Highlights from ECLOUD10
Cornell University 08-12 October, 2010

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Summary of the workshop

Session 1: Updates from Operating Machines

Session 2: Beam Dynamics Issues

Session 3: Electron Cloud Build-Up Modeling

Session 4: Electron Cloud Diagnostics and Measurements

Session 5: Planning for Future Machines

Session 6: ILC Damping Rings Electron Cloud Working Group

Participant: Argonne, Brookhaven, Caltech, Cornell, DESY, Fermilab, INFN-LNF, LBNL, Los Alamos, KEK, KIT, Purdue, SLAC, Tech-X.

News from Fermilab

3 talks from Fermilab

- Robert Zwaska

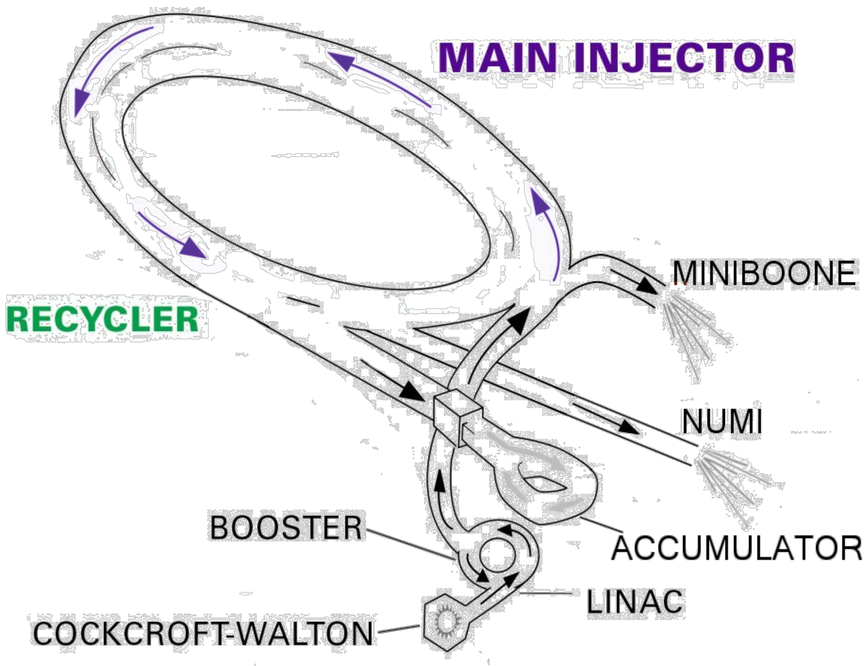
  Electron Cloud Measurements and Plans at Fermilab.
- Jayakar Thangaraj

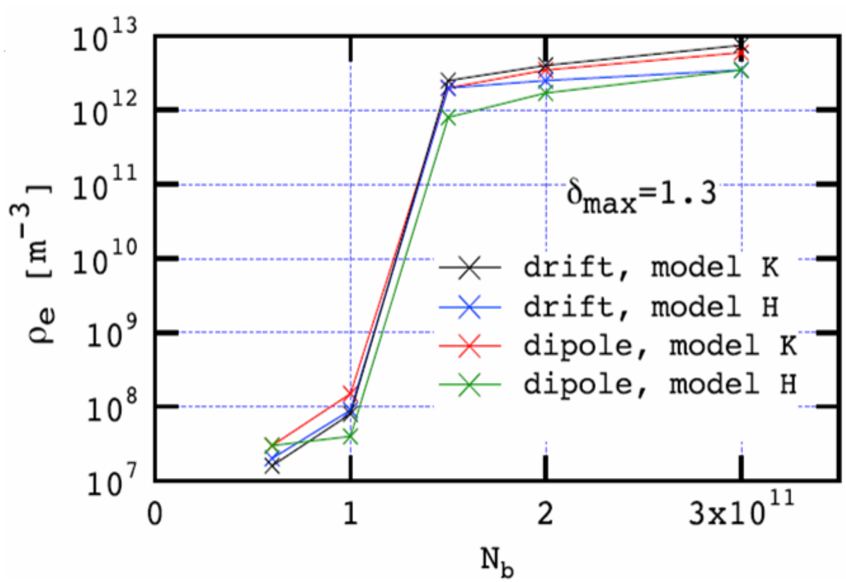
  Electron cloud Studies in the Fermilab Main Injector using Microwave Transmission.
- Cheng-Yang Tan

  The Ecloud Measurement Setup in the Main Injector.

Fermilab has received one a-C coated chamber and performed test in the Main Injector!

Do we want to test TiN chamber? They can make the coating for us.





