Specs for SiPMs for calorimeters. Discussion. O.Tsai

- It was a project initiated meeting on 04/18/23

  SiPMs for ePIC (https://indico.bnl.gov/event/19172/)

- It will be another meeting later today to discuss specs for SiPMs, so…

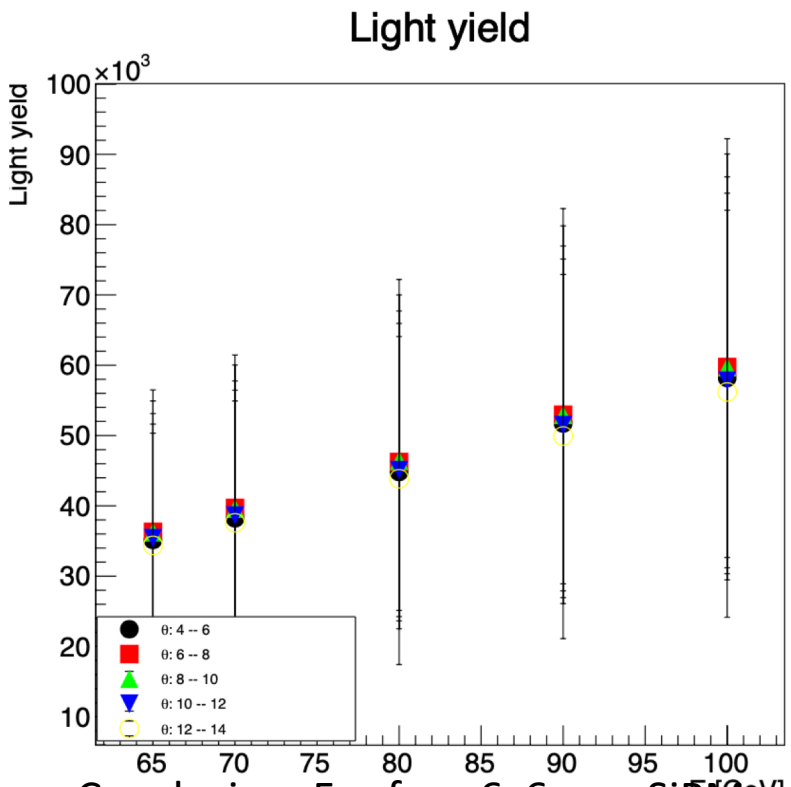
Terasaki-san:

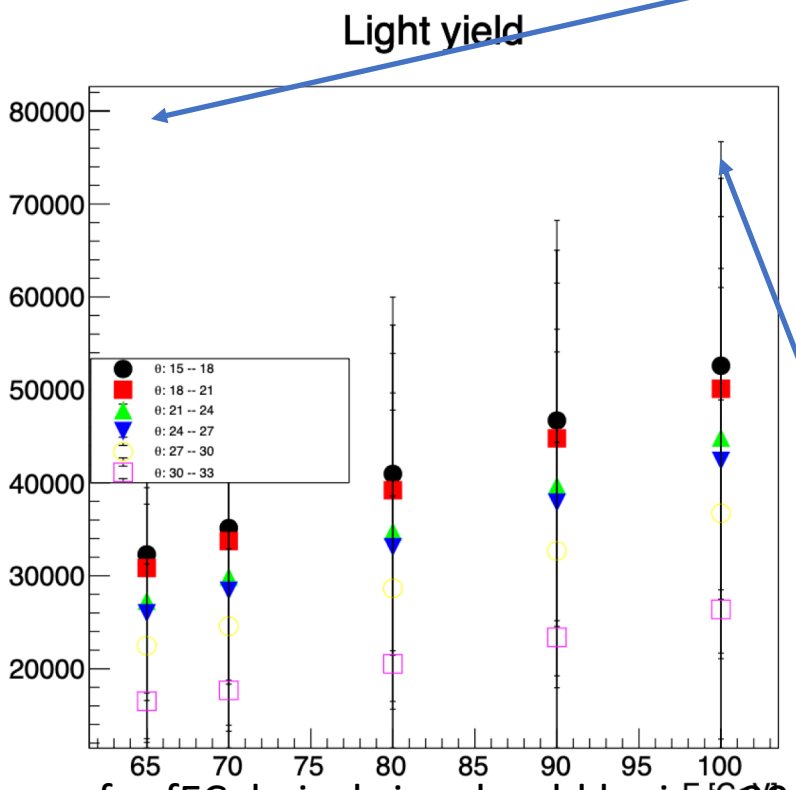
- Similar exercise was done for scintillating fibers – followed with meetings with Kuraray and Luxium to discuss our specs and how they may meet them.

