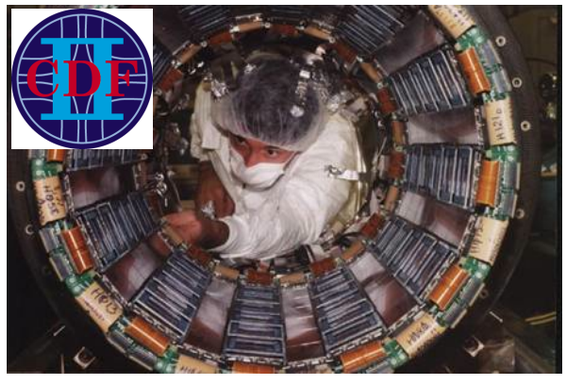
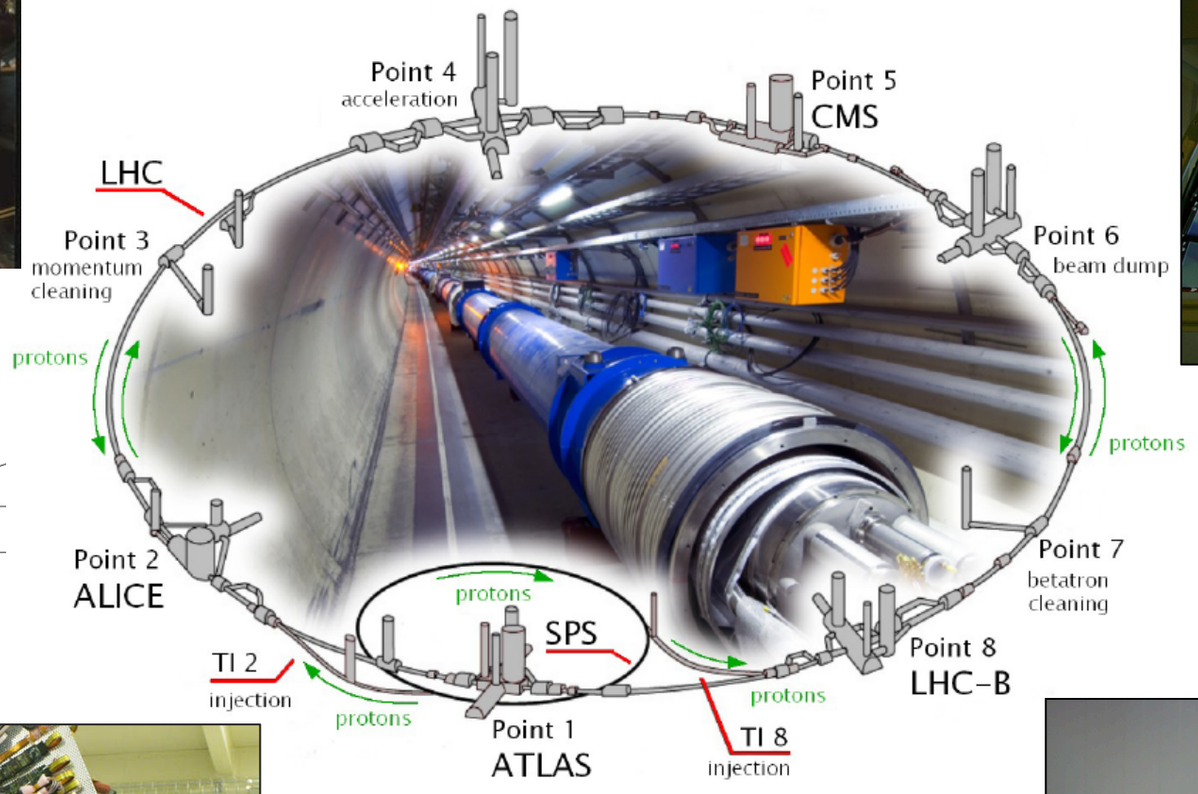
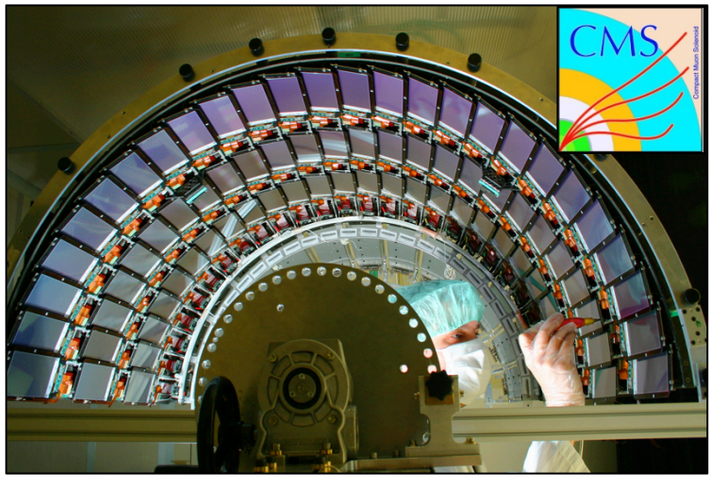
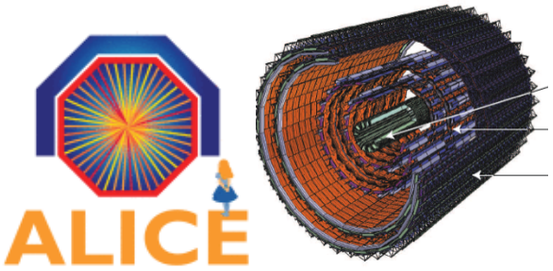
Second Inter-Experiment Workshop on Radiation Damage in Silicon Detectors

