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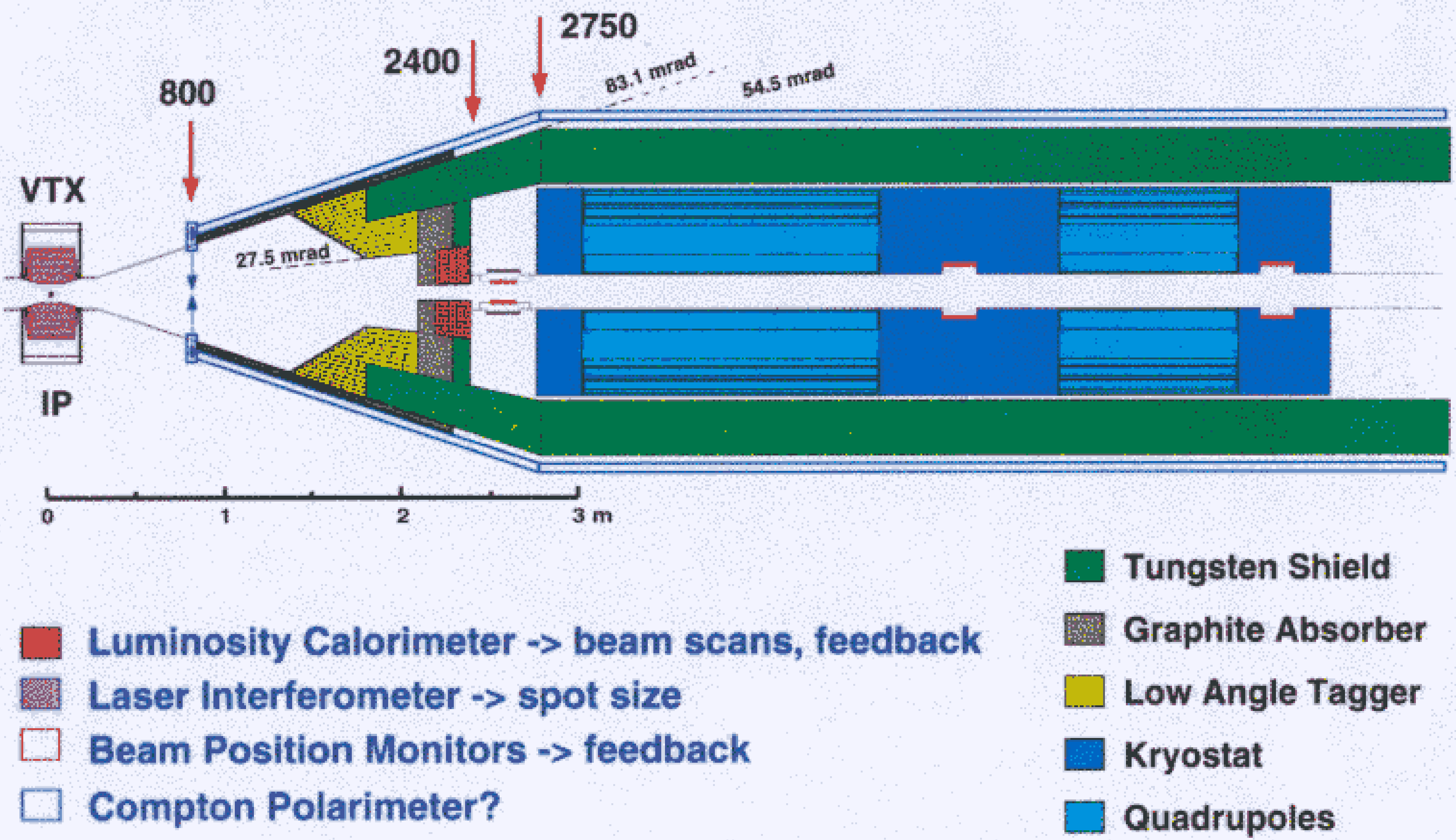
# Machine Related Instrumentation of the Mask

