

Low-Charge Operating Point

FAC Meeting Nov 12, 2008

Motivations for Low Charge Operation

- Peak current limited by CSR breakup to ~3KA
- At 20pC should be able to get ~ 1 micron RMS bunch.
- Emittance expected to improve with lower charge
 - Smaller cathode spot → lower thermal emittance
 - Reduced wakefields in LINAC
- Short pulses very interesting for users.

Gun Simulation and Experiment

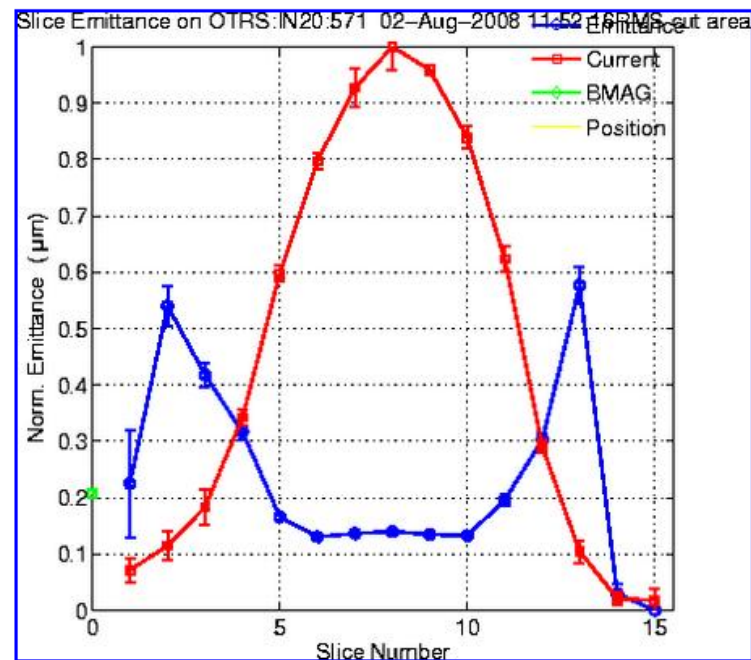
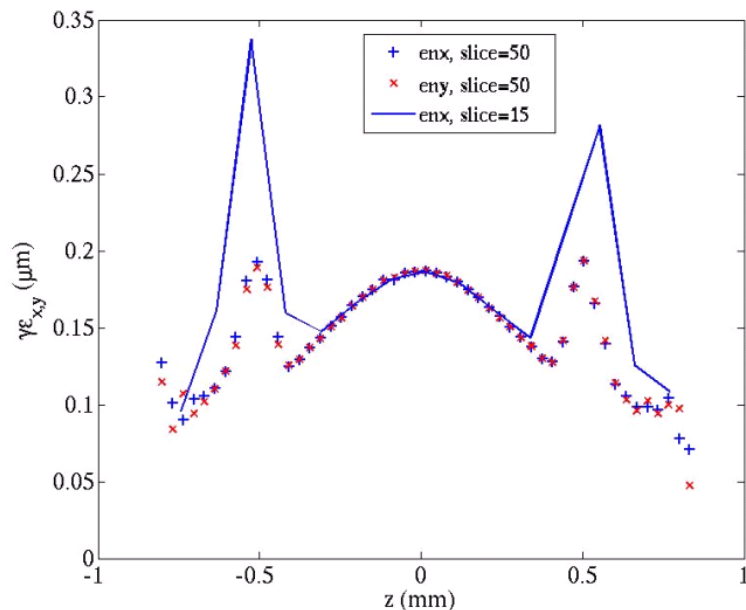
Experiment: Slice emittance @ OTR2:
 19 pC, 0.6mm iris. ~0.15 microns!

Simulation (Impact), 20pC
 0.6mm Iris, Assume 0.105
 micron thermal emittance
 (Y. Ding)

