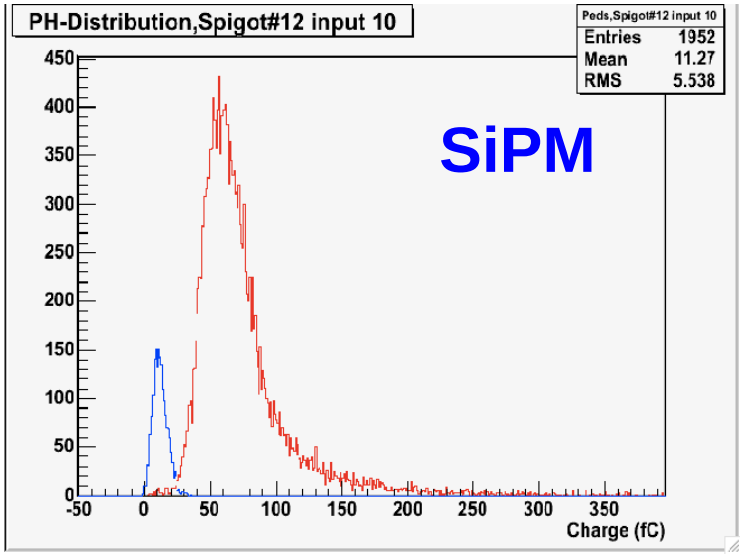
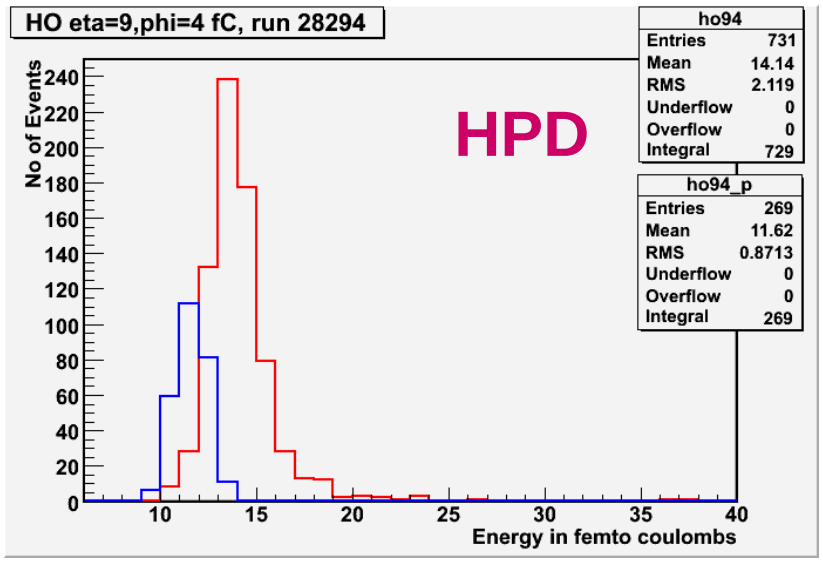
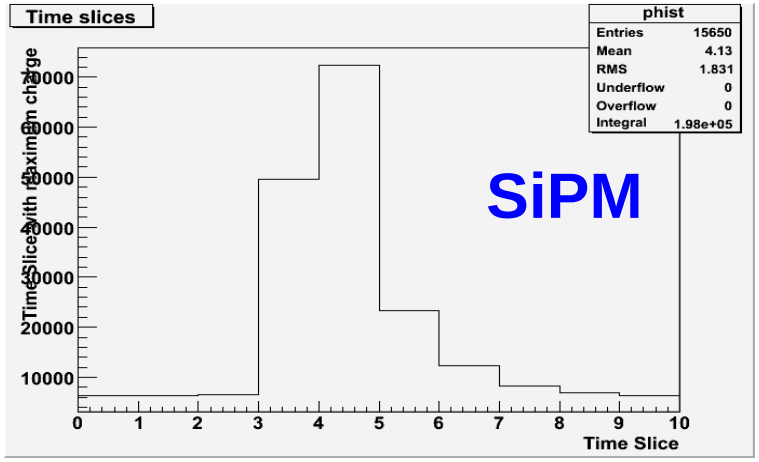
SIPMs for CMS

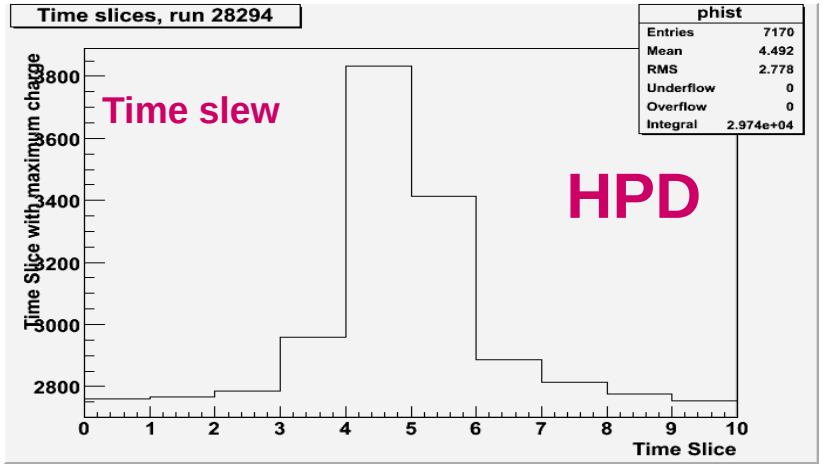
- 2 areas with 2 time schedules
  - Outer Calorimeter
    - Make purchases this year
    - Install in 2011
    - ~ 3000 SIPMs 3X3 mm
    - Note, should receive 3000 FBK diode prototyping run in May 09 (unpackaged)
  - SLHC Phase I upgrade (~ 2013)
    - Replace all HPDs in HB/HE with SIPMs, new electronics