SiPMs for ePIC (https://indico.bnl.gov/event/19172/). 04/18/23

Q1 - What is the dynamic range one needs to cover?

ePIC full simulations by Zhongling Ji presented at Calorimetry WG on Feb 15, 2023
https://indico.bnl.gov/event/18437/contributions/73244/attachments/46022/77786/main.pdf





'Light Yield' on y axis means number of fired pixels with assumption of LY at 1000 pixels/GeV.

Shown mean and min/max for all 'rapidity' bins for fECAl.

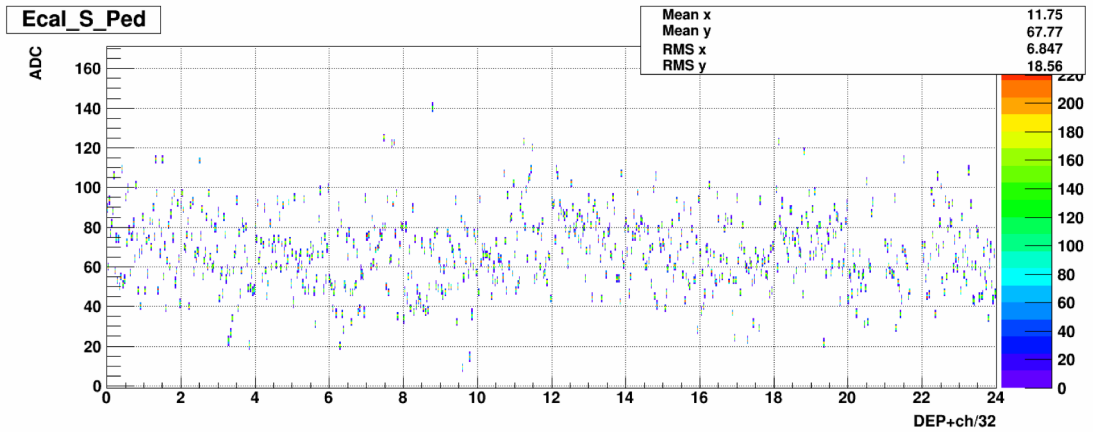
Max. sets requirement on pixel size.

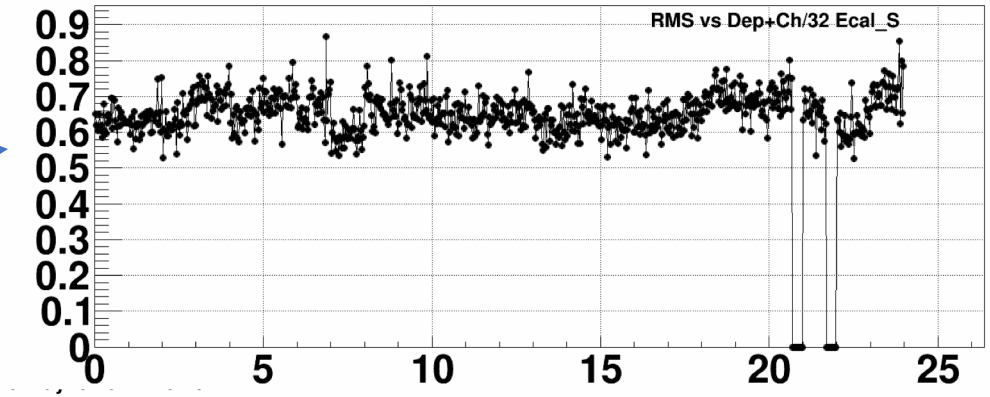
Conclusion. For four 6x6 mm SiPMs per tower for fECal pixel size should be in ~ 20 um size (15 um will work fine).

Q2- What is the impact of radiation damage of the SiPMs on you system.

Increase in a dark current -> increase in noise.

Based on FCS results (n fluxes similar to high lumi EIC) and projections for achievable LY (eRD106) for fECal we expect noise will be somewhat similar to FCS at ~ 3 MeV at highest rapidities. (That has to be measured with the beam, eRD106 test run at FNAL).





3 MeV FCS noise after Run 22 at RHIC

Q3. What specs have you already determined and how? What needs still be determined.

