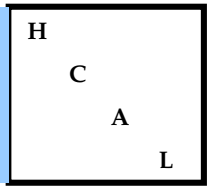
SIPM Status and Issues



Jim Freeman

FNAL

Issue 1

Join me for a toast to John Elias' memory

Today, 6 PM

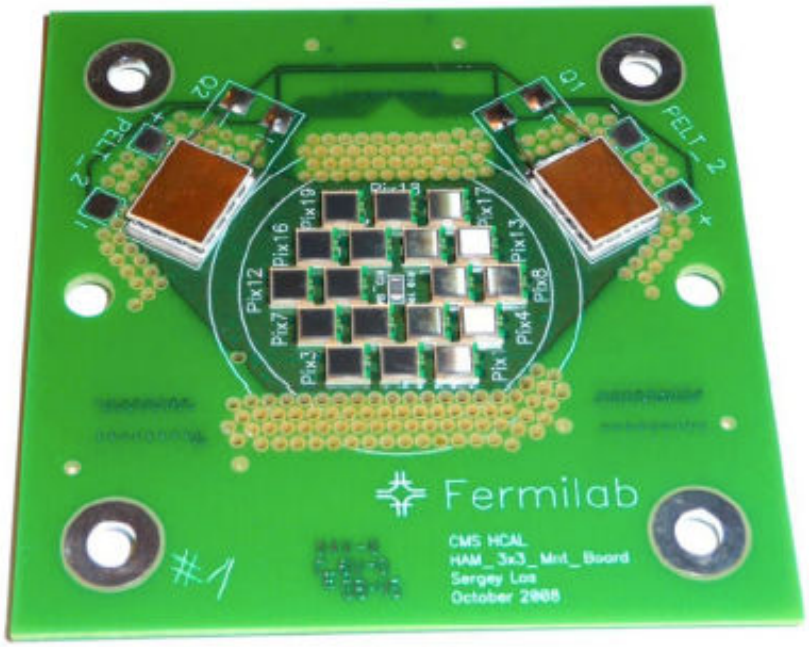
My house

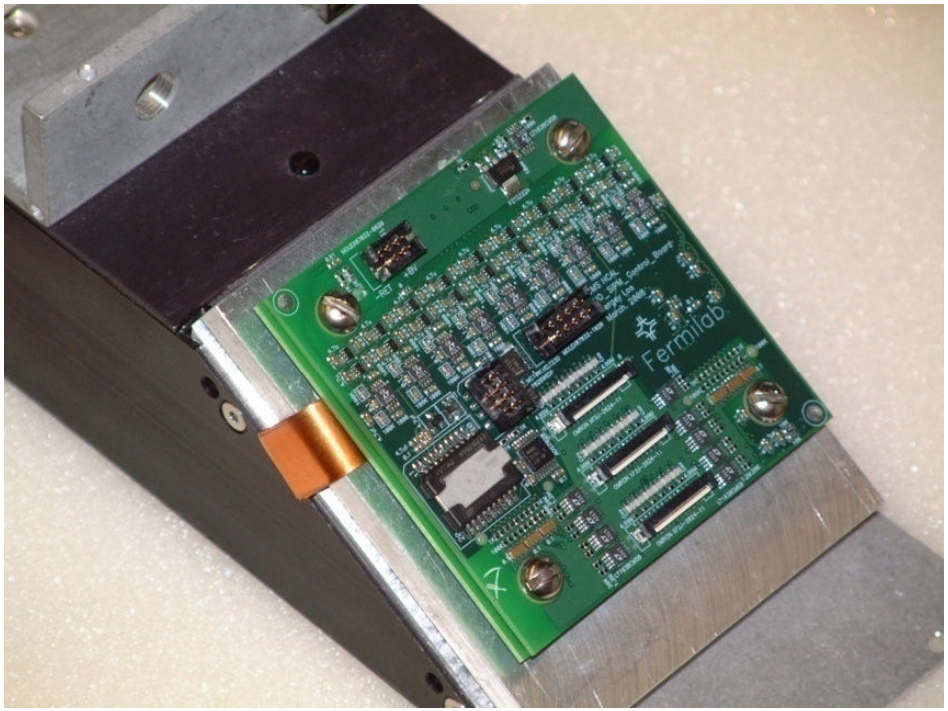
736 Nordic Ct Batavia

SIPMs for HO

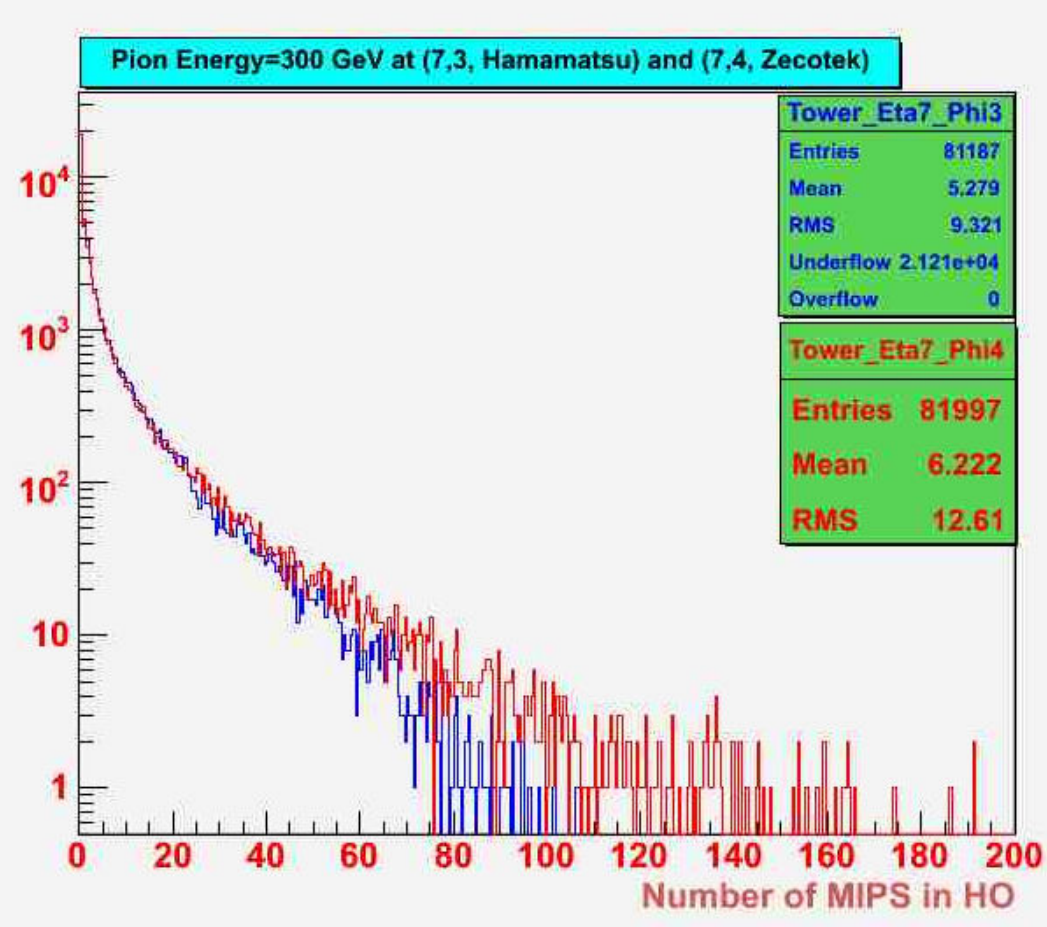
- **We have done a lot of testing**
  - **2 good candidates Zecotek, Hamamatsu**
  - **Both types are installed in RBXs in HO**
  - **Found a few issues from operation**
    - Need hardware low temp limit on cooling circuit
    - Found noise pickup when doing I2C
    - Tune up signal shaping (undershoot)
