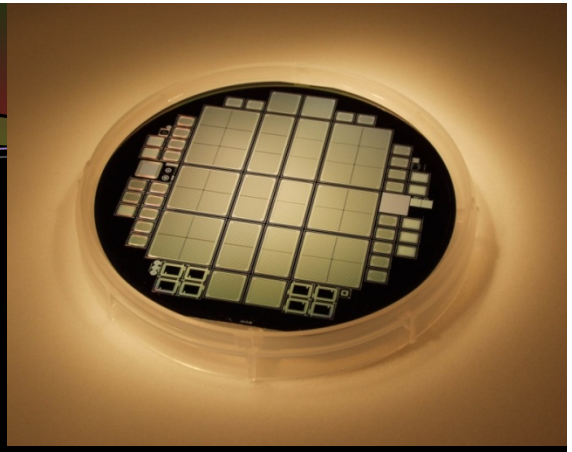
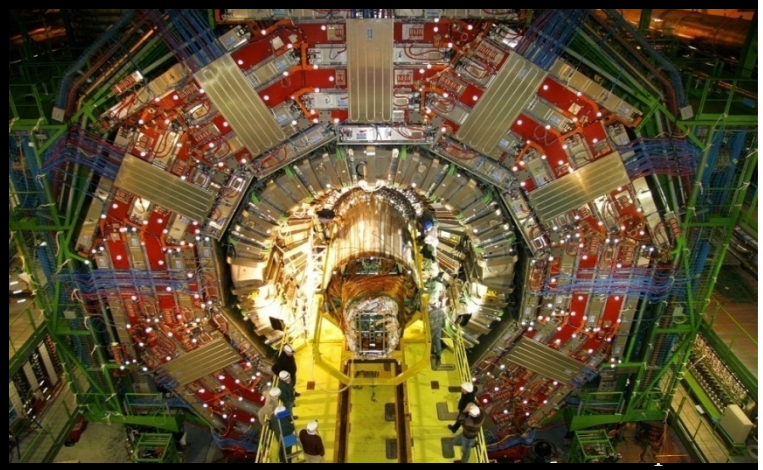
Solid State Detectors



- **Overview of over 40 posters in 20 minutes**
- **I will cover**
  - **The LHC experiments**
  - **Their upgrades**
  - **Radiation hardness issues**
- **Valerio will cover other challenges**
  - **"Ultra" precision detectors for ILC and the super b-factories**

"Ultimate goal remains a massless, cheap, infinite granularity, 100% hermetic and efficient, infinite bandwidth, long lifetime detector"



D. Bortoletto, Purdue University
And Valerio del Re, Bergamo

LHC experiments

- The LHC has been working spectacularly well.
- Operation at 50 ns bunch crossing and peak luminosity of $6X10^{33}$ cm^{-2} s^{-1} leads to average pile of ≈25
- The LHC tracker and vertex detectors have been running now for almost 3 years
  - At the core of great physics performance
- We can derive lessons for the next generation of trackers and vertex detector for hadronic colliders
  - radiation damage
  - pileup

Candidate Ξ_b^{*0} event with 3 secondary and ~10 primary vertices

LHC detectors operation experience, performance, and radiation damage

- ATLAS Silicon Microstrip Tracker Operation and Performance, P. Lundgaard Rosendahl
- Track and Vertex Reconstruction in the ATLAS Experiment, F. Meloni
- Neural network based cluster creation in the ATLAS silicon pixel detector, K. Selbach
- Advanced Alignment of the ATLAS inner detector, J. Stahlman
- Beam Conditions Monitoring in ATLAS, A. Gorisek
- Status of the ATLAS Pixel Detector at the LHC and its performance after three years of operation, A. Favareto
- CMS Tracker Performance, P. Merkel
- The CMS Tracker Alignment in pp collisions, A. Bhardwaj
- Status and Performance of the Diamond-Pixel Based CMS PLT Luminosity Monitor, D. Hidas
- Performance of the LHCb VELO, D. Dossett
- Monitoring radiation damage in the ATLAS Pixel Detector, M. Cooke
- Radiation Damage Effects in LHCb VELO operations, D. Dossett

The upgrades and the development of more radiation hard sensors

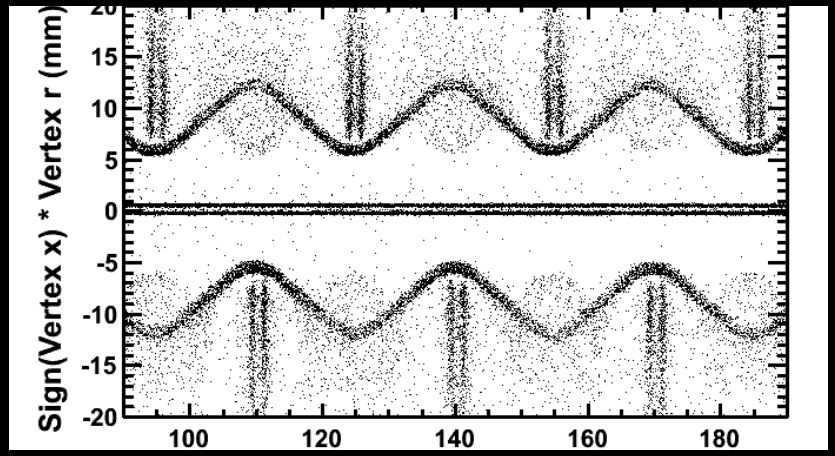
- Planar Pixel Sensors for the ATLAS tracker upgrade at HL-LHC, C. Gallrapp
- Hybrid diamond pixel detectors for the upgrade of ATLAS, F. Huegging
- Test-beam studies of diamond sensors for SLHC, L. Uplegger
- 3D-FBK pixel sensors with CMS read-out: first tests results, M. Obertino
- Silicon sensor alliance: radiation detector development for the LHC upgrade, X. Wu
- Comparative Characterization of Pixel Detectors at Very High Fluences - Diamond versus Silicon, N. Wermes
- Novel 3D micro-structuring of diamond for radiation detector applications: enhanced performances evaluated under particles and photons beams, B. Caylar

