Fast Timing for Pileup Mitigation

Sebastian White, CERN/Princeton CMS week May 7,2015

- Aims and status of our project
- parallel work in MPGD fast timing
- news on Rad hardness
- going forward in CMS

overall goal of this R&D

is to go from 1-d to 2D vertex identification

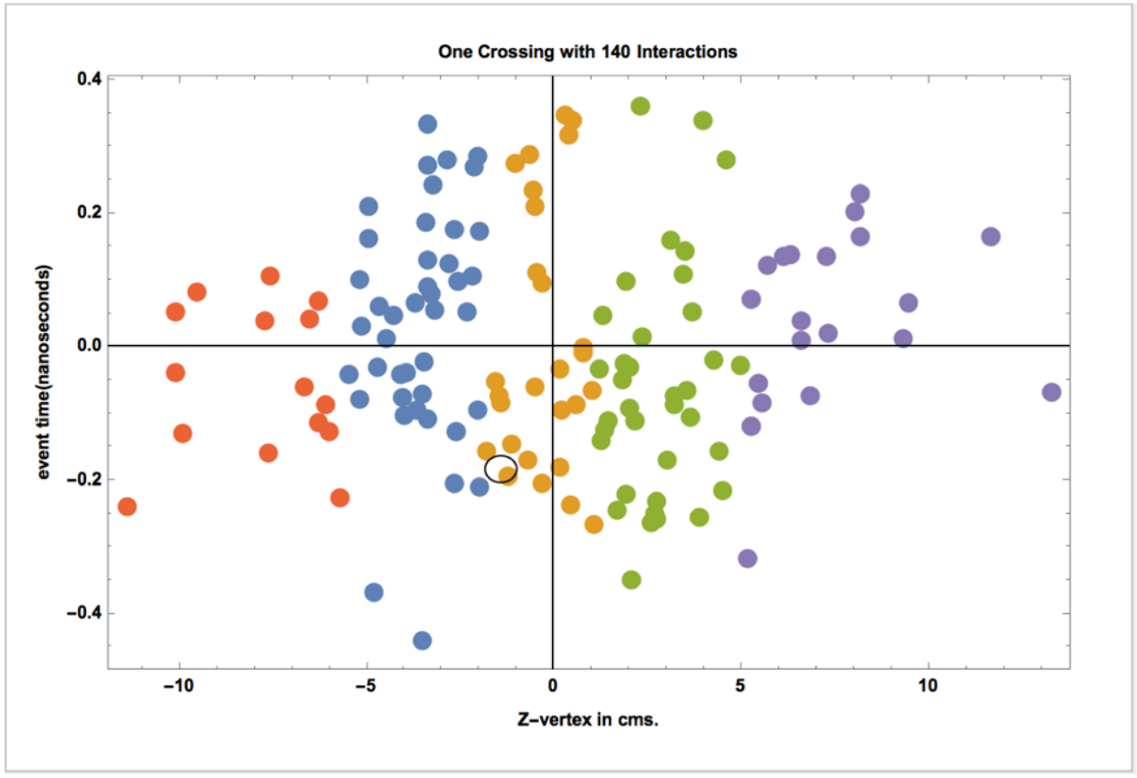
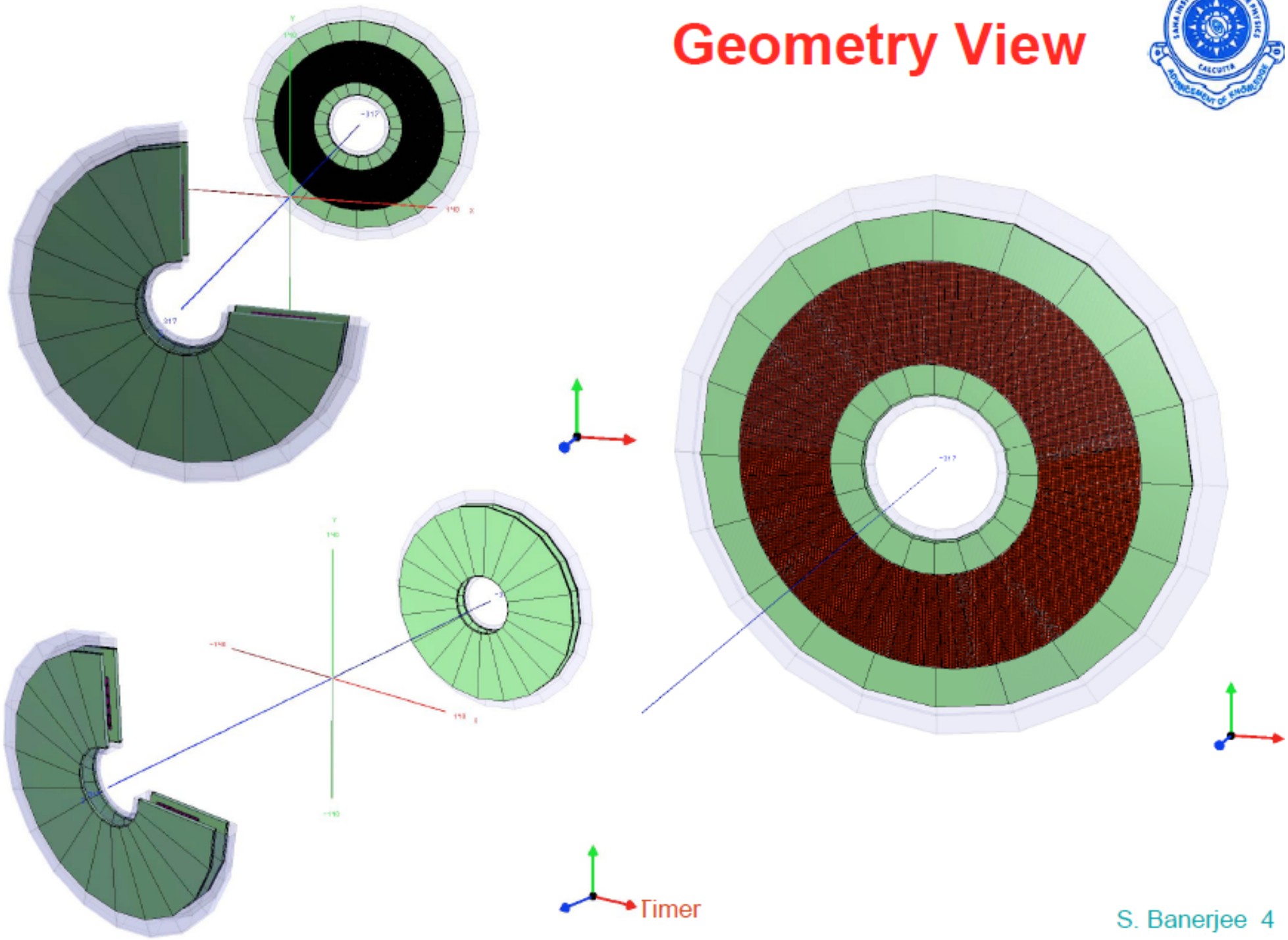


