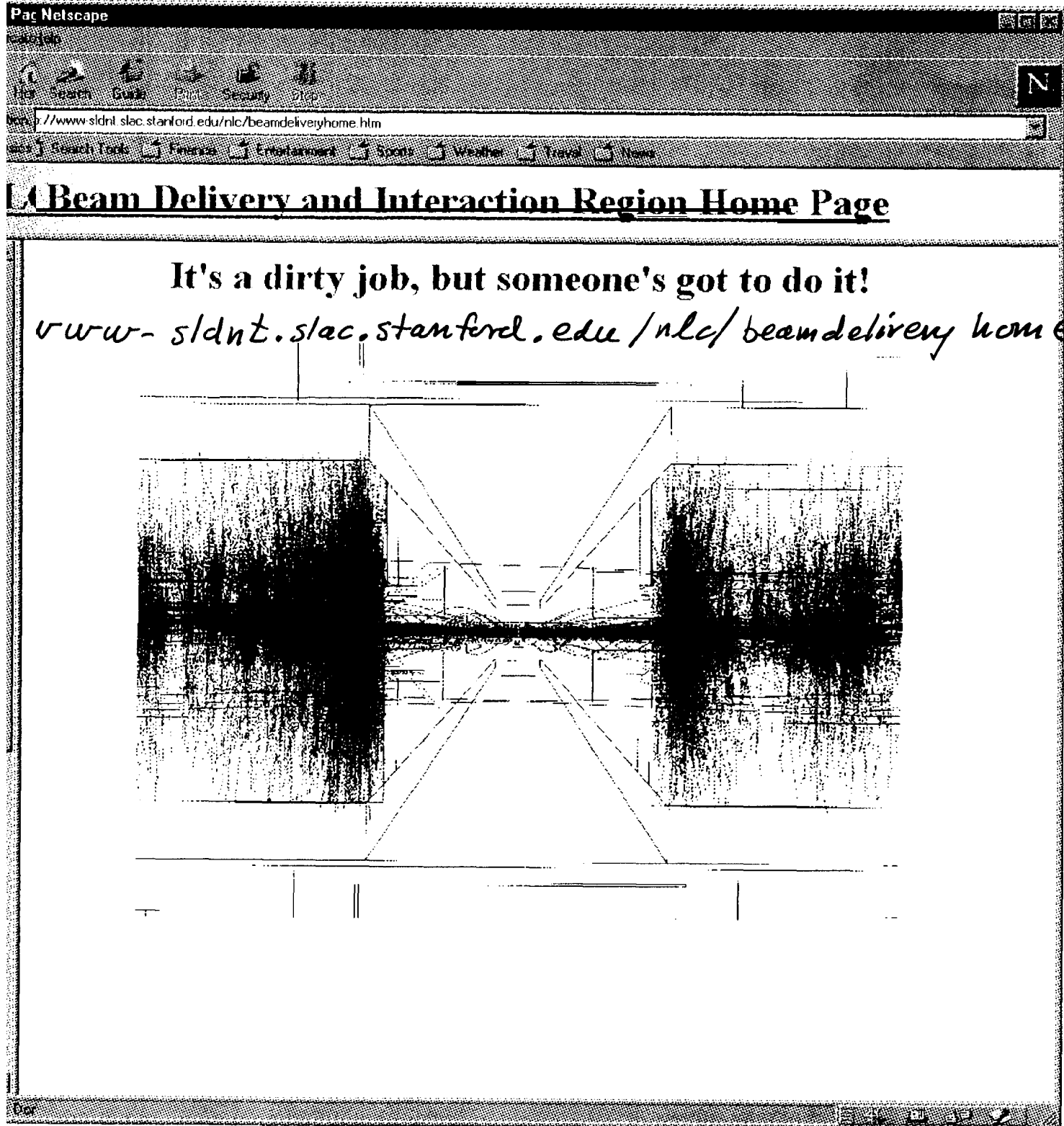


Report from Working Group on Interaction Region & Backgrounds

Speakers

** Tom Markiewicz
Tor Raubenheimer
Kathy Thompson
Tomomi Ohgaki
Takashi Maruyama
David Ciubaro
Tracy Usher
Mike Woods
David Miller
* Stan Hertzbach
Paul Lebrun

