Beam test and Simulation

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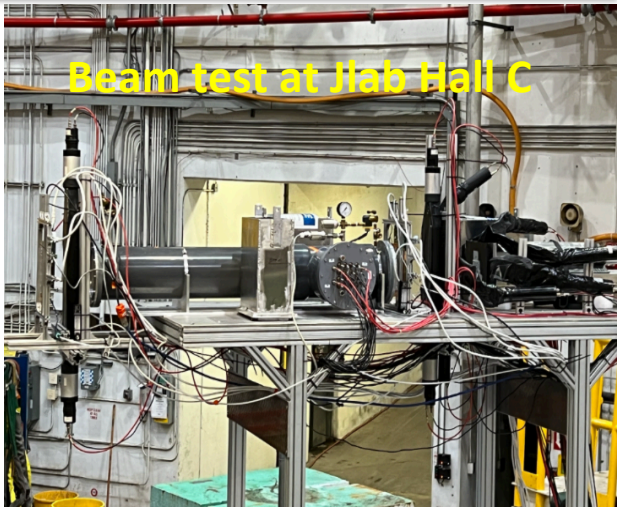
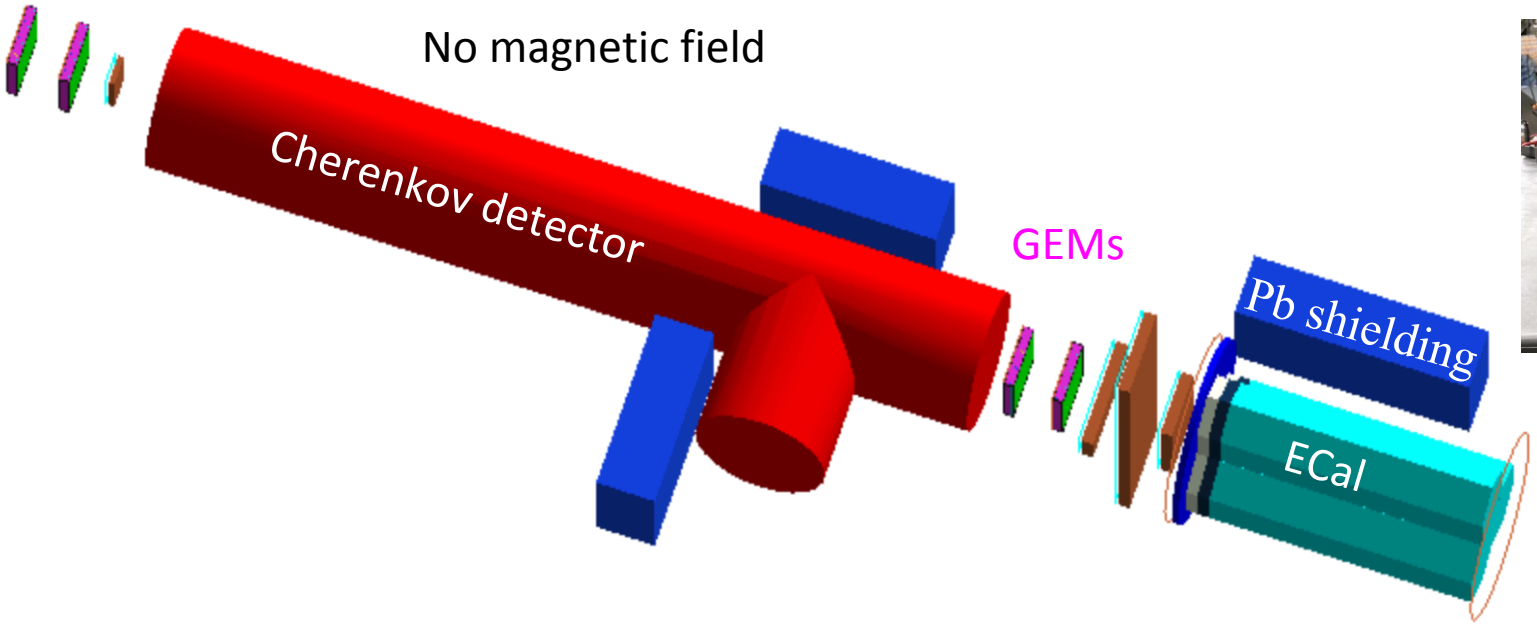
- Beam test simulation configuration
- Simulated backgrounds
- Comparison between simulation and data

Simulation for Beam Test at Jlab

- Benchmarking simulation of rate and background
- Study ECal and LASPD performance under high rate, high radiation, high background condition
- Study ECal and LASPD PID

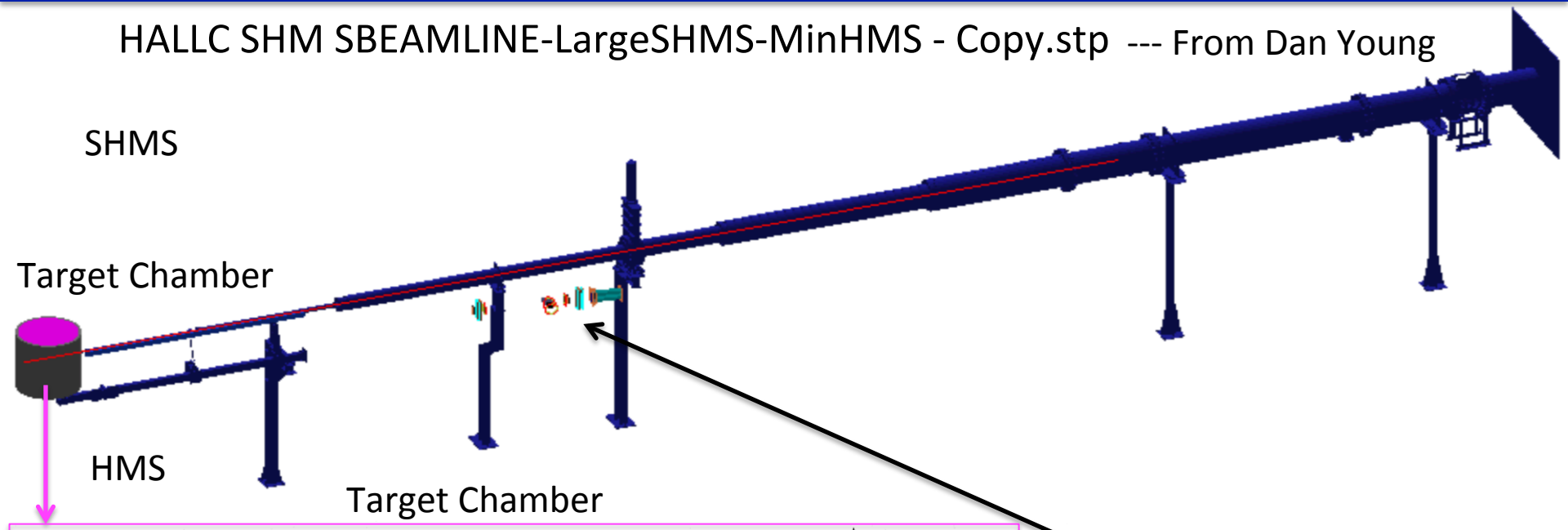


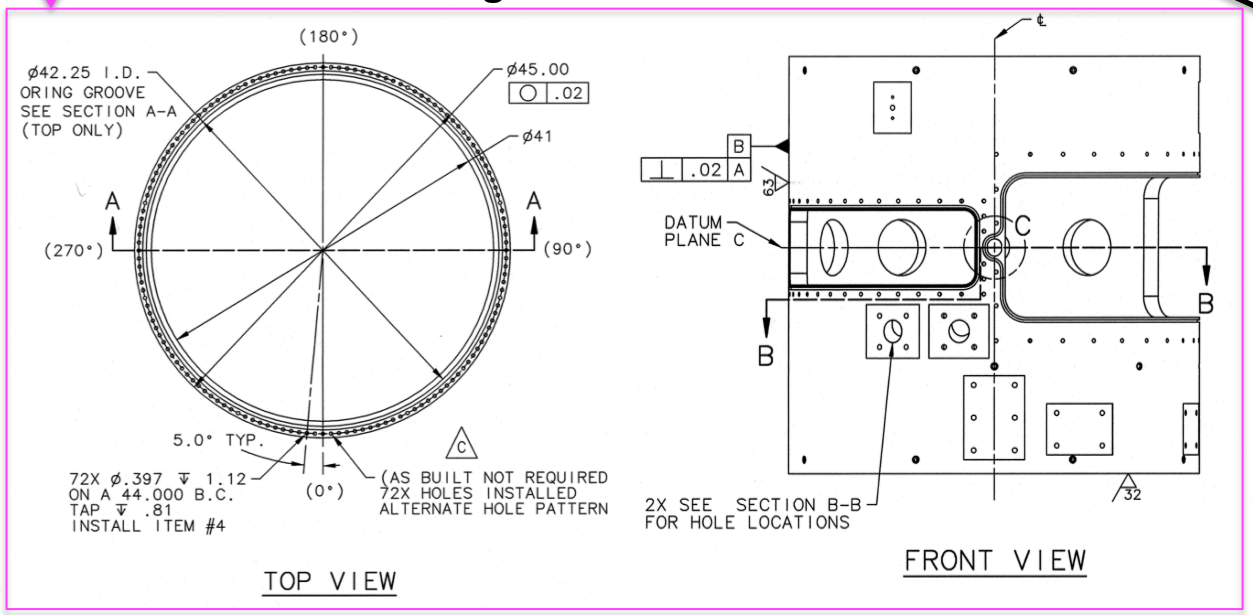


Front to back GEM1+2, SC-A, Cer, GEM3+4, SC-C, LASPD, SC-D, Preshower, Shower, SC-B

