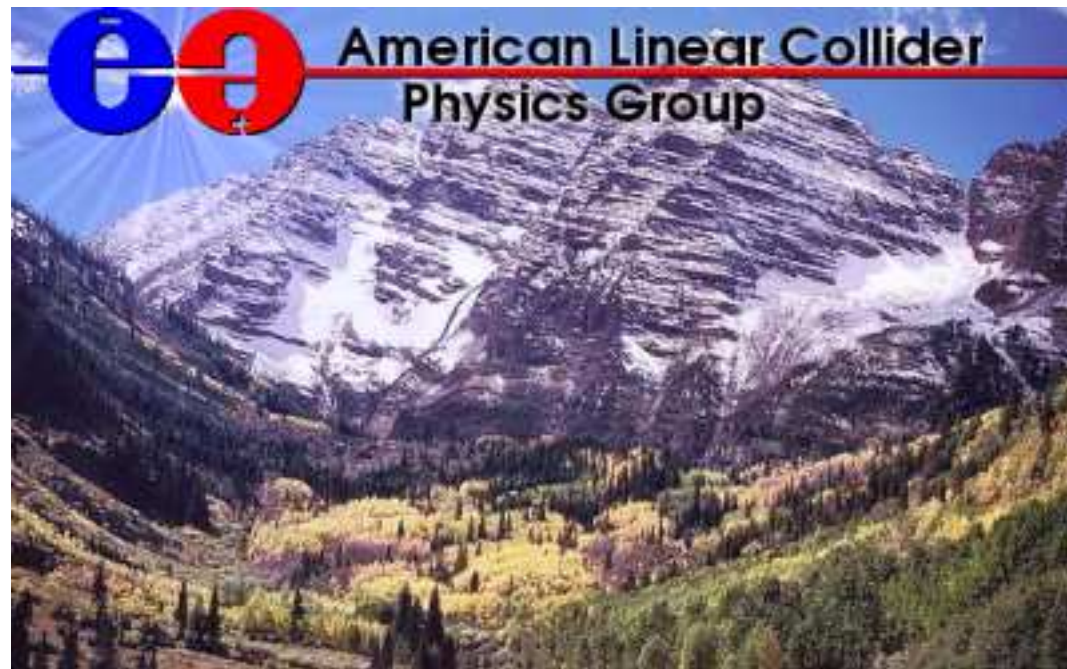




Extraction Line Spectrometry

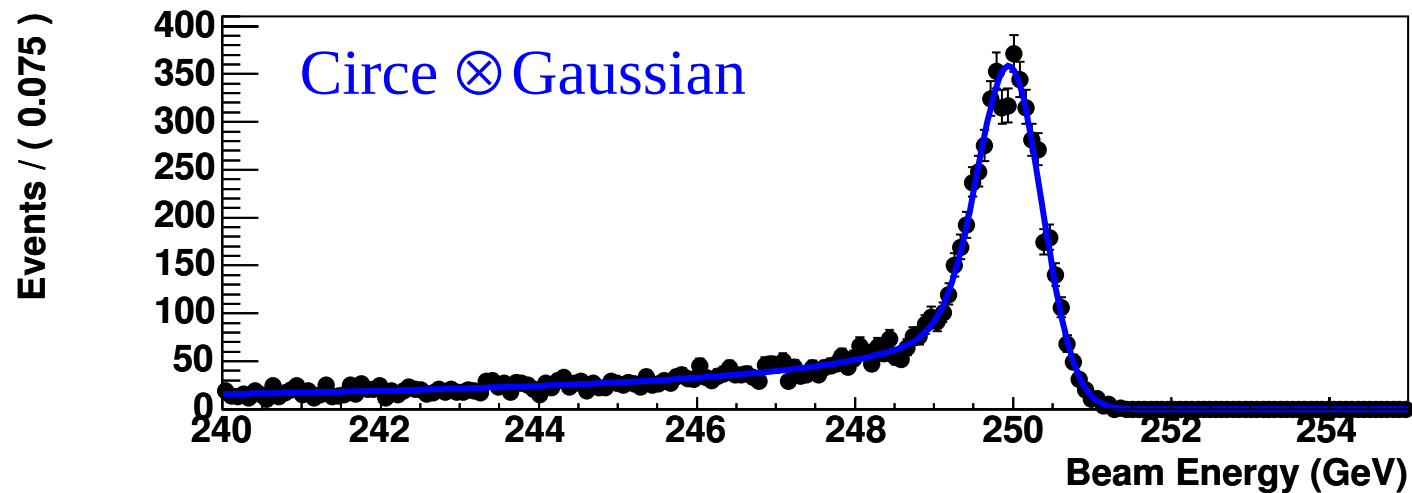


*2005 International Linear Collider Physics and Detector Workshop
and Second ILC Accelerator Workshop
Snowmass, Colorado, August 14-27, 2005*

Eric Torrence
University of Oregon



Outgoing Energy Spectrum



Downstream beam energy distribution

- Not the same as $\sqrt{s}$ spectrum
- Peak highly correlated to incoming E_{beam}
- Tail predicted by Guinea Pig, sensitive to collision parameters

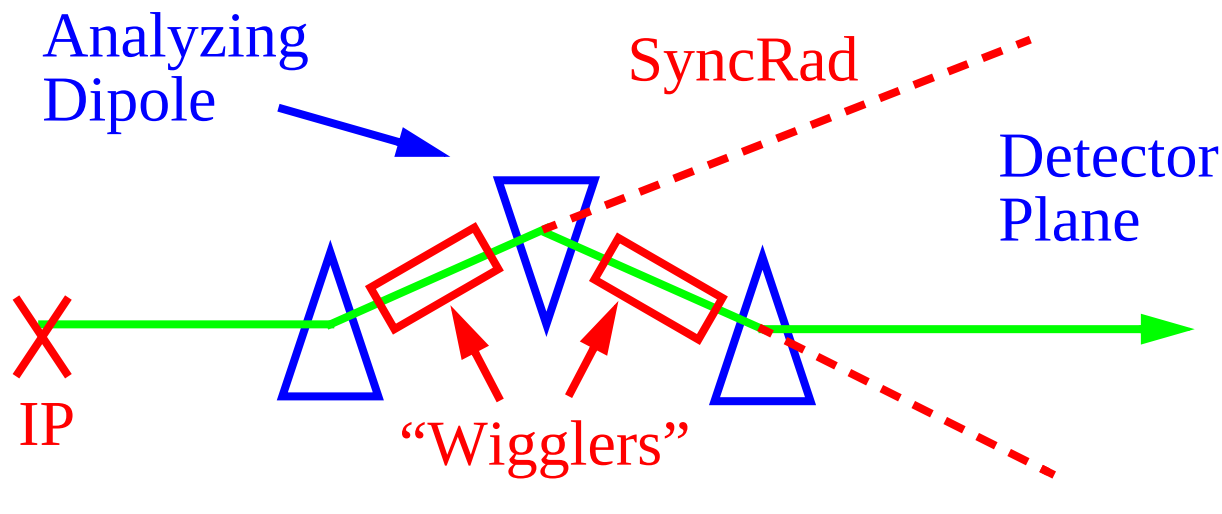
Downstream goals

- Measure absolute energy of incoming bunch (peak position)
- Measure incoming energy spread (peak width)
- Measure disrupted beam spectrum (tail)

Tail measurement is at worst a collision diagnostic.
At best, this can be used to validate collision models.



