Update on activities at LBNL in support of the ILC DR project

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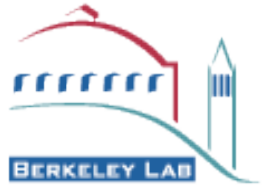
SUMMARY

- Simulations and theoretical studies
  - Code development (WARP-POSINST) and application to e-cloud formation studies, cyclotron resonances and *witness bunch* measurements in Cesr-TA.
- Beam diagnostics
  - TE Wave measurements of e-cloud density in Cesr-TA (with J. Sikora)
- Accelerator engineering
  - Wiggler/RFA vacuum chamber fabrication. Implementation of e-cloud suppression techniques (grooved chamber, clearing electrodes).

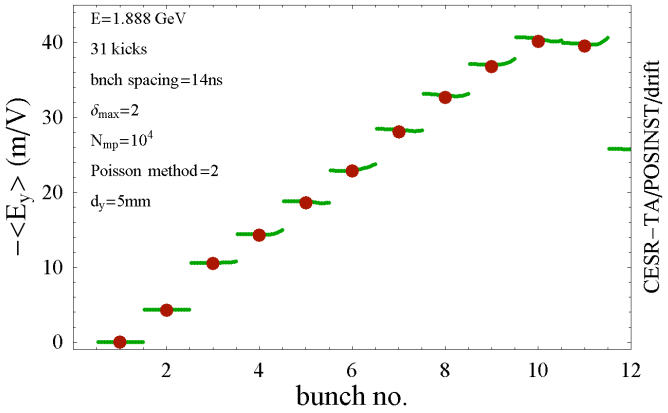
POSINST simulations of Cesr-TA coherent tune measurements



- Tuneshift measurements along trains of bunches are one of the most direct ways to probe e-cloud and harvest useful info.
- POSINST capabilities have been expanded to allow for calculation of 3D averages of the electric field over bunches (directly related to measurable coherent tuneshifts).
- LBNL simulations complement effort already on going at Cornell (in part carried out using earlier versions of POSINST).
- We have carried out simulations of contributions to tuneshift from **drifts** and **regular dipoles** for **positron beams** and **electron beams** (ongoing) with the April-07 machine setting (11 bunches train + 1 witness bunch)
- We started to explore scaling with respect to key parameters.
- We found that in dipoles (horizontal plane) offsetting the trailing bunches affects significantly the tuneshift of a following bunch
  - This configuration is believed be closer to the experimental situation.
  - The simulations with an offset in the trailing bunches yield a noticeable smaller value of the horizontal tuneshift than w/o offset. More in line with the measurements.

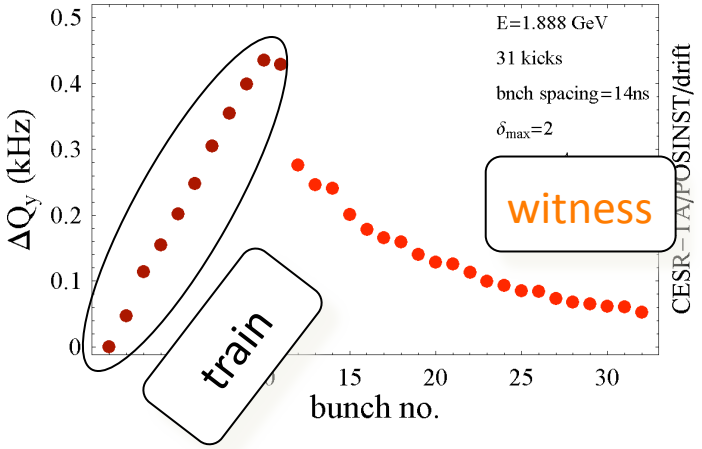
DRIFT:: **Vertical** motion: averaged e-field experienced by bunches is about linear with transverse offset

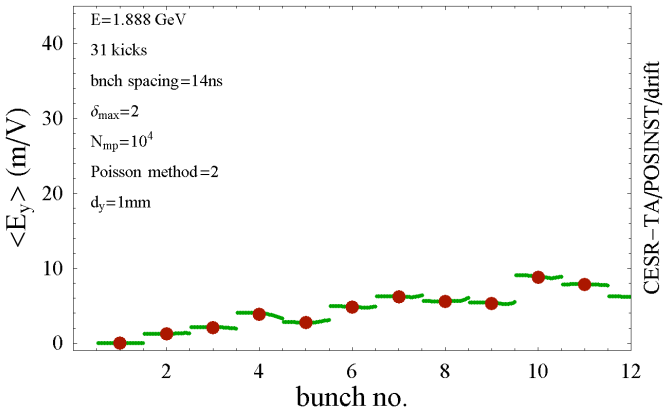
Averaged e-field due to e-cloud along 11-bunch train …