Hall C Downstream Beam Line are included

HALLC SHM SBEAMLINE-LargeSHMS-MinHMS - Copy.stp --- From Dan Young





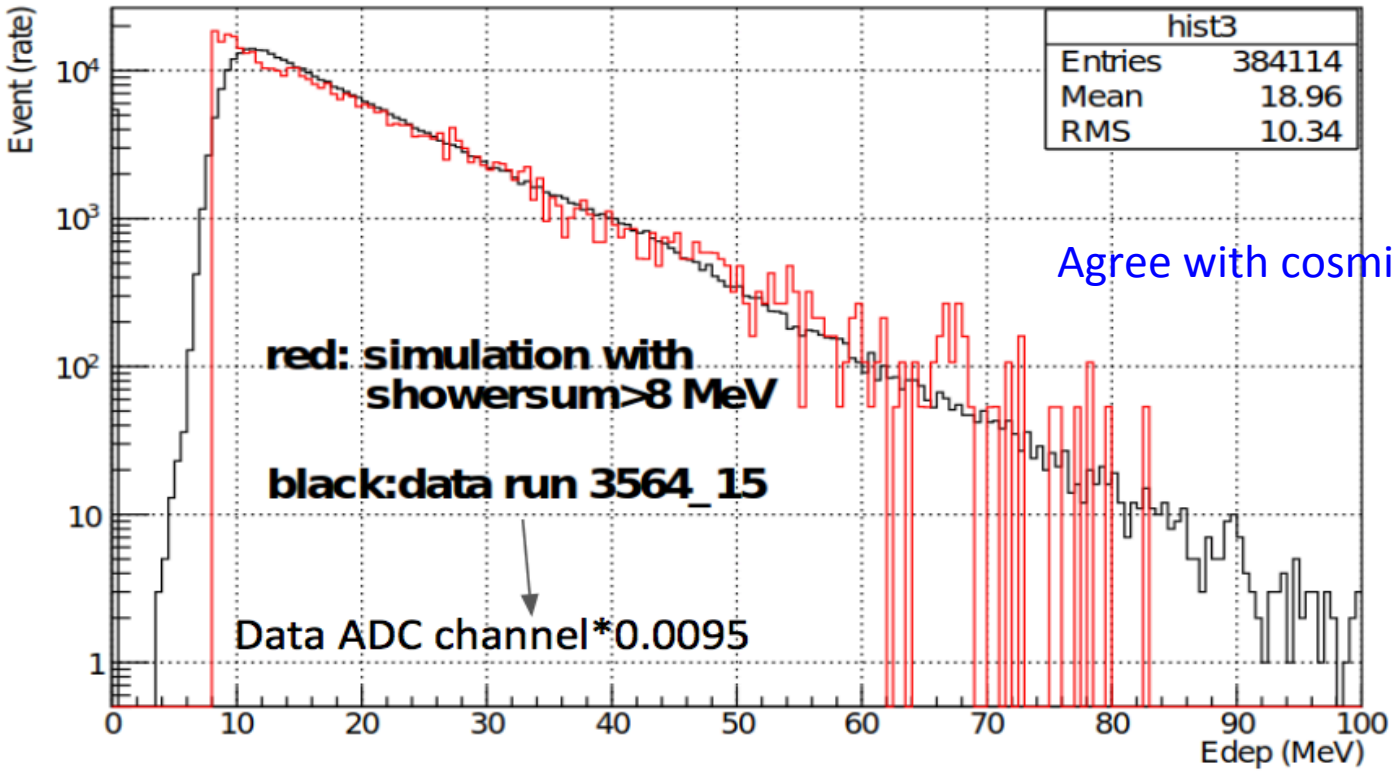
Detector position

- 82 deg: 8m SHMS
- 7 deg: 21 HMS
- 18 deg: 20m HMS

ECal Simulation for Beam Test at 82 deg

➢ **82 deg —luminosity~5e^{37}**

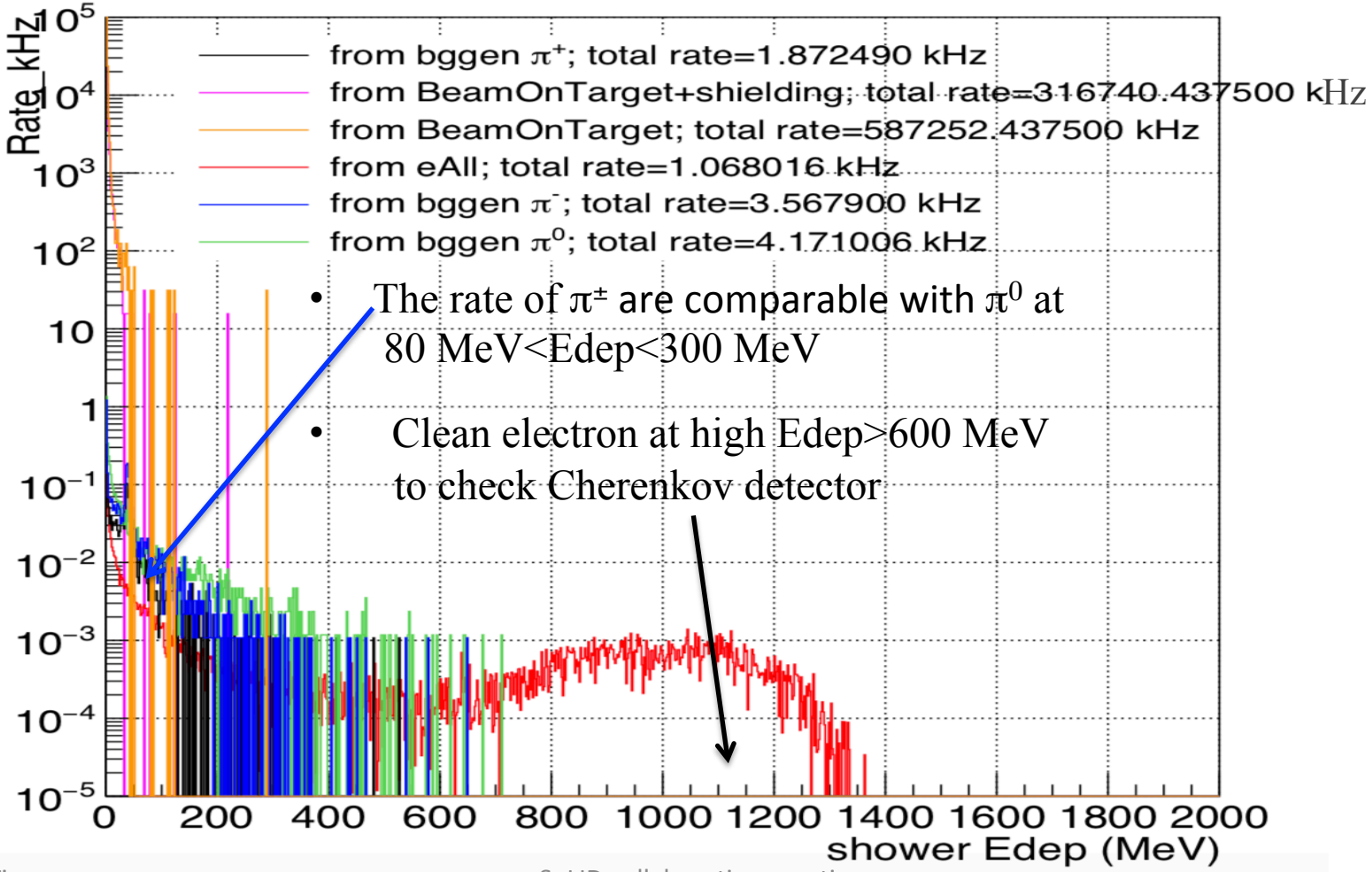
- dominant by pi0
- charged pion energy is not large enough to see the MIP at shower



- The shower deposit energy tail follows an exponential function for both the simulation and the data, providing an alternative method for "calibration" in the absence of MIP peaks.

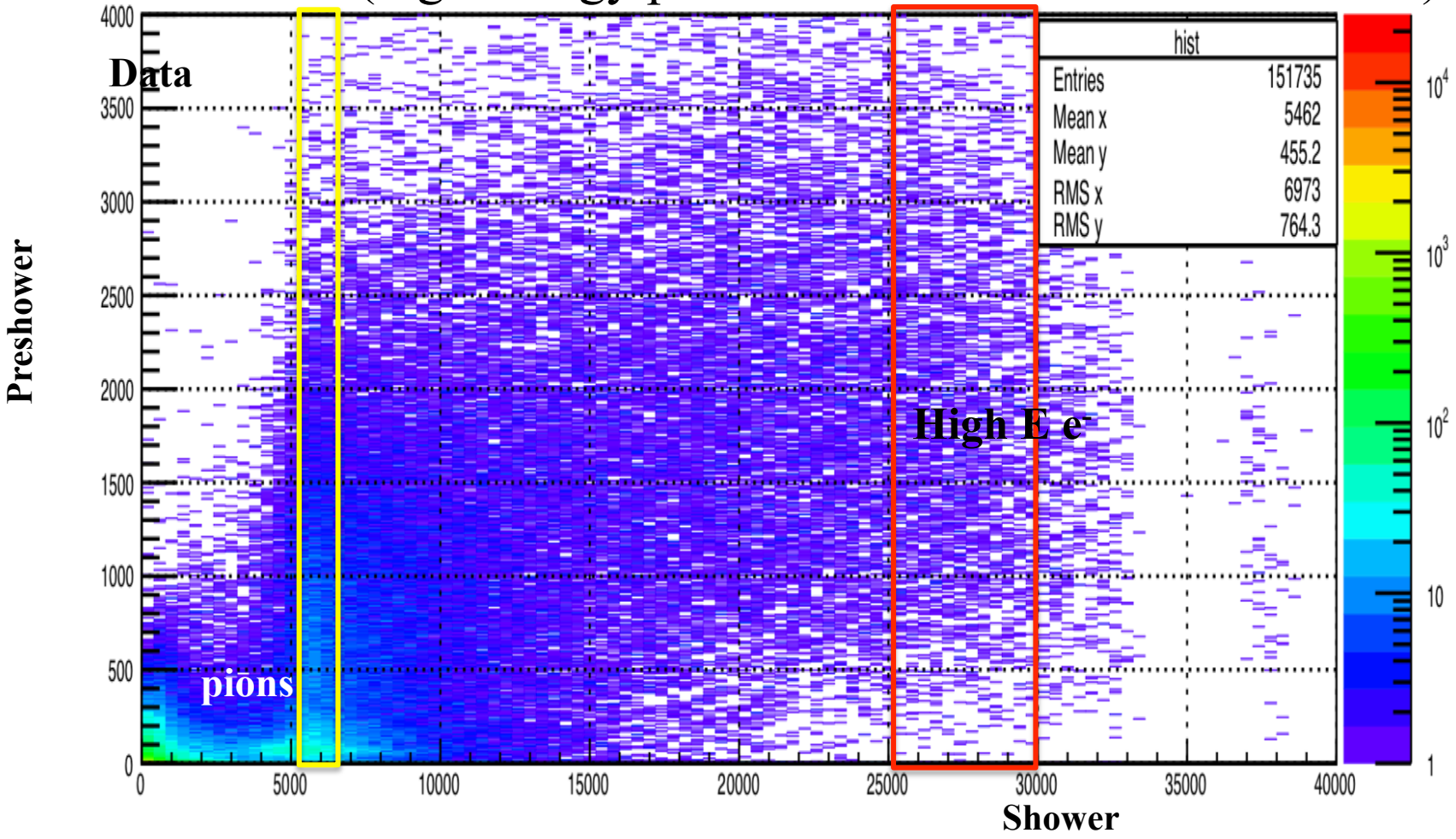
ECal Simulation for Beam Test at 7 deg

- **7 deg—luminosity~e^{37}**
- 60 MeV Moller electron from the target
- γ from beam line (high energy photons covered the MIP at shower)