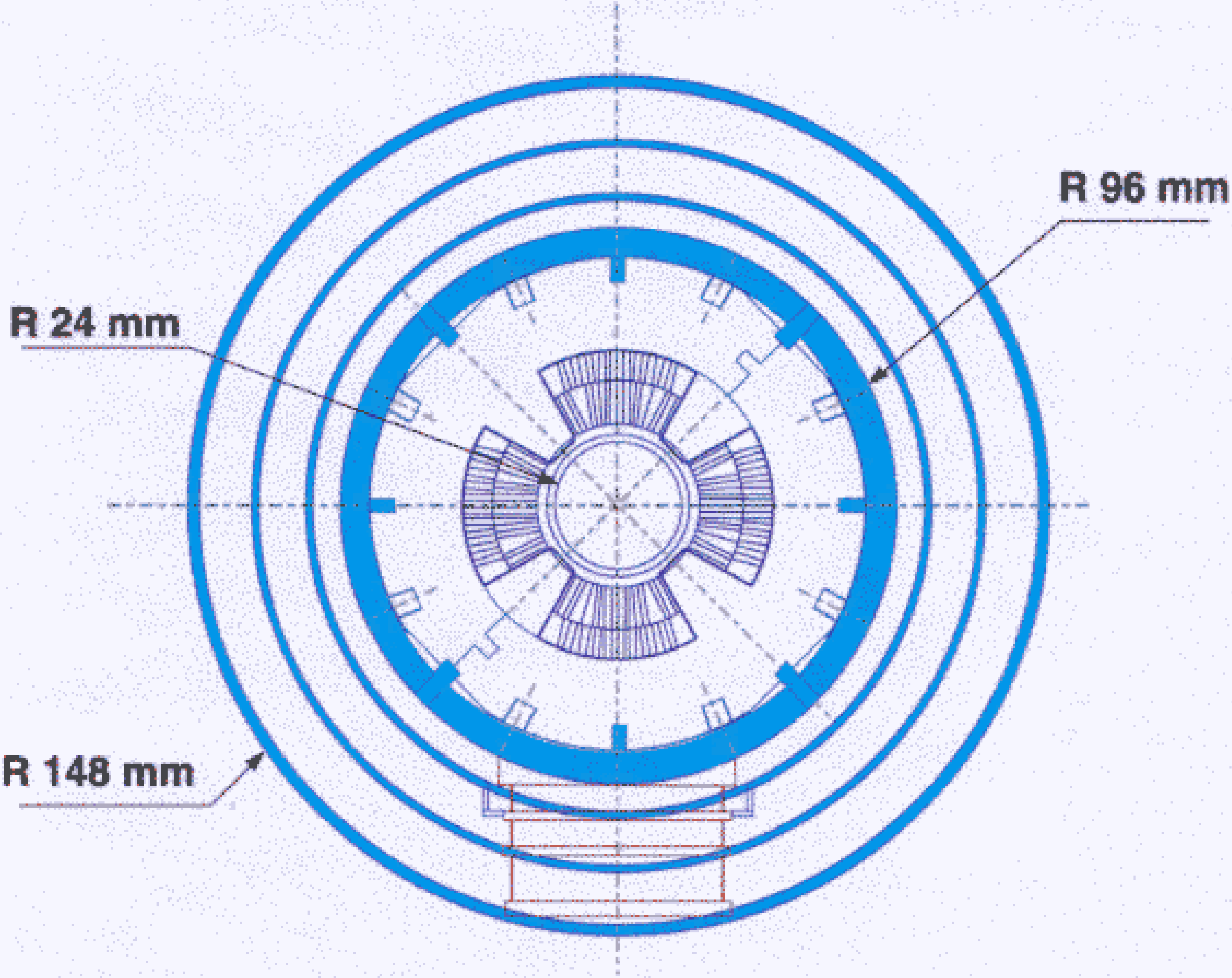
- Luminosity Calorimeter
- Beam Position Monitors
- Laser Interferometer

# Overview machine related mask instrumentation




- Luminosity Calorimeter -> beam scans, feedback
- Laser Interferometer -> spot size
- Beam Position Monitors -> feedback
- Compton Polarimeter?

# Final Quad Design




| | |
|---|---|
| Gradient | 250 T/m |
| Physical Aperture (diam.) | 48 mm |
| Magnetic Length | 1.7 m and 1 m |
| | |
| Inner Coil diameter | 56 mm |
| Outer Coil diameter | 108 mm |
| Helium Vessel outer diam. | 192 mm |
| Vacuum Tank outer diam. | 296 mm |
| | |
| Weight | 300 kg/m |

# Optimize Luminosity with the Luminosity Calorimeter LCAL

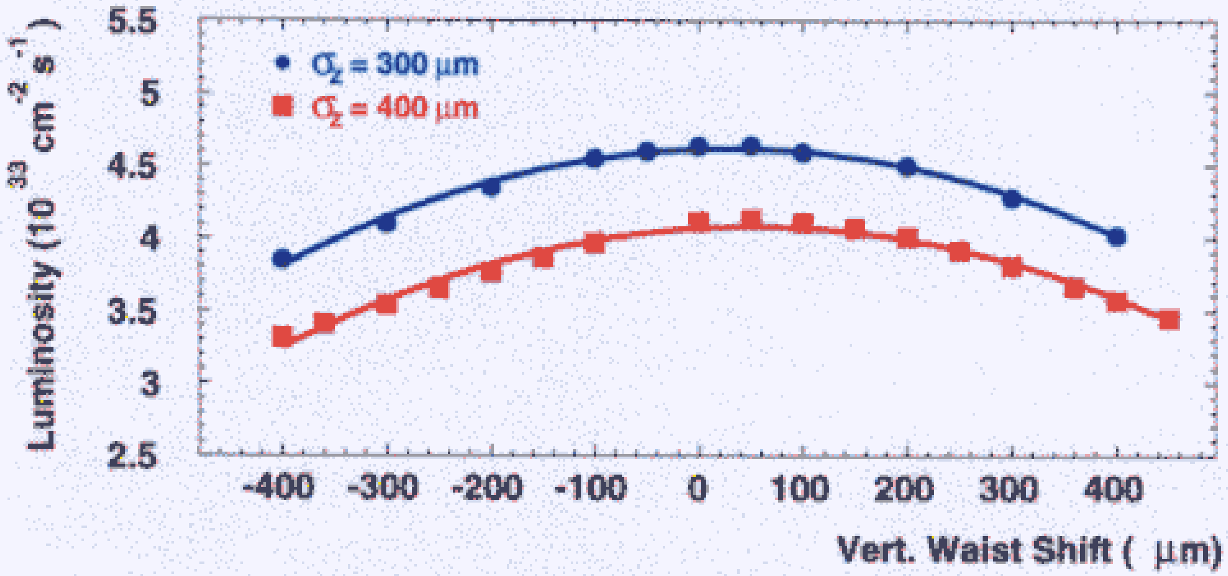
fast relative luminosity measurement with a resolution of about 1 %

goal:
optimize beam collisions (see TESLA 97-17)

(I) LCAL at inner part of the mask
-> measure total energy of pairs — fast!