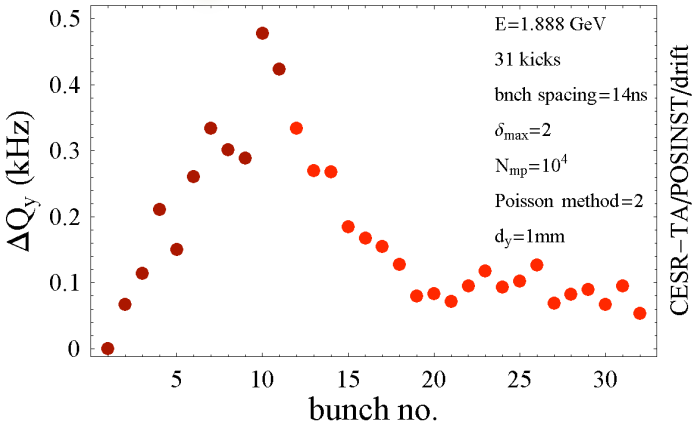
dy=5mm

… corresponding tuneshifts from 175m drift

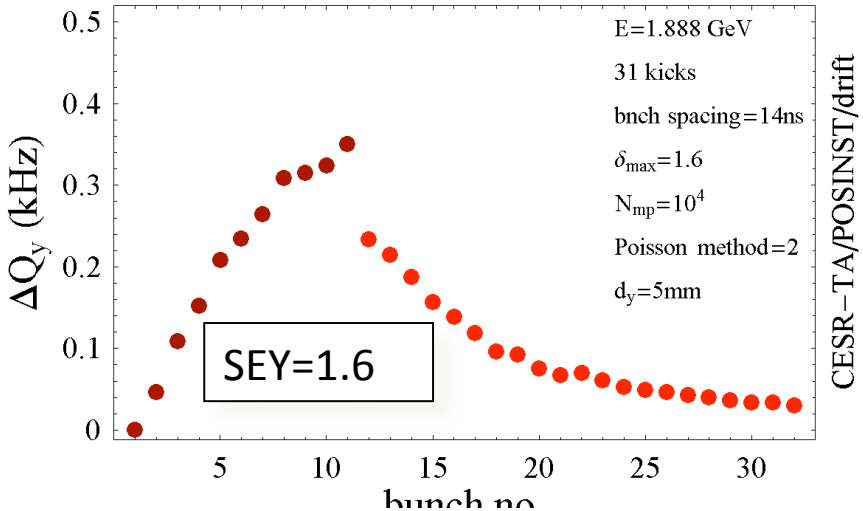


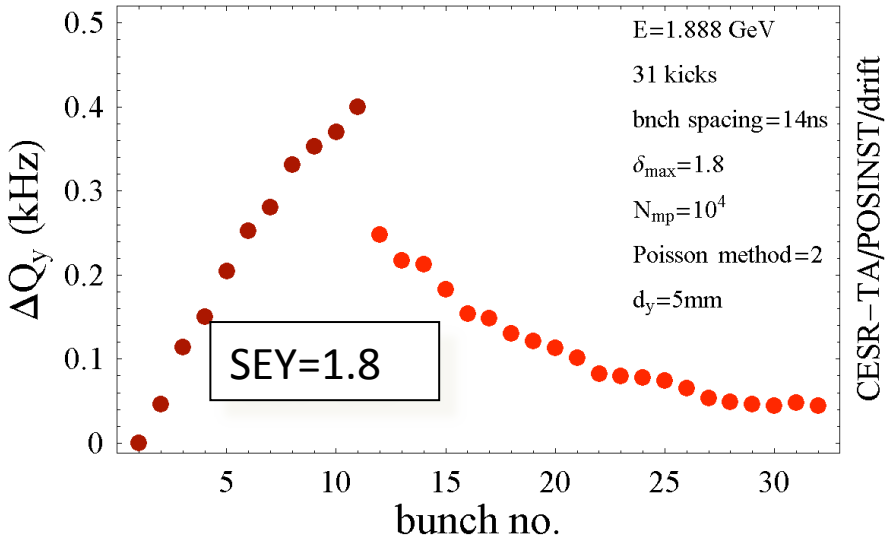


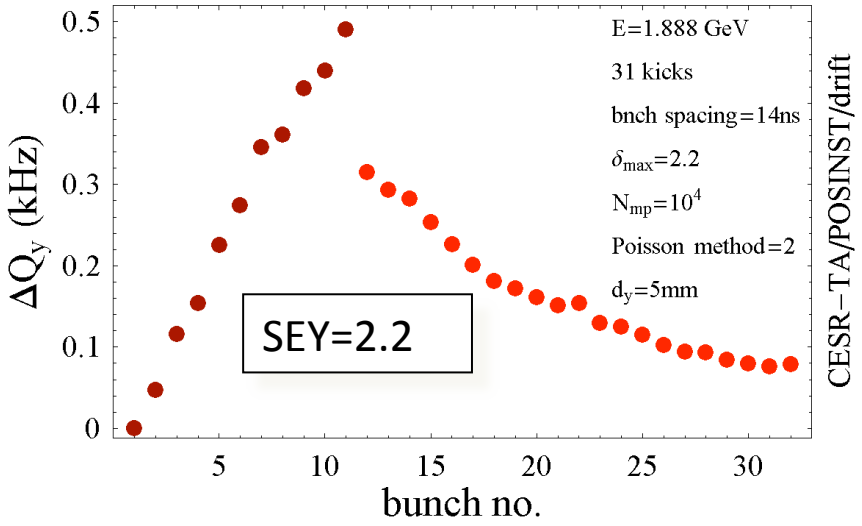
dy=1mm

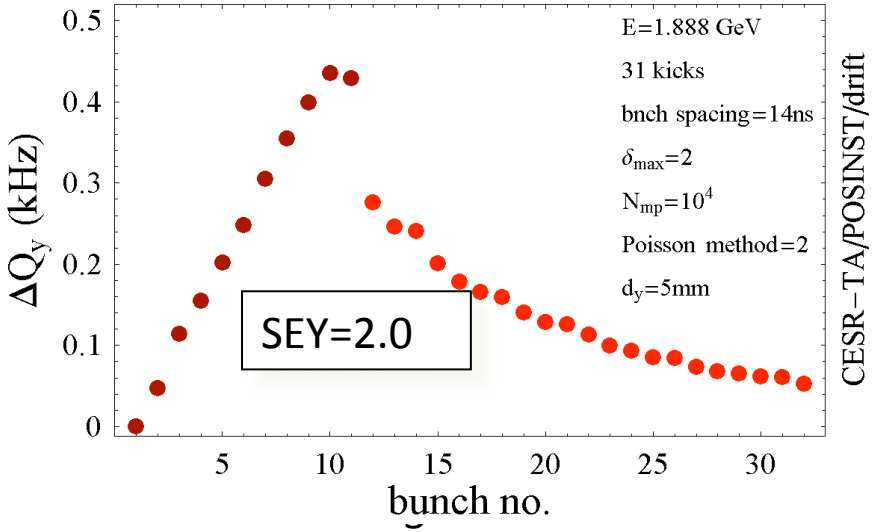


DRIFT:: **Vertical** motion: dependence on SEY apparent only in last bunches of train