Bringing together the experts…

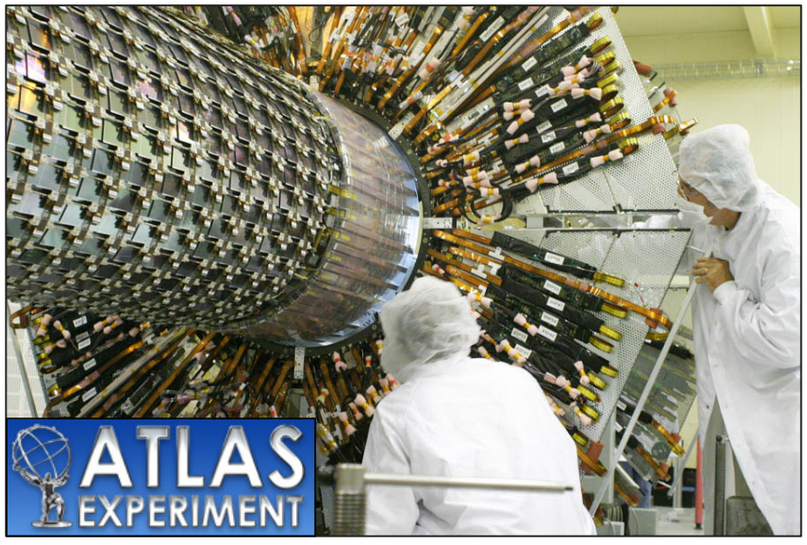








RD50 CERN

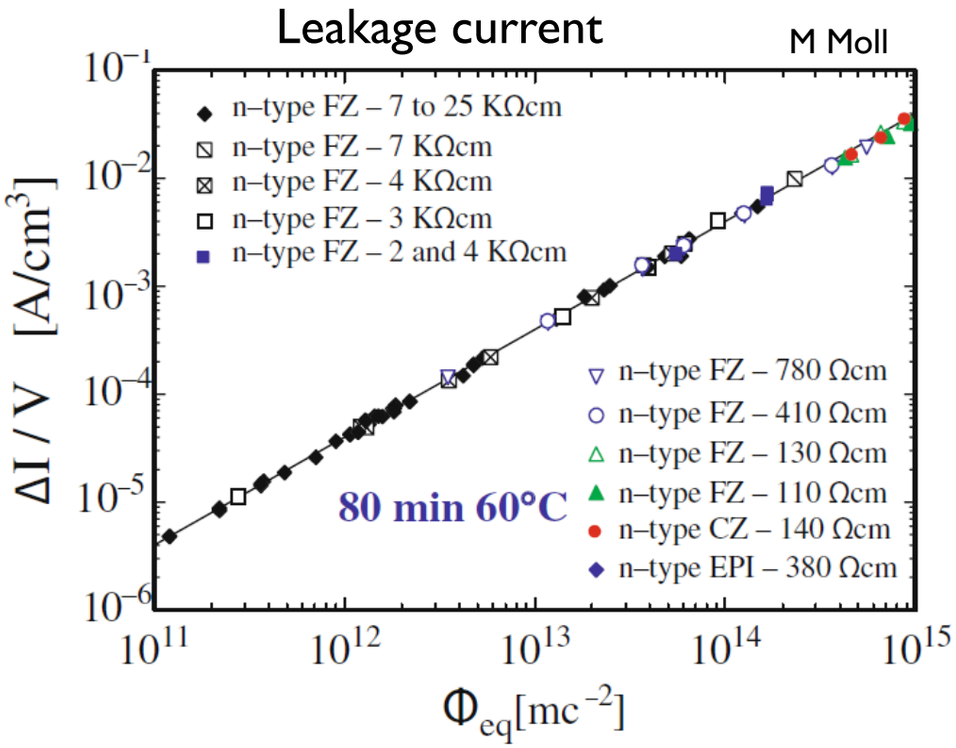


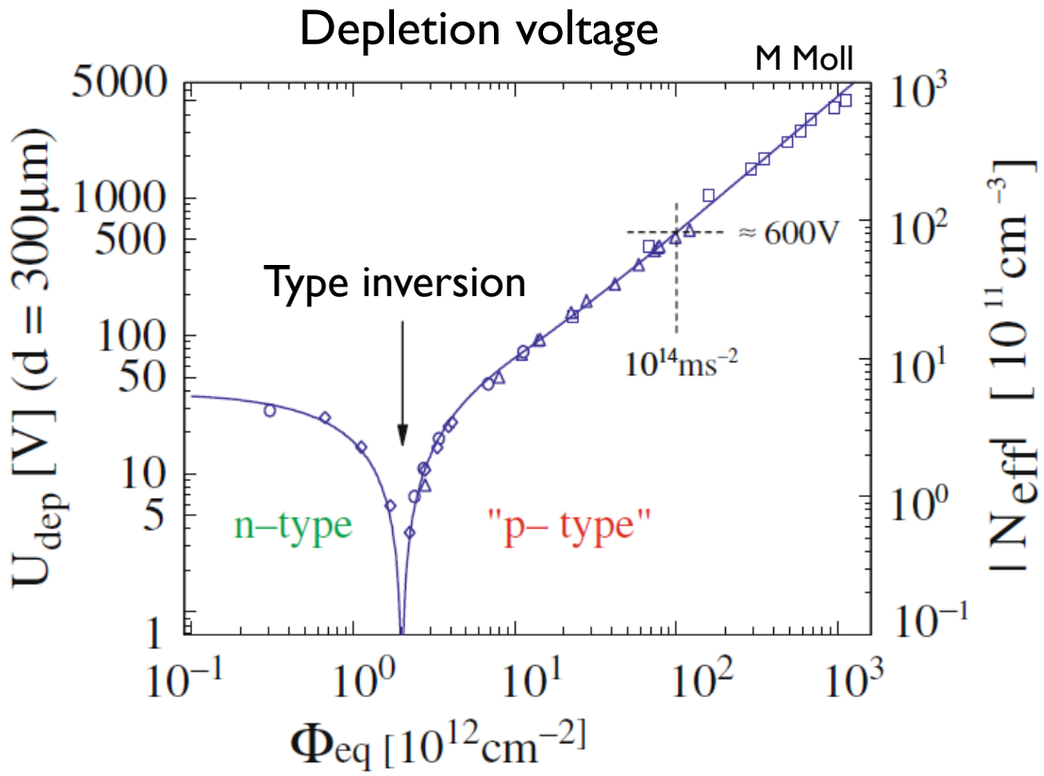
Stephen Gibson
CERN

Welcome

Outline

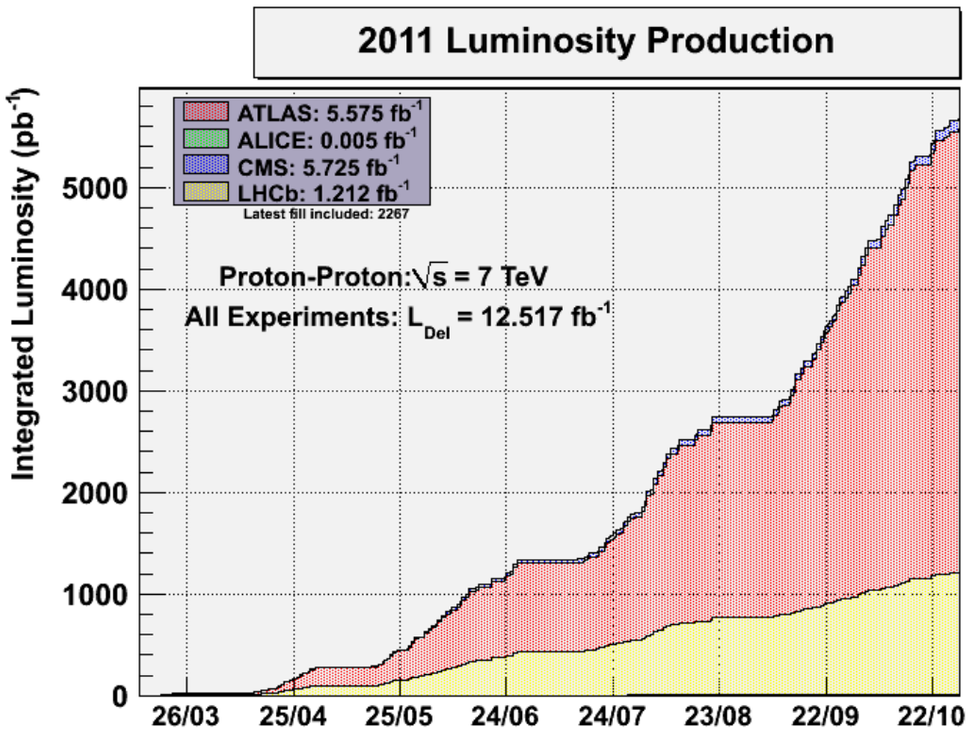
- Motivation - a common interest
- Inter-Experiment Radiation Damage Working Group
- Making the most of the workshop
- Today's menu





Motivation – a common goal

- With the rapidly increasing fluence at the LHC, initial signs of radiation damage are now clearly visible in the first 5 fb^{-1}.
- Our experiments all aim to quantify and understand the macroscopic effects of radiation damage in our silicon detectors, in light of recent measurements.