(II) ECAL at 8.5 to 9.5 m from IP
-> measure radiative Bhabhas (50 GeV) — slow!

## Example e-e- waist shift:




- best luminosity for a waist shift of

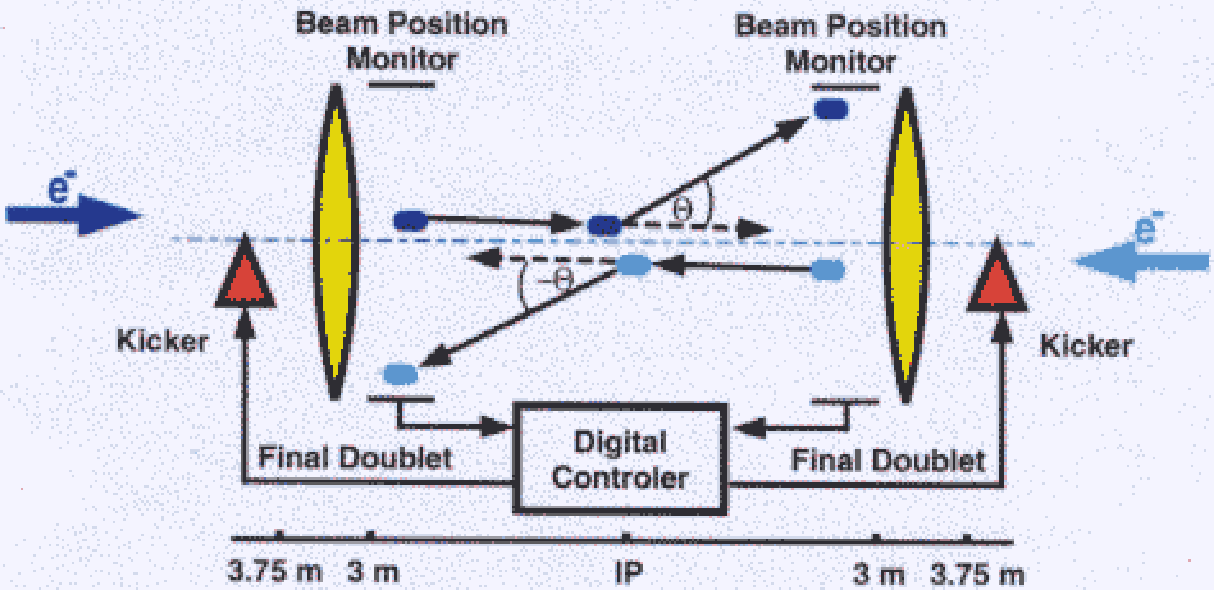
  30 µm for $\sigma_z$ = 300 µm

  53 µm for $\sigma_z$ = 400 µm

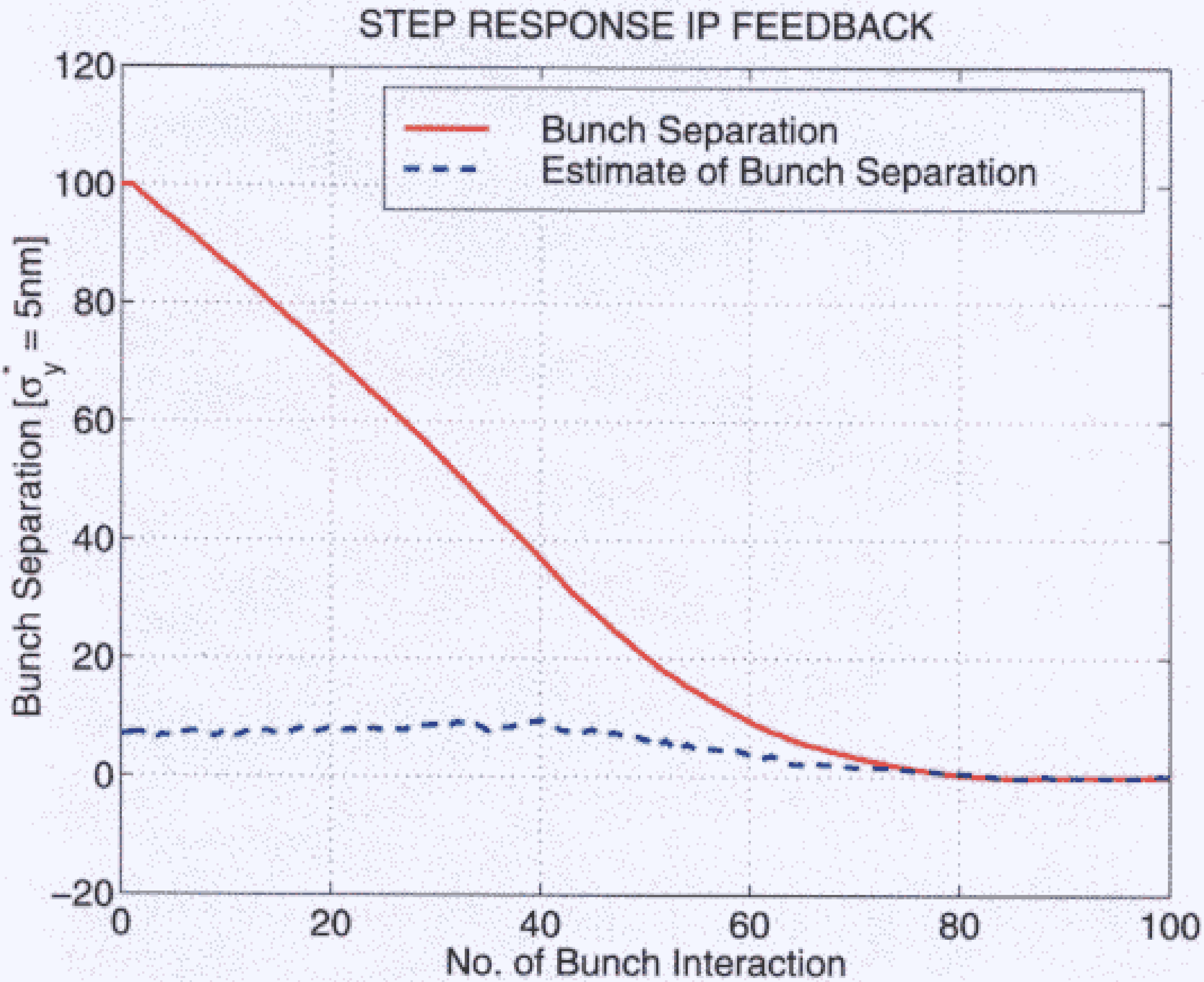
# Concept of the Intra-train feedback

Task:

- steer both beams into collision