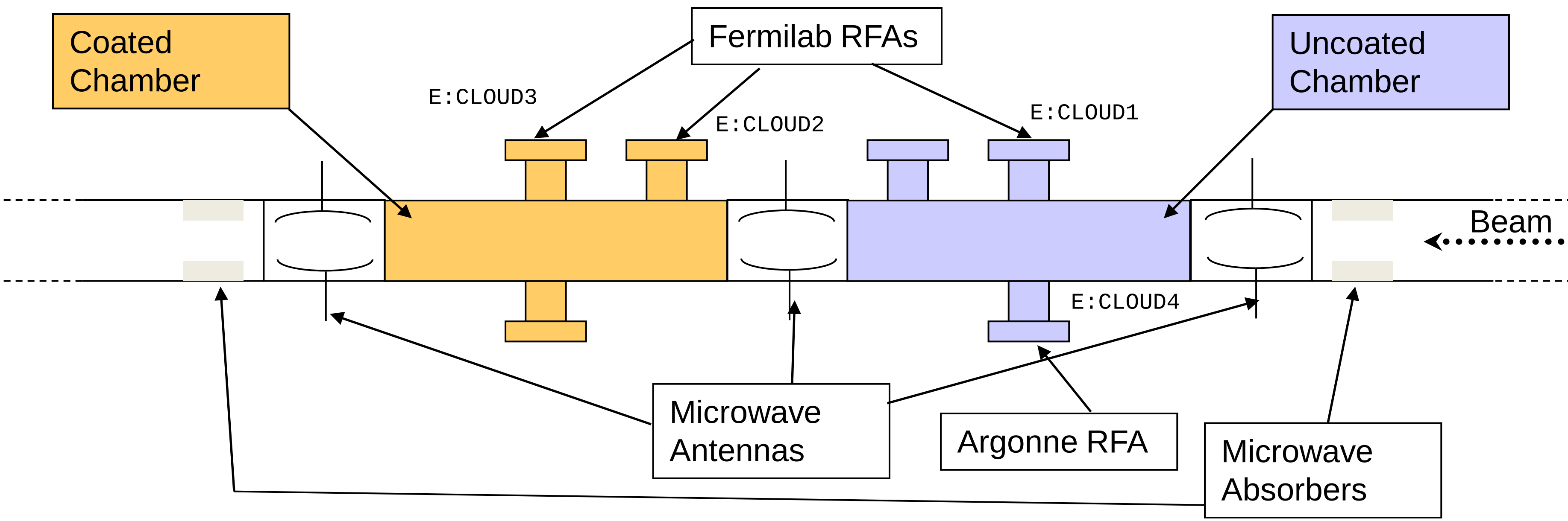
- Main Injector today produces 120 GeV proton beams for neutrinos and antiprotons
  - 400 kW average power
  - 4E13 protons per pulse
    - 10e10 Protons per bunch
- Near future upgrades (NOvA)
  - 700 kW, 4-5E13
- Upgrades in planning –Project X
  - 2+ MW at 60-120 GeV in Main Injector
  - 15+ E13 protons per pulse
    - 30e10 Protons per bunch
- <u>Electron cloud on the top of our minds as a problem for tripling the beam intensity</u>
- Simulations suggested that MI might be near a threshold for electron cloud formation
  - 4-5 orders or magnitude increase of cloud density with a doubling of bunch intensity
- Led to a program of studies:
  - Try to find evidence of a cloud with present MI
  - Expand simulations
  - Look at secondary emission in the MI

