BI Tests for the Linear Collider
Turning the LOI into a Proposal

SLAC ALCPG Meeting

Jan. 9, 2004

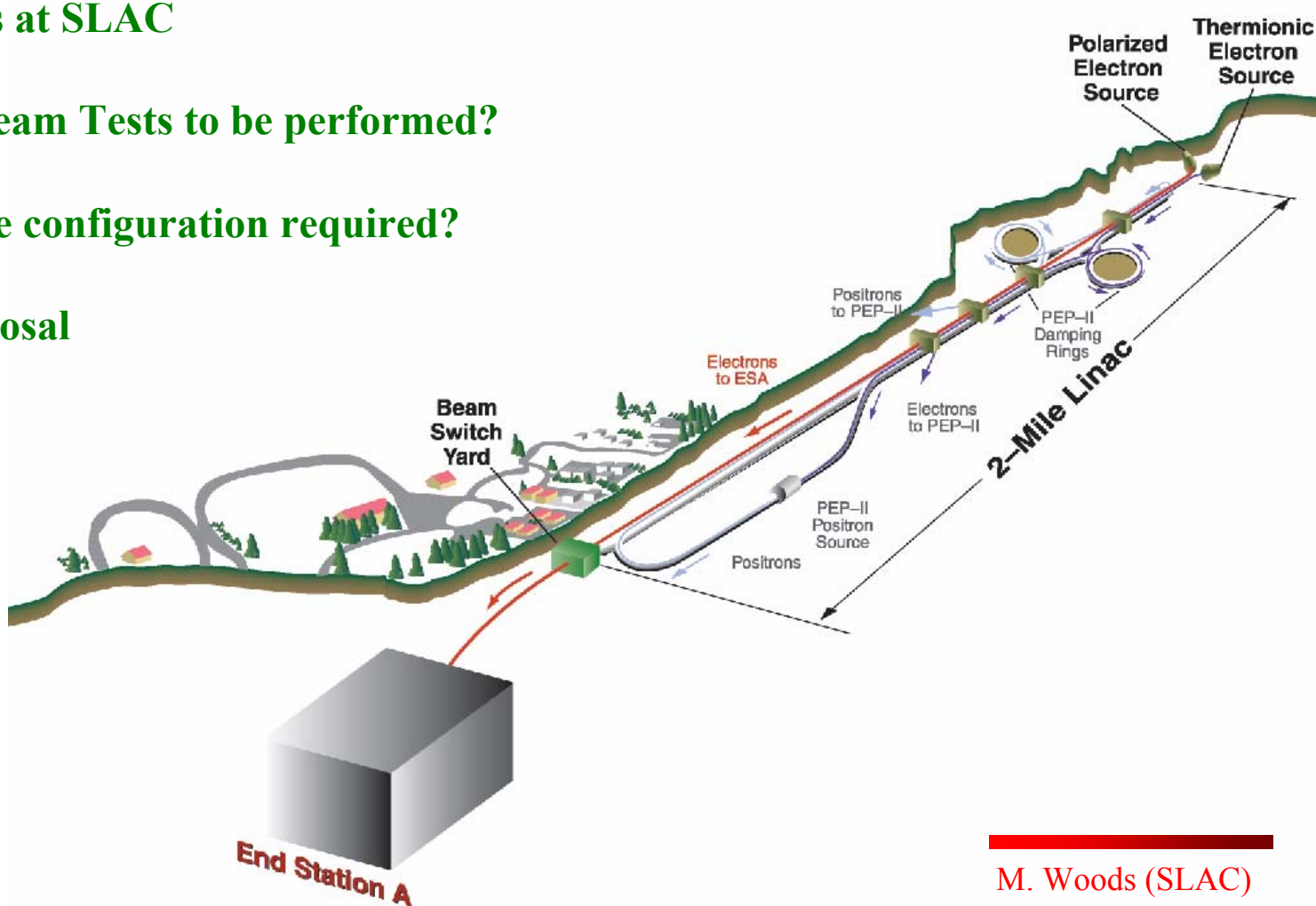
M. Woods, SLAC

LC-LEP Beam Tests at SLAC

What are the first Beam Tests to be performed?

