# SLAC Electron Beam Test Facilities 5 MeV to 20 GeV

## FACET • ESTB • NLCTA • ASTA
## Focus on ESTB

Carsten Hast, SLAC

TIPP 2014, Jun. 5th, Amsterdam 2014

U.S. DEPARTMENT OF ENERGY
Office of Science

SLAC NATIONAL ACCELERATOR LABORATORY

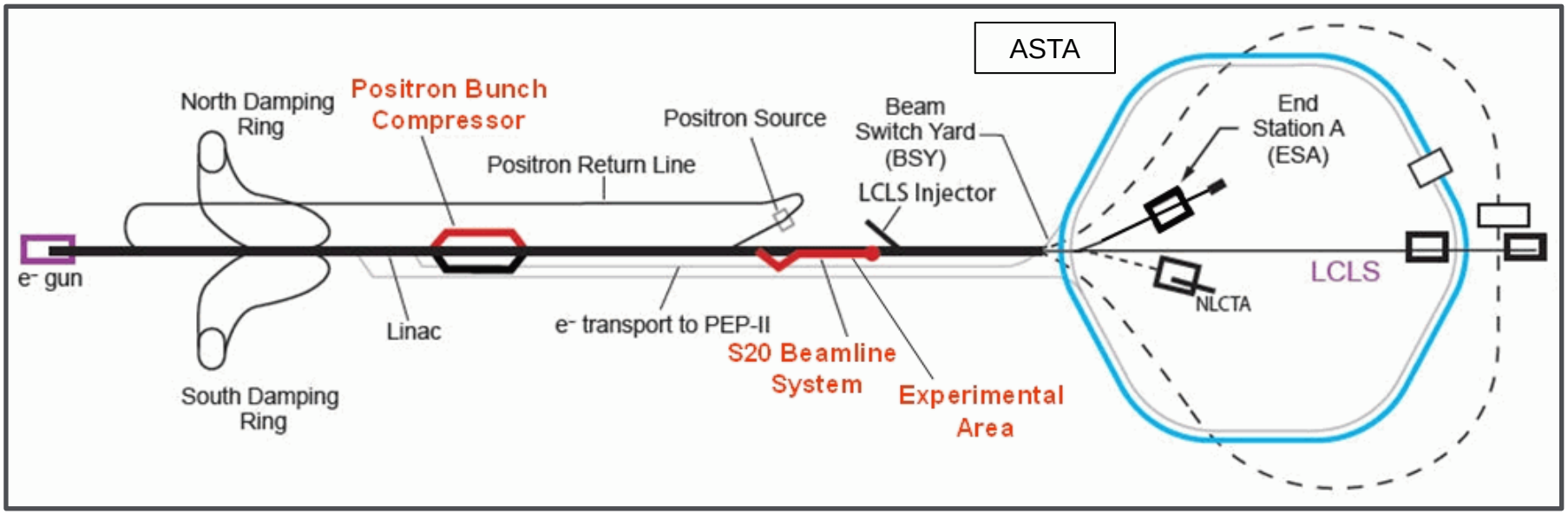

20 GeV
FACET
5 MeV
ASTA
2-15 GeV
& single e-
NLCTA
60-160 MeV
ESTB

# SLAC Beam Test Facilities Overview

| Facility | Purpose | Parameters |
|---|---|---|
| FACET | Accelerator R&D, Material Science, THz | Very focused and short bunches at 20GeV e+/- |
| ESTB | Detector R&D, LC MDI, Radiation Tests | 2-15GeV primary LCLS beam or single e- |
| NLCTA | Accelerator R&D, Medical, Radiation Tests | 60 to 160 MeV, small emittance, very versatile infrastructure |
| ASTA | Gun and RF Testing, RF processing, new Ultrafast Electron Diffraction Beam Line | <50MeV, X- and S-Band RF power |

- All supported by SLAC's Test Facilities Department
- http://facet.slac.stanford.edu and http://estb.slac.stanford.edu
- e-mail: hast@slac.stanford.edu
- Google: SLAC FACET or SLAC ESTB