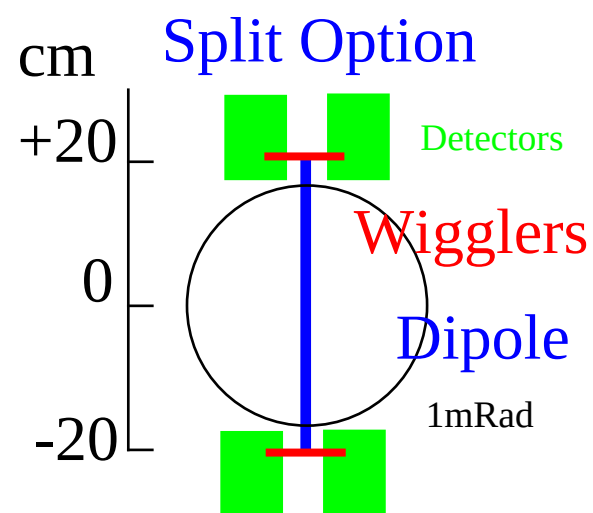
X-Line Spectrometer Overview



- Secondary focus at detector plane
- Wigglers reduce alignment systematics
- Wigglers can be turned off for bgd studies
- Up/down to maximize $\Delta y/l$ (resolution)

Detector Plane

- $L \sim 100\text{m}$, $> 2\text{ mRad}$ bend
- large λ wiggler - SR “tee”
- detector $\sim 100\text{ }\mu\text{m}$ pitch
- $\Delta y = 40\text{ cm}$
40 μm precision required
- $< 125\text{ MeV}/100\text{ }\mu\text{m}$
for 250 GeV beam
- Single arm gives energy spread





Advantages

- Neutral particles avoid stray fields
- Compact detector plane, 10s μm absolute accuracy
- Longitudinal positions need $< 1 \text{ cm}$ accuracy
- Very passive device, high reliability
- Natural to measure pulse-to-pulse

Disadvantages

- Must get SR out to quiet detector location
- Need large apertures in X-line
- Detector plane must sit at secondary focus
- Very dependent upon optics configuration
- Must worry about detector backgrounds

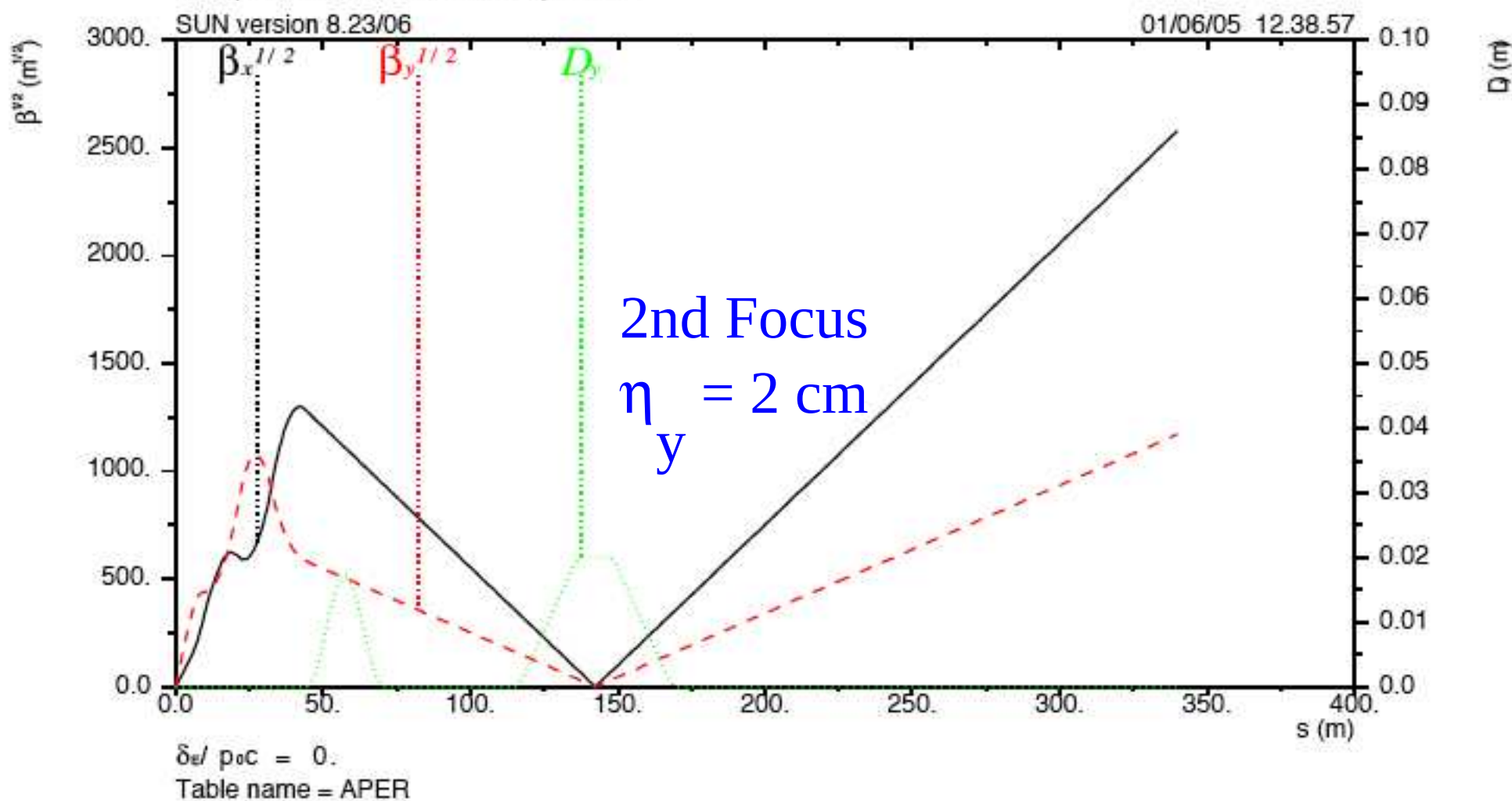


Yuri Nosochkov - June 1st

Energy Polarimeter Collimators

IP Dump

Disrupted beta functions and dispersion.