What is the beamline configuration required?

Developing the Proposal



Beam Instrumentation Tests for the Linear Collider using the SLAC A-Line and End Station A

SLAC-LOI-2003.2

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http://www.slac.stanford.edu/grp/rd/epac/LOI/LOI-2003.2.pdf

LCRD and UCLC

FY04 R&D Proposals to DOE and NSF

Luminosity

Fast Gas Cherenkov Calorimeter (*Iowa St.*)
Parallel Plate Avalanche, Secondary Emission Detectors (*Iowa*)
Large Angle Beamstrahlung Monitor (*Wayne St.*)
3d Si Detector for Pair Monitor (*Hawaii*)

Energy

Synchrotron Stripe Spectrometer (*Oregon, UMass*)
rf BPM Spectrometer (*Notre Dame*, *UC Berkeley*)

Polarization

Quartz Fiber Calorimeter; W-pair asymmetry (*Iowa*)
Background study (*Tufts*)
Quartz Fiber Detector; transverse polarization (*Tennessee*)

General Comments

Risks to LC luminosity and LC physics capabilities

- Any beam or detector instrumentation that cannot be commissioned until the LC is built have very high risk factors.

  ⇒ Do beam tests early!

Beam-beam effects

- much greater than in previous machines
- backgrounds
- large disruption and deflection angles

  ⇒ Mimick some beam-beam effects in a fixed target beam test

Precision Measurements

- Challenging requirements for luminosity, energy and polarization measurements

  ⇒ Instrumentation requires beam tests

General Comments (cont.)

Breidenbach's talk on "Detector and the Technology Choice"

"background in the feedback BPM's could be a severe problem,
and no relevant R&D seems plausible before commissioning.
Actual luminosity (as opposed to offset) feedback may be needed"

Himel's talk on "US LC Options Study"

"MPS and items in the beam delivery system come out as the riskiest
because the problems may not be found until commissioning."

We can do relevant R&D with beam tests in ESA

Instrumentation for Luminosity, Luminosity Spectra and Luminosity Tuning

Luminosity

Bhabha LuMon detector from 40-120 mrad

Luminosity Spectrum

Bhabha acolinearity measurements using forward tracking and calorimetry from 120-400 mrad

+ additional input from beam energy, energy spread and energy spectrum measurements

Luminosity Tuning

Pair LuMon detector from 5-40 mrad

Beamstrahlung detector from 1-2 mrad (further downstream)

IP BPMs

Instrumentation for Energy, Energy Spread and disrupted Energy Spectrum

Energy

BPM spectrometer (upstream of IP)

Synchrotron Stripe spectrometer (in extraction line)

Energy Spread

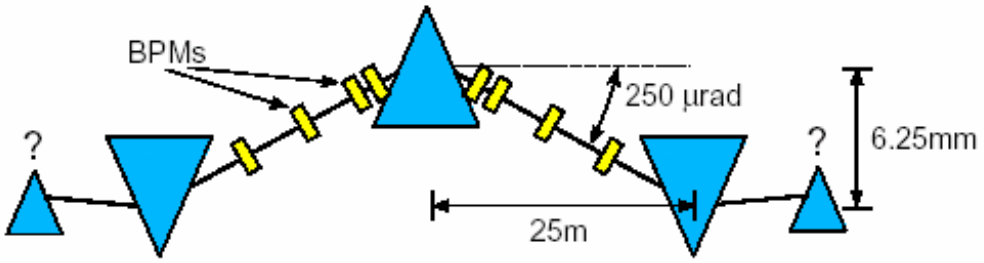
Synchrotron Stripe spectrometer (in extraction line)