ECal Simulation for Beam Test at Jlab

- **7 deg—luminosity~2e^{36}**
- 60 MeV Moller electron from the target
- γ from beam line (high energy photons covered the MIP at shower)



ECal Simulation for Beam Test at 7 deg

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- 60 MeV Moller electron from the target
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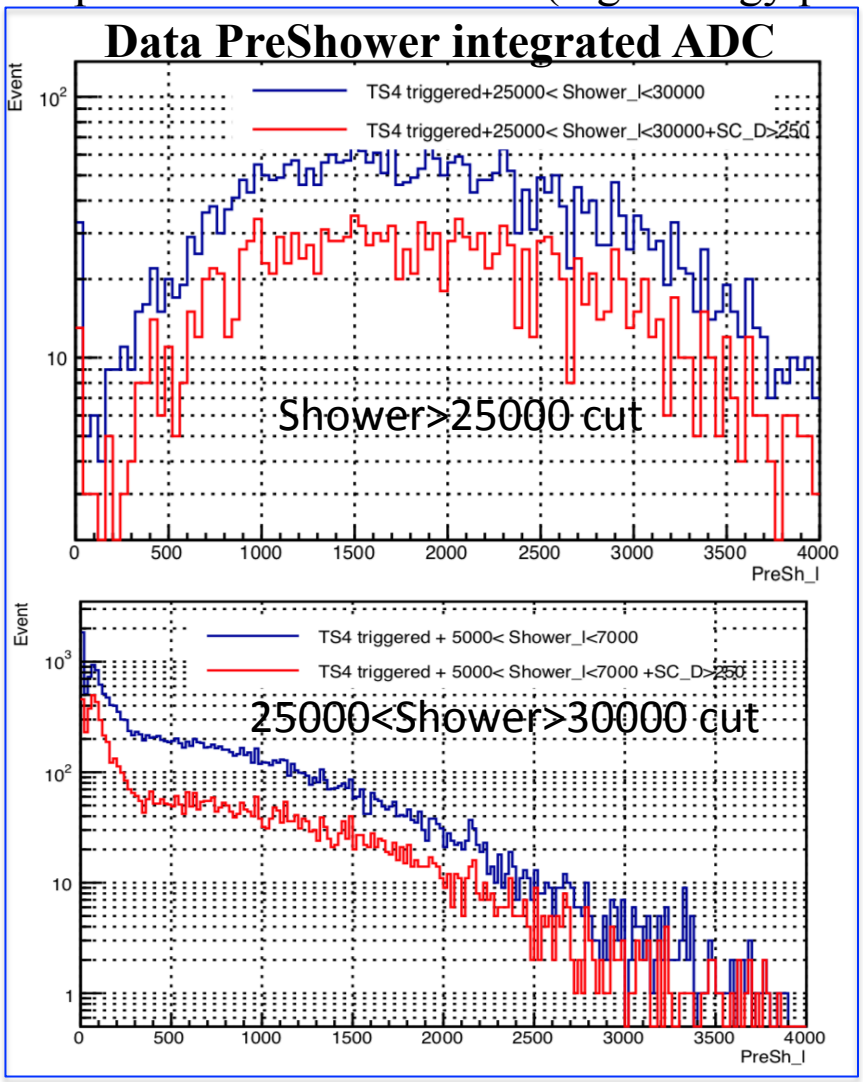
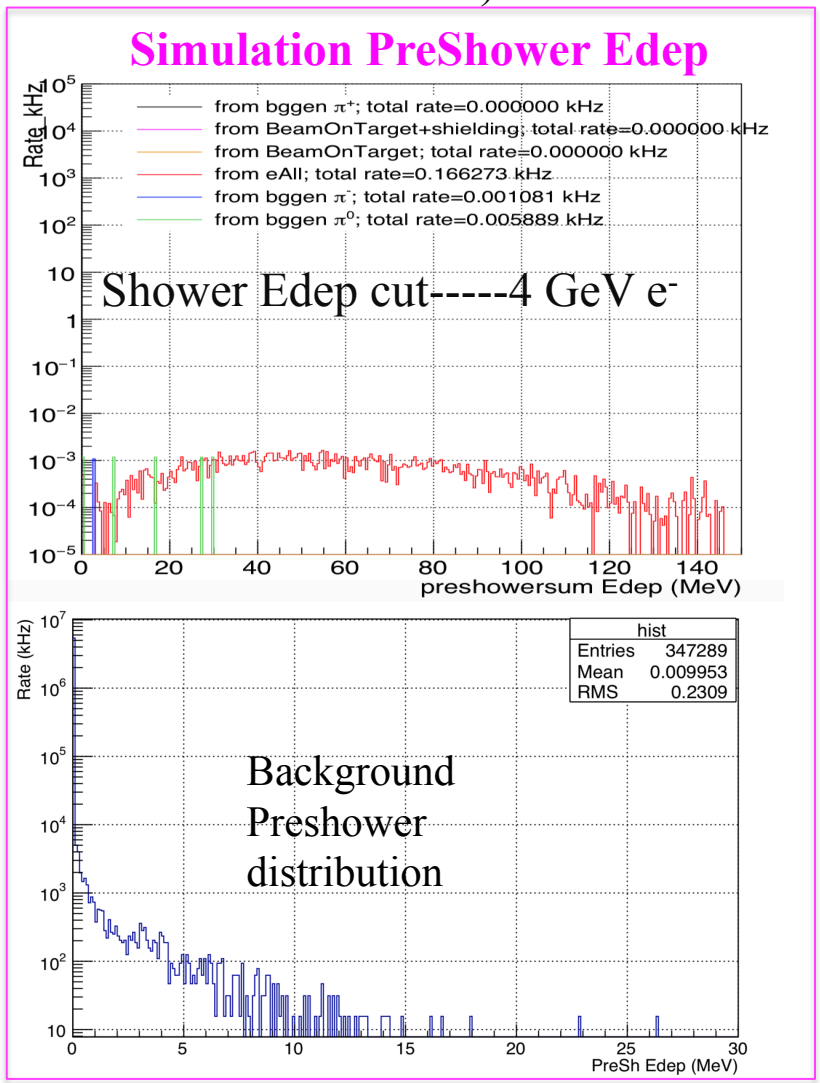
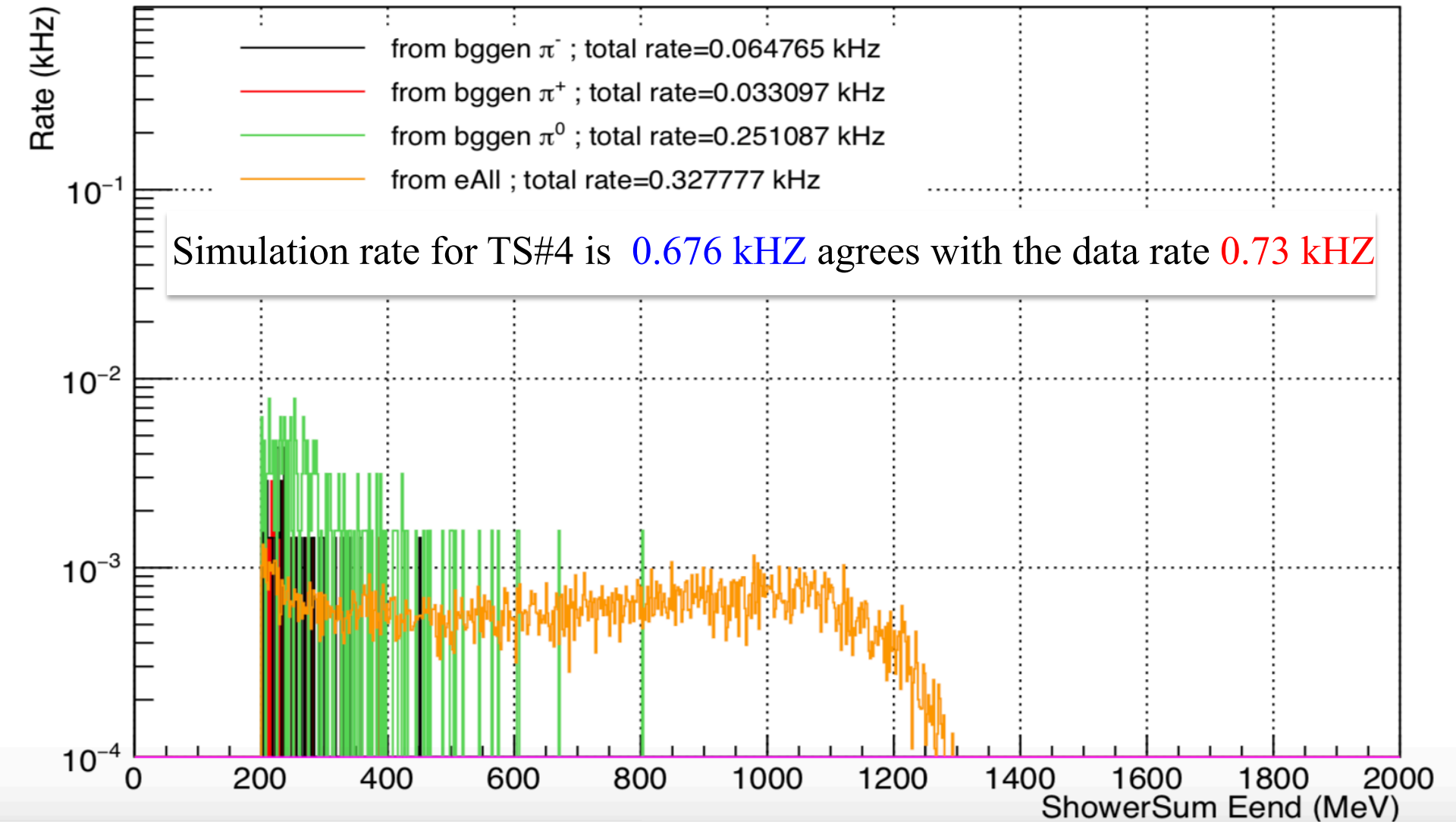