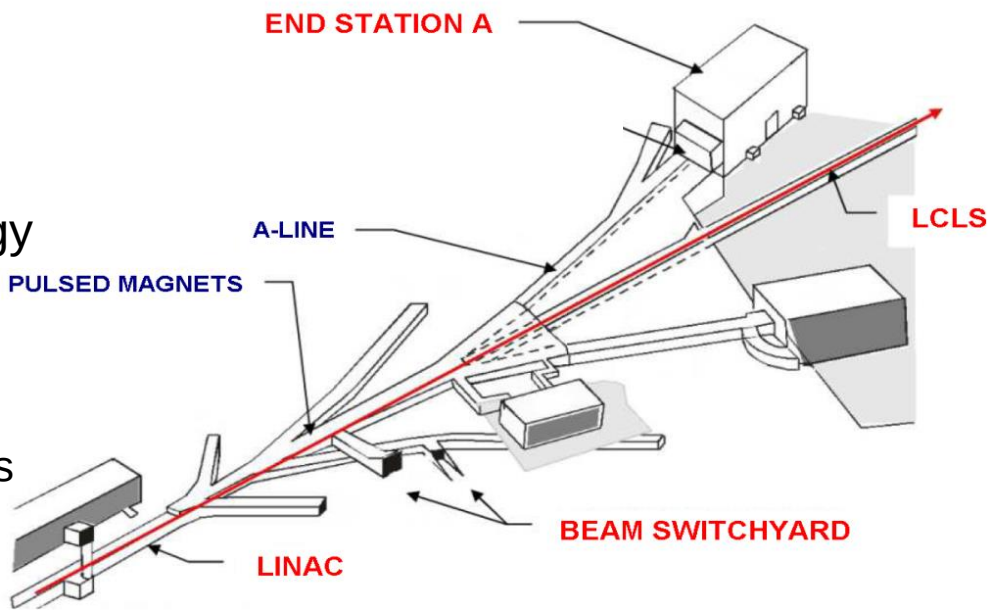
# SLAC Accelerator Layout




FACET uses 2/3 of SLAC LINAC
LCLS uses 1/3 of SLAC LINAC
SSRL
End Station A
LCLS

# End Station Test Beam (ESTB)

- LCLS beam is deflected to ESTB at 5Hz
- 2 kicker magnets in Beam Switch Yard
  - Primary beam up to 10GeV
  - Need 2 additional kickers for 16GeV (funding)
- Secondary particle production target in BSY
  - Just kick beam onto 5mm of Cu
  - Secondary electrons up to 15GeV
- Beam is bend by 24.5$^{o}$ into ESA
- Multi stage collimation system for energy selection and rate adjustment
- Construction completed in May 2013
  - In our first year we had 11 different groups
  - 15 different runs, about 110 User on site