Wire scanner at high dispersion point in extraction line chicane

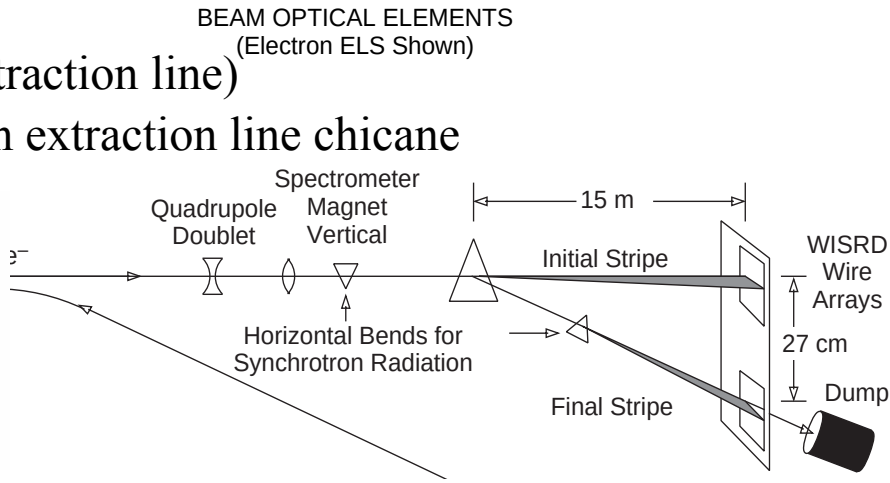
Disrupted Energy Spectrum

Synchrotron Stripe spectrometer (in extraction line)