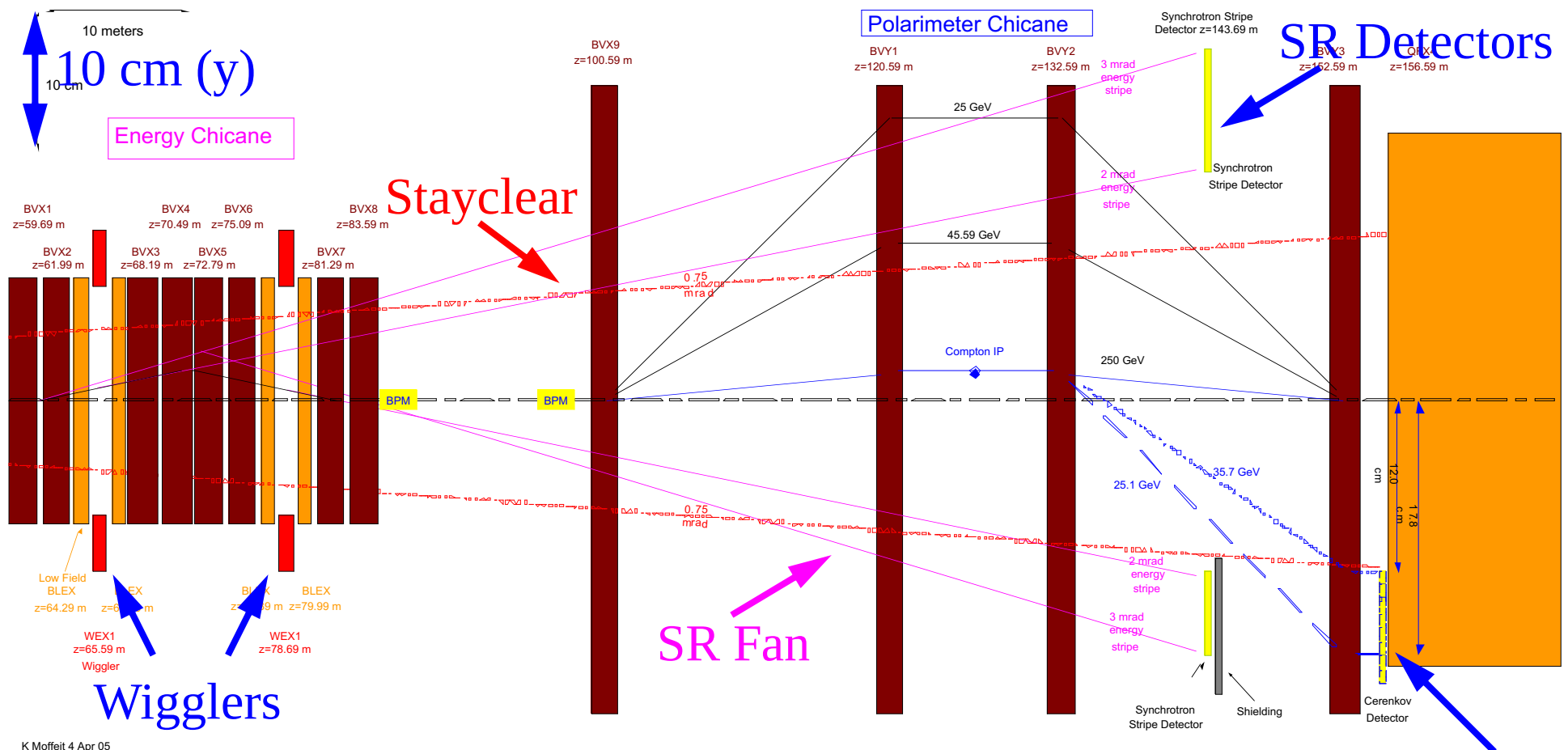




20 mRad Instrumentation Layout

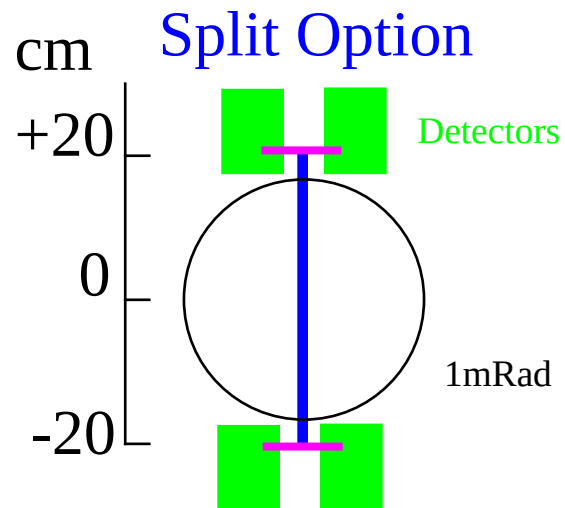


Ken Moffeit - LCWS

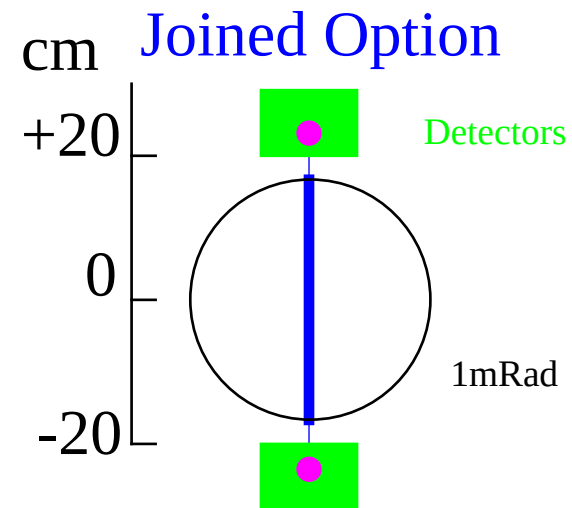
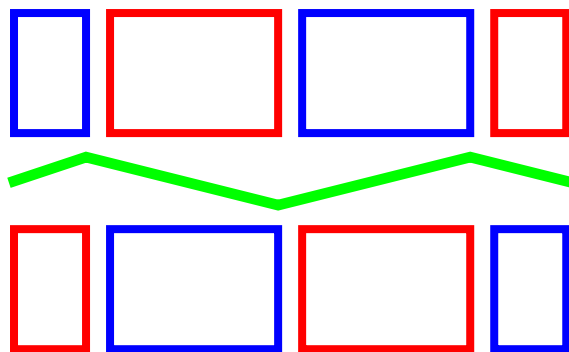