ECal Rate Comparison at 7 deg

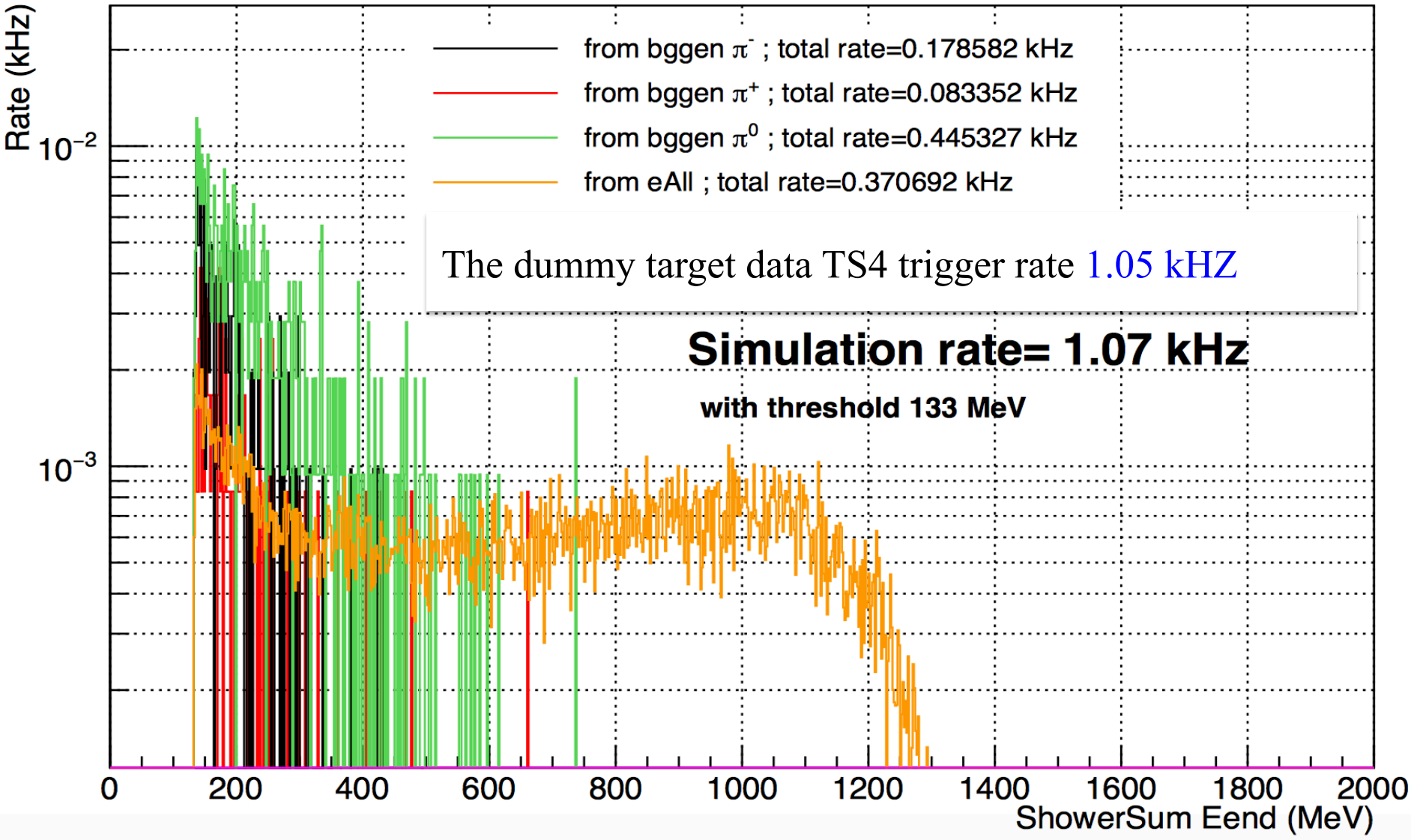
TS#4 threshold Edep=200 MeV calibrated from the run 4121 (3He target):



Simulation rate for TS#4 is 0.676 kHZ agrees with the data rate 0.73 kHZ

ECal Rate Comparison at 7 deg

TS#4 threshold Edep=133 MeV calibrated from the run 4206 (dummy target):



ECal Rate Comparison at 18 deg

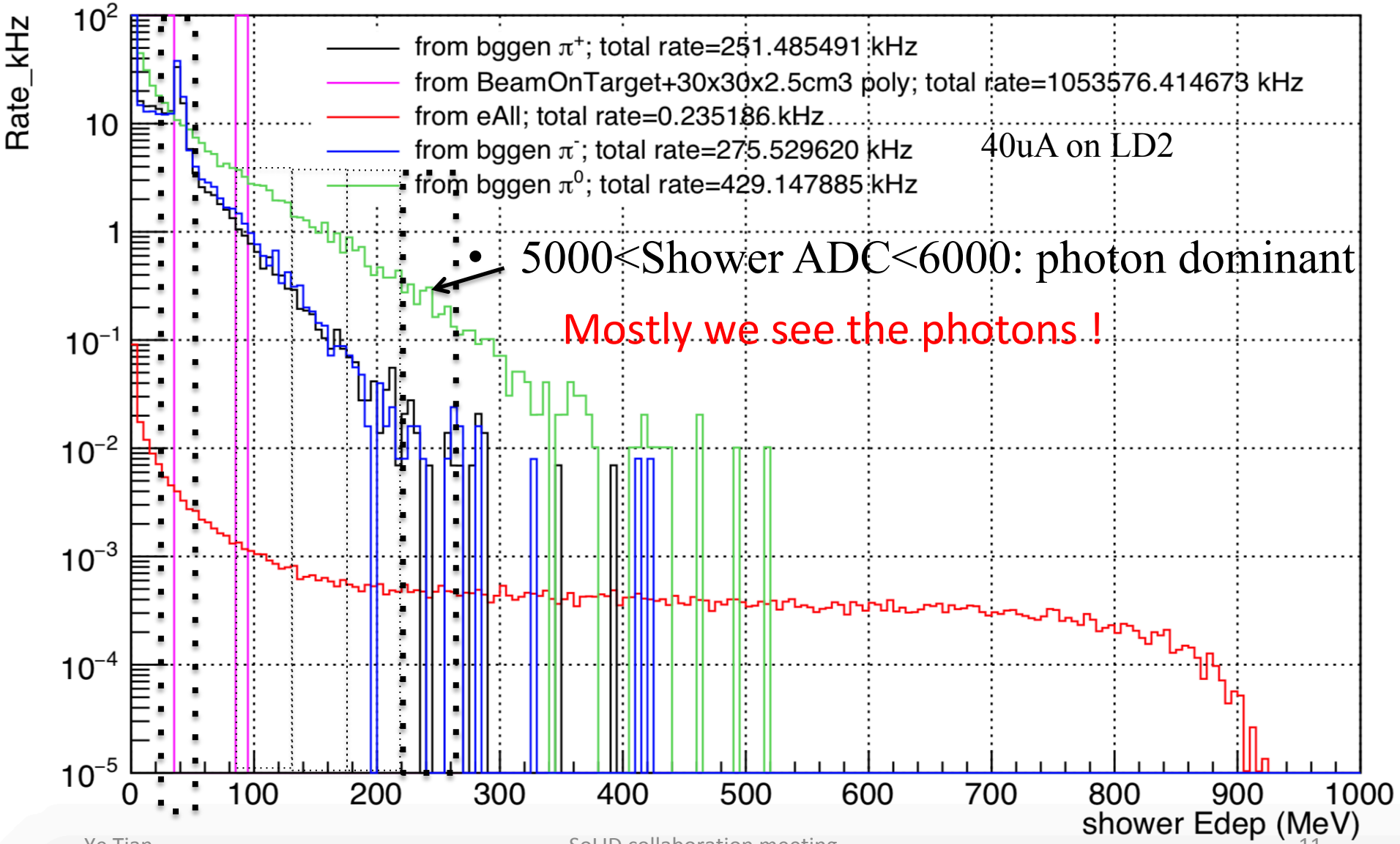
- **18 deg—high rate test luminosity~ $2e^{37}$-$4.5e^{38}$**
- few MeV Moller electron
- It is easy to see the MIP at shower

Rate (kHz)/Occ per ch.	Num. of ch.	SIDIS ^{3}He	J/ψ	PVDIS	comment
LGC	270	400/0.02	1000/0.05	2000/0.1	Np.e.$\geq$ 1
HGC	480	4000/0.2			Np.e.$\geq$ 1
SPD_FA	240	3200/0.16	8600/0.43		cut below MIP
SPD_LA	60	4500/0.225	9200/0.46		cut below MIP
EC_preshower_FA	~1300/~1800	3300/0.17	7650/0.38	9000/0.43	cut below MIP
EC_shower_FA	~1300/~1800	920/0.05	2344/0.12	900/0.05	cut below MIP
EC_preshower_LA	~500	4533/0.23	8119/0.41		cut below MIP
EC_shower_LA	~500	482/0.03	1894/0.1		cut below MIP
GEM	~161e3/~188e3	4e3/0.3	5e3/0.4	5e3/0.4	digitized