Wire scanner at high dispersion point in extraction line chicane



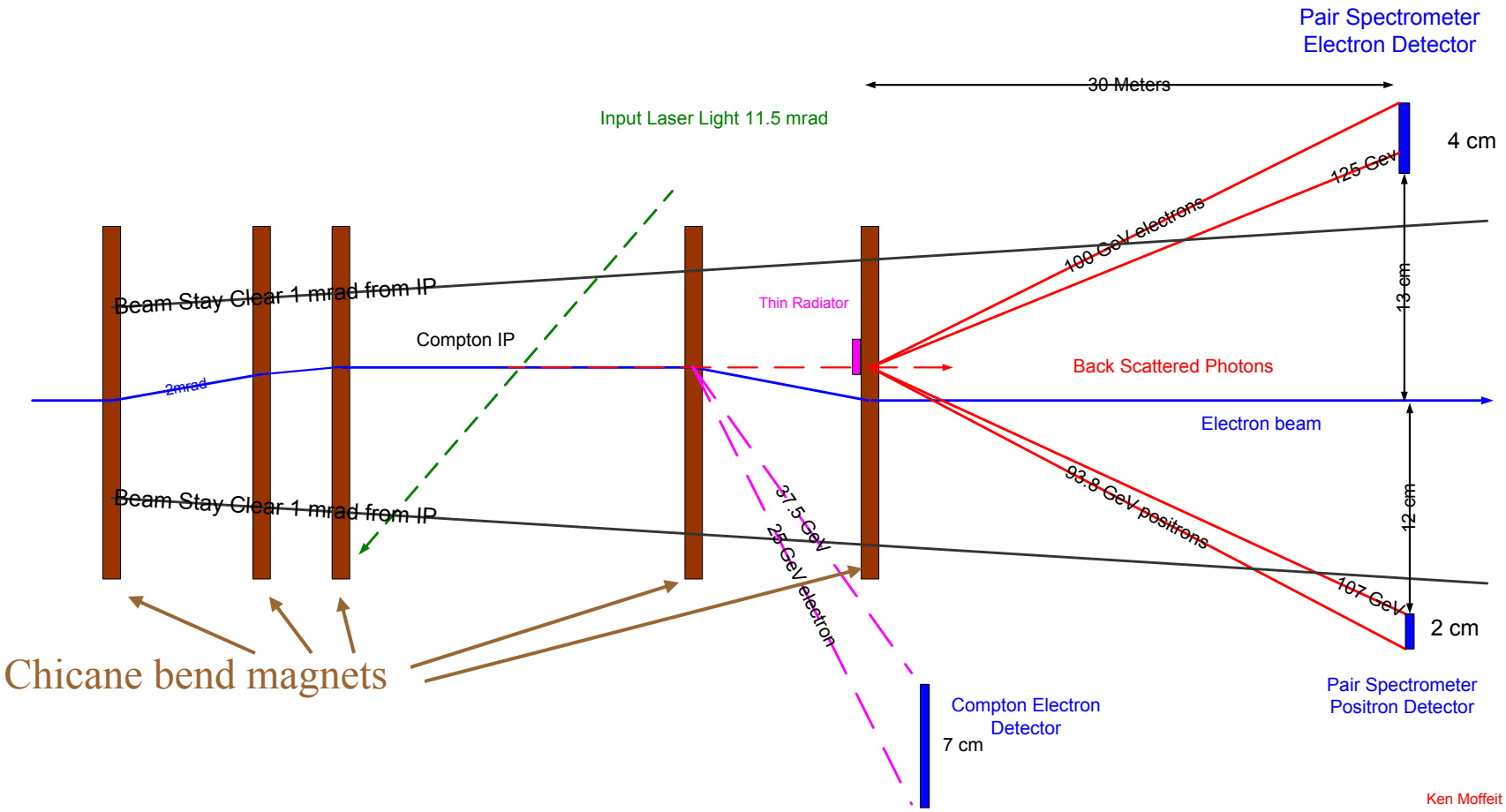
Proposed BPM spectrometer at NLC



Synchrotron Stripe Spectrometer at SLC

Instrumentation for Polarimetry

Compton Polarimeter in Extraction Line



Beam Parameters at SLAC ESA and NLC-500

Parameter	SLAC ESA	NLC-500
Charge/Train	5×10^{11}	14.4×10^{11}
Repetition Rate	10-30 Hz	120 Hz
Energy	25 GeV	250 GeV
e^- Polarization	85%	85%
Train Length	270ns	267ns
Microbunch spacing	0.3ns*	1.4ns
Energy Spread	0.15%	0.3%

*Polarized Source group is pursuing R&D to achieve 714MHz modulation and 1.4ns spacing

Modulation of SLAC Polarized Electron Beam

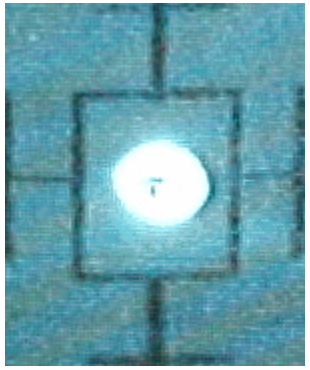
(see Sources talks by A. Brachmann and J. Clendenin)

- **Technique: pass 300-ns flash-Ti laser pulse through Pockels cell modulated at 714 MHz**
- **Result will be a train of μbunches spaced 1.4 ns**
  - Each "μbunch" will have 2 S-band buckets with some charge inbetween μbunches
- **Beam-loading will limit peak current:**
  - If Iavg in macrobunch is 0.5 A (E-158), then Ipk in μbunch is 2 A ⟶ implying 4×10^9 e^- in single "μpulse"

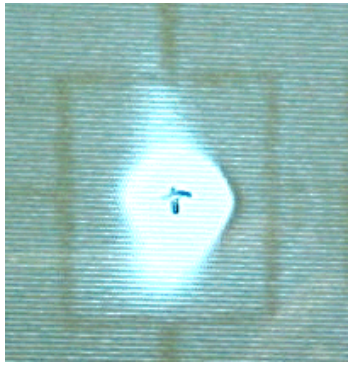
Beam Parameters at SLAC ESA and TESLA-500