**Wide user acceptance of ESTB within a short time**

# LCLS and ESTB Electron Beams

SLAC

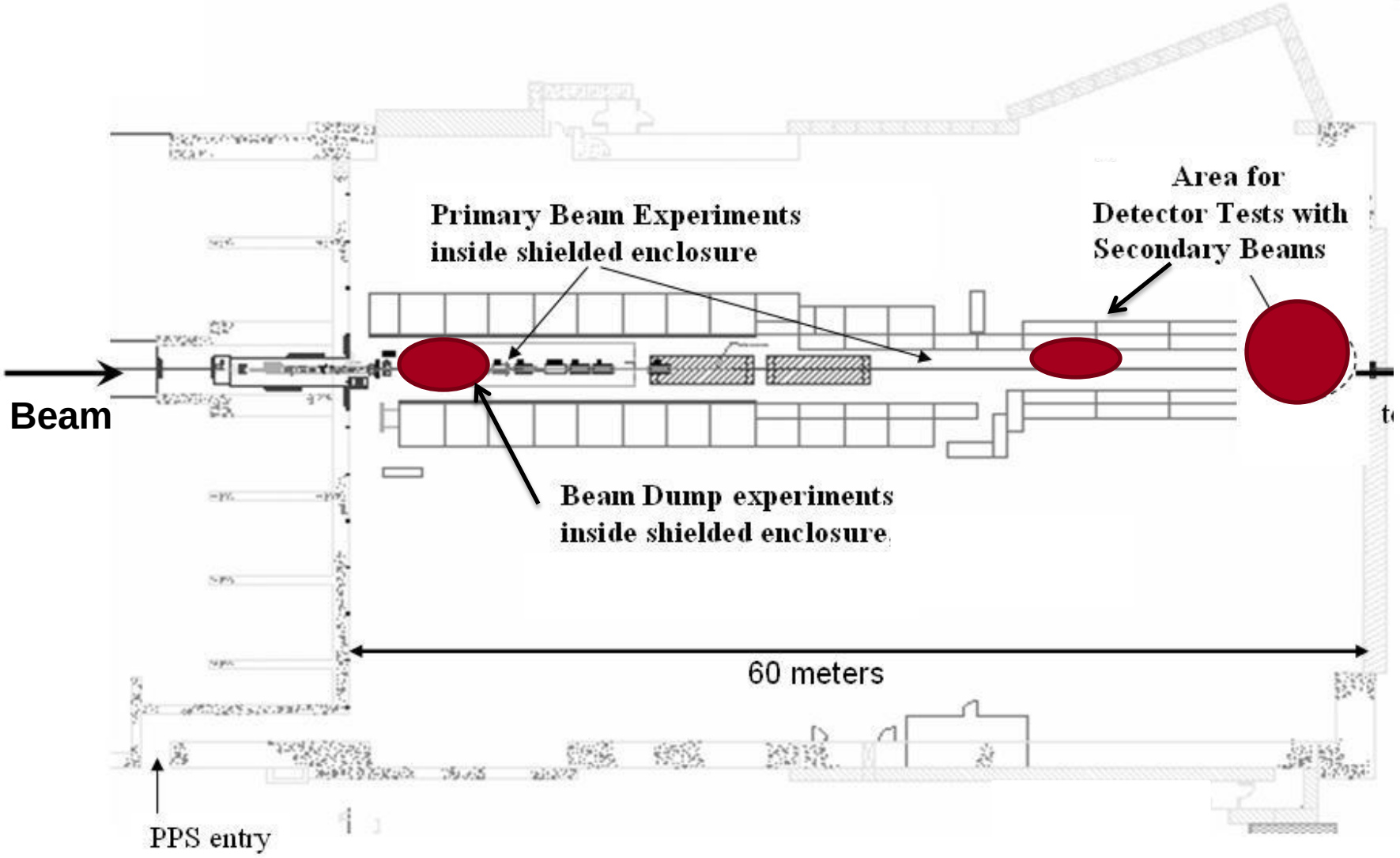
LCLS beam

- Energy: 2.2 –16.6 GeV (typically 3-6GeV or 12-14GeV)
- Repetition rate: 120Hz
- Beam charge: 20 to 250 pC (typically 150pC ~ $10^9$ $e^-$/pulse)
- Beam availability > 95%
- User are scheduled in 2 shifts 9am to 9pm and 9pm to 9am
  - User beam is typically Thursday 9am to Tuesday 9am following week
  - Machine development and maintenance Tuesday and Wednesday
  - Typically beam energy changes at shift change (~1h)

ESTB beam

- Kick the LCLS beam towards ESA @ 5Hz
  - Potential for higher rates when LCLS doesn't need full rate
- Primary beam 2.2 -10.0 GeV (need more kickers for 16.6GeV)
  - Beam energy determined by LCLS
  - Typically 150pC ~ $10^9$ $e^-$/pulse
- Clean secondary electrons
  - 2 GeV to 16 GeV (always lower than primary beam)
  - 1, or a few, up to 100 $e^-$/pulse (Poisson distributed)

# Building 61: ESA



# ESA

- ESA has massive shielding
  - Pretty good temperature stability
- Beam line is at 6’10”=208cm
- Crane coverage
- Vacuum up to your experiment
- Beam path is straight for about 150m after the last bend magnet
- Protection collimators limit spot size to about 20mm diameter max
- Primary beam can be focused to 50-100 microns
- Secondary beam can be focused to about 1mm
- Energy resolution is in the per mill range

# T-507: Test of a RICH-Prototype Based on CsI-GEMs for an Electron-Ion Collider

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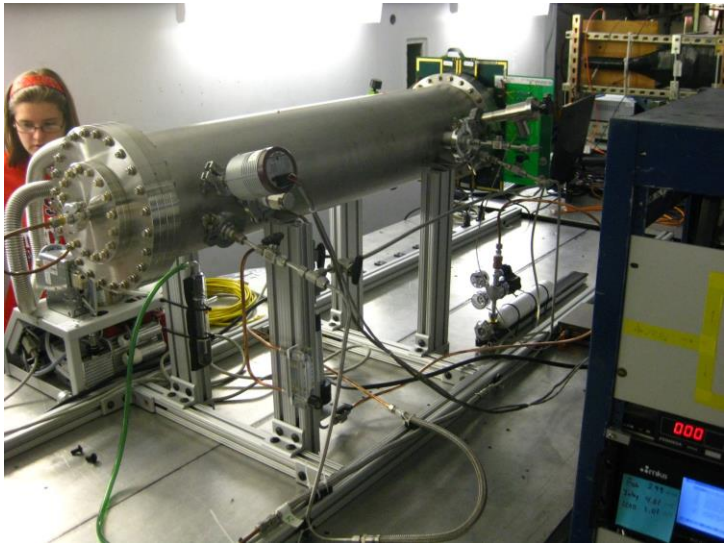
- T. Hemmick, Stony Brook Uni.
- Single electrons @ 5 Hz, 9 GeV
- 4 24h days from 5/31 to 6/03 2013
- Recorded 1.4 million triggers
- Ran for 84% of wall clock time