- maintain collision within a fraction of the vertical beam size of 5 nm

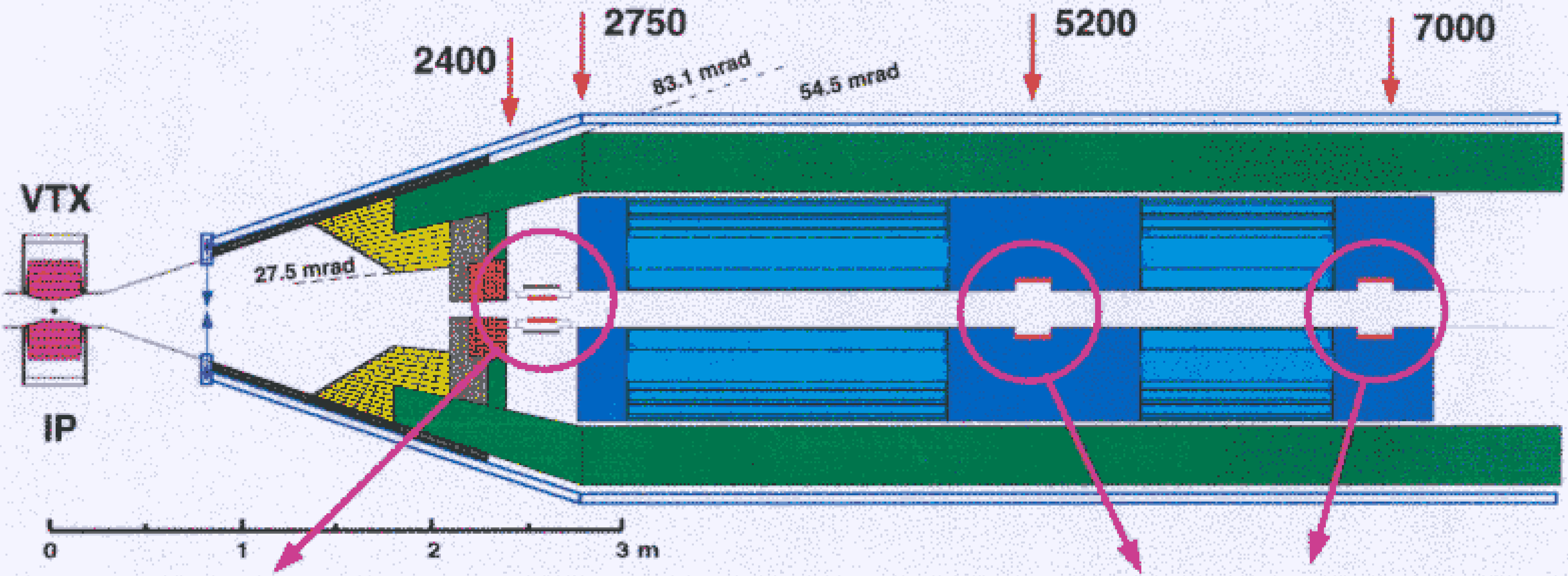



- use strong beam-beam deflection to detect nm beam separations
- correction from bunch to second bunch feasible



STEP RESPONSE IP FEEDBACK
Bunch Separation
Estimate of Bunch Separation
Bunch Separation [σ*y = 5nm]
No. of Bunch Interaction
120
100
80
60
40
20
0
−20
0
20
40
60
80
100

