UNIVERSITY OF NOTRE DAME

Energy Spectrometer Update

Optics Progress and Plans for the End Station A Test Beam

Mike Hildreth

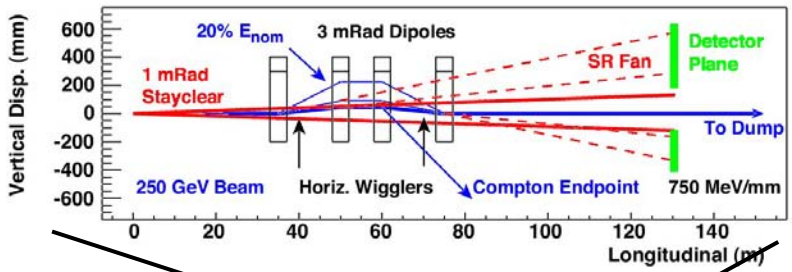
University of Notre Dame

representing

SLAC T-474 & T-475 and our international collaborators

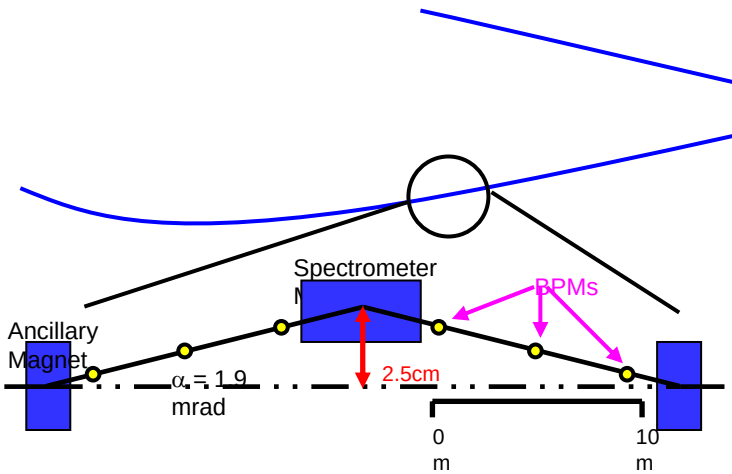
Spectrometry: A Reminder

- Required measurement precision is set by the expected statistical and systematic errors of "benchmark" measurements of m_{top}, m_{higgs}:
  - require $\delta E_{beam}/E_{beam}$ ~ 100-200 ppm
  - (LEP2 achieved ~170 ppm with a combination of techniques)



"downstream"