08/02/2008
 11:56

Dowell, Emma, Christensen, Cyterski, Otts

19 pC and 0.6 mm iris
 FJD1

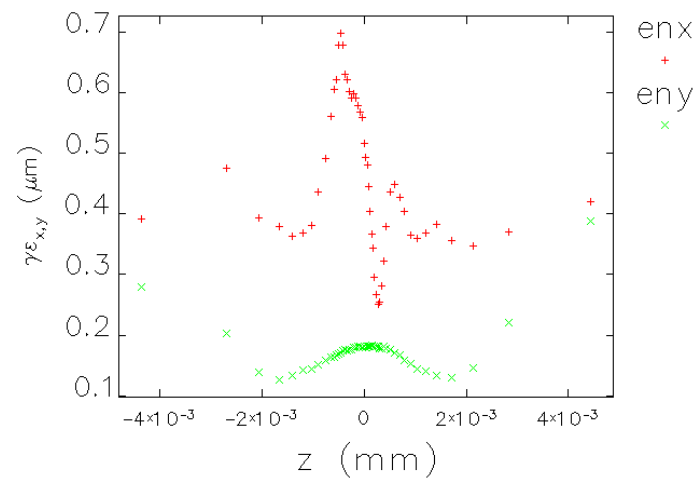
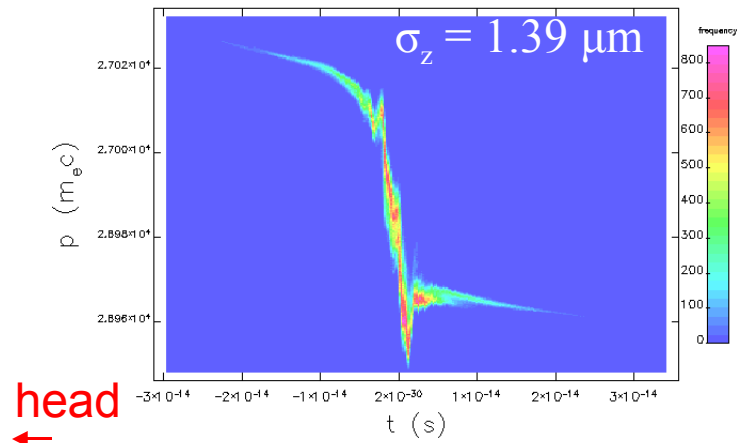


Simulation at beginning of undulator

■ Simulation (Elegant) for over-compression to 1.4 micron RMS bunch length.

■ CSR increases emittance, but only to ~0.7 micron maximum

Data from SDDS file UNDBEGW.out.h2d, table 1

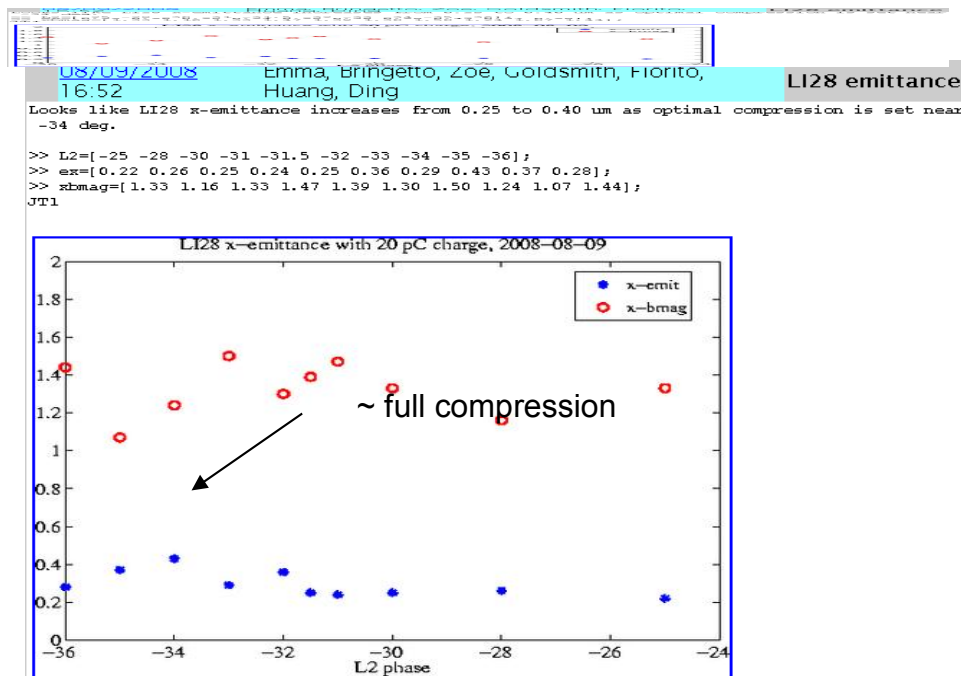


Measured Emittance as a Function of Compression

■ Measured emittance < 0.5 microns at maximum compression

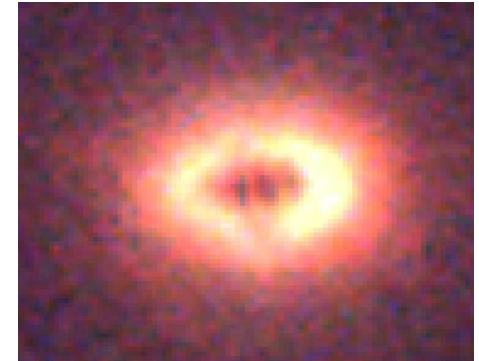
■ Emittance X Bmag < 1.5 microns at full compression

