Accelerator Physics Department: The first 6 month (Oct’05 - Apr’06)

"The Accelerator Physics Department is created to support the increasing activities involving future machines and activities at Fermilab. It will also support the operating program including Run II and the neutrino program. In addition, there will be some R&D activities in the Accelerator Physics Department."

Roger Dixon

Head, Accelerator Division, 4/10/05

Areas of Research

Currently, the APD scientists and engineers carry out experimental and theoretical research in five areas :

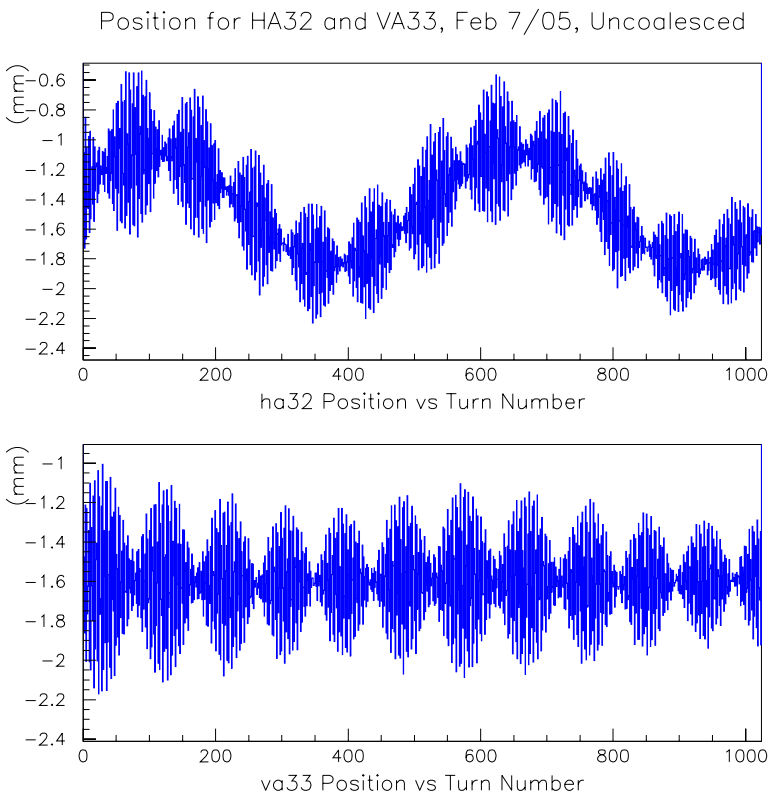
- **Accelerator Physics for the Tevatron Collider Run II**
  Beam-Beam Compensation project, beam-beam studies and simulations, beam optics measurements and optimizations for the Tevatron and other machines, instabilities studies, theory and simulations for Tevatron, Booster and Main Injector.
- **International Linear Collider R&D**
  Main Linac design, ground motion and vibration studies, SC RF R&D, design and construction of the FNAL ILC test facility, photo-injector development.
- **SuperNuMI and High Intensity Neutrino Source R&D**
  High-power SC RF power generation, modulators, phase control, beamline design, electron cloud and resistive wall instability studies in the Main Injector, particle tracking code development for SC proton linacs and conventional facilities design.
- **US-LHC Accelerator Research Program**
  Focused on development of instrumentation for LHC. Participation in beam commissioning, LHC upgrade optics design and advanced accelerator R&D for LHC-like wire beam-beam compensation.
- **Energy Deposition**
  The Energy Deposition group provides its expertise to all four tasks listed above; in addition, it develops parallel processor capabilities for advanced scientific simulations.
- *Total on APR payroll – 25 (as of 04/18/2006)*

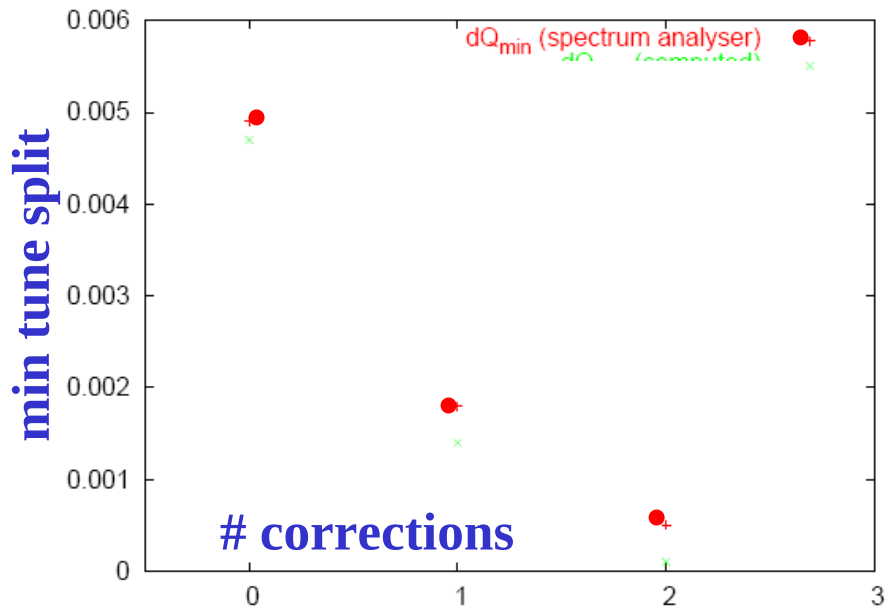
Run II Accelerator Physics Group

- *Major Accomplishments:*
  - *Decoupling application in oper's (EW/YA)*
  - *New helix for after shutdown (YA)*
  - *Beam studies and sextupoles for new WP (YA/AV/EW)*
  - *Good results with TEL SEFT gun (BBC)*
  - *TEL-2 installed, TEL-1 being repaired (VK/GK/VS)*
- *Next steps:*
  - *Commission new helix (YA)*
  - *Beam studies at new WP (YA/EW)*
  - *Beam commissioning TEL2 (BBC)*
  - *Beam studies with TEL-1 and -2 (BBC)*
  - *Muon Cooling simulations and participation in design of 6D-Cool experiment*