  - Do the new measurements match model predictions?
  - Mitigation of reverse annealing and optimising detector performance.
  - Future extrapolations: how long will our detectors last?



Expected radiation levels for Si detectors

	TID [kGy]	Fluence 1 MeV neq [cm-2]	Time [y]
ATLAS Pixel	500	1.0E+15	10
ATLAS Strips	100	2.0E+14	10
CMS Pixel	840	3.0E+15	10
CMS Strips	70	1.6E+14	10
ALICE Pixel	2.7	3.5E+12	10
LHCb VELO	50	1.3E+14	1

Working group history

Radiation Damage Inter-Experiment Working Group

Set up in 2011 to focus on recent measurements and modelling of radiation damage in silicon detectors, particularly first results at the LHC.

- ***History***: the working group was initiated following conversations at RD11 in July.
  - Initially, several sub-detector experts from ATLAS, LHCb and CMS started to meet informally for discussion, together with Michael Moll for RD50.
  - The group was formally launched at the *Inter-Experiment Workshop on Radiation Damage in Silicon Detectors*, 4 October, which aimed to trigger further collaboration between all interested silicon sub-detector communities:
  - https://indico.cern.ch/conferenceDisplay.py?confId=156565
  - Fruitful discussion led to several inter-experiment agreements which enabled a common approach for the special session in the 19th RD50 workshop:
  - https://indico.cern.ch/conferenceOtherViews.py?confId=148833

Further collaborators are welcome - please join us!