Performance

Peter Lundgaard Rosendahl
Federico Meloni
Karoline Selbach
Jonathan Stahlman
Andrea Favareto

David Dossett

Operating at 8.2 mm from the beam



Self image of the VELO sensors + RF Box using hadronic vertices from Beam-gas events

- The typical configuration of SCT modules with 99.3% of modules in operation
  - Only 30 modules missing because of Leaking cooling loop in end-cap C
  - A variety of HV and LV errors
  - Unexpected failures of o-detector optical transmitters (Tx plugins)

Table 1

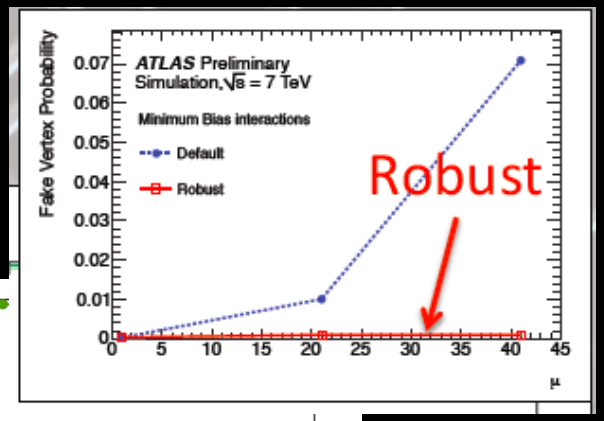
ATLAS SCT Configuration May 2010

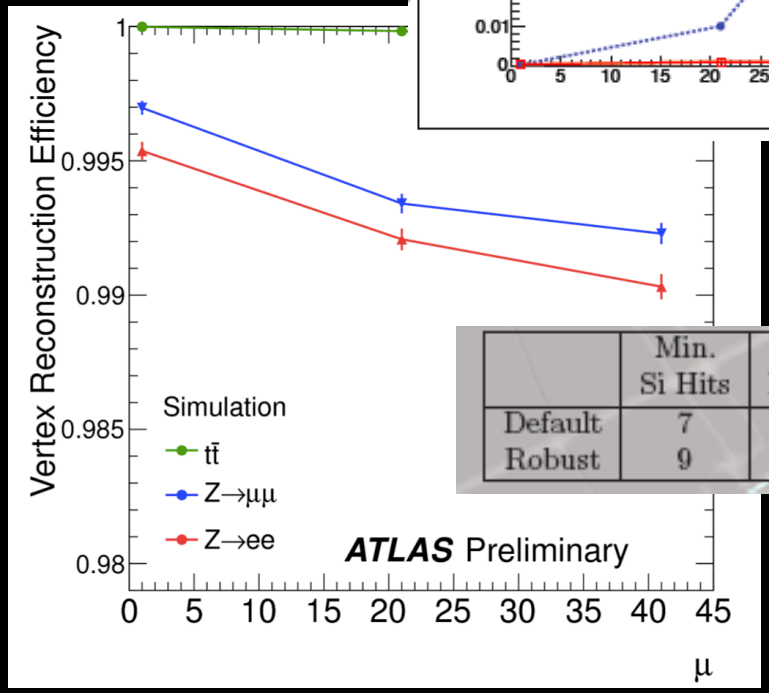
Disabled Readout Components	Endcap A	Barrel	Endcap C	SCT	Fraction (%)
Disabled Modules	5	10	15	30	0.73
Disabled Chips	5	24	4	33	0.07
Masked Strips	3,364	3,681	3,628	10,673	0.17
Total Disabled Detector Region					0.97