Our 3D Code, WARP-POSINST, is being used to simulate CesrTA experiments

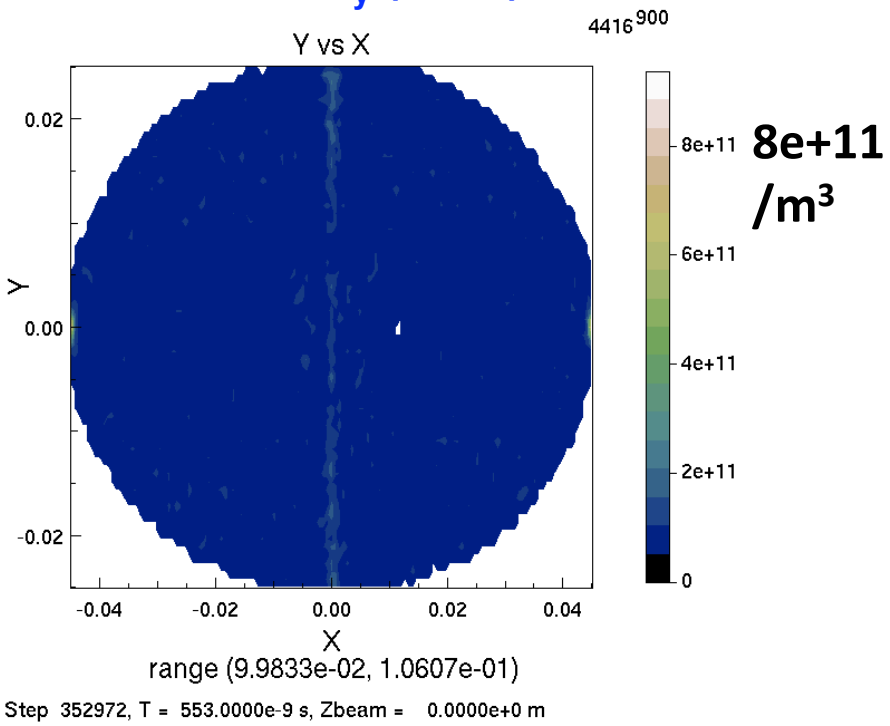
- Goals:
- Simulate ecloud formation & effect on beam in CesrTA wiggler. Investigate role of cyclotron resonances.
- Where we are:
- - Investigating ecloud formation with 3D particle-in-cell code, using CesrTA parameters and wiggler field
- - Simplifications at present:
- cyclotron resonances not resolved yet in z (requires extremely fine resolution ~ μm)
- beam bunches do not evolve
- - Interesting and complicated results starting to come out
- What next?
- - Understand movement of electrons in 3D, and cloud generation
- - Vary parameters to try to fit data
- - Resolve cyclotron resonances

3D Ecloud Simulations of CesrTA Wiggler Experiments show different cloud at peak, null B_y

C. Celata - Cornell & LBNL

Density of Electrons in x-y Plane after 40 bunch passages

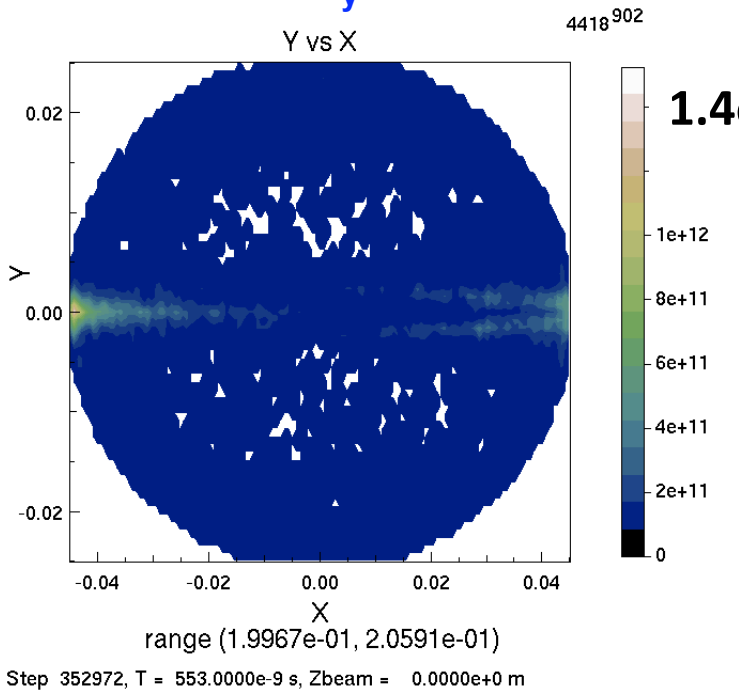
At Peak B_y (1.9 T)



8e+11 /m³

"Stripe" forms where SEY is high.

