

EEEMCal Readout Requirements/ SiPM Testing Updates

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Agenda

- Today focused on enabling the required siPM testing to get done as soon as possible
- Schedule
- Updated Readout Requirements Status
- Testing proposals - Need (to report?) more detailed plans on how/what tests can determine siPM choice from the four being considered.

siPM's Inventory:

- News - see [“SiPM Inventory”](#) in google drive folder
- Discuss now or later?

	A	B	C	D	E	F	G	H	I
1	Model :	Waiting Jan 24	Received Jan 24	Other stock	In stock	To Gerard	To Miguel	To UmassLowll	Tot (>0 ?)
2	S14160-6015PS	20			0				
3	S14160-6010PS	10			0				
4	S14160-3015PS	96	4		4				
5	S14160-3010PS	0	5		5				
6									
7									
8	Expected by April 30:					To Gerard by May1			
9	S14160-6015PS	20			0				
10	S14160-6010PS	10			0				
11	S14160-3015PS	96	4		4				
12	S14160-3010PS	0	5		5				
13									

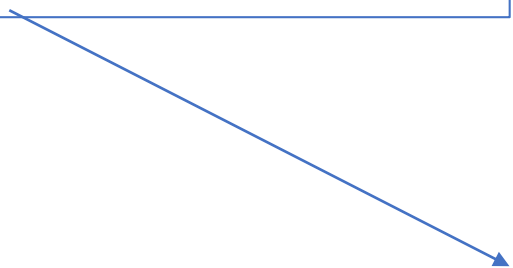
Irradiation News and Ultimate Deadline

- We can't fully characterize the siPM choices/decision till we have some irradiated siPM's of each type.
- I contacted Miguel Arriata: we are welcome to join in on the effort to irradiate at UC Davis(?) : They expect to do the irradiations starting in "late April". Perhaps they could wait if our siPM's orders are slightly later? I will ask
- An independent effort using Umass Lowell and/or DESY? -- if needed or after more siPM's come.
- We need to decide on the siPM's by September - Bazilevsky

List of Needed Performance Parameters

- **Energy Resolution** (cluster) $2.5\%/\sqrt{E} + 1\%$
 - **Earlier 2023** $1\% + 2.5\%/\sqrt{E}$ [$+ 1\%/E$?]
- **Spatial resolution:** $1 + 3\%/\sqrt{E}$
- **Linearity** : correctable to 0.5%
- **Threshold (single tower)** : ~ 5 MeV [[Bazilevsky studies](#)]
- **Dynamic Range:** Tower level 2-5 MeV to ~ 15 GeV ($\times 7500-3000$) (Cluster level -20-100 MeV – 20 GeV)
 - (assume $\geq 1-3$ ADCU per 5 MeV – which is threshold target.)
 - In pC : ~ 10 pC to 30-75 nC [?] – per channel : (min 10 pC from summer epic calo questionnaire document answer of “10-10000 pC”)
 - ADC : 14bit [?]
- **Rate Capability** : 20-100 kHz (highest [eta?] channels): Dominated by beam backgrounds, to be confirmed by further studies

This 20 is an old number?
YR: 50 MeV, later studies 100 MeV OK



List of Needed Performance Parameters

- **Waveform/timing:** All three of the below TBD
- *Timing resolution* : identify bunch crossing ~ 10 ns -- [can assume ≥ 2 tower measurements if needed $\rightarrow 14$ ns?]
- *Peak Time, N_samples* : $\geq 3-5$ in Peak + 2 pre-pedestal?
- *Sampling rate* : determined by above 40-80 MSPS
-
- **Noise Requirements** TBD by timing/resolution requirements: Pre-raddamage : DCR $\leq 3-10$ MHz Dark Current: ≤ 1.4 microAmps [Gerard's fEcal siPM presentation] Post-rad-damage

List of Needed Performance Parameters

- **Temperature/ Heating :**
- ***Temperature Sensitivity of siPM's*** - (Confirmation) tests of this would be good w/ w/o rad damage etc... look for opportunity
- ***Temperature Stability Requirement*** - tied to previous, later studies?
- ***Power consumption / Heating*** Pre-amp location [on adapter or preferably on IU adc board w/ 60 cm cable] - will be tested by Gerard IU.
 - TBTested with Dark current increase from Irradiation tests

Adapter Boards

- **Designs :**
- Larry: Updated (finished?) designs for 4x4 6010 [also 6015?] adapter boards]
- We currently don't have board designs for 3mmx3mm models? Can we again start with the $3 \times 3 = 9$ siPM boards (made for previous prototype testings)
- For sooner tests if siPM's delayed can we make a customized board for say four 3mm sipm - usefl?
- **Production of Testing Adapter Boards:**
- How much? Can Gerard/someone make cheap test boards?