WISRD-style



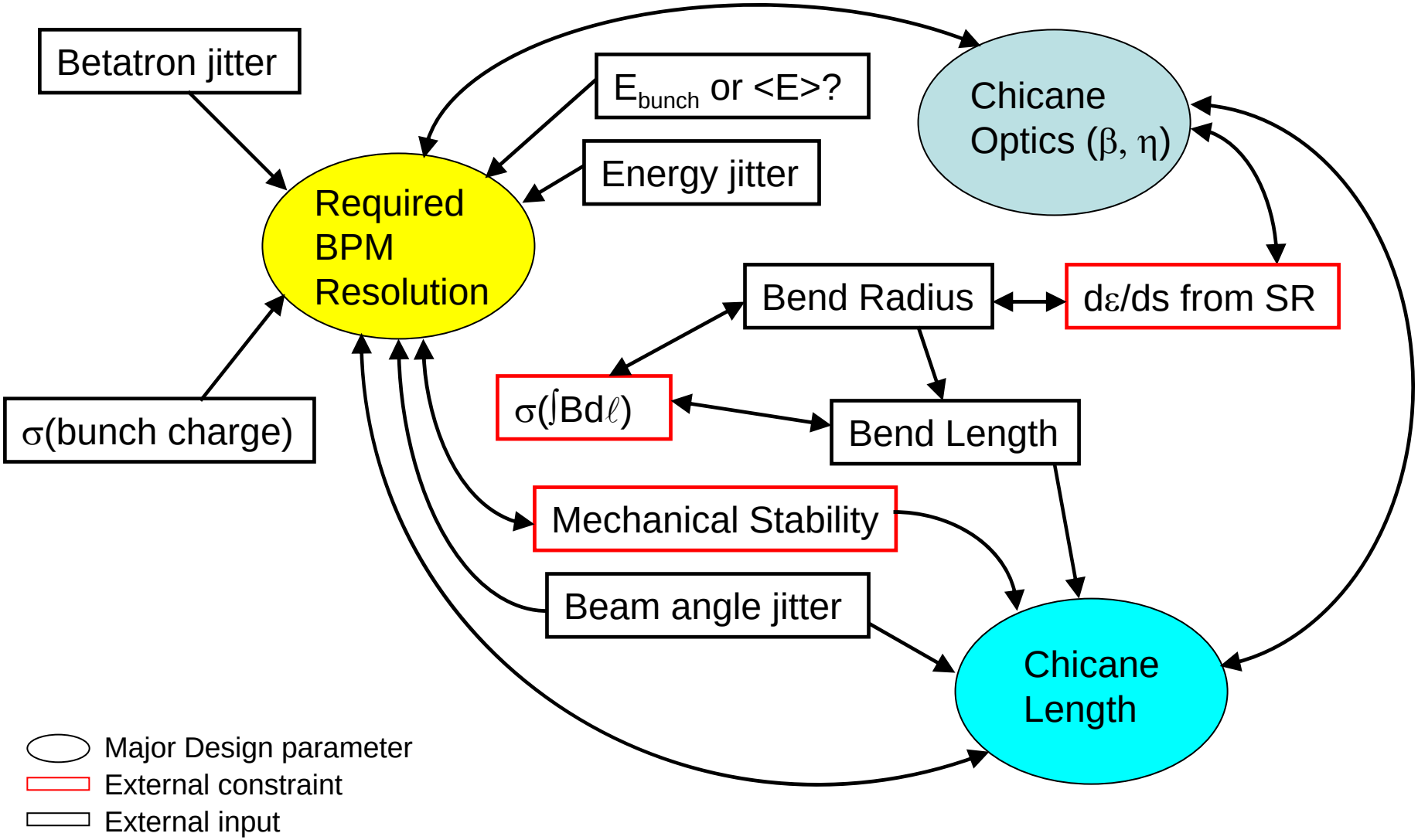
BPM-based

"upstream"

Considerations

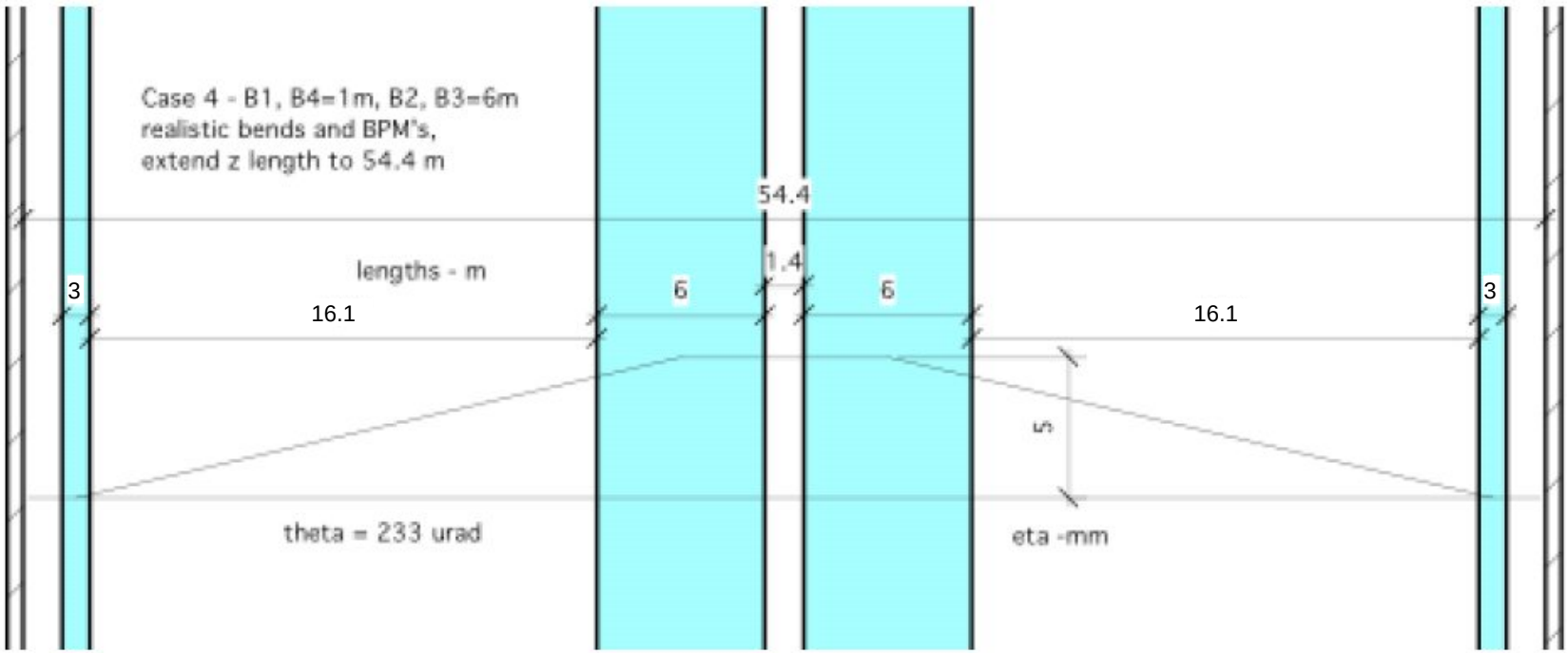
- Upstream Spectrometer
  - Constrained by allowed emittance growth from SR
  - Constrained by available real estate in BDS, overall size
    - These constraints determine needed BPM resolution/stability
  - Other issues drive systematic errors, diagnostics
  - Must be robust, invisible to luminosity
- Downstream Spectrometer
  - Constrained by available space in extraction line
    - 20 mrad crossing angle is fine, 2mrad?
    - background/interference-free region necessary
  - Detailed GEANT simulation of extraction line needed (underway)
  - robust, rad-hard detectors necessary