Fig. 1. Simulation of the space(z-vertex) and time distribution of interactions within a single bunch crossing in CMS at a pileup of 140 events- using LHC design book for crossing angle, emittance, etc. Typically events are distributed with an rms-in time- of 170 picoseconds, independent of vertex position.

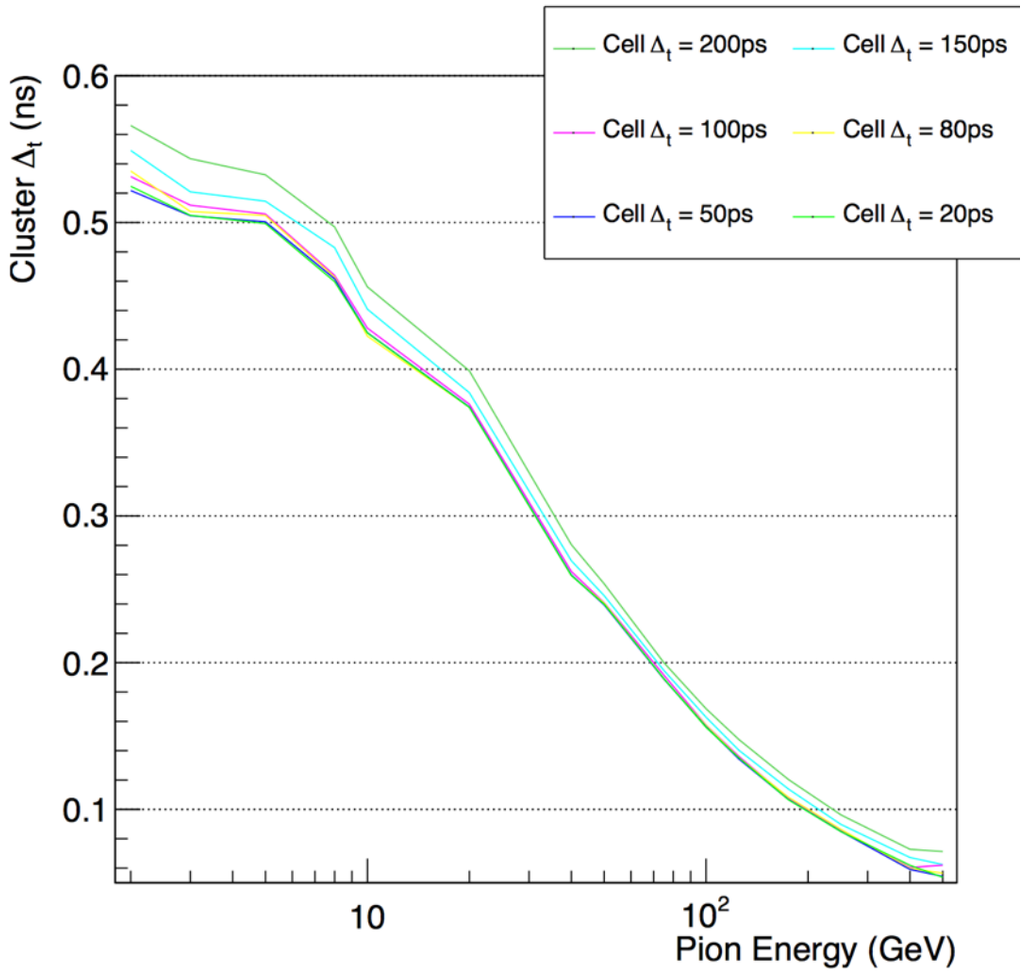
Efforts in CMS(this working group) and ATLAS to evaluate usefulness for mitigation of vertex merging, Jet-misassociation, etc. in HL-LHC environment

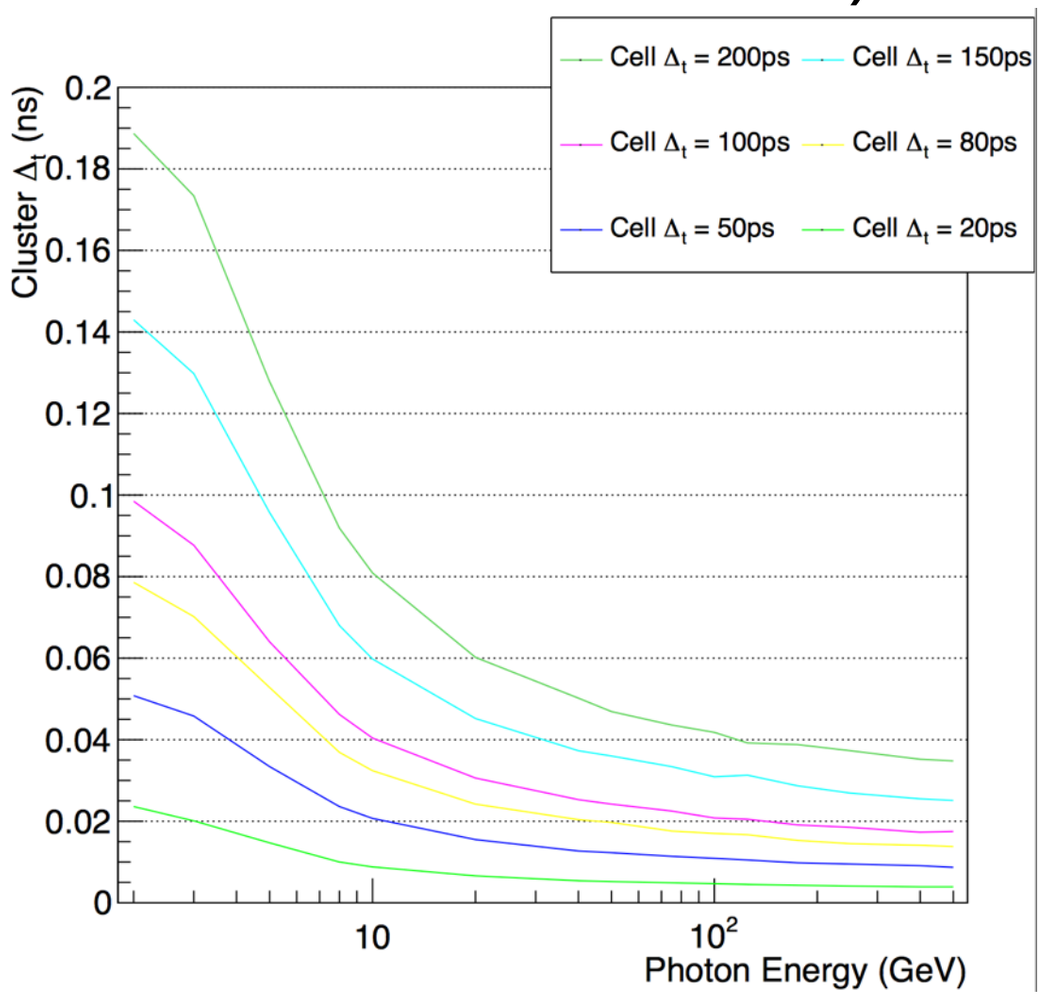
since about a year we have a model based on dedicated timing layer to enable such simulations