- Meetings are announced via e-group mailing list: rad-damage-iewg.
- Join the e-group to access the sharepoint: https://cern.ch/rad-damage-iewg/

Common framework

- At our first October 2011 workshop we saw an interesting overview and initial comparison of our separate experimental results, with their different geometries, fluences, sensors etc. We agreed on common framework for simpler comparison:

1. Correct leakage currents to a common reference temperature of T_{REF} = 0 °C
   Chosen to suit the range of sub-detector operating temperatures.
2. Use the same temperature correction:

$$I(T_{\mathrm{REF}}) = I(T)\left(\frac{T_{\mathrm{REF}}}{T}\right)^2 . \exp\left[-\frac{E_g}{2k_{\mathrm{B}}}\left(\frac{1}{T_{\mathrm{REF}}}-\frac{1}{T}\right)\right]$$

   Dedicated discussion today

   Effective silicon band gap E_g =1.21 eV
   following RD50-2001-01 recommendation

3. Normalize current to the volume of silicon [cm^3] rather than per module.
4. Standard units: $\frac{\mu A}{fb^{-1}cm^3}$

- This enabled much better comparisons at the special session of the RD50 workshop, and triggered the start of more detailed comparisons.

Making the most of this workshop

- At today's second workshop, let's aim for a balance between the interesting experimental updates and enough time for discussion on how to proceed with the common framework to ultimately improve together our understanding of the common issues.
- Also time for presentation of "hot topics" /novel observations form the experiments, so perhaps we can help learn from each other. Discussion of interesting problems is positively encouraged!
- Some of the topics:
  - Second metal layer charge loss in LHCb
  - Any non-conformance of results from certain sensors.
  - Understanding depletion voltage evolution / annealing before type inversion.
  - LHC simulated fluences and agreement with leakage currents at low radii.
  - Understanding leakage currents in new alpha regime.
  - Effective band gap and recent measurements.
  - Common framework and future.

Today's menu

Wednesday, 7 March 2012

14:00 - 14:10 Introduction *10'*
Speaker: Stephen Gibson (CERN)

14:10 - 15:55 Updates from the experiments
- 14:10 **CMS silicon bulk radiation damage studies** *30'*
  Speaker: Seth Zenz (Princeton University (US))
- 14:40 **ATLAS silicon bulk radiation damage studies** *30'*
  Speakers: Taka Kondo (High Energy Accelerator Res. Organ. (KEK)), Taka Kondo (High Energy Accelerator Research Organization (JP))
- 15:10 **LHCb VELO + ST bulk radiation damage studies** *30'*
  Speaker: Adam Dane Webber (University of Manchester (GB))
- 15:40 **CMS Preshower bulk current measurements** *15'*
  Speaker: Anna Elliott-Peisert (CERN)

Updates from the experiments

15:55 - 16:25 Coffee break

16:25 - 17:30 Hot topics / novel observations
- 16:25 **Second metal layer charge loss in LHCb VELO** *20'*
  Speaker: Jon Harrison (University of Manchester (GB))
- 16:45 **Excess currents observed in the CMS Preshower** *15'*
  Speaker: Alan Honma (CERN)
- 17:00 **Depletion voltage annealing effects in ATLAS** *15'*
  Speaker: Andre Lukas Schorlemmer (Georg-August-Universitaet Goettingen (DE))
- 17:15 **Simulating LHC fluences for the ATLAS Inner Detector** *15'*
  Speakers: Dr. Paul Miyagawa (University of Sheffield (GB)), Ian Dawson (University of Sheffield (GB))

Hot topics / novel observations

17:30 - 18:00 Discussion on common framework
Including:
- Effective band gap
- Leakage current comparisons and new alpha regime
- Organization for the future

Time for discussion towards the end.

18:00 - 18:05 Departure