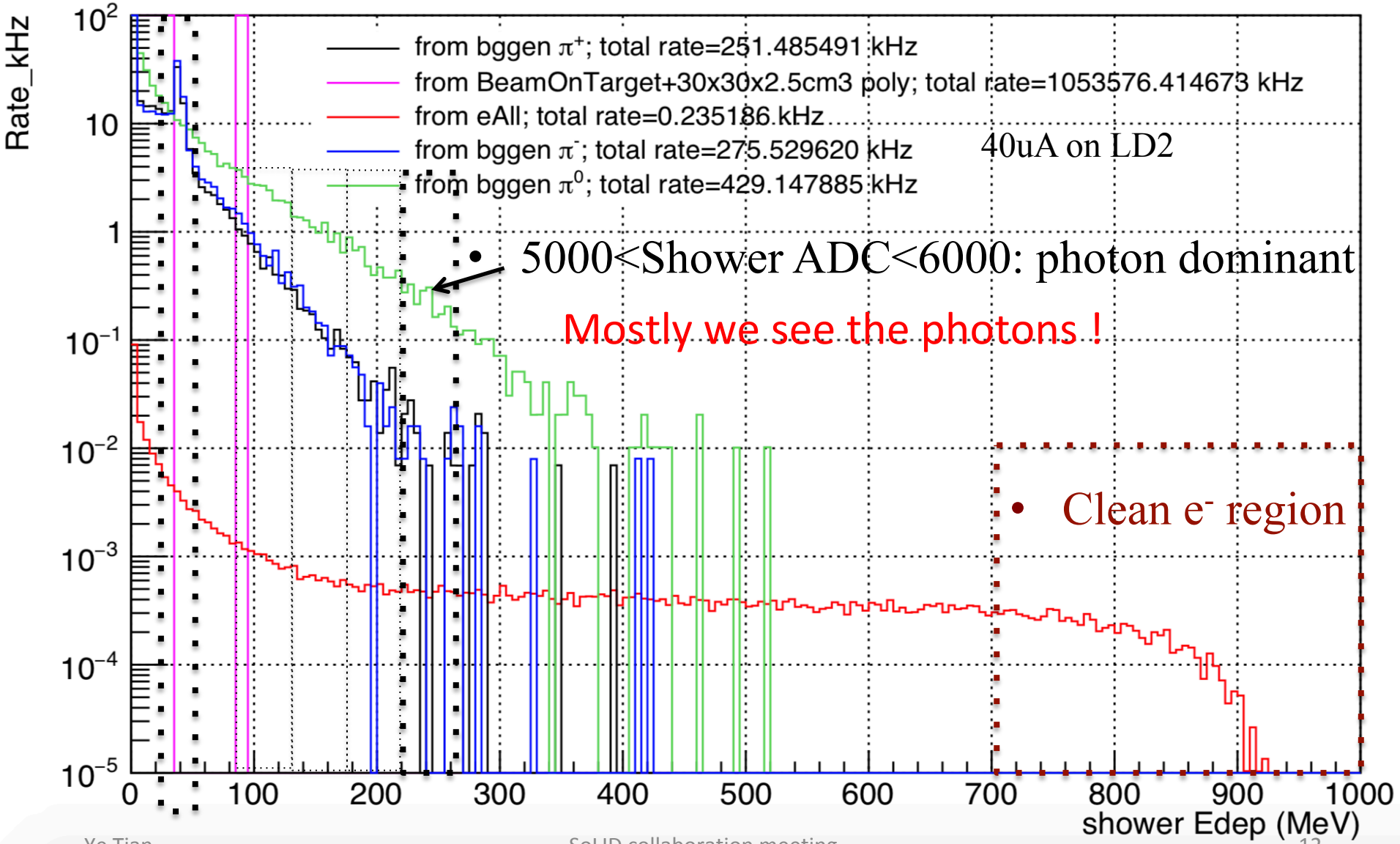
(Table 25 from SoLID PreCDR) Detector maximum rate and occupancy per channel

- LASPD rate= 10200 kHz: based on 5uA run 4680 wavefrom from https://userweb.jlab.org/~tianye/SoLID/ECAL_beamtest_simulation_2022/run4680_LASPD_rate_pulse.pdf
- Shower half MIP trigger rate = 10240 kHz based on 68 uA run4813 trigger rate