- **Preparing for HCAL internal review**
  - **Sunday afternoon before CMS week**
  - **Present to CMS Management during CMS week**
  - **Realistically make SIPM order in Feb 2010**
  - **Order through FNAL?**

HO SIPMs


Q2
Q1
PELT_2
Pix19
Pix17
Pix16
Pix13
Pix12
Pix8
Pix7
Pix4
Pix3
Fermilab
CMS HCAL
HAM_3x3_Mnt_Board
Sergey Los
October 2008
#1


Fermilab

Testbeam 300 GeV pions



CRAFT Muons

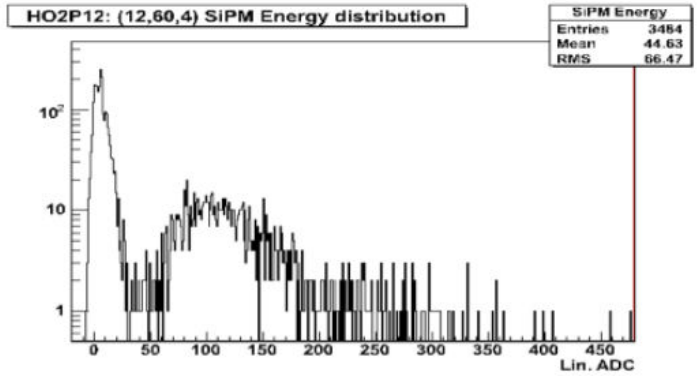


Figure 10a: Individual energy distribution, mwgr18, for a single HO channel, HO(ieta=12, iphi=60). Here energy E_{μ} is not corrected for muon angle of incidence.