---



What can you get from Calorimeter itself ? (Lindsey/Pedro -HGC simulation)





-Charged/pion jitter dominated by shower development.

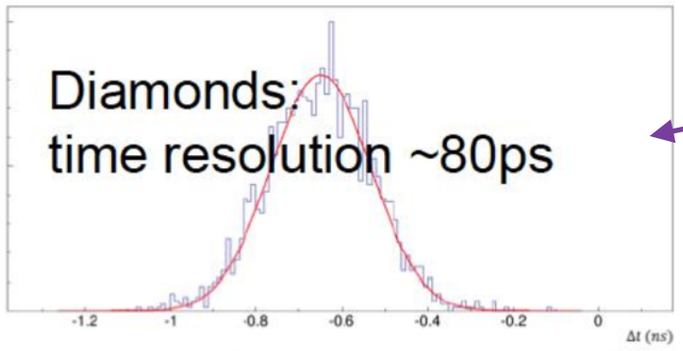
-Photons->~30 picosecond assuming same performance as GTK achieved with electronics used by HGCAL

But recall that photons only part of the story. Vertex timing tool is required -> Dedicated fast timing layer

Timing Sensor Landscape (Joao's Plenary talk yesterday)

Diamond detectors

- effort led by TOTEM

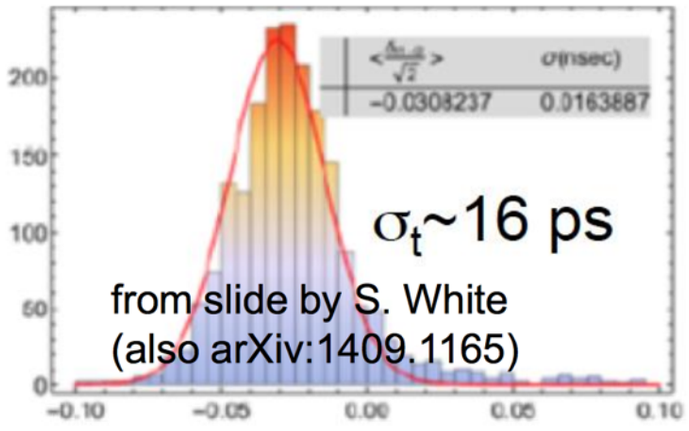


Current TOTEM technology choice

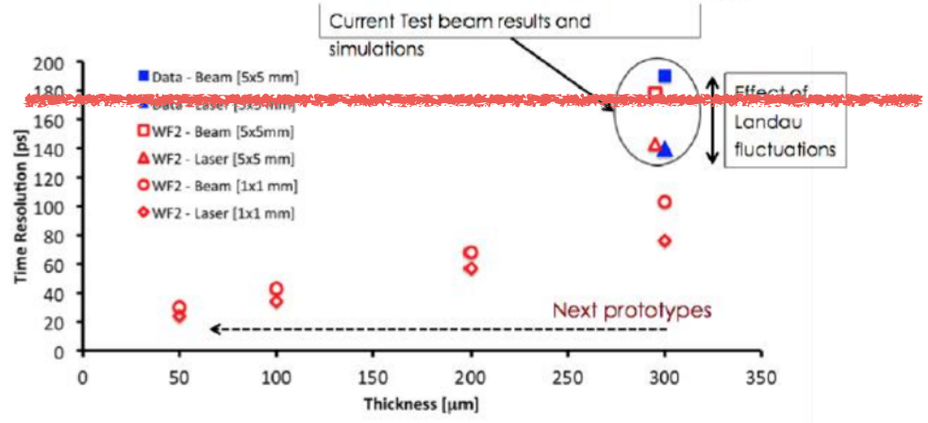
Silicon detectors

- ~~UFSD:~~ test beam in 2015 "LGAD"
- Start exploiting Avalanche PhotoDiodes

aka "Hyperfast mesh readout APD"



We are here (Princeton et al.)

