NLC - The Next Linear Collider Project

DIMAD Simulation of an Extraction Line Energy Spectrometer

Progress Report

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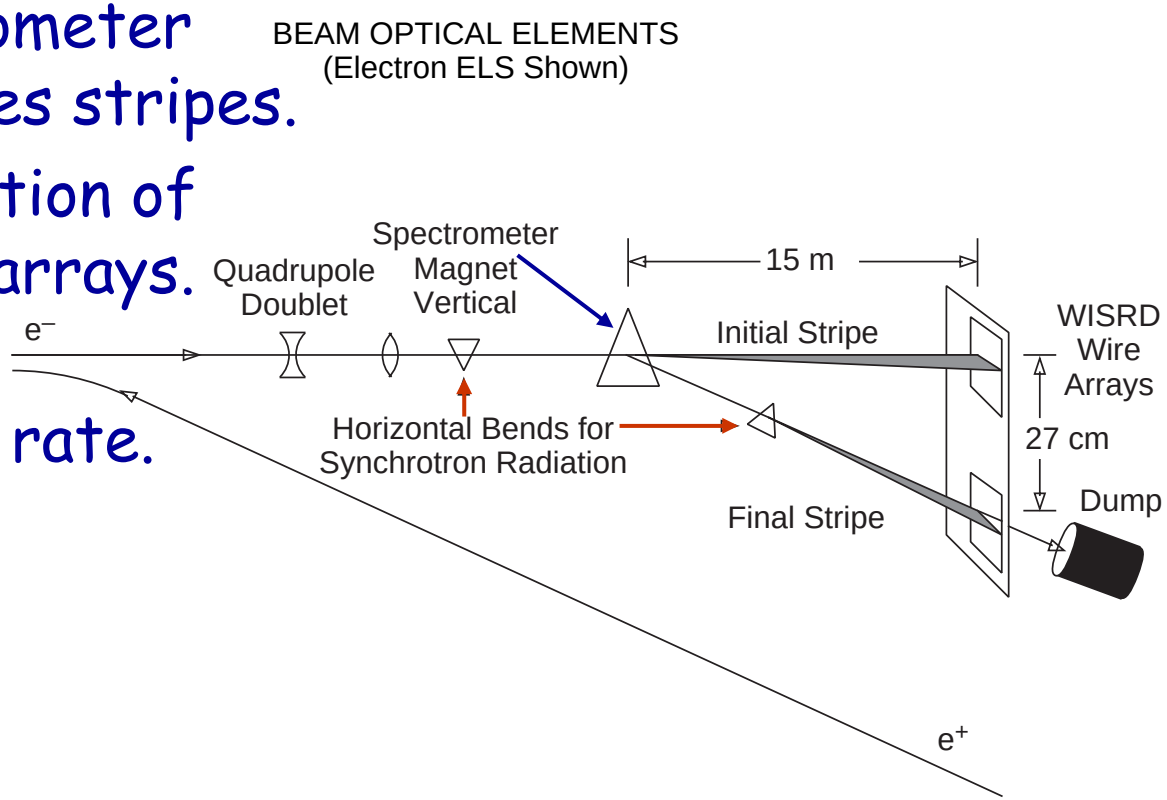
SLC/SLD Energy Spectrometer

SR Stripes Define Beam Directions

- Energy spectrometer in extraction line, before dump.
- Horizontal bends create synchrotron radiation stripes.
- Vertical spectrometer magnet separates stripes.
- Measure separation of stripes on wire arrays.
- Measurements at 120 Hz beam rate.



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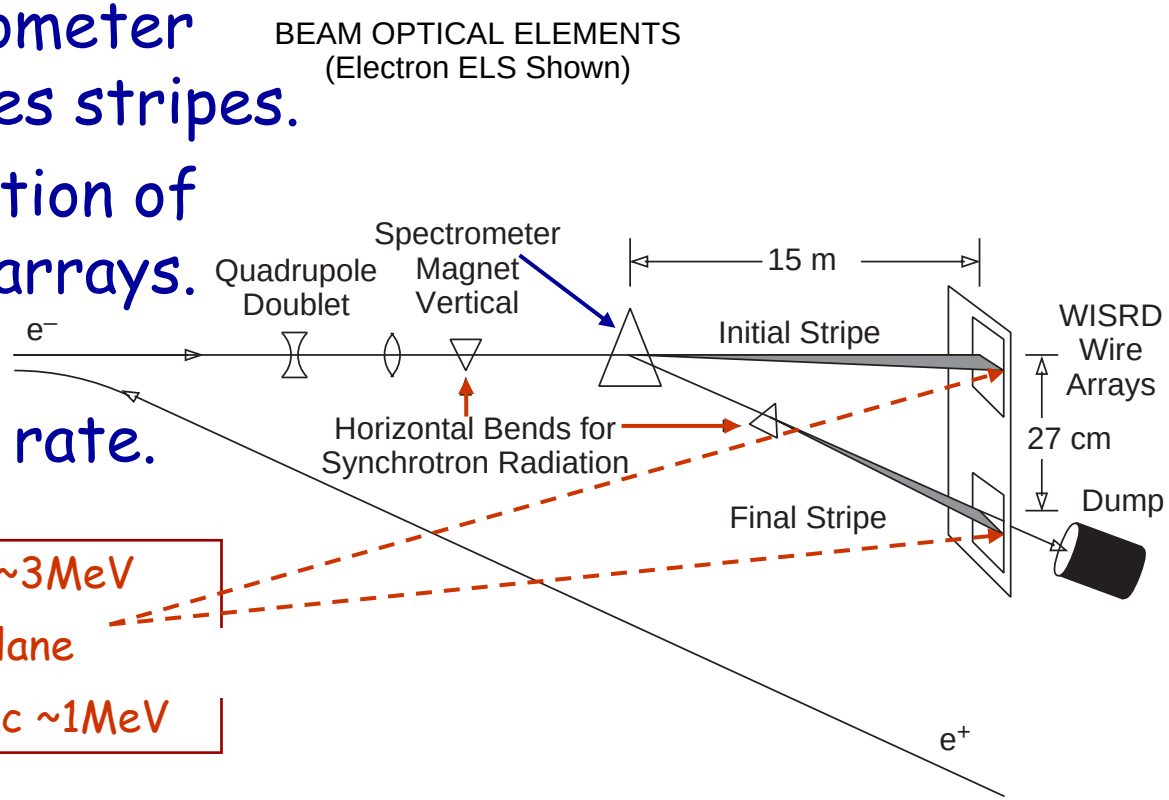