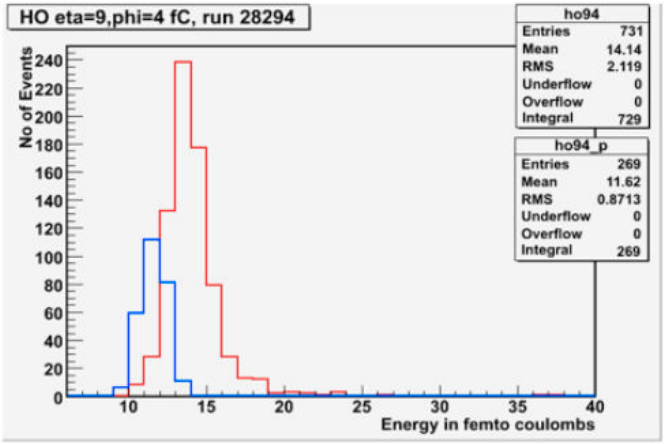


Figure 10b: For comparison, individual energy distribution, single HO channel read out with HPD, TB2007 data. Blue line: pedestal events, red line: muon signal.

(Pawel calib note)

CRAFT Muons – Pulse Shape

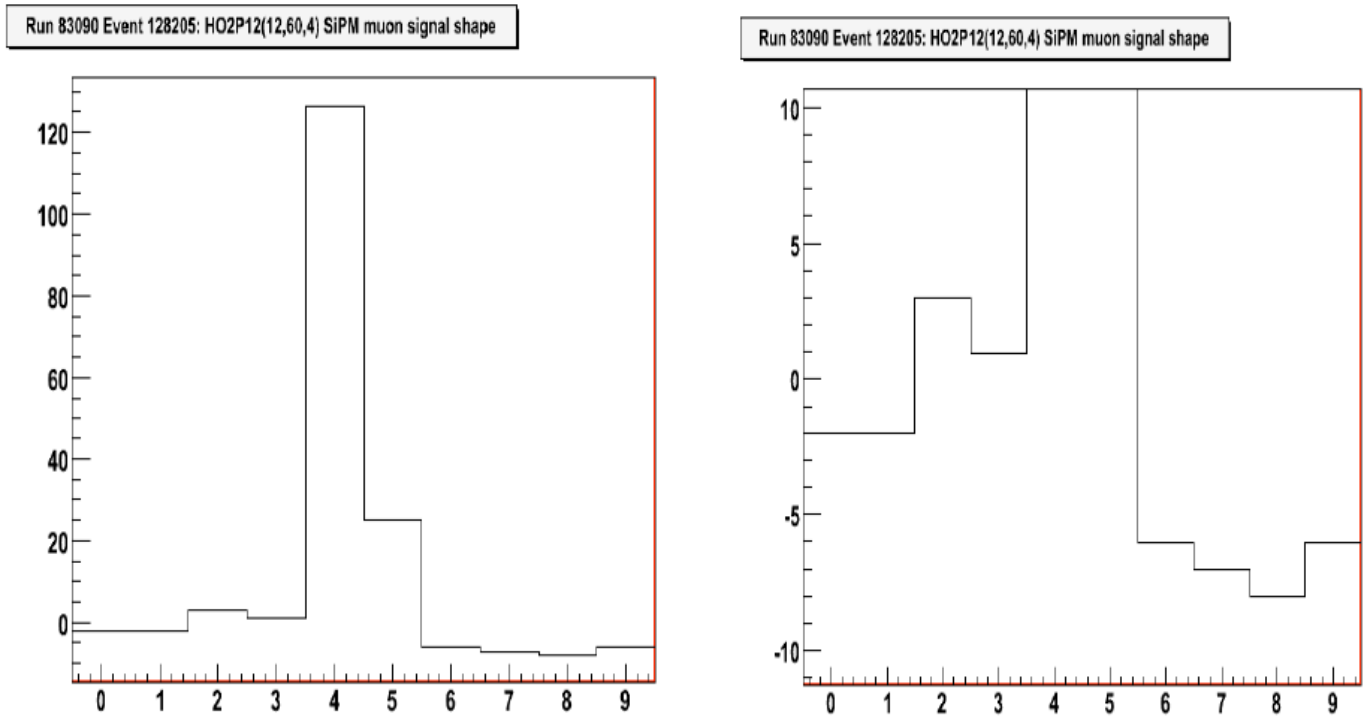


Figure 5a: Example of muon energy deposit in individual HO tower read out by SiPM device. X-axis shows HCAL readout window, in 25ns time slices (1TS=1bx), TS=0 through TS=9. Y-axis is muon response, pedestal subtracted, in linearized ADC counts.