Tev TBT De-Coupling Application

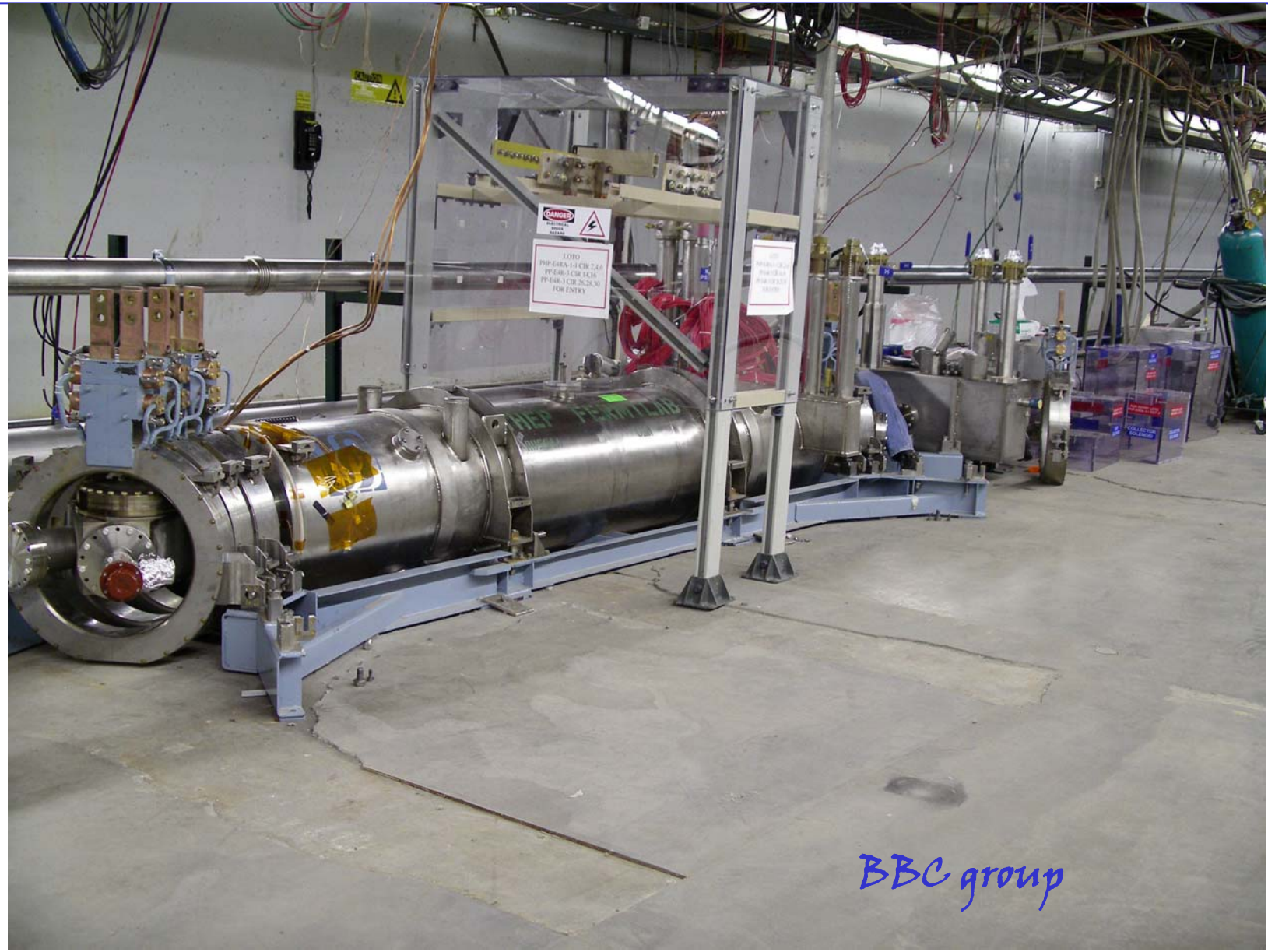
- Calculating all optics functions and coupling correction using TBT data from many BPMs





E.Gianfelice-Wendt
Yu.Alexahin

TEL-2 in the Tevatron @ A0



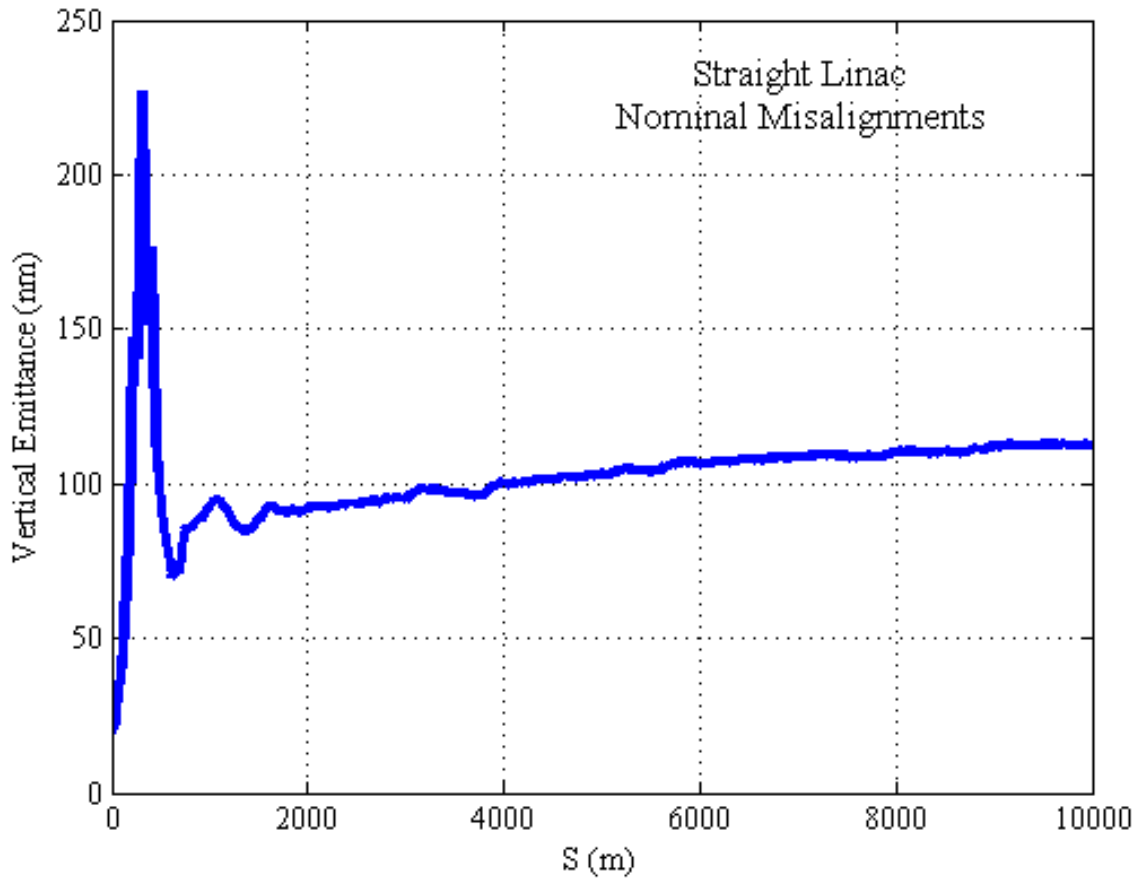
Assembly of TEL-2 Collector

ILC R&D

- *Accomplishments:*
  - *dEmittance in Linac simulations (AV)*
  - *LLRF phase tolerances for BC and Linac (MC)*
  - *CHEF for ILC, 1st try (FO)*
  - *LIAR modification for ILC (FO)*
  - *Cavity testing/conditioning for ILCTA (CYT, JS)*
  - *Test facilities Workshop (MC)*
  - *HERA-e for ILC DR optics (EW)*
- *Next Steps:*
  - *dEmittance in Linac simulations (AV)*
  - *Ground motion studies in deep tunnels (JV)*
  - *Vibrations in cryostat (JV)*
  - *Take part in New Muon test experiment design*
  - *DR in Tev tunnel considerations*

