Beam Dynamics and Simulation IR and Beam Delivery*

Working Groups Summaries

Fulvia Pilat*, BNL
Tom Mattison*, UBC
Tor Raubenheimer, SLAC
Ron Poling, U.of Minnesota

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IR/Beam Delivery WG

Accelerator Working Group: Beam Delivery & IR

Tuesday, July 15, 8:30-10:30 a.m.

8:30-8:55	Overview of IR & BDS issues	Tom Markiewicz
8:55-9:25	Collimation and Second IR for NLC	Andrei Seryi
9:25-9:45	Status and plans for linear colliders R&D in UK	Philip Burrows
9:45-10:10	The compact superconducting final focus doublet option	Brett Parker
10:10-10:30	Vibration and stabilization	Richard Partridge

Conveners: T. Mattison, F.Pilat

No time for real review→**selective/subjective summary**

"editorial" comments

IR designs are converging

projects **adopting**, or at least **considering**, ideas from other designs:

optics, crossing angle, super-conducting quads, vibration, collimation

Eternal questions remain (there are no solutions, only decisions……) → trade-offs:

- **machine luminosity - vertex detector radius**
- detector acceptance and access - machine components and supports

IR Issues (Markiewicz)

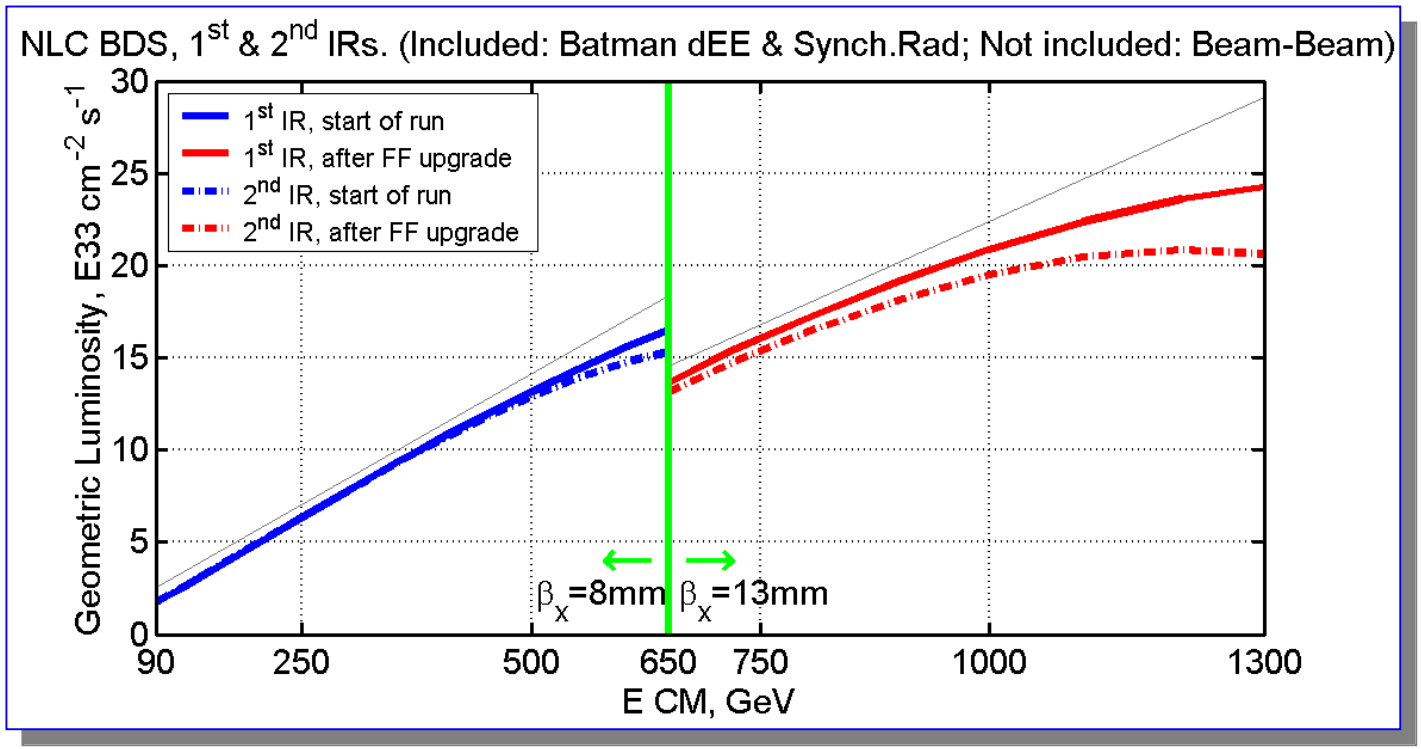
- Crossing Angle
  - Crab Cavities
  - Beam Extraction
- Physics & Detector
  - Beam Pipe Radius @ IP
  - Solenoid Field
  - Detector Access Model
  - Energy Flexibility
- **Backgrounds**
  - Detector Masking
  - Heat / Radiation
- **Final Doublet Support**
  - Support Tube
    - Cantilevered
    - Across IP
  - Vibration Control
    - Inertial Feedback
    - Optical Feedback
    - Feed-forward
  - Beam-Beam Feedback
    - Intra-train
    - 120 Hz
- Machine Diagnostics
  - Luminosity
  - Energy
  - Polarization