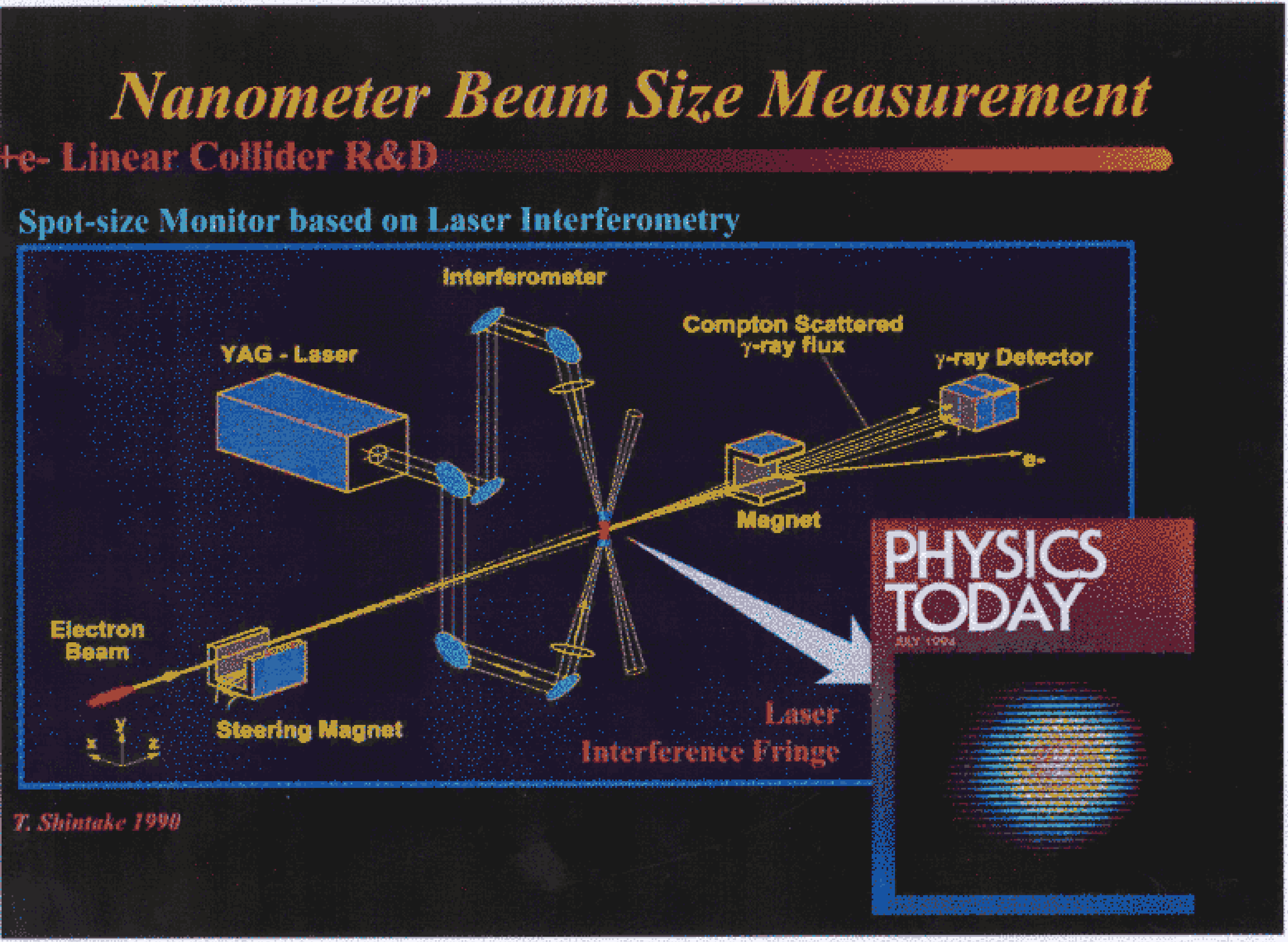
# Beam Position Monitors at the mask for feedback




- **need:** BPM resolution: < 5 um
  must resolve e+/e- bunches -> response < 20 ns
- **best solution:** stripline monitors
  **advantage:** strip lines are directive
  **but:** difficult to put them into the kryostat

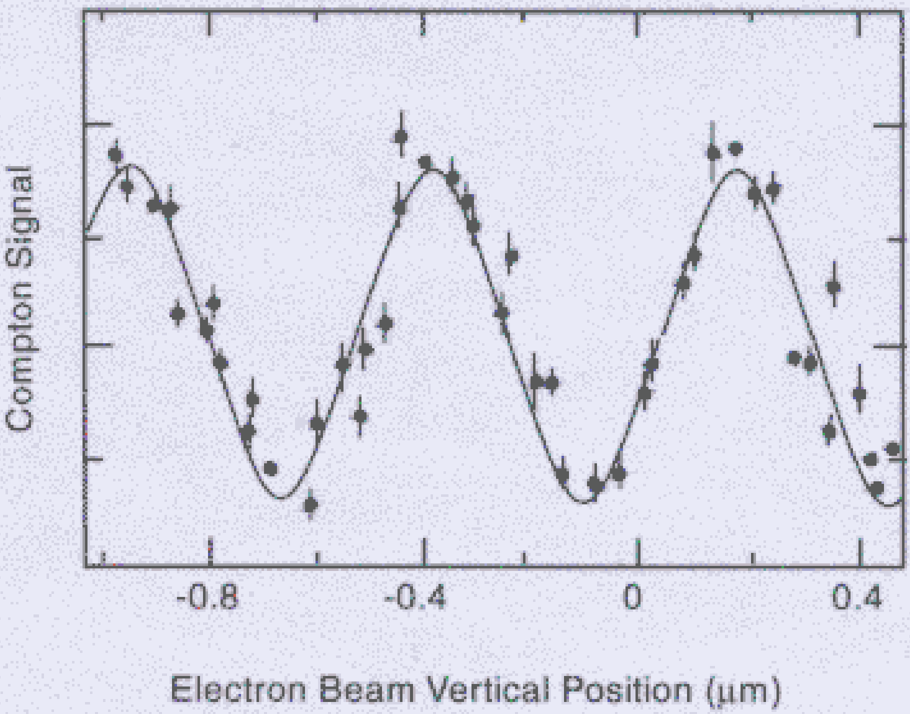
- 2 additional BPMs useful to determine the beam orbit
- reentrant cavity BPMs in the kryostat
- resolution < 5 um
- difficult to resolve e+/e-
  response < 30/50 ns