Gerard recent studies for fEcal w/ 6015 siPM's

- Gerard presented study for fEcal Readout [last week at Calo mtg](#):
 - Parts can be applied almost directly or done similarly for us to us?
- LED testing for 4 6015 siPM's on test adapter board - different pre-amp expectation than for us?
- Different dynamic range need (15 MeV threshold – 100 GeV) different light yield conversions
- Showed behavior of near threshold (for fEcal 15 MeV- ~20 pixel) and higher pulse and digitization characteristics
 - 13.5 pixel RMS 4.5 w/ simulated 100 μ A dark current rad damage RMS @ 13 is **18**
 - Timing resolution: assuming 14bit ADC digi-noise 39MSPS sampling need 5 ADCI pulses to achieve bunch crossing 10 ns resolution

Testing Proposals (who does them next slide?)

- Repeat Gerard's last tests on all (other) siPM's models
 - mostly same stuff done , but for other models (too much work?)
 - do we need to better characterize the LED for PDE do we want cosmics/crystals?
 - Need calibrated comparison (e.g. PMT) setup – at least for cosmics?
- Not covered so far but to be added
 - same tests : sim rad damage → real rad damage – repeat same tests?
 - Timing resolution is a pure sim study, can be done by anyone – To be improved by real pulse shape [pulse shape can be adjusted by design of adapter board,etc.]

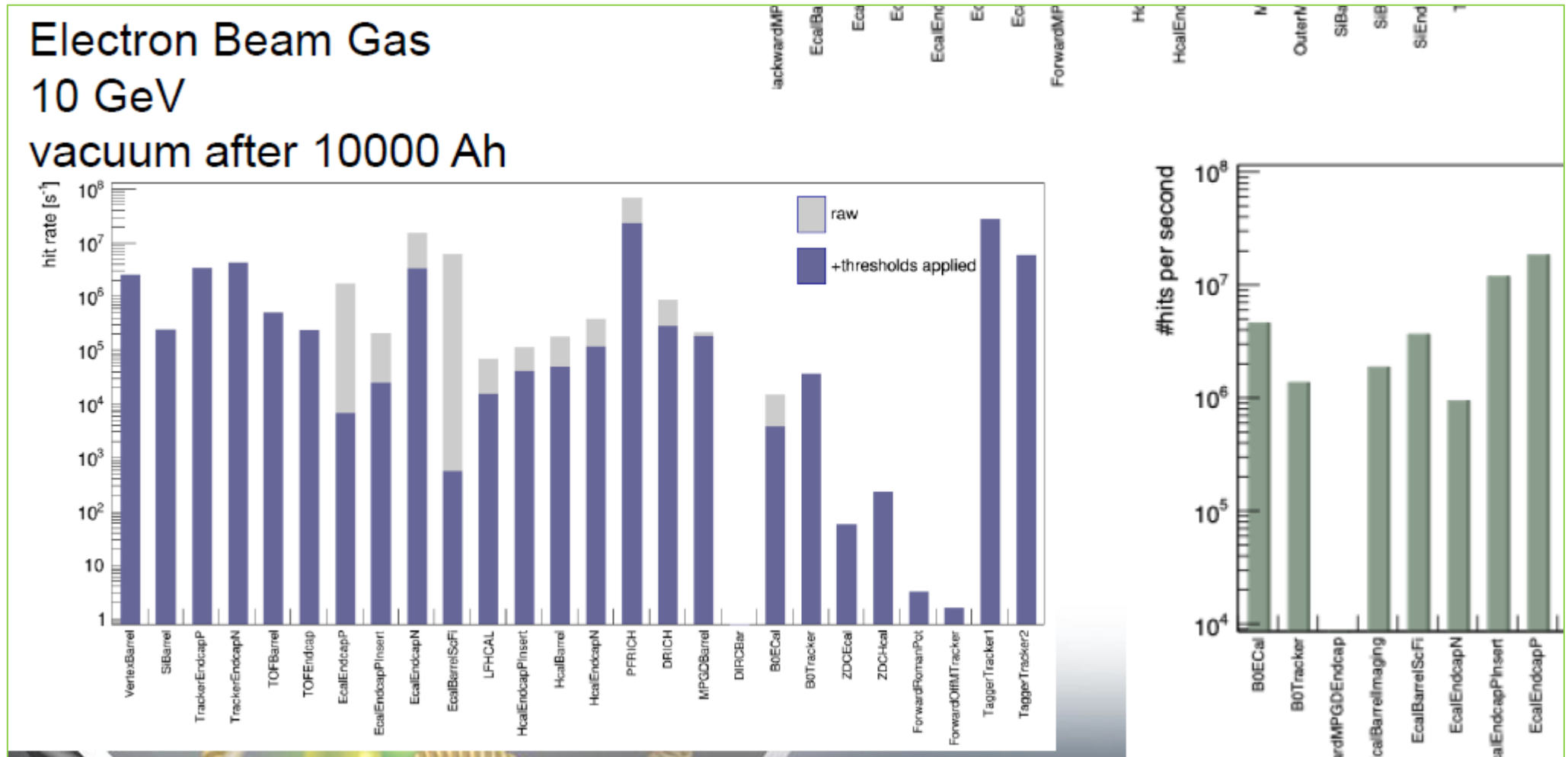
Who does testing?