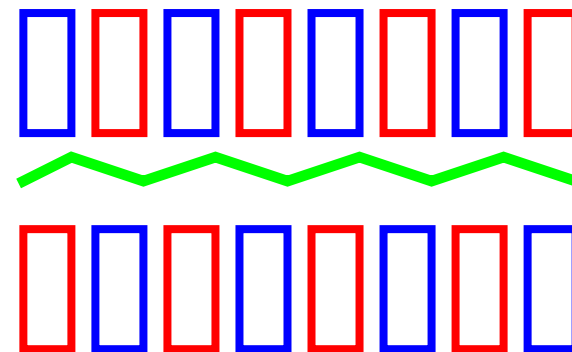
Wiggler Design



Large λ wiggler



Small λ + Soft Bends

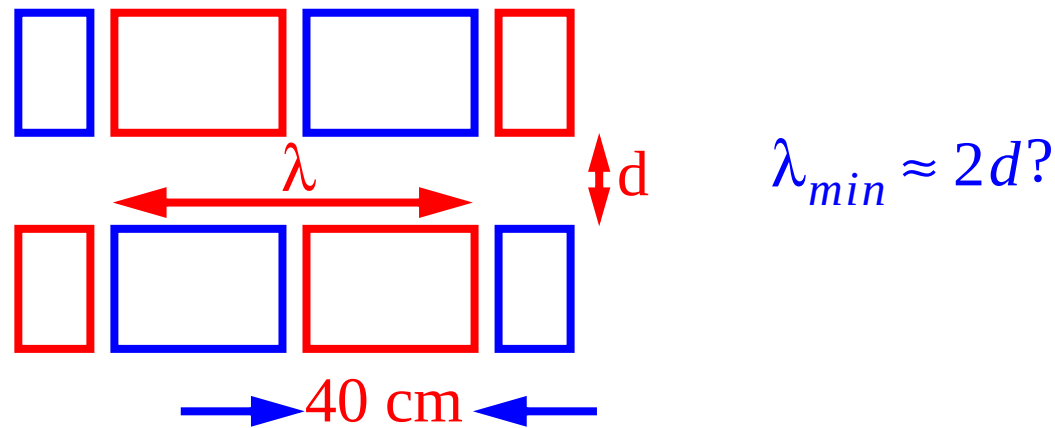


More signal with smaller λ , must include soft bends

Better separation from background with large λ , weaker signal



Aperture constraints



Large 20 cm aperture unsuitable for “traditional” wigglers

Place a few 40 cm (?) dipole poles back-to-back (more to boost signal)

SR stripe on detector should be around +/- 10 cm (perhaps less?)

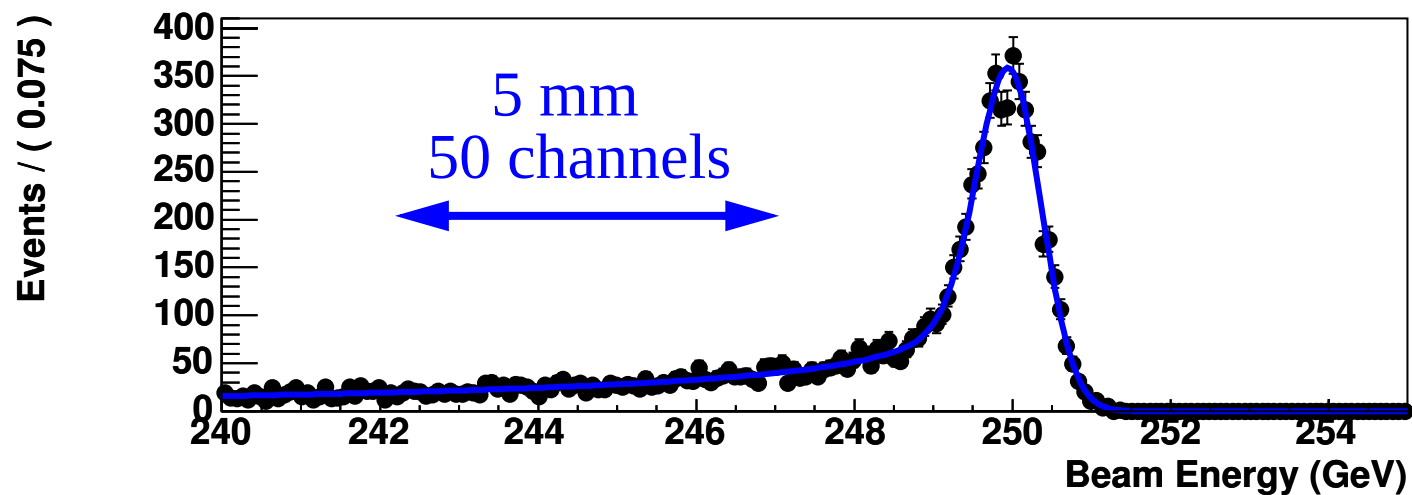
Bend Strength ~ 0.1 mRad / 20 cm $\rightarrow 0.5$ mRad/meter

Dipole SR energies

E_{beam}	E_{crit} (MeV)	(for 0.5 mRad/m)
50	0.15	$E_{\text{crit}} = 3hc\gamma^3/(2\rho)$
250	17	
500	138	

Too low for 50 GeV beams (larger field at expense of signal intensity?)

Analyzing dipoles have similar bend angles (must avoid at 500 GeV)



Beam Energy mapped to y position on detector plane
Order 1 GeV/mm sampled at 100 μm pitch

