PDS Analysis with CRT-Tagged Muons

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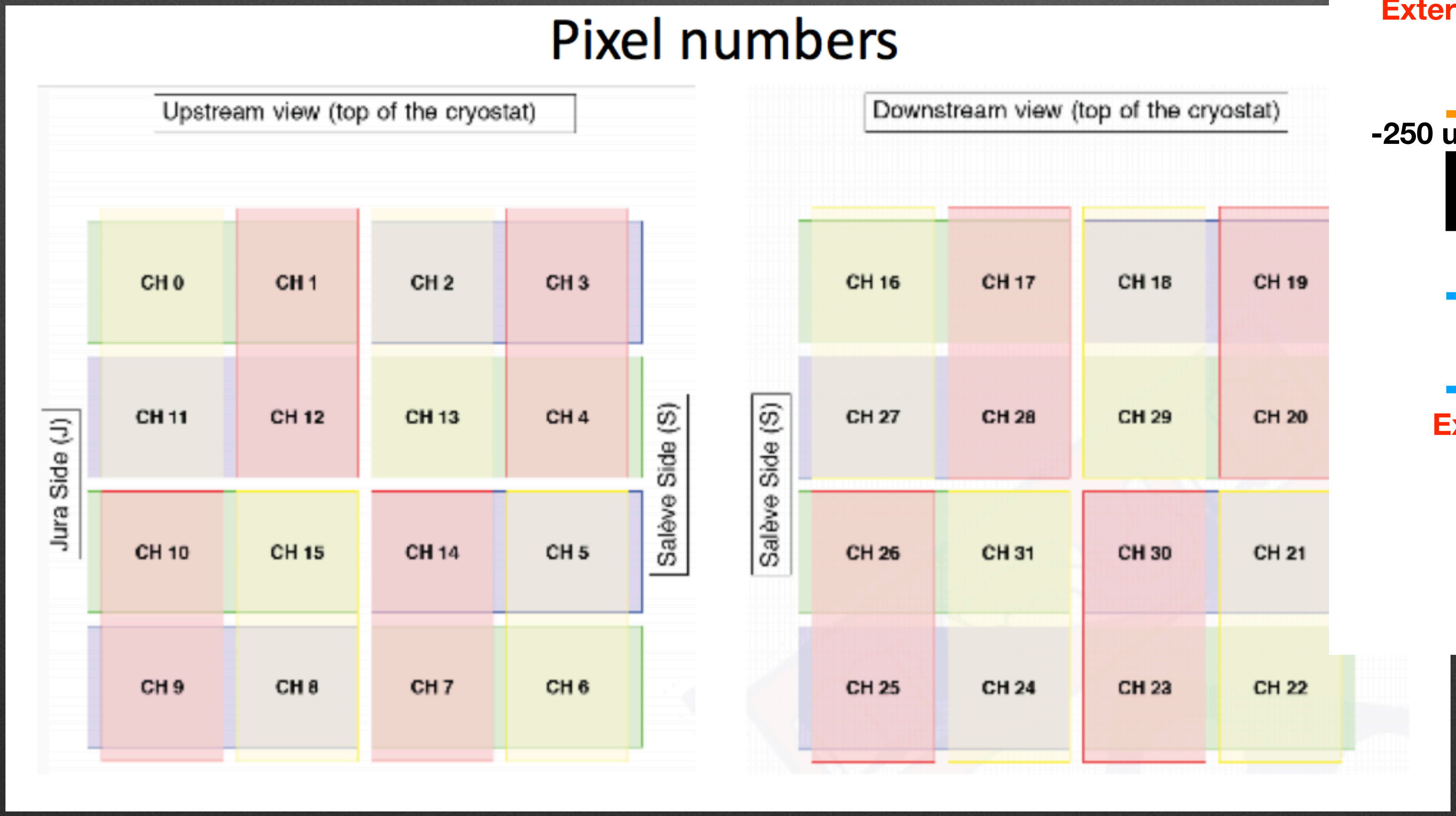
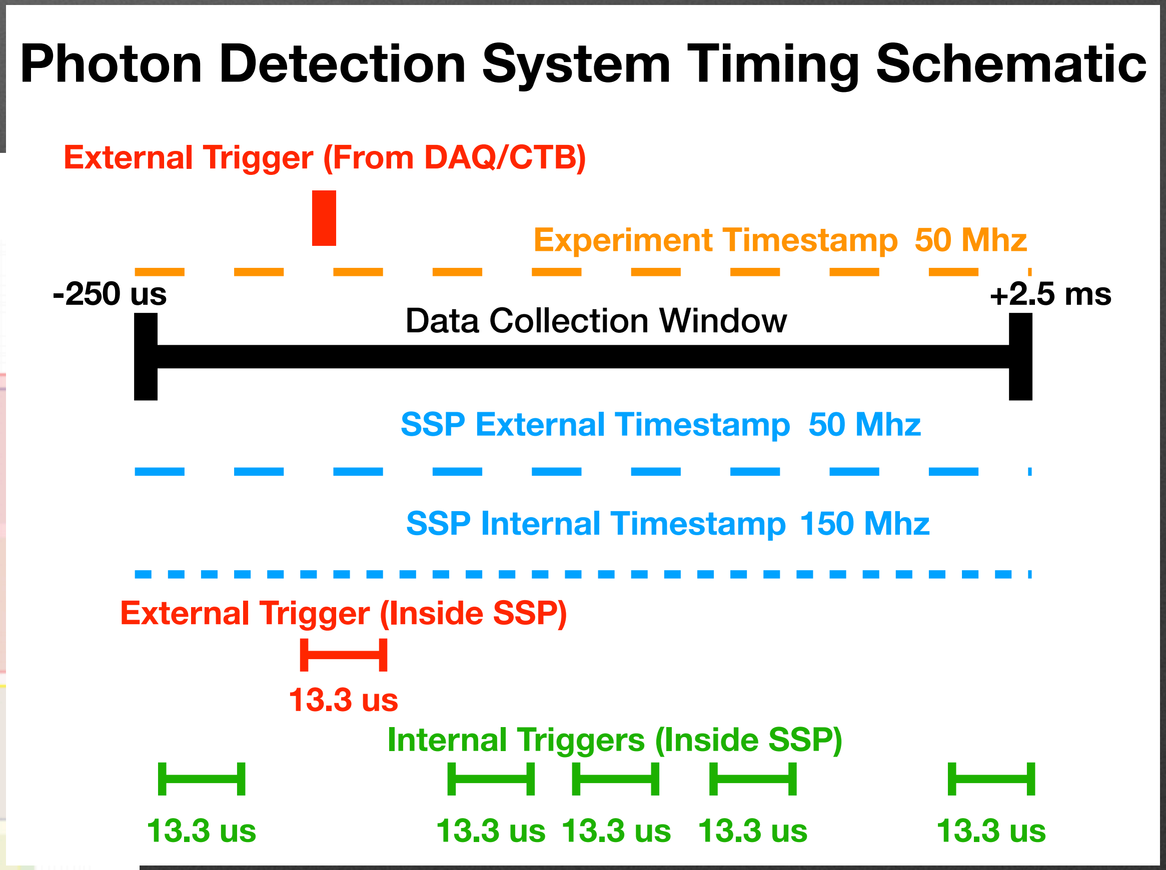
Refresher on Method