Upstream: Design Constraints



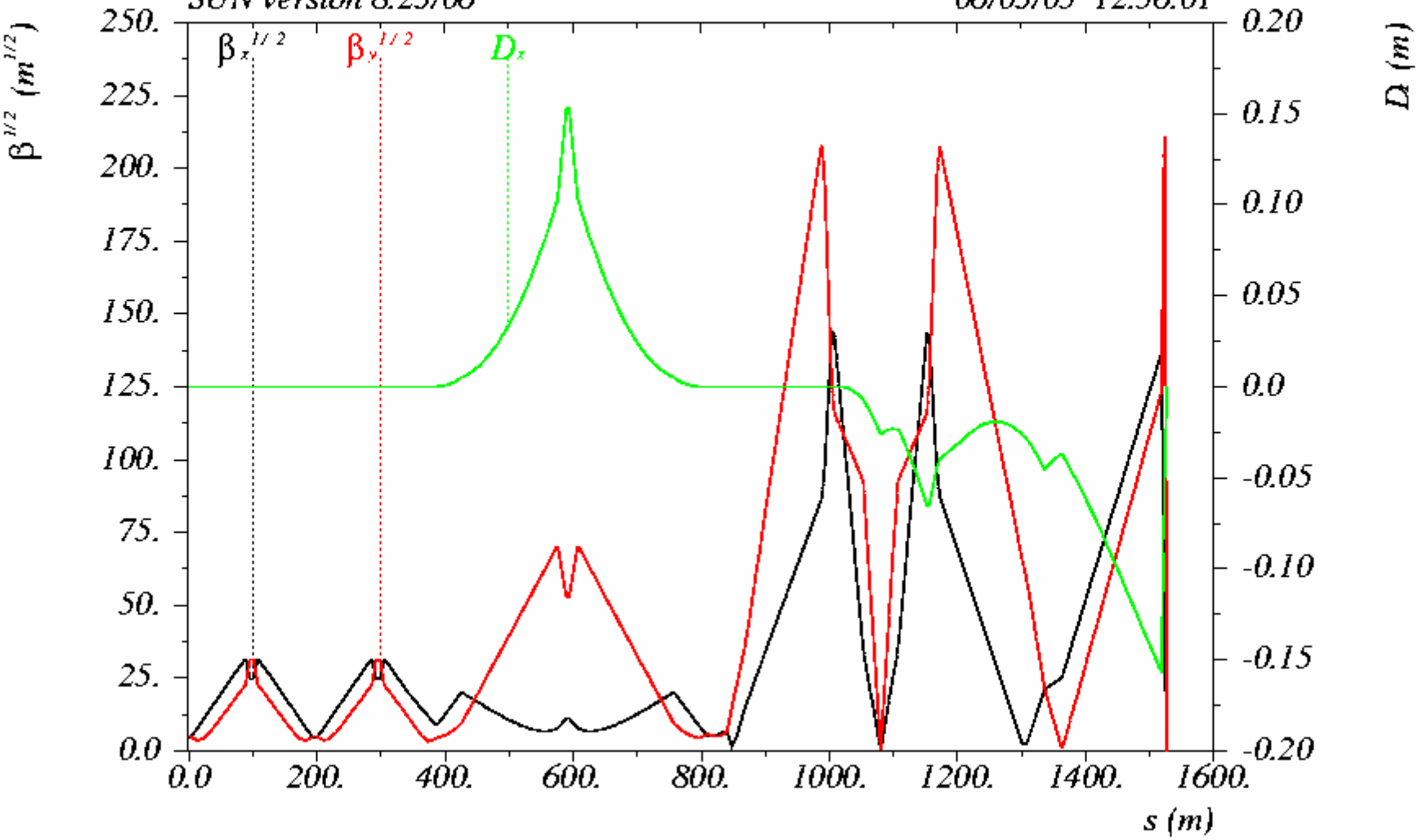
Prototype

- Presented at Jan MDI Workshop at SLAC
  - first attempt at an optimization within the available parameter space
  - large, softer bends at high-dispersion point to minimize emittance growth from synchrotron radiation