- Gerard IU?
- Backup: Ohio U?

Backup

Bkg Rates: whole detector

- Latest talk by Elke @ Jan collab mtg: whole detector: 5Mhz (5 MeV threshold) 20 MHz (~zero threshold?)

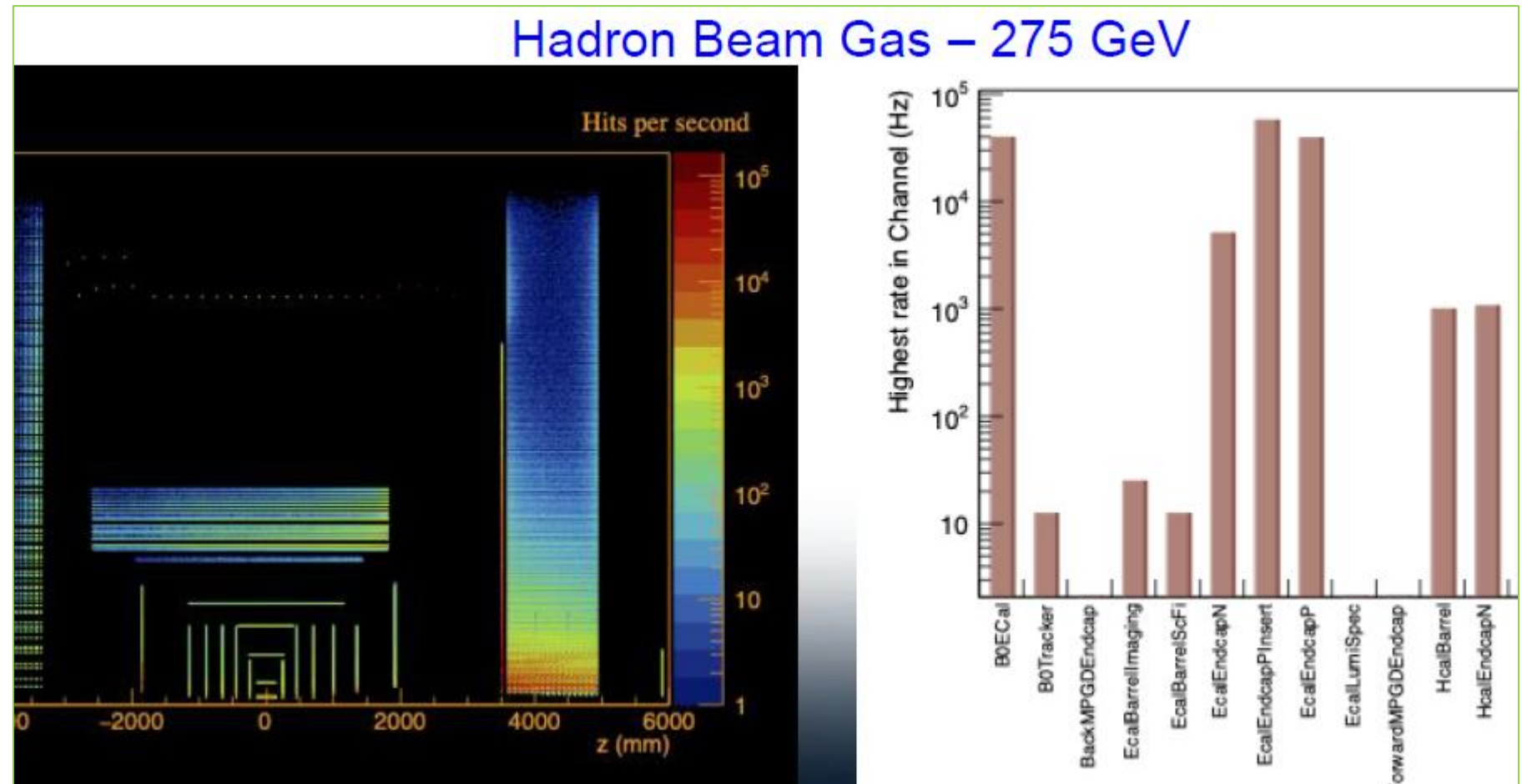


Bkg Rates: highest channel

- Converted to highest rate channel for Hadron BG factor of reduction : 1 Mhz \rightarrow ~ 5 kHz assuming digitization model ? [“analog feature : total hit time reso: few ns, HGCROC t_{reso} 100ps?] \rightarrow for 4Mhz \rightarrow 20 kHz highest channel

• Dmitri: similar type of reduction factor based on geometric locations

(Using \sim this, (?))
how to deduce time reso requirement?





https://wiki.jlab.org/cuawiki/index.php/OVERVIEW_OF_SPECIFICATIONS