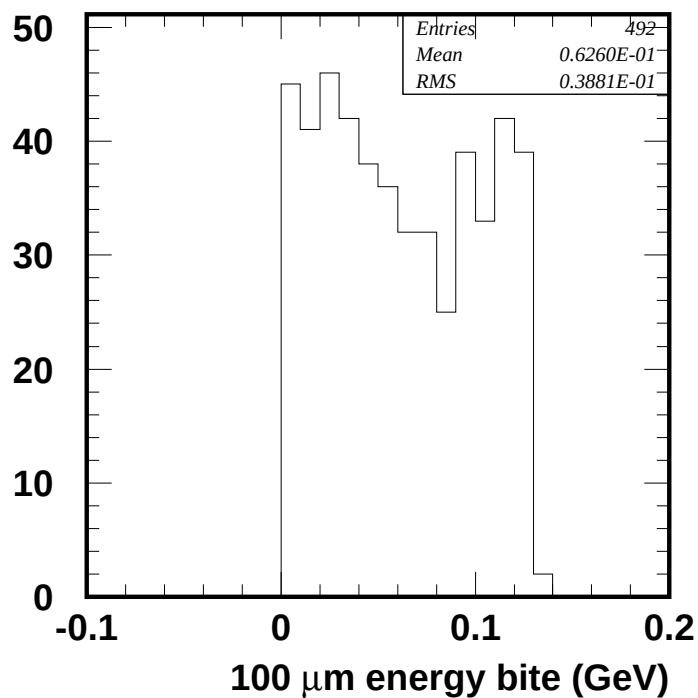
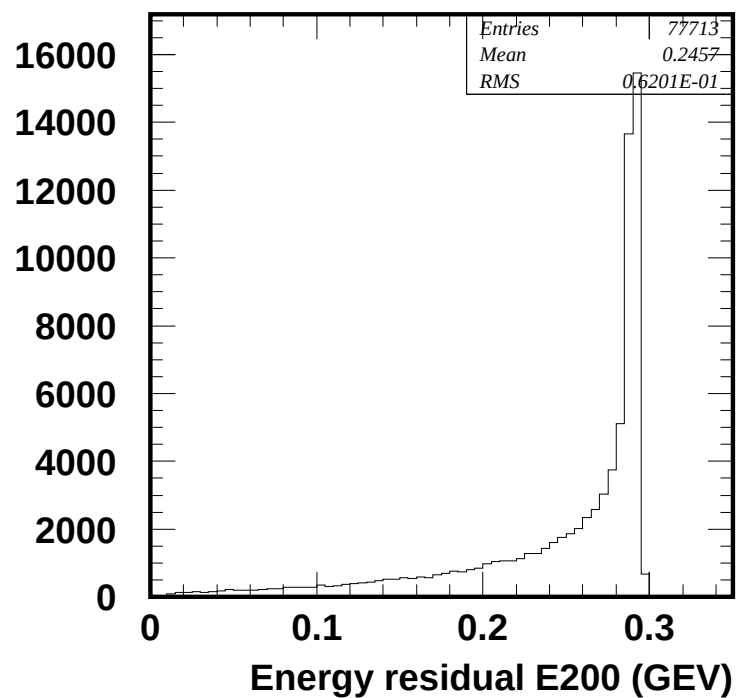
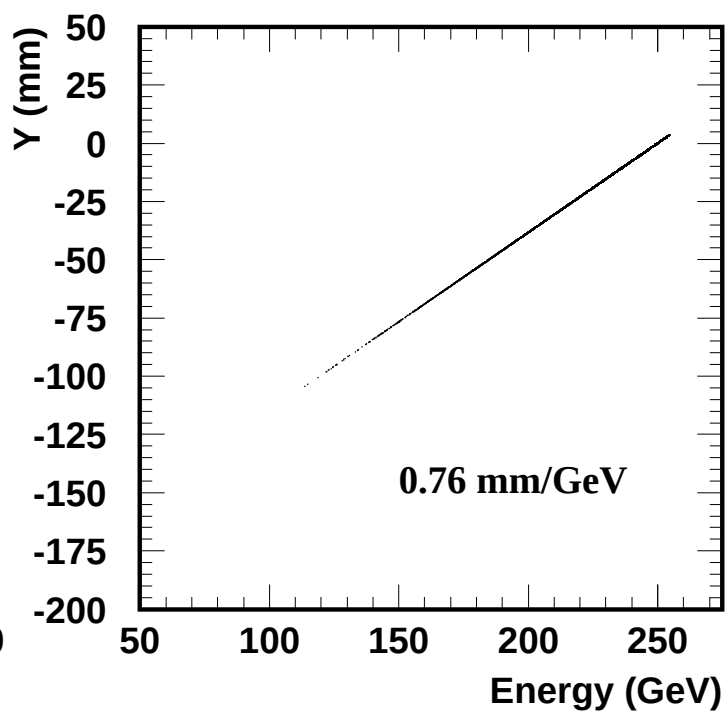
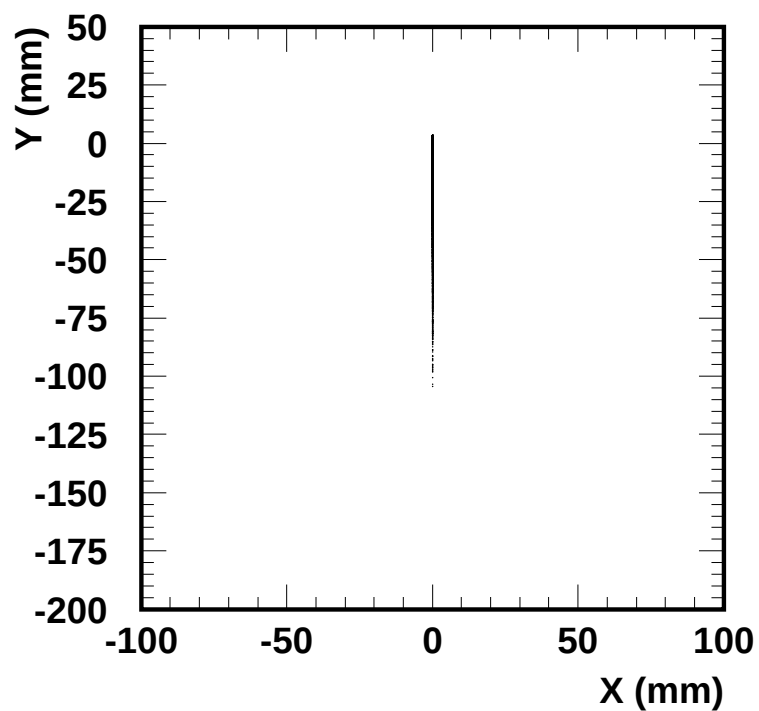
Use quartz fibers: low efficiency, but rad hard
and some background tolerance. Large dynamic
range with MAPMTs. 64 channels/PMT.

Sampling to 50% of E_{nom} would require ~ 20 cm detector.
Reduce pitch to ~ 1 mm outside of core,
use larger fibers (600 μm ?) to boost signal intensity.

Total channel count: [128 (fine) + 256 (coarse)] x 4
27 cm active length per stripe, 24 PMTs per beam.