Pixel size 15 um, active area for a single sensor 6 x6 mm, four SiPMs per tower.
(ePIC simulations, past EIC R&D, STAR FCS readout)

Q4. How do your SiPM specs impact the readout electronics, especially the FEEs

Impact will be small. As verified by Gerard V. with four 6x6 SiPMs connected to FCS FEE. Some shaping may need to be tweaked.

Range of leakage currents to be handled by voltage regulators need to be verified, should not be an issue.

Table with expected parameters for fECal SiPMs as an example, compiled for Sasha B.
Some of these are specs some other is just a parameters?

	Parameter	Specs	Notes
1	Active area	6 mm x 6 mm	
2	Pixel Size	15 um or 20 um	Desired 20 um
3	Package type	Surface mount	
4	Peak Sensitivity	Max PDE at ~ 450 nm	430 nm – 520 nm
5	PDE	>30%	@ 3V overvoltage
6	Gain	~2x 10^5	@ 3V overvoltage
7	DCR	< 3000 kcps	@ 25C, 0.5 PE threshold, @3V overvo
8	Temperature coefficient of Vop	< 40 mV/C	
9	Direct crosstalk probability	< 1%	
10	Terminal capacity	< 2nF	
11	Packing granularity	Multiple of 4 per tray	
12	Vop variation within a tray	+/- 0.02V	

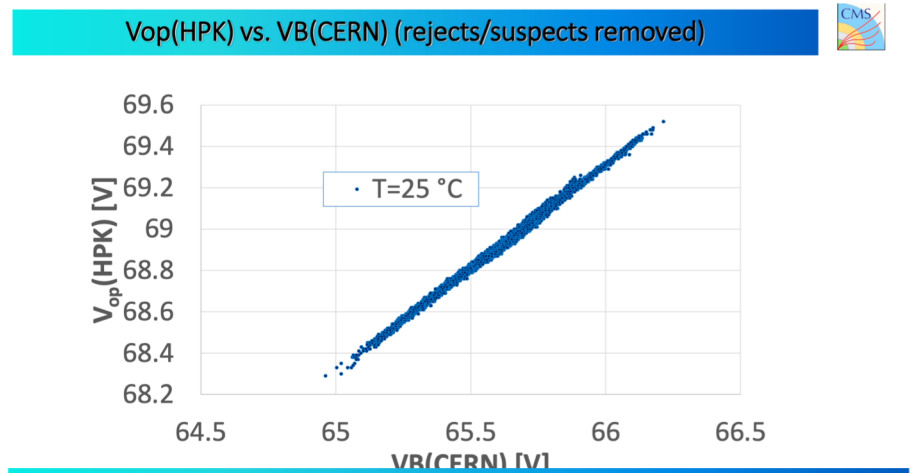
#7, Manufacturer usually provides dark current at Vop

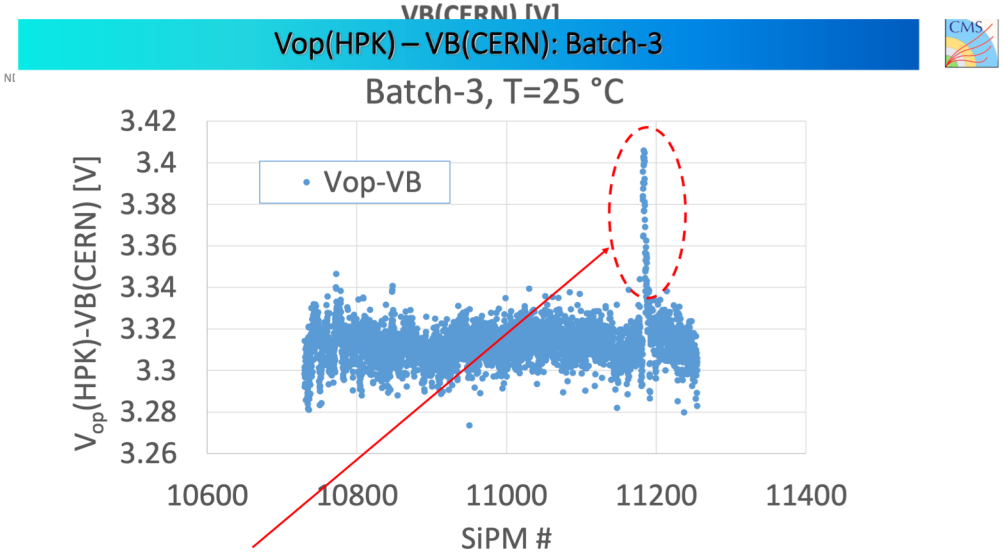
Not a specs, but additional request to manufactures (HPK provided it automatically).