X emittance measured at 20pc as a function of compression at 12 GeV



No Quantitative Bunch Length Diagnostic

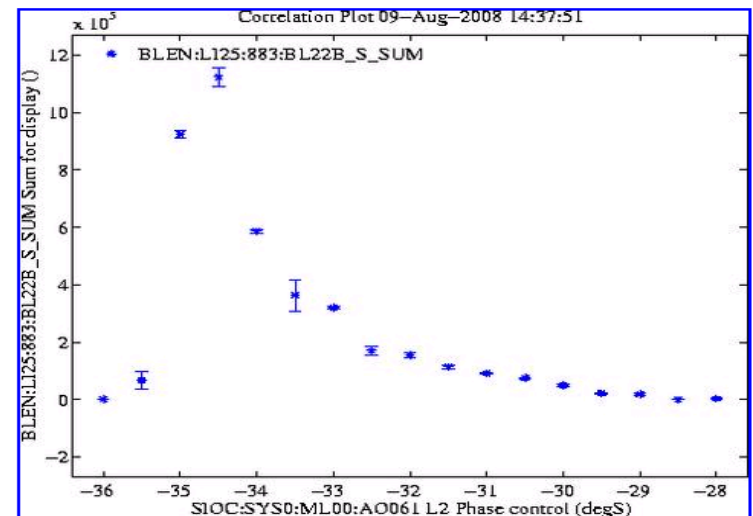
- Pulses too short for S-band TCAV
- Resolution limited to ~ 10 micron RMS
- Use visible light detector looking at OTR screen to find approximate maximum compression phase



08/09/2008
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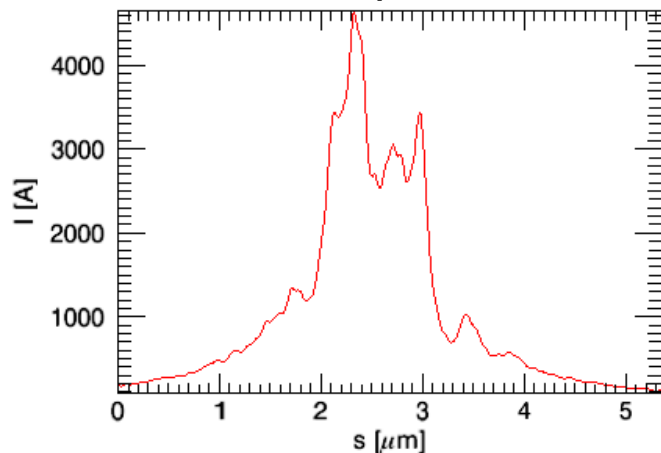
Emma, Bringetto, Zoe, Goldsmith, Fiorito,
Huang, Ding

Joe's new photo-diode in OTR22 sees COTR at ~ 1 μm - (re-took data point JT1)

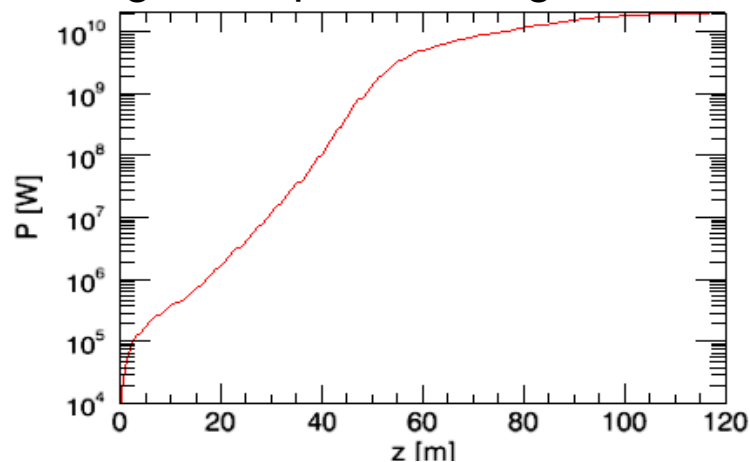


Simulated FEL Operation

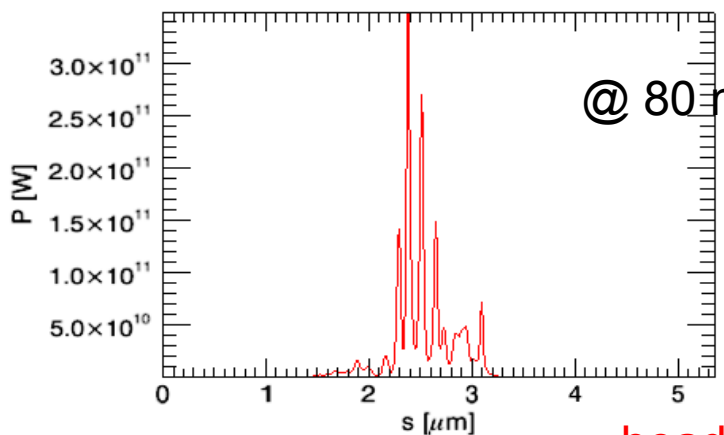
Current profile



Average FEL power along undulator

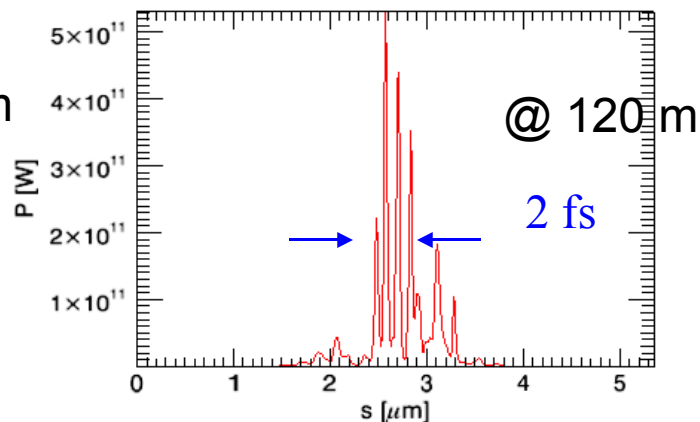


Radiation
power profiles



@ 80 m

→ head



@ 120 m

2 fs

2.8e11 photons

What do we need to operate in ultra-short bunch mode?