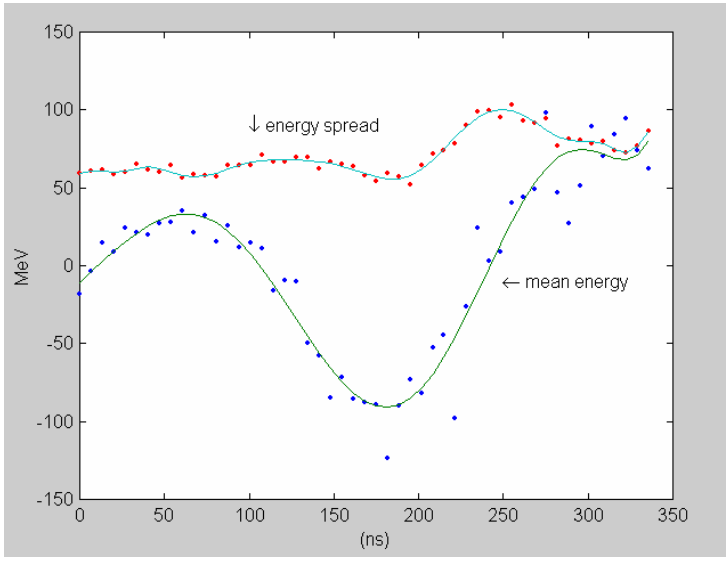
Parameter	SLAC ESA	TESLA-500
Repetition Rate	10-30 Hz	5 Hz
Energy	25 GeV	250 GeV
e^- Polarization	85%	85%
Train Length	340 ns	1 ms
Microbunch spacing	340 ns	337 ns
Bunches per train	2	2820
Bunch Charge	2.0×10^{10}	2.0×10^{10}
Energy Spread	0.15%	0.1%

Can provide clean beams (little halo or beam tails)

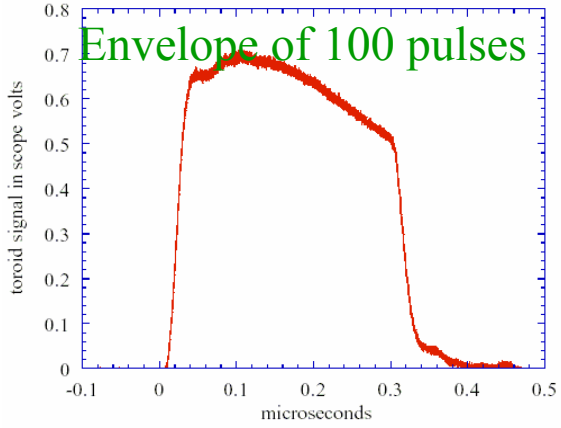


Can provide beams with tails!





Can provide "banana" beams in energy By pulse shaping source laser intensity



Can translate banana energy dist'n to banana spatial dist'n by introducing dispersion