SIPMs for Phase I

- **HB/HE much more challenging enviroment**
  - **10X radiation**
  - **Much more rate**
  - **Much more required dynamic range**
- **Done a lot of testing here as well**
  - **Radiation damage looks OK**
  - **EDU concept looks OK (Evaluated in H2 in summer)**
- **Need to continue development process**

SIPM Issues (from last summer)

Thermal stabilization (control temp)

Radiation hardness (evaluate)

Dynamic range (pixels)

Adjust recovery time (specify to vendor)

Each Issue is being studied

Radiation Damage

Several rounds of proton exposures

1-10 E12 doses

Expected dose 1E12 and 3Krad ionizing

(plus safety factor)

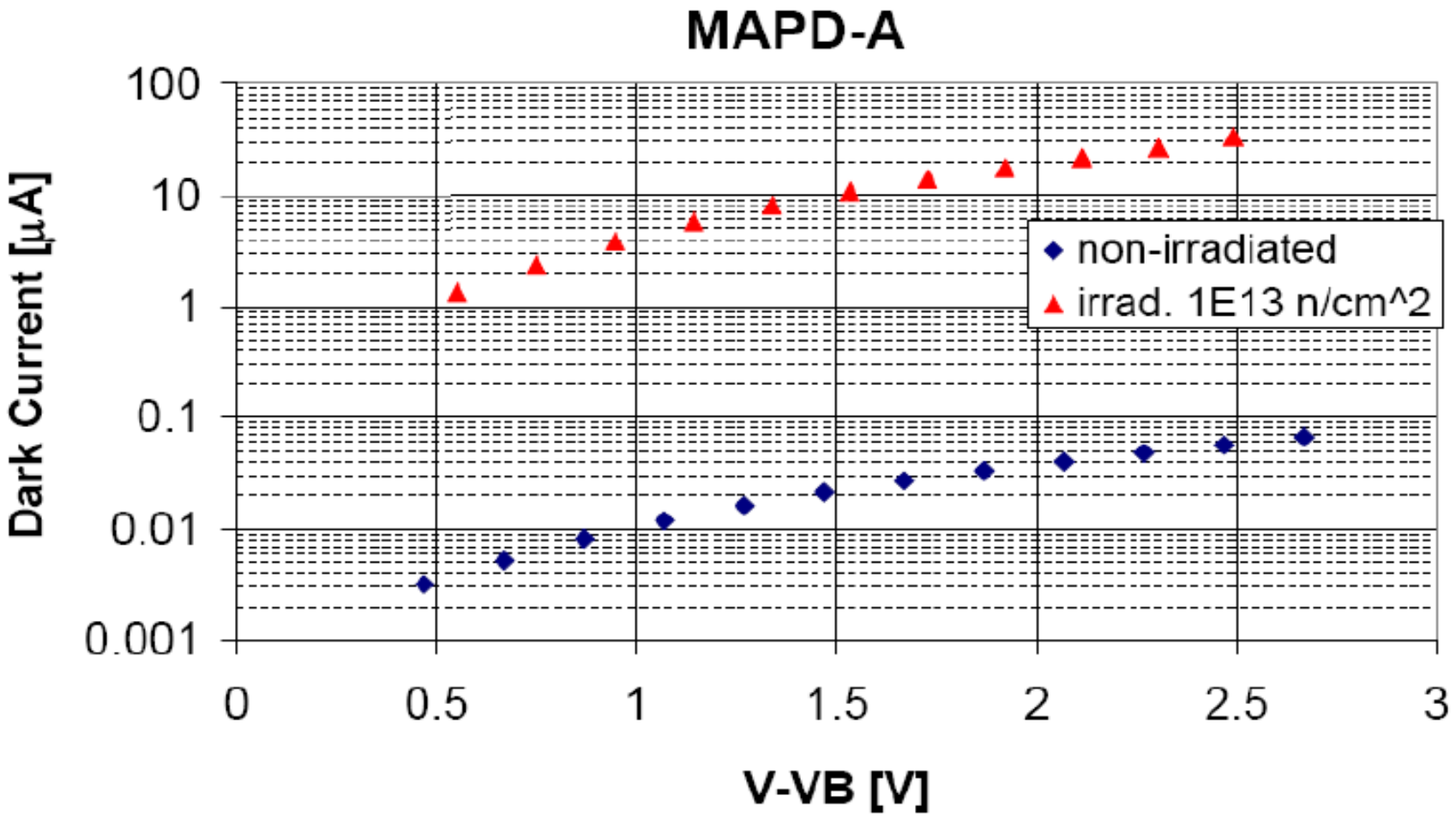
Protons do too much ionizing (Results require annealing)

