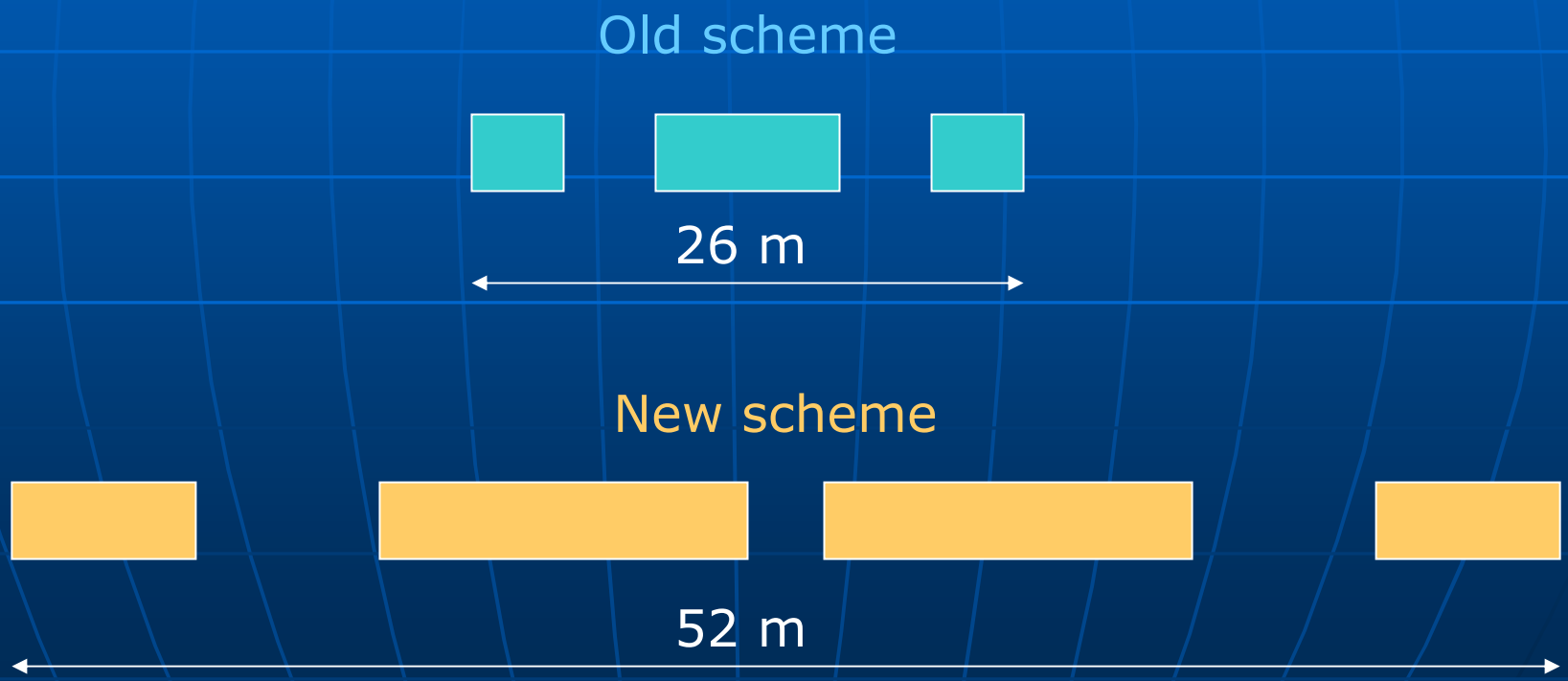
4-magnet-version

ILC energy measurement by synchrotron radiation

K.Hiller, Zeuthen meeting, June 2007



New 4-magnet chicane

Old scheme

M1 2.78 kG l=1.5 m
M2 -2.78 kG l=3.0 m
M3 2.78 kG l=1.5 m

New scheme