Simulation: γ, $\pi^{\pm}$, e^{-} Ratio as a Function of DepE



Simulation: γ, $\pi^{\pm}$, e^{-} Ratio as a Function of DepE



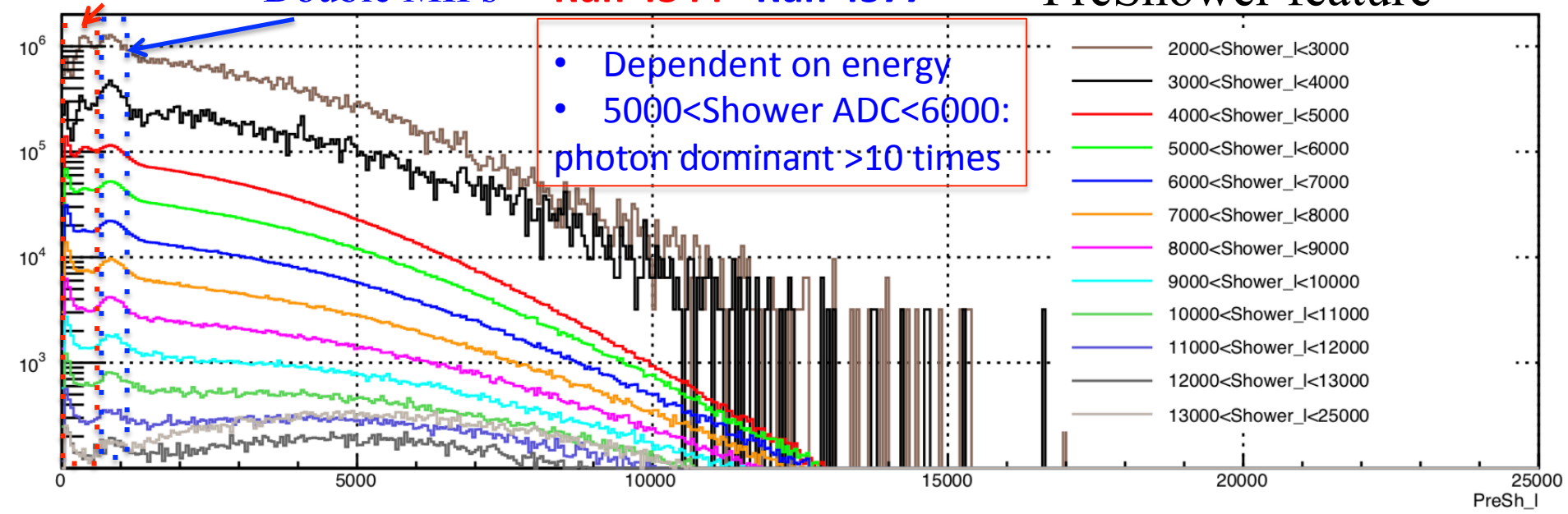
PreShower feature

Pion MIPs

Double MIPs

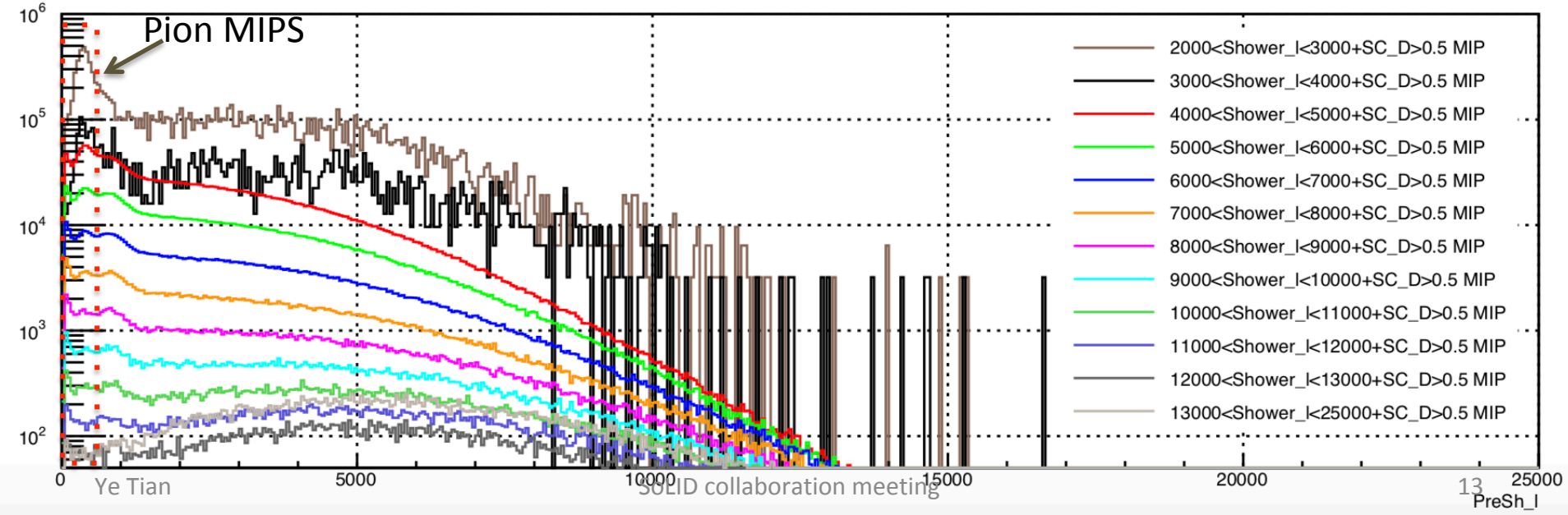
Run 4344+ Run 4577

- Dependent on energy
- 5000<Shower ADC<6000: photon dominant >10 times

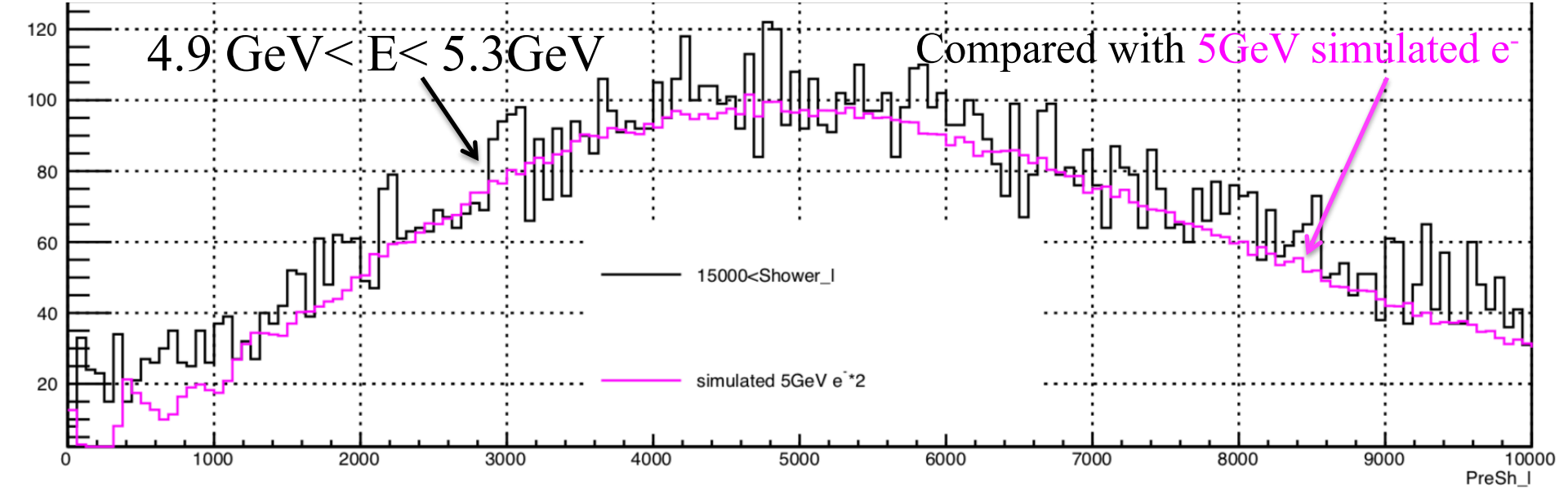


PreShower_I

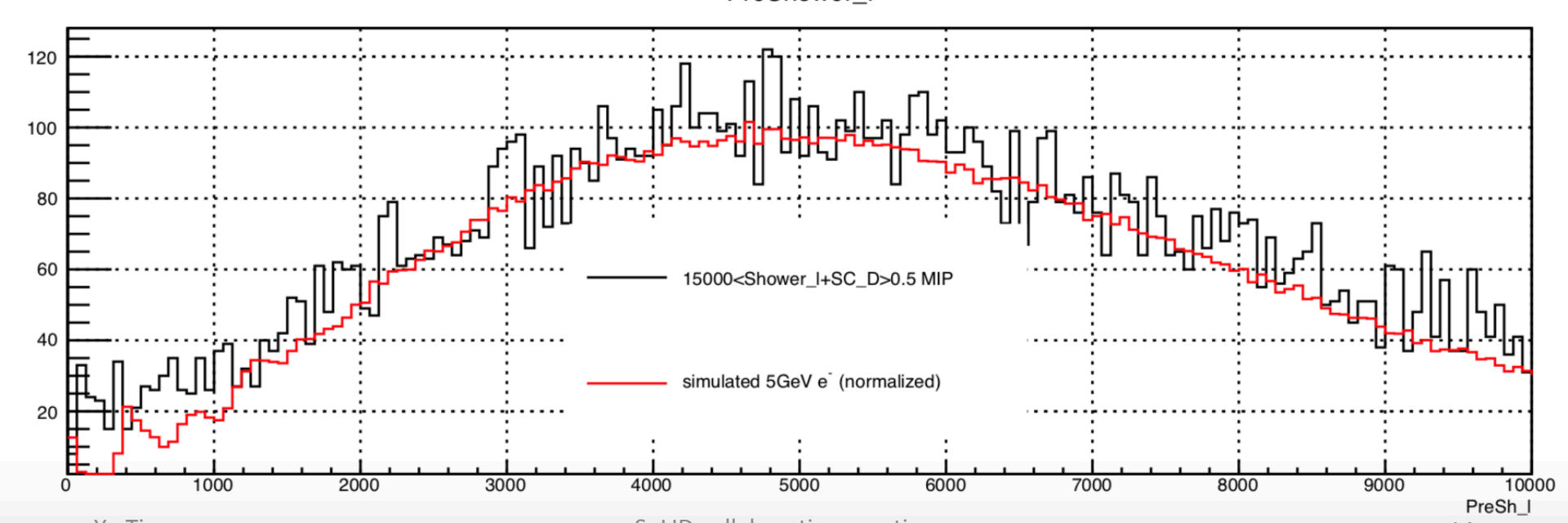
Pion MIPS



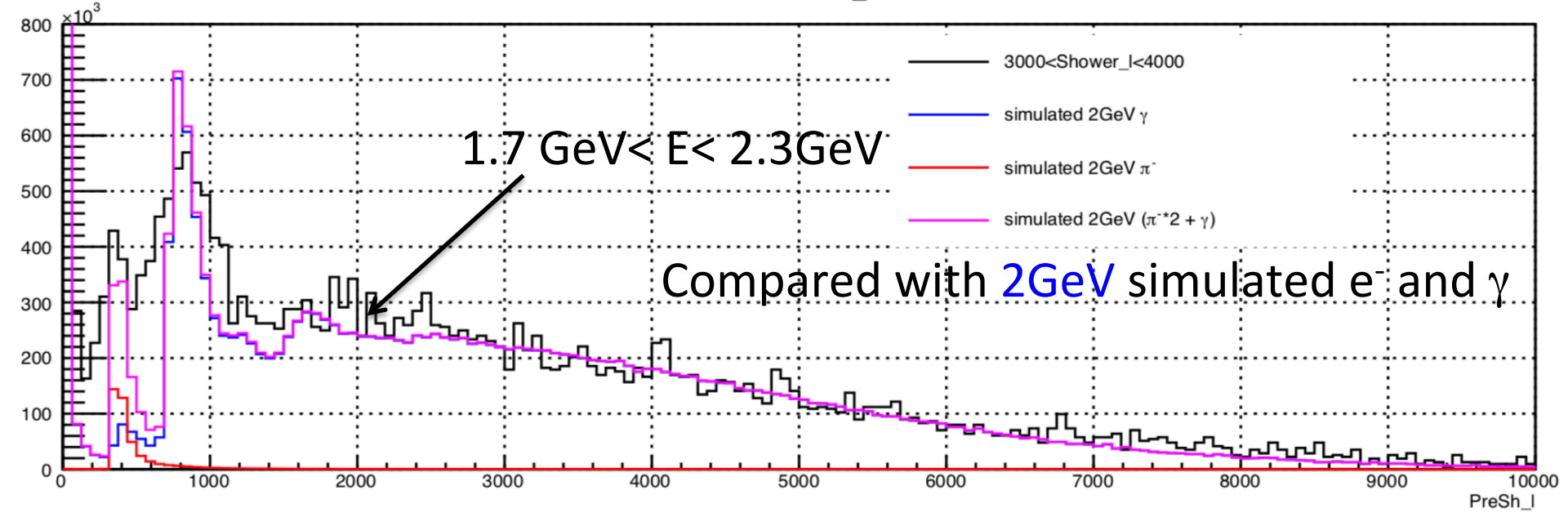
Run 4577 40uA on LD2

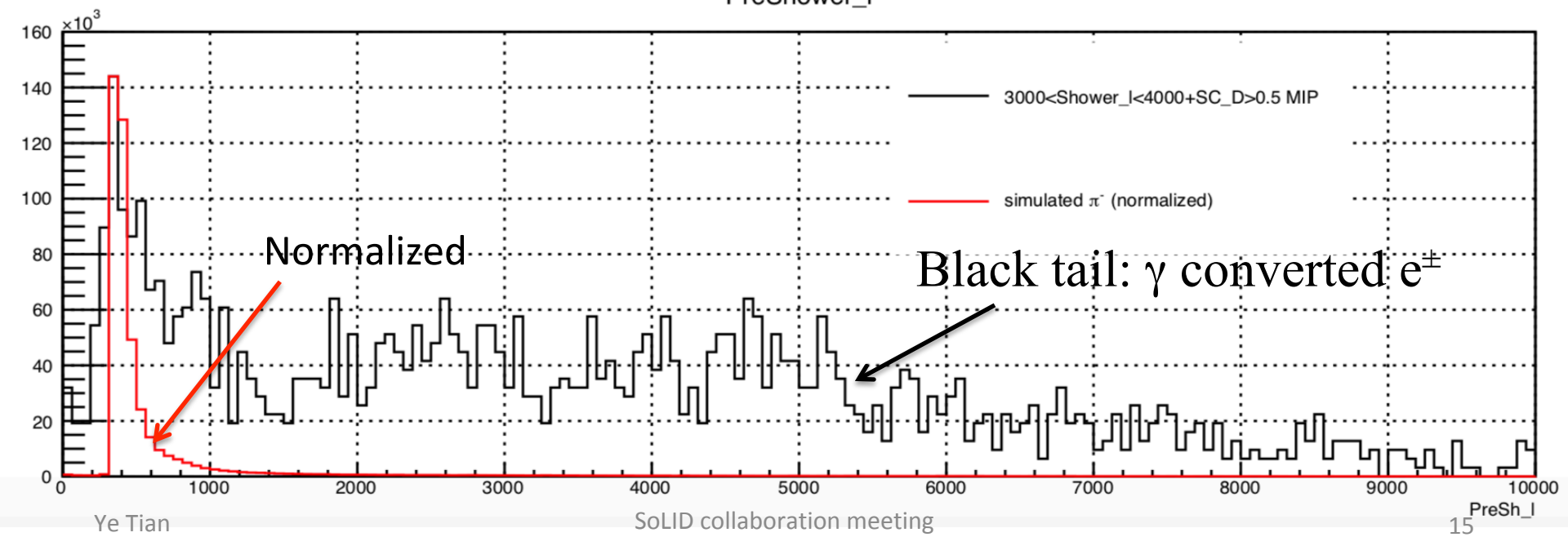