1.Provide V_{op}

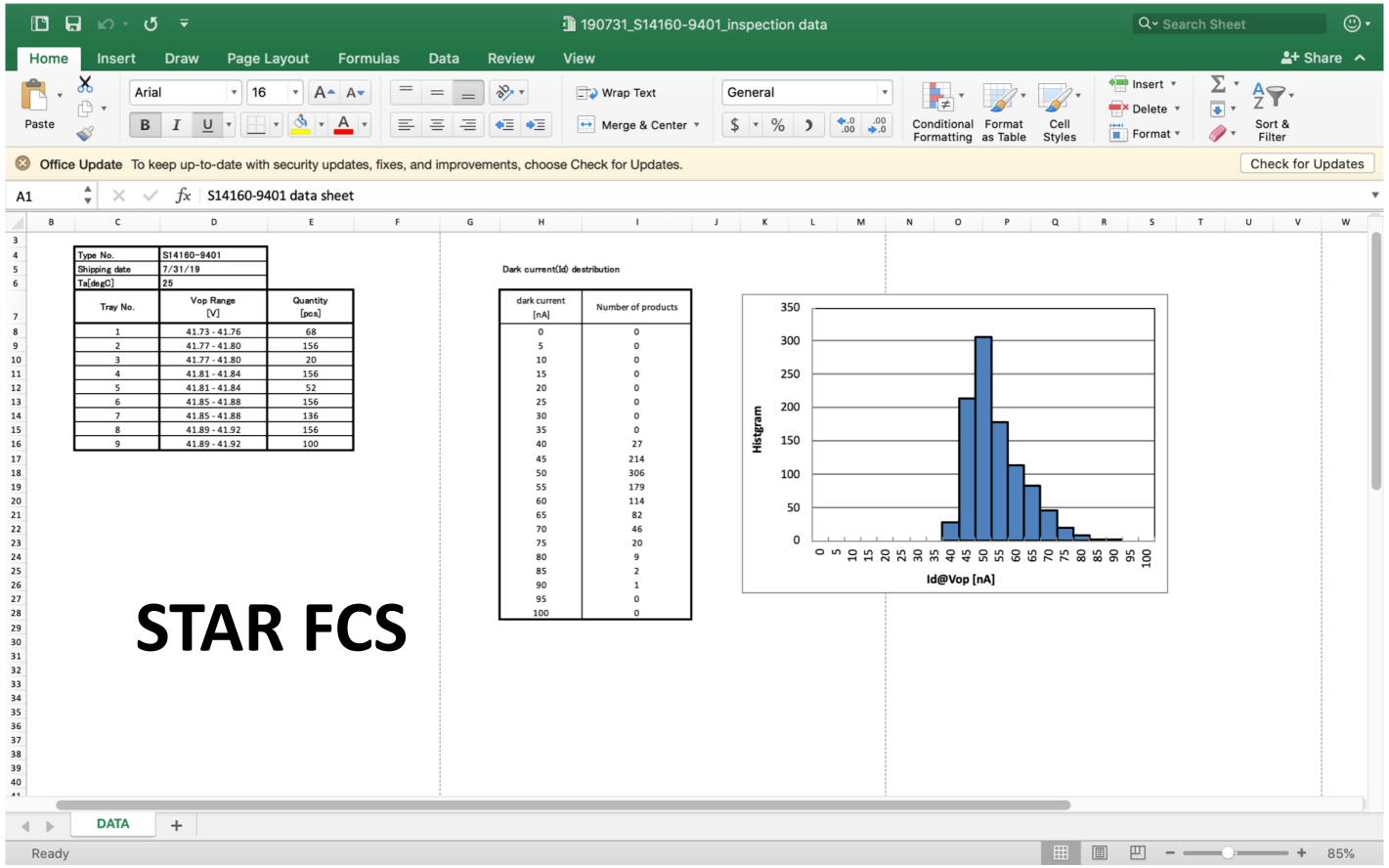
2.Provide dark current at given V_{op}

- Anything else?





12 HB arrays (out of 1680): significant difference between our VBs and Vops provided by Hamamatsu



STAR FCS

- Notes

Packaging with better thermal conductivi

New S14160-6010PS/6015PS
With better thermal packaging.