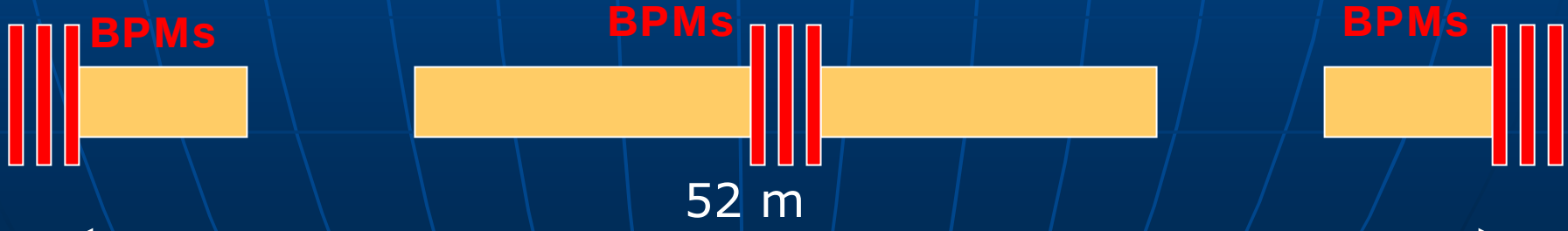
M1 0.67 kG l=3.0 m
M2 -0.34 kG l=6.0 m
M3 -0.34 kG l=6.0 m
M4 0.67 kG l=3.0 m

→ Due to smaller field strength bend is reduced 0.5 mrad to 0.24 mrad

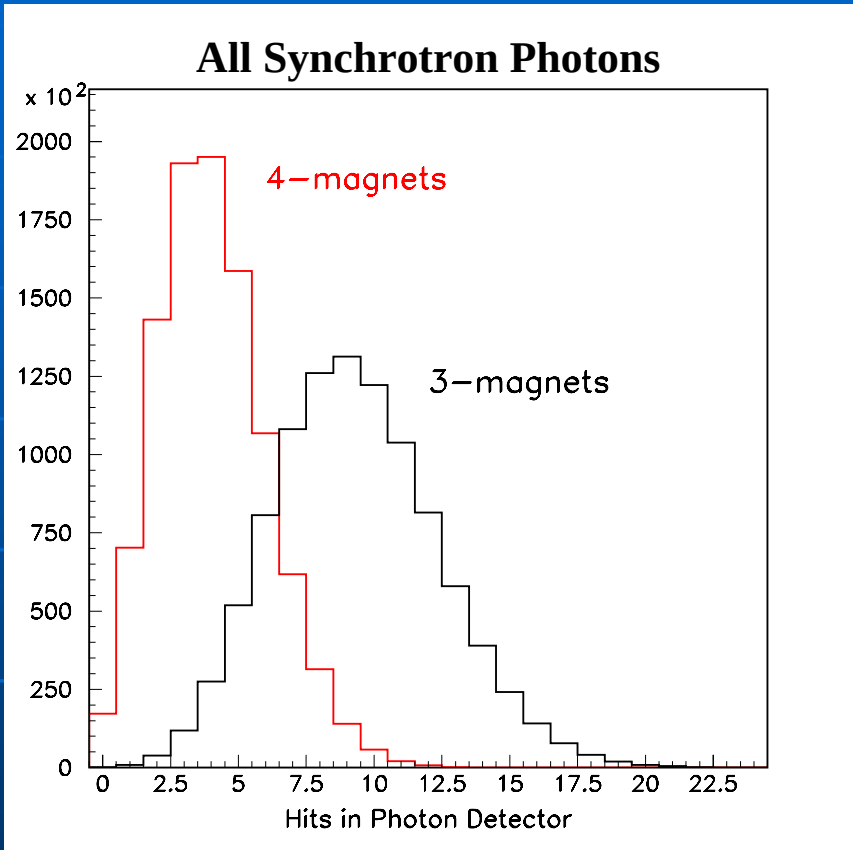
→ To obtain beam offset of 5mm spectrometer is more extended

