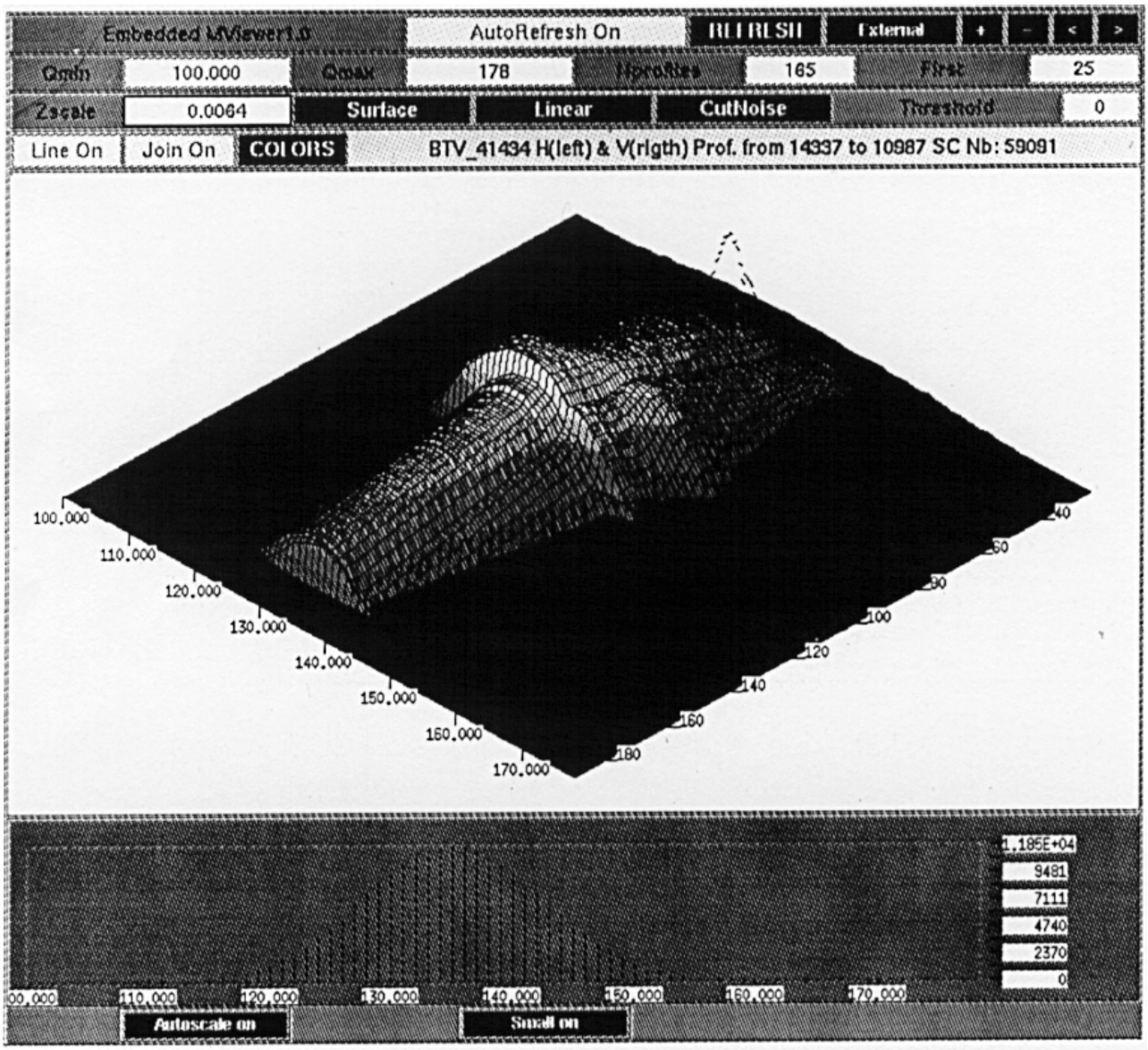




$T = 860\,\mu m$

Preliminary results with Nitrogen at 10^{-5} to 10^{-6} Torr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External
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Qmax
178
Nprofiles
165
First
25
Zscale
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Surface
Linear
CutNoise
Threshold
0
Line On
Join On
COLORS
BTV_41434 H(left) & V(rigth) Prof. from 14337 to 10987 SC Nb: 59091
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110.000
120.000
130.000
140.000
150.000
160.000
170.000
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7111
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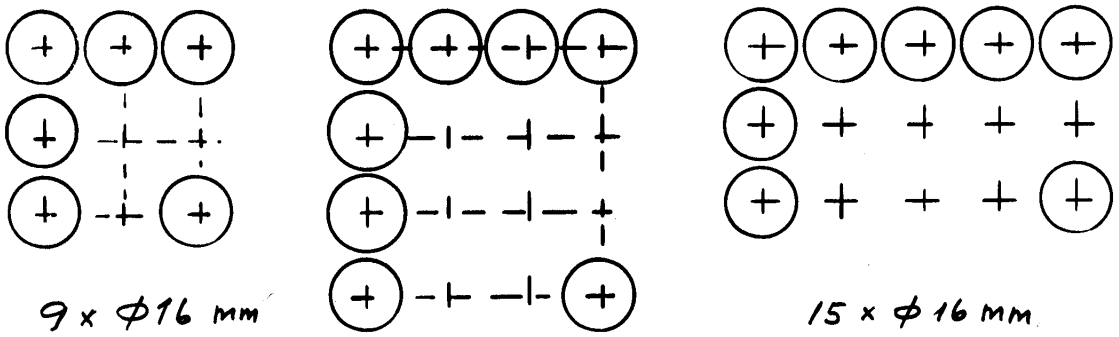
2370
0
Autoscale on
Small on