First Beam Tests

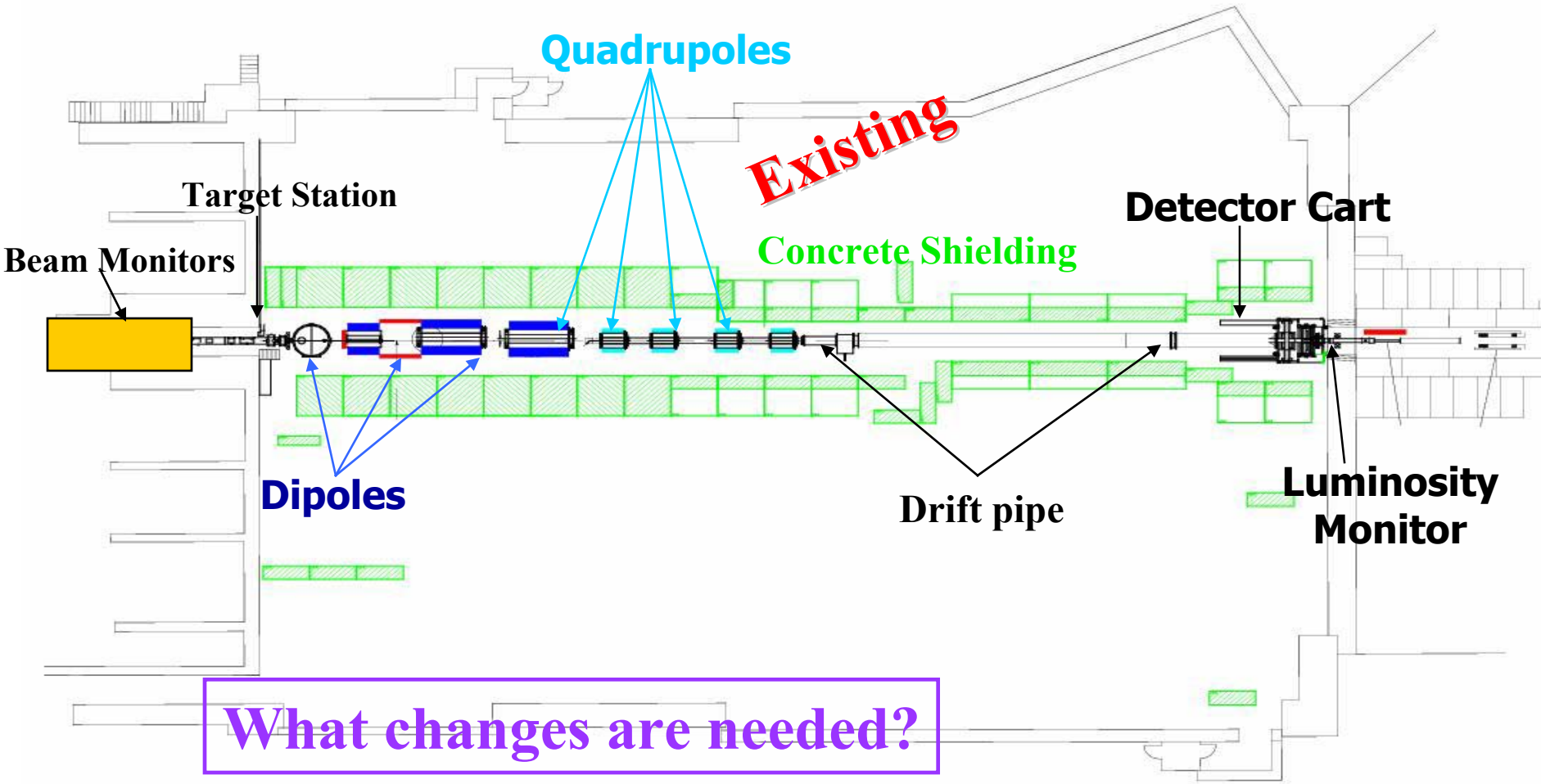
Needed for Proposal and to determine Beamline Configuration

1. IP BPMs (necessary for fast inter-train and intra-train feedbacks)
2. Energy BPMs
3. Synchrotron stripe diagnostics for measuring energy, energy spread and the disrupted (brem) spectrum.

Other possibilities:

4. Pair detectors.
5. Beamstrahlung detector backgrounds (can't model 'visible' backgrounds at 1-2 mrad)
5. Test A-Line spin precession for use as energy measurement.

Determining the Beamline Configuration in ESA



Developing the Proposal

1. **Identify first users for the Beam Test Facility**
2. **Users develop full technical description of beam tests**
3. **Use beam test descriptions to determine beamline configuration**
4. **Formulate Run Plan for first beam tests**
    - Beam requirements
    - Time required
    - Common DAQ?
5. **Prepare SLAC Impact Report**
    - Budget
    - Resources provided by SLAC
    - Resources provided by users
6. **Proposal needed by May 2004**