- CTB collects fragments from all subsystems on CRT "pixel" coincidence (US+DS with 60 ns)

- Comparison to pixel centers gives rough positioning of track in TPC at trigger issuance





Dataset

Was able to get data for four months of running:

November 2018

RUN	DATE	SIZE
5785-5786	11/05/18	2202
5851	11/12/18	330

December 2018

RUN	DATE	SIZE
6119-6120	12/10/18	1667
6129,6141, 6156,6191	12/11/18	1865
6200-6202	12/14/18	1845

January 2019

RUN	DATE	SIZE
6509	1/22/19	1520

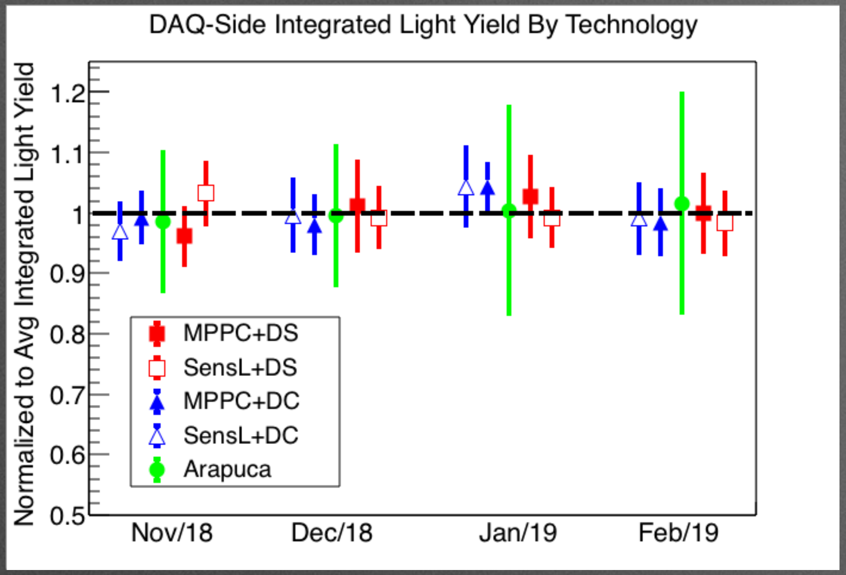
February 2019

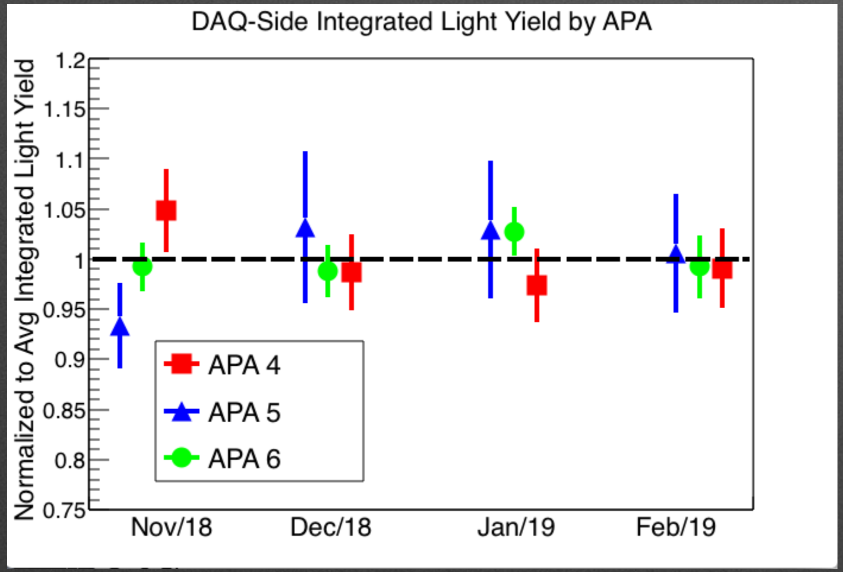
RUN	DATE	SIZE
6696,6698, 6700	2/7/19	2373
6776	2/12/19	476
6812	2/14/19	1413
6834-6835	2/18/19	1472
6836-6838	2/19/19	2802
6856	2/20/19	2049
6872-6874	2/21/19	2536
6909, 6912-6913	2/27/19	1485
6927	2/28/19	397