Muon response for YB1



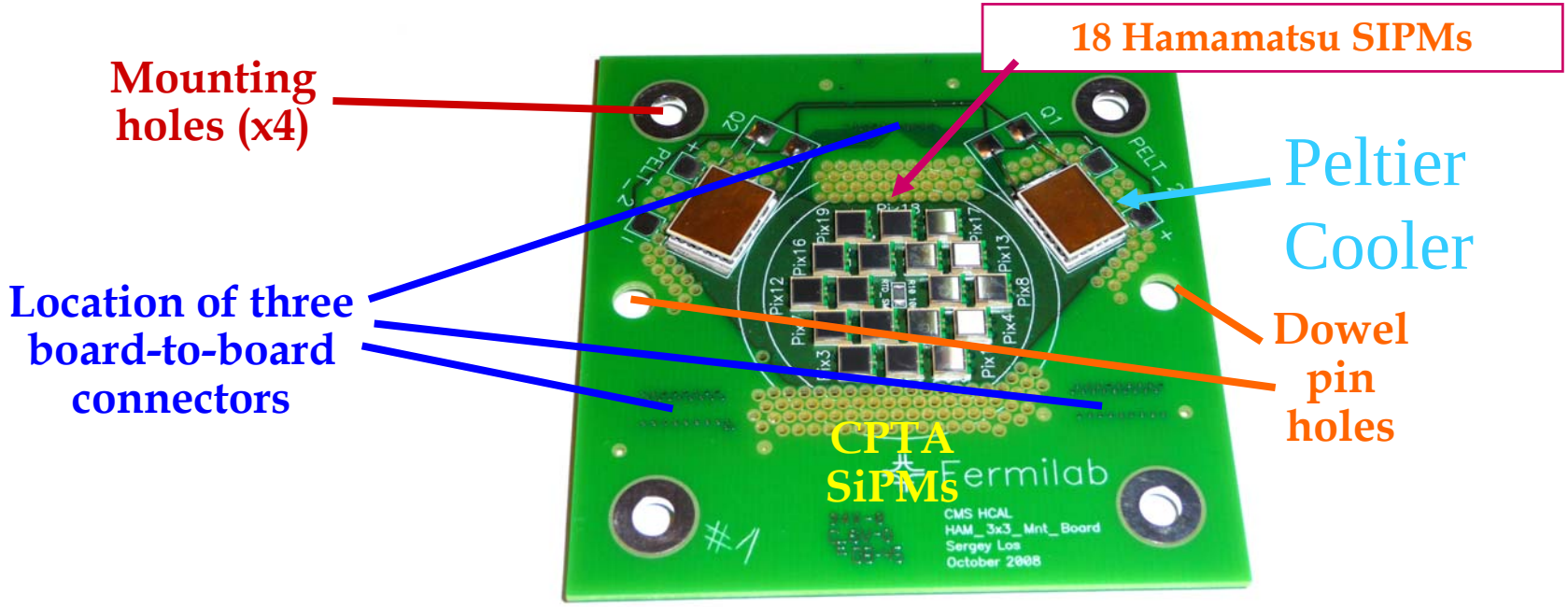






SiPM Readout Concept for HO

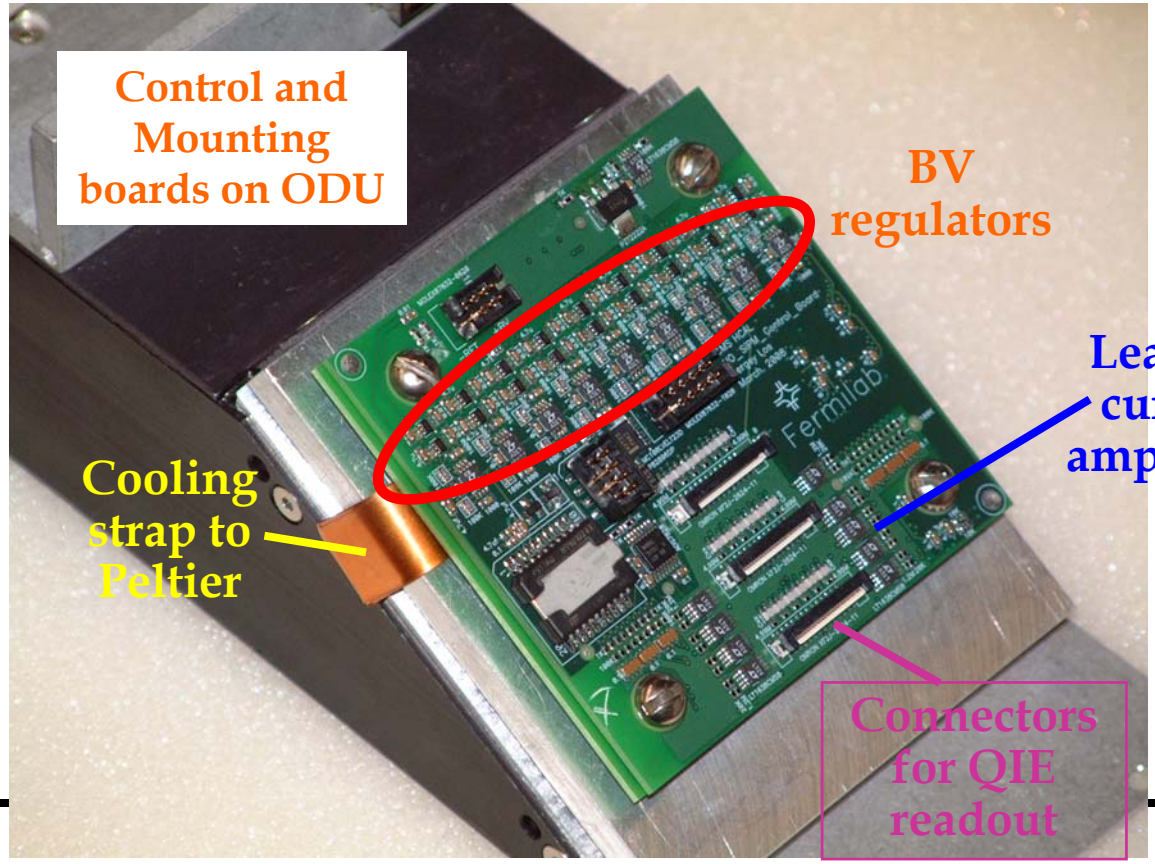
- SiPMs will be arranged in a pattern corresponding to the fiber bundles of the optical decoding unit output flange (cookie), and mounted on a printed circuit board, which also incorporates the bias voltage R-C filters (Mounting board). The Mounting board is registered to the cookie by two dowel pins, and is held in place by four screws (together with a Control board)