At B_y=0



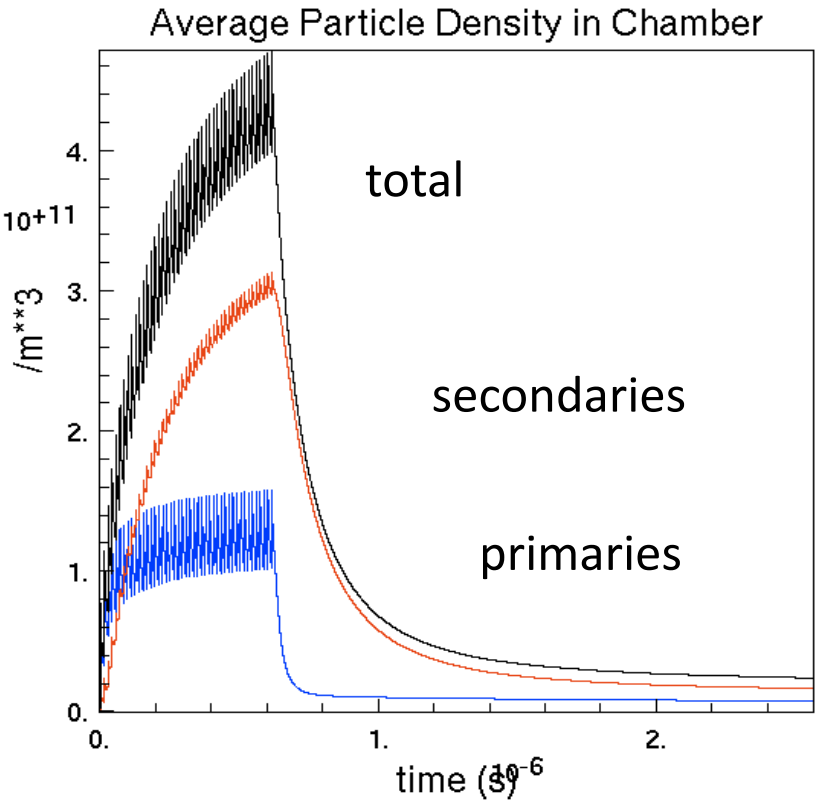
1.4e+12 /m3

Electrons drift slowly in x across field lines. Preliminary: Believe ExB drift causes left-right asymmetry, grad B drift causes x motion .

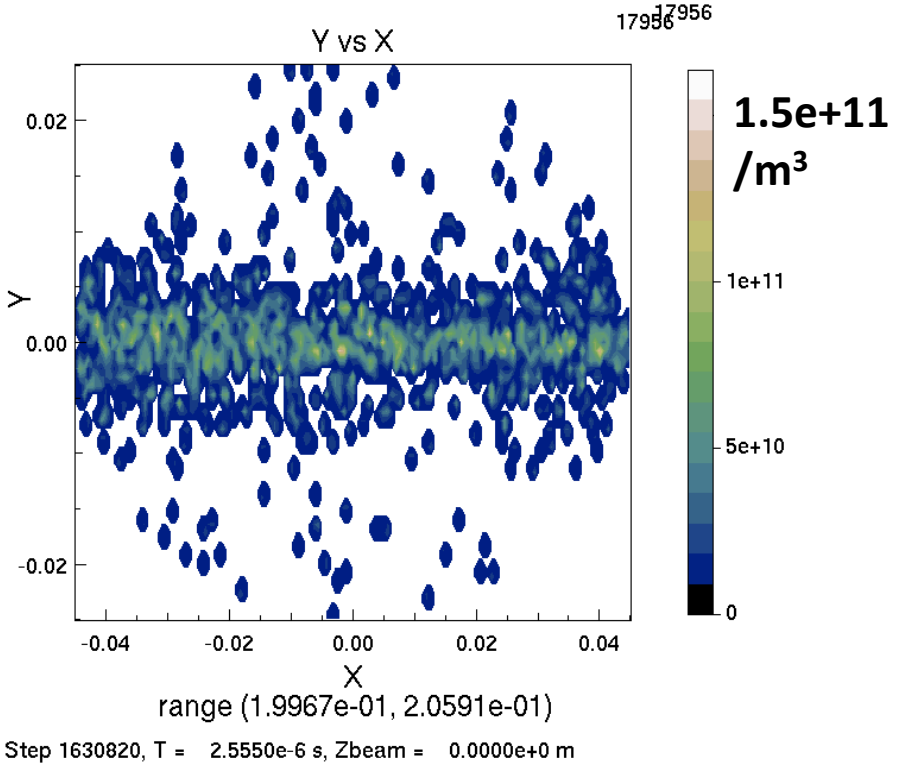
Note: Cyclotron resonances not resolved in z

