An extensive study for correcting the nonlinear particle density measured by GRAPES-3 scintillator detectors

On behalf of GRAPES-3 Collaboration

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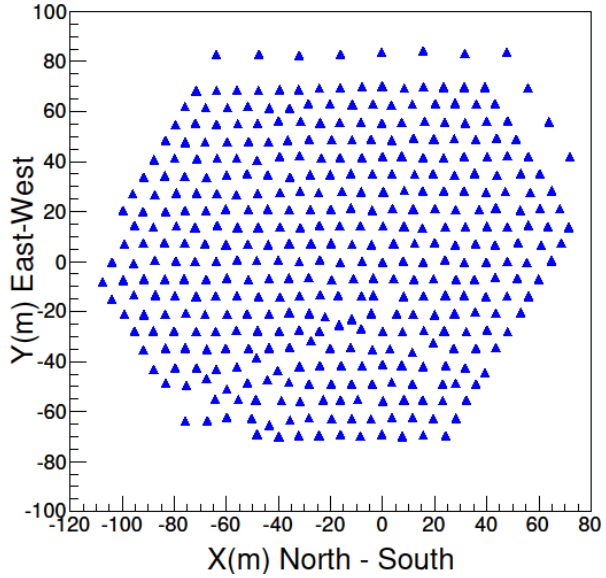
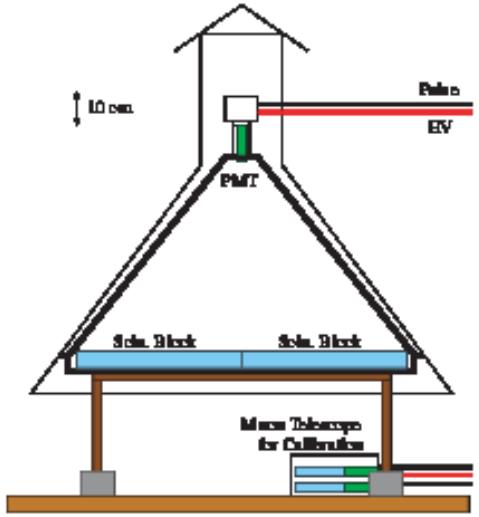
GRAPES-3 Air Shower Array

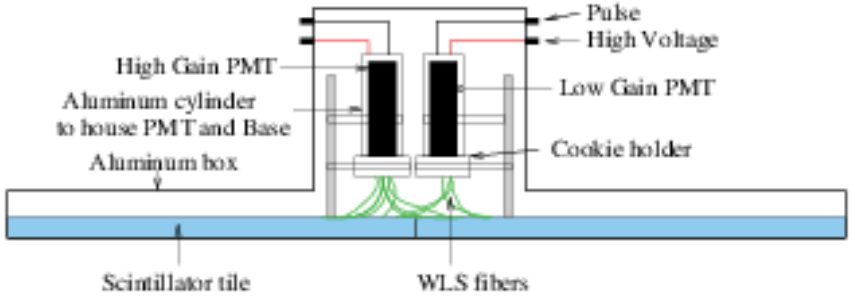
11.4^0 N, 76.7^0 E, 2200 m a.s.l, in Ooty, Tamilnadu, INDIA.