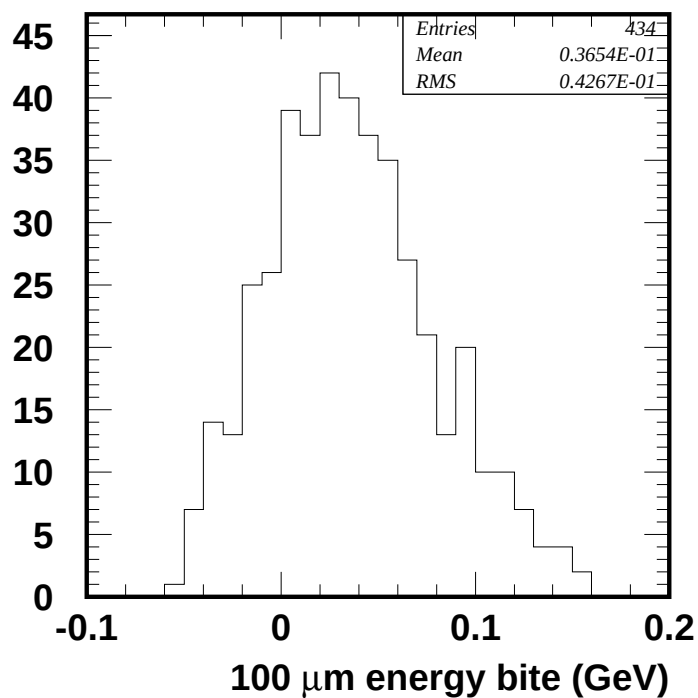
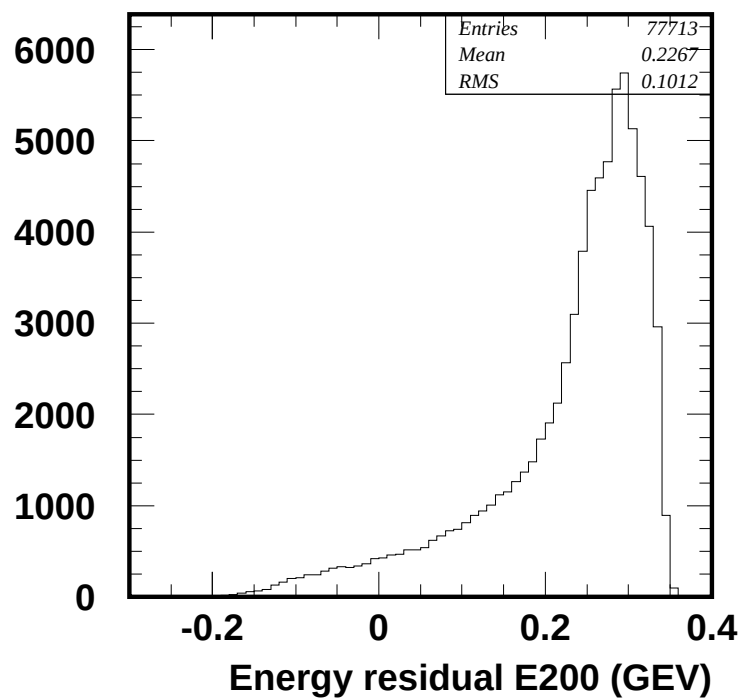
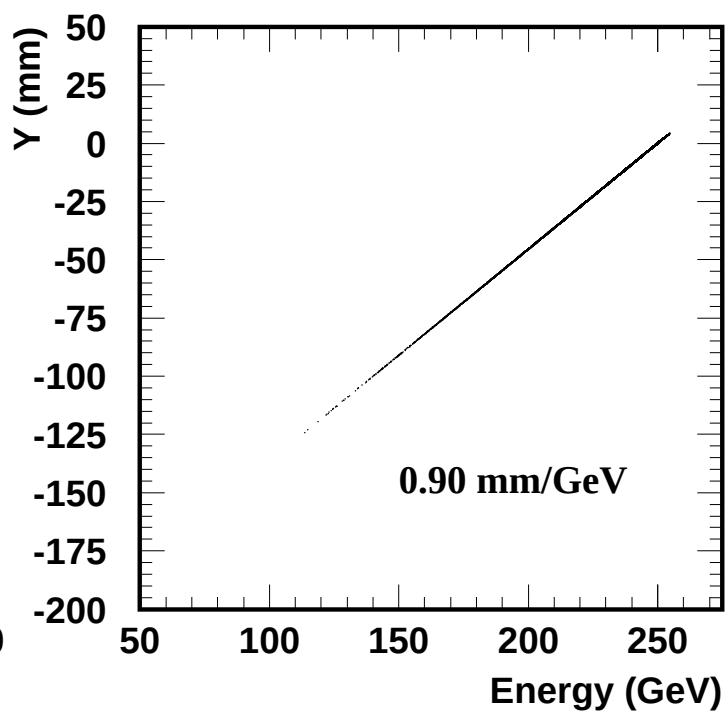
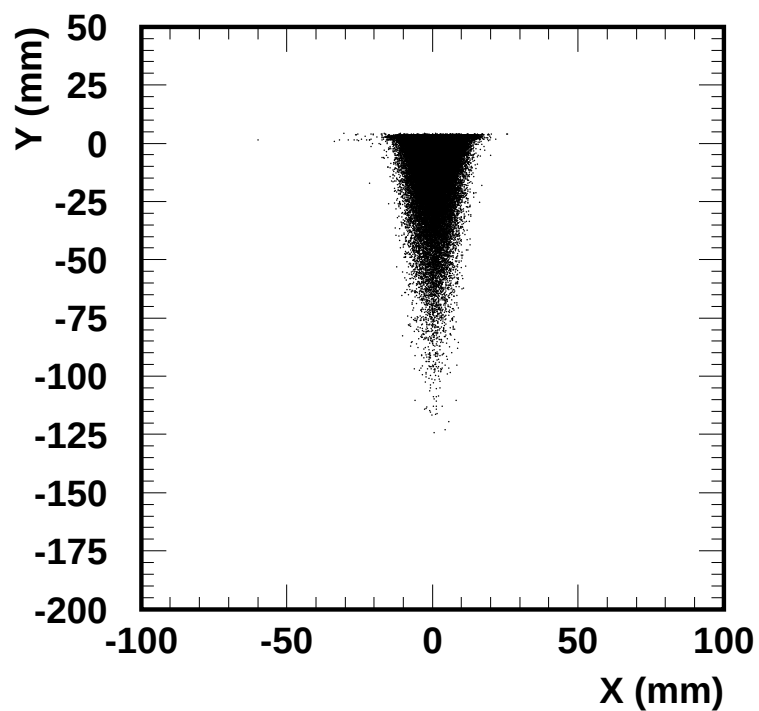