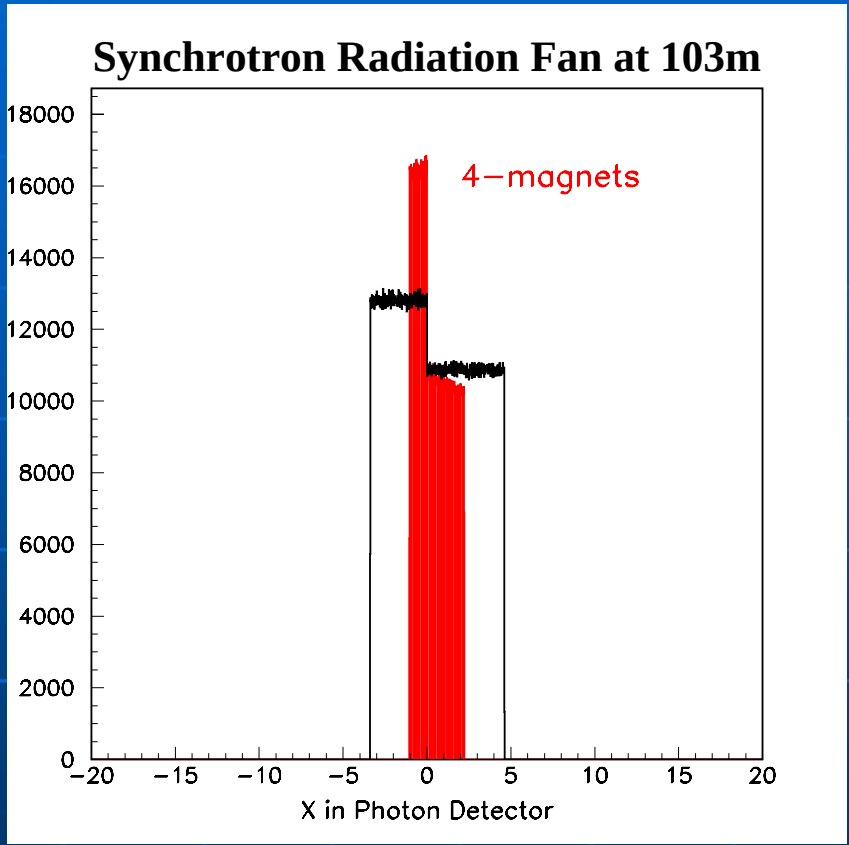
→ Gap between magnets now 16 m instead of 10 m before

→ Additional 4 quadrupole magnets after chicane



Consequences for synchrotron photons

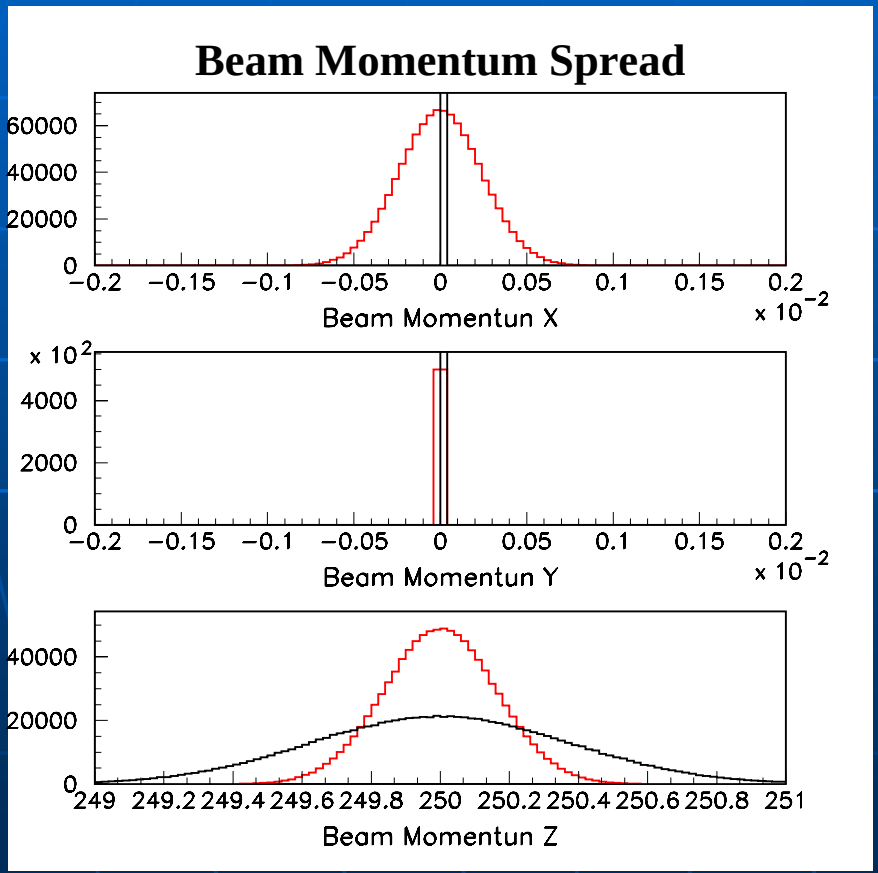




→ photons per electron reduced ~ 10 → 4
→ photons more soft <2MeV> → <0.8MeV>
→ fan more squeezed from ~ 8 cm → 3 cm (old detector position)
➔ positions of mirrors and photon detectors should be changed