Electron Cloud Experimental Upgrade - 2009

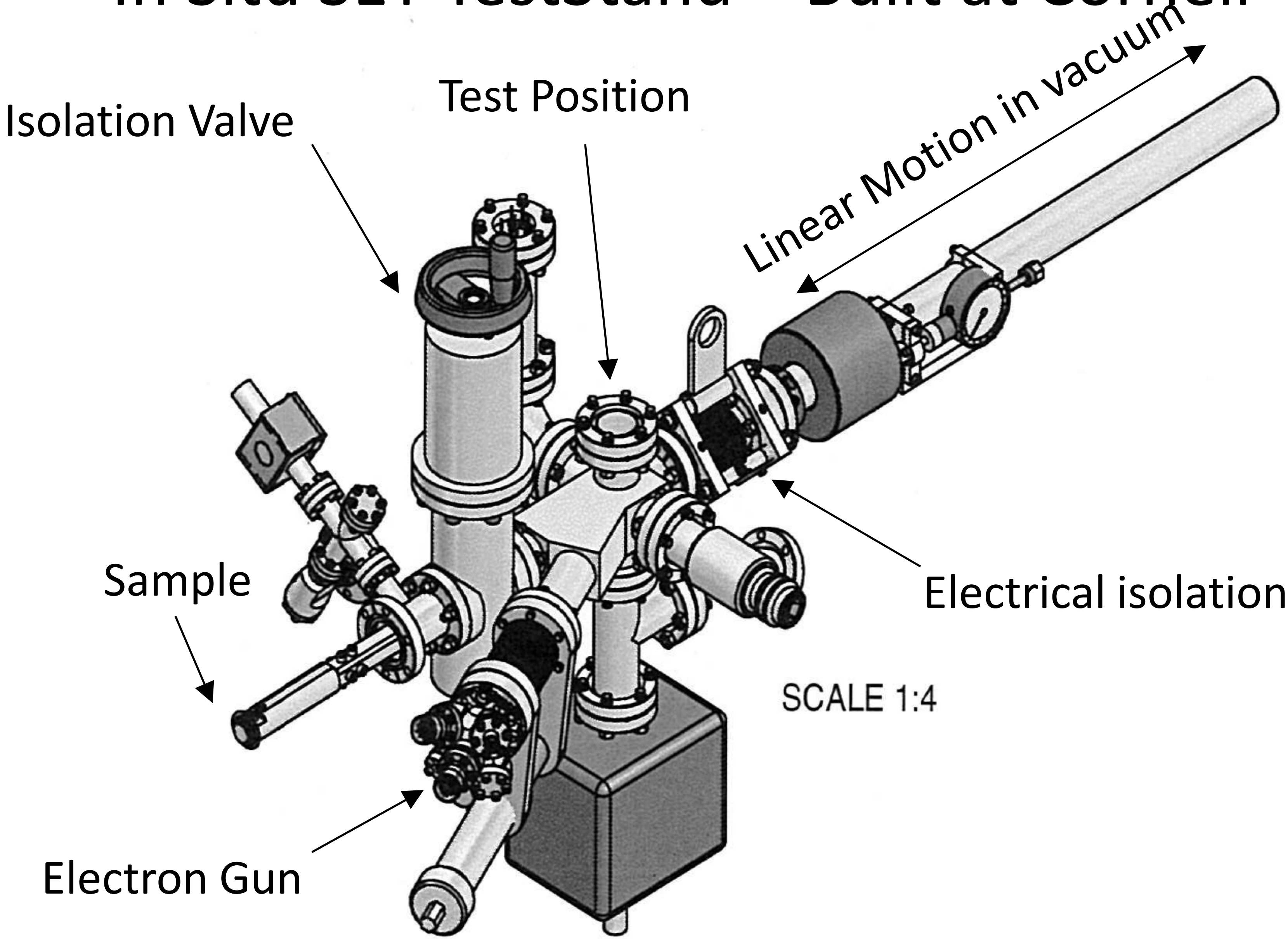
Major upgrade installed summer 2009

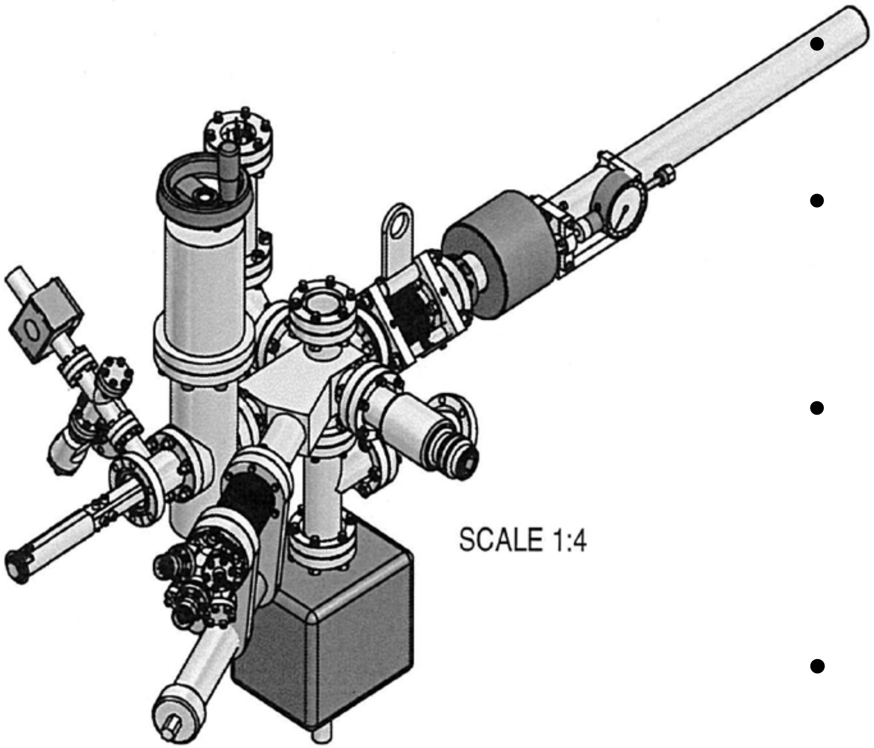
- 2 New experimental Chambers
  - Identical 1 m SS sections, except that one is coated with TiN
- 4 RFAs (3 Fermilab & 1 Argonne)
- 3 microwave antennas and 2 absorbers
  - Measure ECloud density by phase delay of microwaves

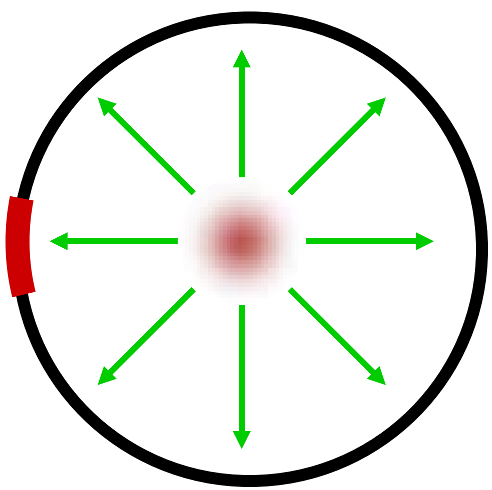
- Primary Goal: validate coatings as potential solutions for Project X
- Secondary Goals:
  - Remeasure threshold and conditioning
  - Further investigate energy-dependence
  - Measure energy spectrum of electrons
  - Test new instrumentation
  - Directly compare RFA and Microwave
  - Measure spatial extinction of ECloud



In Situ SEY TestStand – Built at Cornell







- SEY measurement station from Cornell
  - Adapted from SLAC
  - Allows in situ measurement of SEY on samples
- Place sample "buttons" of materials as portion of beampipe circumference
  - Beampipe made of standard materials – for us: Stainless 416L
- Directly measure the SEY of the sample
  - SLAC did this by removing the button and testing in a surface physics lab
  - At Cornell, it has been modified for *in situ* measurement
- Will allow comparison between conditioning in electron/positron ring, and our proton ring
- Other considerations:
  - Change pieces without breaking accelerator vacuum
  - Monitor electron flux
  - Differential scrubbing can be factored out

Microwave Measurements

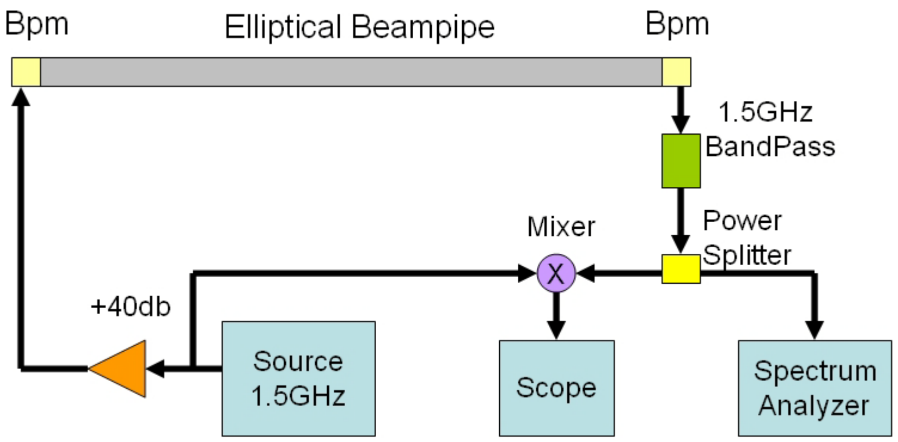
- ECloud induced phase shift
- Three different methods