■ Diagnostics

- BPMs
- Profile Monitors
- Bunch Length Monitors

■ Controls

- May need improved LLRF
- MPS – probably not an issue

■ Accelerator hardware: **NONE!**

Beam Position Monitors

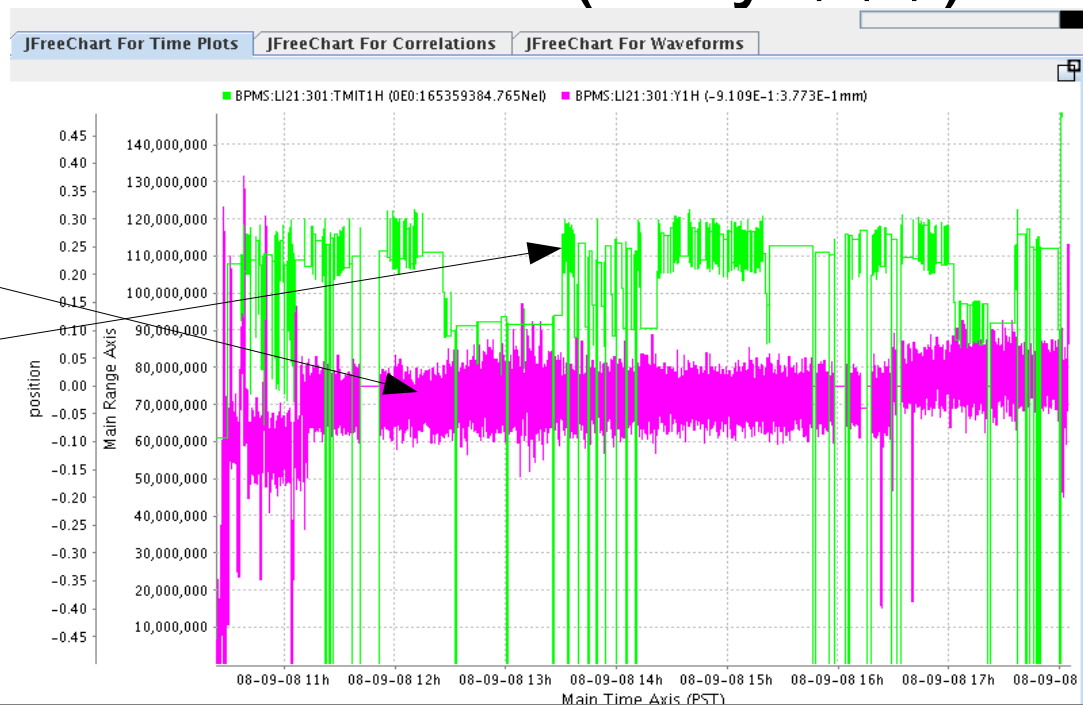
■ Old SLC BPMs will not read 20pC pulses

■ Designed for ~5nC.

■ New LCLS EPICS BPMS work (Only \$\$\$)

20 pC

Beam position ~25 micron
 RMS motion (BPM noise +
 actual beam motion)