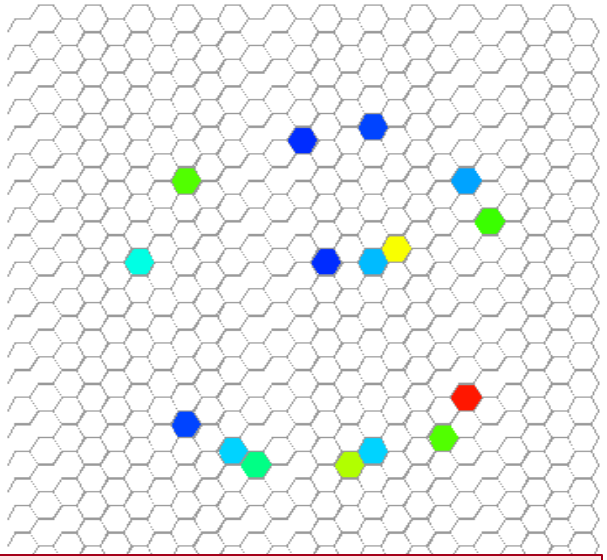
**Tom Hemmick**

**Abhay Deshpande**

**Klaus Dehmelt**

**Nils Feege**





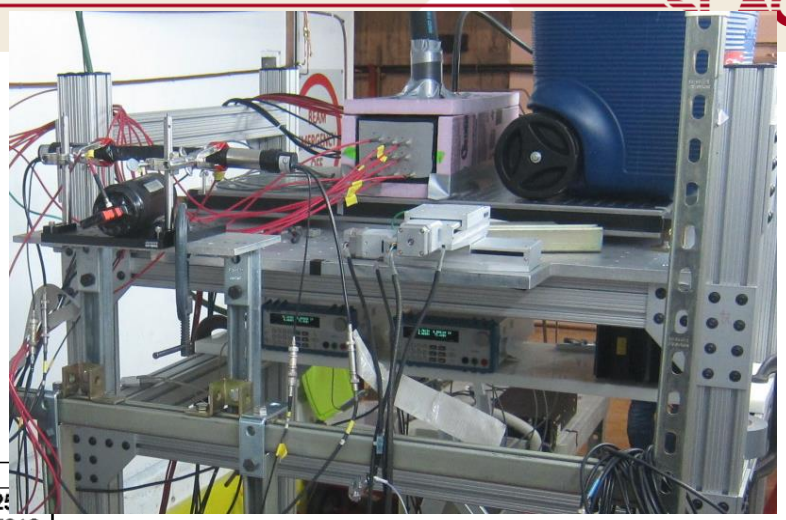
**Stephanie Zajac**

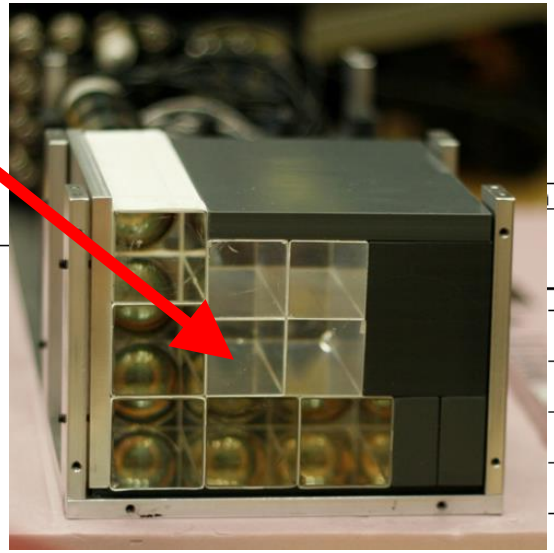
**Marie Blatnik**

T.Hemmick is leading T-517 Phenix Calorimeter later this year

# T-512: Test of FNAL g-2 Calorimeter

- D.Hertzog, Univ. of Washington
- 8 collaborating institutions
- Single electrons @ 5 Hz, 2-6 GeV









g-2 back at ESTB for 2 weeks in July and 2 in October for calorimeter calibration