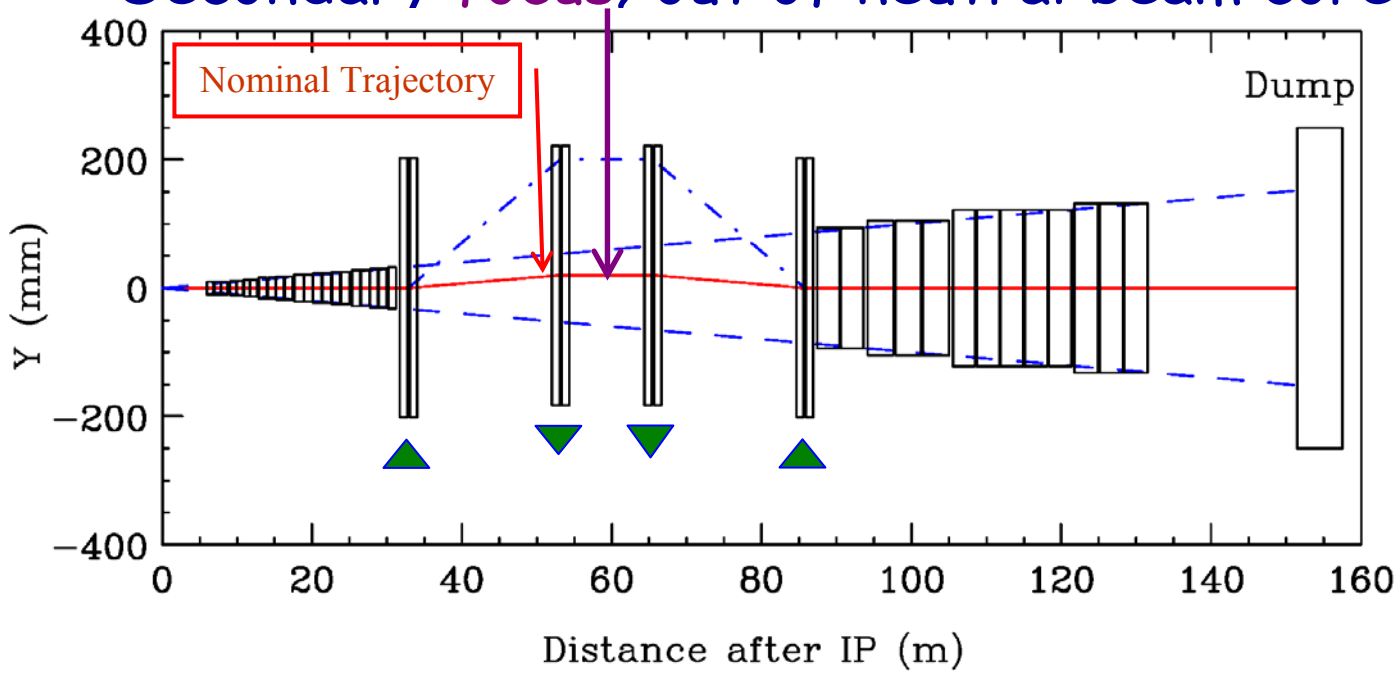
SR from Stripe Magnet: kc ~3MeV

Vertical focus in detector plane

Spectrometer Magnet SR: kc ~1MeV

NLC Extraction Line Chicane
(Location for Instrumentation)

- Four vertical bends ▲ form a 2 cm chicane
- Secondary focus; out of neutral beam core



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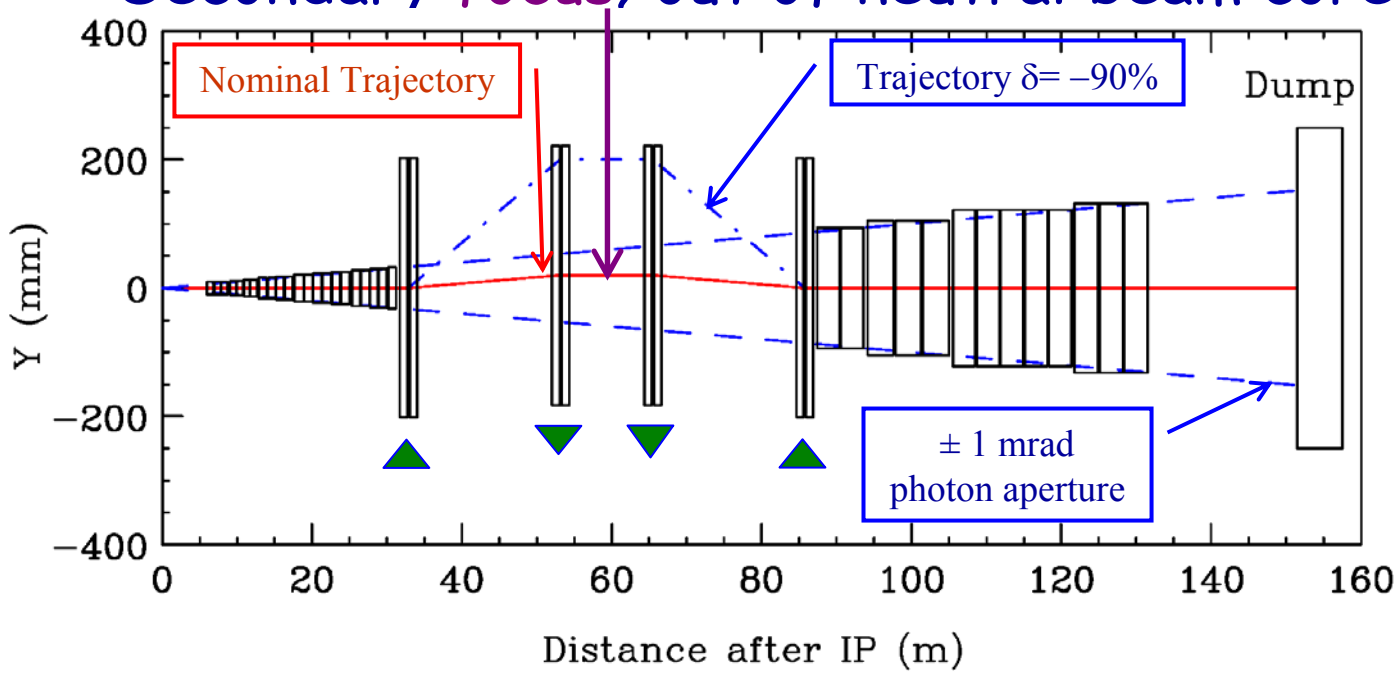