After dose, 1 year recovery

- no change in gain/QE
- leakage current increase

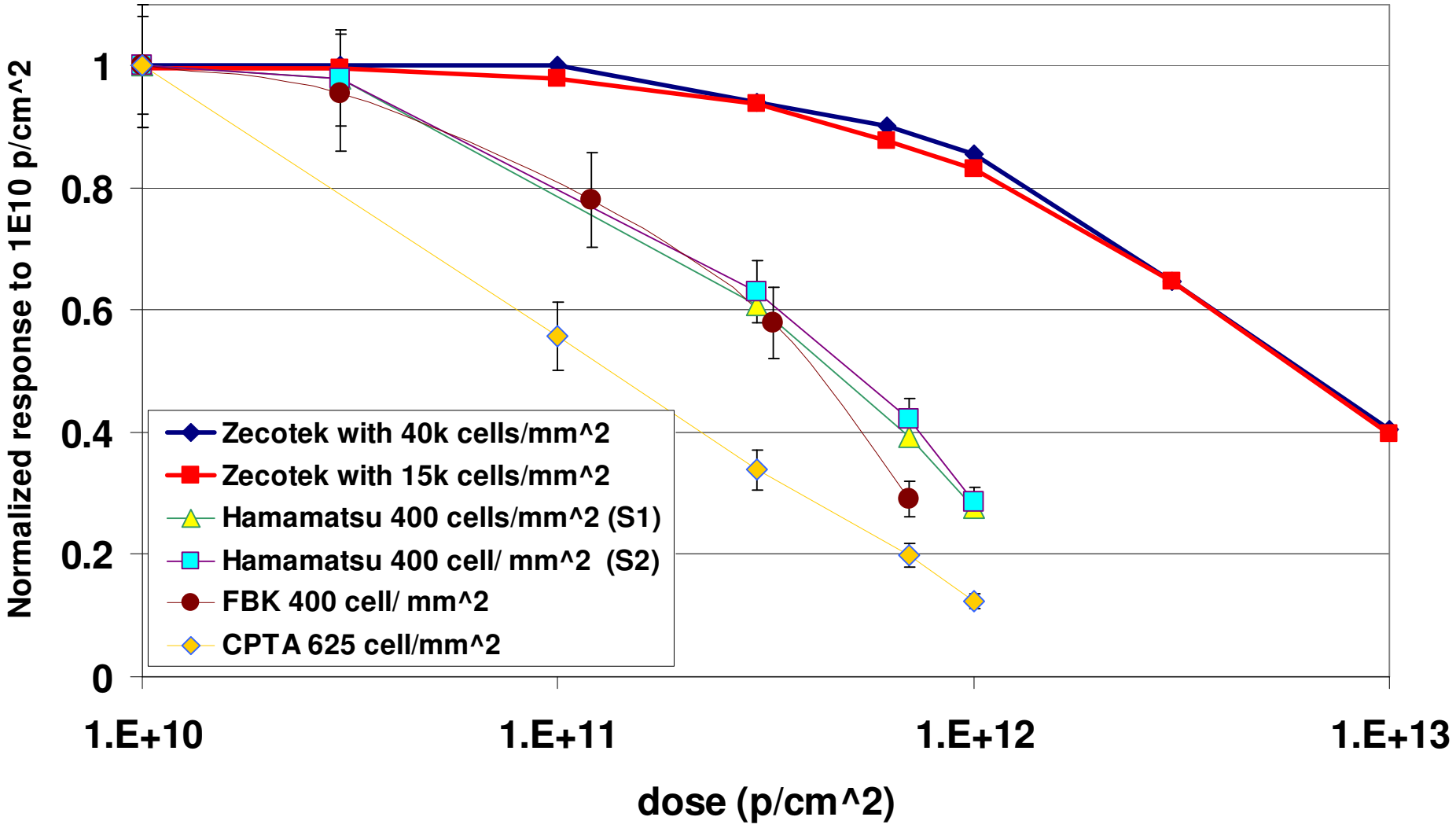
Need to do test and avoid ionizing dose

Dark Current vs. V-VB (T=21 C)