Second IR

Possible to achieve very comparable luminosity, over wide energy range

Design strategy: lengthen the 2nd IR BDS (several design iterations) – reduce SR $\delta\varepsilon/\varepsilon$ in the big bends

Seryi



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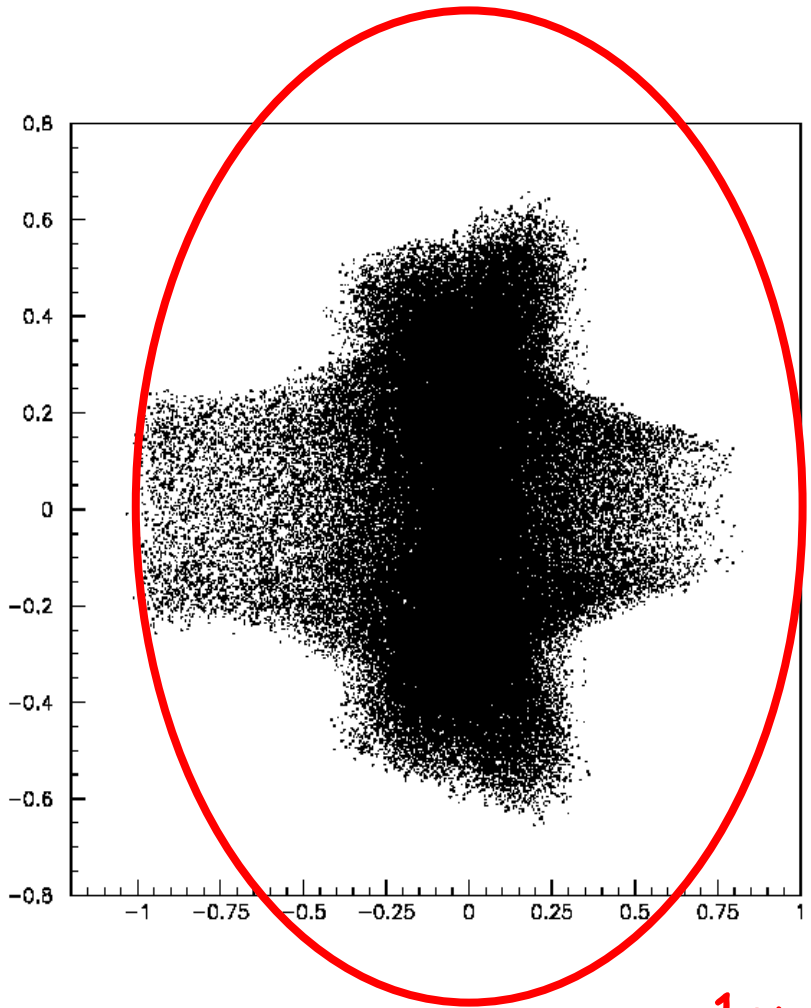
Backgrounds

control with:

- Large apertures
- beam collimators
- radiation shields
- muon spoilers

ILC-TRC: designs are an existence proof that solutions exist



Markiewicz Seryi

SR at IP from halo

X Y plot (cm)

1cm Beampipe

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Vibrations/stabilization

Vibrations of final quads (Markiewicz, Partridge, Burrows)

- **Feedback using beam-beam deflection + steering**
  everyone uses it for **slow drifts** (many seconds)
  TESLA can do it **bunch by bunch**
  tests of **nanosecond bunch feedback at NLCTA**
- **Quad position measurement and control feedback**
  SLAC: 6-axis feedback of block on springs with accels + electrostatic
  quad and support mockup feedback project
  specialized accelerometer R&D
- **Rigid support tube across IP**
  KEK comparing finite-element calcs to simple cantilever & span geometries
  building 1/10 scale support tube prototype

Quad&support mockup FBK

Partridge

Compact SC FF doublet

Parker

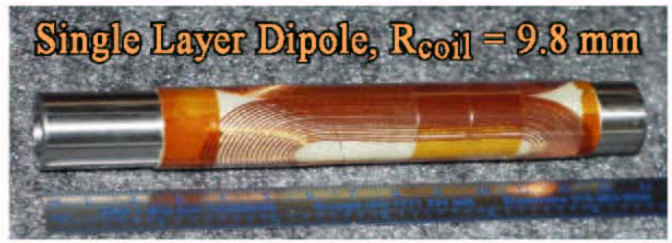
Planned: warm field quality measurements, cold quench tests

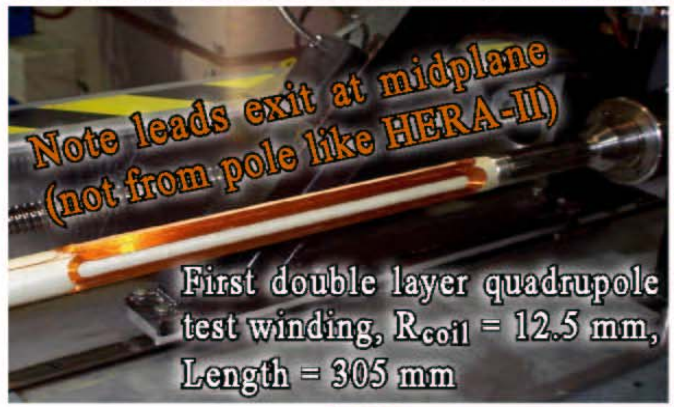
BNL LDRD Accomplishments & Areas of Ongoing Development

BROOKHAVEN NATIONAL LABORATORY
Superconducting Magnet Division
NLC - The Next Linear Collider Project

First made small diameter single-layer (HERA-II) coils with desired features. Then went on to short double-layer windings.

Next wound 1m coils (see above) & found stylus pressure bows tube. Now making 2m coils with mid-point support (right).