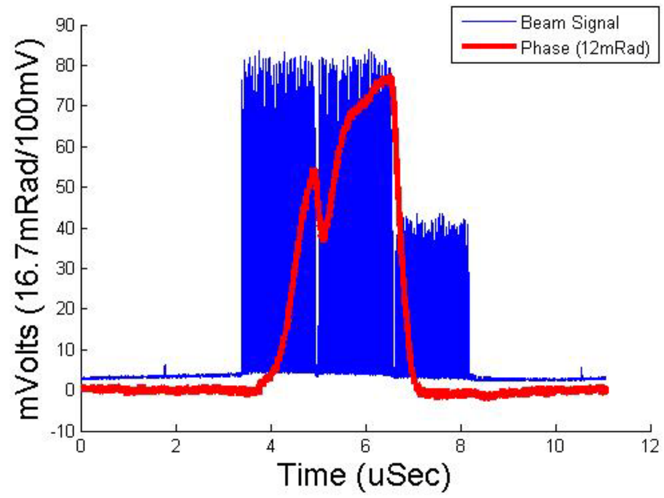
  Direct phase shift

  Sideband spectrum

  Zero span

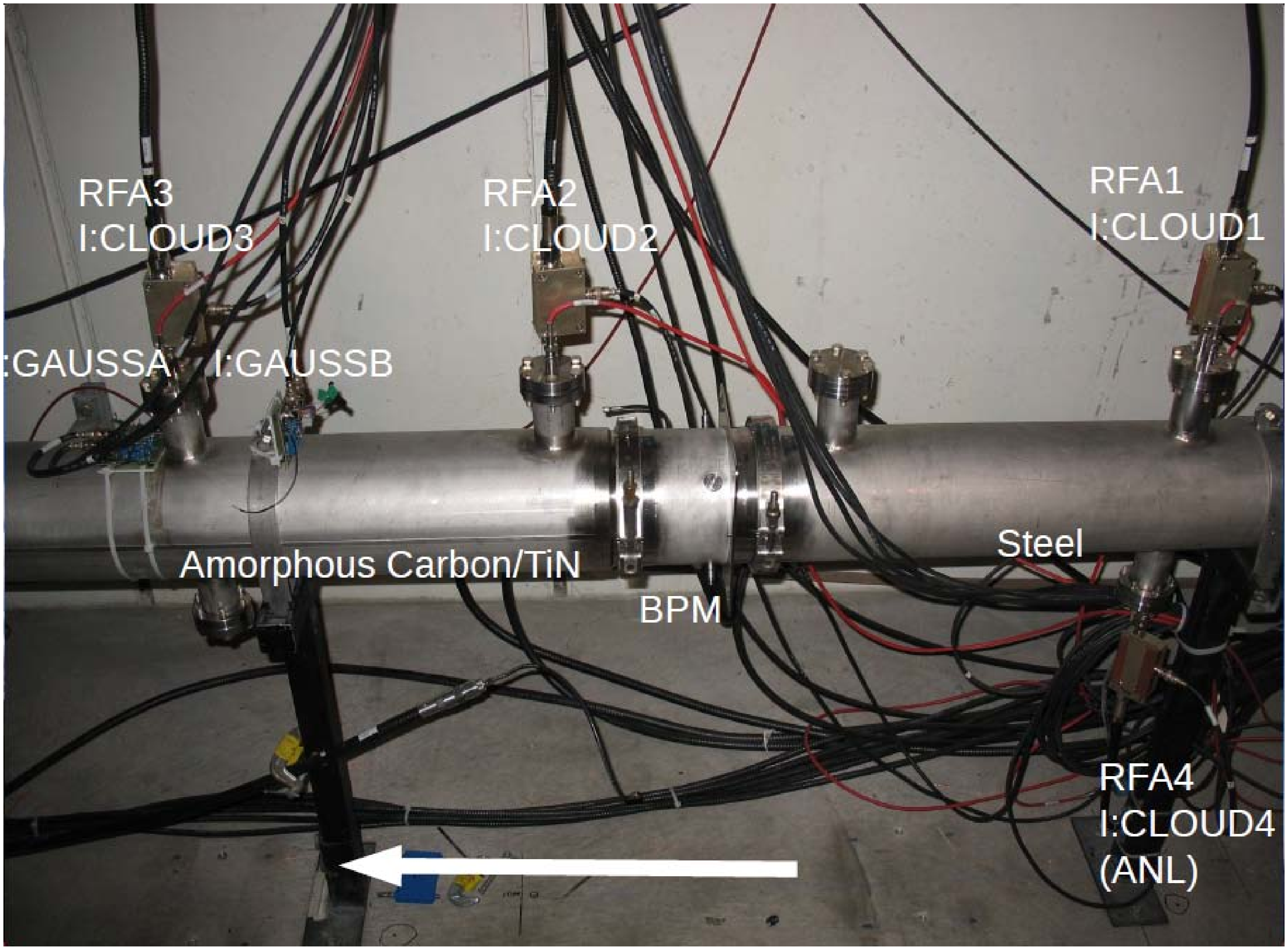
  - Very good time-resolution with direct phase
- May allow measurement in dipole sections
  - No room for RFAs in Main Injector Dipoles
- Need better theoretical understanding of phase shift, particularly in magnets
  - Plasma modeling & ECR issues
- Need to understand the issues arising from reflections within the accelerator
  - Do not understand normalization
  - Uncertain where the measurement is occurring



