# SiPM for ePIC Calorimeters

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ePIC Calorimetry Meeting

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Calorimetry SiPM meeting on Apr 19, 2023
https://indico.bnl.gov/event/19172/

# SiPMs as LLP

## EMCal:

| | | | |
|---|---|---|---|
| Backward: | 52,096 (=3256×16 of 3x3 mm2, 10 or 15 um) | ⟹ | 6x6 mm2 ? |
| Forward: | 76,000 (=19000×4 of 6x6 mm2, 15 um) | | |
| Barrel Pb/SciFi: | 30,720 (=7680×4 of 6x6 mm2, 50 um?) | | |

## HCal:

| | |
|---|---|
| Backward: | 10,800 (1.3x1.3 mm2, 15 um or 25 um) |
| Forward: | ~600k (1.3x1.3 mm2, 15 um or 25 um) |
| Barrel: | 7,680 (3x3 mm2, 15 um ) |

# Towards PDR/TDR

Sensitivity to neutron flux

Up to a few $10^3$ increase in DCR is expected

Non-linearity

5-10% expected

Temperature dependence

Up to -4% / degC is possible

Cooling

T-compensation?

Monitoring

Calibration

Annealing?

Replacement?

# Neutron Flux Effect

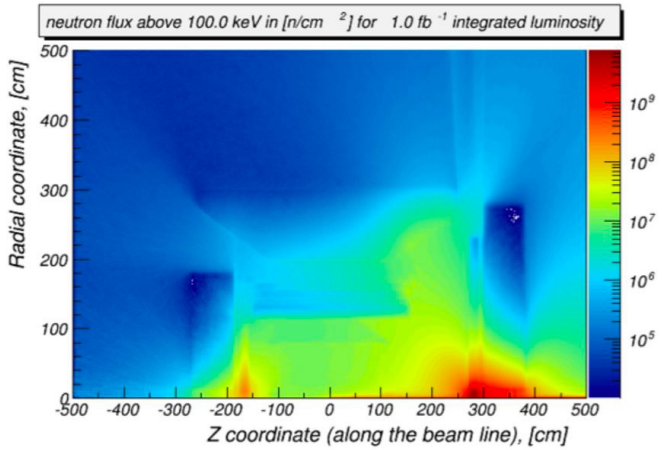
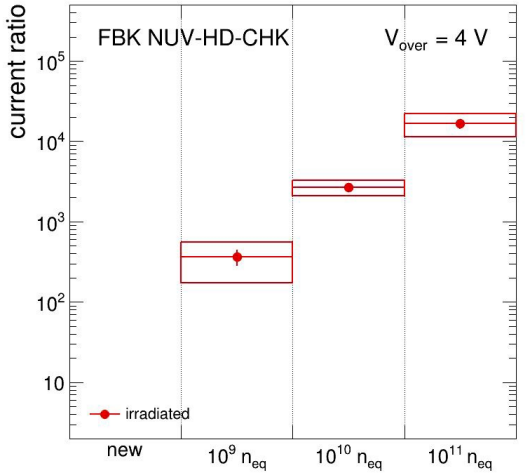



**Figure 10.8:** Neutron flux from the $e$+$p$ collision at $\sqrt{s_{ep}} = 140$ GeV studied using the BeAST detector concept with the assumed location in the RHIC, located/placed in the RHIC IP6 experimental hall, which also applies to the reference EIC detector as in this report.

Forward: ~$10^{11}$ n/cm$^2$/year at L=$10^{34}$ cm$^{-2}$s$^{-1}$
Backward: ~$10^{10}$ n/cm$^2$/year at L=$10^{34}$ cm$^{-2}$s$^{-1}$
Barrel: ~$10^{9}$ n/cm$^2$/year at L=$10^{34}$ cm$^{-2}$s$^{-1}$

eRD110:
Increase in SiPM DCR after irradiation




A factor of 300 at $n_{eq}=10^9$
Another factor of 10 at $10^{10}$
Another factor of 10 at $10^{11}$

May lead to high noise level:
- A few MeV in barrel and backward EMCal
- A few 10s MeV in forward EMCal

STAR FCS (from Oleg)
- 3 MeV noise after $10^{11}$ n/cm2 (for 4 3x3mm2 SiMPs?)
- … underestimated?

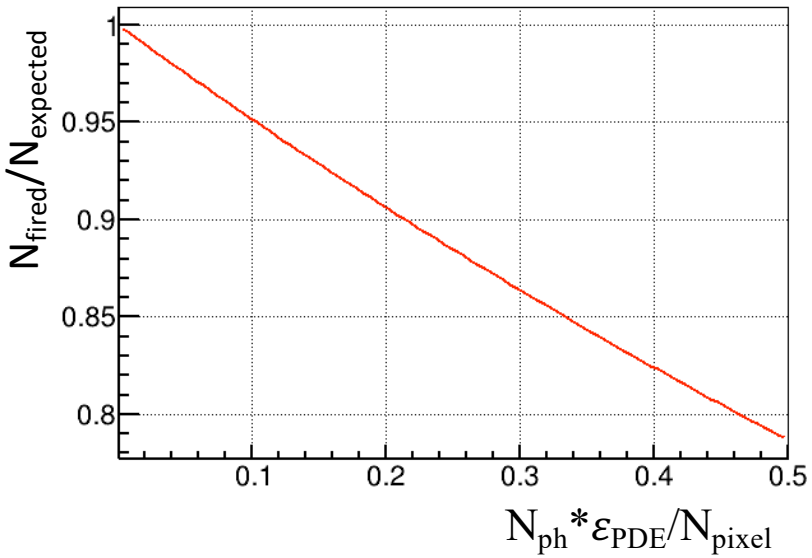
Need SiPM irradiation test

Cooling? Annealing? Replacement?