SC FF doublet stabilization

Parker

From RHIC BPM data (triplet cryo vibration):
~200 nm (horizontal)
~0 nm (vertical)

First Superconducting Magnet Vibrations Studies at BNL Magcool

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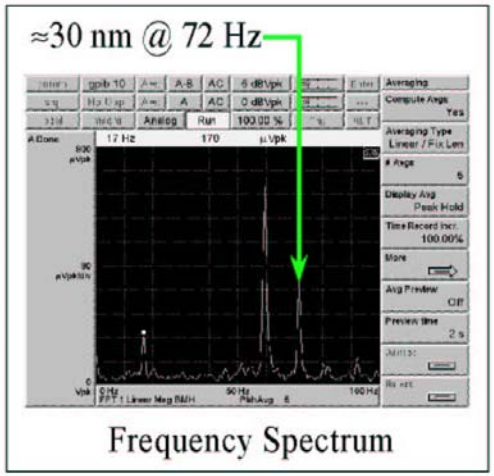
NLC - The Next Linear Collider Project



Frequency Spectrum

- Some equipment is now available (see photos).
- Thinking about how to do cold measurements.
- But still just getting started.

- Plans for measurements on cryostats and then cold masses
- Vigorous R&D on vibration and stabilization of SC magnets necessary, needs:

RESOURCES ($)
COLLABORATION

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LC Program in UK (Burrows)

Accelerator Science & Technology Centre established in 2000

$4M seed money for **FY00-03** from PPARC + UK labs for ASTeC + universities

8 accel-related projects, 18 FTEs incl 6 students in collab with offshore labs

no time to summarize them

$14M for **FY04-05**, perhaps $17M for FY04-06, for accelerator science, **"bulk" for LC**

PPARC LC steering group: focus on **beam delivery and machine-detector interface**

Goal is to ramp up to ~10% UK contribution to LC project

(Phil says the Queen has still to sign though….☺)

Simulation/Dynamics WG

Accelerator Working Group: Beam Dynamics and Accelerator Simulation I

Sunday, July 13, 1:00-3:00 p.m.

1:00-1:20	UCLC Progress Report: Accelerator Physics Research at NIU, July, 2002 - July, 2003	Court Bohn
1:20-1:40	UCLC Progress Report: Beam Simulation (ppt pdf)	David Rubin
1:40-2:20	Reliability and Operations Modeling of a Linear Collider (ppt pdf)	Tom Himel
2:20-3:00	Emittance Tuning: Details, Details,... (ppt pdf)	Peter Tenenbaum

Accelerator Working Group: Beam Dynamics and Accelerator Simulation II

Tuesday, July 15, 10:55 a.m. -12:55 p.m.

10:55-11:15	LCRD Progress Report: Low-Emittance Electron Beams for Wakefield Measurements (ppt pdf)	John Power
11:15-11:35	UCLC Progress Report: Update on the Usability of Spent Beams for Physics Experiments at the Linear Collider	Sekazi Mtingwa
11:35-12:15	Simulation of Damping Ring Issues	Andy Wolski
12:15-12:55	Simulation Techniques	Andrei Seryi

Conveners: Raubenheimer, Poling

LC simulations/dynamics

- **Object**

Performance_→ peak luminosity (PT, Seryi)

Reliability → integrated luminosity (Himel)

- **Level of detail**

More physics (Wolski: wiggler in DR, Bohn: space charge)

Integration (Seryi: DR-to-IP, 2 beams, GM BB FBK..→luminosity)

- **Validation**

'building blocks' (Seryi→ collimator wake measurements vs.model)

X-checks, benchmarking of different codes (Seryi, ILC-TRC)

- **Widening LC dynamics/simulation community**

LC simulation environment setup (Rubin – Cornell, UK, BNL….)

Simulation results database (Burrows)

Reliability simulation (Himel)

Preliminary results: cold machine

% time down	access per month	# tun-nels	energy over-head	MTBF fudge	special conditions
25.3	2.9	2	2%	1	← Double tunnel
45.4	14.1	1	2%	1	
39.6	12.1	1	4%	1	
36.9	10.1	1	2%	10	← Increase MTBF
26.8	6.4	1	4%	10	
27.0	6.1	1	4%	10	← different seed
13.6	3.4	2	2%	1	← Decrease tuning time
24.7	2.9	2	2%	1	
19.8	3.3	2	2%	1	
15.6	2.3	2	4%	10	