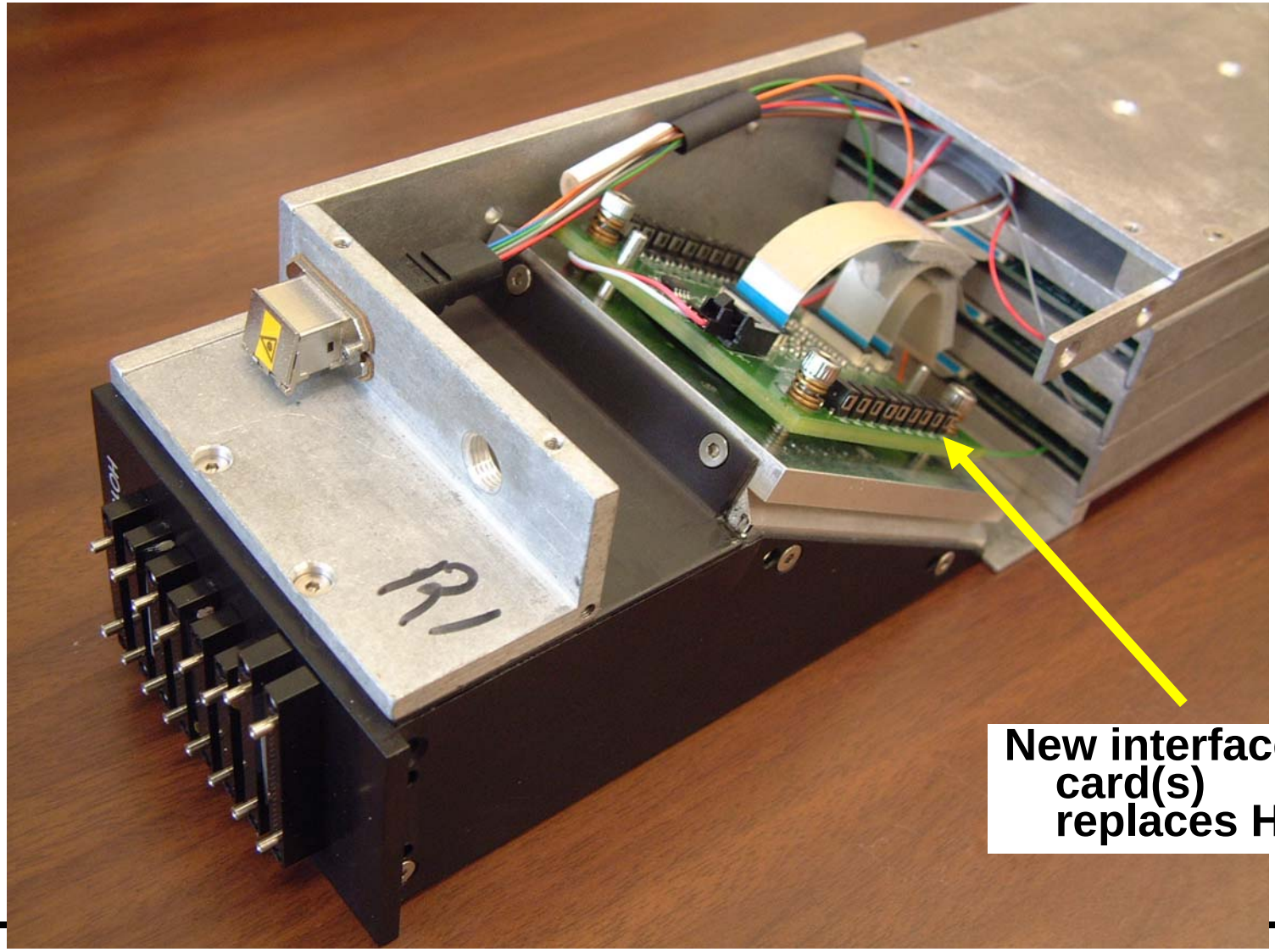
SiPM Readout Concept for HO (S Los)

- The Mounting and Control boards are connected by three low profile connectors (3 mm board to board) forming a sandwich. Control board, which is in the back, has three 26-contact FPC connectors for QIE readout.
- Control board supplies SiPMs with individual BV, measures leakage currents, and provides attenuation to match QIE resolution and dynamic range. DACs and ADCs are controlled via the readout box (RBX) existing I2C communication channel.

- For power Control board is tapping into the RBX backplane
- Peltier coolers are used to provide additional SiPM cooling
- Input voltage for the BV regulators (in the 40-80V range) will be generated on the spot by a voltage multiplier running off the RBX LV power
- There is a Pt RTD mounted between the SiPMs on the Mounting board to monitor their temperature to 0.17 C



Assembled HO RM (older 1 card version)

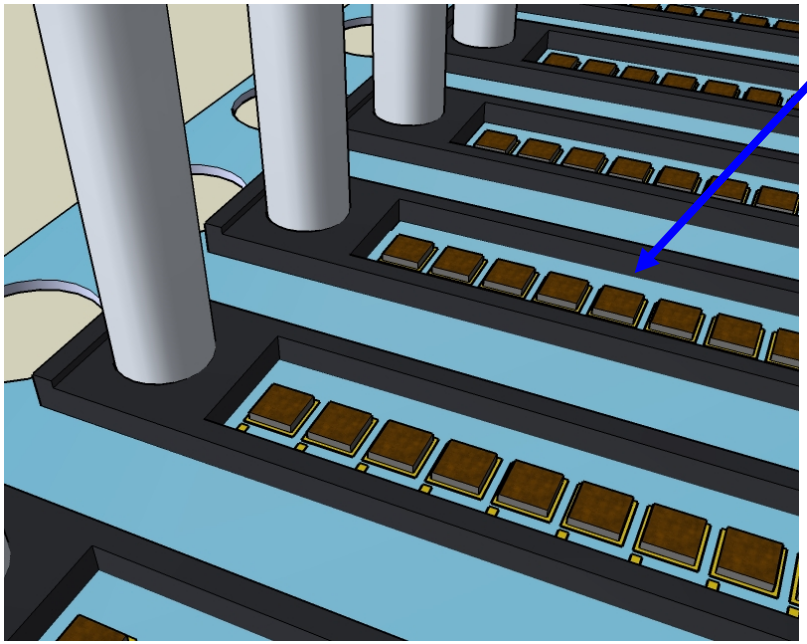


Phase I Upgrade (SIPMs)

- Phase I is ~ 2013 (3E34 Lumi upgrade)
- Major concept is replacement of HPDs with SIPMs
  - Work well in B field
  - Much higher gain and QE
    - less noise (in MeV)
    - can split signal to a TDC
  - Operates at ~50V (not 8KV)
  - Compact geometry allows new segmentation possibilities

Replace HPDs with SIPMs. Allows arbitrary segmentation

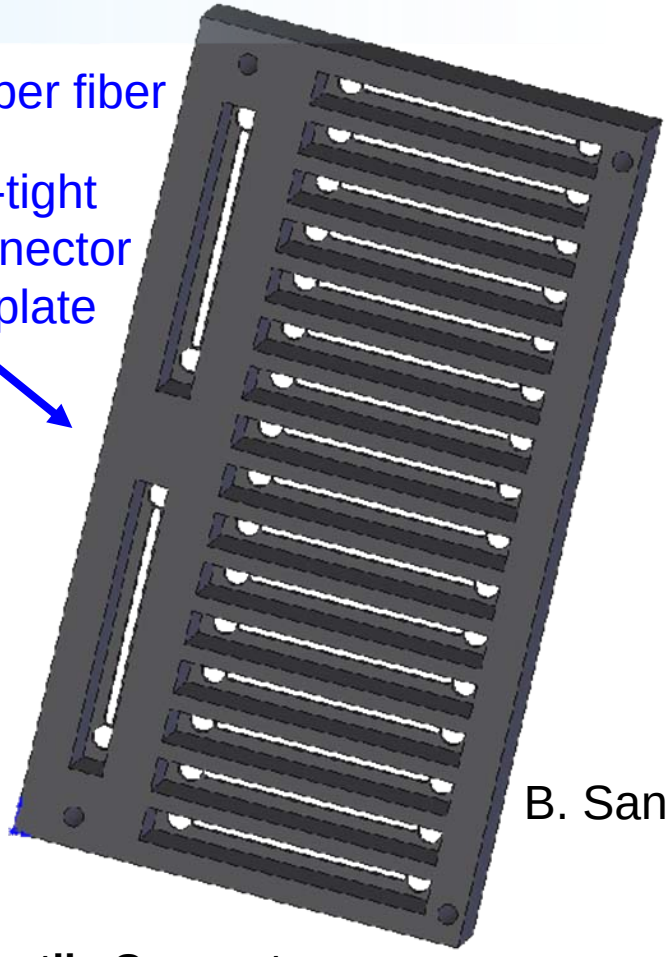
Proposed by Arjan Heering and Sergey Los