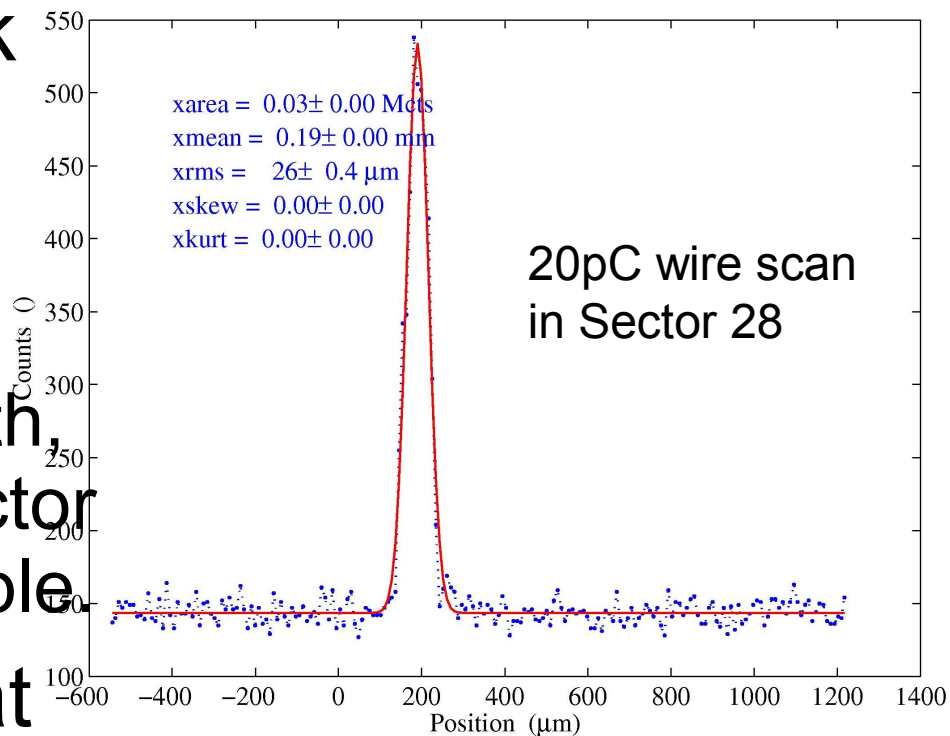
Profile Monitors

■ OTR unlikely to work due to COTR

■ Laser heater may fix microbunching

■ For 1 μ m bunch length, overall bunch form factor can radiate in the visible

■ Wire Scanners OK at 20pC

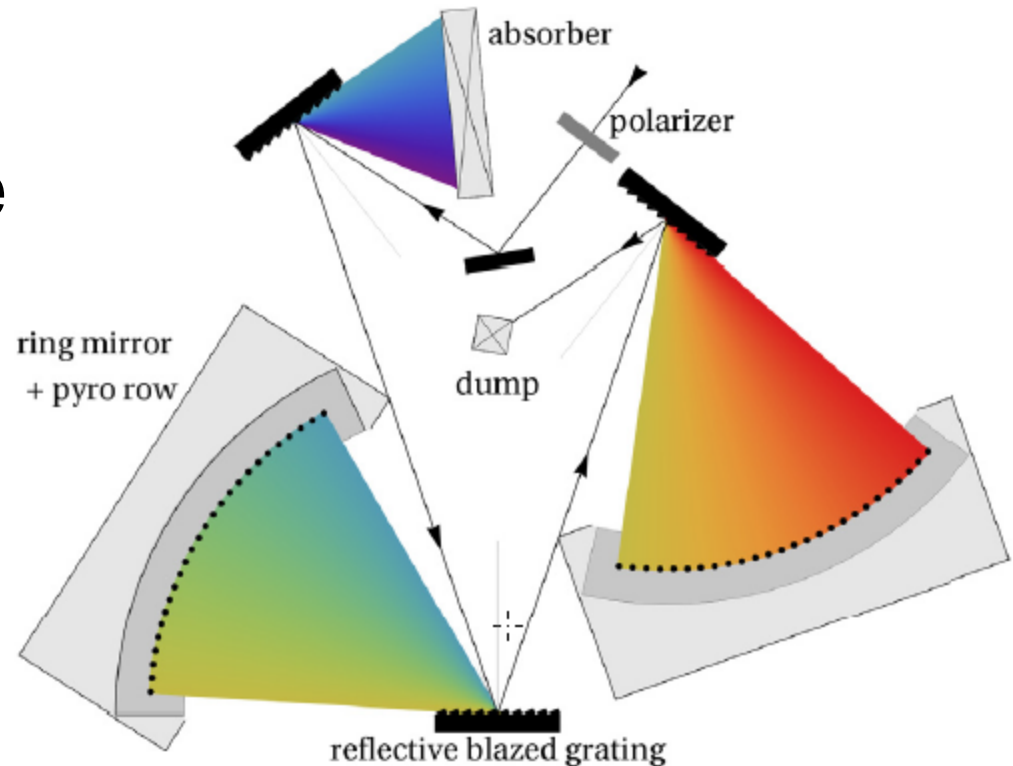


Bunch Length Monitor

- Existing transverse cavity cannot measure 1 micron bunch (limit ~ 10 micron)
- X-band TCAV should do better
 - Expect 2.5 micron
 - Possibility of ~ 1 micron with pulse compression system
 - Complex, long lead time – but excellent measurement
- In short term need spectral measurements

DESY Multi-grating Spectrometer

- Multiple gratings for broad wavelength range
- Need X10 range to reconstruct pulse (.5 to 5 microns)
- 4-grating system should work