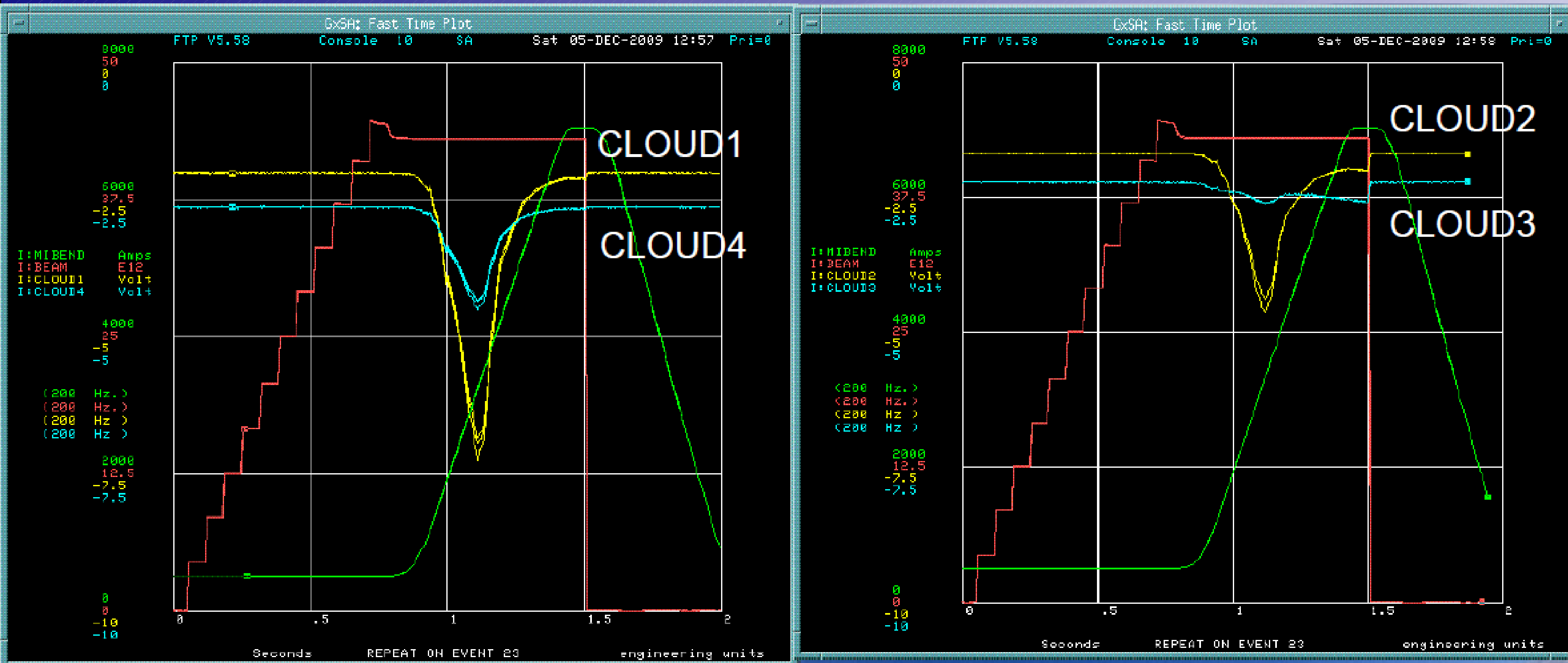


RFA Measurements

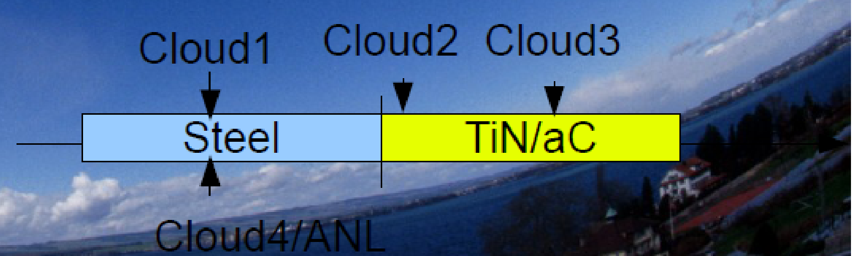
Located in straight section, 6'' diameter beam pipe, 1 m long section of a-C or TiN.



Typical Signals (with amps on)