P. Rubinov

1 SiPM per fiber

Light-tight
18-connector
Faceplate



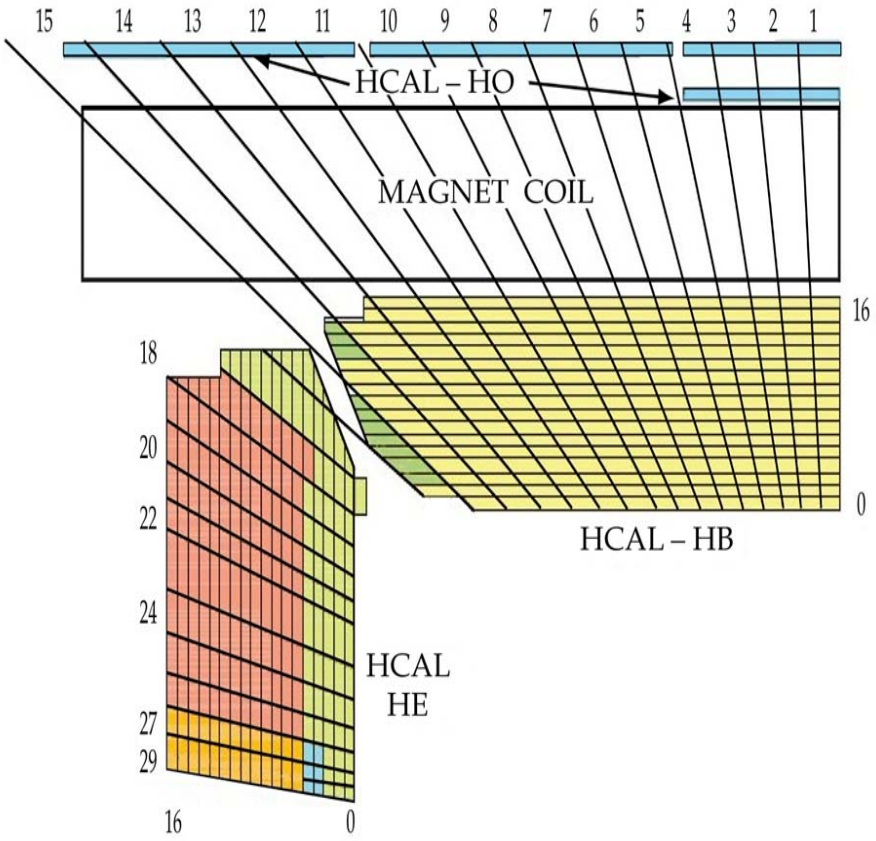
B. Sands

Basic Concept

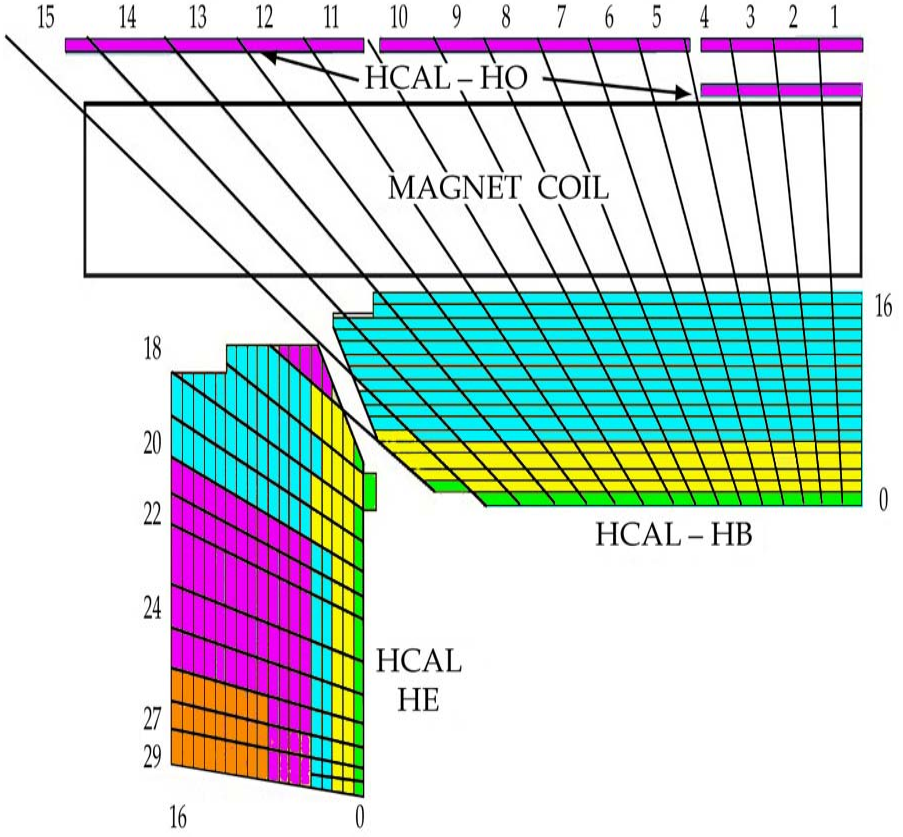
- **Do Optical/Electrical Conversion at the Megatile Connector**
- **1 SiPMs (1mm^2) per fiber (324 fibers per Readout Module)**
- **Perform Analog Addition to form (segmented) towers**