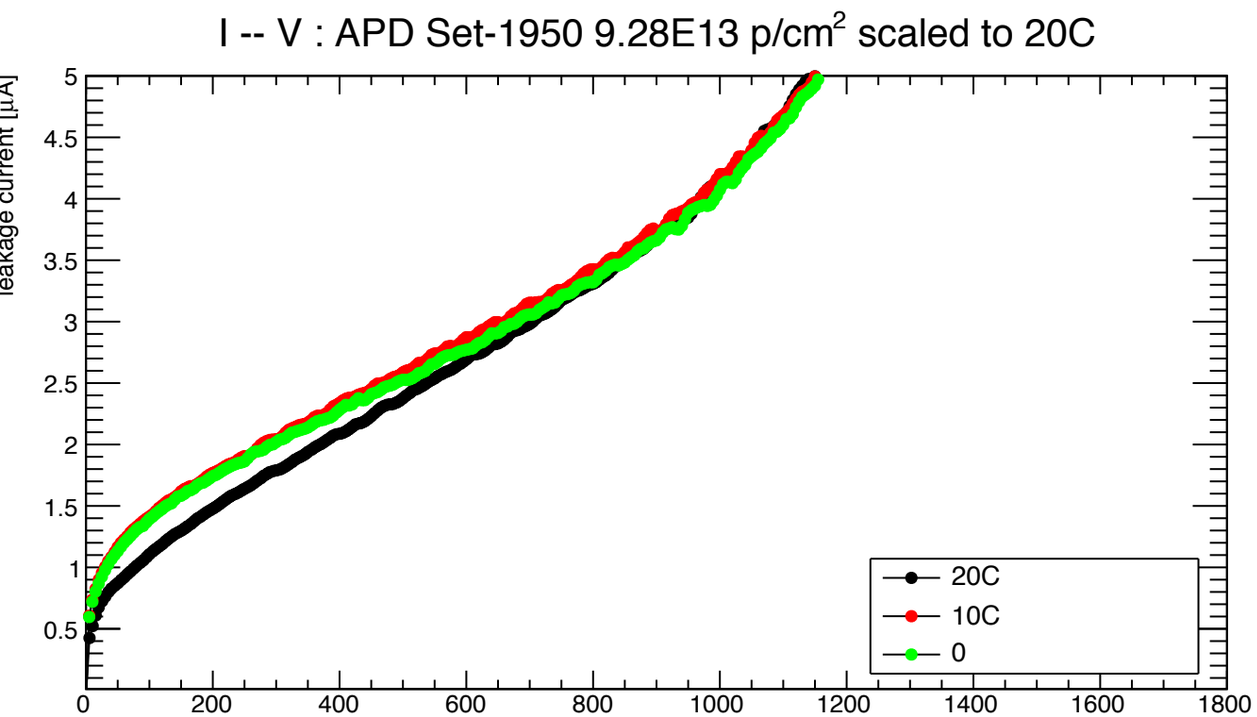


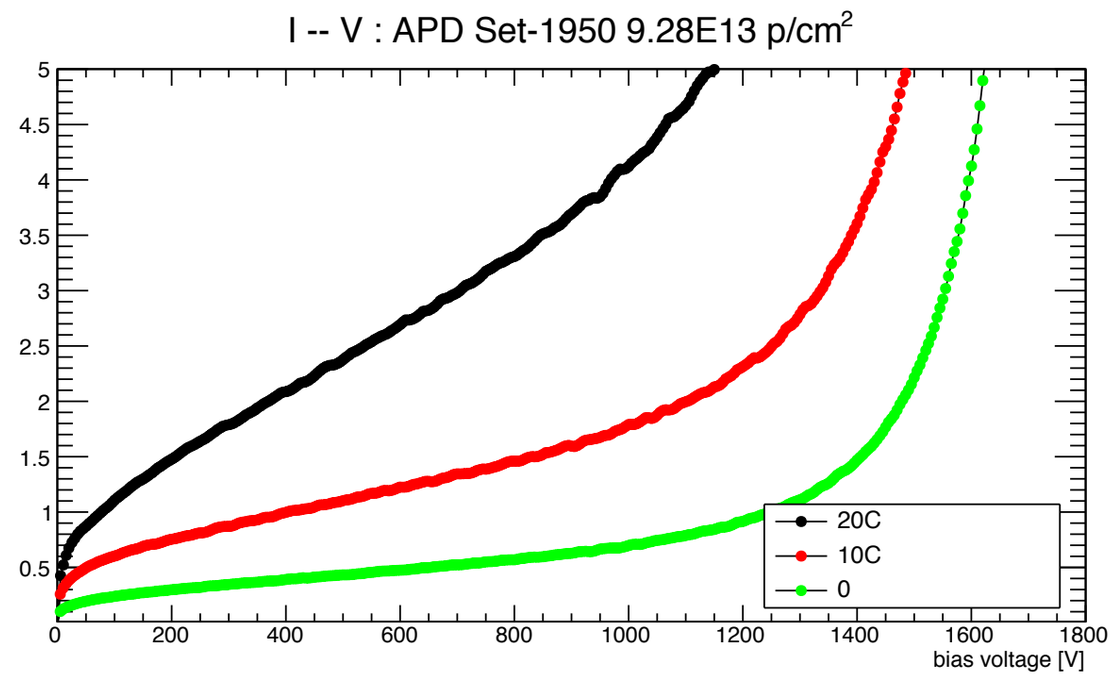
RD50/Sta. Cruz "LGAD"

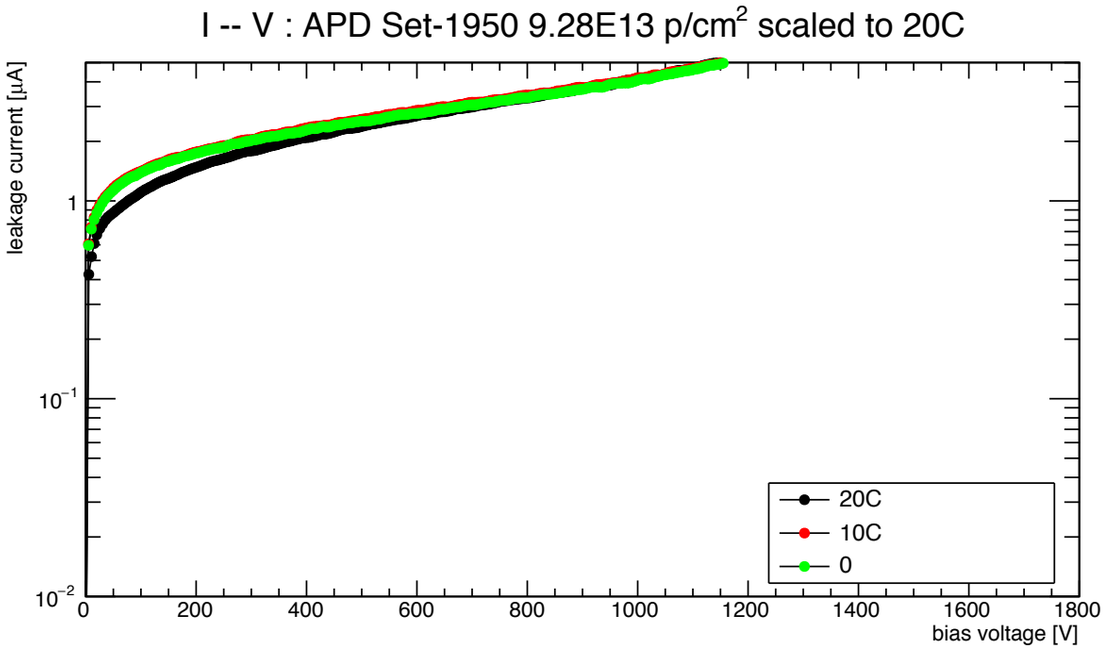
Sta. Cruz LGAD originally initiated to achieve high rad tolerance but gain unstable at ~10^14 neq/cm^2
We are currently working collaboratively w. RD50 on fast timing Silicon Sensors.
Note: Prior work by NA62 GigaTracker on fast timing w. Planar Si.
-> Similar performance to current LGAD