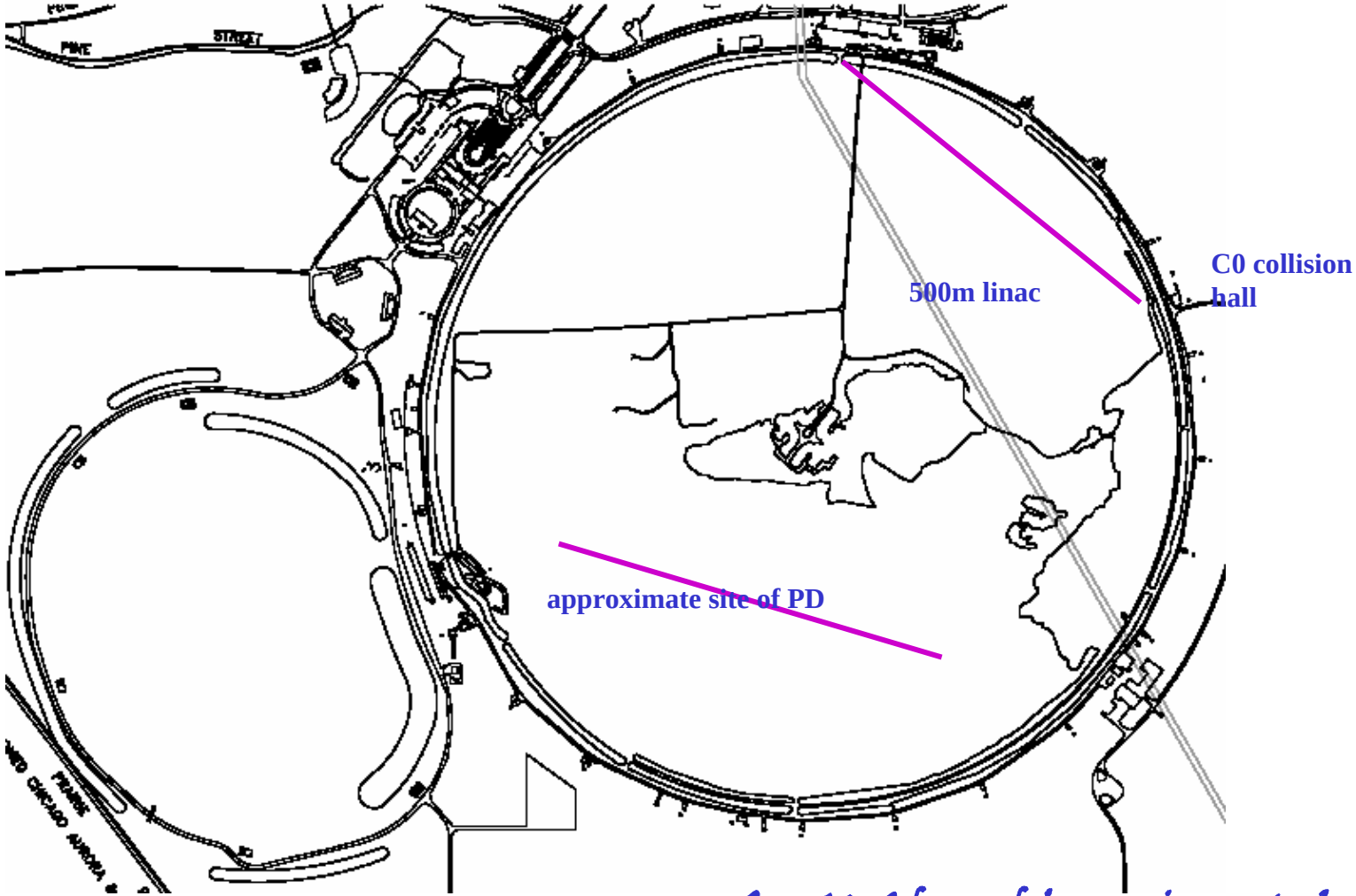
Emittance Evolution in the ILC Main Linac

- Lattice is "BCD" with 1 Quadrupole per 4 Cryo Modules. Length of a FODO cell is 86 m. Number of cells is 114
- Initial Beam Energy is 15 GeV, final 250 GeV
- Initial Vertical Normalized Emittance is 20 nm*rad
- The plot shows that large emittance growth occurs in th first 10 FODO cells (~1 km length), even with all steering algorithms applied (both 1-1 steering and Dispersion Free steering applied).



A.Valishev
F.0Stiguy

500m Linac Inside Tevatron Ring: TF=5GeV SC RF Linac + 5 GeV ILC DR



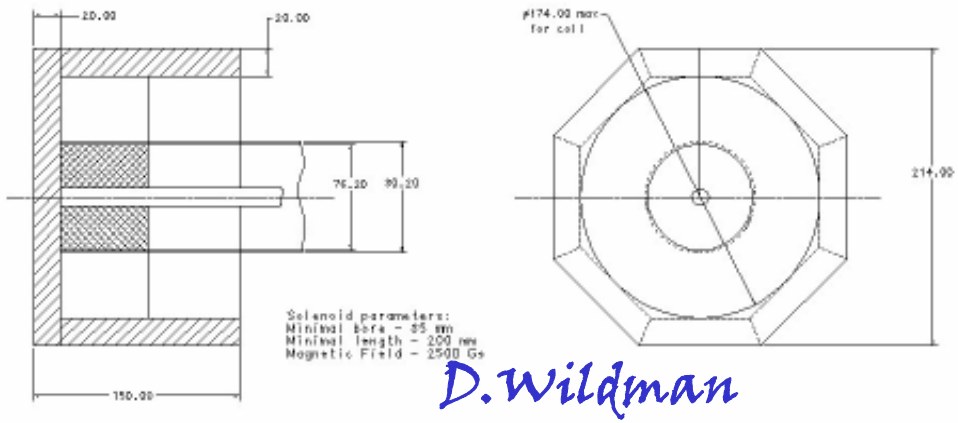
See M.Church's seminar today

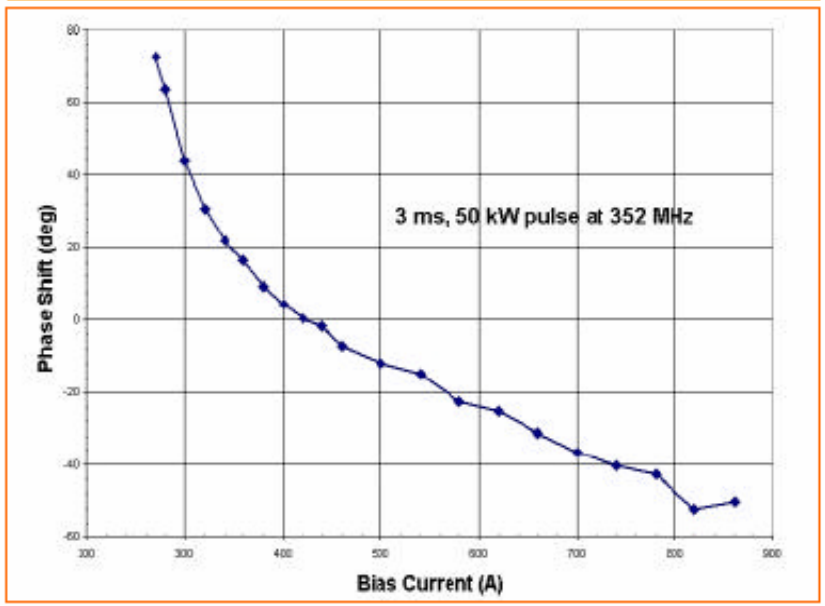
High Intensity Neutrino Source

- *Formerly known as "Proton Driver"*
- *Now refocused toward SuperNuMI (0.7-1MW beam power on target with help of Recycler and Accumulator) and HINS (SC Linac base facility)*
- *Accomplishments :*
  - *80MW test of ferrite phase shifters for the PD RF (DW)*
  - *Progress on design of H- transport lines (DJ)*
  - *ASTRA runs on a CD 50-PC farm for H- and e- (JPC)*
  - *Civil construction for 5(8) GeV SC Linac (DB)*
  - *Planning of PD R&D at Meson (RW)*
  - *Studies/efforts on MI/RR e-cloud/detectors (RZ)*
  - *Operational support for MI and RR*
  - *Technical support for MI BPM project (RW)*