Stan Hertzbach
University of Massachusetts
Keystone CO
29 Sept. 98



Tom Markiewicz

Overview & topics not covered
in other presentations

- SLD/SLC experience $\Rightarrow$
 - Some backgrounds come from beam tails
 - cannot calculate tails from 1st principles
 - cannot ignore tails
- Collimation
- MUONS (from above)

(MANY more topics covered)

Collimation System

An experimental concern as it limits beam and SR backgrounds and produces muon backgrounds

- Currently very long ~2.5km
- Collimators cannot survive impact of one bunch train
- Poorly understood wakefields from collimators may be deleterious to beam
- Experiments planned for spring 1999 to test wakefields
- Active research effort on-going

Muons

- No new calculations since Snowmass

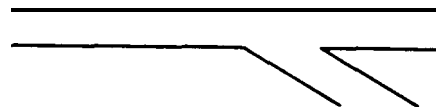
- Big Bend
- Long (~5 km) distance from collimators to IP
- Muon spoilers
- Easily achieve very conservative goal of 1 muon in 8x8 m² detector/train crossing

- Suggestions for future calculations:

- optimize spoiler geometry and location
- take into account radiation shielding apparently required in the collimation region to protect against ground water activation (assuming each collimator absorbs 1% of beam energy = 80 kW, ESH&H rule of thumb says will need 1' concrete and 1' steel around beam pipe)



- consider tunnel spurs to funnel muons away



- consider offset tunnel segments



Tor Raubenheimer

NLC Parameter Optimization

In going from 1.4 ns to 2.8 ns bunch spacing,
number of klystrons reduced by 25%.

500 GeV parameters now re-optimized.

- BUT can use 1.4 ns w/ same $\sigma_x^* \sigma_y^*$
and 1) decrease δ_B & loosen linac
alignment tolerance ($\sim 1/N$)
OR
2) increase L with lower E_{cm}
- Does the detector care about 1.4 vs 2.8 ns?
(retain 1.4 ns option?)
- Tor wants guidance on L spectrum. (L vs δ_B)
(Do we care about δ_B if L doubles?)
- Would like some standard processes to
optimize L spectrum; i.e., some weighting
function, s.t.

$$L_{\text{useful}} \sim \int f(\delta) L(\delta)$$

Kathy Thompson

Simulation of beam-beam interaction
with { Guinea Pig (Daniel Schulte)
 { CAIN (Yokoya, et al.) ← on web

- Good agreement between the 2 codes
for L , N_x , L_{spectrum}

(Some discussion of statistical errors in results;
unresolved ...)

- Can now generate backgrounds to
overlay physics events for studies
- More info on web.
- I think a logical next step is to provide
files of background particles coming
out of IR, normalized, say, to 1 bunch.

Tomomi Ohgaki

Hadronic Backgrounds from $\gamma\gamma$

{ JLC/NLC parameter set A
JLC-I detector ; $|\cos\theta| < 0.95$
Simulation with CAIN, PYTHIA 5.7, LUND

- Resulting minijet cross section larger than used by P. Chen.

- Calculation $\Rightarrow$ minijet events from beamstrahlung

	<u>500 GeV</u>	<u>1 TeV</u>
per bunch	0.032	0.11
per pulse	3.1	10.9

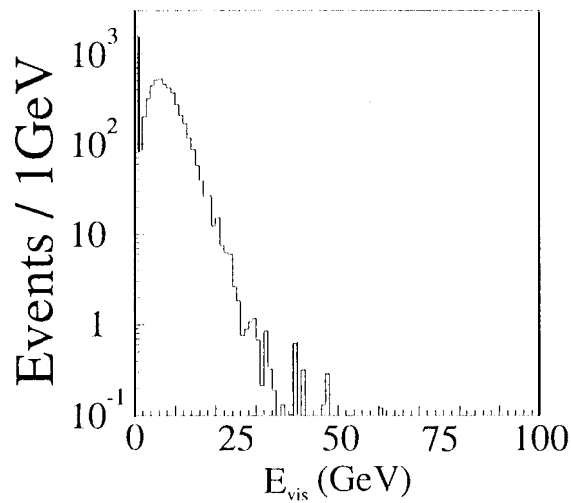
- With an average of 30 GeV/event in CAL this looks like a problem (300 GeV/train)

$\rightarrow$ Would require detector to resolve some fraction of a bunch train.