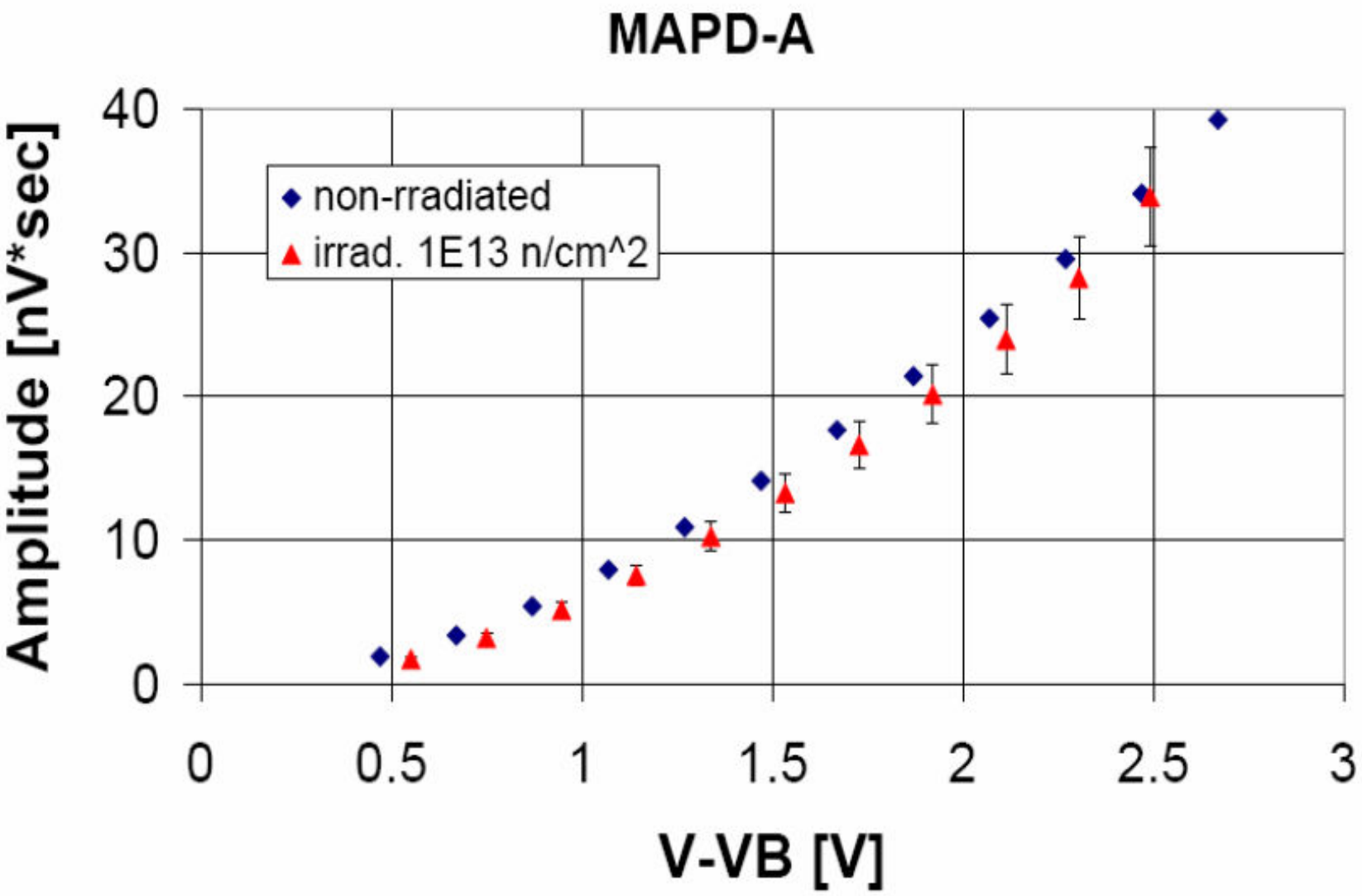


(Yuri Musienko)

Radiation damage



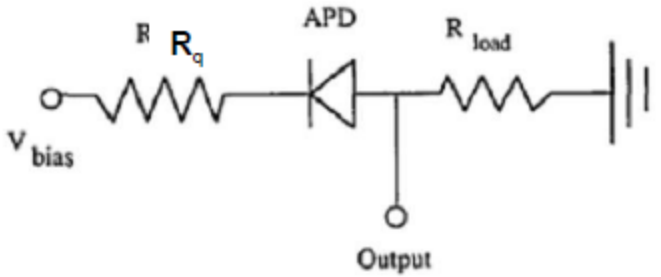
LED amplitude vs. V-VB



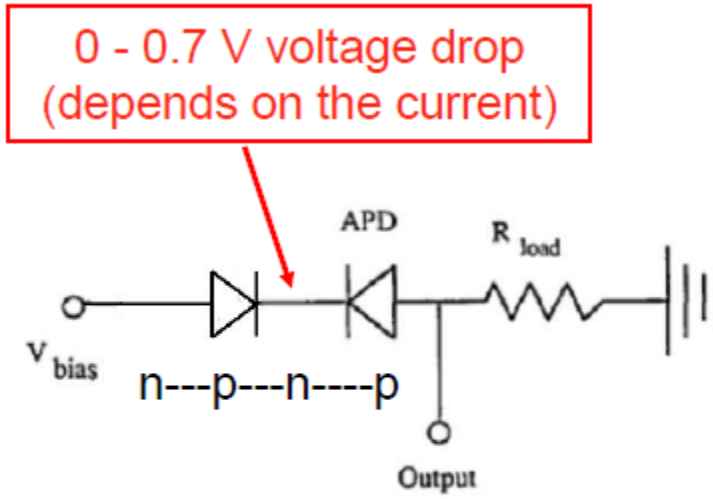
(Yuri Musienko)