HB/HE Long. Segmentation

Current:
18 Channel RMs

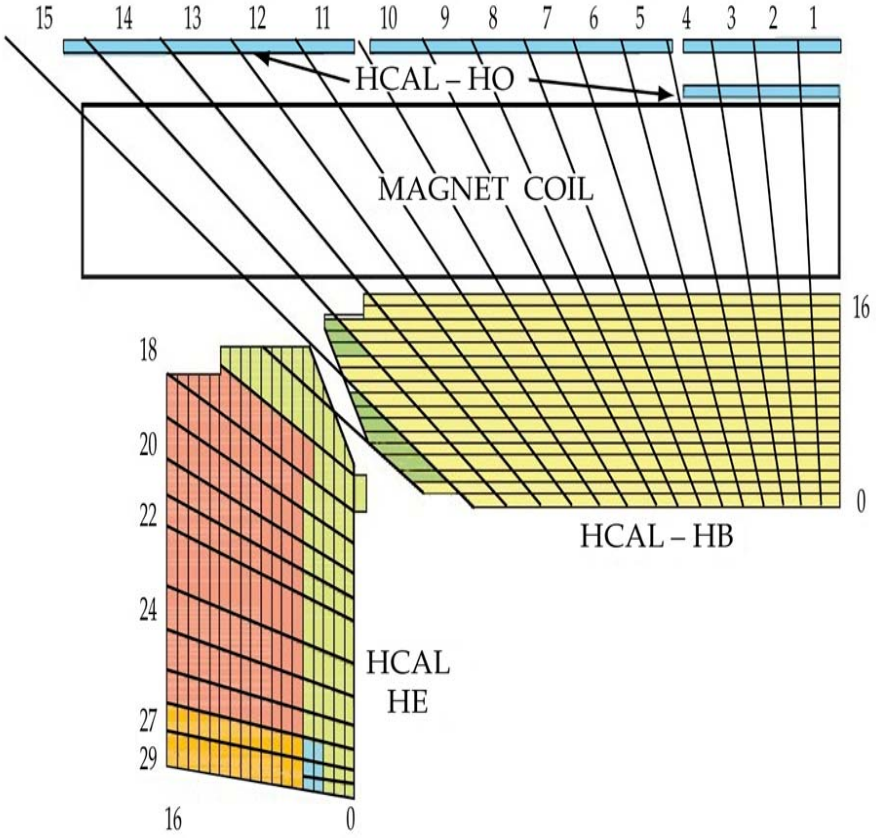


48 Channel HB RMs
32 Channel HE RMs

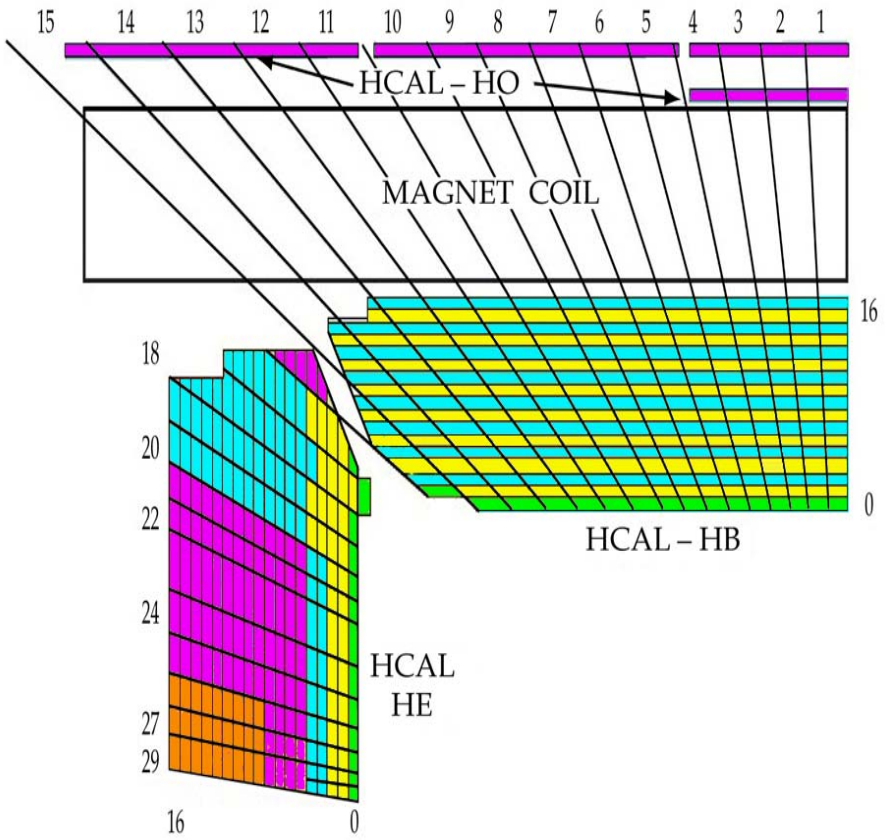


Allows other possible Longitudinal Segmentations

Current:
18 Channel RMs



48 Channel HB RMs
32 Channel HE RMs

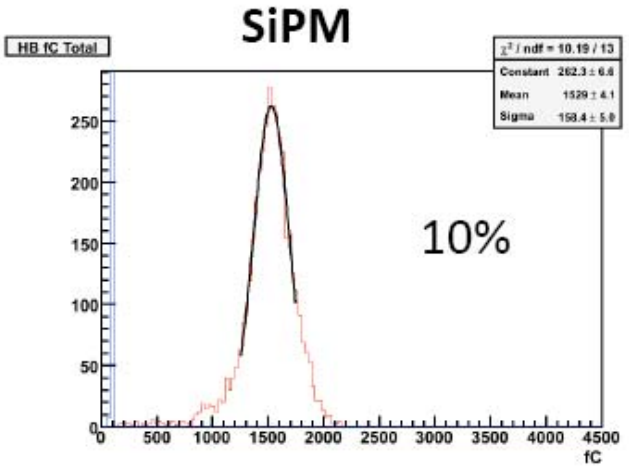


Phase I HCAL upgrade critical components

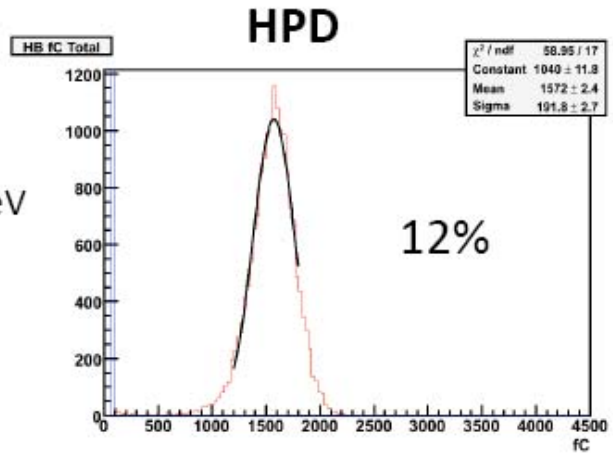
- SIPM tailored to HCAL
- New ADC (QIE10)
- Increased GOL Bandwidth, New VCSEL
- Better Cooling for Power
- Temperature Regulation for SiPMs
- Rad. Tolerant Discrete parts (regulators, FPGAs)

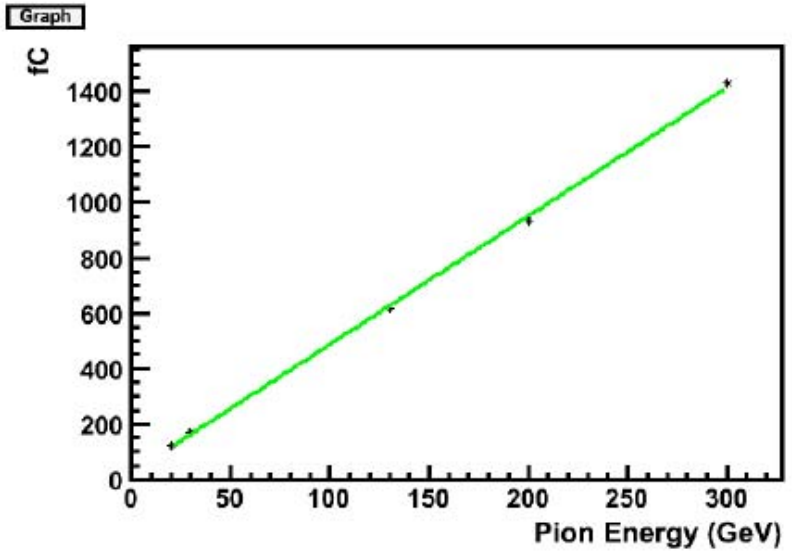
SIPM that satisfies HB dynamic range needs

MAPD by Zecotek, 40k pixels per mm^2, 9 mm^2 (360k pixels)