# T-516 Atlas Si Tracker Upgrade work at ESTB
## Andrew Blue, Glasgow

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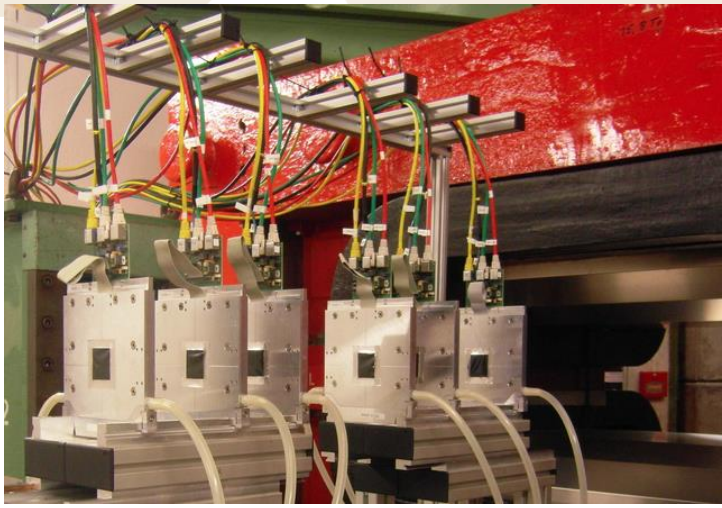
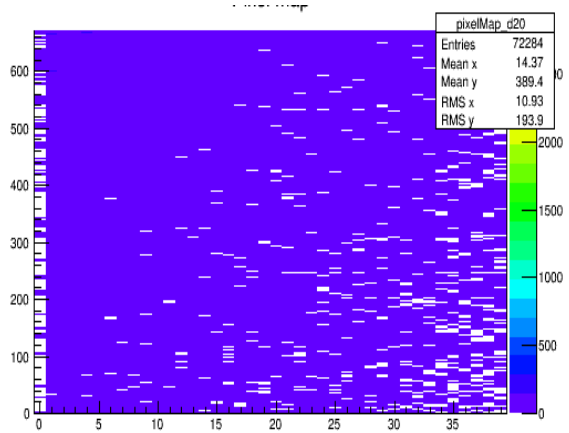
Tested 8 devices

- At various biases, thresholds and positions
- 3 Irradiated with 1x$10^{15}$ 1MeV neutrons
- 1 quad (2x2 chips)

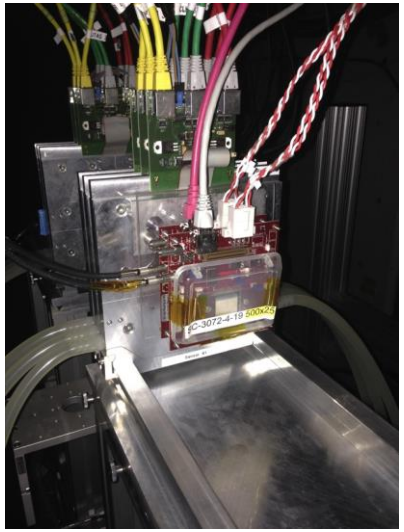
SLAC's 13.5GeV allowed us to

- Reduce multiple scattering
- Test multiple devices
- Beam trigger has also increased stats
  - Instead of using smaller scintillator