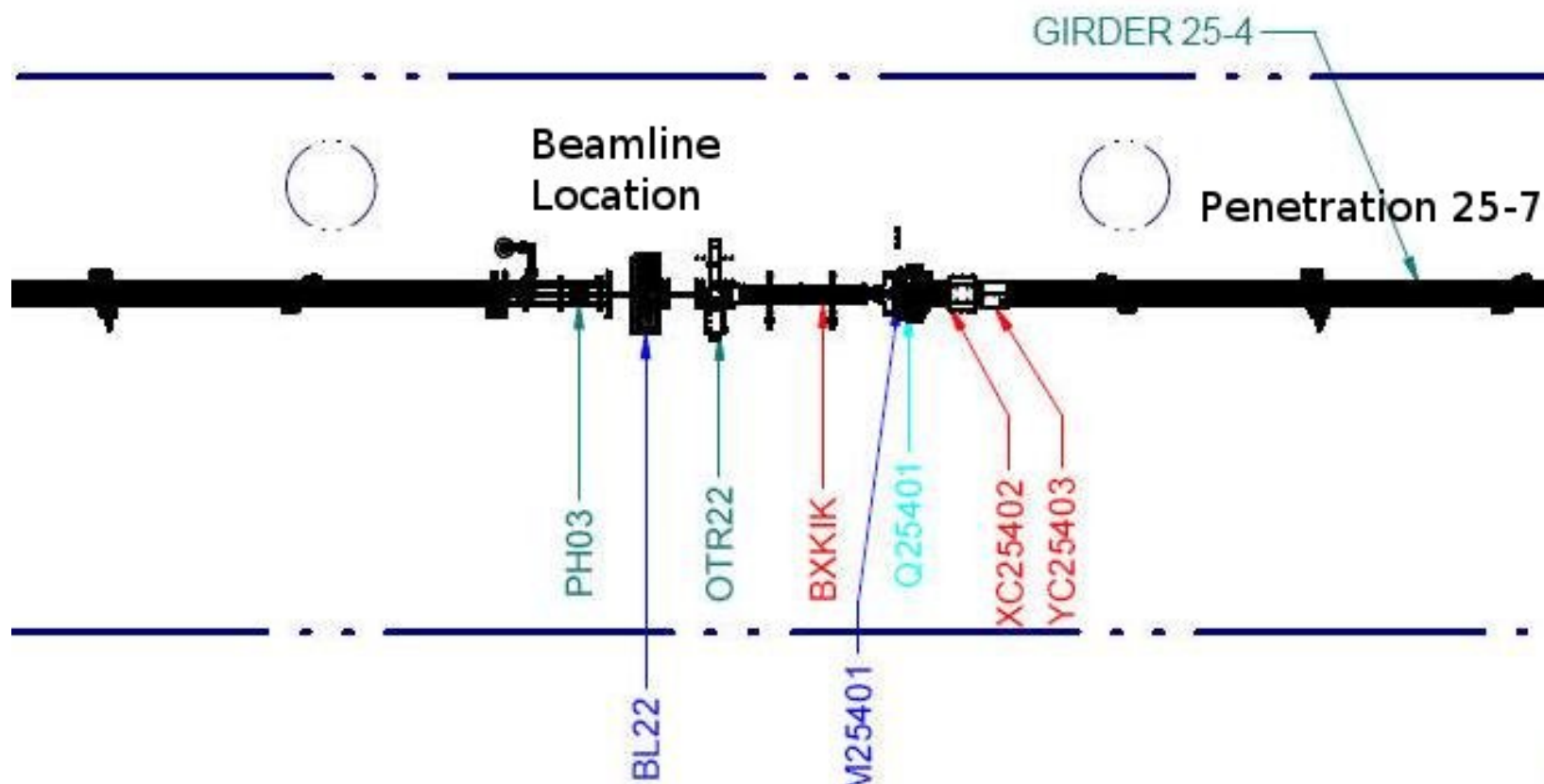


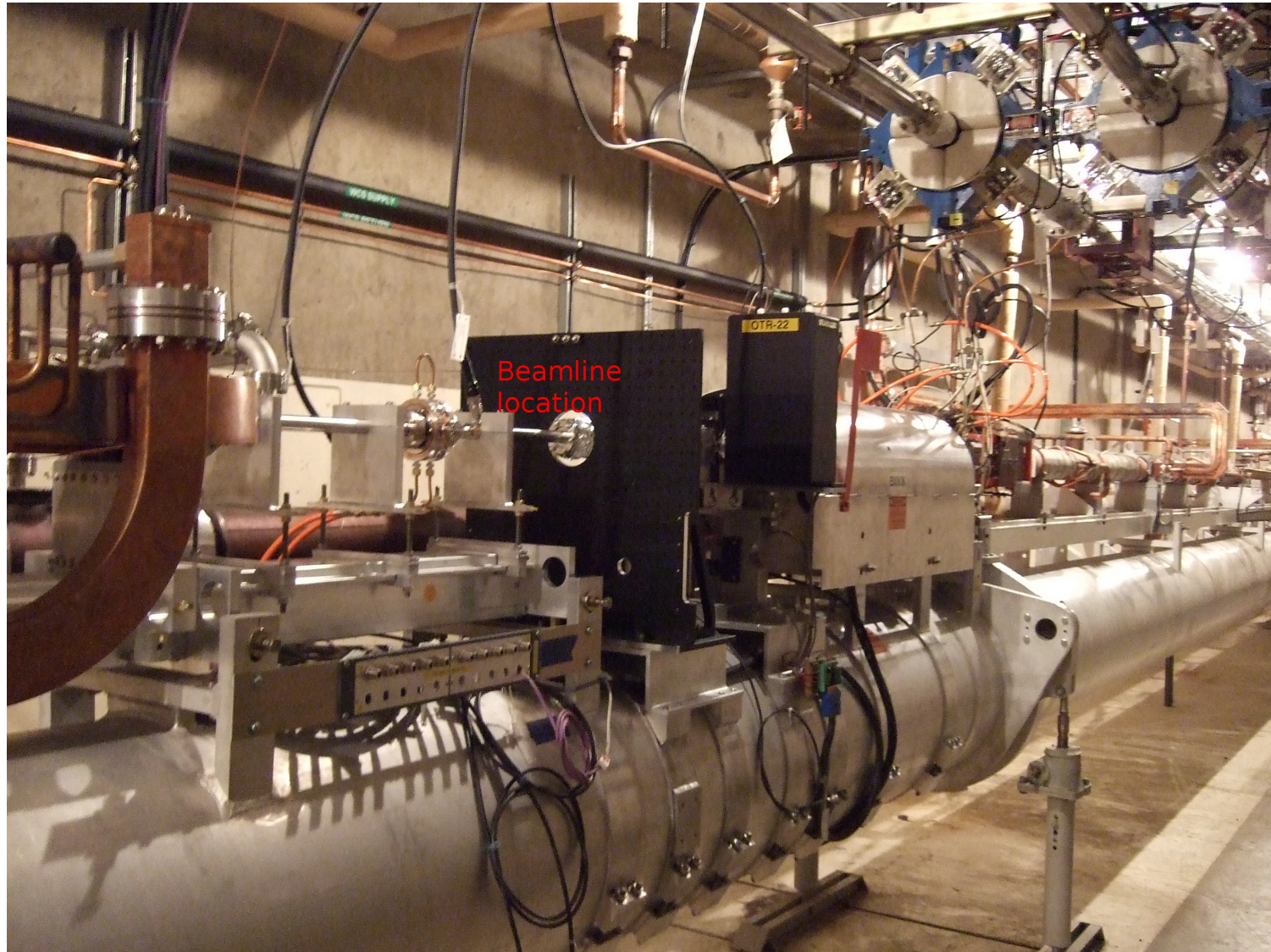
Spectrometer Installation

- Spectrometer DAQ fairly complex
 - 120 independent ADC channels
- Spectrometer must operate in vacuum or dry gas
- Remote control of alignment is difficult
- Install spectrometer in klystron gallery