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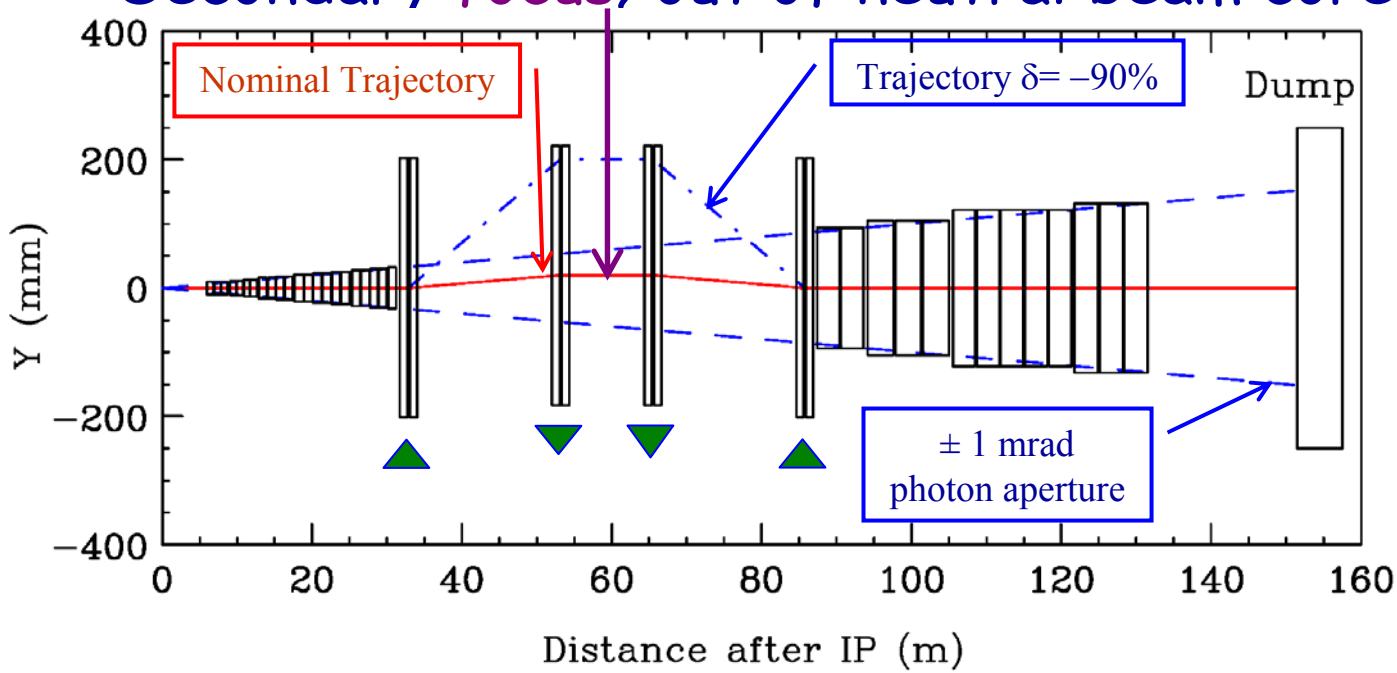


- Use half of 2nd chicane bend as spectrometer magnet
- Add horizontal bends to generate SR stripes

Outline of DIMAD Simulation Progress

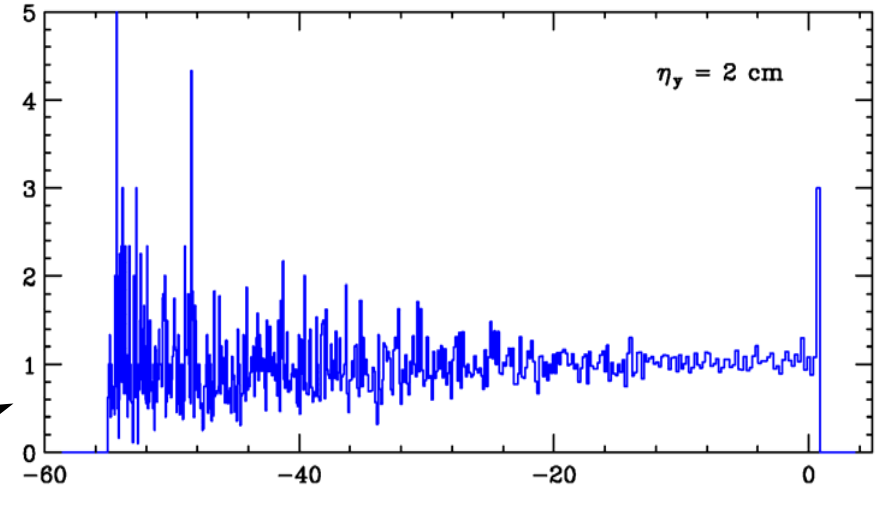
Followed by Details

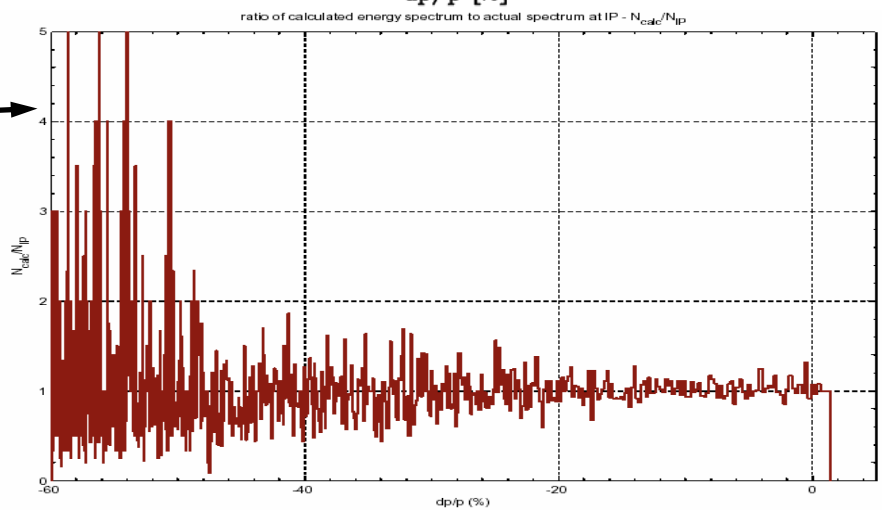
- Verify that we can reproduce IPBI distributions
- Reproduce Yuri Nosochkov's simulation of a wire scanner energy measurement at secondary focus
- Add horizontal stripe magnets, and look at effect on
  - Distributions at the dump
  - Distributions at the secondary focus
  - Particles lost in extraction line (number, energy, location)
- Estimate vertical size of SR stripe at detector
- **Note:** The results shown here were calculated
  - For 1 TeV E_{cm},
  - Using a 50,000 ray Guinea Pig file
  - With the 36 mm aperture extraction line lattice