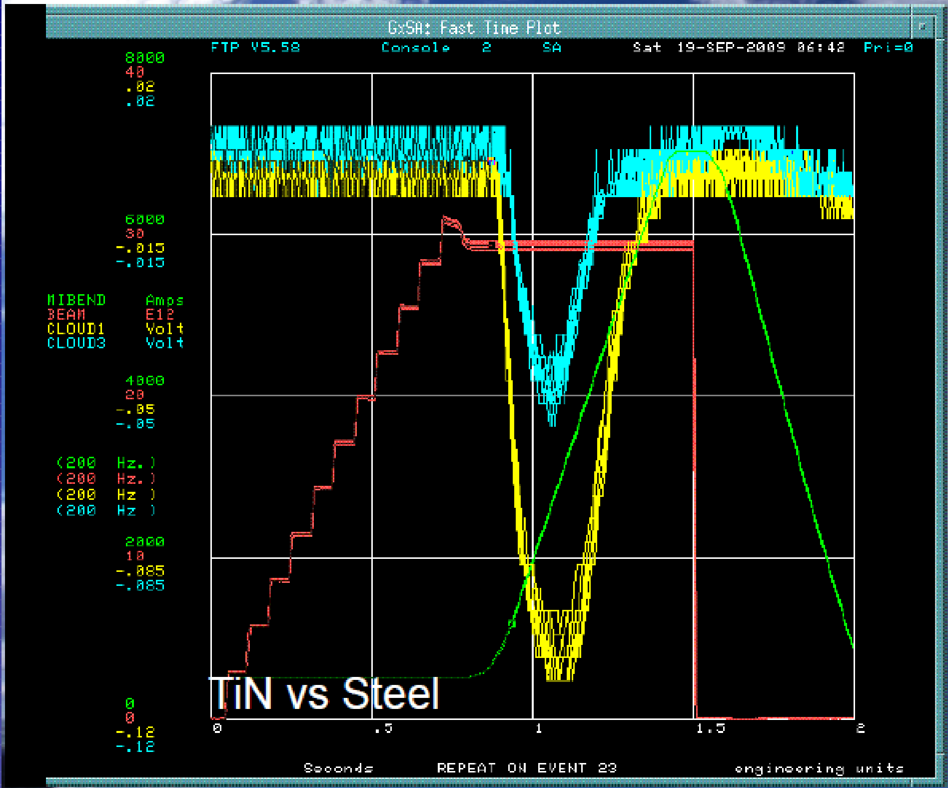


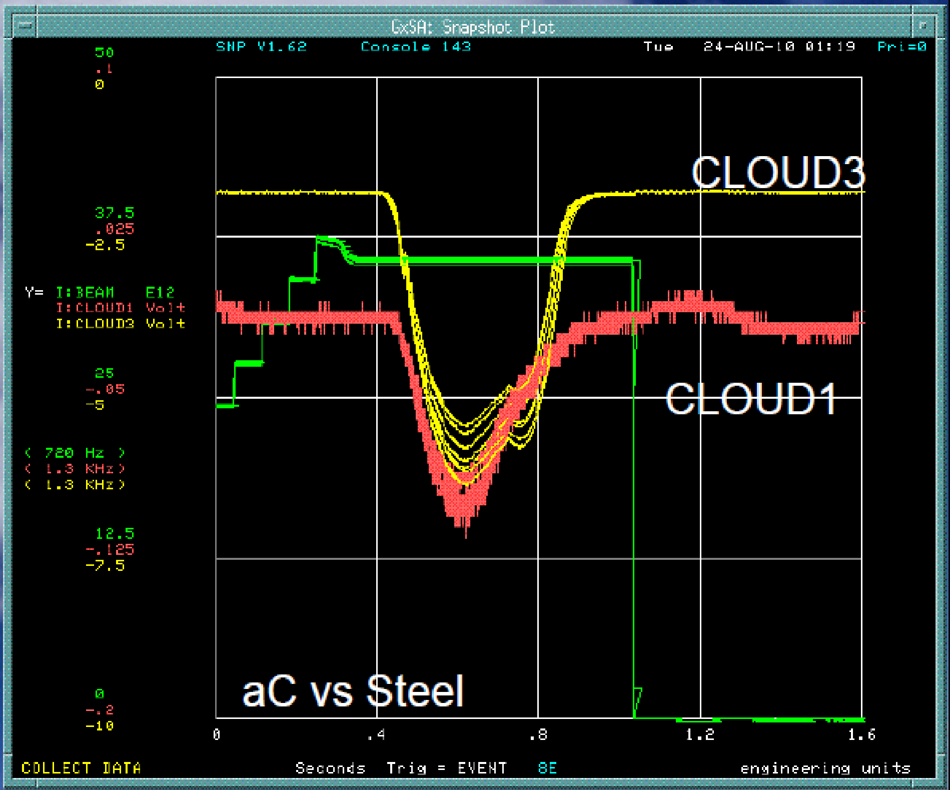
Cloud 1 and 4 on steel
Cloud 2 and 3 on TiN (mu metal shielding)
Maximum dip around transition 20GeV

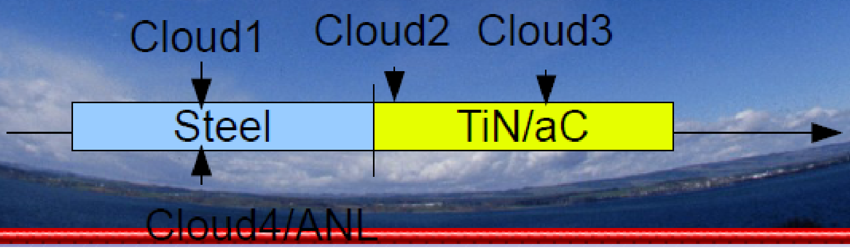


No explanation on why the RFA signal drops earlier than beam yet.

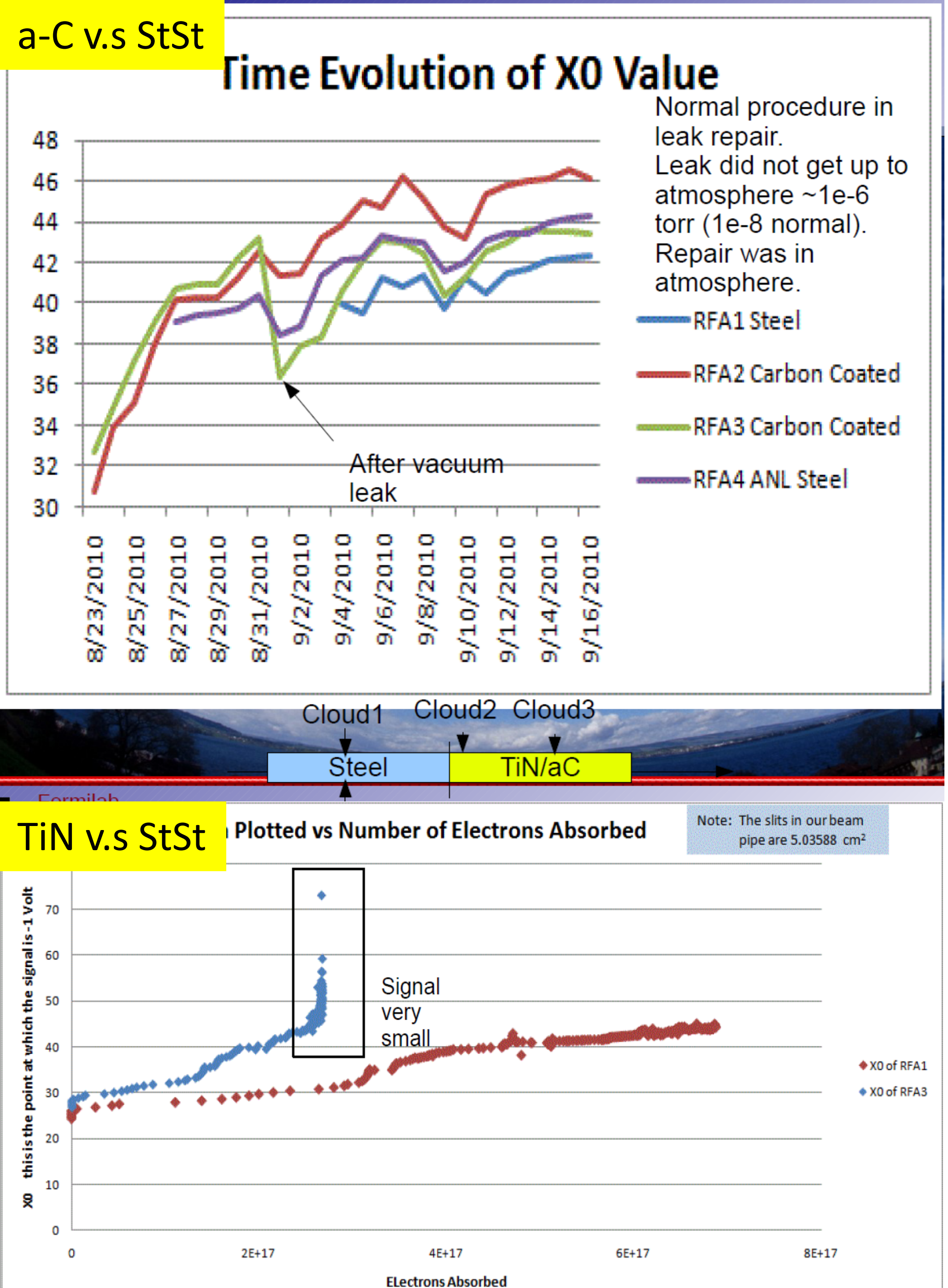
Comparing TiN, aC and Steel







Double hump also seen on scope without amps



- Conditioning is seen on both TiN and a-C.
- Preliminary results show that TiN and a-C are comparable in performance?
- a-C is not very robust?