Performance versus Pileup

Peter Merkel

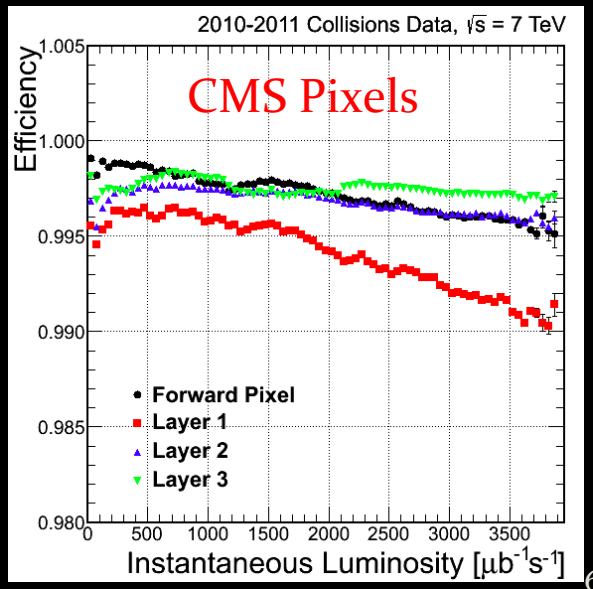
- Vertex reconstruction in high pile-up





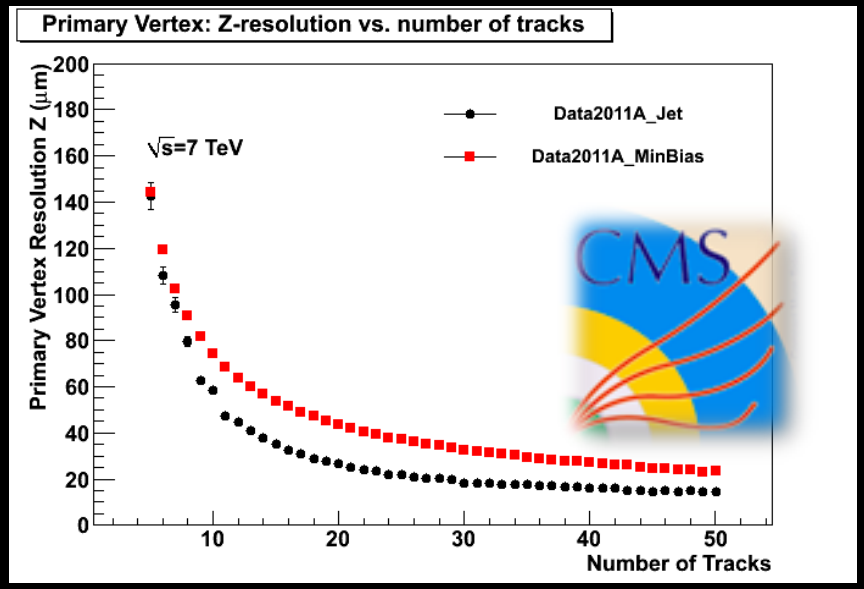
	Min. Si Hits	Max. Pixel Holes
Default	7	2
Robust	9	0

- Average pixel hit efficiency is 99%
  - It depends on the instantaneous luminosity, the trigger rate and beam background

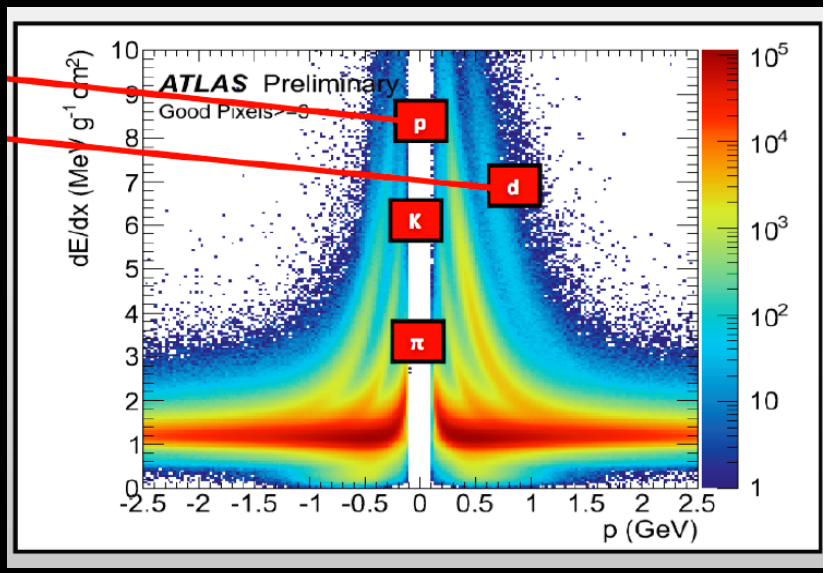


Other Performance factors

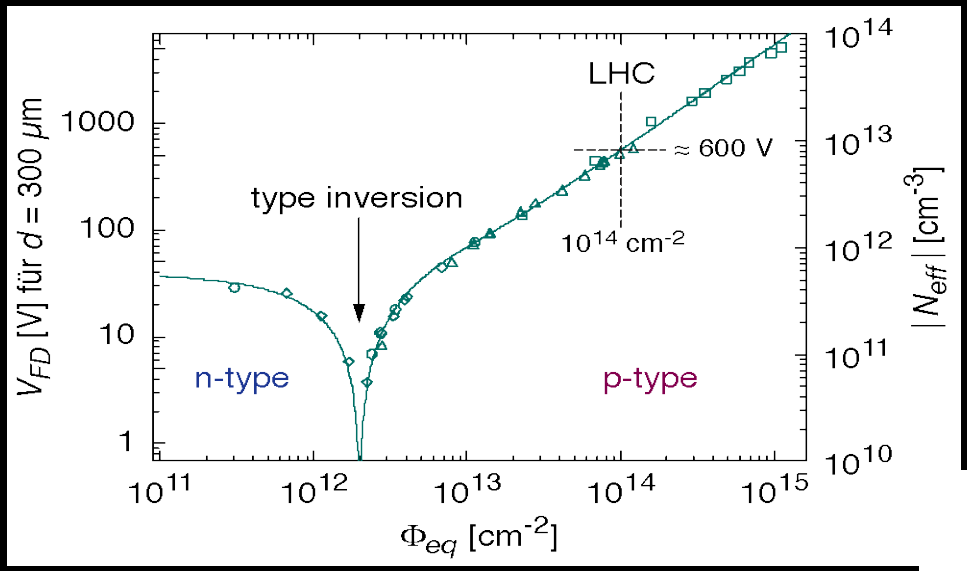
- Good primary vertex finding efficiency and resolution are essential to physics using the busy LHC collisions. The luminous region in CMS is ~5cm in z, containing an average of 8 (15) pp interactions for 2011 (2012) data taking conditions.



- dE/dx resolution 12% with 3 pixel hits
- Application of pixel dE/dx in the search of new particles (high mass, long lived) such as SUSY colorless states composed byt stable quarks and gluinos