Repeat Wire Scanner Simulation

Energy Measured at SF / Energy at IP

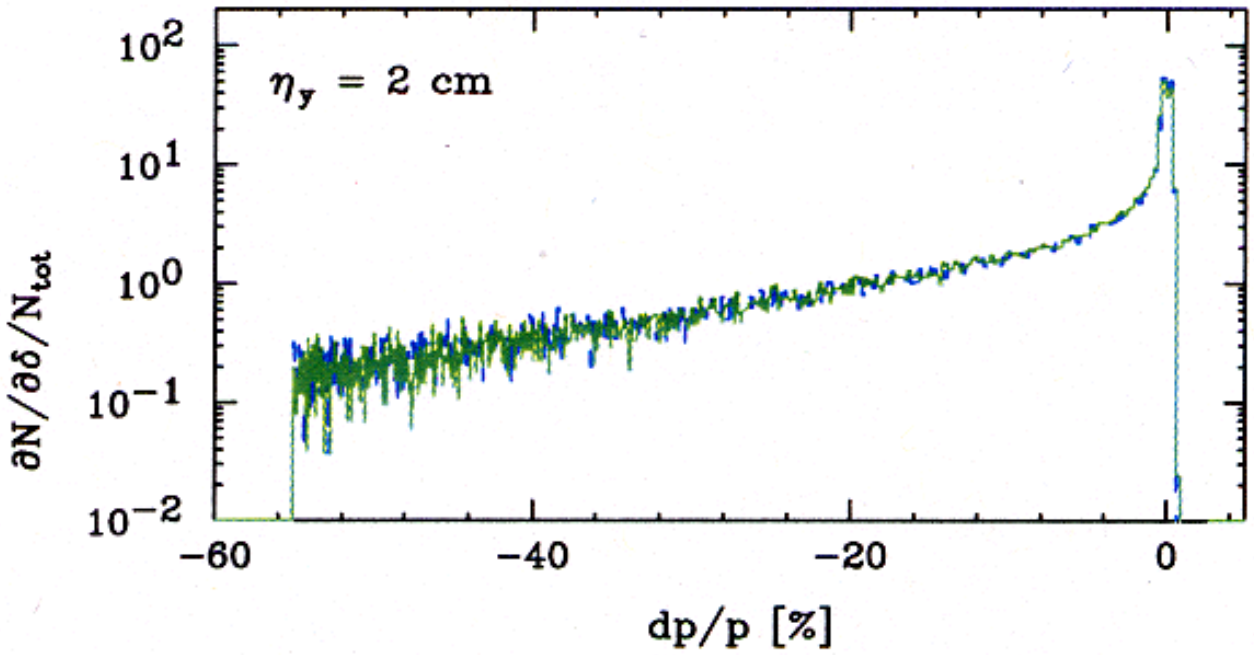
- Ratio of energy "measured" at secondary focus (SF) to energy at IP
- "Measured" means calculated from the dispersion and the vertical position at the SF
- Yuri Nosochkov LCC-0045
- Our calculation