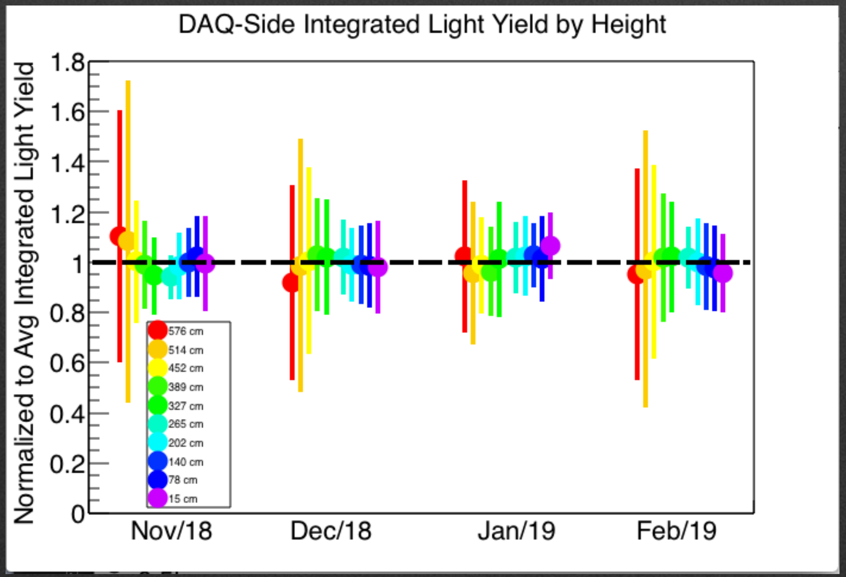
Total of 23,163 total files

~1.5 Million triggers

PDS Stability





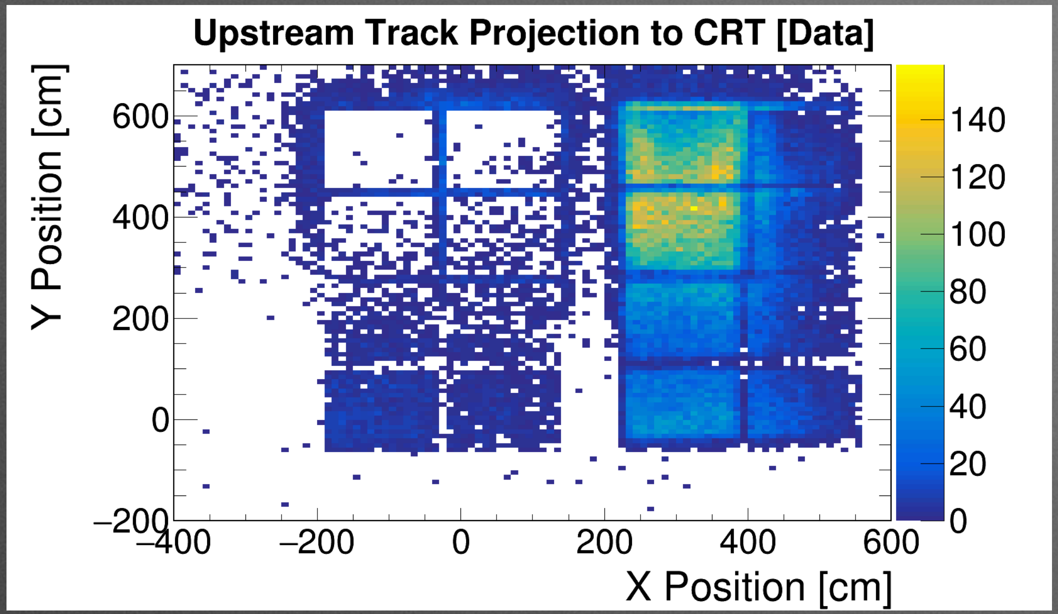


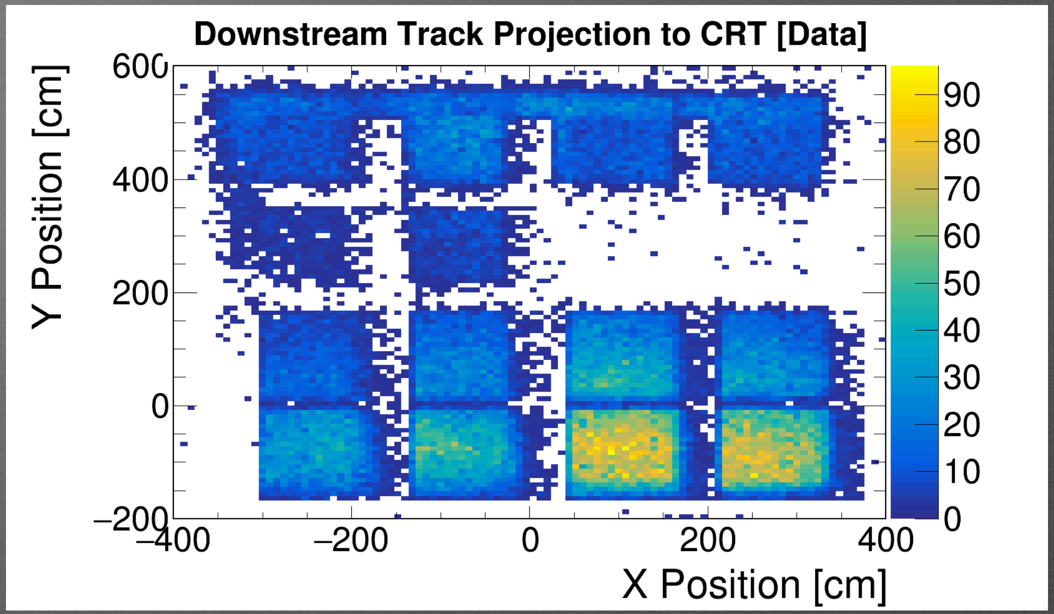
Stability by technology shows ARAPUCA is most stable, other technologies ~2-4%

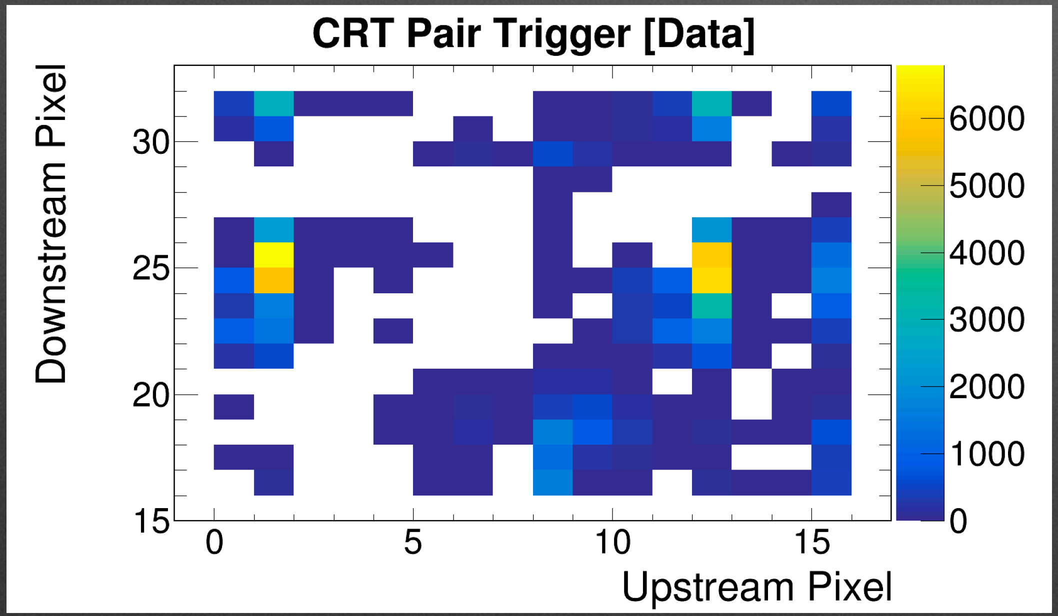
Stability initially shows some z-dependence (space charge)?