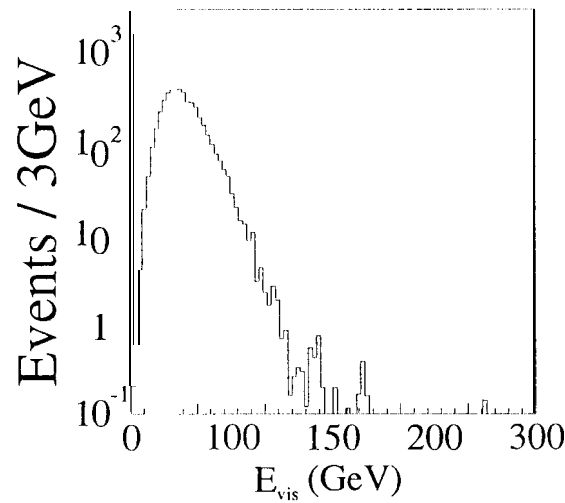
? My Questions: $\Rightarrow$

JLC/NLC 500 GeV A

Tracking Detector



Calorimeters

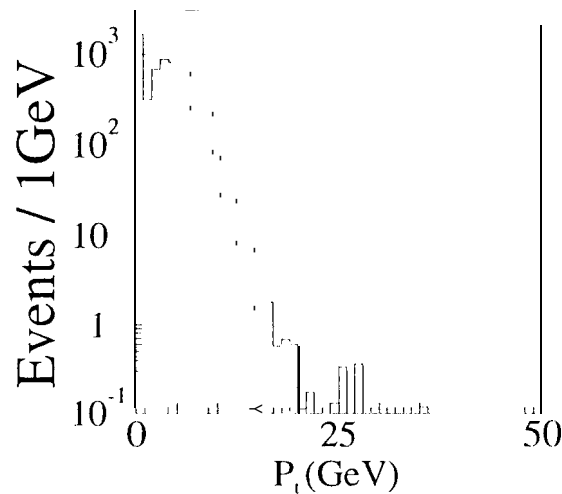


of track per event ~ 10
of cal per event ~ 30 (HD)

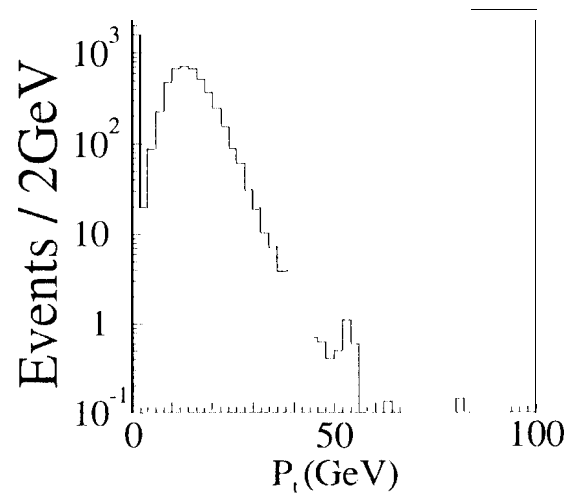
Average of E_{vis} & P_t

Track	Cal
E_{vis} 5.9 GeV	30 GeV
P_t 3.5 GeV	11 GeV
Ratio of No hitting event 24%	

Tracking Detector



Calorimeters



$$L_{e^+e^-} = 0.5 \text{ pb}^{-1}$$

$$\sqrt{s_{\text{coll}}} > 20 \text{ GeV}$$

? I have some questions about these results:

- I thought the mini jet problem was gone.
 - Is there a problem, or not?
 - Is there an unambiguous answer?
-

Notes added after the Keystone Workshop.

- Several points were made in the discussion

following this summary talk:

- ① The cross section is probably an overestimate.
- ② This calculation neglected the fact that much of the cross section is diffractive, with particles lost down the beam pipe.
- ③ The results presented should be considered a worst-case scenario.

- My conclusions are:

- Minijets are not as severe as presented here.
- The calculation should be repeated with a more realistic set of assumptions.

Final note: Hadronic & minijet backgrounds are discussed in the ECFR/DESY Study (Ch. 2), but conclusion unclear.

Takashi Maruyama

Background simulations at 1 TeV L.C.