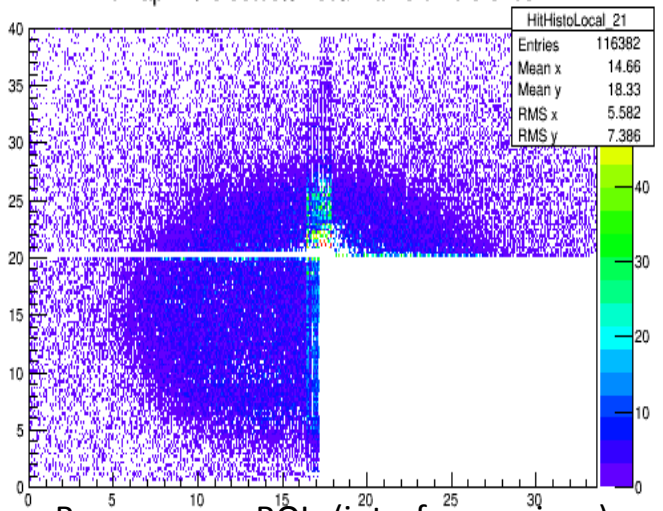





Full coverage of sensor with 50-100 tracks/pulse



Hit map in the detector local frame of reference



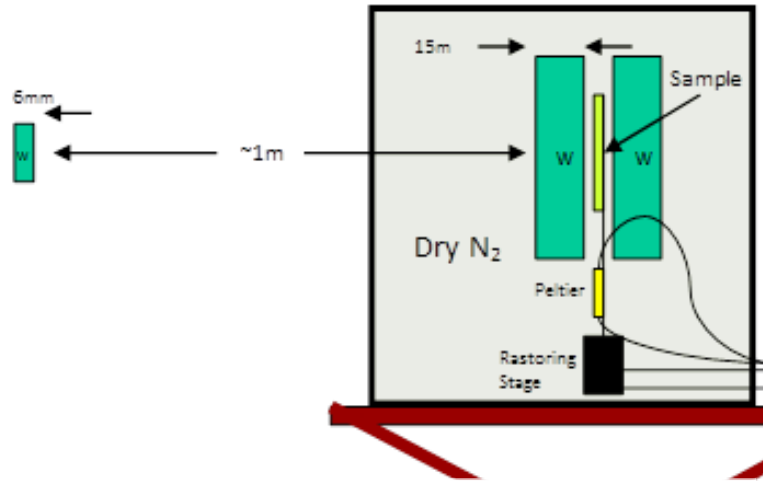

Beam covers ROIs (interface regions)