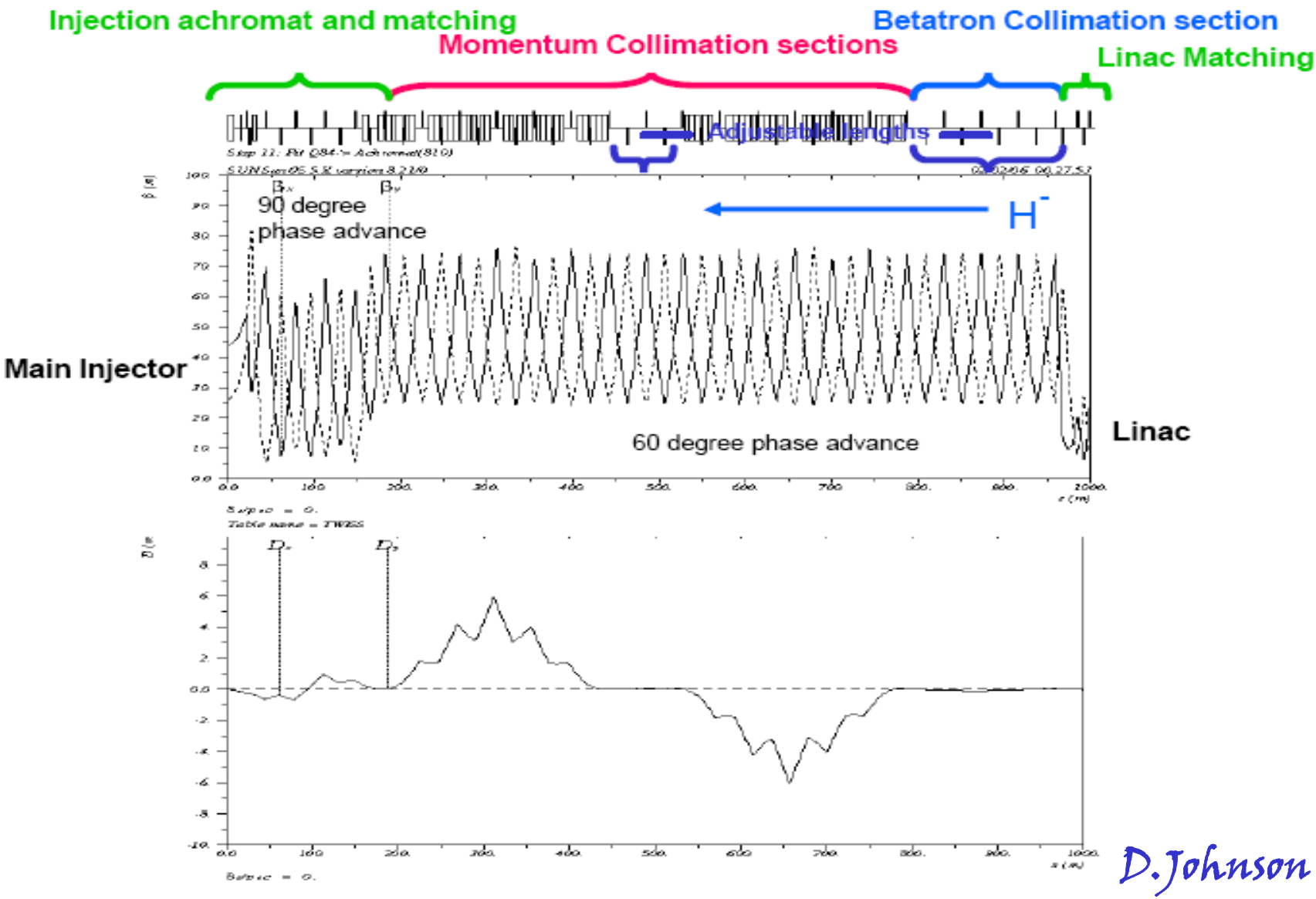
Dave Wildman's Coaxial Phase Shifter

- Coax design is preferred at 325MHz
- In-house design tested to 660kW at 1300 MHz
- Tested at 300 kW at Argonne with APS 352MHz Klystron
- Fast coil and flux return should respond in ~50us