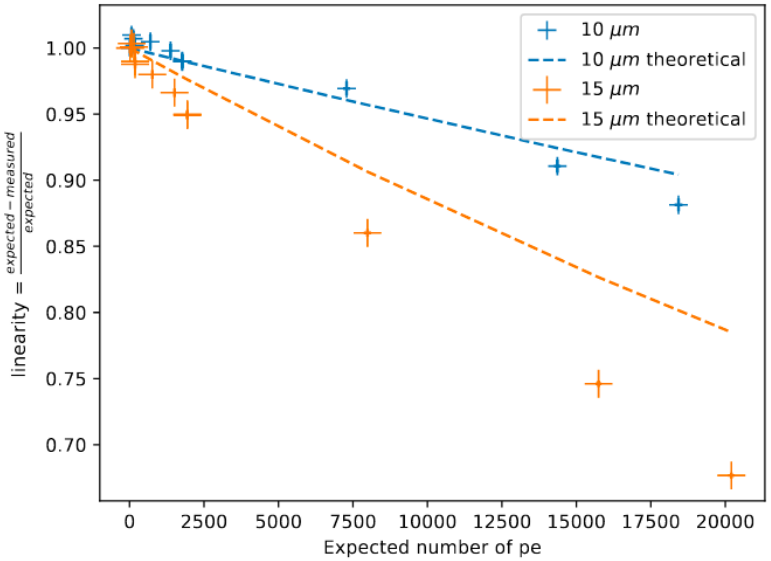
# Non-linearity

$$N_{fired} = N_{pixel} * (1 - \exp(-N_{ph} \cdot \varepsilon_{PDE}/N_{pixel}))$$

Non-lin vs fraction of fired pixels




From Carlos




~10% non-linearity even for 20% of fired pixels

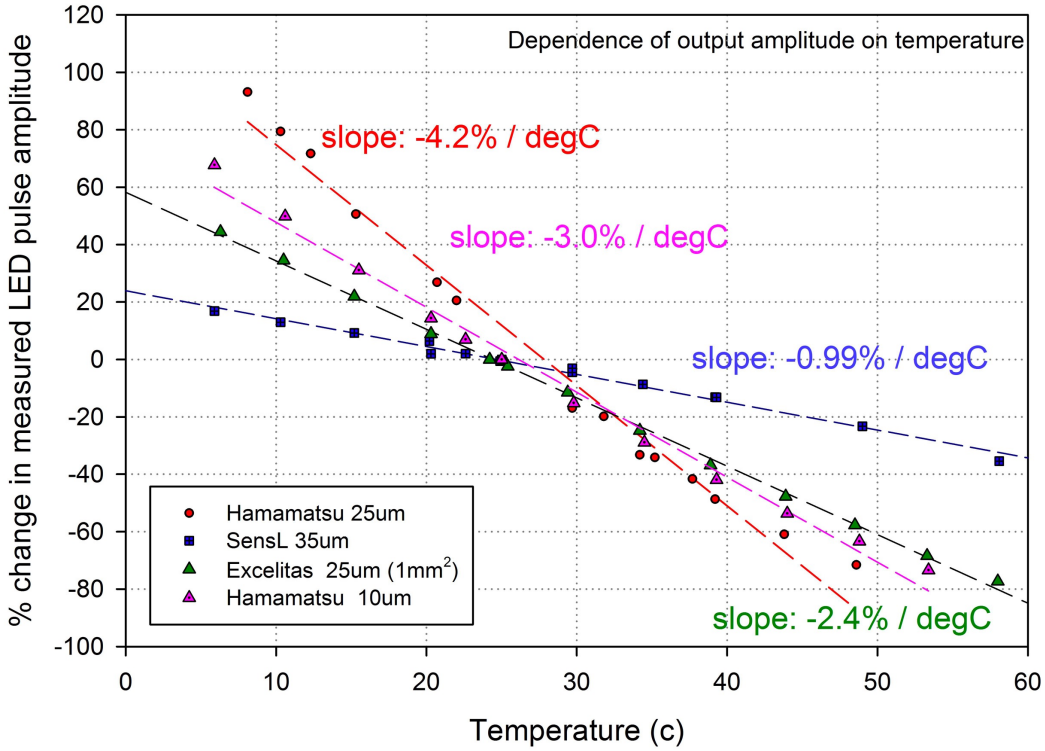
Inconsistency between calculation and measurements

Need to learn how to correct for non-linearity

Special calibration/monitoring system?

# Temperature Dependence

From sPHENIX TDR




May be as large as -4%/degC

Need to correct for temperature dependence

- Cooling
- Calibration/monitoring system
- Temperature compensation?