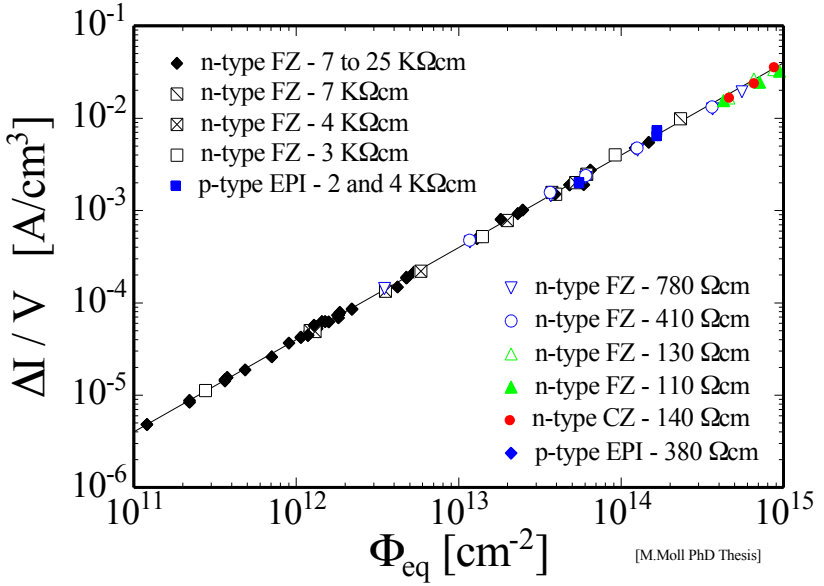


Radiation damage



Changes in depletion voltage

Changes in leakage current

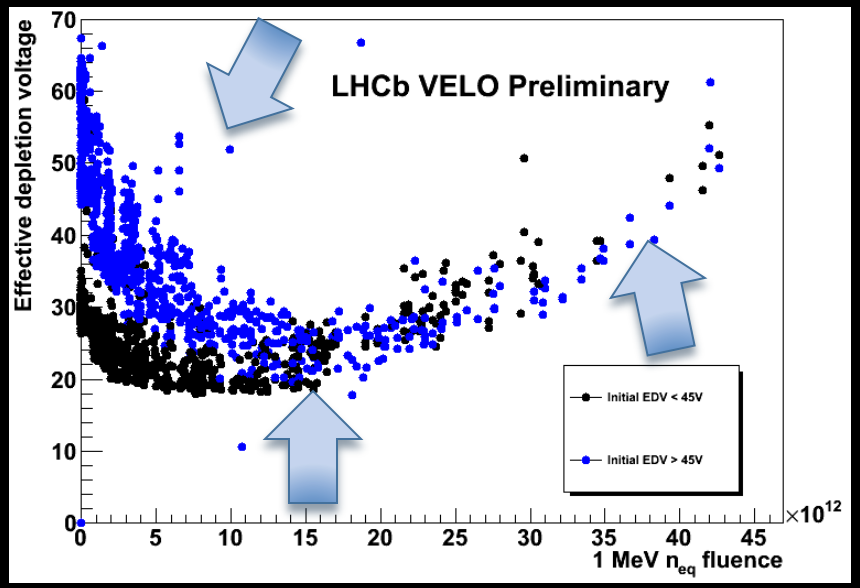


David Dossett

Mark Cooke

Radiation Monitoring

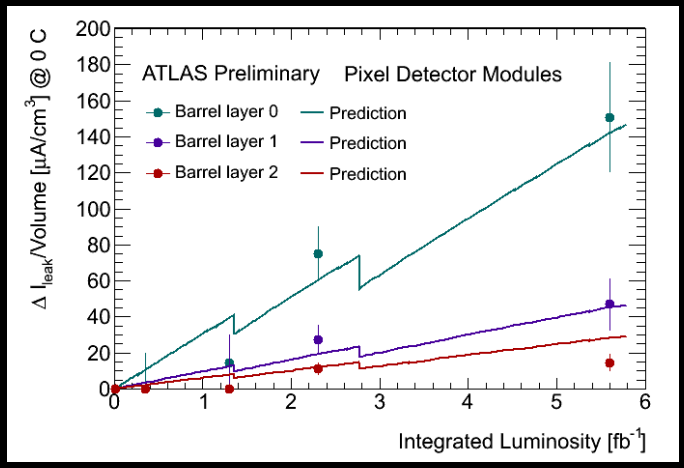
The n-on-p sensors also see a drop in EDV before increasing at a much lower fluence than the n-on-n.

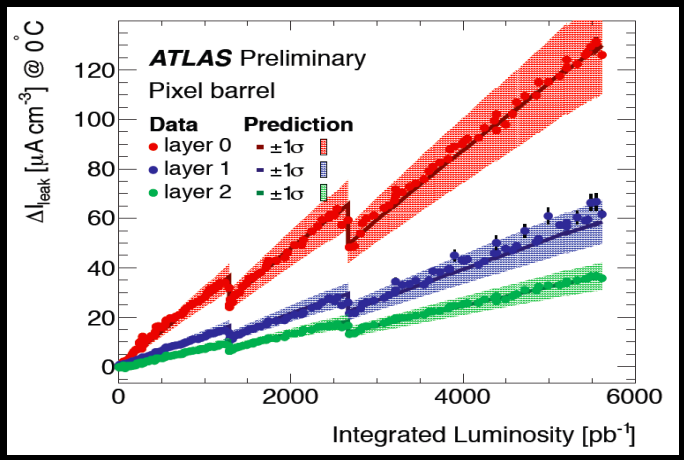


Common inversion point at ~10^{13} 1 MeV neq fluence, in line with expectations.