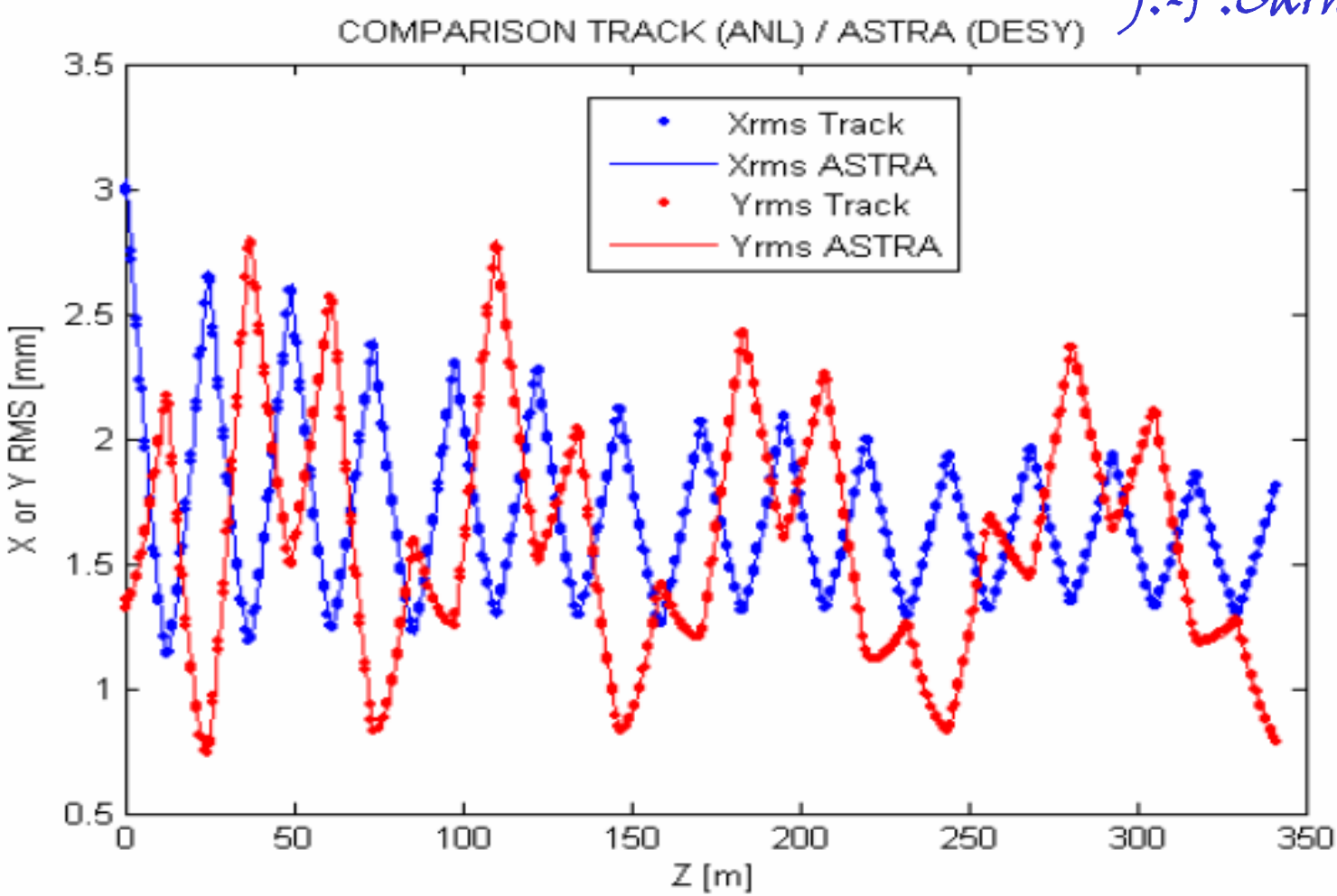


Revised H- Transport Line



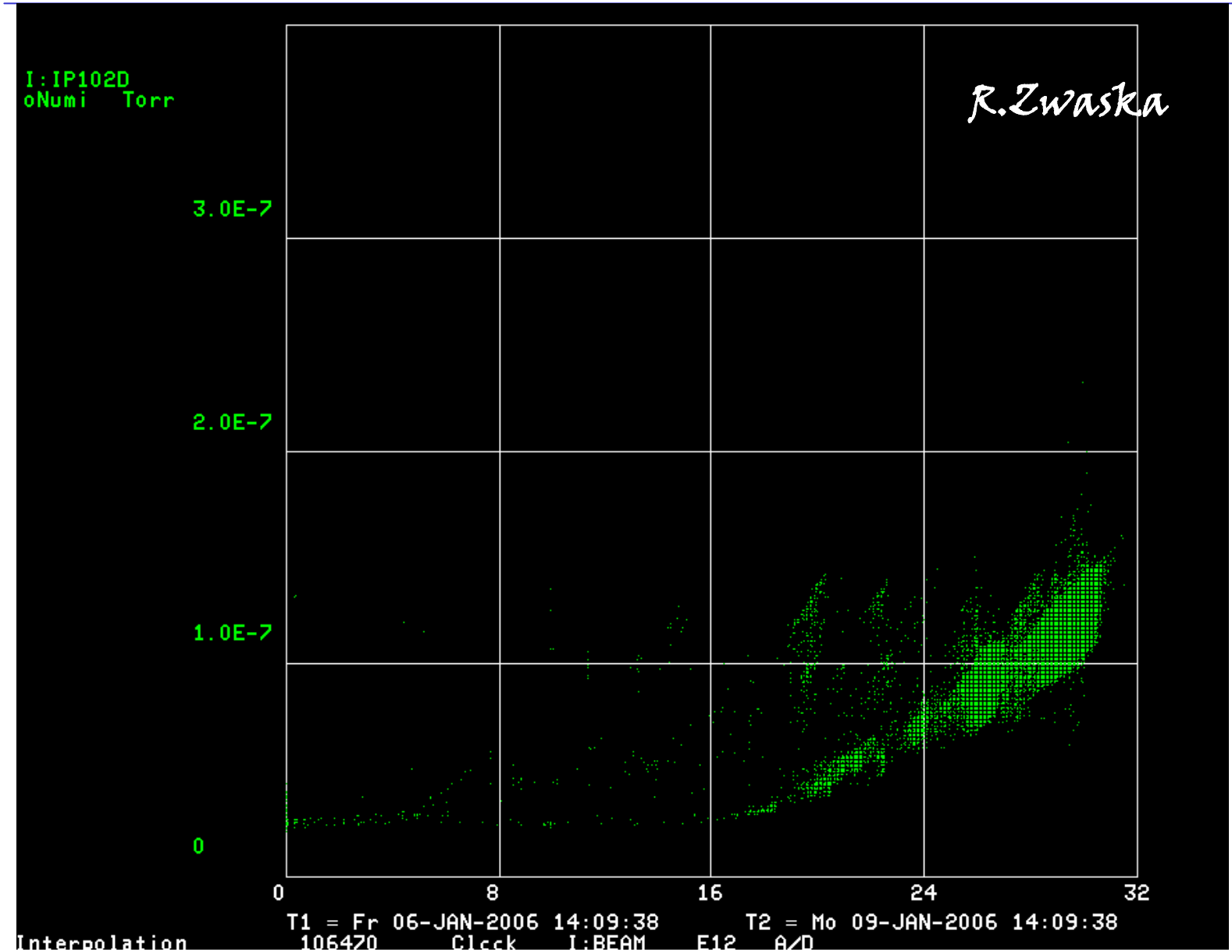
ASTRA vs TRACK - agree

J.-P.Carneiro



H- Through Entire Beta = 1 Linac Section

Intensity Related Vacuum Rise in MI



High Intensity Neutrino Source: Next Steps

- *Over next ½ yr or so:*

  - Establish 325MHz RF power in Meson Detector Building and prepare forinstallation and commissioning of 2.5MeV RFQ in early 2007.

  - Continue design of 8 GeV H- injection into MI.

  - Continue the investigation into the feasibility of 'dual-use' ILC / Proton Driver facility from beam physics and practical perspectives.

  - Report to AAC in May on Proton Driver (High Intensity NeutrinoSource[HINS]) R&D status and plans.

  - Prepare for possible ILC/HINS 'synergy' review this summer.

  - Continue R&D on high power RF vector modulators and high speed 2.5 MeV beam chopper power supply.