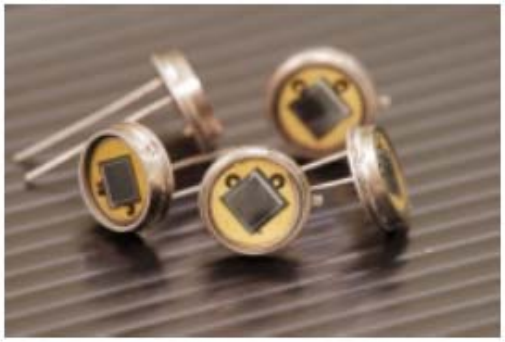


300 GeV pions

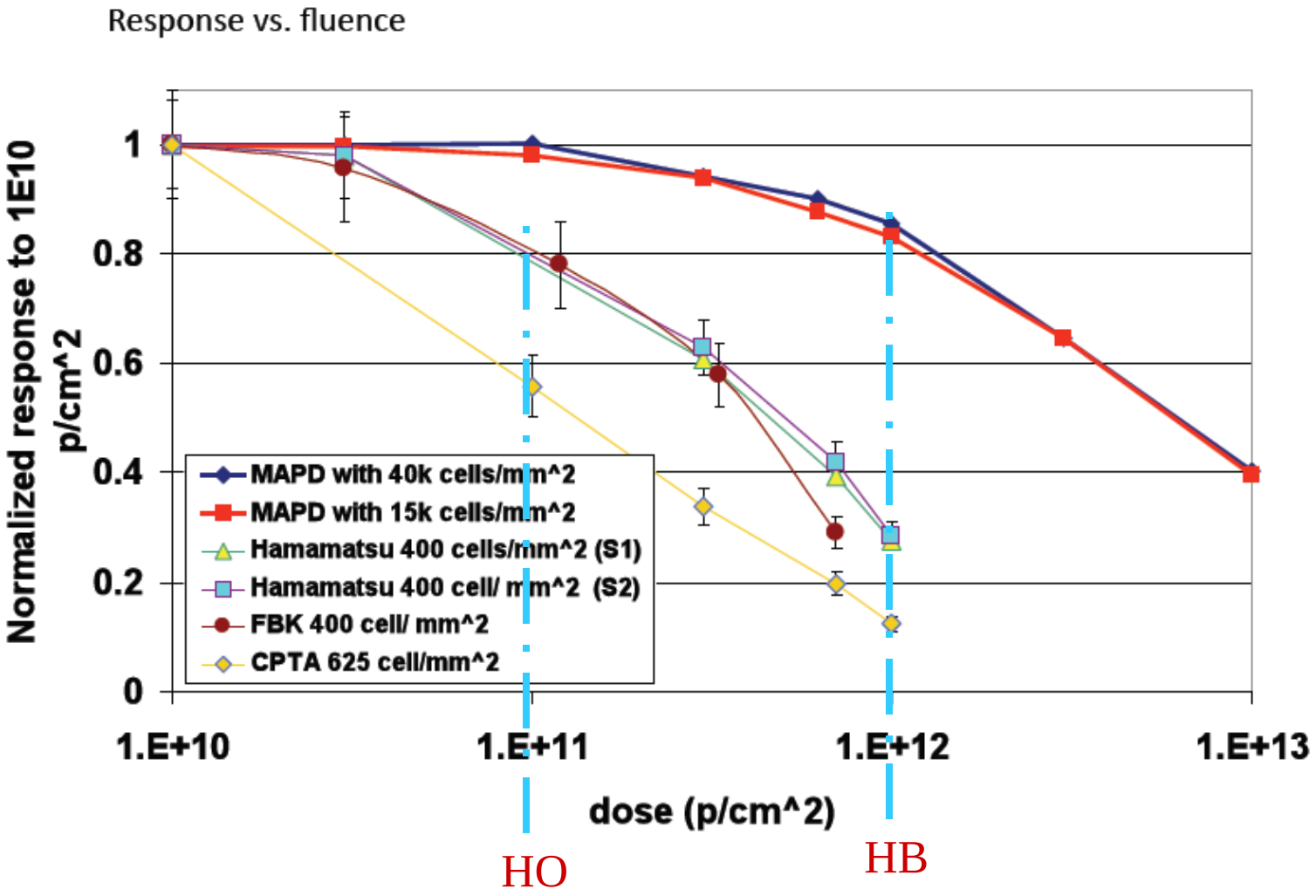




SiPM Linearity

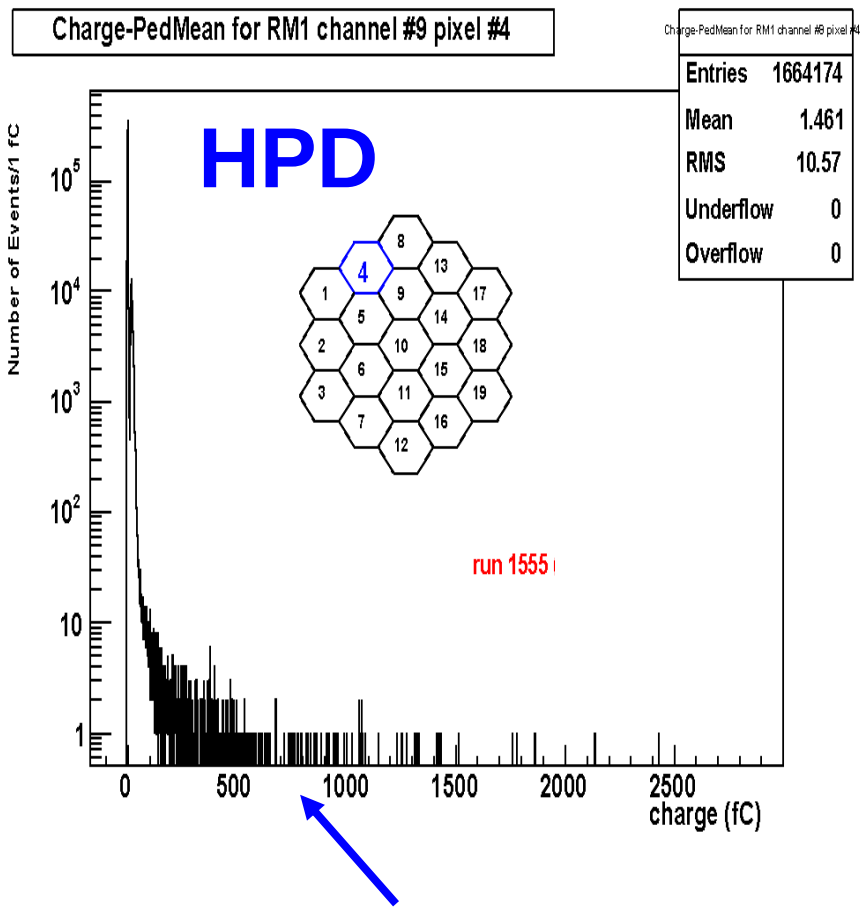


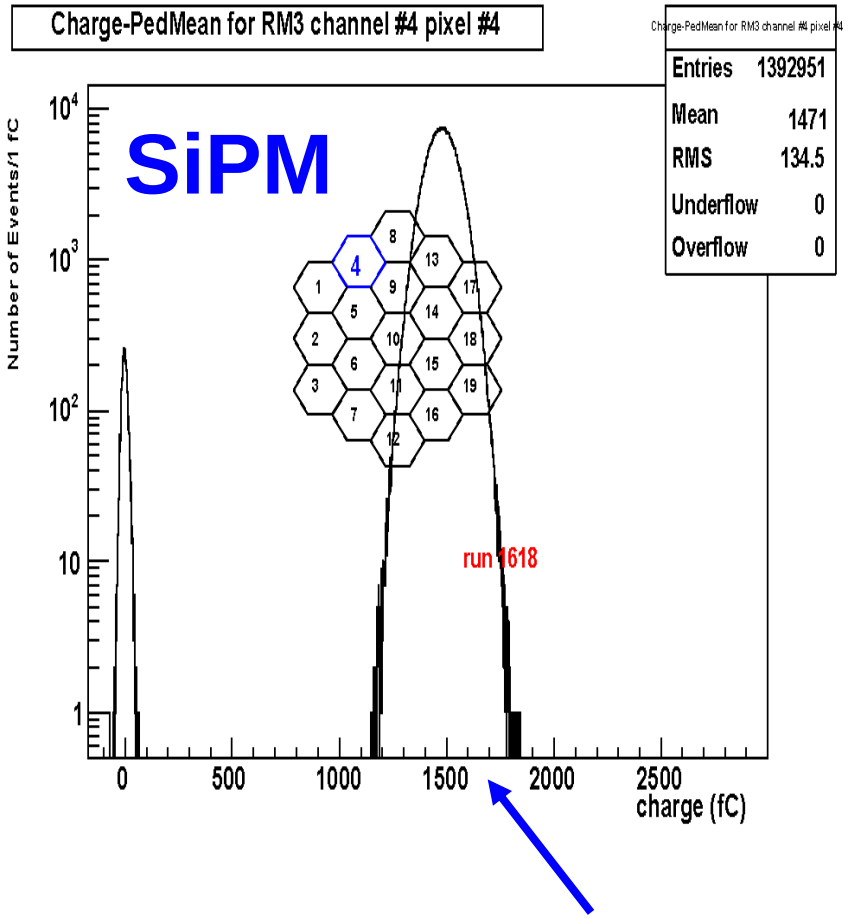