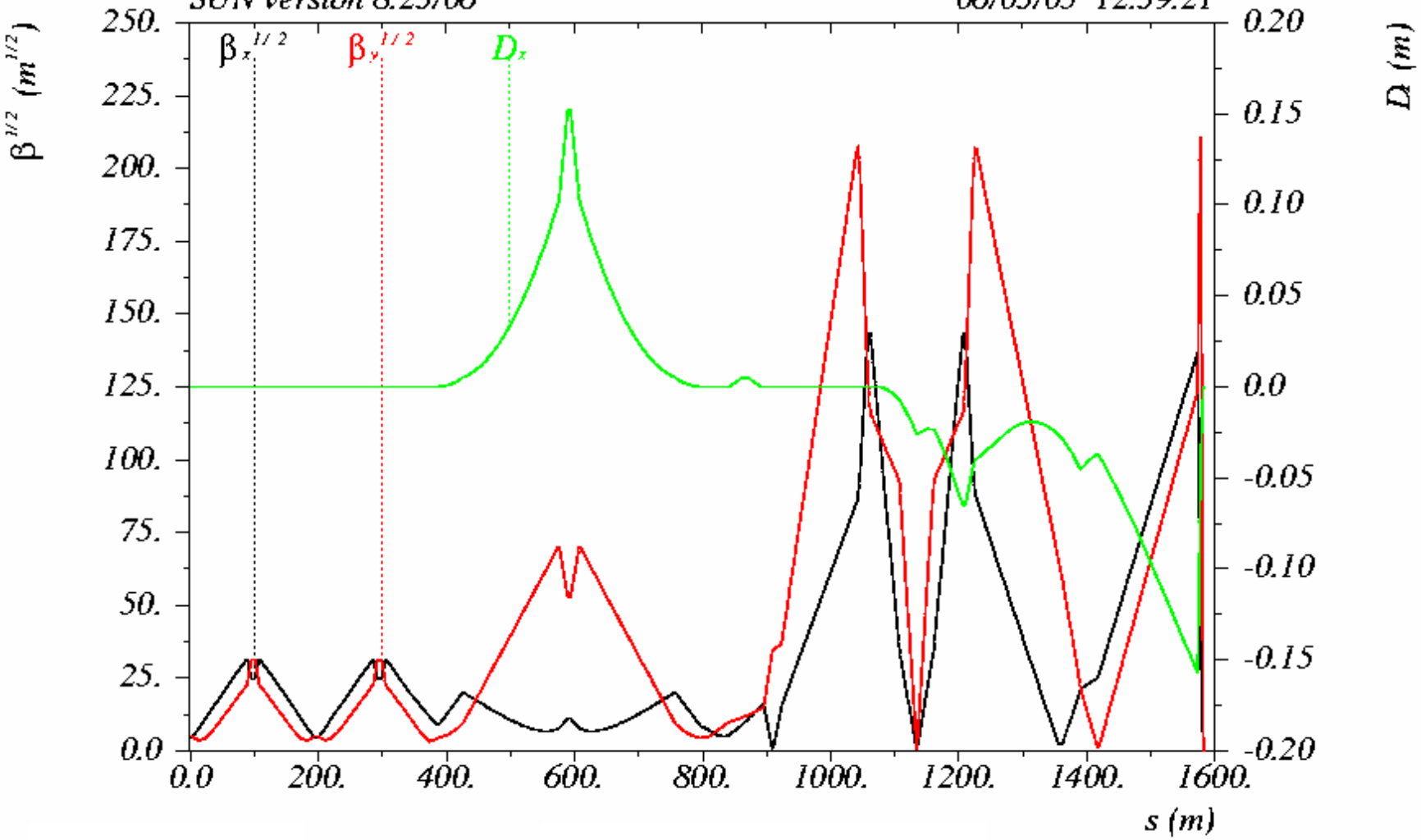
Progress: New Optics!