PreShower works very well for the high energy region

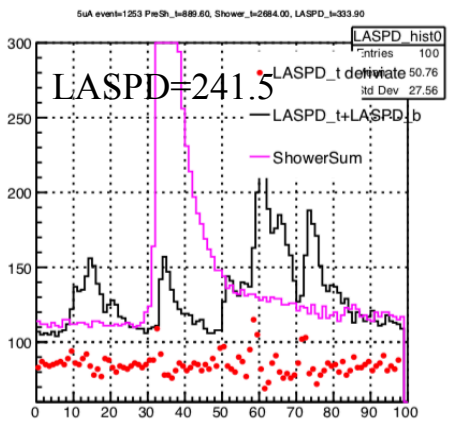


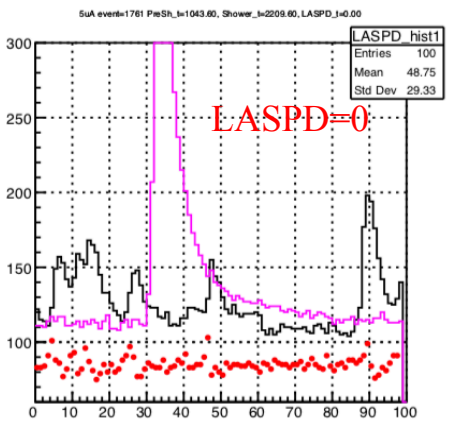
Run 4344 10uA on LH2

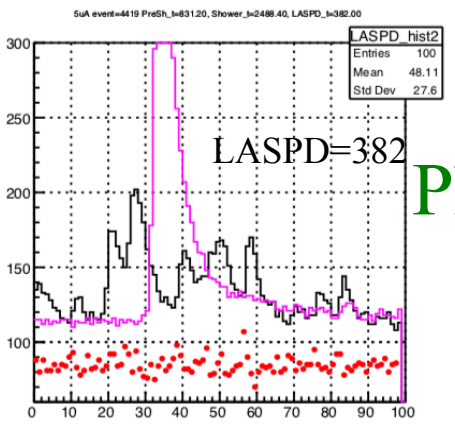


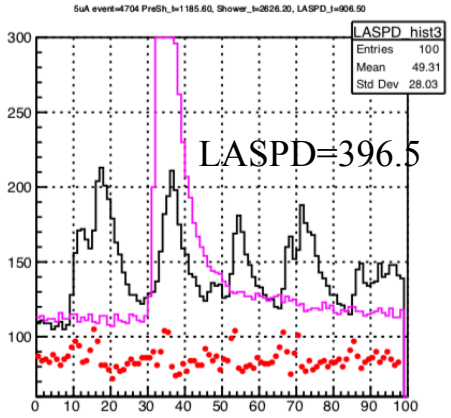


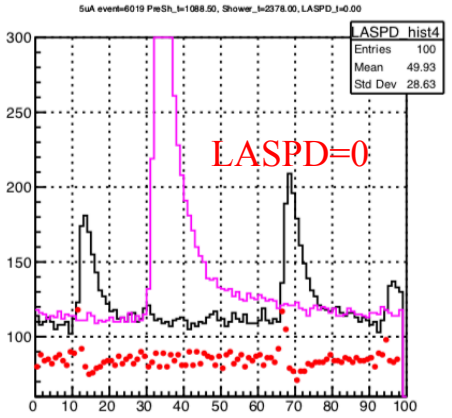
Photon Rejection Study

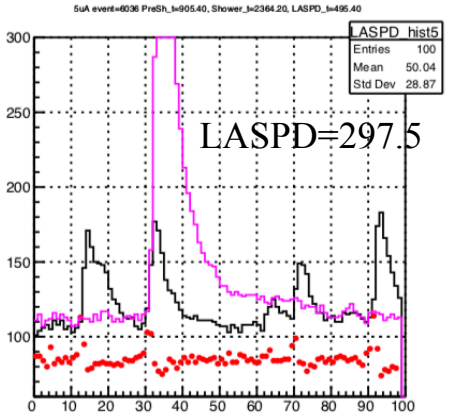


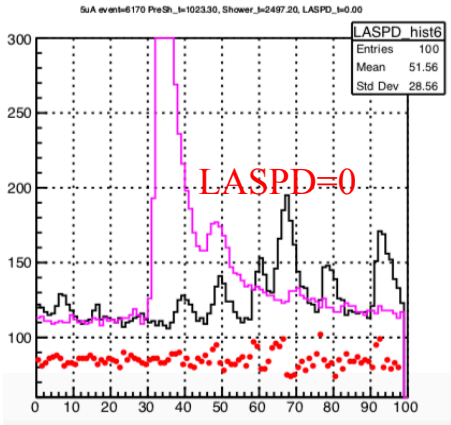


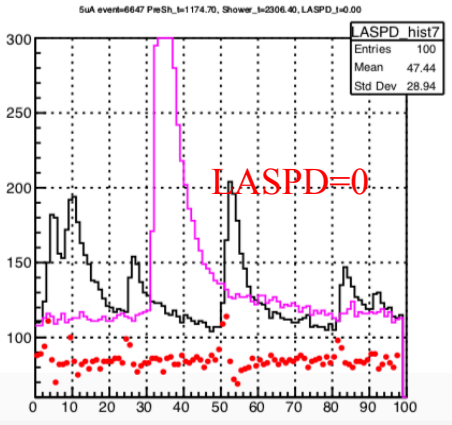


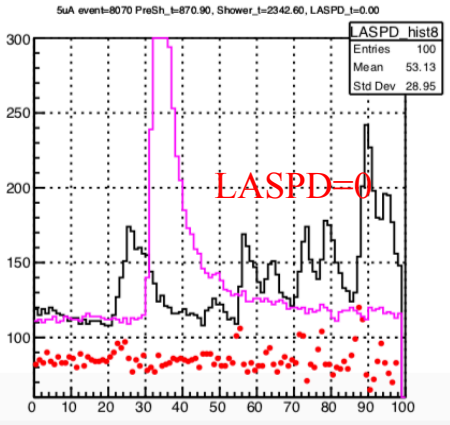










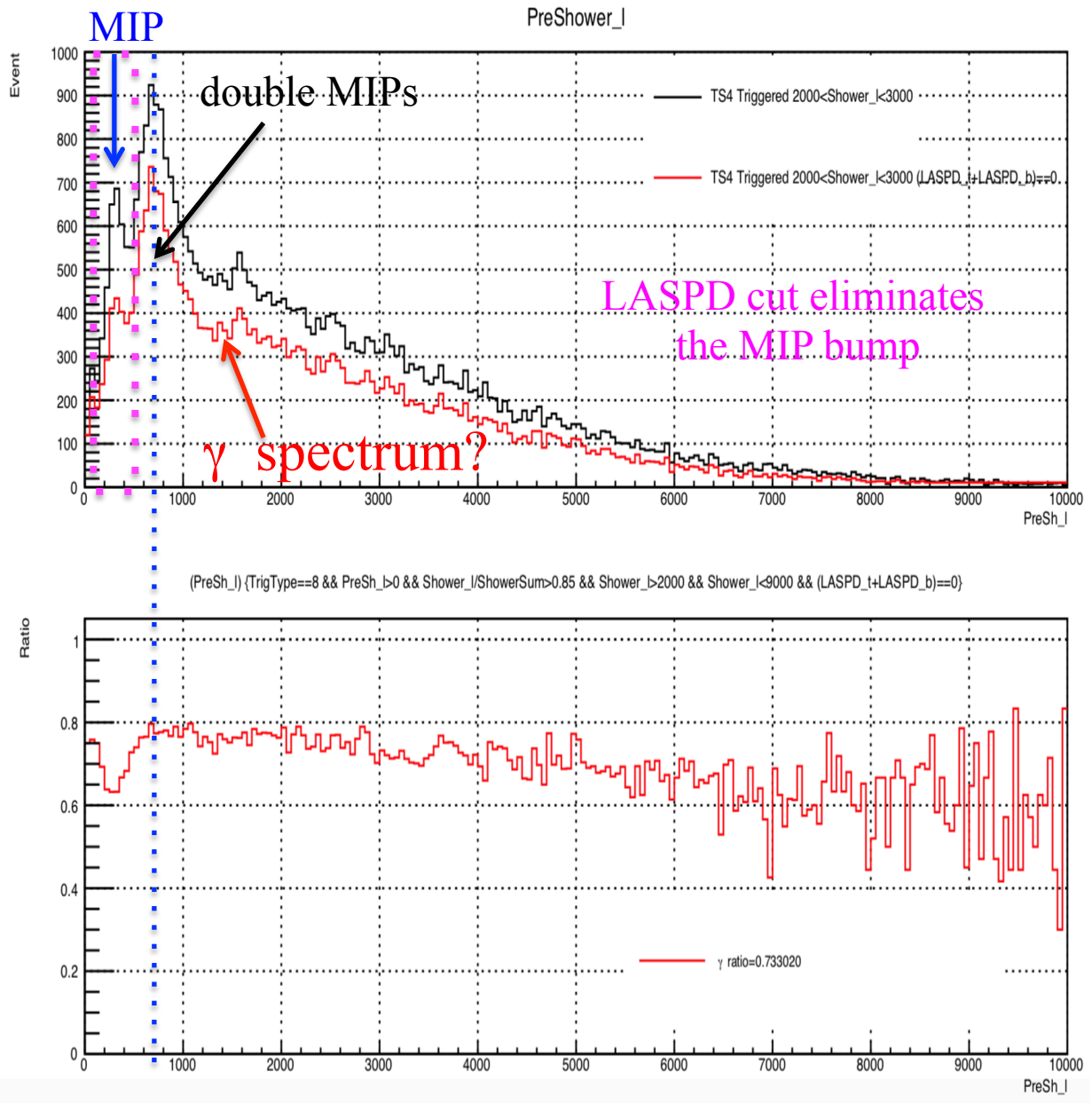


- LASPD_t derivative
- LASPD_t+LASPD_b
- ShowerSum

- Run 4680
- **5uA** on LD2