After time for 1 turn of 45-bunch train, electrons remain at B_y=0

Total number of electrons vs. time



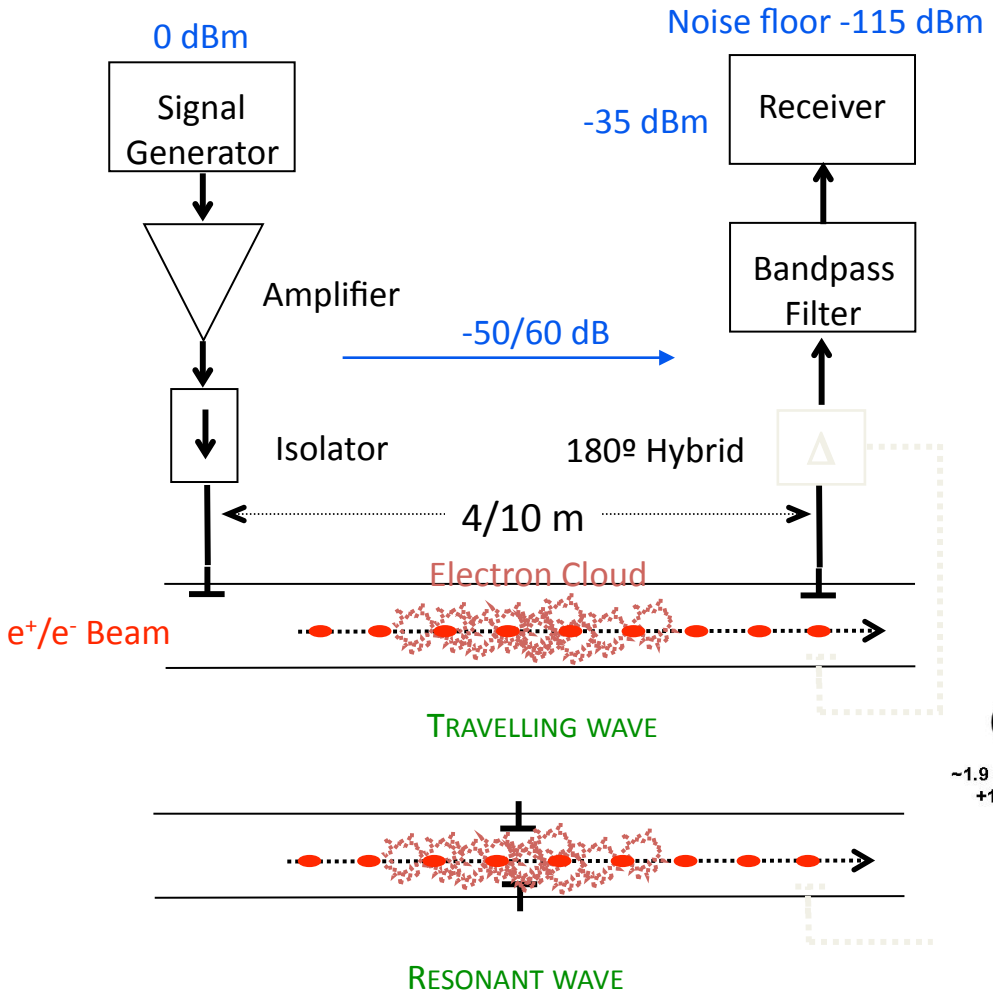
Density in x-y Plane at z where B_y=0

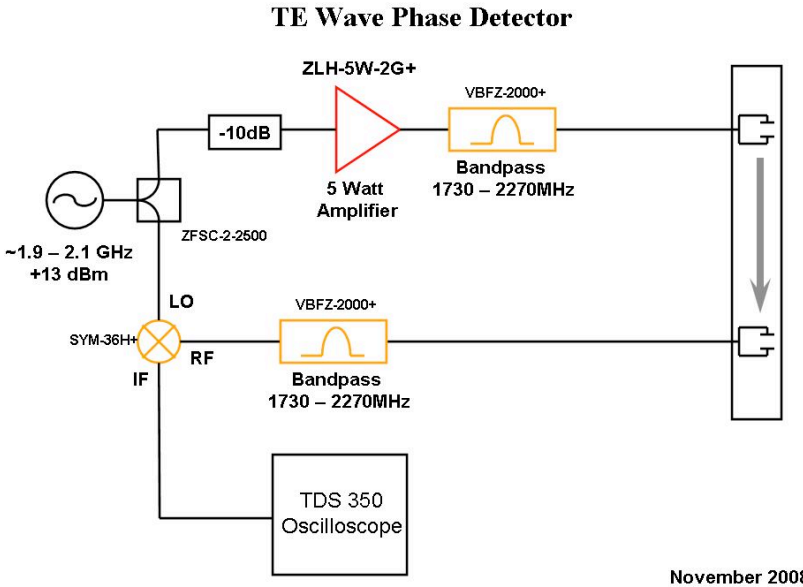


No electron cloud remains at z of peak B_y

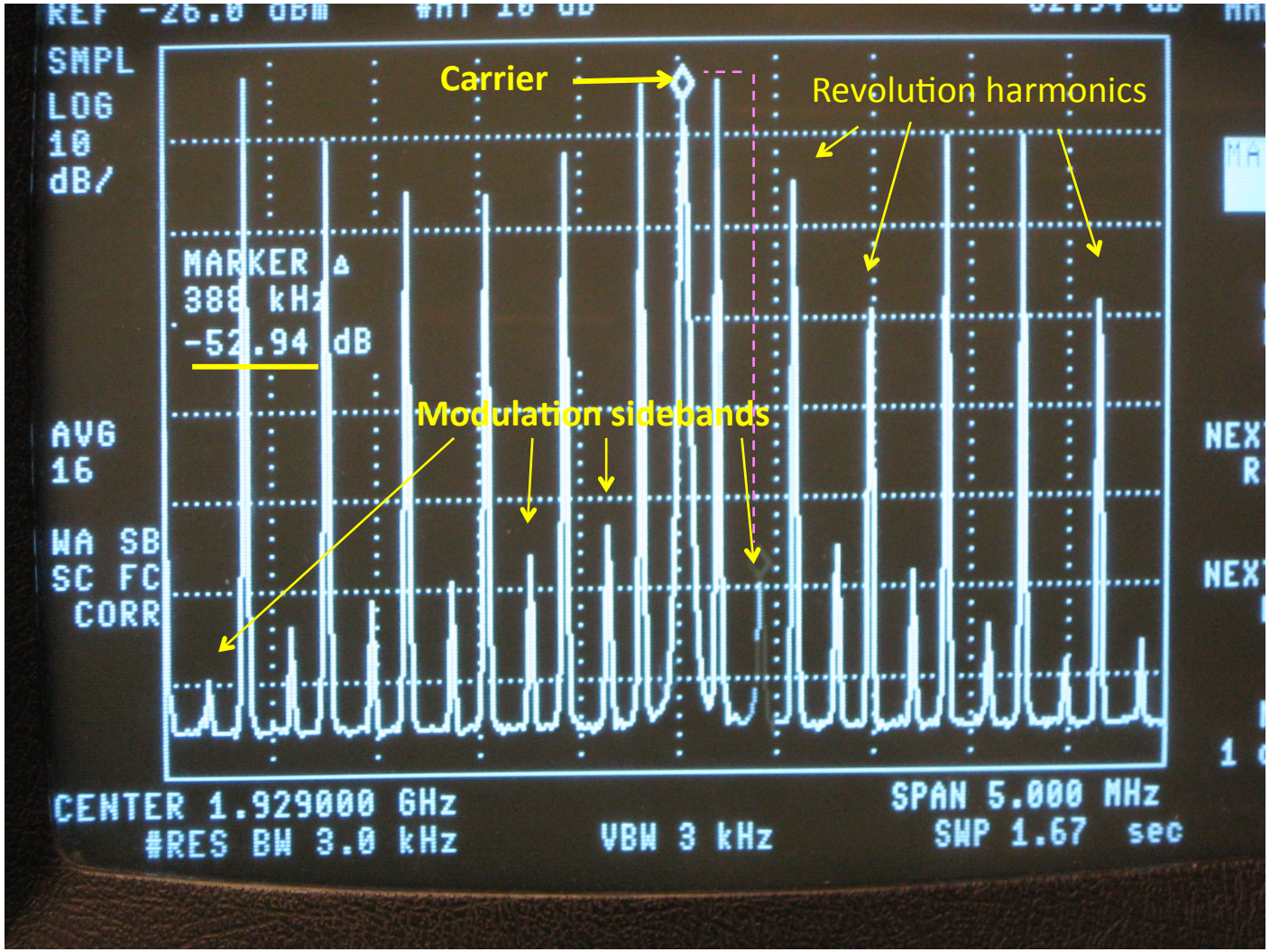
TE-Wave Measurements

- New set of measurements taken in January
  - New instrumentation hardware. Dipole and wiggler measurements.
- Implementation of new techniques
  - "Resonant-wave" measurement. Phase detector.
- Applications