Question about conditioning of TiN and a-C coating.

News from Cornell

Talks:

- David Rubin
  Overview of the CesrTA R&D Program.
- Gerry Dugan
  CesrTA EC-Induced Beam Dynamics.
- Mark Palmer
  CesrTA Preliminary Recommendations for the ILC Positron Damping Ring.

Many posters

Many Implementations and Operations of Ecloud diagnostics are ongoing

- **Retarding Field Analyzers – Cornell Thin Style Design**

1. Implement Thin RFAs in Superconducting Wigglers
2. Deployed Thin RFAs in an dipole chamber
3. Deployed RFA in Quadrupole

- **Vacuum Performance of Various Coatings**
- **SEY measurement in-situ (built 6 setups, can lend to CERN for SEY in-situ measurements for free).**

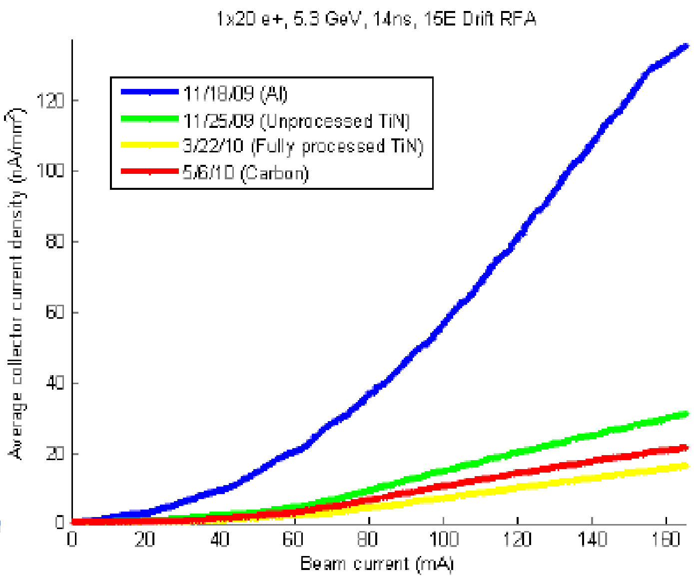
Brief Summary of Implementation of Vacuum Diagnostics @ CesrTA

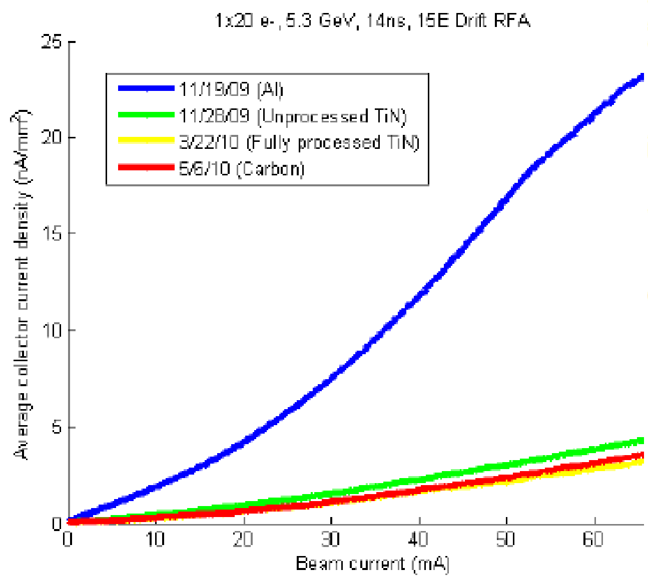
	Drift	Quad	Dipole	Wiggler	VC Fab
Al	✓	✓	✓		CU, SLAC
Cu	✓			✓	CU, KEK, LBNL, SLAC
TiN on Al	✓	✓	✓		CU, SLAC
TiN on Cu	✓			✓	CU, KEK, LBNL, SLAC
Amorphous C on Al	✓				CERN, CU
NEG on SS	✓				CU
Solenoid Windings	✓				CU
Fins w/TiN on Al	✓				SLAC
Triangular Grooves on Cu				✓	CU, KEK, LBNL, SLAC
Triangular Grooves w/TiN on Al			✓		CU, SLAC
Triangular Grooves w/TiN on Cu				✓ (planned)	CU, KEK, LBNL, SLAC
Clearing Electrode				✓	CU, KEK, LBNL, SLAC

✓ = chamber(s) deployed ✓ = planned

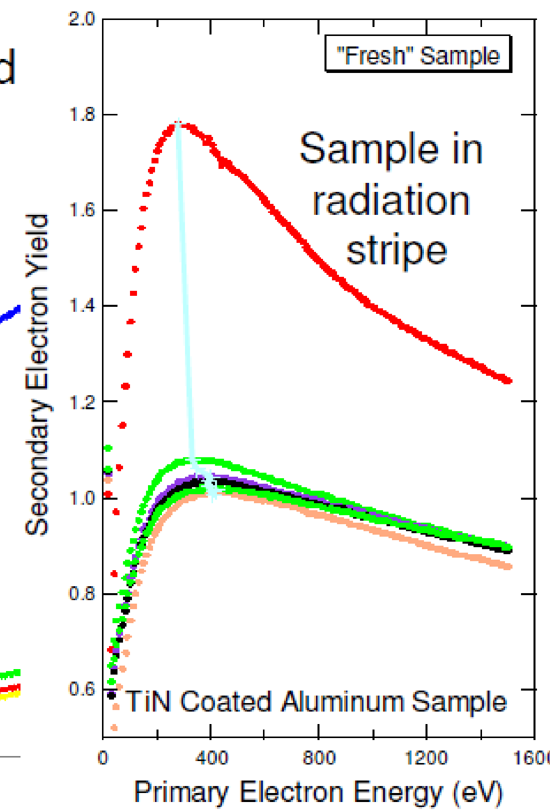
Drift Observations

- Bare Al vs TiN coating vs amorphous C coating comparisons have been carried out using the Q15E/W test regions
  - Allows for detailed relative comparison as well as comparison with simulation to determine key surface parameters (talk and poster by J. Calvey)
  - EC performance of TiN and a-C found to be quite similar in regimes with significant SEY contributions as well as regimes which should be most sensitive to PEY
- NEG tests carried out in L3 region
  - Makes detailed comparison with Q15E/W tests more challenging
- Preliminary analysis of surface parameters indicates good SEY performance by each of these 3 coatings
- Tests with other chamber types around the ring





In Situ SEY Station



News from KEK

Talks:

- Shigeki Kato

  E-Cloud Activity of DLC and TiN Coated Chambers at KEKB.