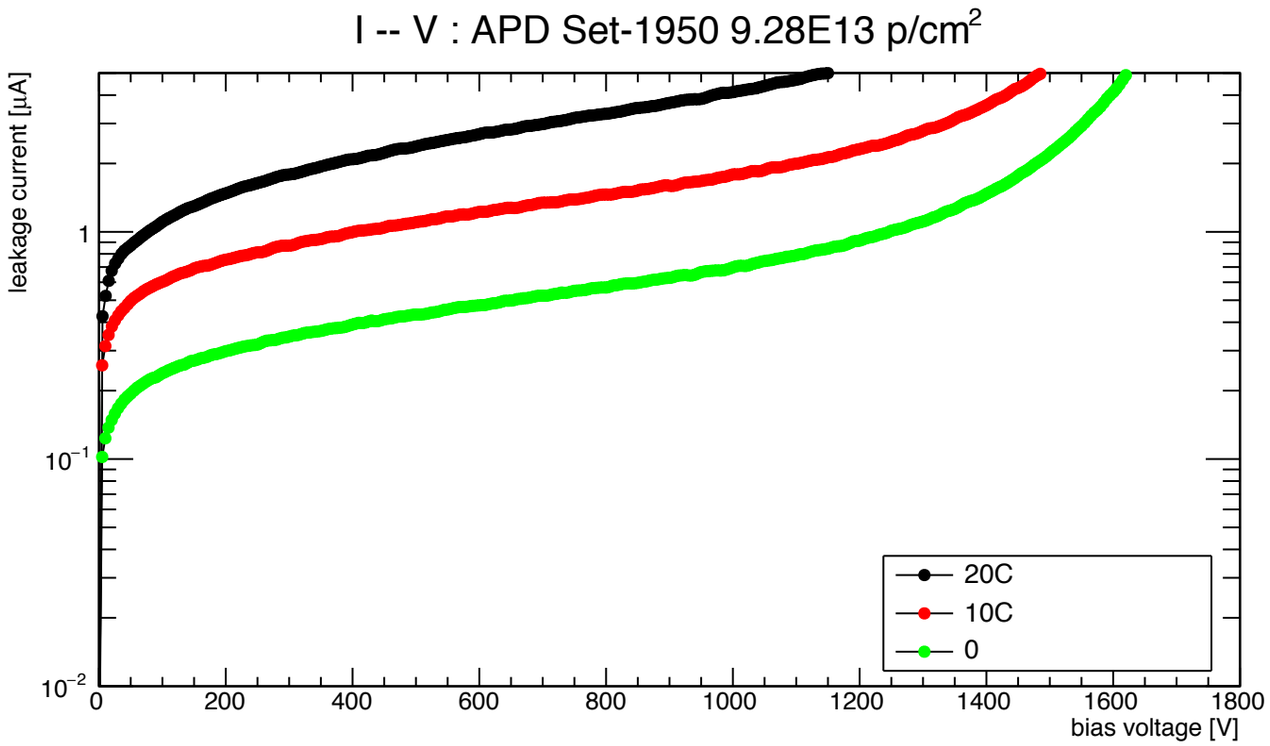
"He who acts on what should be rather than what actually is gets into trouble" -N. Machiavelli

Recent data to evaluate radiation damage issues (now approaching 10^14 neq/cm^2) w. M. Moll, C. Gallrapp, M. Fernandez Garcia