Hexagonal Layout

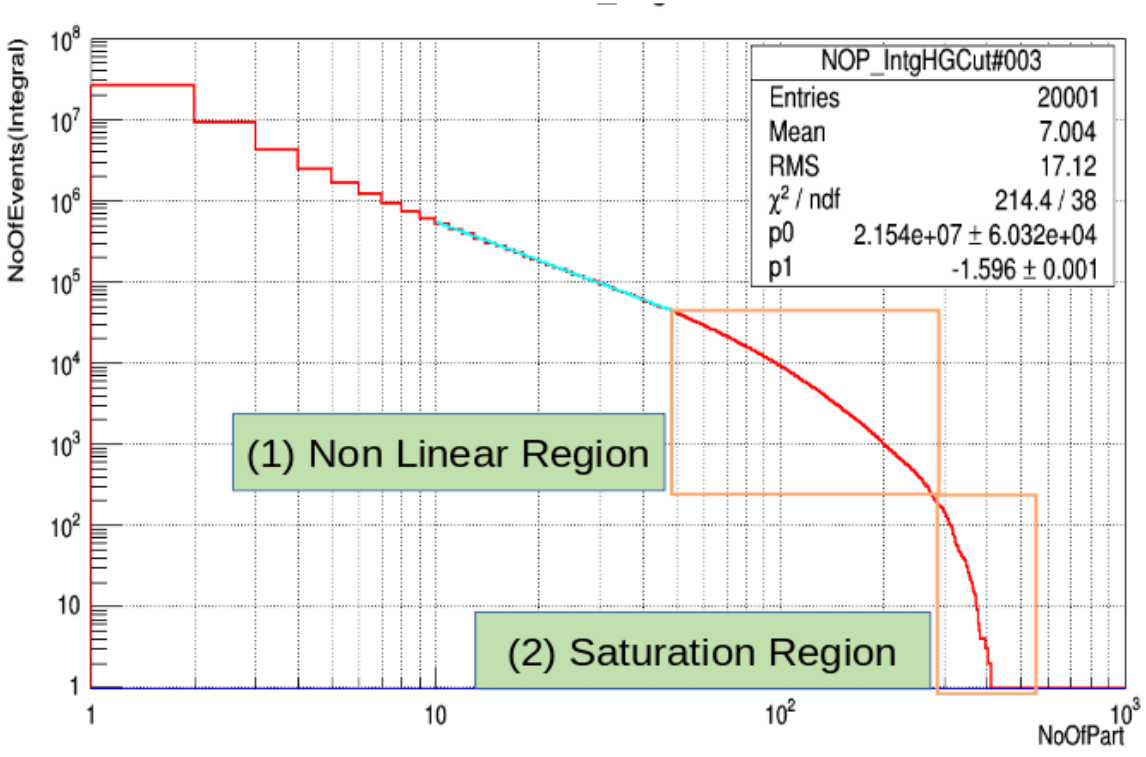


Cone Type Detector



Fiber Type 2-PMT Detector

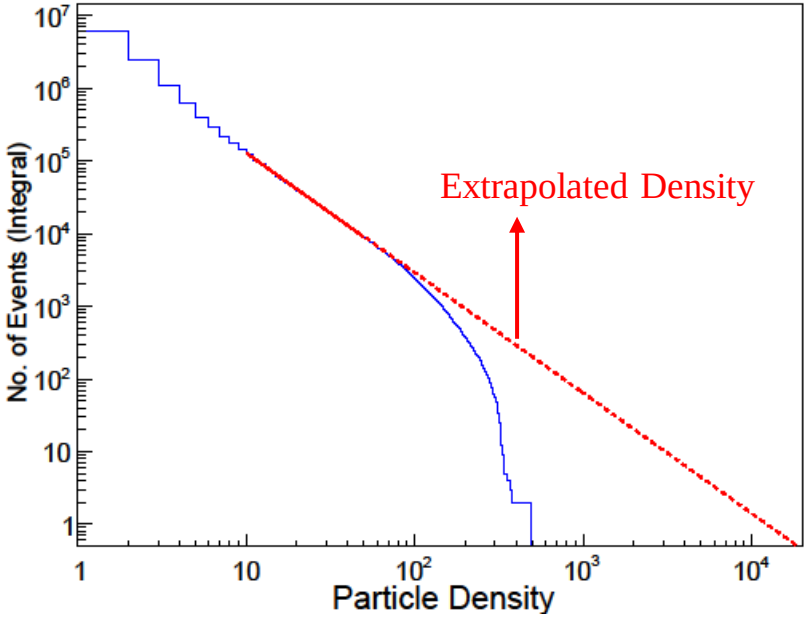
Observed Particle Density (High-Gain PMT)



Non Linear Region: A slow variation of inaccuracy.
Saturation Region: An abrupt variation of inaccuracy.

The density observed in these 2-regions is attempted to correct.

Extrapolation: $Y = A_{50}(x/50)^{-\gamma}$, where A_{50} is the integral number of events for particle density > 50.0, and γ is the spectral index of density spectrum in the range of 10 – 50 particles.