New SIPMs satisfy predicted SLHC Rad Needs



HPD vs. SiPM in 4T B Field

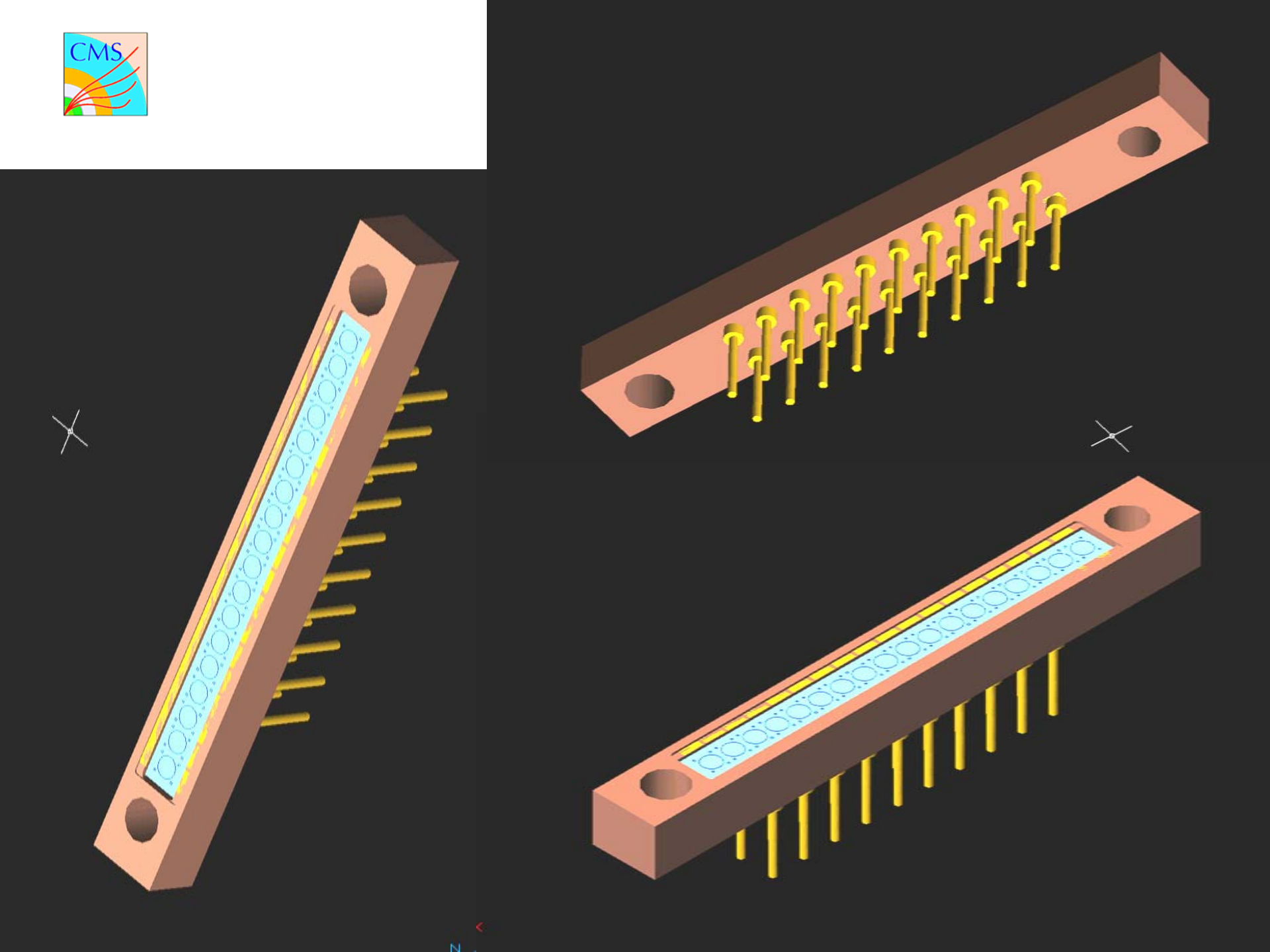
SiPMs are very quiet and operate at higher gain.