- Write a simulation that given the **MTBFs**, **MTTRs**, components **access requirements** for repair can calculate **availability** & **integrated luminosity**
- Collect component data in existing machines for guidance
- **Iterate** as many times as we have time to **minimize the overall cost** of the LC while maintaining the goal availability

Different methodology (Tesla):

FMEA (Failure Mode Effect Analysis)

→ identify **critical components**

- ❑ Interesting for existing machines
- ❑ Potential for assessing machine availability during commissioning phase

The devil is in the details (PT)

- Emittance growth from DFS – Tesla
- Effect of jitter in NLC DFS
- Emittance growth in NLC bypass line…..

❑ **necessary to include details**:

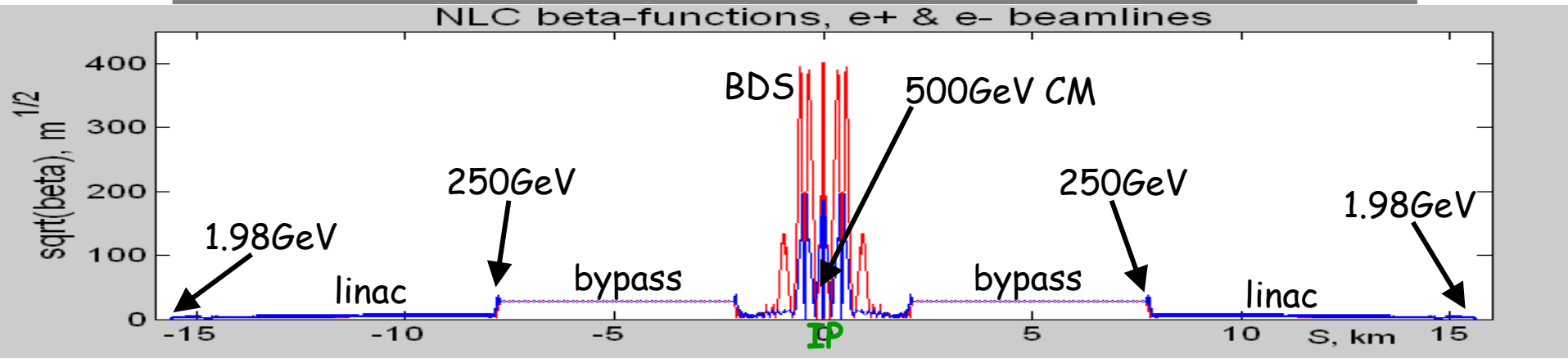
jitters, drifts, RF trips and deflections and especially interaction with **feedback loops**

❑ Tuning simulation on **signals that will be available in control room**

→ Will be necessary to carefully develop a **commissioning strategy**

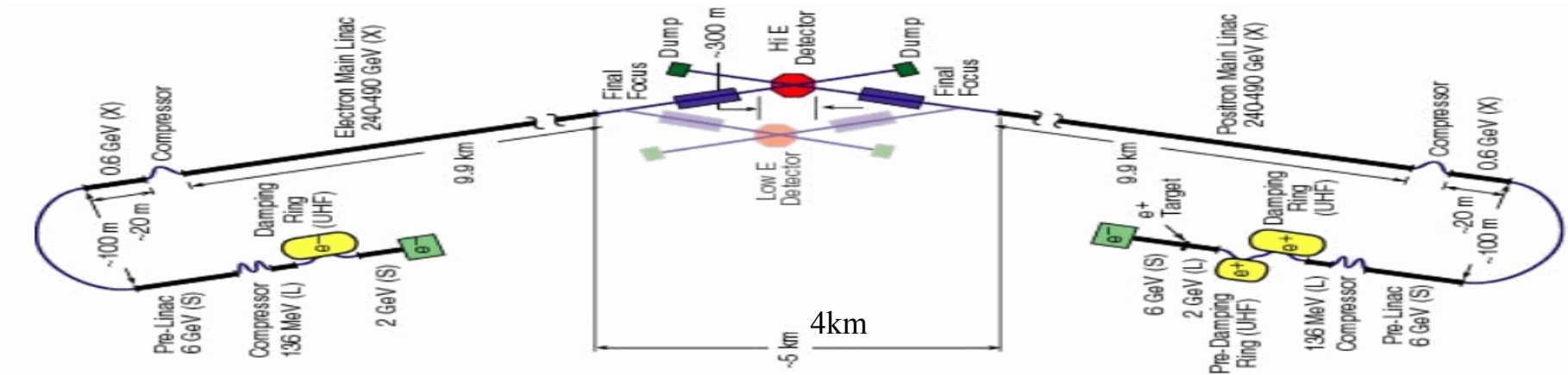
DR => IP <= DR
integrated simulation tools