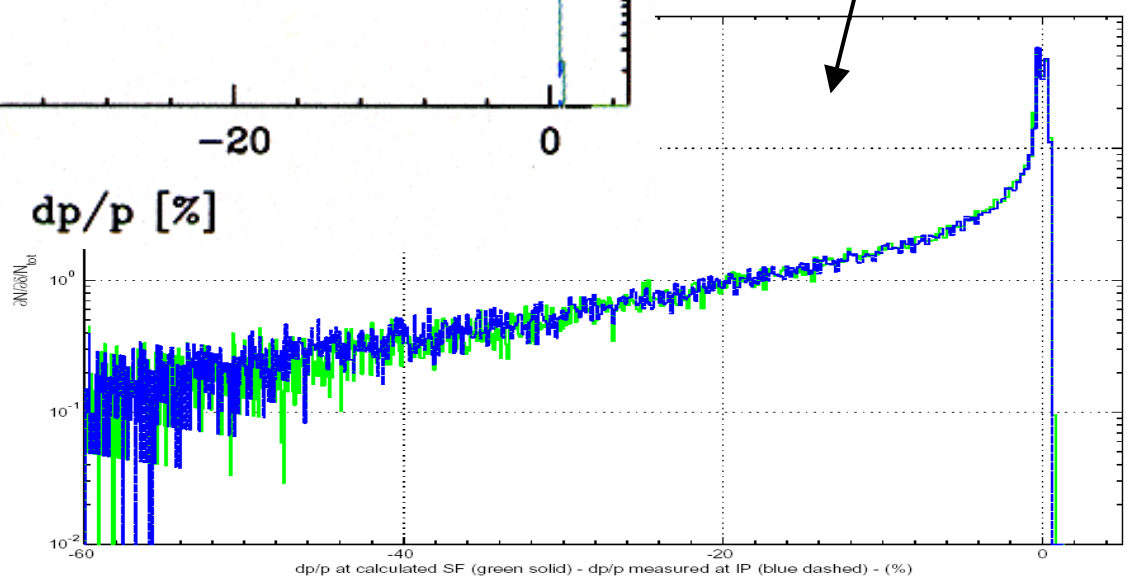
Repeat Wire Scanner Simulation

Energy from y and η_y at SF *vs.* Energy at IP



Yuri

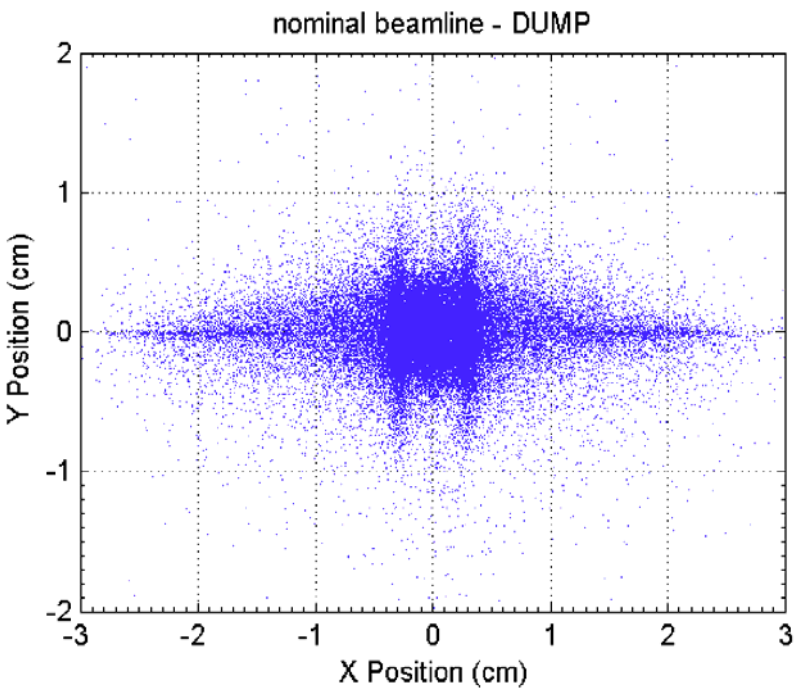
Us

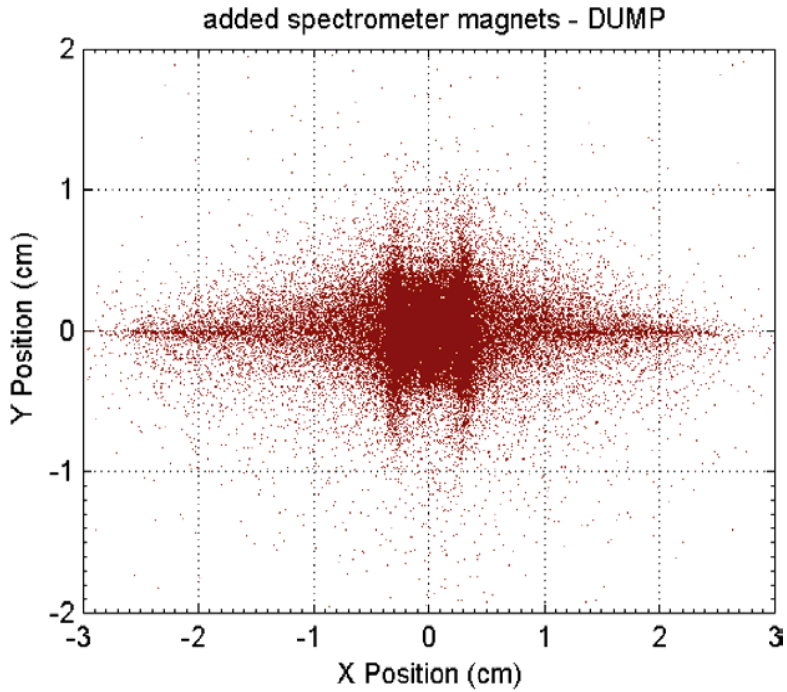


- Energy at IP – Blue
- Energy at SF, calculated from y and η_y at SF - Green

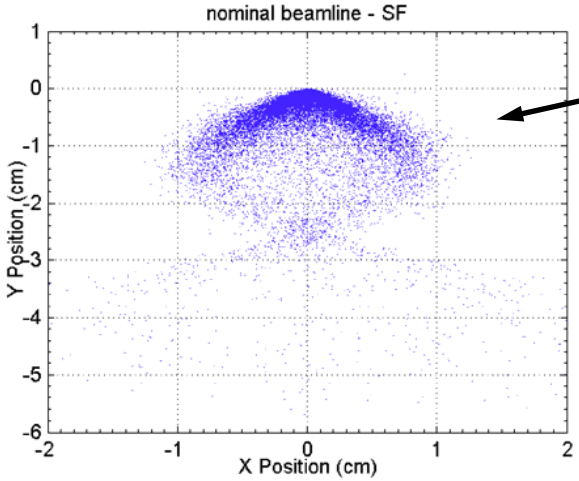
Beam at Dump with Stripe Magnets

- Addition of the two stripe magnets caused no major changes in beam distributions.
  No obvious change in beam size at the dump!