No dependence on the initial EDV after type inversion

- I_{leak} using the FE-I3 chip



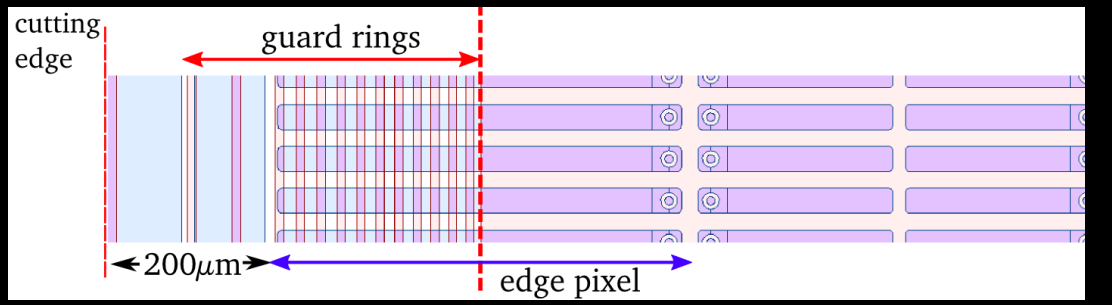


- I_{leak} from power supplies

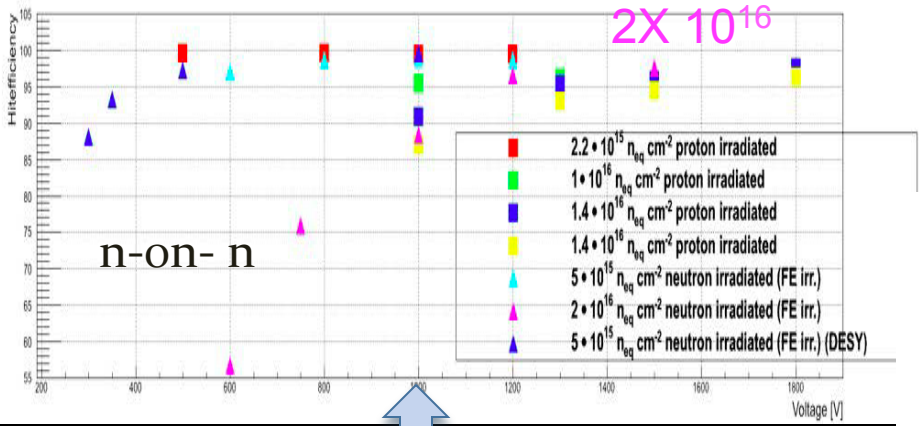
Planar silicon sensors for LHC upgrades

Christian Gallrapp
Alessandro La Rosa

- TCAD simulations combined with measurements of the dopant profiles are favored methods to understand and to optimize the sensor behavior.
- Optimize pixel size, pixel implant and bias ring
- Reduce edge area

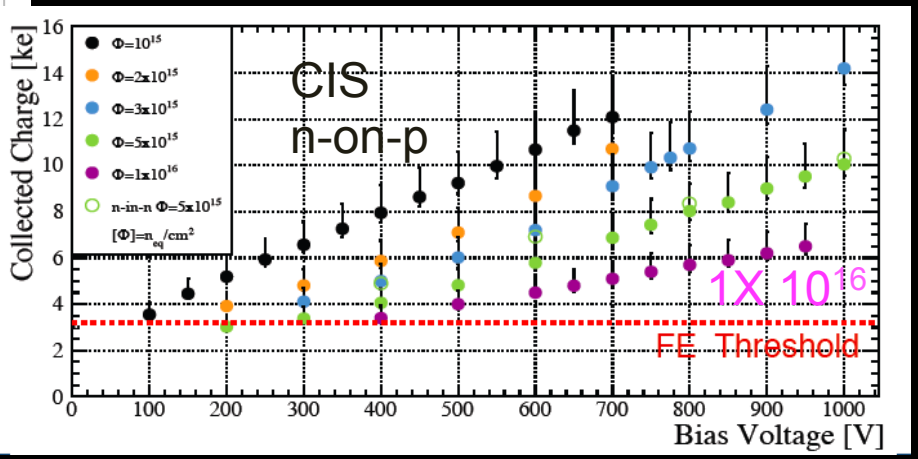


- Recover hit-efficiency by increasing the bias voltage
- Charge multiplication in planar detectors



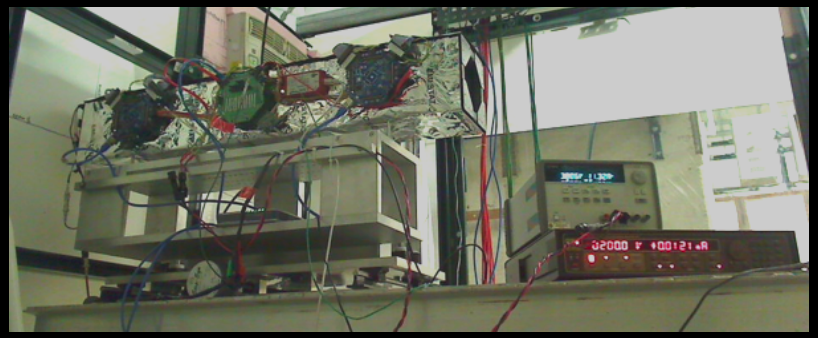
1000 V

- Planar n-in-p as future sensor tech.
- Excellent candidate for large volume
- Single side processing ➔reduced cost