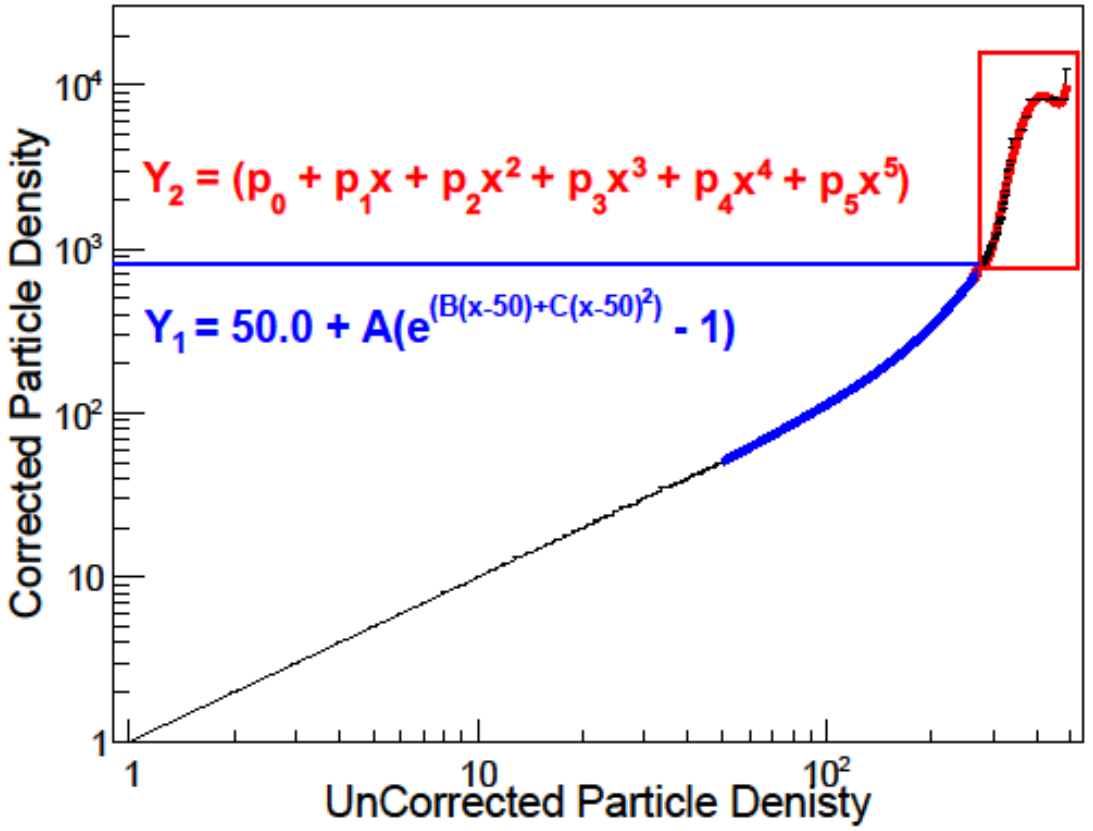
Correction Models:

Dependance of corrected density on uncorrected density is plotted.
Dependance models are obtained.
Correction is done with two cases:

Model1 (Non-linearity region):
$Y_1 = 50.0 + A(e^{(B(x-50)+C(x-50)^2)} - 1)$

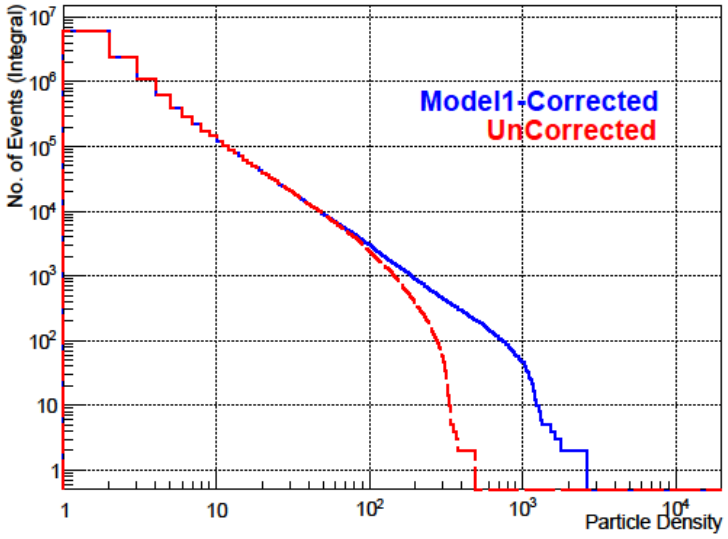
Model2 (Saturation Region):
$Y_2 = (p_0 + p_1x + p_2x^2 + p_3x^3 + p_4x^4 + p_5x^5)$

Event-by-Event correction can be possible now onwards.