MAPD quenching mechanism

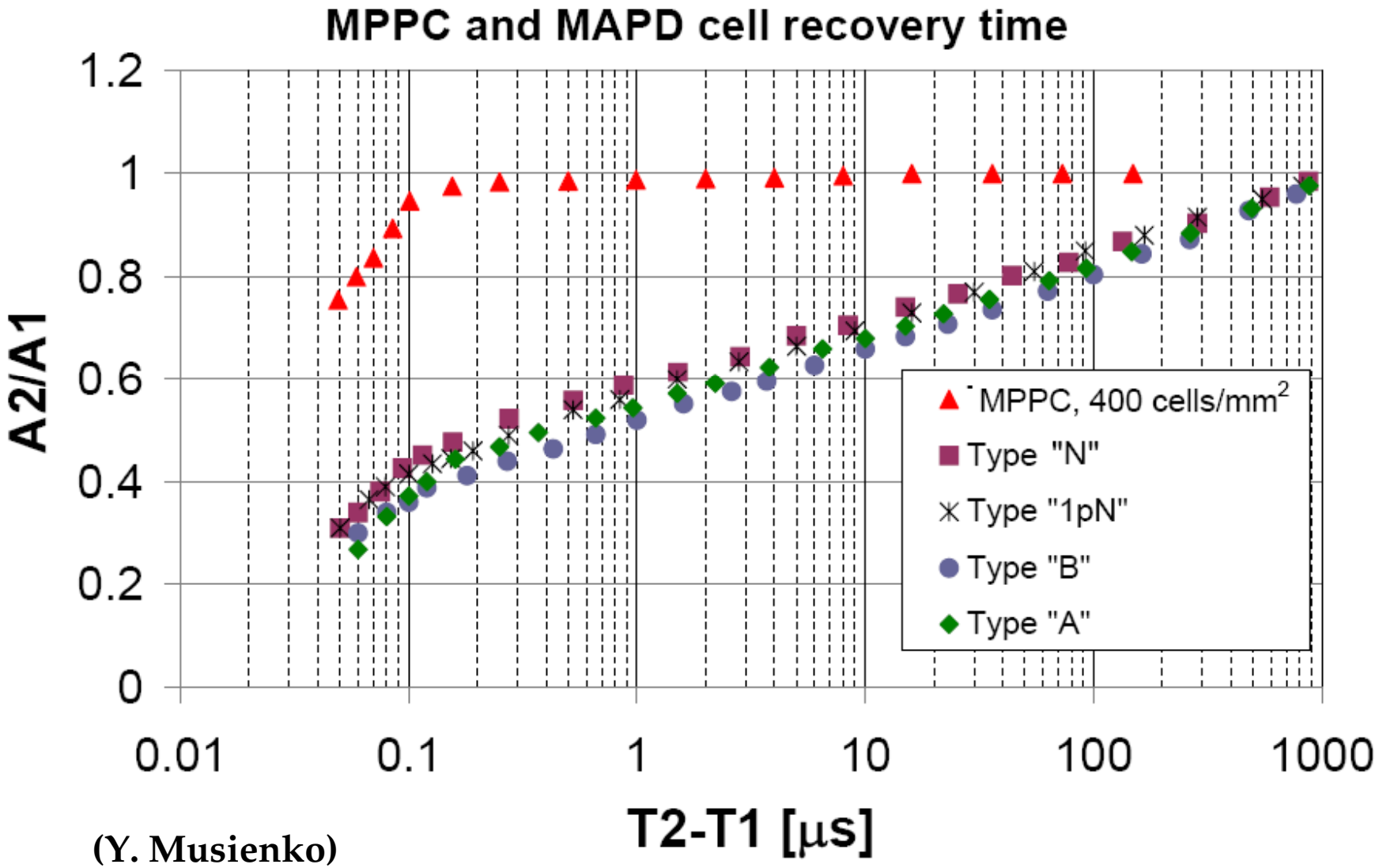
SiPM: quenching is done using quenching resistor – located at the SiPM surface.



MAPD: no quenching resistor – quenching is done using specially designed potential barrier located behind the main p-n junction (p-n-p-n structure?)