Tungsten Shield  Kryostat  Quadrupoles

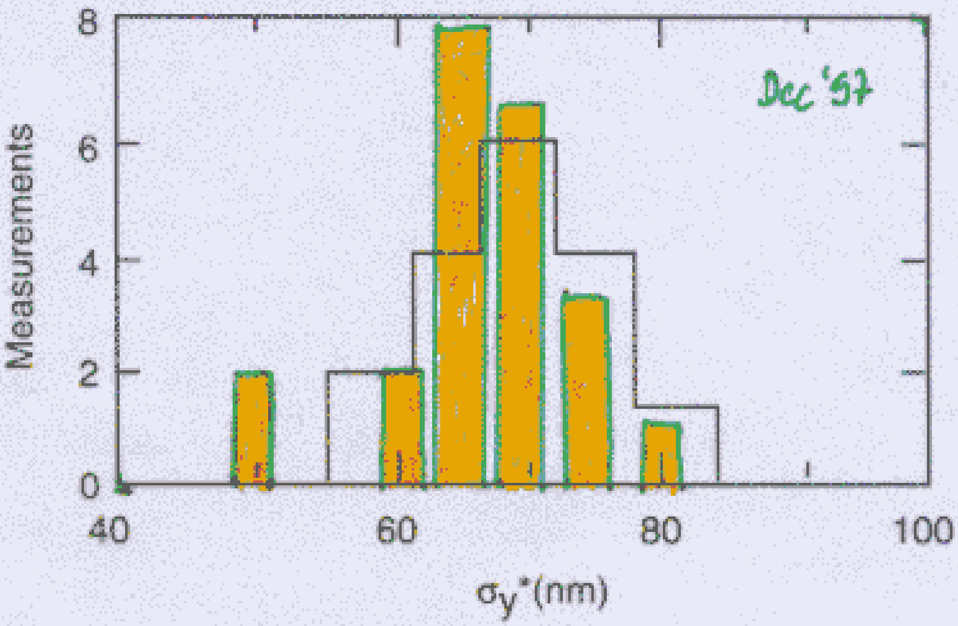

Nanometer Beam Size Measurement
+e- Linear Collider R&D
Spot-size Monitor based on Laser Interferometry
Interferometer
YAG - Laser
Compton Scattered
γ-ray flux
γ-ray Detector
e-
Magnet
Electron
Beam
Steering Magnet
Laser
Interference Fringe
PHYSICS
TODAY
T. Shintake 1990