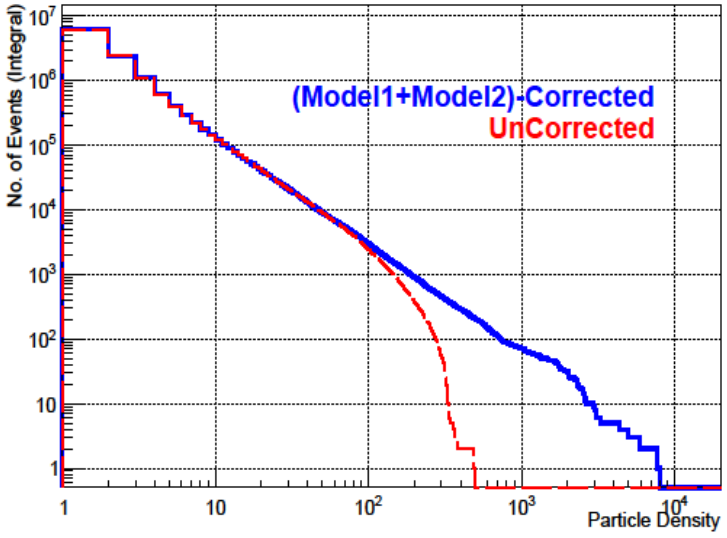
Comparisons of Corrected Densities with Observed Densities:

Model1

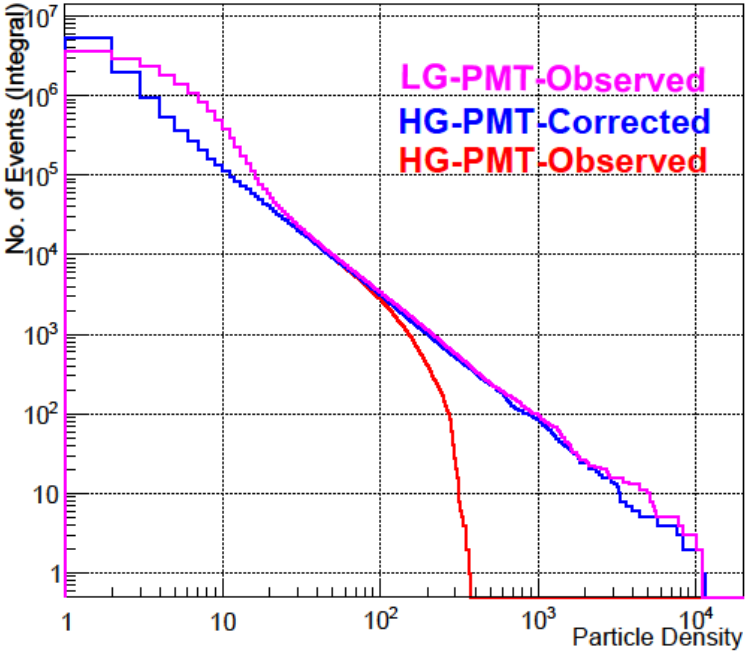


- Only Non-Linearity region is corrected
- Correction is possible up-to ~(500 - 800) particles.

Model1 + Model2



- Correction is extended up-to Saturation Region.
- Correction is extended further ~1000 particles.



- Comparison of extended corrected density spectrum with the Low-Gain PMT density spectrum.

Conclusions

1. Correction applied with only Model1, extends the corrected densities in the range of ~(500 - 800) particle-m^{-2}.

2. Correction introduced in Saturation region with Model2, further extends the corrected densities ~3000 particles-m^{-2}.

3. The corrected density of HG-PMT is compared with the observed density from LG-PMT, and found to be very much similar with each other.

Thank You