# T-506: Electromagnetic Shower Damage to Silicon Diode Sensors

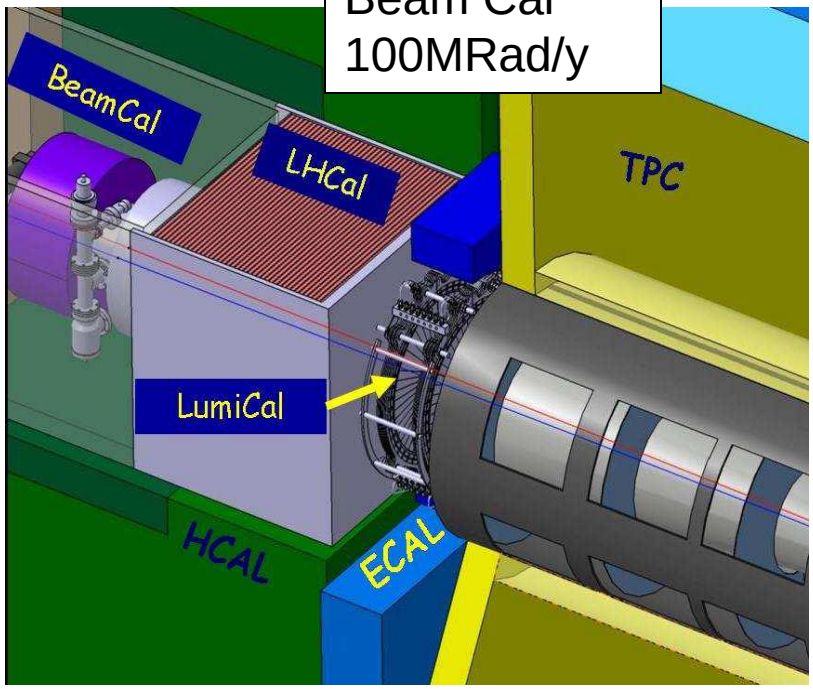
SLAC

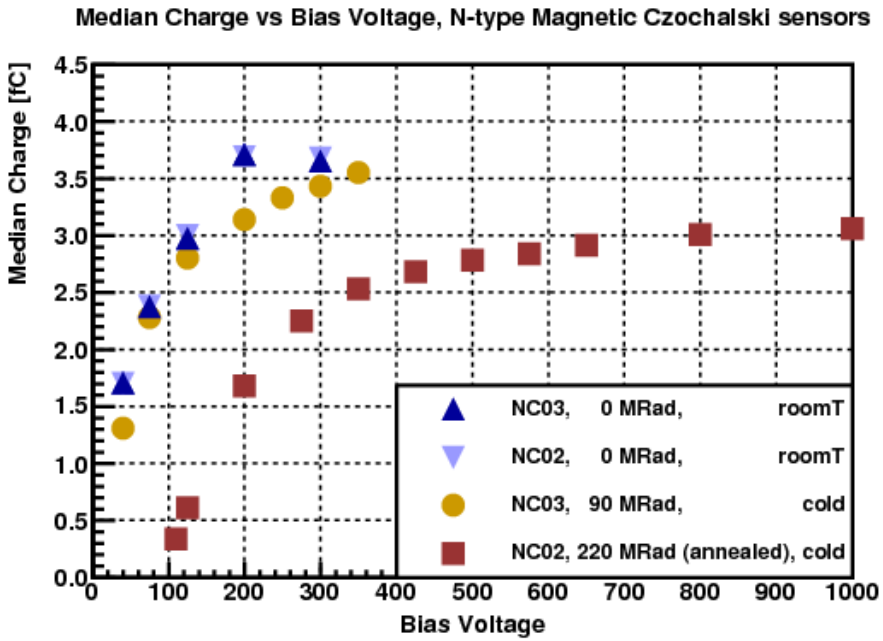
PI: Bruce A. Schumm, UC Santa Cruz

Physics Goals: Test of radiation tolerance of various silicon sensor technologies in realistic shower spectra for ILC forward detectors




Beam Cal
100MRad/y



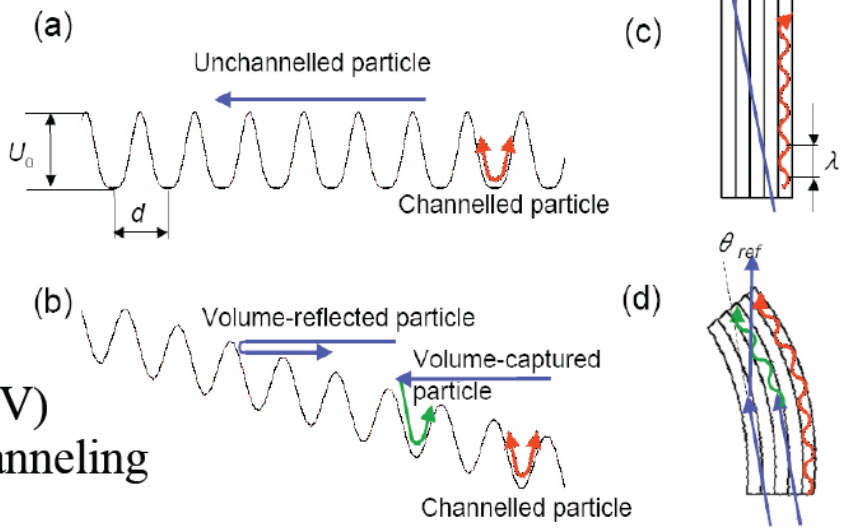
# T-513: Channeling and Volume-Refection in Crystals
## Uli Wienands, SLAC

SLAC

- Beam Collimation
- Multi MeV gamma ray generation

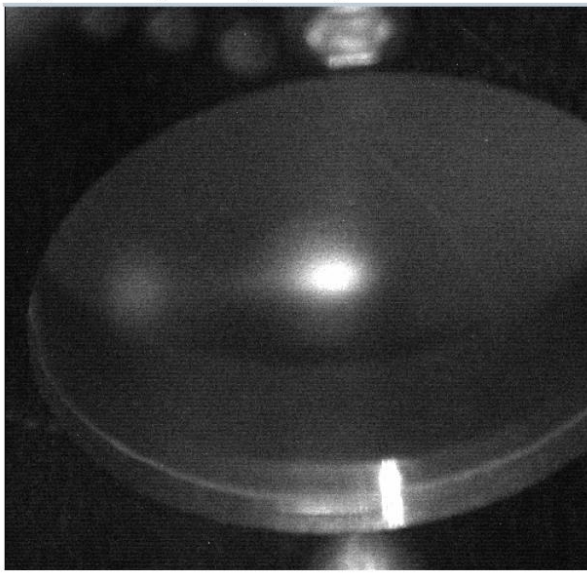
Possible processes:

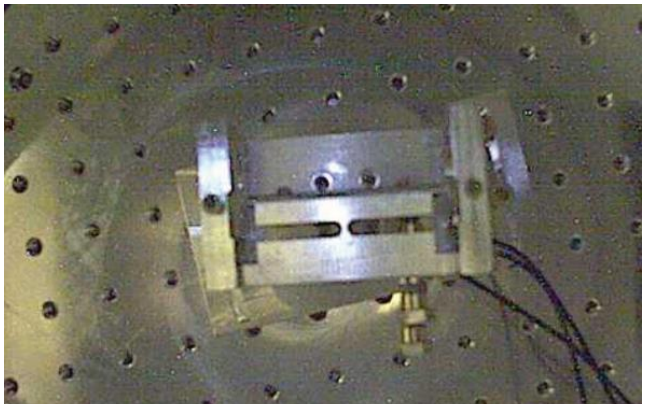
- multiple scattering
- channeling
- volume capture
- de-channeling
- volume reflection