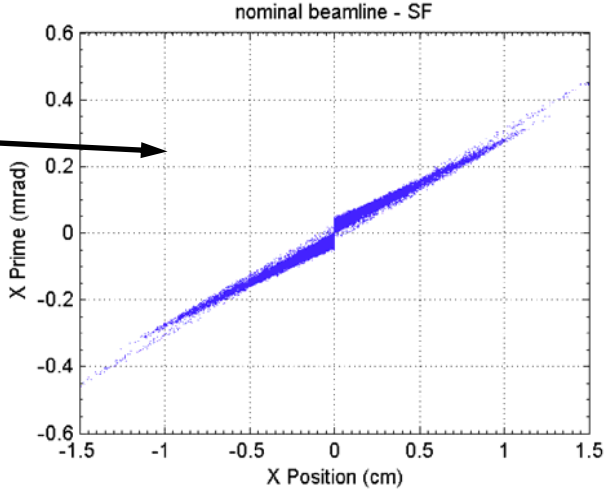


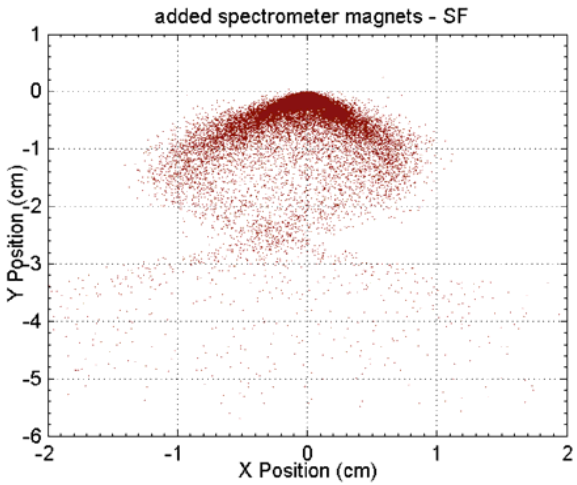


Beam at 2nd Focus with Stripe Magnets



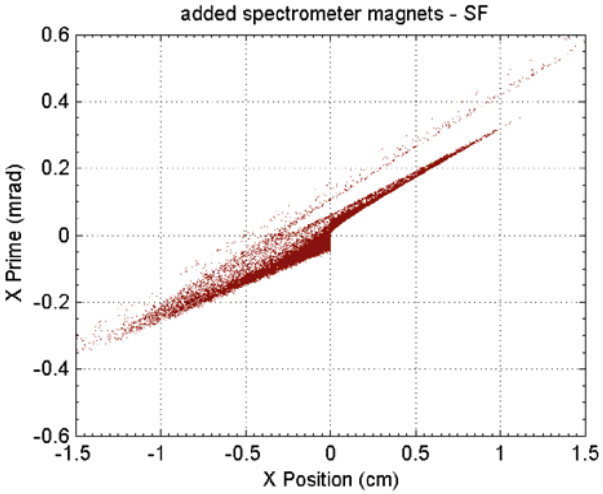
- Y *vs* X
- X' *vs* X
- Some change in X distribution also seen elsewhere.