- Kazuhito Ohmi

  Electron instability in low emittance rings, Cesr-TA and SuperKEKB.

- Suetsugu Yusuke

  Mitigation strategy of electron cloud effects in the Super KEKB positron ring

Mitigation strategy in SuperKEKB:

– Drift section (incl. Q magnet sections)

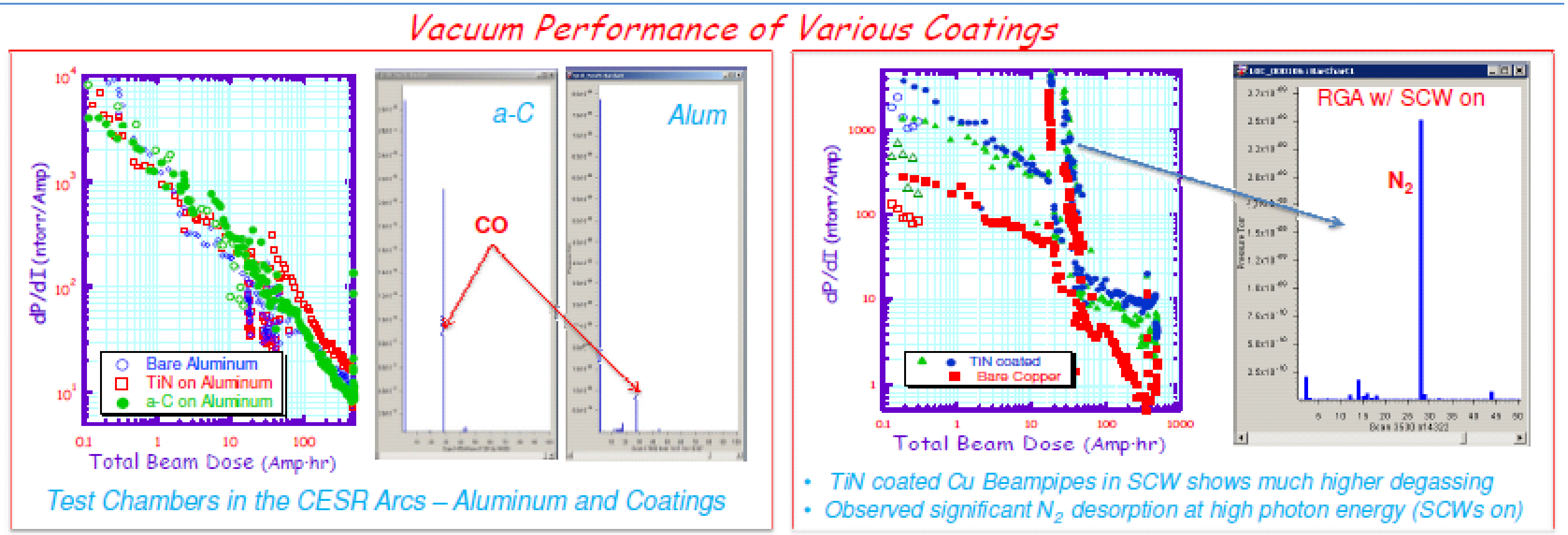
– Bend section

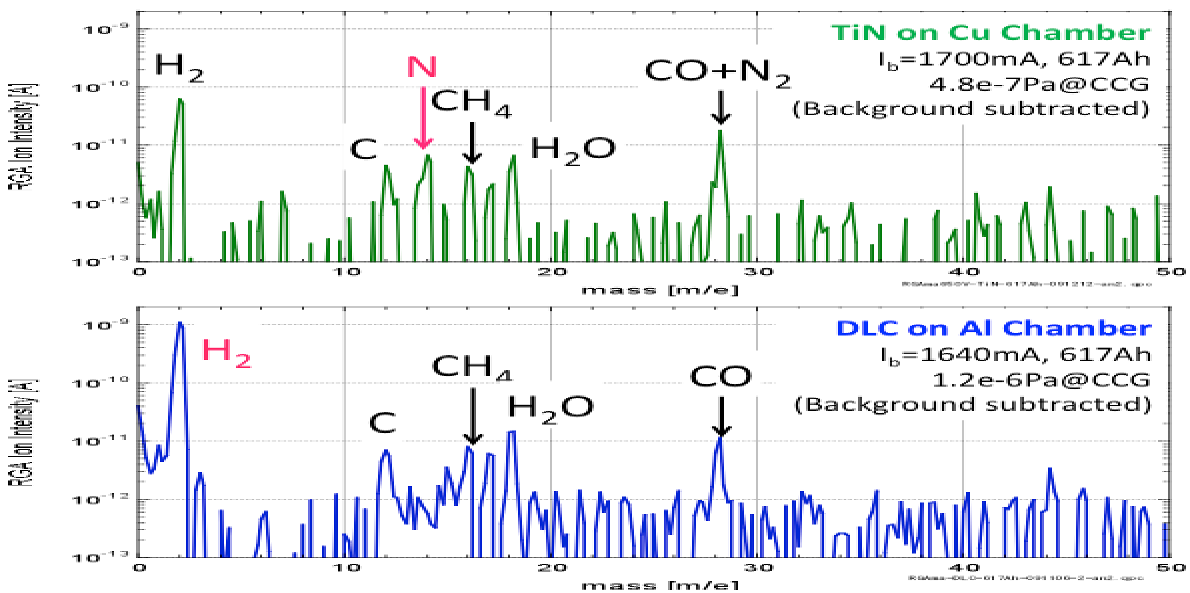
– Wiggler section

Main parts

Drift section	Antechamber +Solenoid +TiN Coating
Q and Sx mag.	Antechamber +Solenoid +TiN Coating
Bend section	Antechamber +Groove+ TiN Coating
Wiggler section	Antechamber +Electrode (Cu)

RGA spectra: Cornell v.s KEK





High nitrogen was found both at Cornell and at KEK, indicating the decomposition of TiN.