ILC-TRC



DIMAD – in Bunch Compressor and Beam Delivery System (high order optics, accurate particle tracking)
LIAR – in Linac (wakes, fast tracking of macroparticles)
GUINEAPIG – beam-beam collisions at IP
PLACET or MERLIN – in either BC, Linac or BDS

} MATLAB driven



Virtual NLC ?

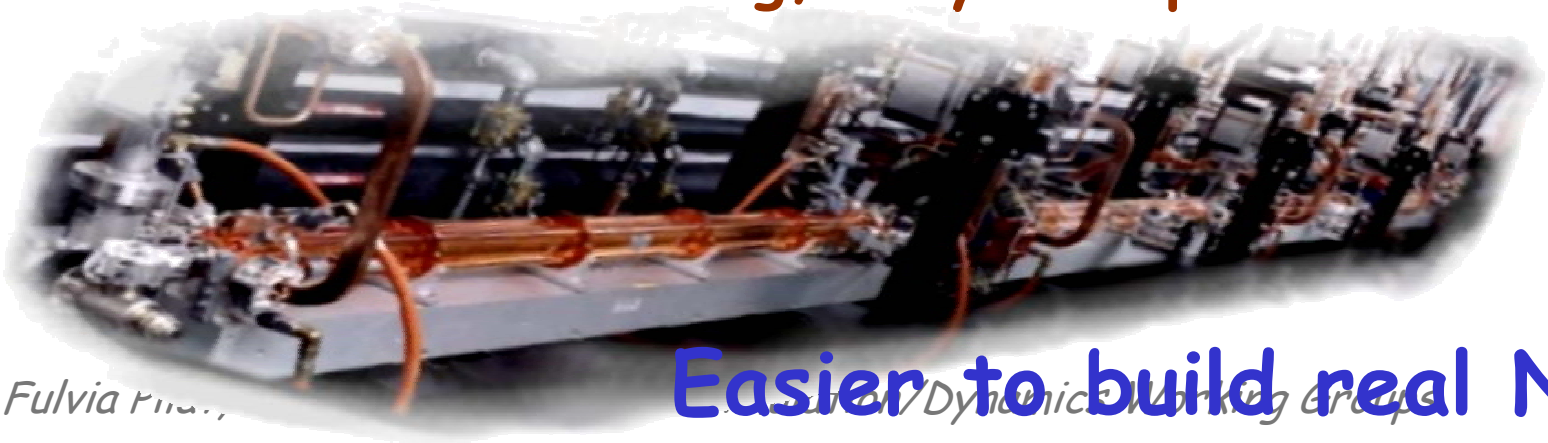
1 bunch, 500 pulses takes 10 hours on 2GHz PC

(and this is with quite limited physics included)

Real time calculations (120Hz, 192 bunch/train) will require:

300000 of 11.4GHz ideally parallel processors

If each of them is 1cm long, they will span over 3km



Easier to build real NLC

Conclusion(s)

It's a long way to go but the road is getting paved….