  - Comparison with RFA measurements; primary vs. secondary electron contribution (e^- vs. e^+ beam); dependence on vacuum chamber shape (CLEO E vs. W); cyclotron resonance; dependence on total beam current, bunch current, train length.


0 dBm
Noise floor -115 dBm
Signal Generator
-35 dBm
Receiver
Amplifier
Bandpass Filter
-50/60 dB
Isolator
180º Hybrid
4/10 m
Electron Cloud
e+/e- Beam
TRAVELLING WAVE
RESONANT WAVE

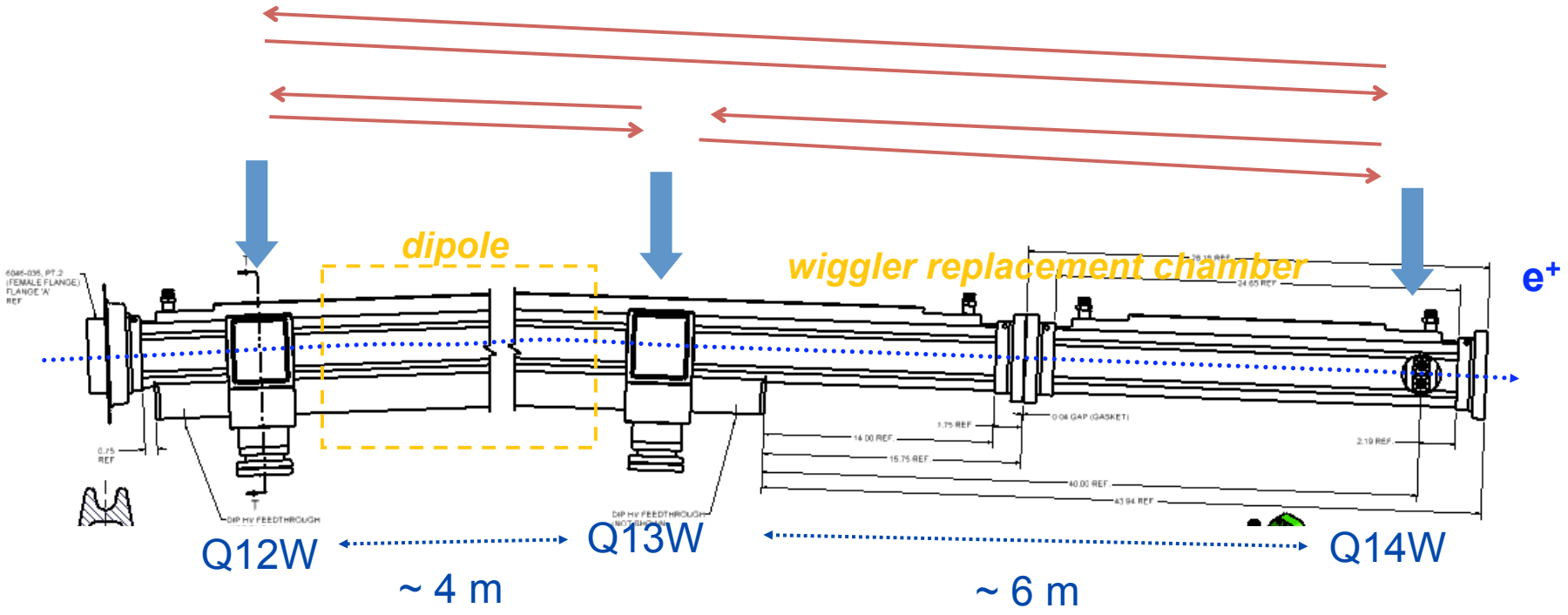

TE Wave Phase Detector
ZLH-5W-2G+
VBFZ-2000+
-10dB
5 Watt Amplifier
Bandpass 1730 – 2270MHz
ZFSC-2-2500
~1.9 – 2.1 GHz +13 dBm
LO
SYM-36H+
RF
IF
VBFZ-2000+
Bandpass 1730 – 2270MHz
TDS 350 Oscilloscope
November 2008