New beam kinematics, envelope …

Envelope at IP: σ_x / σ_y = 20 / 2 µm → 23 / 3 µm
➔ marginal influence on edge smearing



σ_{px} = 0 / 0.240 MeV

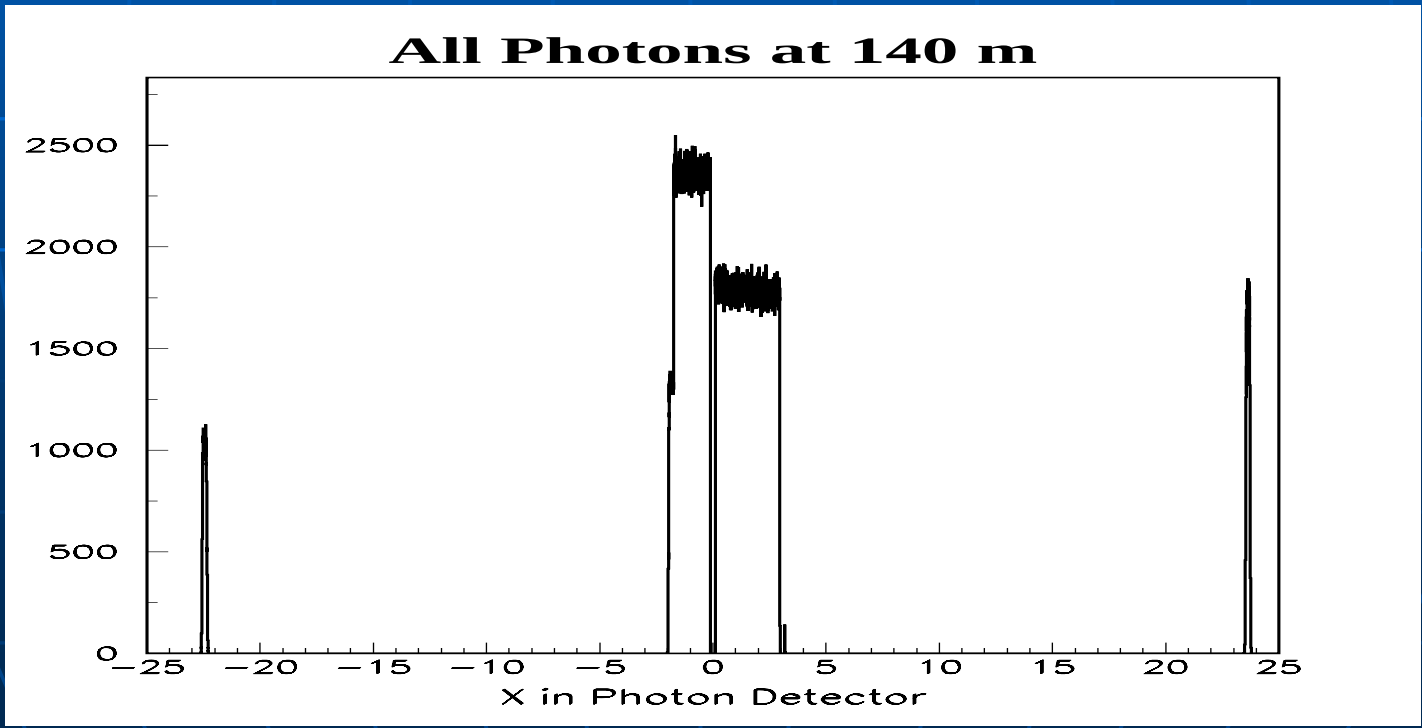
σ_{py} = 0 / 0.009 MeV

σ_{pz} = 375 / 163 MeV

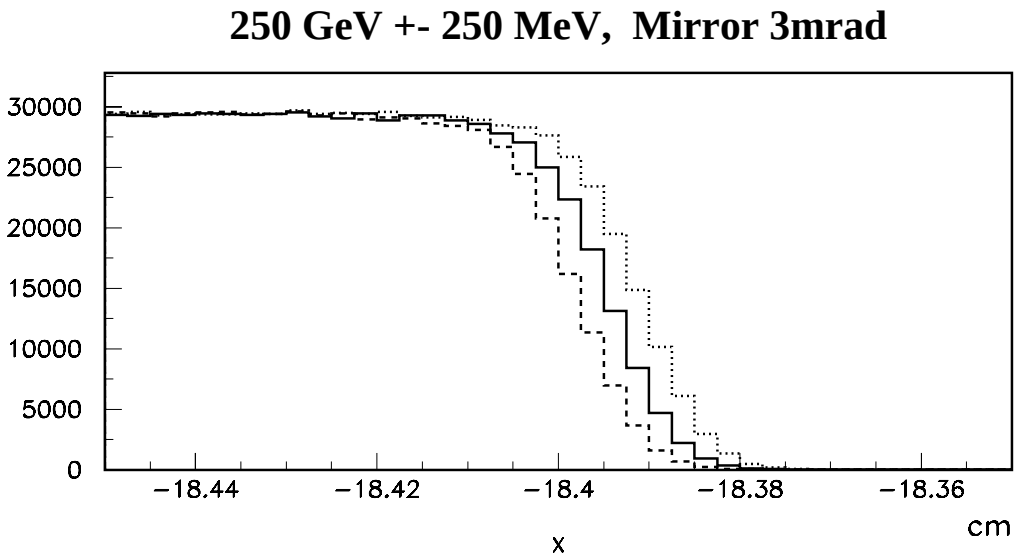
➔ Contribution to edge smearing reduced …