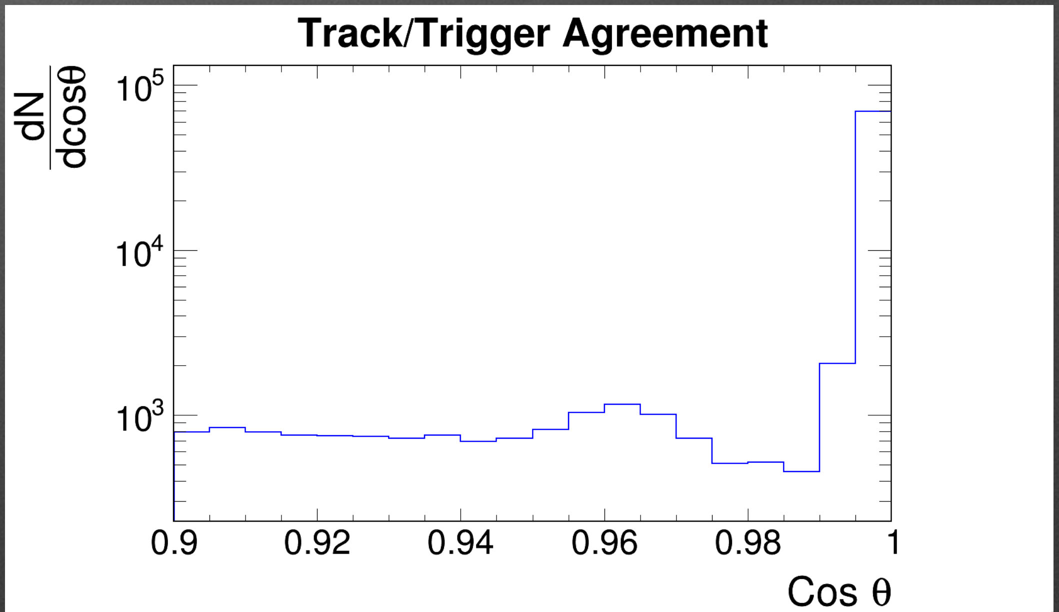
Top of detector less consistent than bottom over months (also space charge)?