Received Signal

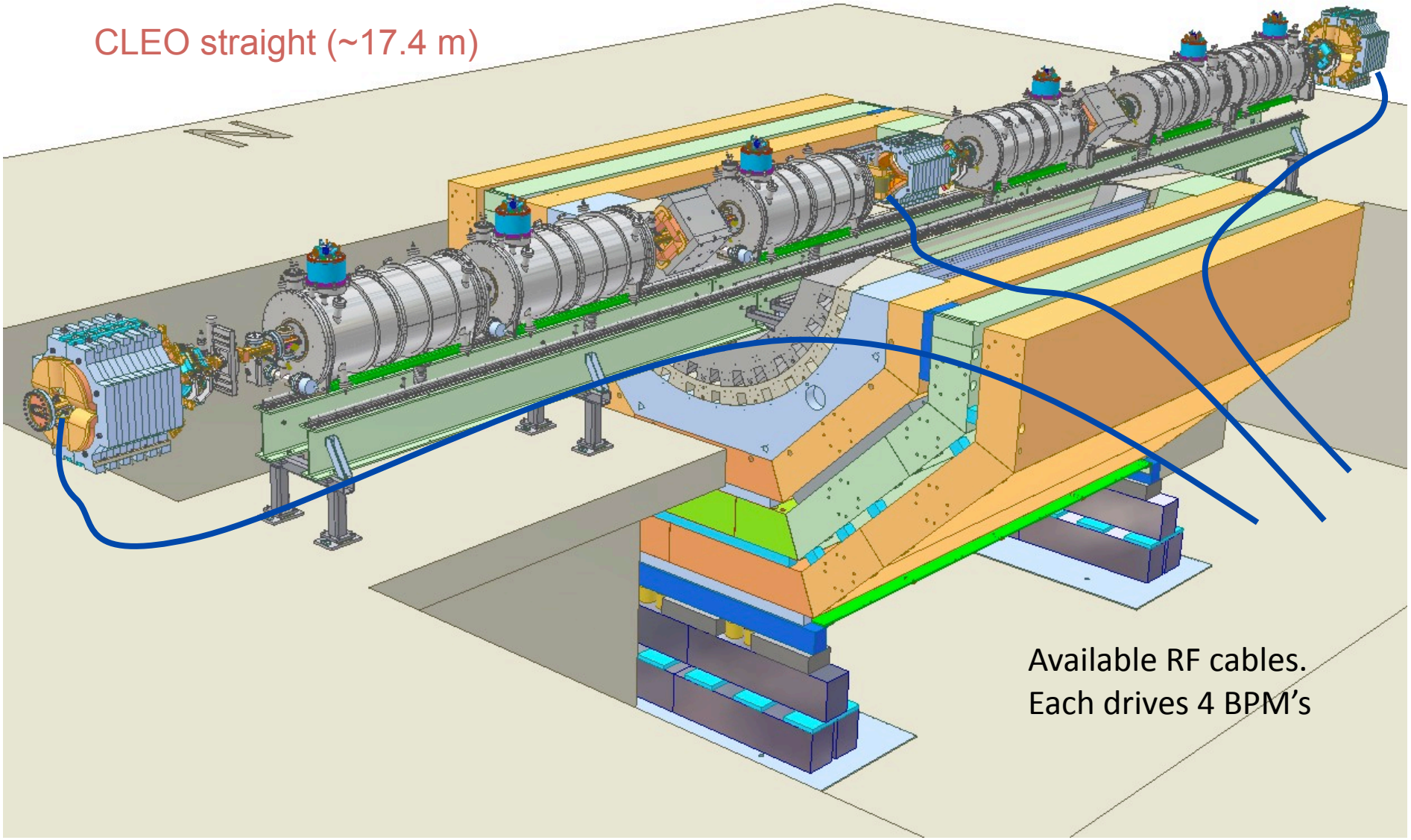


Transmitter/Receiver Positions (*g-line*)

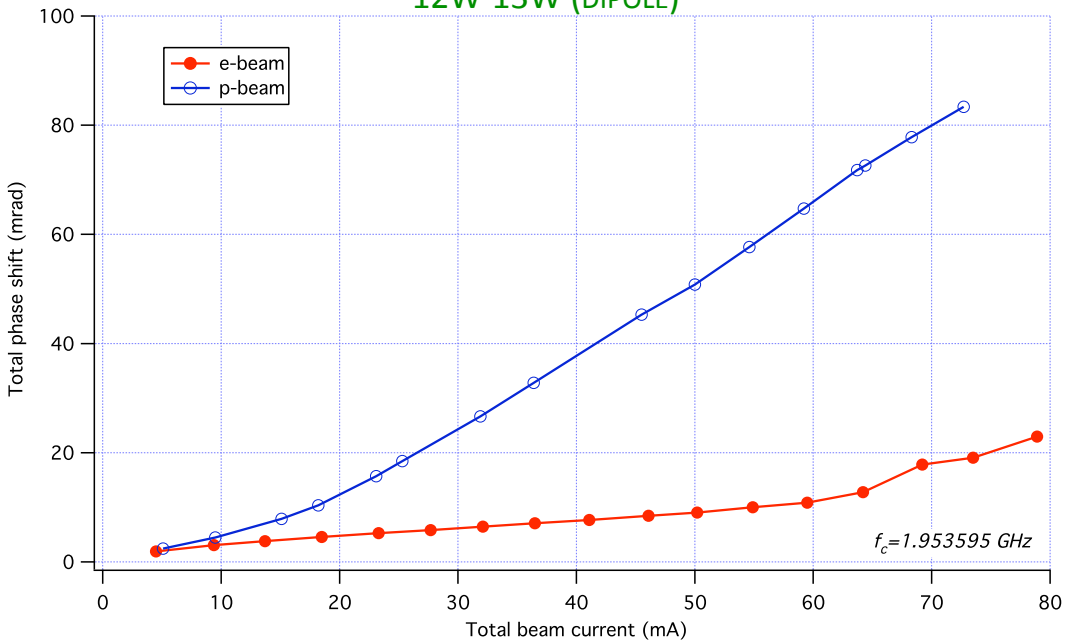
We had 3 BPM available for the measurement, to be used either as transmitting or receiving port.
By trying all the possible combination, we were able to test the effects of different vacuum chambers, different propagation lengths, and different propagation direction between e^+ or e^- beam and TE wave.
The measurements were taken at both 2.0, with a variety of fill patterns.