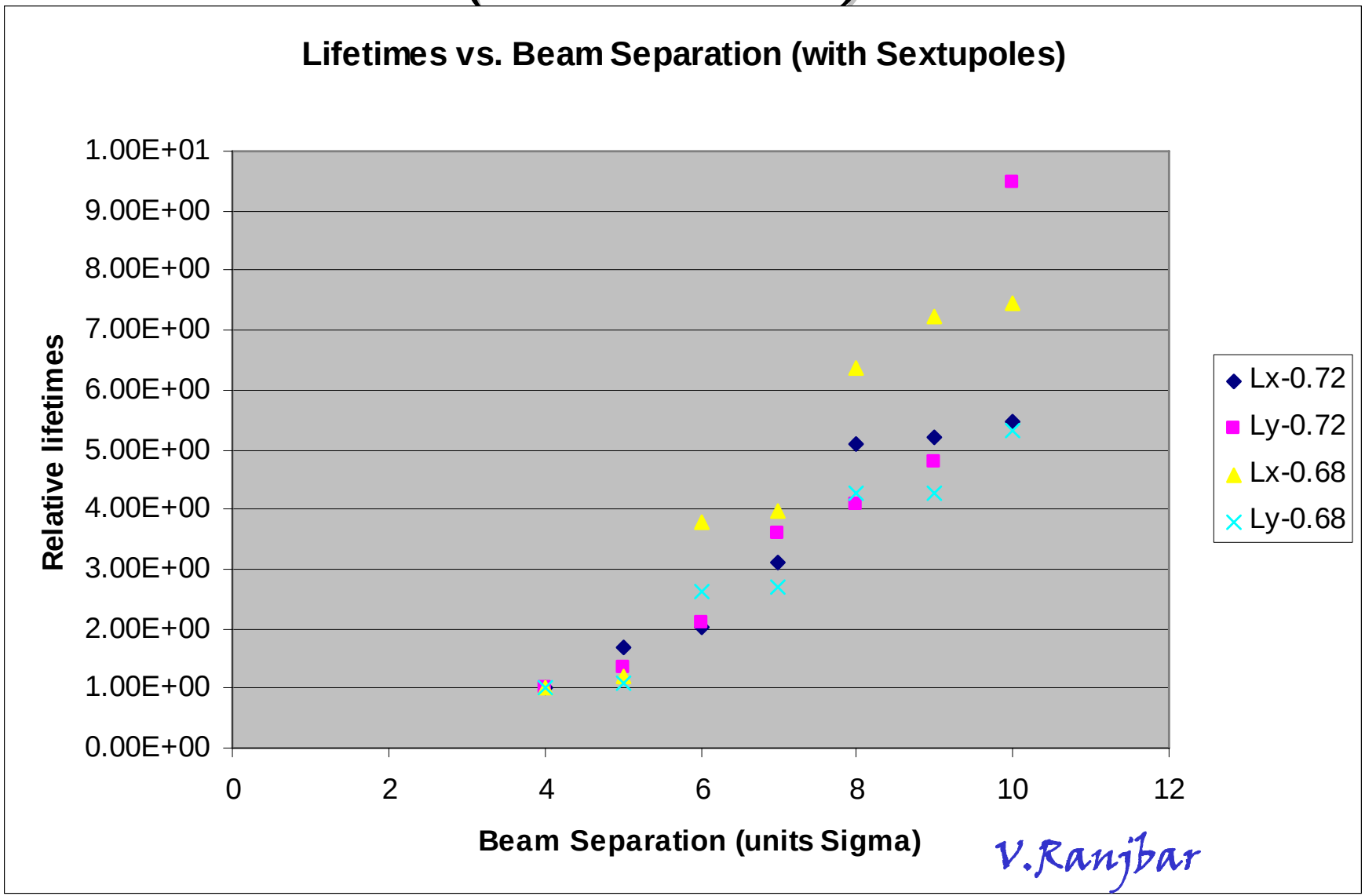
Meson Schedule 2006

- **325 MHz klystron delivery**
  - March 2006
- **Modulator completion**
  - April 2006
- **325 MHz RF power system commissioning**
  - May 2006 ← more like June
- **325 MHz Test Cryostat (now in final design) delivery**
  - August 2006
- **RFQ (now in procurement) delivery and power testing**
  - October 2006
- **2.5 MeV tests**
  - November 2006
- **325 MHz SC spoke resonator test in test cryostat**
  - November 2006

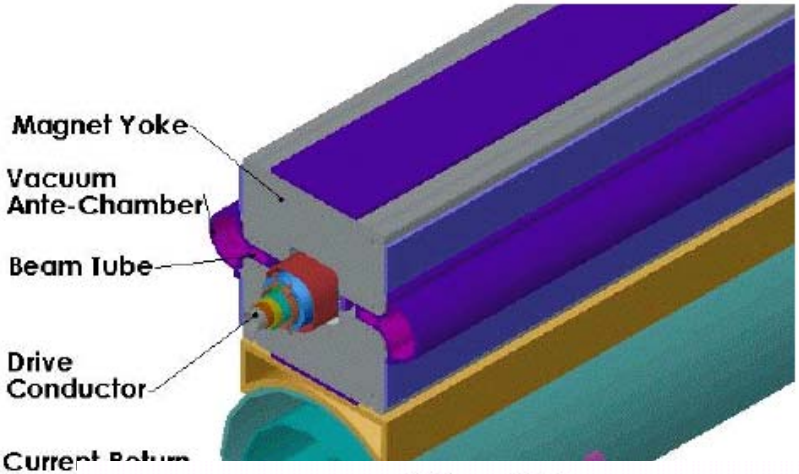
LARP:

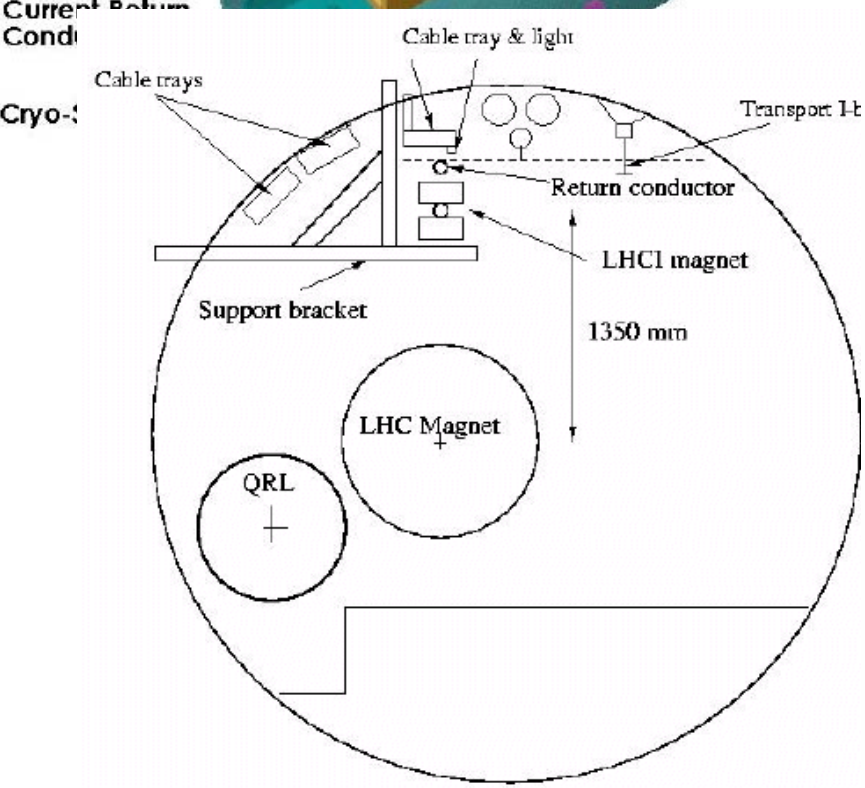
- *Accomplishments:*
  - *Beam-beam simul's for RHIC experiment (VR)*
  - *Lattice for LER-LHC (JJ)*
  - *LHC@FNAL designed/approved (EH)*
  - *Schottky monitor designed (RP)*
- *Next Steps*
  - *Take part in RHIC and SPS beam studies (bb, HT, Q')*
  - *Organize CollabMTG/DoE Review*
  - *Send Bob Flora and 2 TD guys to CERN*
  - *Finish and install beam-beam wire @ RHIC*
  - *Coordinate beam-beam simulations for Tev/LHC*