old

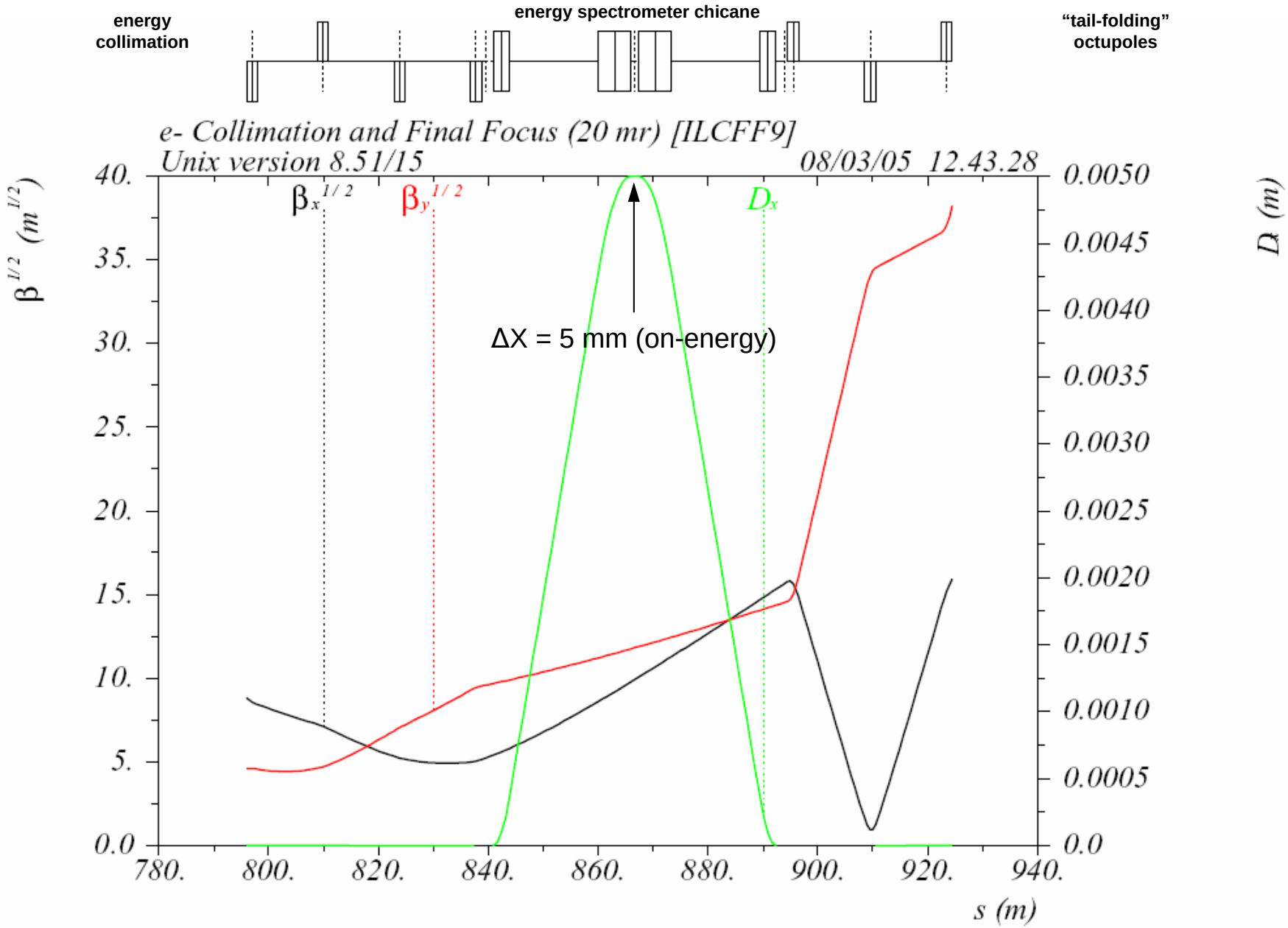


Progress: New Optics!

new

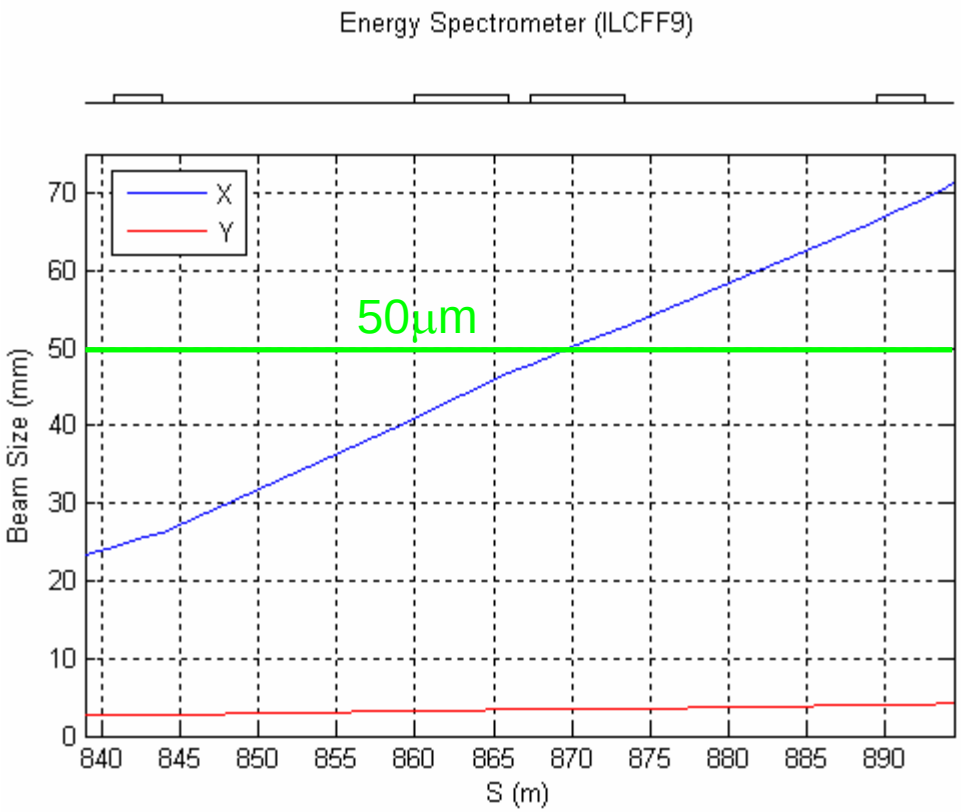


Optics: details



Optics: more details

Comments:



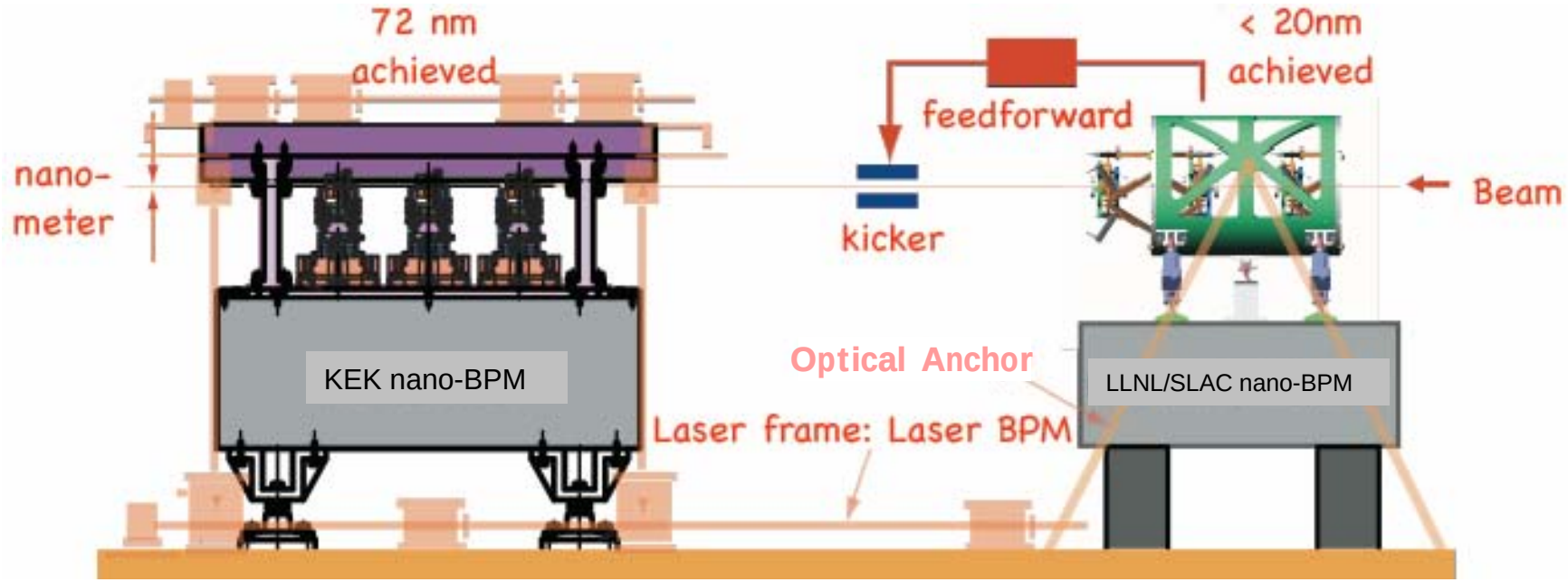
$\Delta\gamma\varepsilon_x$ = 1.2×10^{-10} @ 250 GeV
= 7.5×10^{-9} @ 500 GeV

⇒ small beam growth due to SR

- much smaller beam sizes than previous sketch (x5)
- high dispersion
  - makes measurement easier
- longer (~55m)
  - ditto
- Basically, meets many of the constraints on spect design
- betatron phase issues while scanning B field?

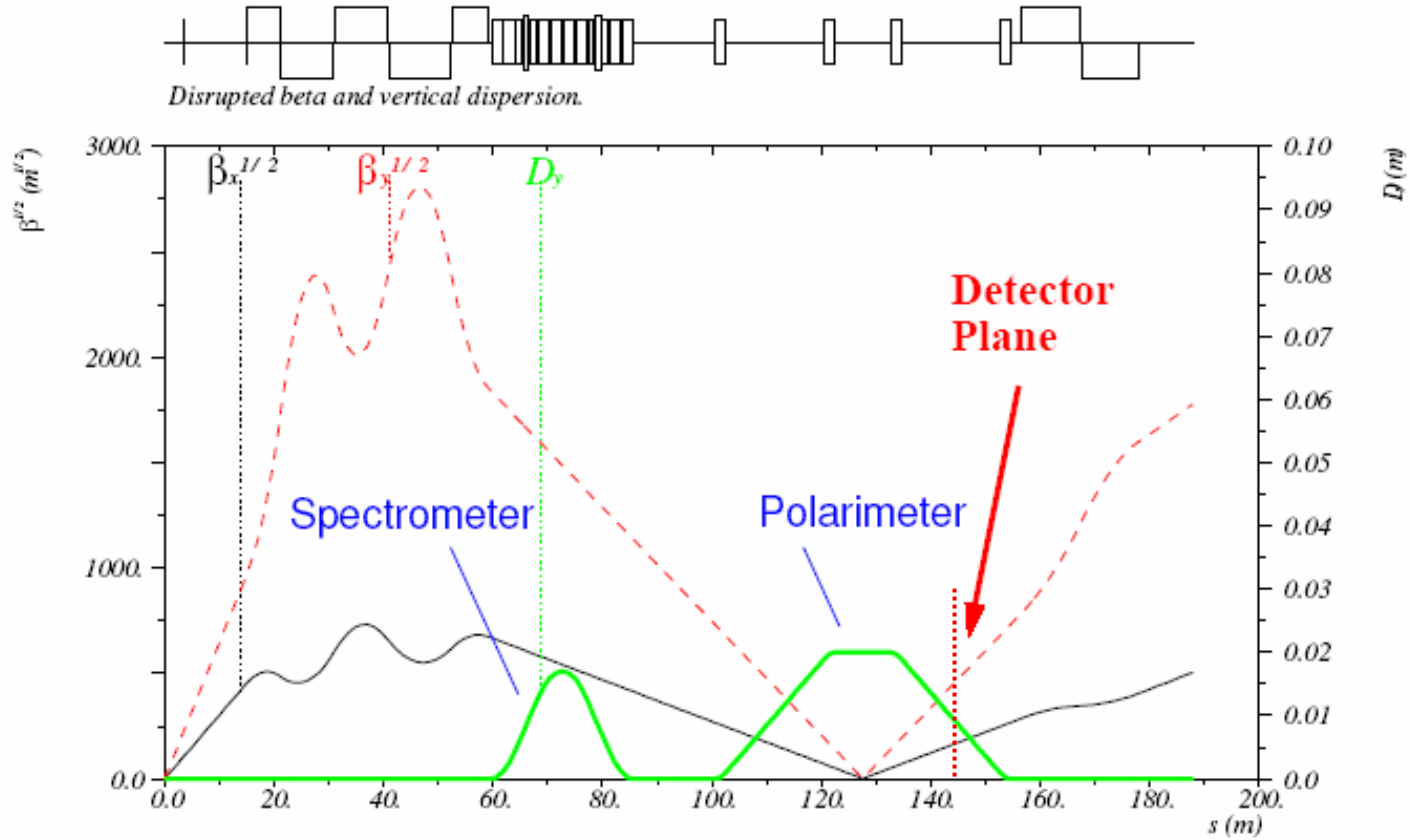
News from ATF:

- nano-BPMs being used to test some spectrometer concepts
  - optical link under construction to connect two pairs of BPM triplets
  - optical straightness monitor with ~10nm resolution under development
  - promising resolutions!
  - stability will be key issue



Downstream Spectrometer

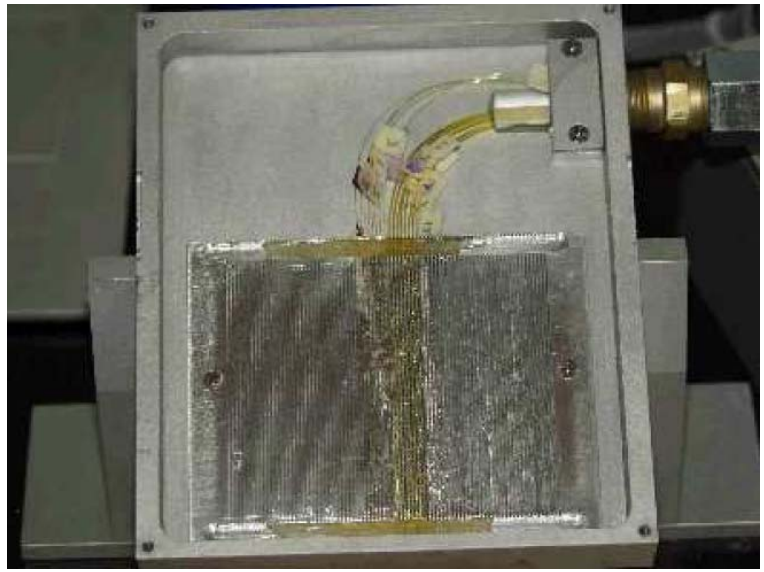
- Also, new optics (20 mrad)

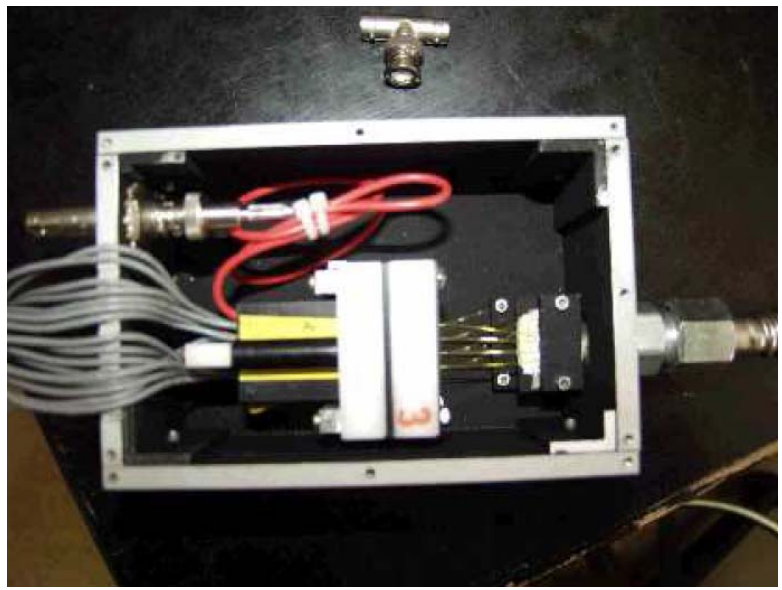


  - Advantageous to have Spectrometer detector plane near 2nd IP
  - separate chicanes for spectrometer, polarimeter ⇒ much easier!