Pair Trigger Characteristics



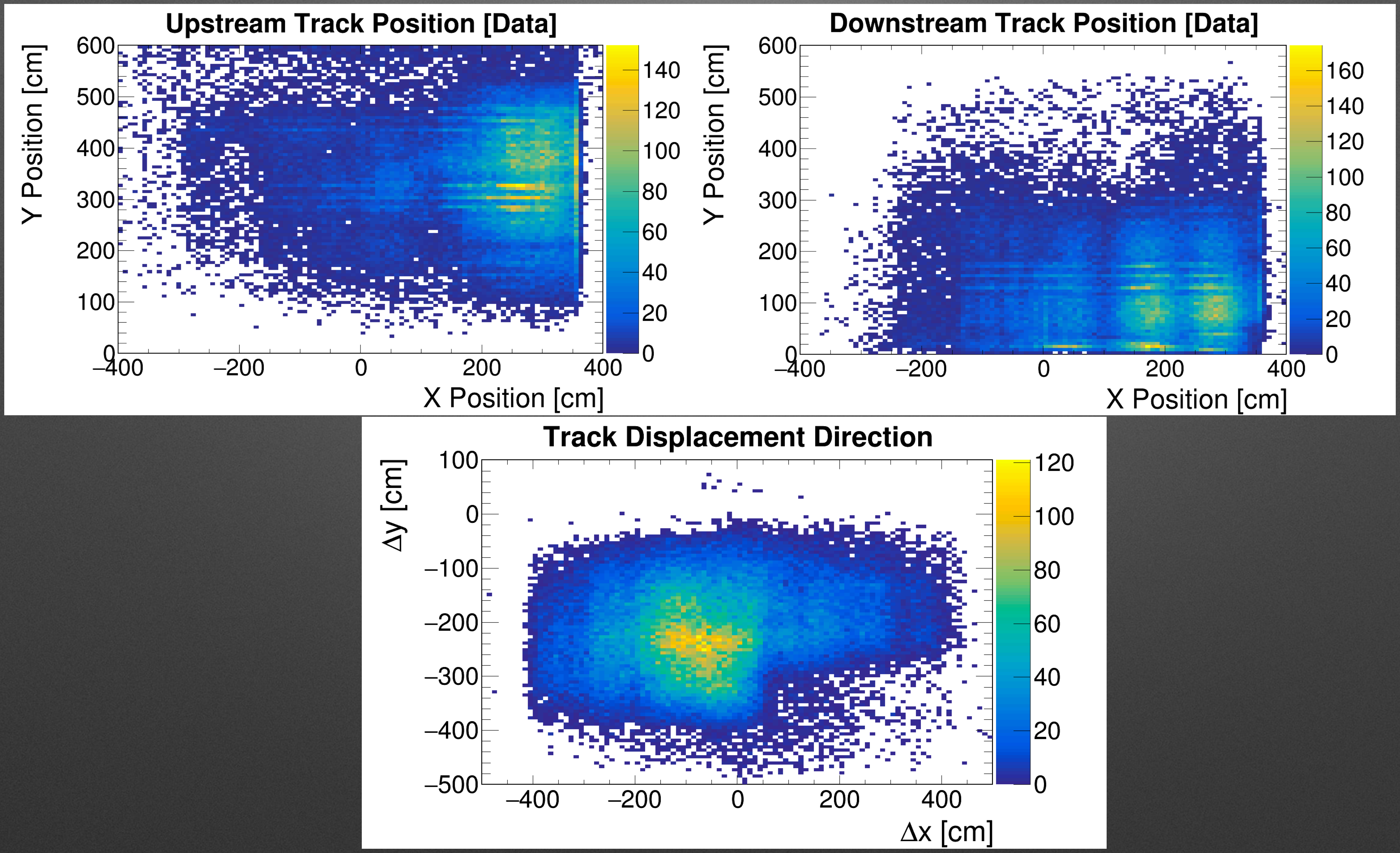






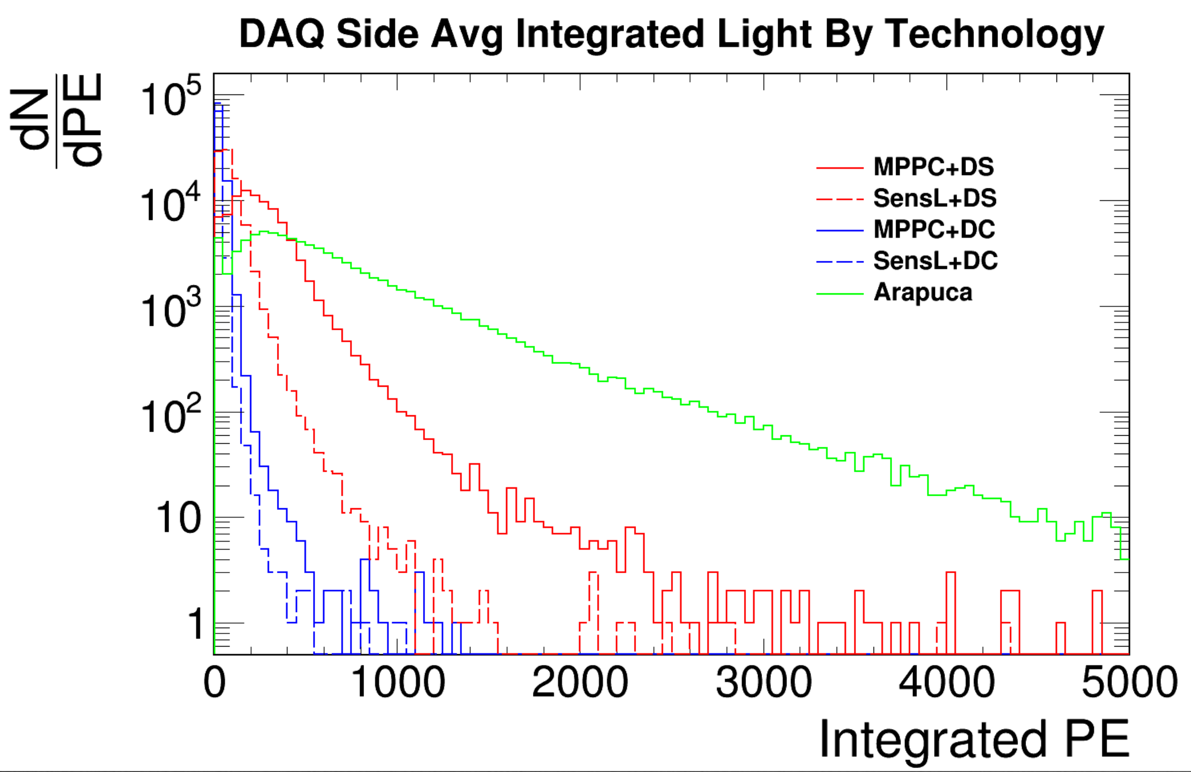
- ~98,000 throughgoing tracks, ~75,000 hair
- Most populated pair has 7,600 trails
- 1:25 DAQ Side:Rack Side

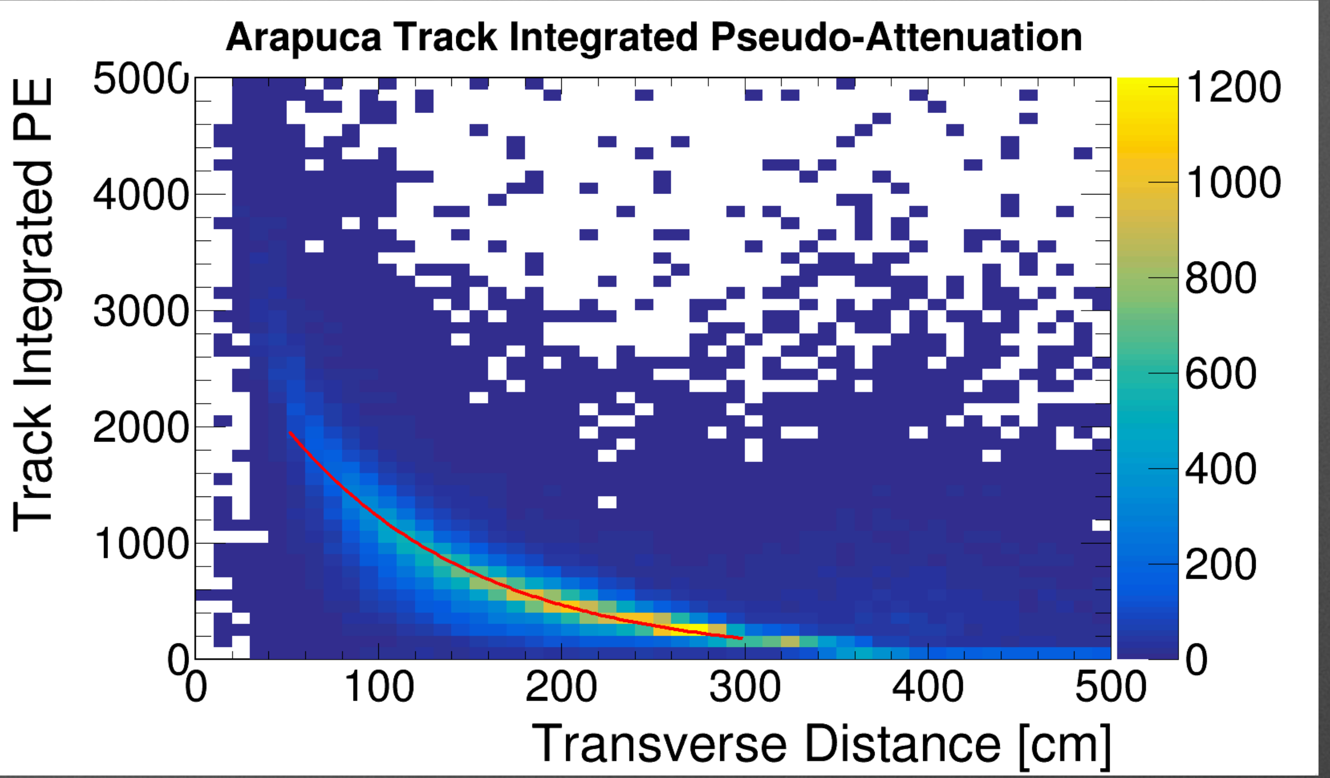
Track Characteristics



- Characteristic downward direction due to trigger masking
- Majority of tracks are *directly* in front of the PDS

Base Light Characteristics





Descriptive Stats

TECH	AVG	STDDEV
SENSL+DC	20.24	17.19
MPPC+DC	37.61	27.49
SENSL+DS	84.22	79.39
MPPC+DS	256.38	201.62
ARAPUCA	689.23	630.13