CdTe array configurations envisaged

for applications in LHC Lumi-monitors



9 x ϕ16 mm

~ 50 x 50 mm^2

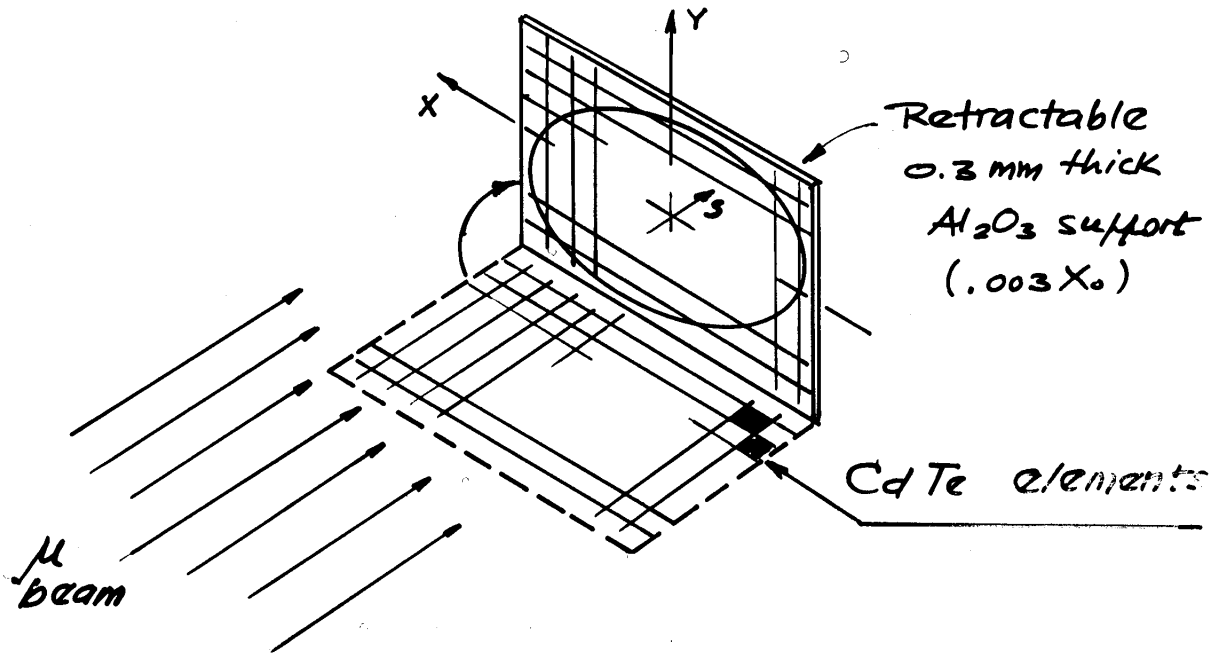
16 x ϕ16 mm

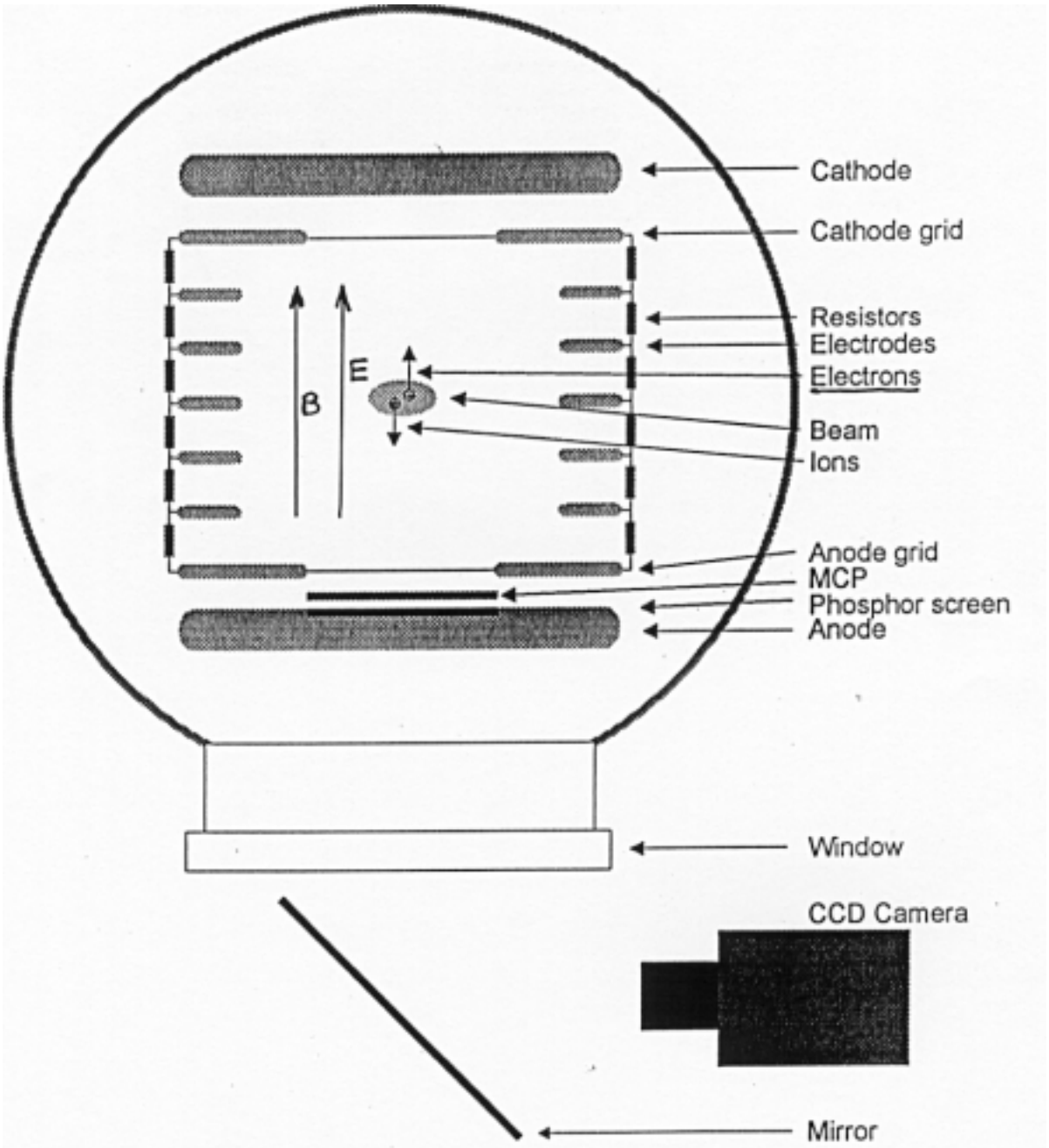
~ 67 x 67 mm^2

15 x ϕ16 mm

~ 84 x 50 mm^2

CdTe array envisageable for μ-beam profile





DESY Restgas Ionisation Profile Monitor used at CERN

3- Conclusion

- **The signal response of Thick-polycrystalline-CdTe is sufficient for 40 MHz event rate measurement.**
- **The sensitivity of 10 000 electrons/MIP and the fast 50 ohms-preamplifier allows simple design.**
- **Irradiation-test up to 10^15 Neutrons/cm2 have demonstrate no significant loss in sensitivity or speed.**

Test with MIP (Sr90)