Transmitter/Receiver Positions (*L0*)



12W-13W (DIPOLE)

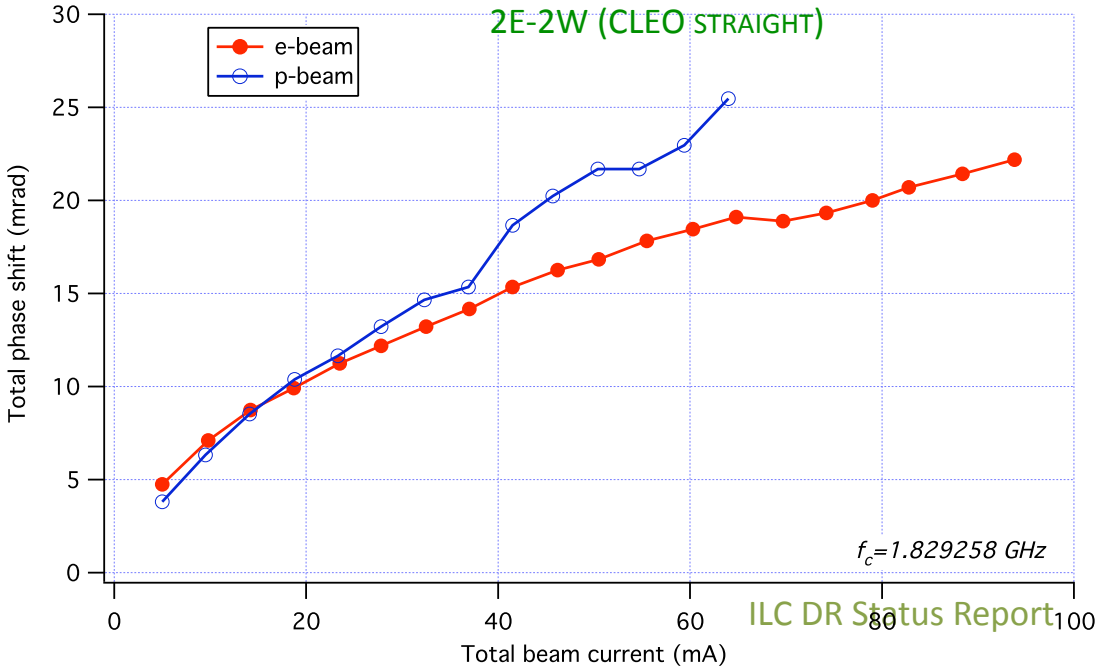


45-bunch train (14 ns)

1 mrad ≈ 10^{11} e^-/m^3 x 0.3 (mod)

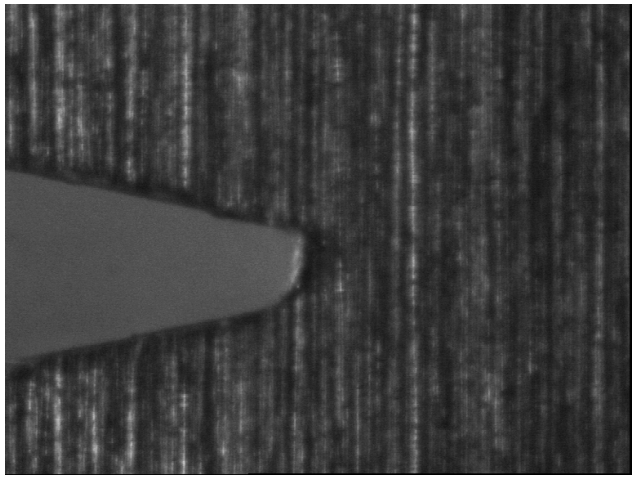
Sensitivity: $2 \cdot 10^9$ e^-/m^3 (SNR)

2E-2W (CLEO STRAIGHT)

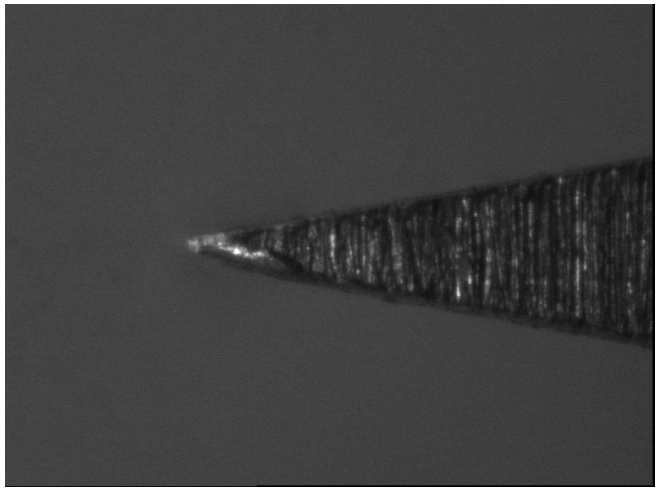


Wiggler Chamber Fabrication Update - LBNL

- One wiggler extrusion chamber is fully machined and ready for machining of grooves in the bottom half.
- Measurements have been taken of a grooved test piece and found to be very good.



Groove valley, approximate radius .002”



Groove tip, virtually sharp.

- Rough machining of all flanges and support hardware for the grooved chamber has begun. Final machining of the chamber profile will be completed after the electron beam welding operation.

Coated Electrode Chamber

- Copper samples with the Tungsten/Alumina coating are being evaluated for resistance to heat due to welding.
  - Samples have been capacitance and hipot (2kV) tested.
  - Coating uniformity has been mechanically measured.
  - Samples will be welded on the uncoated side with two methods; tig weld with CuSil filler and fusion welded to stainless steel with no filler.
  - Capacitance and hipot tests will be performed after welding as well as mechanical/visual inspection.

Machining of copper extrusions