Detector R&D

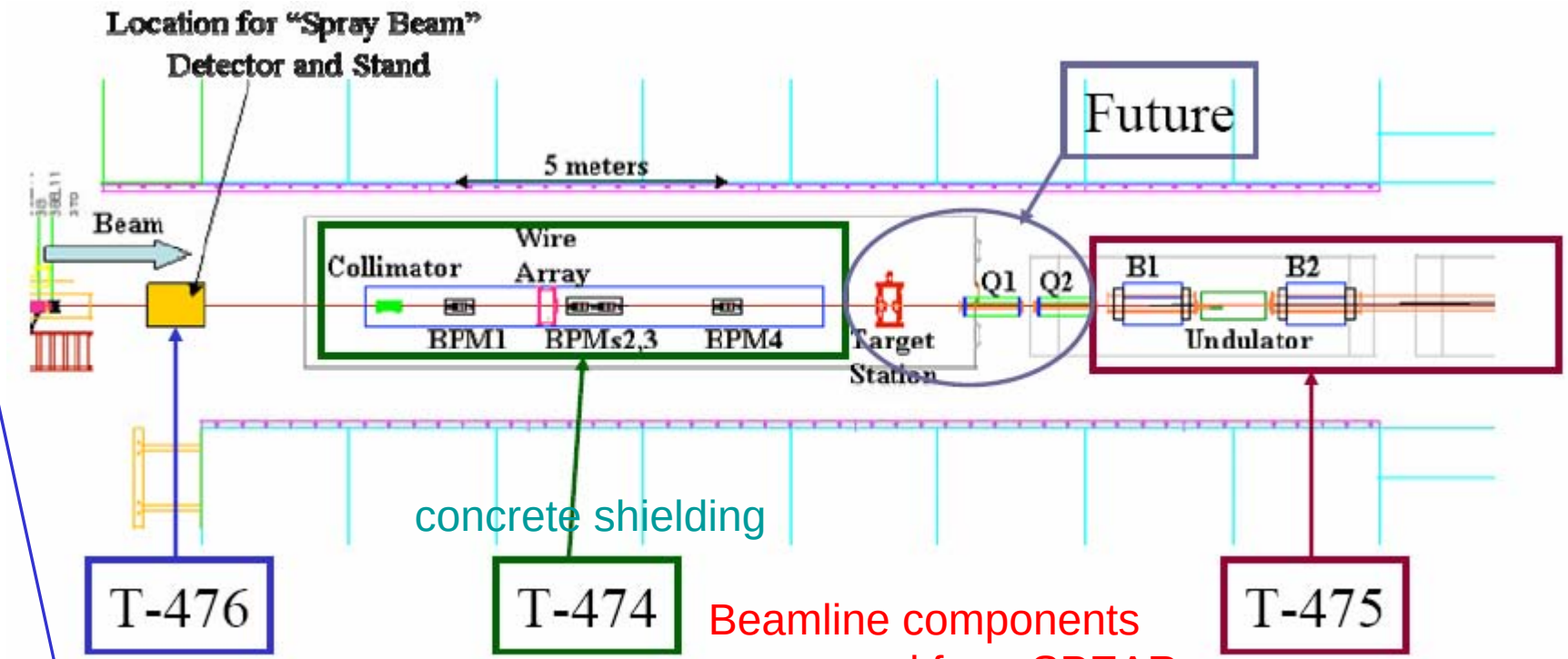
- Entirely passive, rad-hard detector is ideal
  - quartz fibers
    - intrinsically fast
    - no inductive pickup, crosstalk
    - 200keV Cerenkov threshold
    - detector prototype
      - 100 μm and 600 μm fibers
      - 1mm pitch
  - Multi-anode PMT readout
    - high gain
    - simple device
    - up to 64 channels





End Station A Test Beams

- T-474 (BPM Spectrometer) and T-475 (Wisrd Spectrometer) approved
  - will also incorporate collimator wake-field studies, other experiments



Nano-BPMs

Existing RF BPMs can be used for stability, resolution tests

Beamline components scavenged from SPEAR, other SLAC surplus

Goal: Demonstrate Spect performance in "real beam"

ESA Program

- ESA provides “ILC-like” beam in “realistic” conditions:

Parameter	SLAC ESA	ILC-500
Repetition Rate	10 Hz	5 Hz
Energy	28.5 GeV	250 GeV
e^- Polarization	(85%)	>80%
Train Length	up to 400 ns	1 ms
Microbunch spacing	20-400 ns	337 ns
Bunches per train	1 or 2	2820
Bunch Charge	2.0×10^{10}	2.0×10^{10}
Energy Spread	0.15%	0.1%

  - Can always tweak jitter parameters to make things worse
  - Can “simulate” beamstrahlung pair production by using radiators
  - Complementary to ATF tests

Conclusions

- Spectrometer designs advancing
  - Test beam work necessary SOON to meet CDR time goal
  - ESA + ATF = complementary R&D program
    - many parameters to consider
  - Emphasis is currently on hardware
    - don't lose sight of physics cross-checks
    - built-in redundancy will be key
      - in monitoring *and* measurement systems
  - Truly international collaborations

- "Trust, but Verify"
  - Beam Tests are critical for these systems
    - tolerances are very tight, many surprises are possible