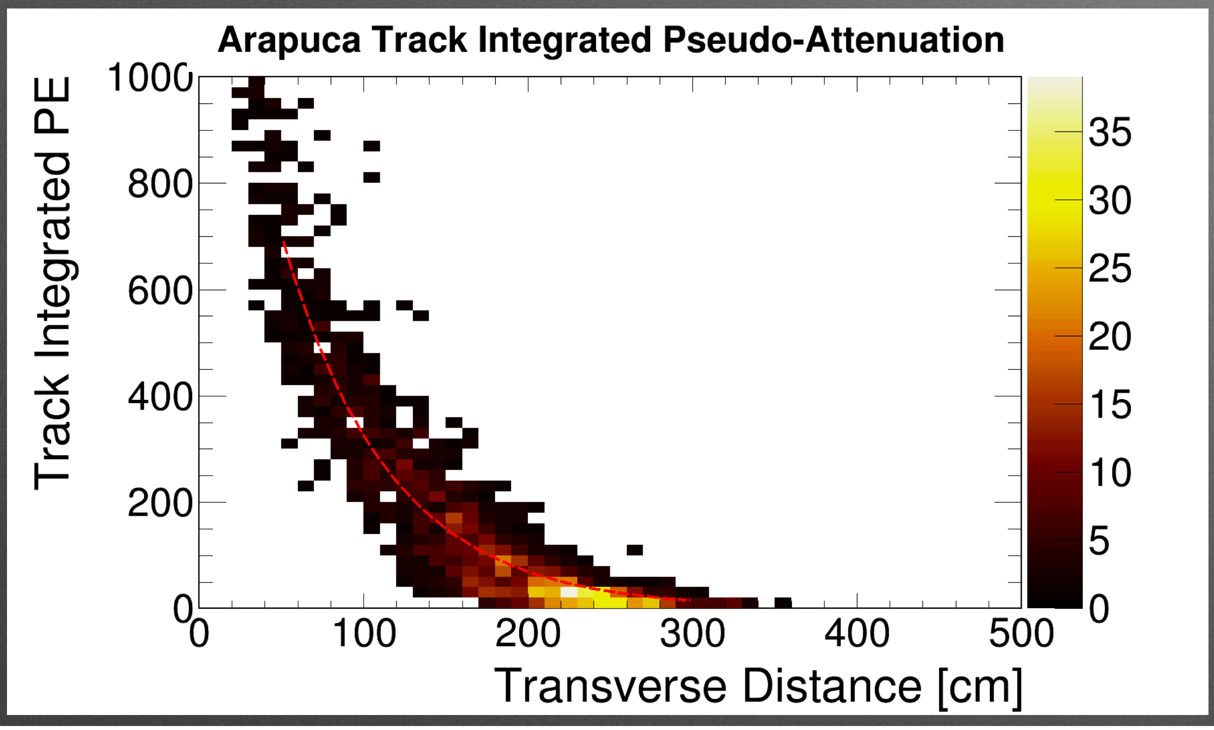
$$T = exp(C_0 - \lambda x)$$

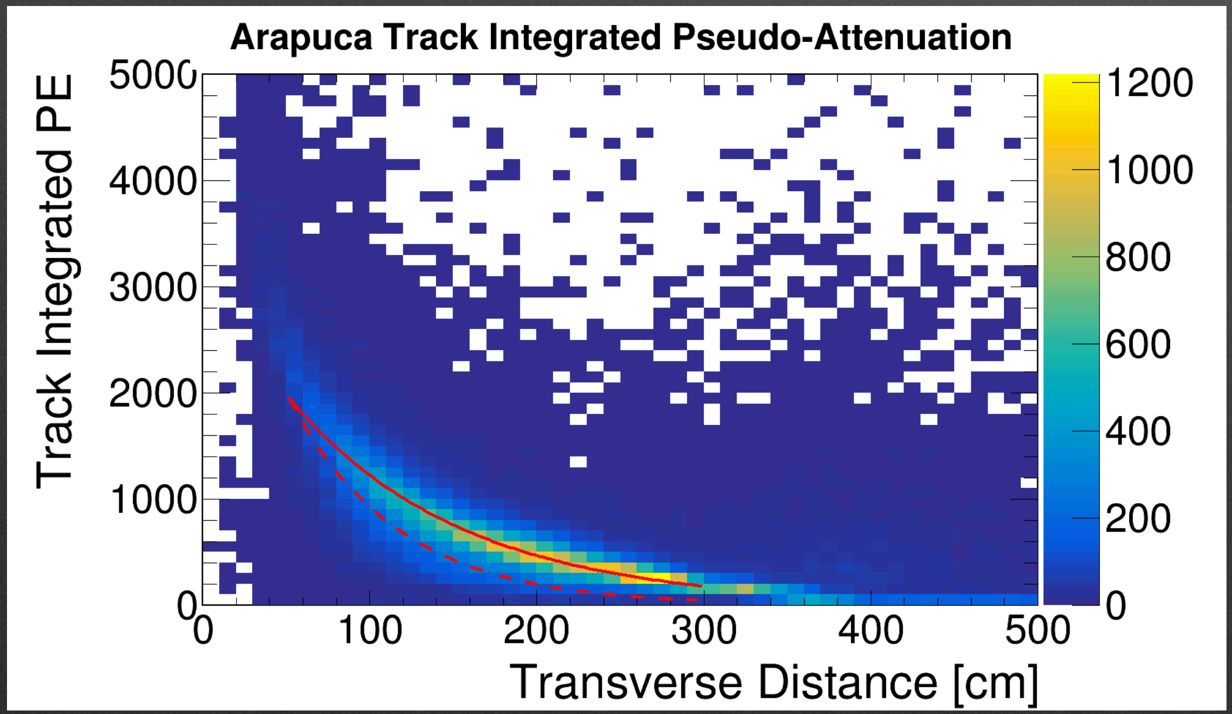
$$exp(C_0) = 8.07 \pm 0.04$$

$$\lambda = 0.009 \pm 0.003$$

Comparison to Monte Carlo

First threw flat MC through the TPC:





$$T = exp(C_0 - \lambda x)$$

$$exp(C_0) = 7.33 \pm 0.05$$

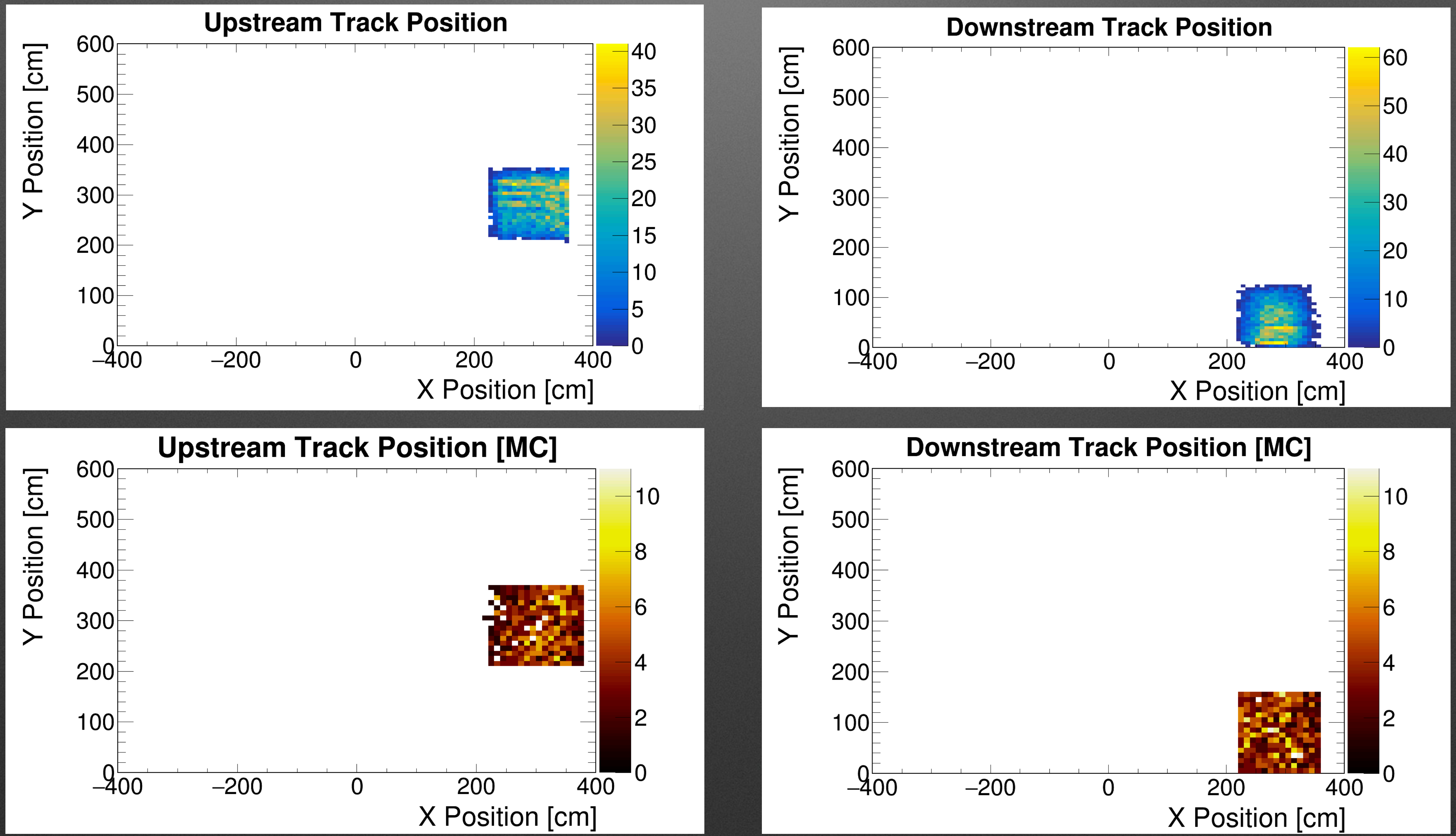
$$\lambda_{MC} = 0.015 \pm 0.001$$

$$\lambda = 0.009 \pm 0.003$$

Is this geometry or an attenuation problem?

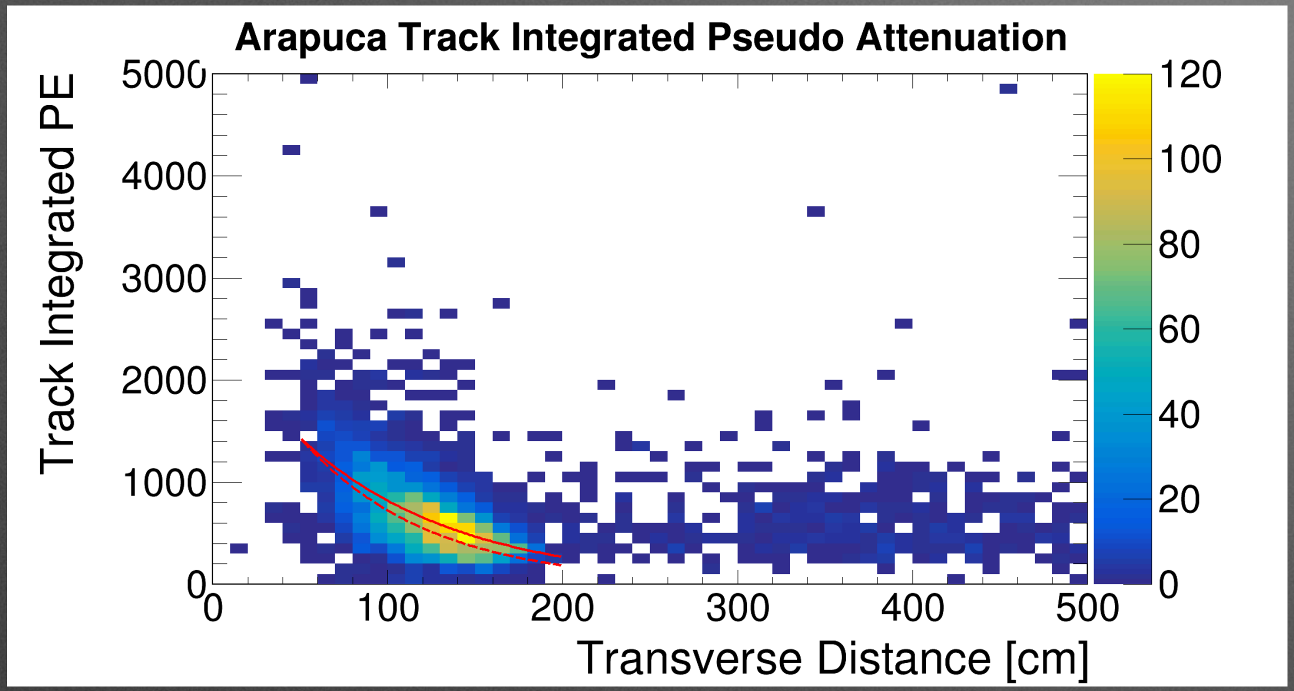
Comparison to Monte Carlo

Threew MC with random angle distribution corresponding to CTB Pixel channels 12 & 25:

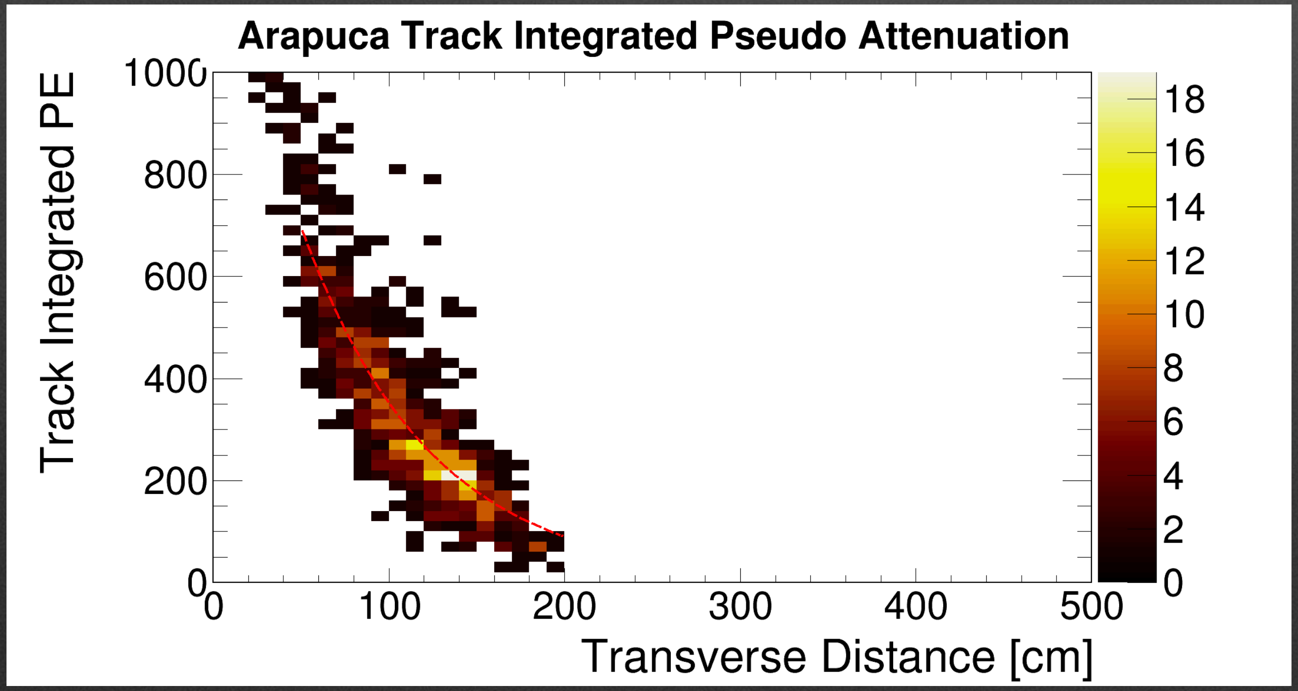


Note: this data sample used for stability calculation

Comparison to Monte Carlo



$$\lambda = 0.011 \pm 0.001$$

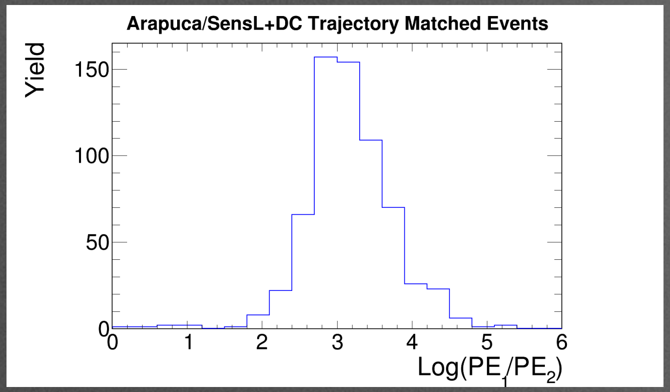


$$\lambda_{MC} = 0.014 \pm 0.001$$

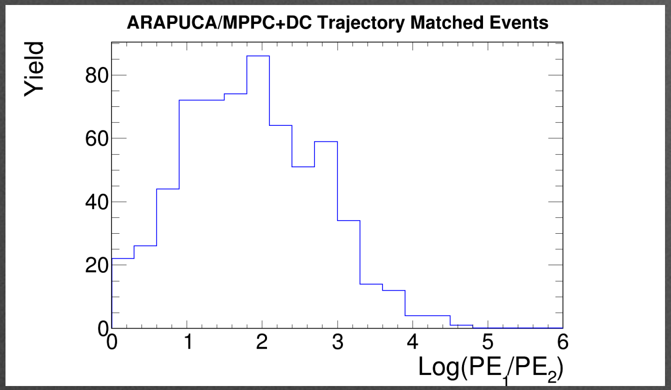
Trajectory Matching MC

- Matching trajectory and position goes a long way towards making the MC agree with data. Can this be further exploited?
- Pick real data and throw MC with the same angle only changing start position (event-by-event).
- Uncertainty in x and y of start position 100 MC per event. (Used ~700 events).
- Result should be OpDetectors in MC that are matched given a trajectory.

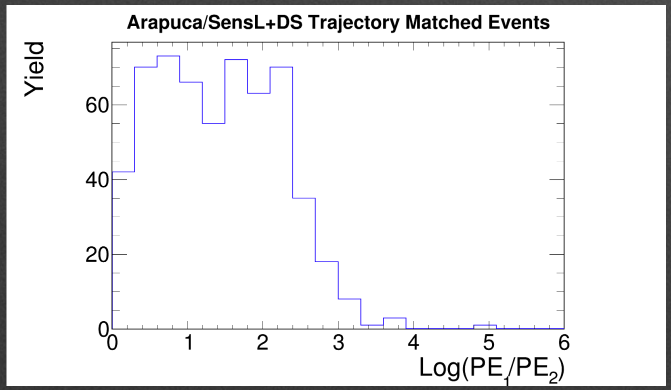
Early Results



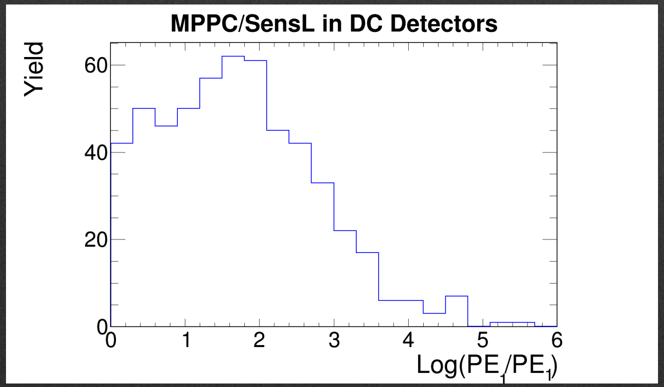
$$< PE_{Ara}/PE_{S+DC} > = 23.64 \pm 1.78$$



$$< PE_{Ara}/PE_{M+DC} > = 6.46 \pm 2.43$$



$$< PE_{Ara}/PE_{S+DS} > = 4.10 \pm 2.26$$



$$< PE_{M+DS}/PE_{S+DS} > = 5.55 \pm 2.85$$