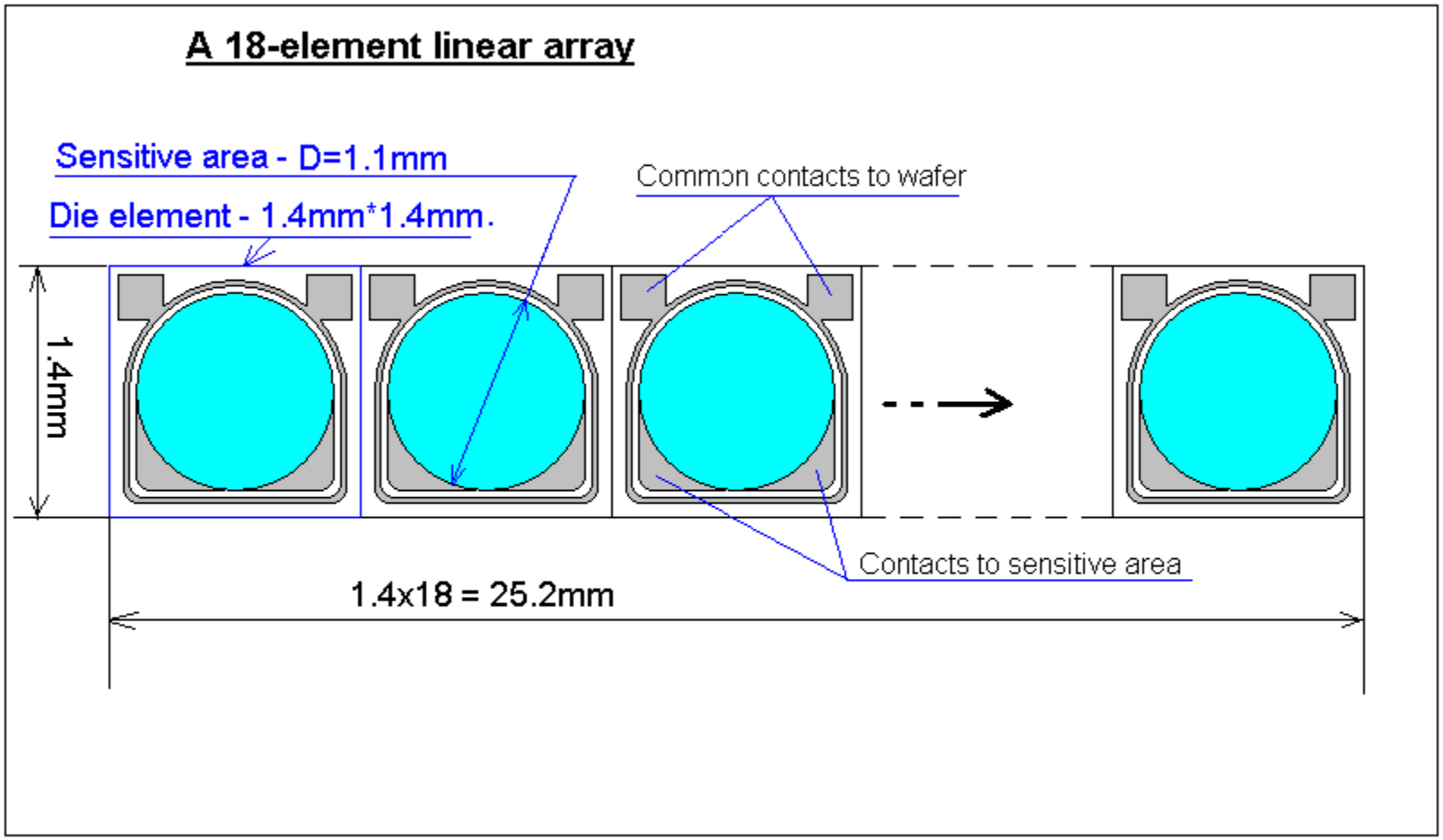




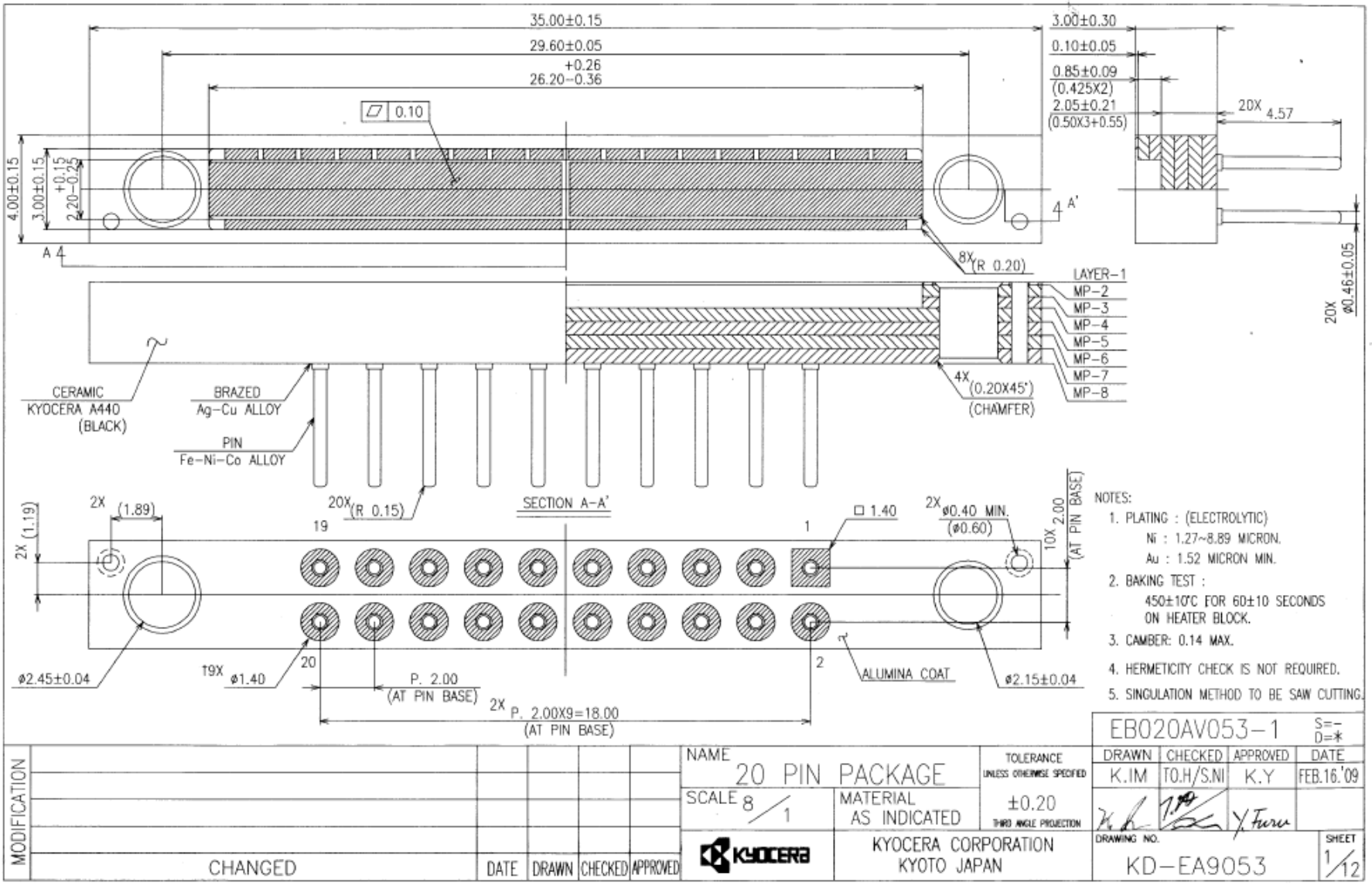
HPD Discharge Noise

LED calibration pulse




A 18-element linear array
Sensitive area - D=1.1mm
Die element - 1.4mm*1.4mm.
Common contacts to wafer
1.4mm
Contacts to sensitive area
1.4x18 = 25.2mm

Kyocera 20 Pin Package



SIPM Purchases

- 100 Hamamatsu delivery march 31
- 100 Zecotek in small package delivery march 31- april 15
- 75 Zecotek 18X1 strip packaged June 15
- Will need ~ 6000 Strips (110K SIPMs)

FNAL involvement

- Production quantity evaluation and burn-in facility
- Unpackaged parts?