Recovery time

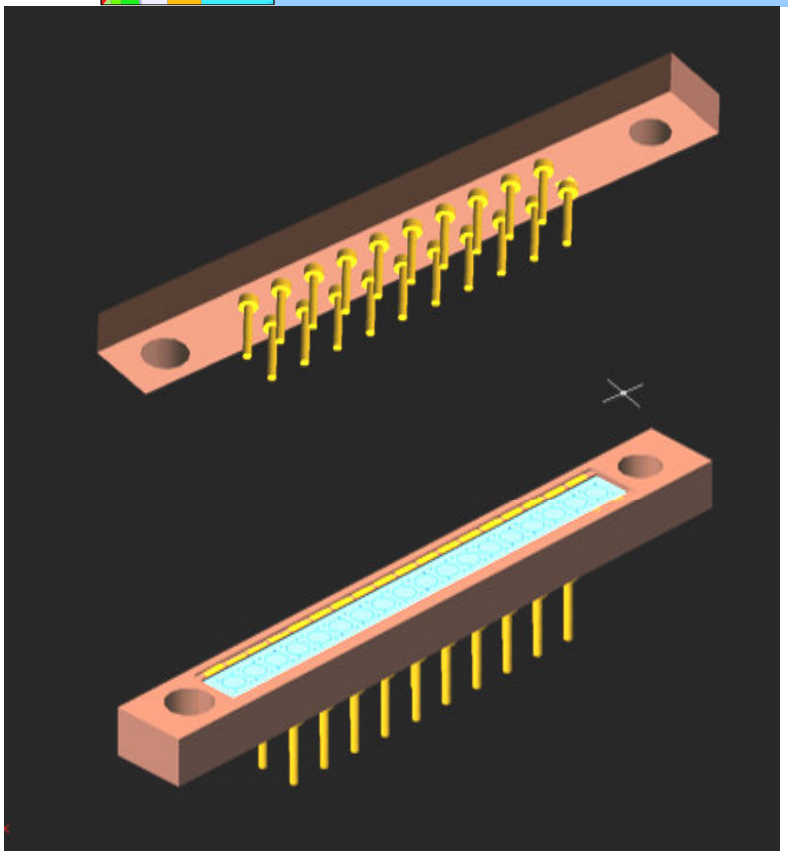


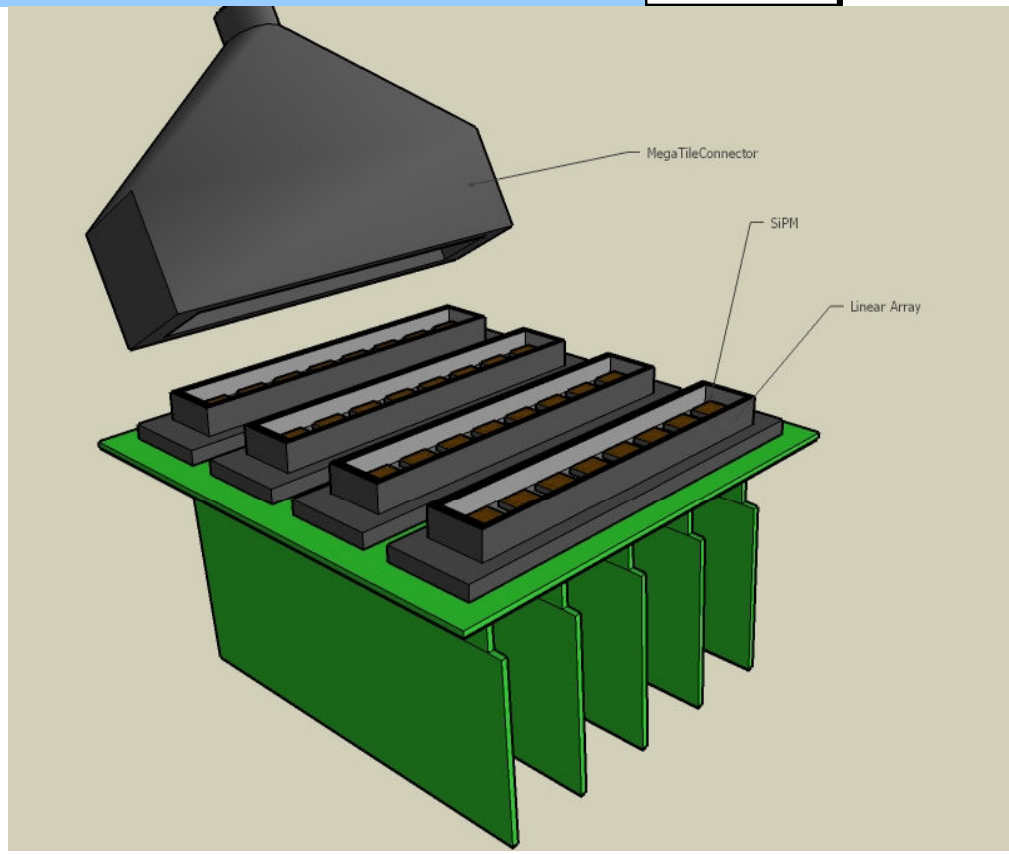
(Y. Musienko)

Progress Since Last workshop

- Quasi-final design for HO.
  - Solved temperature stabilization
  - Thorough study in testbeam
  - Installation of 2 RBXs in HO
  - Real experience in operation at CMS (and lessons)
  - Ready for CMS go-ahead on HO
- Demonstrated that EDU concept is feasible, no problem ganging together SIPMs from each layer.
  - Development of 18 pixel array SIPM, packaging
  - Testbeam study of performance. No noise issues.
- Shown that SIPMs can survive radiation dose
- Have developed powerful simulation tools to understand performance requirements. Lots of progress understanding:
  - Dynamic range requirements for jets
  - Effects of pileup for saturation/recovery, baseline shift

Array SIPM / EDU





Tasks

- Refine radiation damage technique to avoid too much ionizing dose (either elevated temperature annealing or find 100 KeV neutron source)
- Work with Zecotek to improve recovery time. (private communications indicate new development is in the works)
- It is troubling to have only one source for SIPM. Need to continue work with vendors to find alternative.
- Continue developing specs for Phase I application.
- Build prototype RM including “FPGA card” and readout.