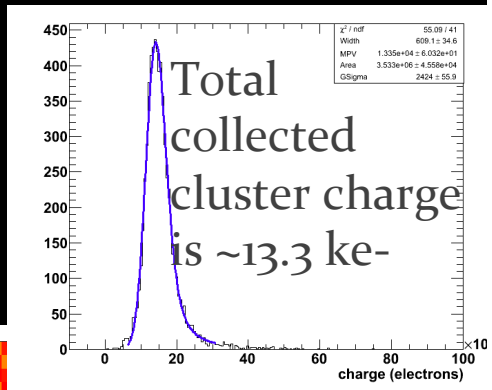


Comparison of 3D and diamond

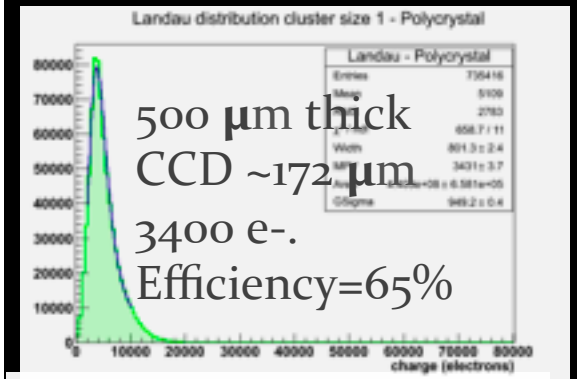
M.M. Obertino
L. Uplegger

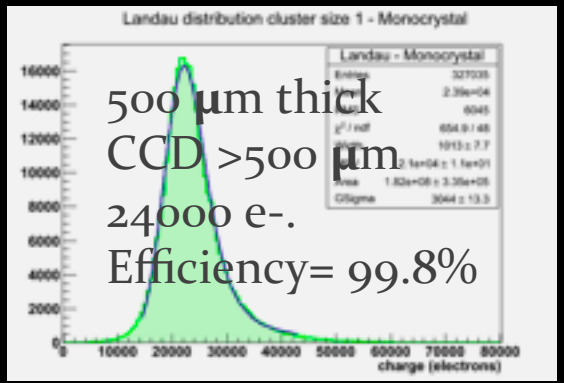


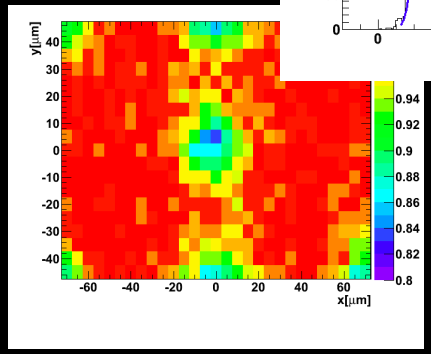
- Pixel Telescope at FNAL based on CAPTAIN DAQ system
  - 3D from FBK-1E at 20 V

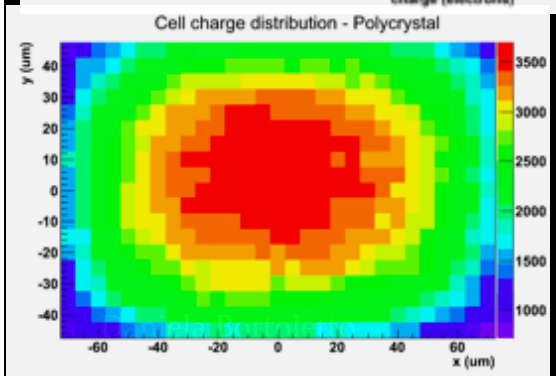


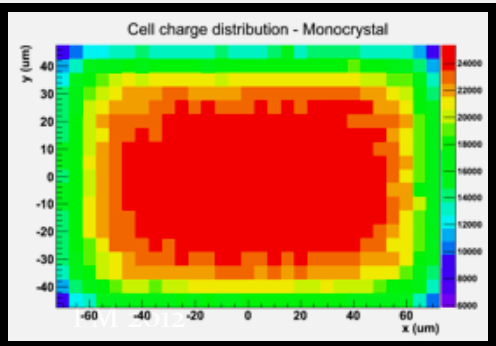
- Polycrystalline
- Crystalline

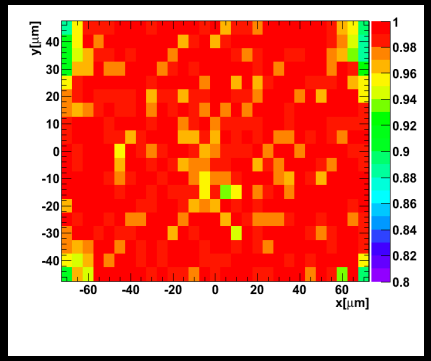












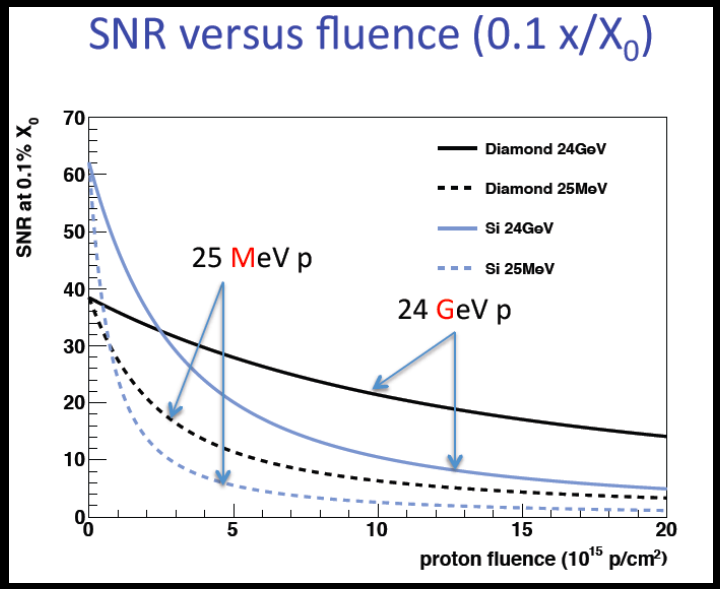
0º Loss of efficiency due to implant

20º degrees

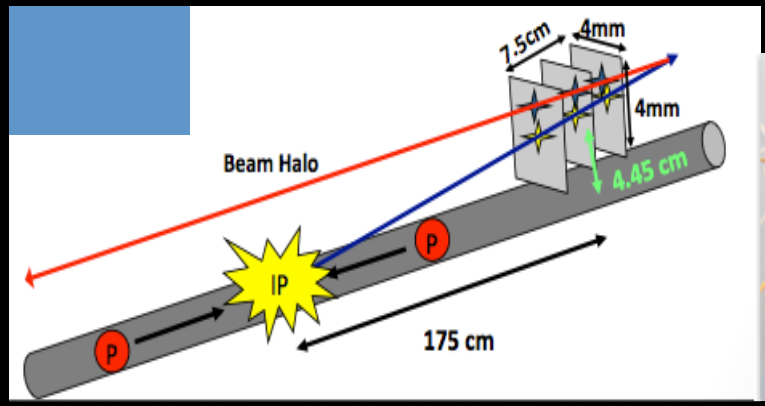
Comparison of silicon and diamond and Diamond applications