- UHV transport line in Sector 25 (after BC2)
 - Space downstairs, upstairs, and penetration available.

Transport Line Installation Location

Install after BC2, upstream of structure 25-4.





Nov 11, 2008

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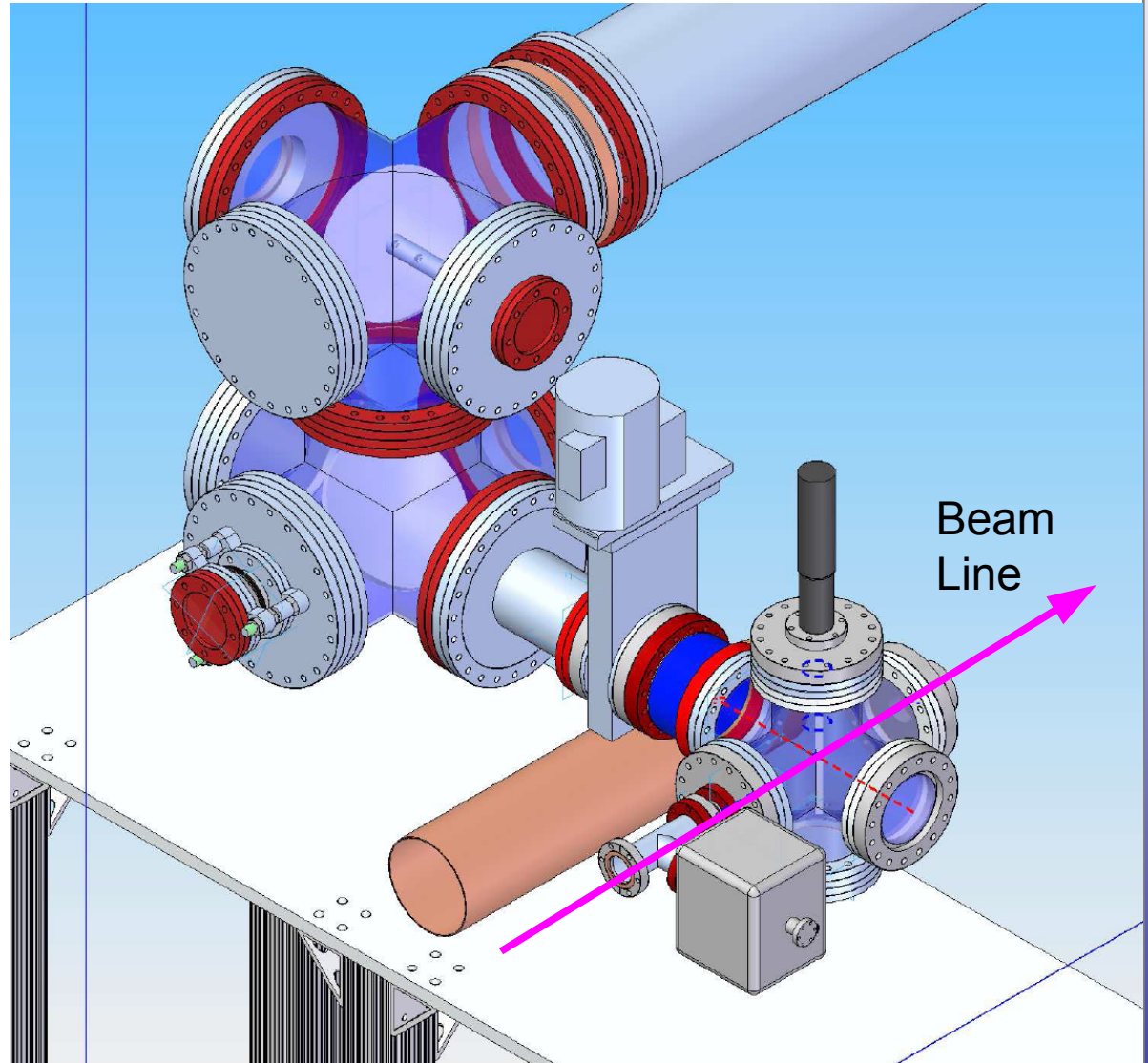
15