# FFTB: Beam Size Measurement example

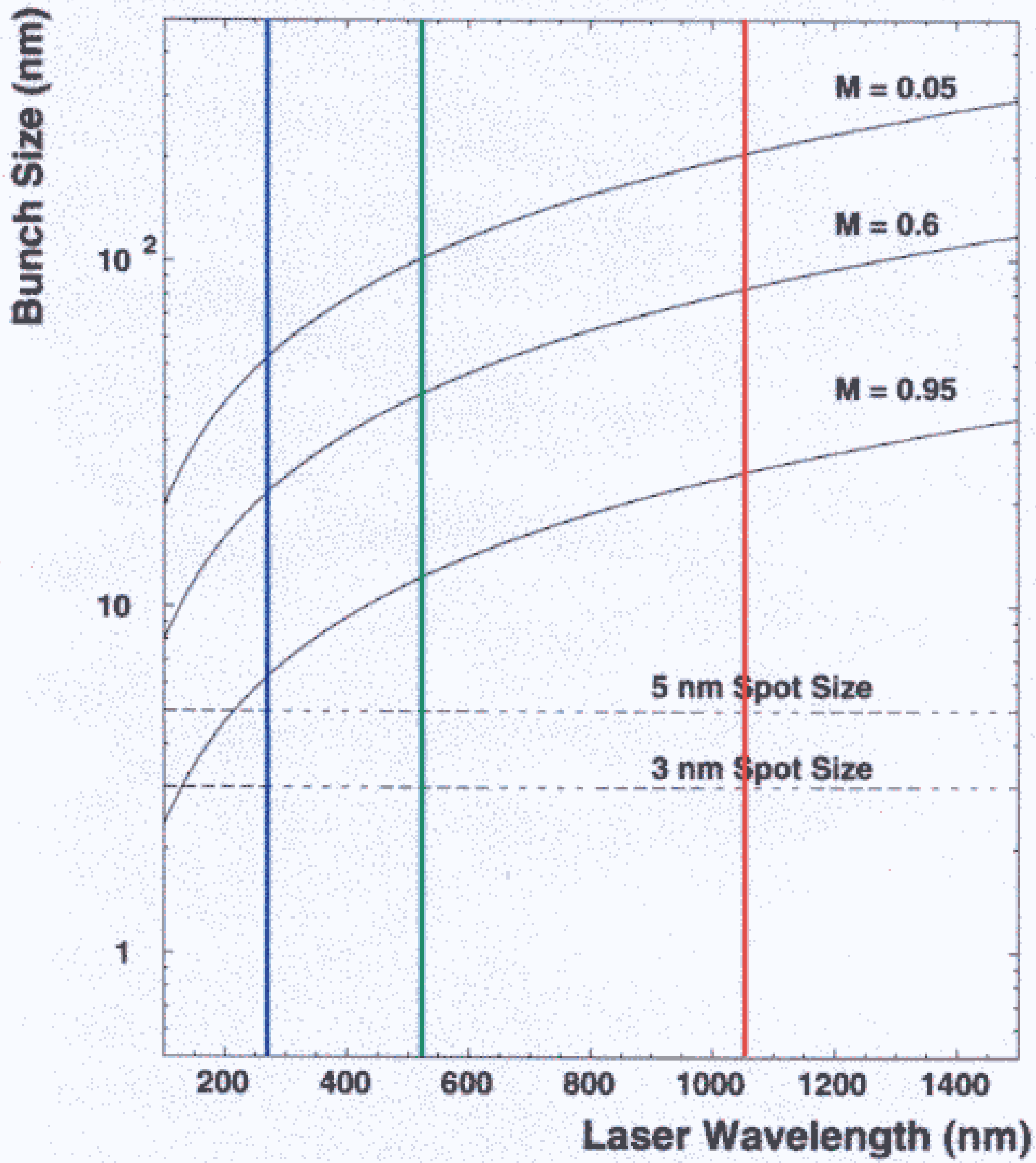
**Intensity Modulation from the Laser Beam Size Monitor for a spot size of 70 nm**




Measured beam size distribution (taken within 3 hours)