- Since Snowmass 96 simulations moved from EGS to GEANT
 - improved low energy simulation
 - improved geometry
 - include details of magnetic fields, even p.m. quads
 - Comparison of beam-beam backgrounds
✓ using ABEL & Guinea Pig for sources.
 - Results for neutrons produced within 5 m of IP
 - Now looking at neutrons and other particles coming from dump.
- Question asked about effect of radiation on Sm-Co quads.

Neutron productions

- $e^{\pm}$ pairs from beam-beam interaction
 $\langle n \rangle = 494$ neutrons / bunch
- Sync. Radiation
 $\langle n \rangle = 90$ neutrons / bunch

Neutron hit density

$$\begin{aligned} &\sim 3 \times 10^{-3} \text{ hits/cm}^2/\text{train} \\ &\quad \times 120 \text{ pps} \times 3 \times 10^7 \text{ sec/year} \\ &= 1.1 \times 10^7 \text{ hits/cm}^2/\text{year} \end{aligned}$$

CCD limit: 3×10^9 hits/cm² (Damerell)

David Cinabro

CLEO experience with IR issues
↳ L.C.

- 0.1% X₀ Be beam pipe at $r = 1\text{ cm}$
for L.C.
- thin conductive coating sputtered on
inner surface of beam pipe
⇒ RF shield
- Remotely operated UHV flange
increases IR assembly options
- Simulation of wide angle beamstrahlung
⇒ might be a useful diagnostic
of beam problems

Conclusions

① Beryllium

CLEO has a 0.27% , 2cm radius pipe today. 0.17% , 1cm radius is feasible (Strength $\propto 1/r^4$)

Complex, thin Be structures are possible (time + money)

② Thin conductive coatings (5-10 μm) are in use today

$\Rightarrow$ RF shields.

③ Remotely closed UHV flange works $\Rightarrow$ Increased options in IR design.

④ Wide angle beamstrahlung a great beam diagnostic.

Tracy Usher

SLC/SLD experience with backgrounds
& successful model based on
"abnormal" low-energy beam tails.

- Model simulates sources of lost particles that create background.

AND

- Lattice modifications based on the simulation have reduced the background.

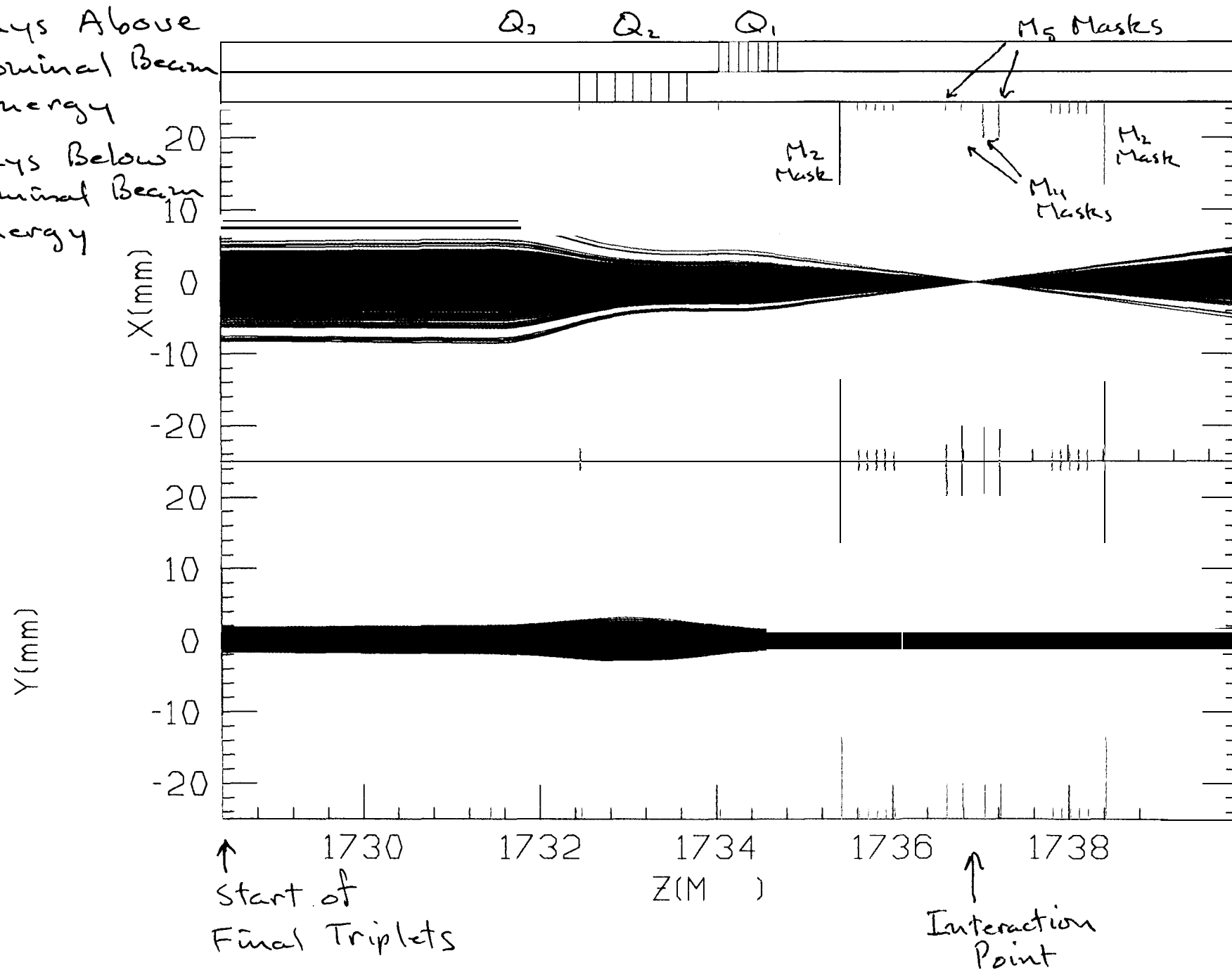
We cannot calculate the tails from the obvious suspects, but they seem to be present.