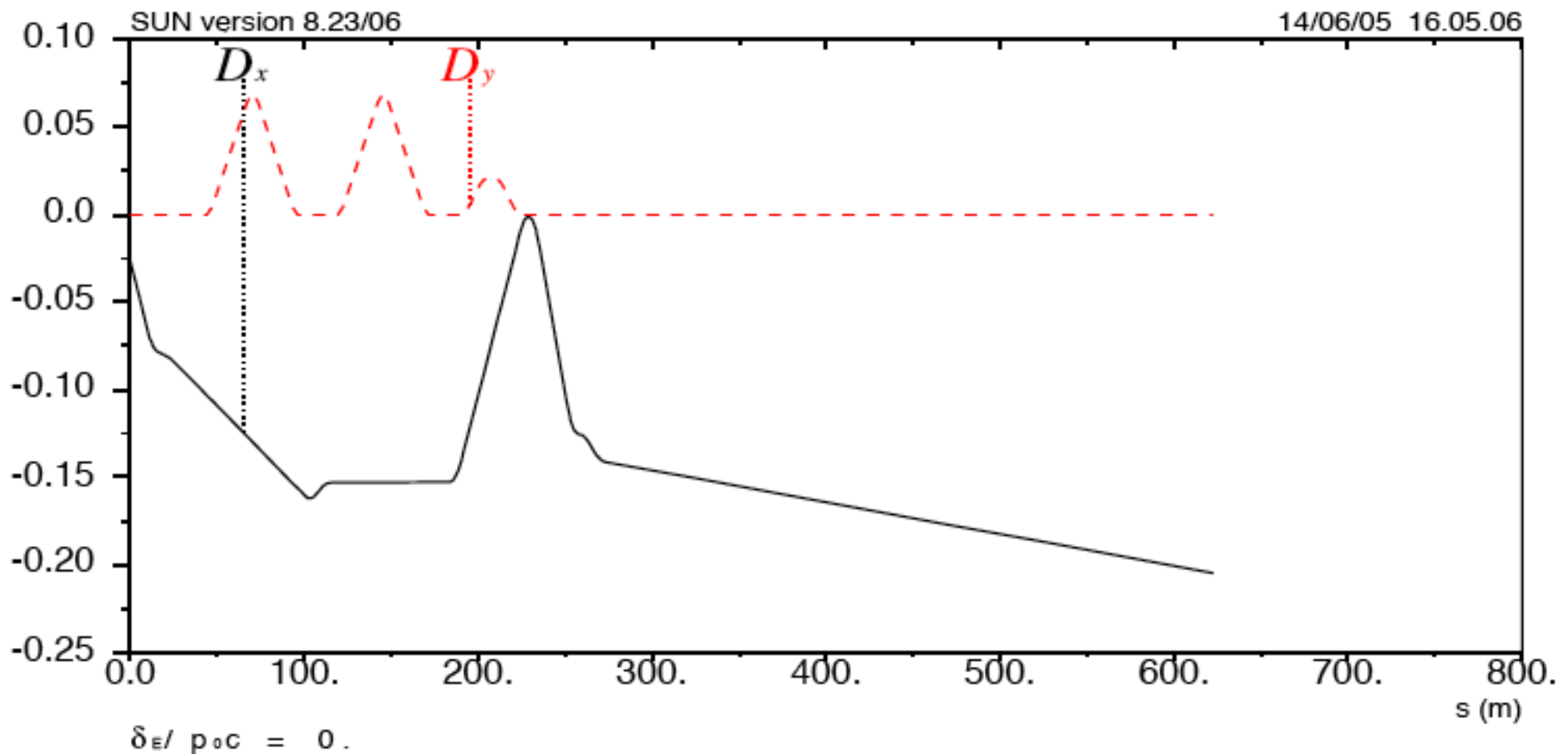
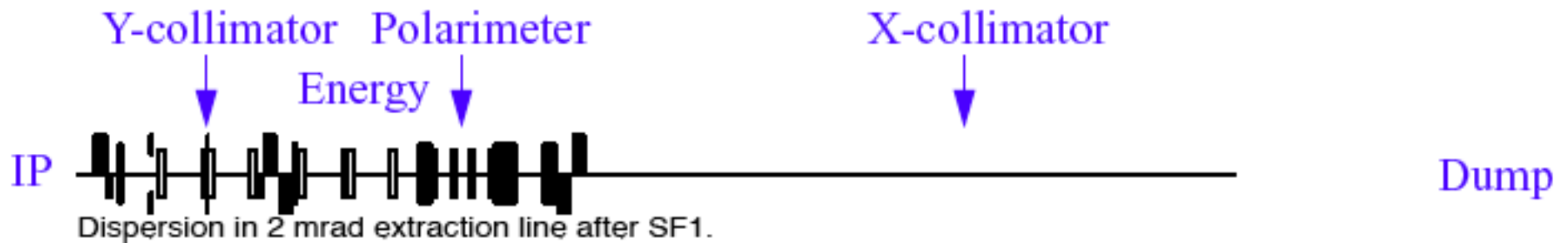
Projected beams at 2nd Focus





Projected Beam at Detector Plane





Three vertical chicanes!
First defines energy acceptance
Energy collimation at $\sim 10\text{-}20\%$ E_{nom}



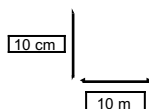
2 mRad Instrumentation Layout



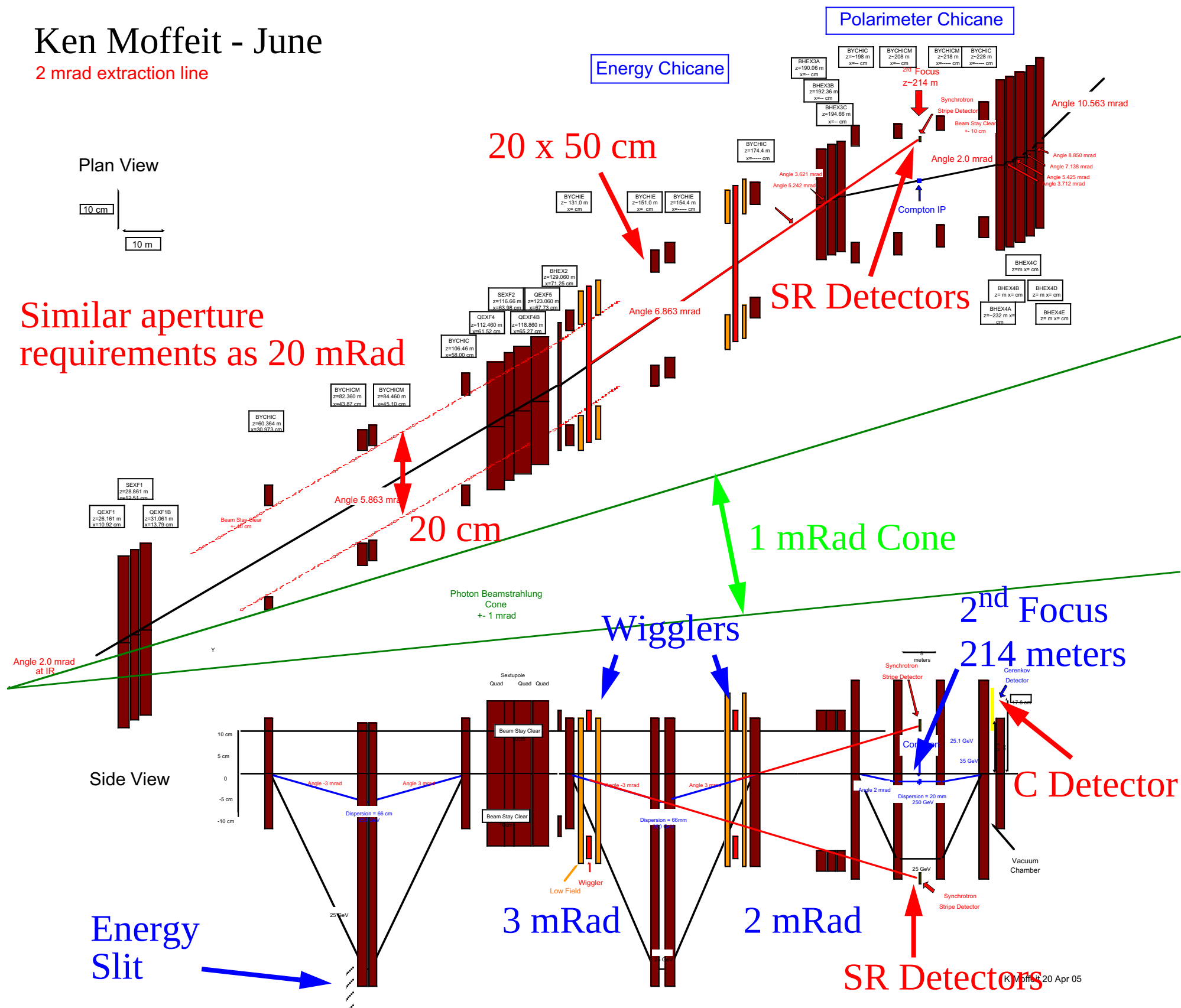
Ken Moffeit - June

2 mrad extraction line

Plan View



Similar aperture requirements as 20 mRad





2 mRad Detector Plane



Dipole SR is potentially a serious background problem for both detectors...