Josef Frisch

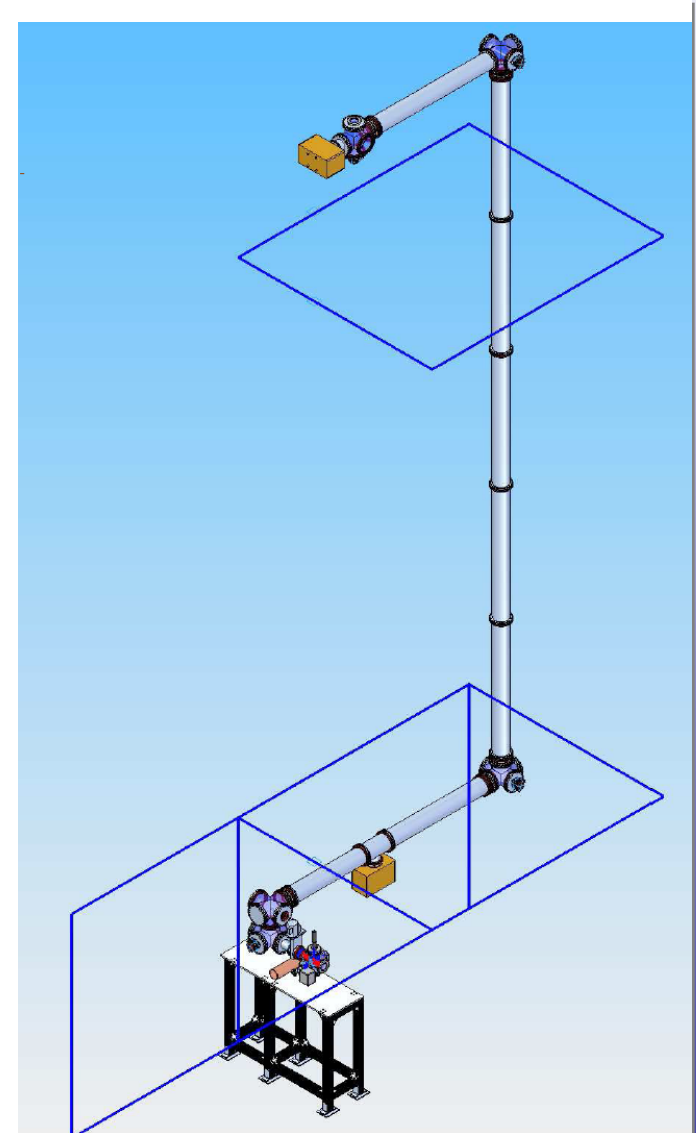
frisch@slac.stanford.edu

Select either 1cm
diameter aperture or
OTR foil

UHV transport



- Transport Line to Surface
- No window in tunnel
- Diamond window upstairs
 - Option for UHV connection to upstairs experiment
- Visible to near IR for ultra-short bunch length measurement
- 10 micron to 2 millimeter transmission for mm-wave / FIR tests
 - Very bright FIR source



Ultra-short Bunch Operation Status

- Believe we have low emittance, high peak current 1 micron RMS bunches
- Need diagnostics to operate accelerator in this mode
 - New BPMs, Spectrometer bunch length measurement.
- Transport line for spectrometer also useful for mm-wave / FIR experiments
- **“Only” Money and Manpower**