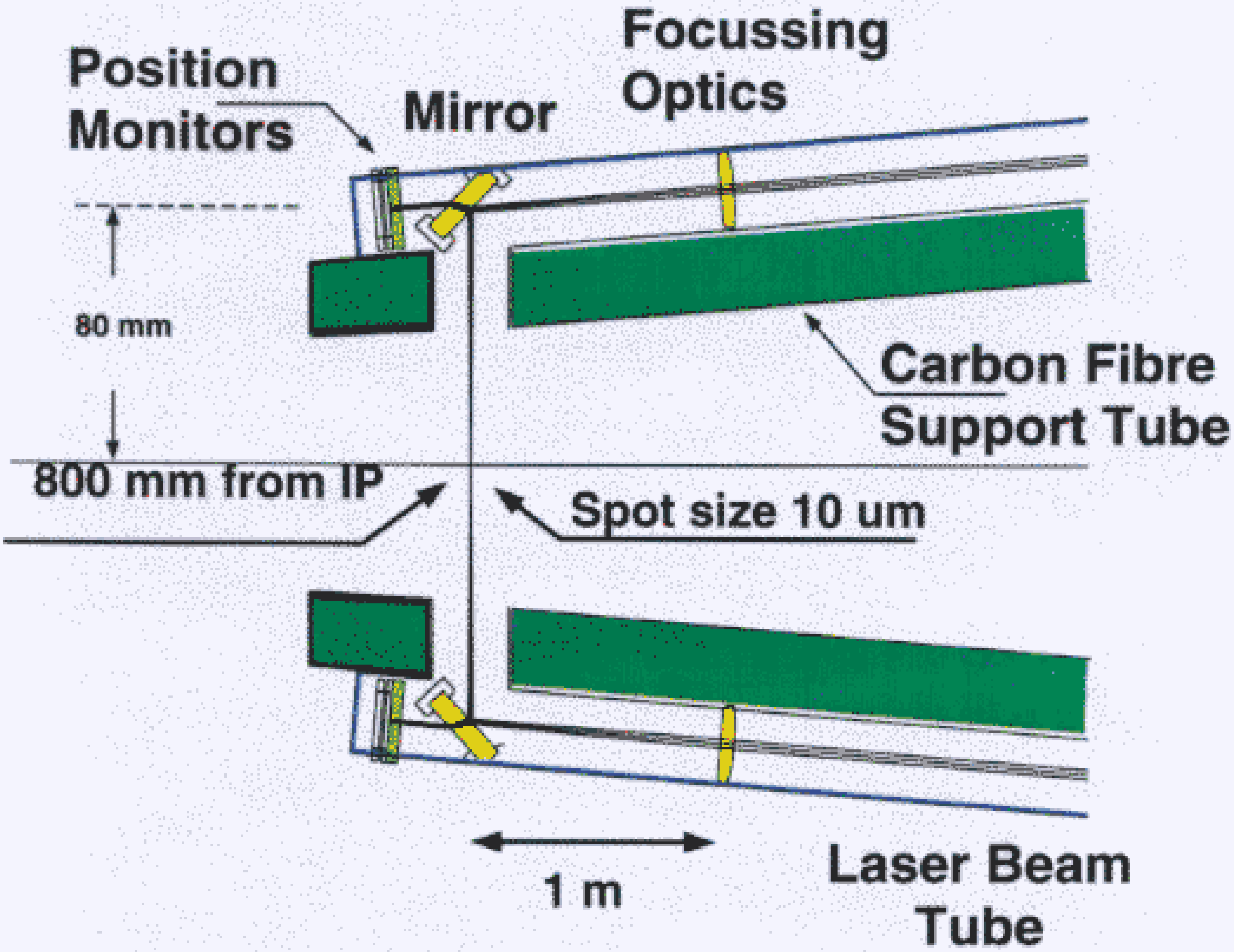


# Dynamic range of the laser interferometer BSM




Spot sizes below 10 nm are very difficult to measure with standard laser wavelengths

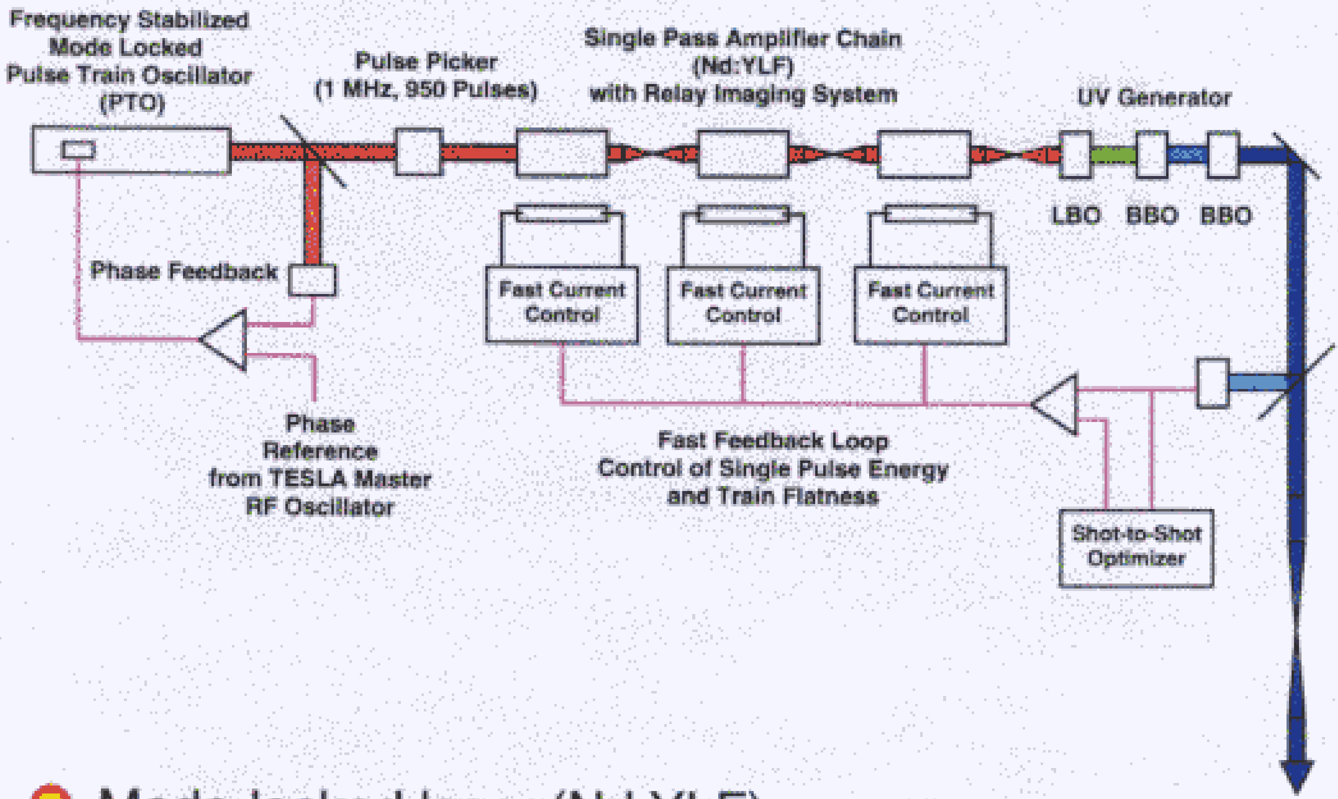
# Implementation of the Laser Beam Size Monitor into the Mask




- the laser beam line is in vacuum (HV to UHV)
- spot sizes on optical elements are small
  but still below damage thresholds (below 1 GW/cm2)
- control of position and timing with
  position sensitive devices and fast photo diodes
- last mirror is fixed
  correction of alignment from outside steerers

# Laser System for the Beam Size Monitor

- **Based on the running TTF Laser:**




- Mode-locked laser (Nd:YLF)
  in phase with the bunches
- allows a complete measurement within the train
- some 10 ps pulse length increases the peak power compared to ns YAG's
- Expected Compton rate for 1 MW laser power in the fifth harmonic about 2000 gamma's per pulse (10 um spot size, 10 ps length)
- Need good coherence and planar wave front:
  narrow bandwidth, adaptive mirror