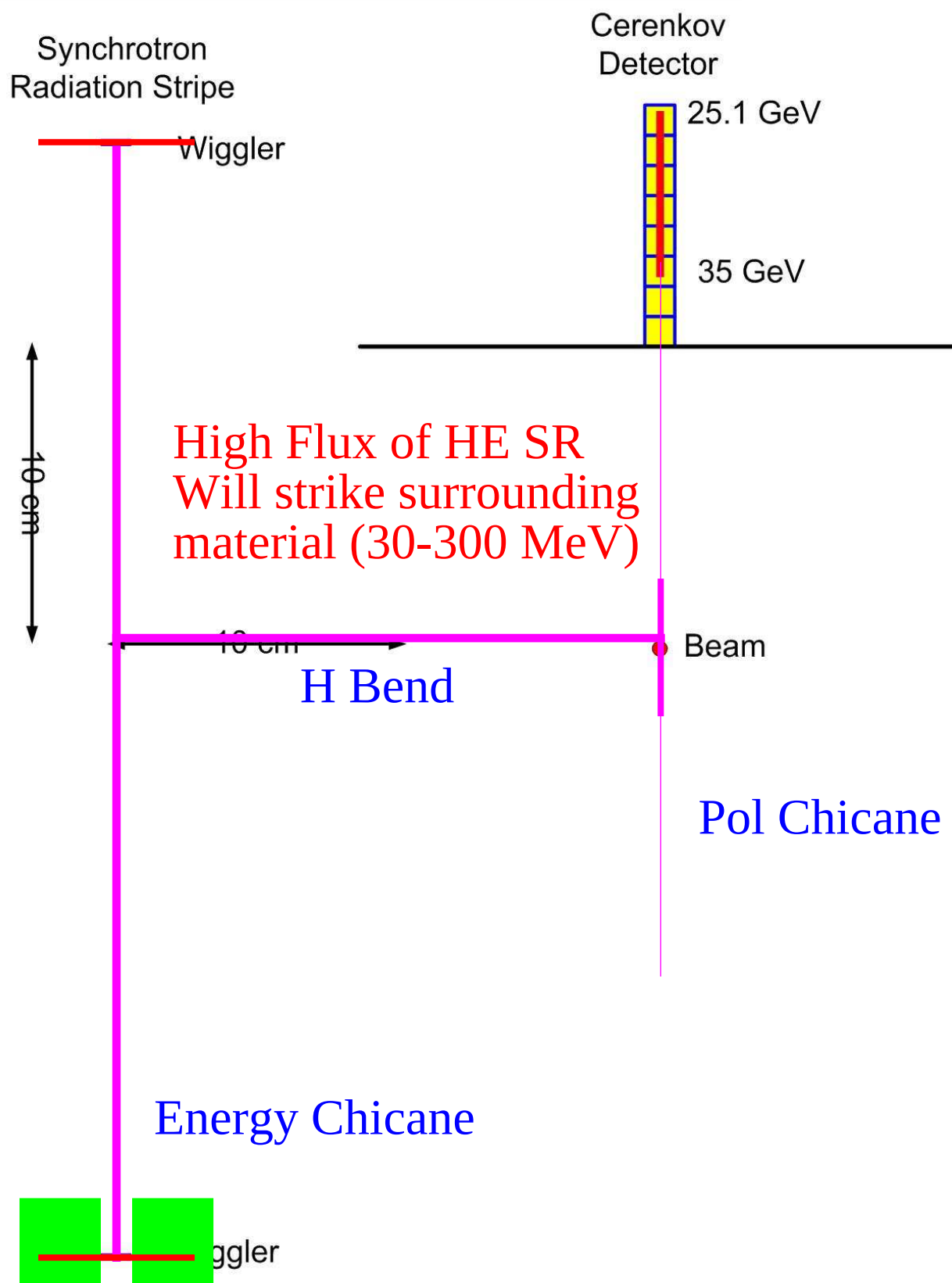
Gas Cerenkov: 10 MeV

Quartz Fiber: 0.7 MeV

Need careful study of backgrounds and shielding options. Separation of detectors, no BSL a plus.

Not at all clear whether this will work!

(2 mRad or 20 mRad)

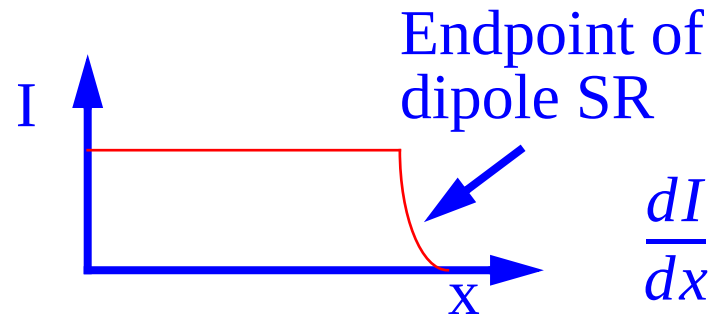




Crazy Idea



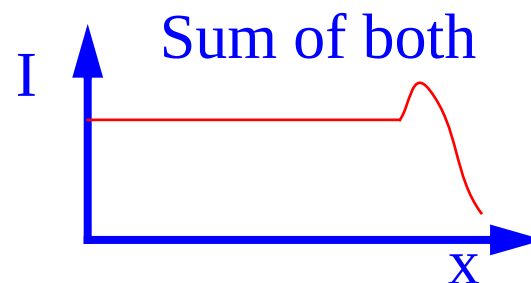
Do we need wigglers at all?



Could measure endpoint of analyzing dipole SR directly

Energy spectrum related to derivative of intensity,
very sensitive to widths.

Forget about avoiding dipole SR



Subtract wiggler-off background?
Probably biases peak position too much.



Current Design

- No obvious show-stoppers in conceptual design
- Quartz fibers proposed for detector plane
Imminent beam test to verify efficiency
- Detector tolerances appear reasonable
- Large but not impossible magnets for X-line

Next Steps

- Explore optics layout and intrinsic resolution
- Begin simulations with BDSIM
- Gradually improve accuracy of fields and material
- Evaluate 2 mRad and 20 mRad in detail