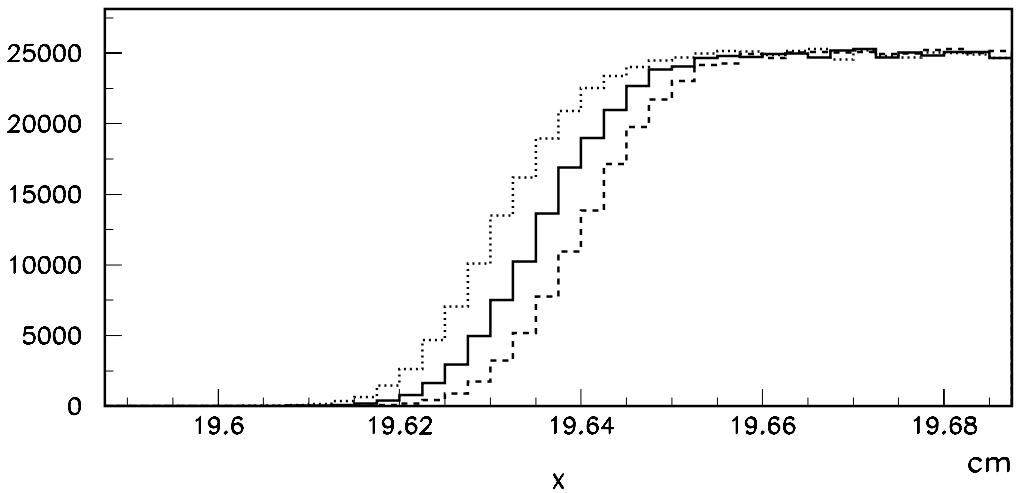
Changes in positions

- Direct edge measurement → impossible due to radiation damage
  → mirrored edge measurement
- After chicane 4 quadrupole magnets: 60m - 100 m
- New positions: mirror at 103 m (before 73m)
  photon detectors at 140 m (before 103 m)