RHIC 1x1 Lifetime vs Beam Separation (simulations)

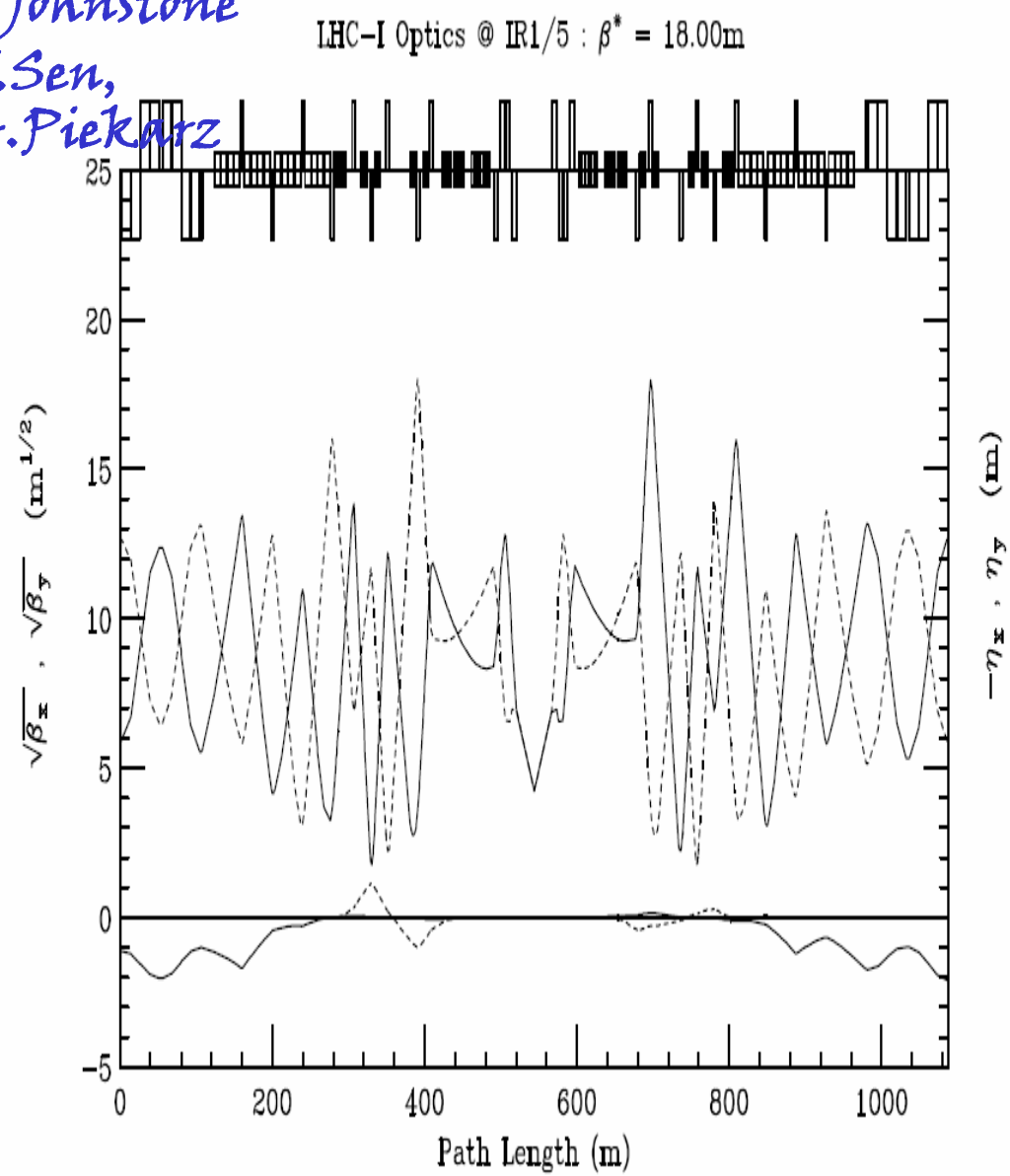


1.5 TeV SuperFerric Injector in LHC tunnel

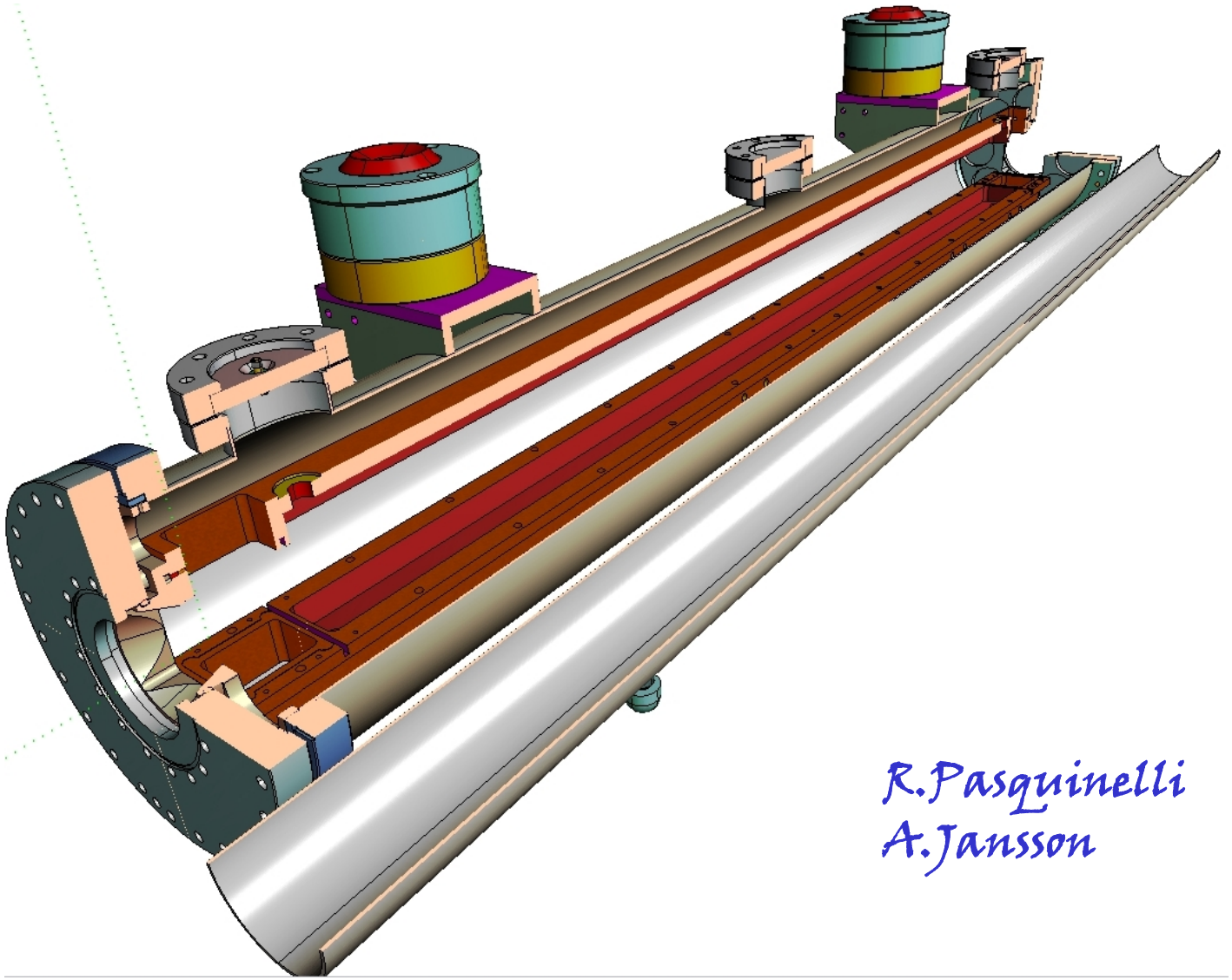




J.Johnstone
T.Sen,
H.Piekarz



LHC 4.8 GHz Schottky Design

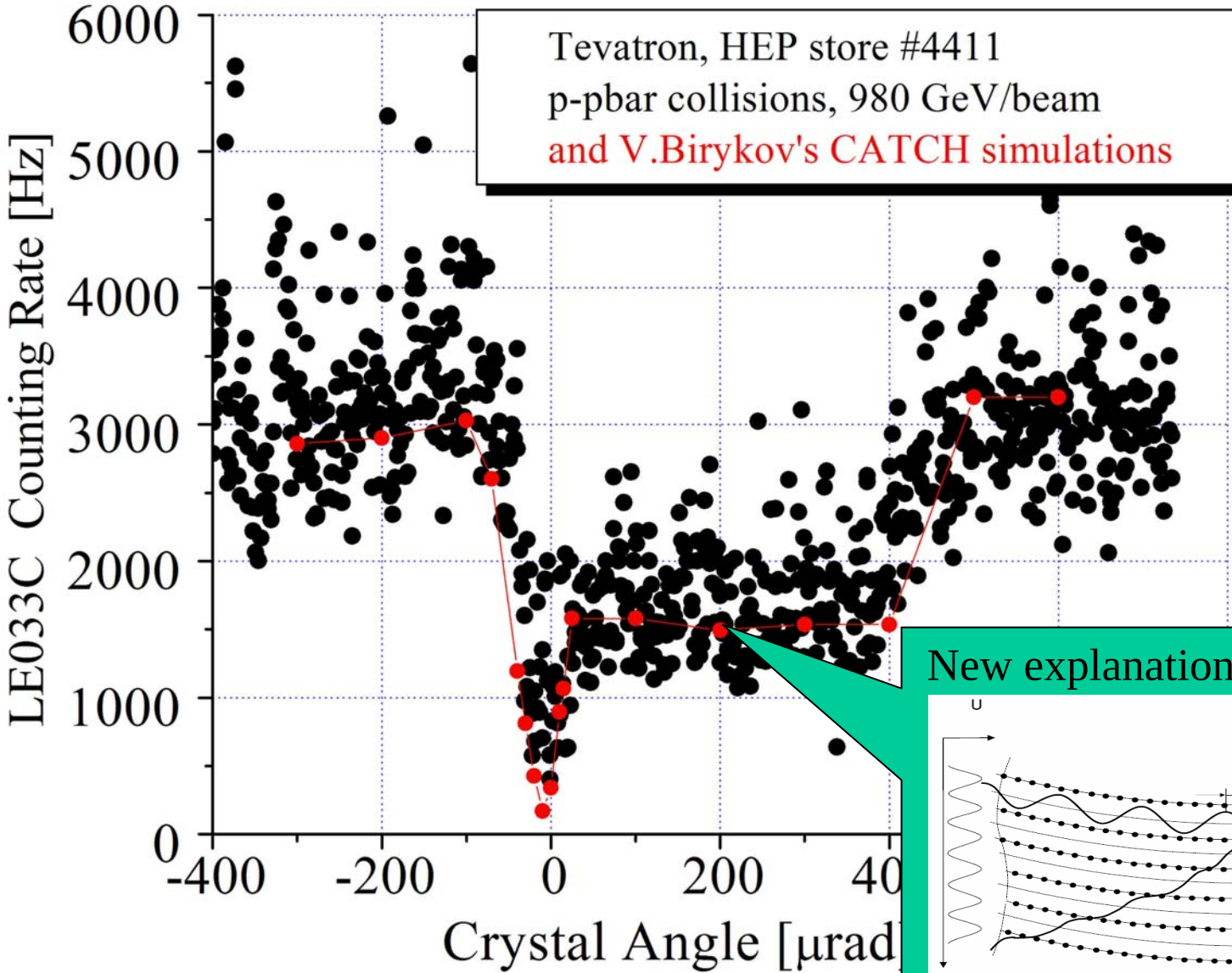


R.Pasquinelli
A.Jansson

Energy Deposition Group

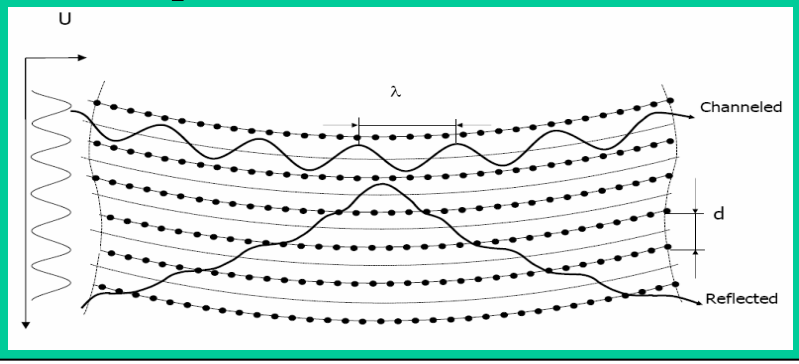
- *Accomplishments:*
  - *MI SS loss studies → collimation system(AD)*
  - *MI-8 line collimator/absorber design, MI-30 masks*
  - *Schielding optimization for MTA*
  - *Radiation levels in MERIT (CERN)*
  - *LHC IP5 MARS model rebuilt*
  - *MARS studies for Nb3Sn for LARP IR Upgrade (IR)*
  - *Crystal collimator studies/simulations (VS/NM)*
  - *ILC BDS bkgrnd (SS)*
- *Further work :*
  - *Further studies MI collimation system*
  - *Optimized crystal beam studies*
  - *ILC BDS for 3 angles*
  - *Studies of the ILC sub-detector background.*

1TeV Beam Channeling & Model



N.Mokhov & Co
D.Still

New explanation: volume reflections



Summary/Comments

- **Accelerator Physics Department had a good start**
- **There is a good progress in all 5 areas of research, many accomplishments**
- **There is a healthy balance of theoretical/ analytical work and experimental/hardware R&D**
- **More and more work to do ...= good sign**