Build on this experience & look at L.C.

Ray Trajectories in Core of Beam (1st 200 rays)

North Final Focus: Standard Beam

- Rays Above Nominal Beam Energy
- Rays Below Nominal Beam Energy

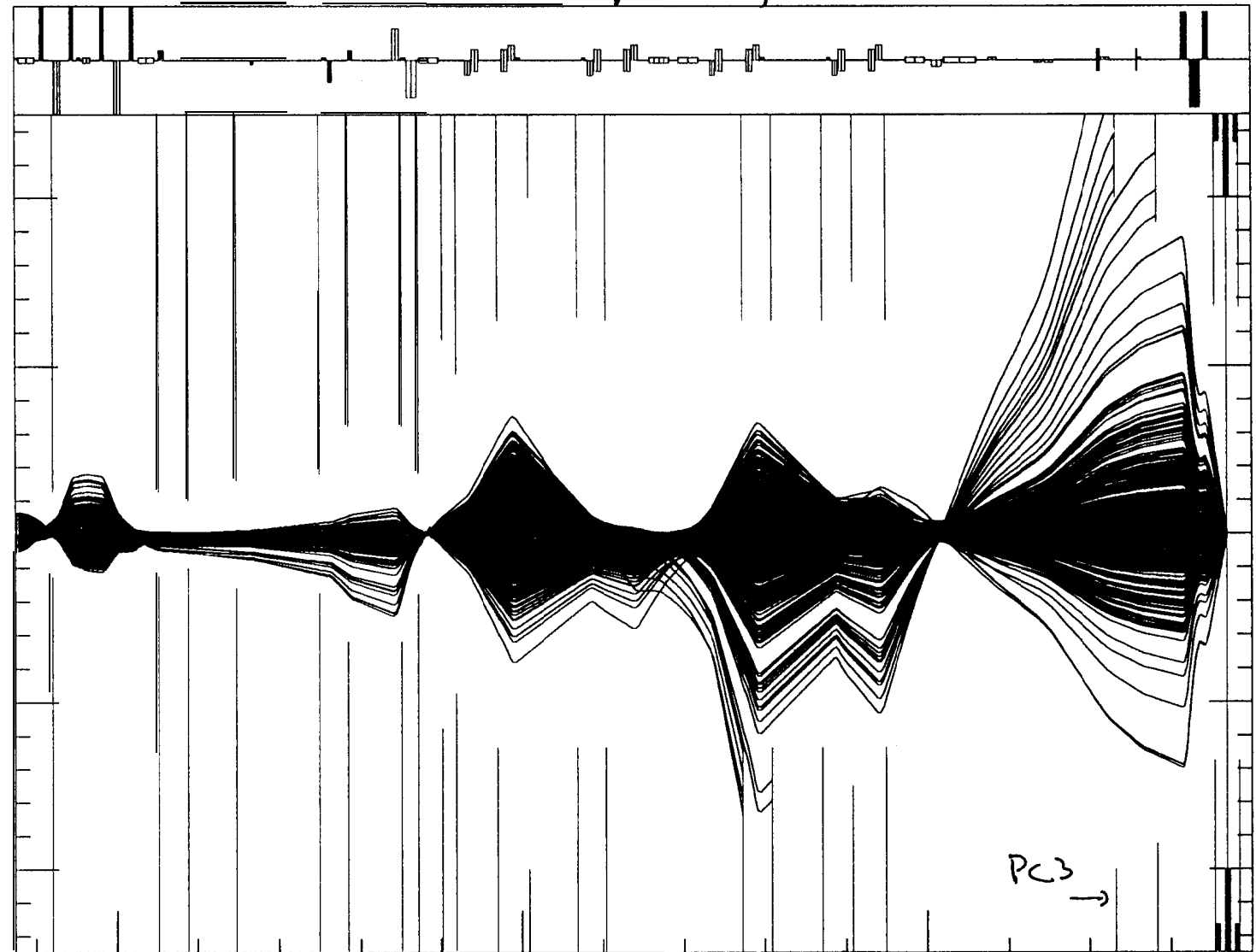


SLC Final Focus circa August 1997

NFF11
(x plane)

→ Standard ϵ
→ 1% energy spread

- Rays below nominal energy
- Rays Above nominal energy
X (mm)
First 400 rays tracked through
TURTLE-20



1600 1650 1700
Start of FF PC1 PC2 PC3 M1 Mask
Z (M)

For Raubenheimer

IR Choices (L^* , θ_c , B_s)
(2m 20mr 4T)

- L^* = 2m now

⇒ Some guads in detector & } vibration
others on bedrock } concerns

- If $L^* = 1m$, might be able to support
guads within detector

- If $L^* = 3m$, might support all guads
on bedrock

Optics looks good ; short & long L^* designs to come.

- θ_c - sees no major limitation.

Need verification of crab cavity.

- B_s - Depends on θ_c , but

6T at $\theta_c = 20mr$ and $L^* \leq 2m$

Should be no problem

Summary

L^* - looks like some gain from $L^* = 1m$. However, longer L^* might simplify quadrupole support problem - direct to bedrock.

Suggest two cases: long L^* with direct support and short L^* ($1 \sim 1.5m$) consistent with detector.

Θ_c - Need verification on crab cavity but do not see any major limitations - smaller is better but do not limit IR design because of crabbing.

B_s - Depends on above but 6T at $E_c = 20mr$ and $L^* \leq 2m$ should be no problem.
Add toroidal component??

Mike Woods

IR vibration issues

-
- FFTB vibration problem understood now.
 - Believes 40 nm vibration can easily be reduced to 15 nm