The edge in the old scheme



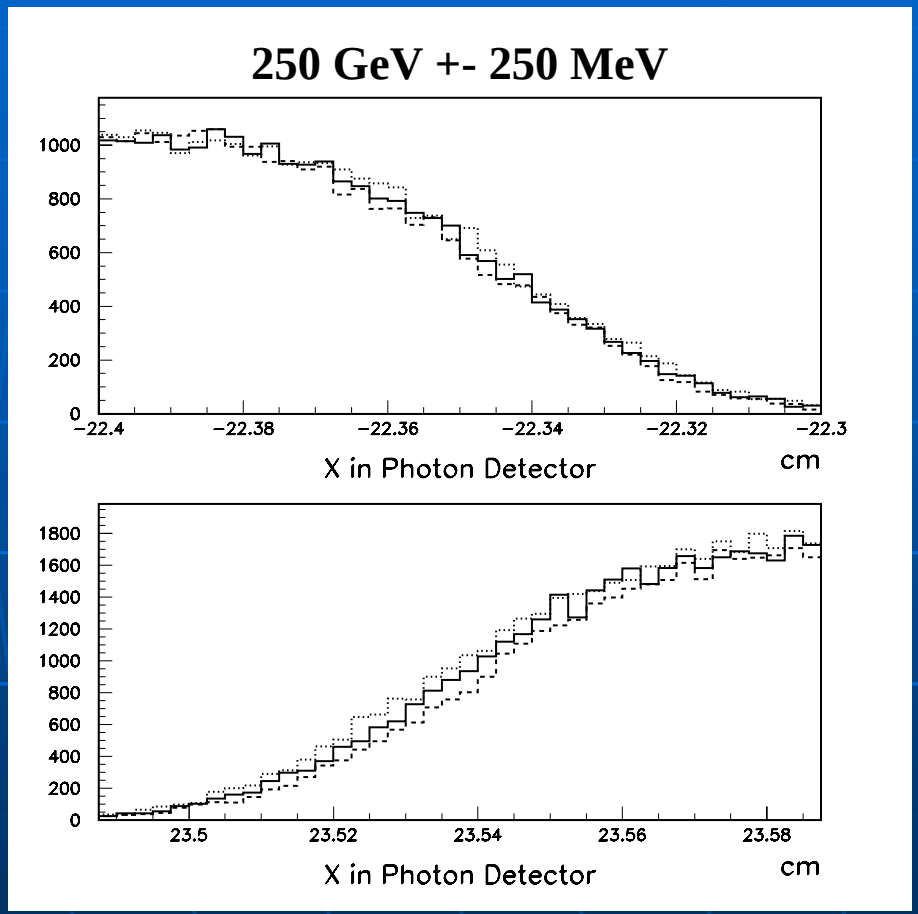


Mirrors: φ = 3mrad
No dispersion $\Delta\beta = 0$

"Silicon-Detector"
Z = 80 m
Pitch/binning = 25 µm

Conclusion:
$\Delta E / E = 10^{-3}$
clearly visible

Edge in 4-magnet scheme ...



Mirrors: φ = 3mrad
dispersion $\Delta\beta$ = 1 arcsec

"Silicon-Detector"
Z = 140 m
Pitch/binning = 25 µm

$\Delta E / E = 10^{-3}$
badly visible

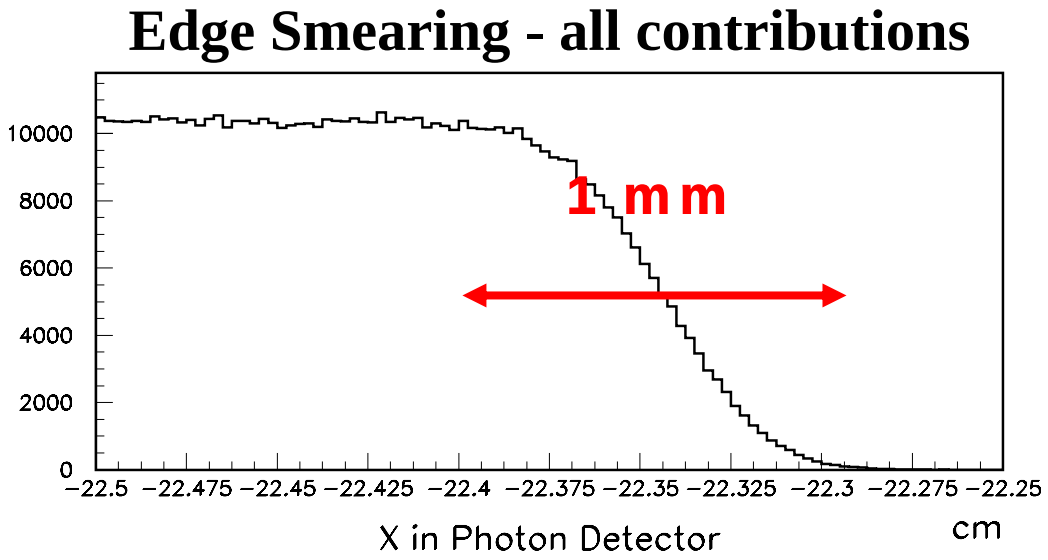
Resolution gets worse as a consequence of the reduced field