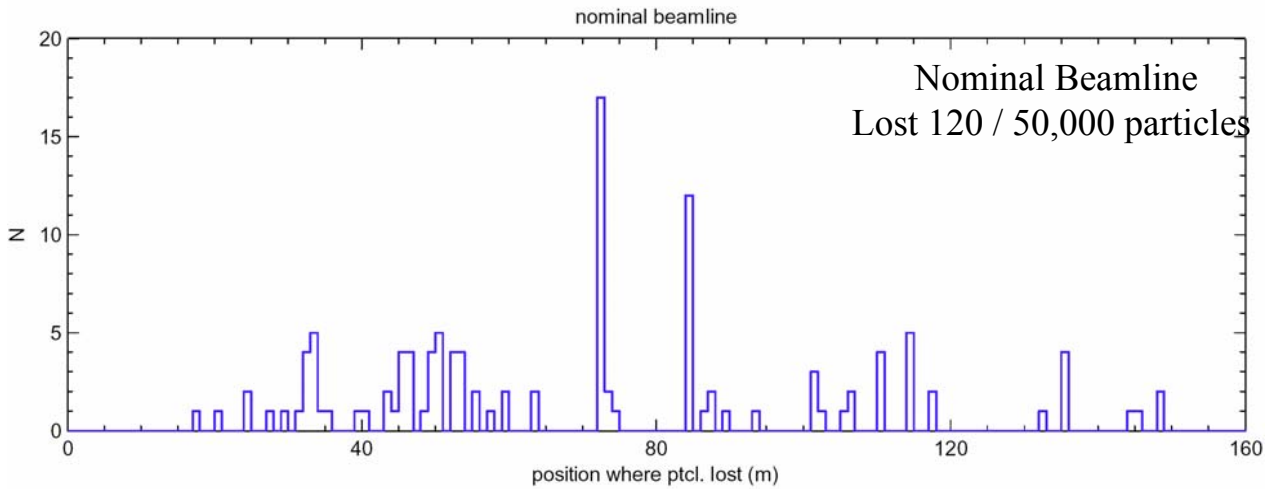
Nominal Beamline: Blue

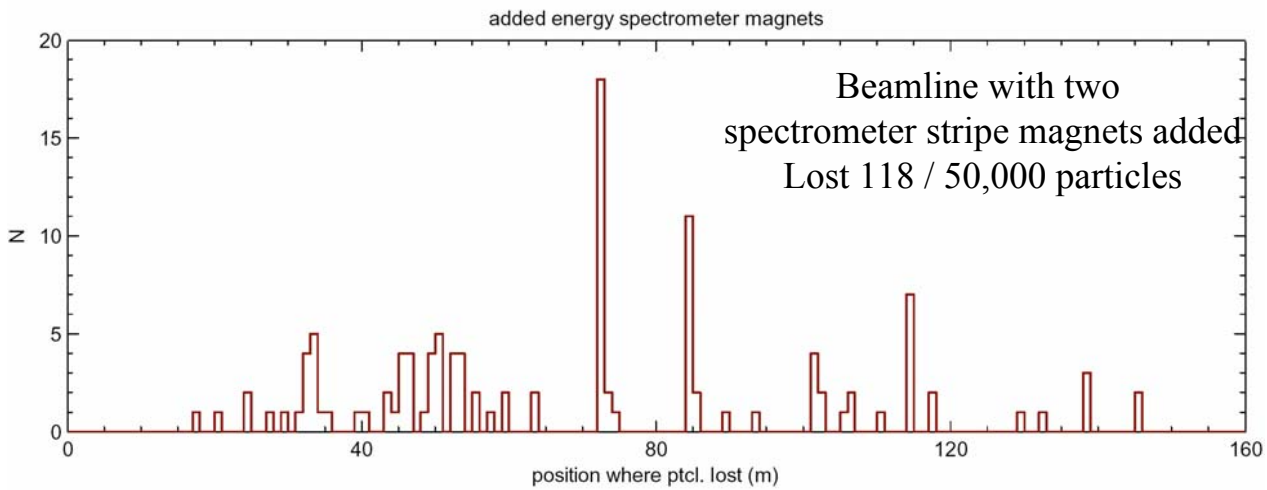
Magnets Added: Red



Lost Particles with Stripe Magnets

Location of Particle Loss

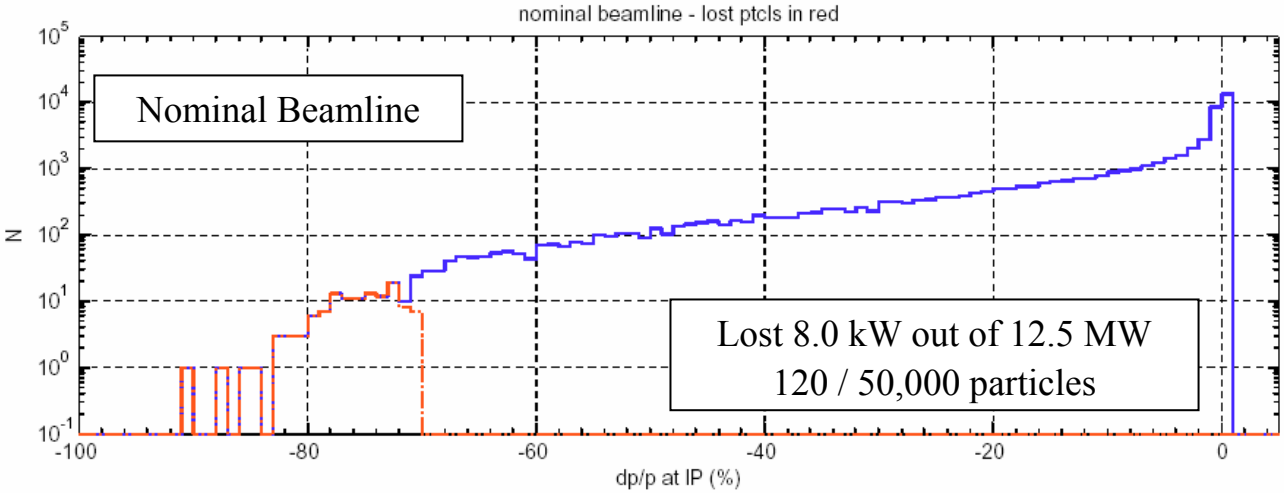


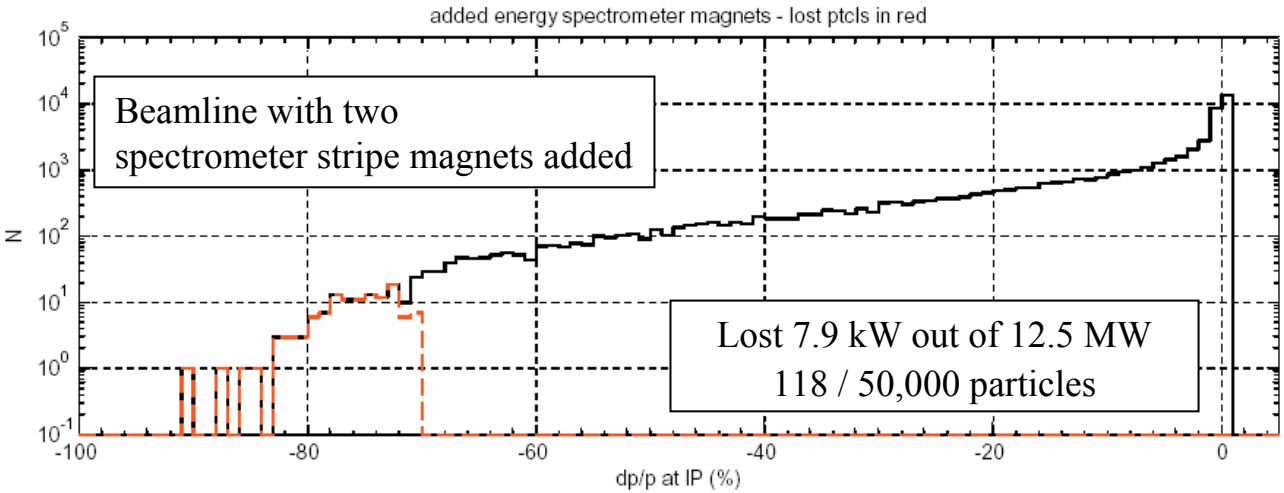


Addition of stripe magnets did not change particle loss significantly

Lost Particles with Stripe Magnets

Energies of Lost Particles





Addition of stripe magnets did not change lost energy significantly.

Simulation Issues

- Some details in the simulation of the wire scanner energy measurement differ from Yuri's results
  - to be discussed with him next month.
- Remaining simulations did not have "batman" energy distribution due to a problem with file. ?
- We saw an energy loss of 8.0 kW *vs.* 2.3 kW for Yuri; need to understand this
- These simulations were with the 36 mm aperture extraction line used for Yuri's wire scanner simulation; will run the 10 mm aperture version.

Chicane Beam Optics Issues

- Chicane bends are ~1 mrad (0.5 + 0.5)
- SR must focus at the SR detector; the secondary focus (SF) is in the center of the 10 m chicane
- Using a chicane bend for the spectrometer, the stripe separation is 1 mrad x 5 m = 5 mm, too small!
- SR from bend of 1 mrad/m
  - k_c = ~280 MeV for 500 GeV beams
  - k_c = ~35 MeV for 250 GeV beams
- Can one measure the stripe separation, with high SR energies, short stripes, close together?

Summary

- Horizontal stripe magnets can be added without significantly changing the beam at SF or dump
- We want to understand the small differences between our simulation results and Yuri's
- Will run simulation for 500 GeV Ecm and small aperture extraction line
- Could move to a simulation that includes the SR,

But … energetic SR and small distances =>

- We will need to explore changes in XL design to determine if this concept is feasible

Addendum
Added after the Workshop

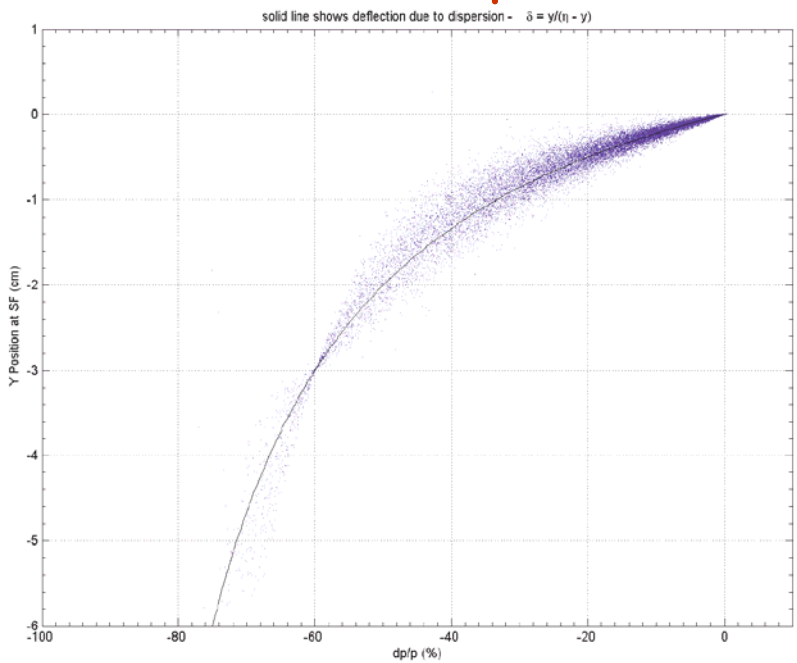
- Mike Woods suggested that the SR detector does not have to be at a focus, as long as one could find the centroid.
  - As Ray Frey pointed out, there are lots of photons for finding the centroid of the SR distribution.
  - This is true; the size of detector segments can increase.
  - We will look at this in future simulations.
- Dispersion throughout the chicane may be a problem.
  - This was not an issue at SLC, I believe by design.
  - Caleb is running simulations to study the effect of the presence of spatial and angular dispersion at both stripe magnets.