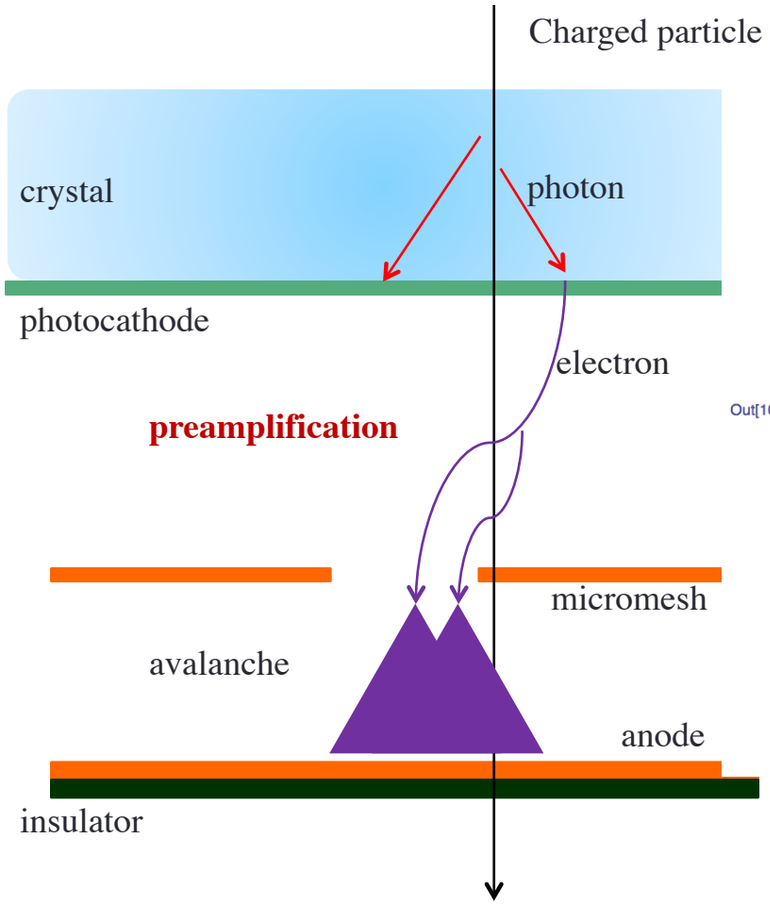


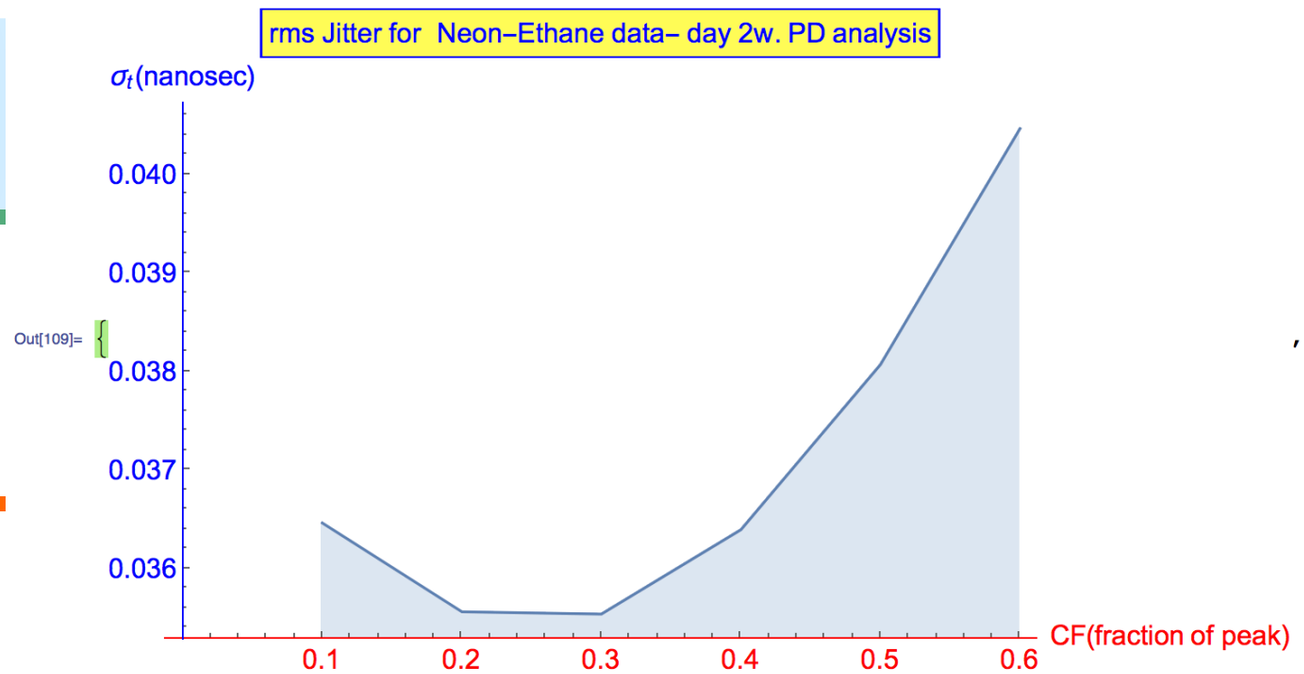




Not mentioned by Joao

MPGD based charged particle sensor





Out[109]= {

0.1	0.0364597
0.2	0.0355588
0.3	0.0355354
0.4	0.0363913
0.5	0.0380673
0.6	0.0404614

}

Several potential benefits:

- cost @ scale
- elimination of Landau jitter

going forward

- Both detector technologies can soon move from generic proof of concept to CMS specific design and beam testing

- We should finalize physics simulation to understand physics benefits of timing (most CMS tools now in place?) for mitigation of vertex merging, jet mis association…..

- should it be accepted as a component of the CMS strategy there are many areas (FEE, clock distribution..) on which we have already started.

lab work at Princeton