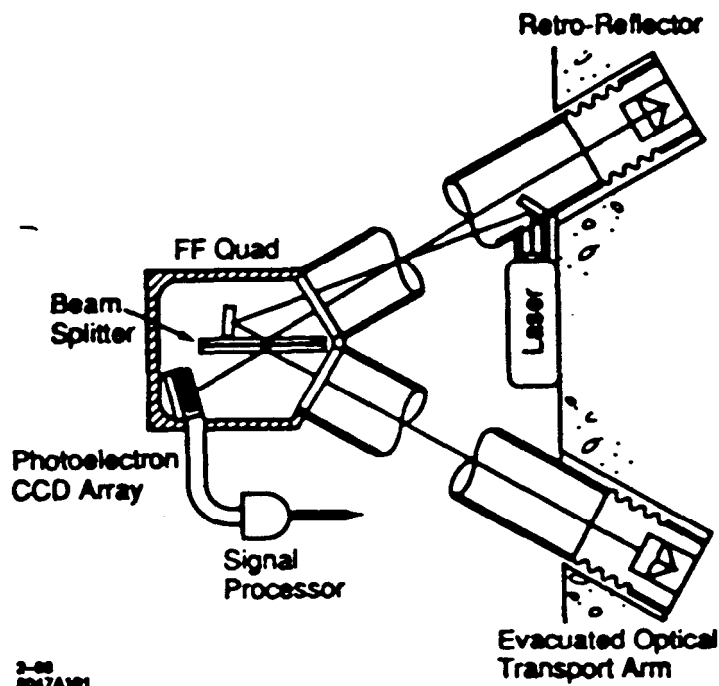
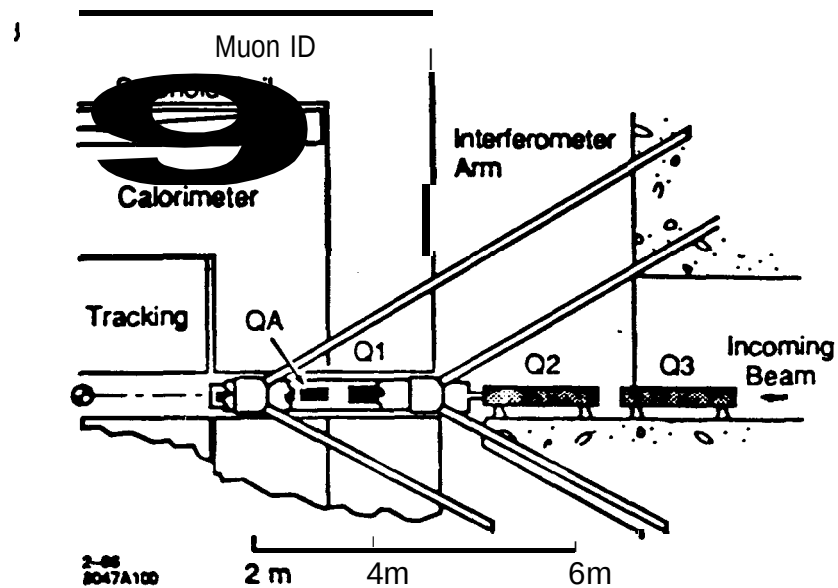
and that a 40 nm spot can be made.

- Would like another FFTB run to demonstrate
-

Optical Anchor research program (easier than LIGO)

- 1 m long interferometer arms stabilized to 1 nm rms with piezo movers
- 10 m long interferometer almost ready
- next step is to stabilize 100 kg "quad" mass
- FY00 goal is IR mockup with 1 nm stability of FF quads

Artist (G. Bowden)
 Conception of
 NLC Interaction Region
 with Optical Anchor



David Miller

Measuring $\mathcal{L}(\sqrt{s})$ using acollinearity
of Bhabha events ($\cos\theta \sim 100-450 \text{ mrad}$)

→ Want true spectrum for m_Z determination

- For threshold scans want small energy spread & low beam strahlung
⇒ Less than full $\mathcal{L}$ in scans
- want to measure acollinearity to 1 mrad ,
 $< 1 \text{ mrad}$ in forward dir.
- acollinearity $\Rightarrow \Delta p = p^+ - p^-$
 & signed Δp gives energy spread in each beam
- To do this, detector needs good e^+e^- tracking
 & calorimetry to $\sim 100 \text{ mrad}$ (or to mask)
- Based on old simulation; would like to see it updated.

Stan Hertzbach

SLC energy spectrometer &

what might one do at a L.C.?

- Overview of SLC spectrometer & systematics
- Similar device would work, want more suitable synchrotron radiation detector
- Could probably measure beams to 2×10^{-4}
 $\Rightarrow \sqrt{s}$ to $\sqrt{2} \times 10^{-4} \Rightarrow 50 \text{ MeV at } 350 \text{ GeV}$
- Seems OK for m_Z . Does any physics require better than $\frac{\Delta\sqrt{s}}{\sqrt{s}} = \sqrt{2} \times 10^{-4}$?

Paul Lebrun

Update on some aspects of the

Muon Collider IR. since Snowmass

Observations on some similarities
and differences
between e^+e^- and $\mu^+\mu^-$ IR.

Group discussion →

Beam line to the dump needs attention

This is where all the diagnostic instrumentation will live

- polarization
- energy
- energy spread
- radiative bhabha ctn,
- luminosity monitor

Will need simulation to design instrumentation & beam line

Instrumentation will dictate some of the beam line optics.

Think about Ton's question:

What $\mathcal{L}$ spectrum should he produce?
and what trade offs are OK?