Extras

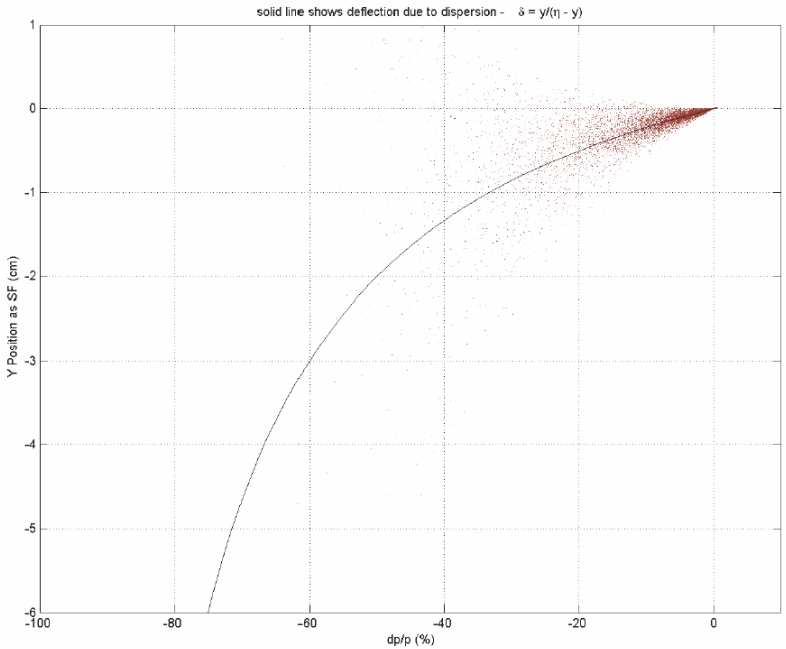
Large Aperture XL has Better Energy Resolution

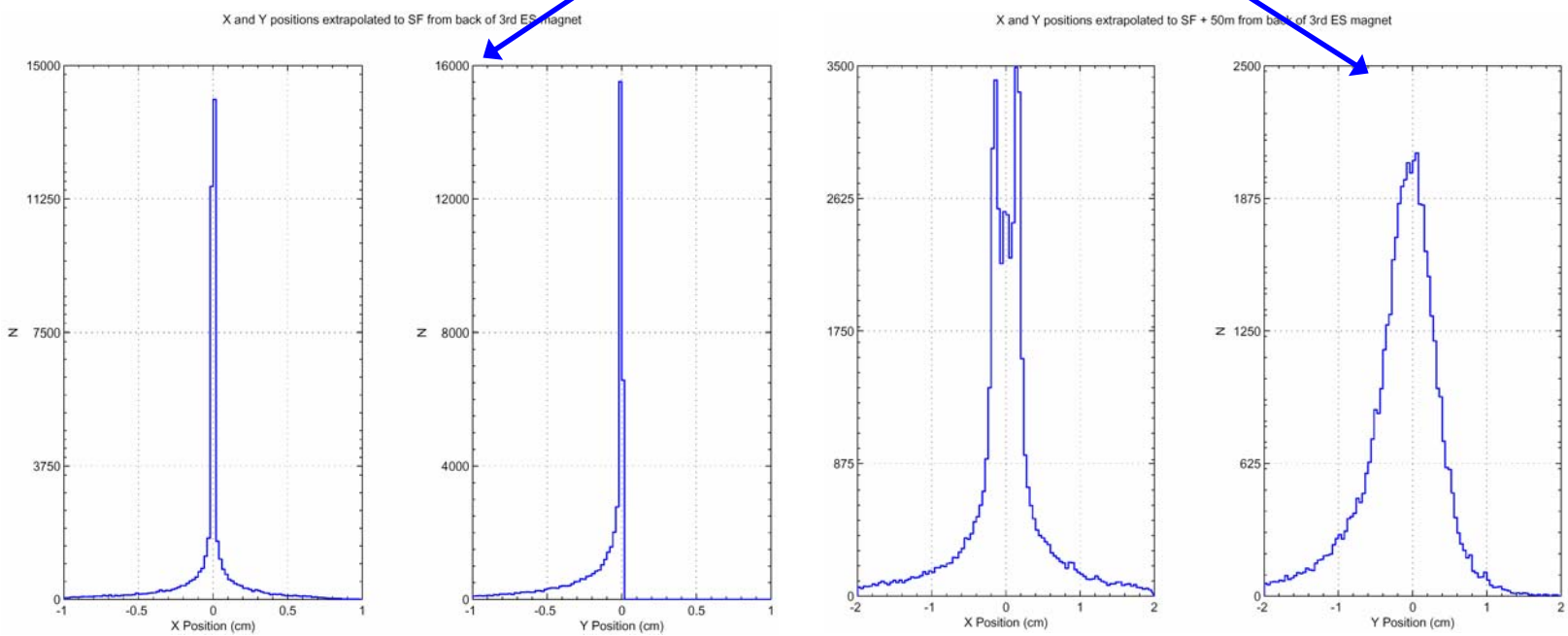
- $y = \eta\delta/(1+\delta)$
- Large aperture optics follows the equation better than the alternate small aperture optics.

LARGE Aperture



SMALL Aperture



SR Stripe Detector must be at 2nd Focus

- When the SR detector is at the secondary focus, the width of the distribution of stripe positions is due to just the energy spread.
- Stripe at secondary focus Stripe 50 m away