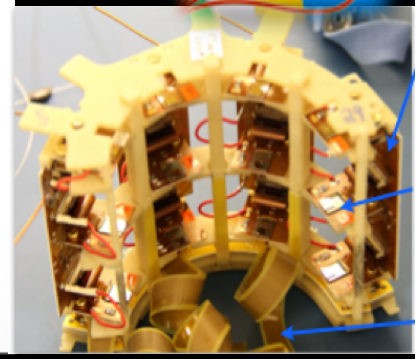
Norbert Wermes
Fabian Huegging
Dean Hidas

- SNR of Diamond is larger than that of planar Silicon pixels at fluences above a few×10^{15} p/cm^2



Pixel Luminosity Telescope



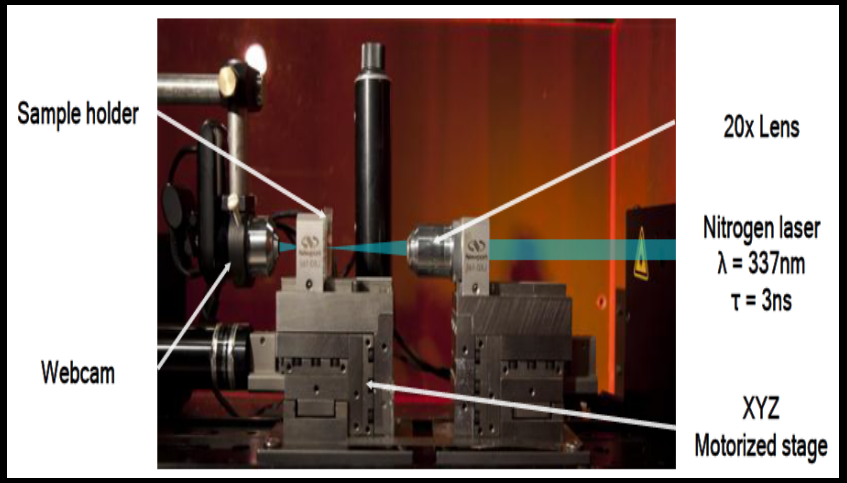


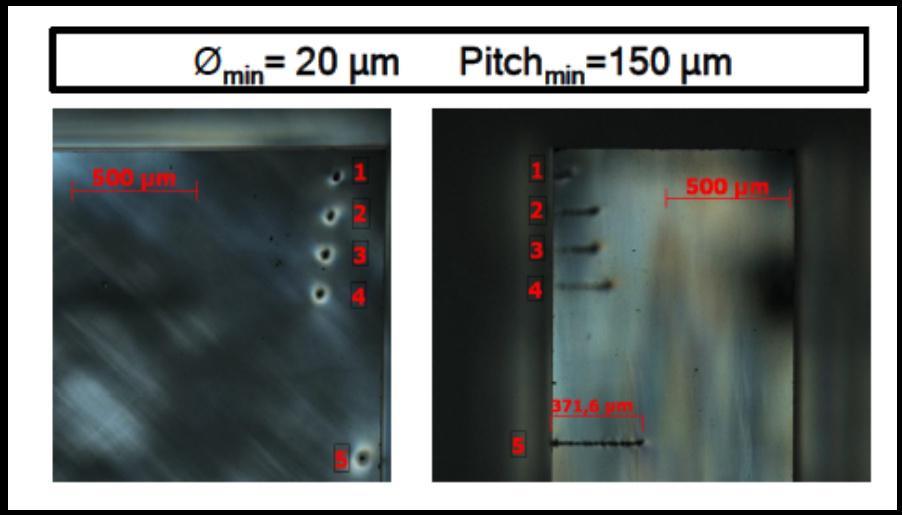
Diamond Beam Monitor

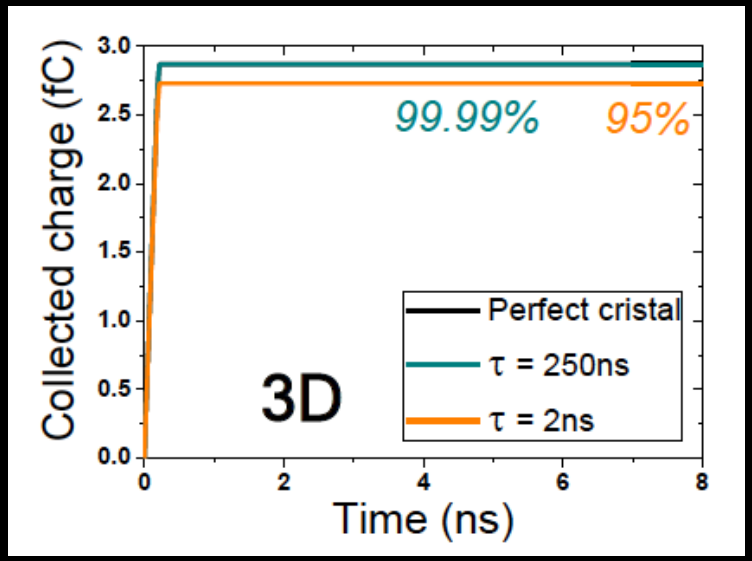
- Bunch by bunch luminosity measurement
- Integrated into the pixel package
- Installation with IBL in the 2013/14 LHC shutdown
- Application of Pixel Modules in ATLAS