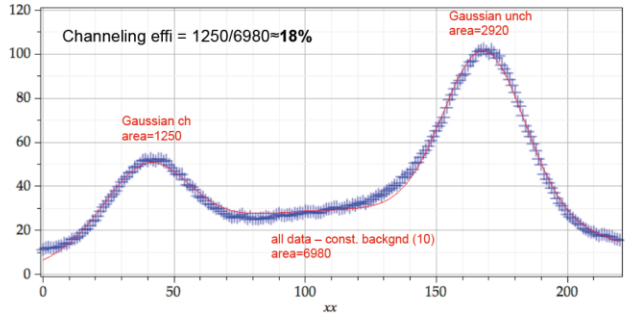

$\Psi_{crit} \approx 60$ µrad (6.3 GeV)
for Si (111) planar channeling

≈ 450 µrad (in a 60µm crystal!)





Highly preliminary analysis




- Corresponds to a 150T magnet
- 18% channeling efficiency

# T-510: Geosynchrotron emission from extensive air showers

# ESTB User Experiments FY2013 and FY2014

FY 2013

- T-505: Tests of 3D silicon pixel sensors for ATLAS, P. Grenier, SLAC
- T-506: EM Shower Damage to Si Diode Sensors, Bruce Schumm, UCSC
- T-507:Test of a RICH-Prototype Based on CsI-GEMs for an Electron-Ion Collider, T. Hemmick, Stony Brook University
- T-508: HERA-B ECal modules beam test in ESTB at SLAC for $G_{Ep}(5)$ at Jefferson Lab, E. J. Brash, Christopher Newport University
- T-511: Test of a Silicon-Tungsten Electromagnetic Calorimeter for the ILC SiD, R. Fry, Univ. of Oregon

FY 2014

- T-505: Tests of 3D silicon pixel sensors for ATLAS, P. Grenier, SLAC
- T-512: Calibration of the g-2 calorimeter, D. Hertzog, Univ. of Washington
- T-513: Channeling and Volume-Reflection Studies of High-Energy Electrons in Crystals, U.Wienands, SLAC
- T-510: Geosynchrotron radio emission from extensive air showers to detect ultra-high energetic neutrinos at Antarctica, K. Belov, UCLA
- T-513: Channeling and Volume-Reflection Studies of High-Energy Electrons in Crystals, U.Wienands, SLAC
- T-509: Develop a Neutron Beam Line for Calibration of Dark Matter Detectors, J. Va'Vra, SLAC
- T-506: EM Shower Damage to Si Diode Sensors, Bruce Schumm, UCSC
- T-516: ATLAS Inner Tracker (ITK) Upgrade, Test of several pixel sensor technologies, M. Bomben (Paris), P. Grenier (SLAC), S. Grinstein (Barcelona), D. Muenstermann (Geneva) and J. Weingarten (Gottingen), on behalf of the ATLAS-ITK Pixel Group
- T-520: Radiation Test of Epoxy for LCLS Delta Magnet, C. Field, SLAC

FY 2014 coming up

- T-517: PHENIX MPX-EX Calorimeter, T. Hemmick, Stony Brook University
- T-516: ATLAS Inner Tracker (ITK) Upgrade, Test of several pixel sensor technologies, ATLAS-ITK Pixel Group
- T-519: Calibration of the g-2 calorimeter, D. Hertzog, Univ. of Washington

# Summary

- ASTA-NLCTA-ESTB-FACET span a broad spectrum
  - $e^-$ energy between a few MeV to 20 GeV
- Together they cover broad research themes
  - Novel and better acceleration techniques
    - RF, X-Band, WFA, DLA, GTL, FEL Seeding, UED
  - BDL/MDI for Linear Colliders
  - Detector R&D
- User and technical support is via Test Facilities Department
- Formal proposal review processes for FACET and ESTB
  - Please submit your proposals
    - Formal call is coming out this week for review in September
    - http://facet.slac.stanford.edu and http://estb.slac.stanford.edu

**Need Electrons? Come to SLAC !**