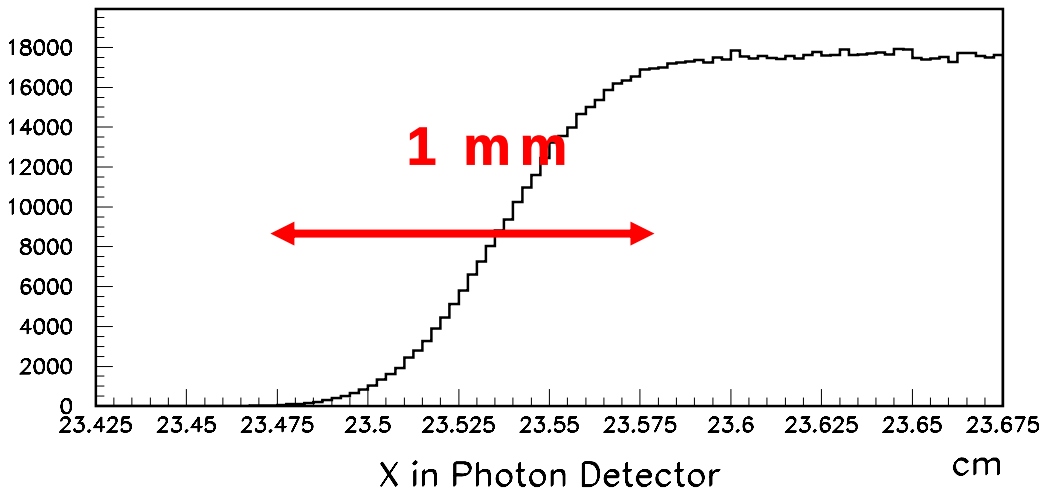
Edge smearing contributions

	Old Scheme length ~ 80 m	New scheme length ~ 100m
1) angular spread of synchrotron radiation hard / soft photons = 2 / 12 μrad	160/960 μm	210 / 1250 μm
2) transverse beam size	20 μm	20 μm
3) beam energy spread 1.5 10^{-3} (0.7 10-3)	40 μm	20 μm
4) fringe field 1%	200 μm	100 μm
5) mirror reflection error 0.1 – 1.0 arcsec	15 – 150 μm	15 – 150 μm

edge smearing of 300 … 1000 μm in dependence on soft/hard photon and mirror quality not much changed

Edge smearing – detector size





1 mm total smearing

➔

needs ~ few mm detector size

Sensitivity and Energy Resolution

1) Sensitivity: old 320 μm / GeV → new 200 μm /GeV
related to lower field strength

2) Energy resolution: $(\Delta E/E) = \sqrt{(\Delta Bl/Bl)^2 + (\Delta\Theta/\Theta)^2}$

2.1 magnetic field

old scheme $\Delta Bl/Bl = 2\ 10^{-5}$
new scheme Bl reduced by ~ factor 10 → $\Delta Bl / Bl = 2\ 10^{-4}$??? Nikolai

2.2 spatial resolution $\Delta\Theta / \Theta = 2\Delta x / \Theta\ L_{tot}$

assume $\Delta x = 2$ μm
old scheme $\Delta\Theta/\Theta = 5\ 10^{-5}$
new scheme $= 8\ 10^{-5}$

New 4-magnet scheme deteriorate the E-resolution

Summary

Set-up for synchrotron radiation enlarged
~ 100 m → 150 m

Lower magnetic field reduces E-resolution
by ~ factor 2