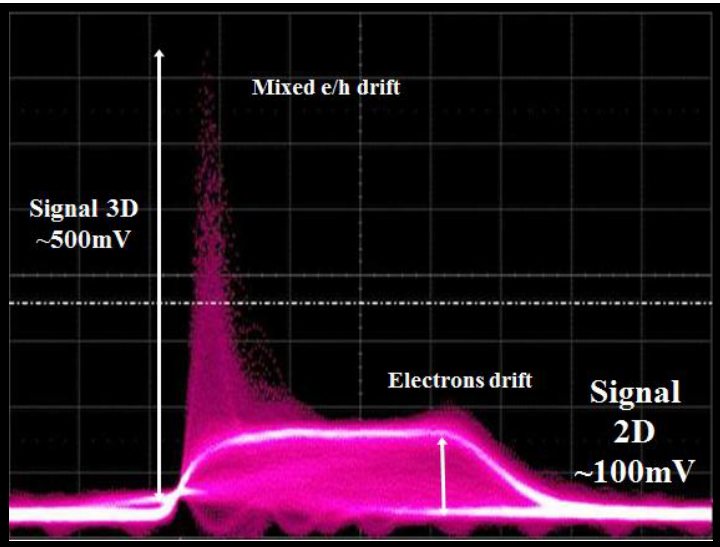
3D micro-structuring of diamond

- Laser graphitization is a good way to achieve 3D diamond detector









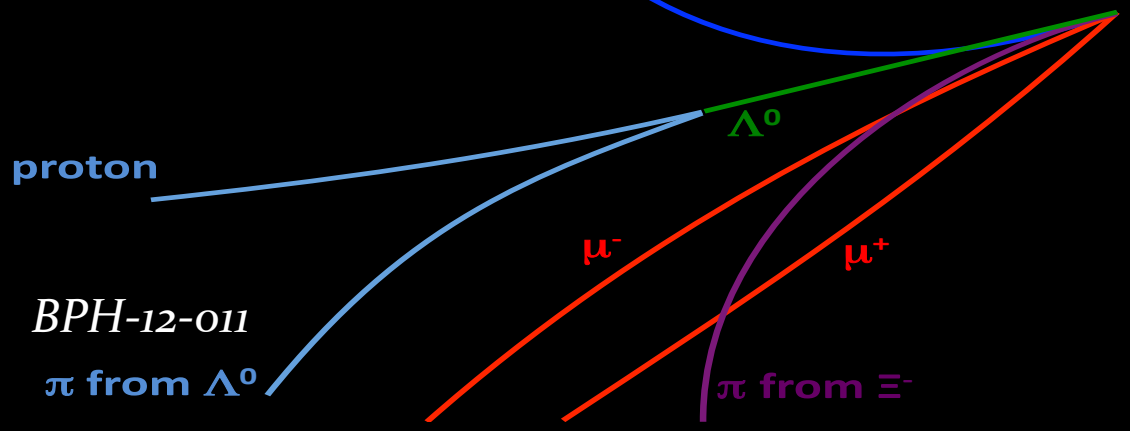
BACKUP

$\Xi_b^{*0} \to \Xi_b^- \pi^+ \to \Xi^- J/\psi\, \pi^+ \to \Lambda \pi^- \mu^+ \mu^- \pi^+ \to p^+ \pi^- \pi^- \mu^+ \mu^- \pi^+$

arXiv:1204.5955

π from PV

$$
\begin{aligned}
M(p^+\pi^-) &= 1116.7\ MeV \\
M(\Lambda^0\pi^-) &= 1315.5\ MeV \\
M(\mu^+\mu^-) &= 3117.1\ MeV \\
M(J/\psi\Xi^-) &= 5787.8\ MeV \\
Q(J/\psi\Xi^-\pi^+) &= 15.7\ MeV
\end{aligned}
$$



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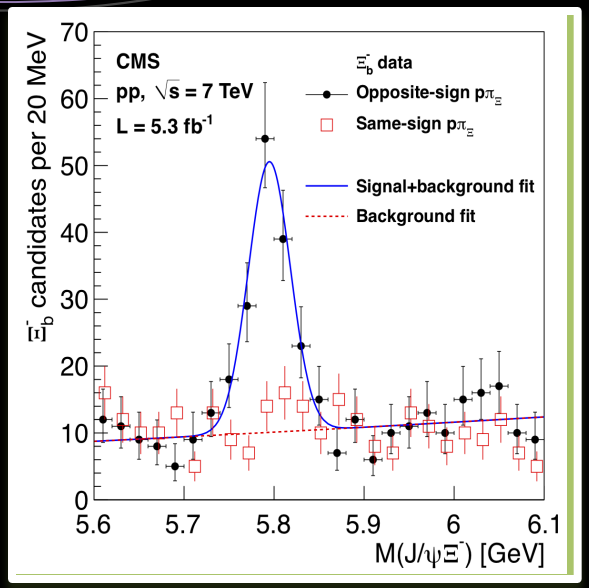

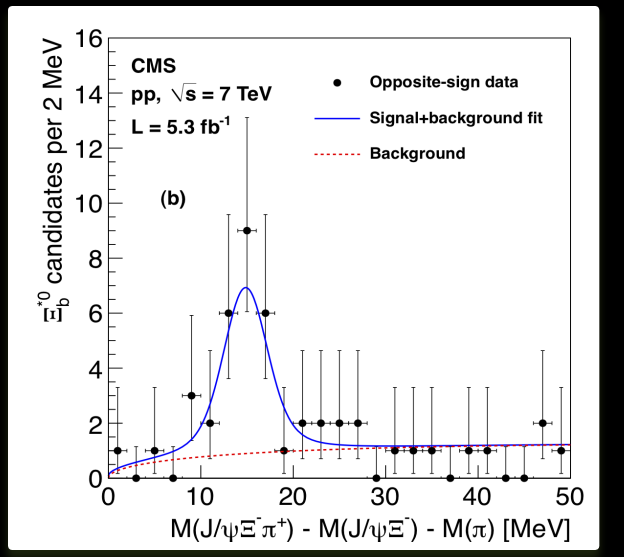

Candidate Ξ_b^{*0} event with 3 secondary and ~10 primary