- TS4
- 2200<Shower_t<2800
- 800<PreSh_t<1200

LASPD Photon Rejection Study



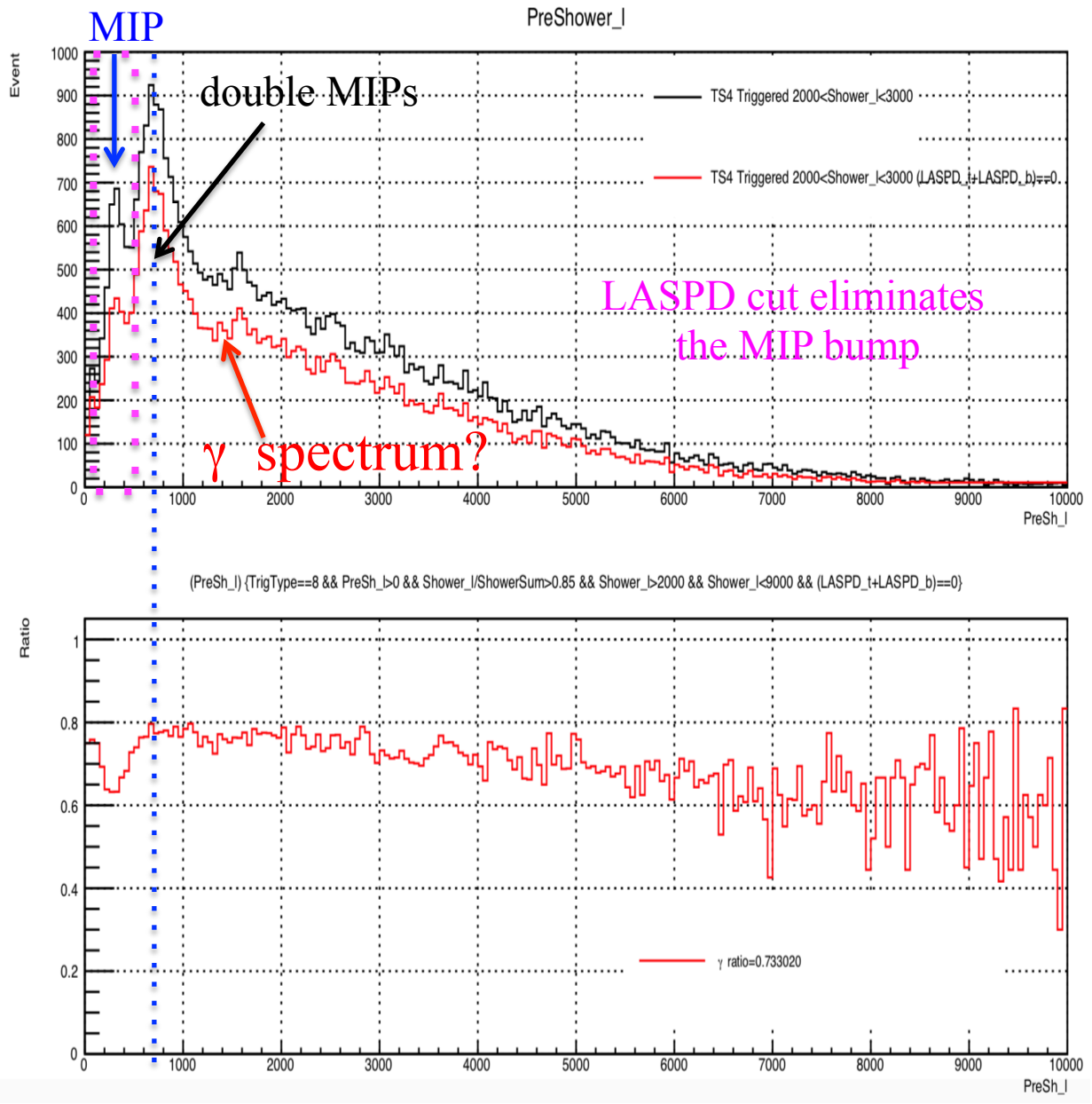
N_(LASPD=0)/N=73.3%

- Run 4680
- 5uA on LD2

PreCDR LASPD photon rejection 10:1

(π^0 γ+low energy e^- + γ bkg)

LASPD Photon Rejection Study



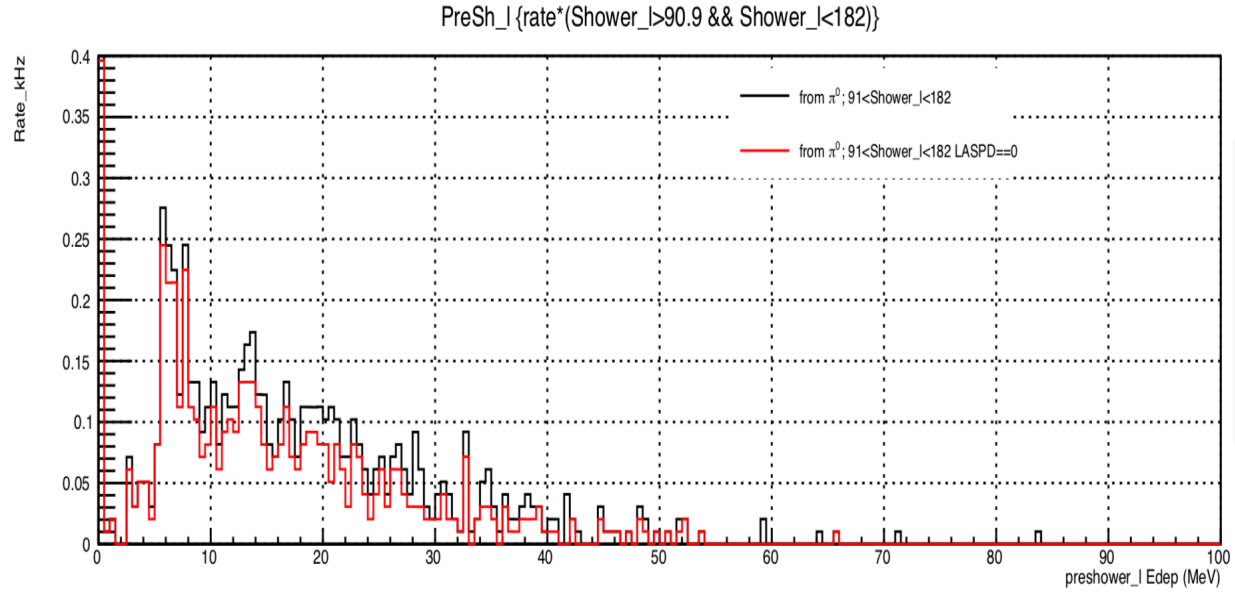
N_(LASPD=0)/N=73.3%

- Run 4680
- 5uA on LD2

PreCDR LASPD photon rejection 10:1

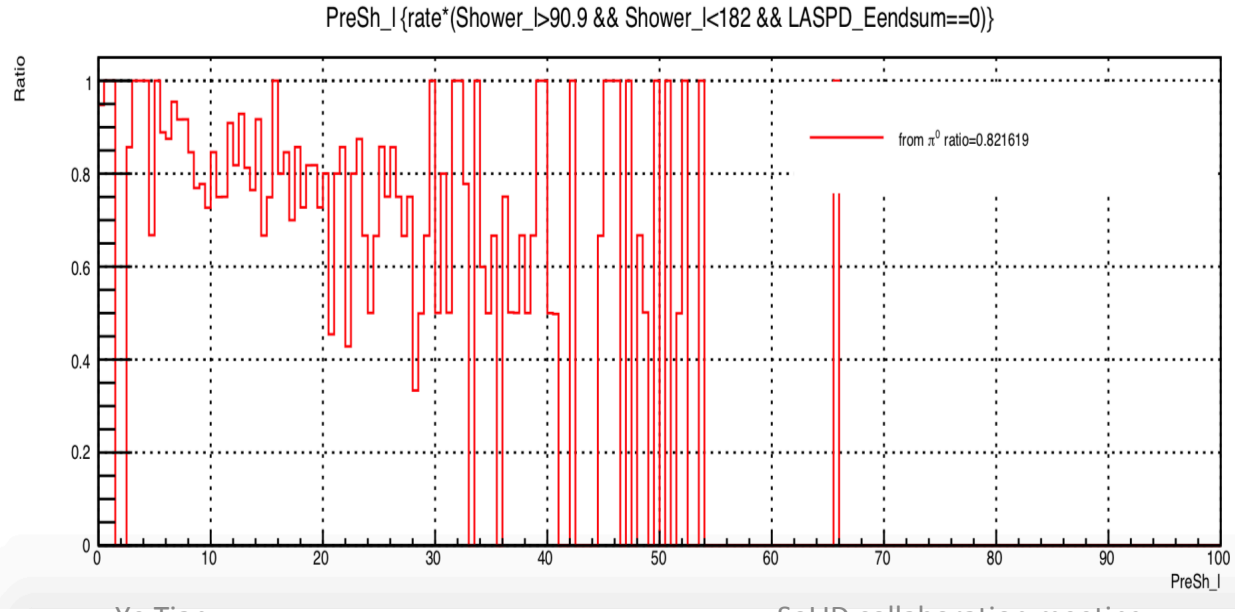
(π^0 γ+low energy e^- + γ bkg)

Simulation----Photon Rejection



N_(LASPD=0)/N=82.2%

~17.8% γ converted before LASPD



- 40uA on LD2
- from bggen π^0

Summary

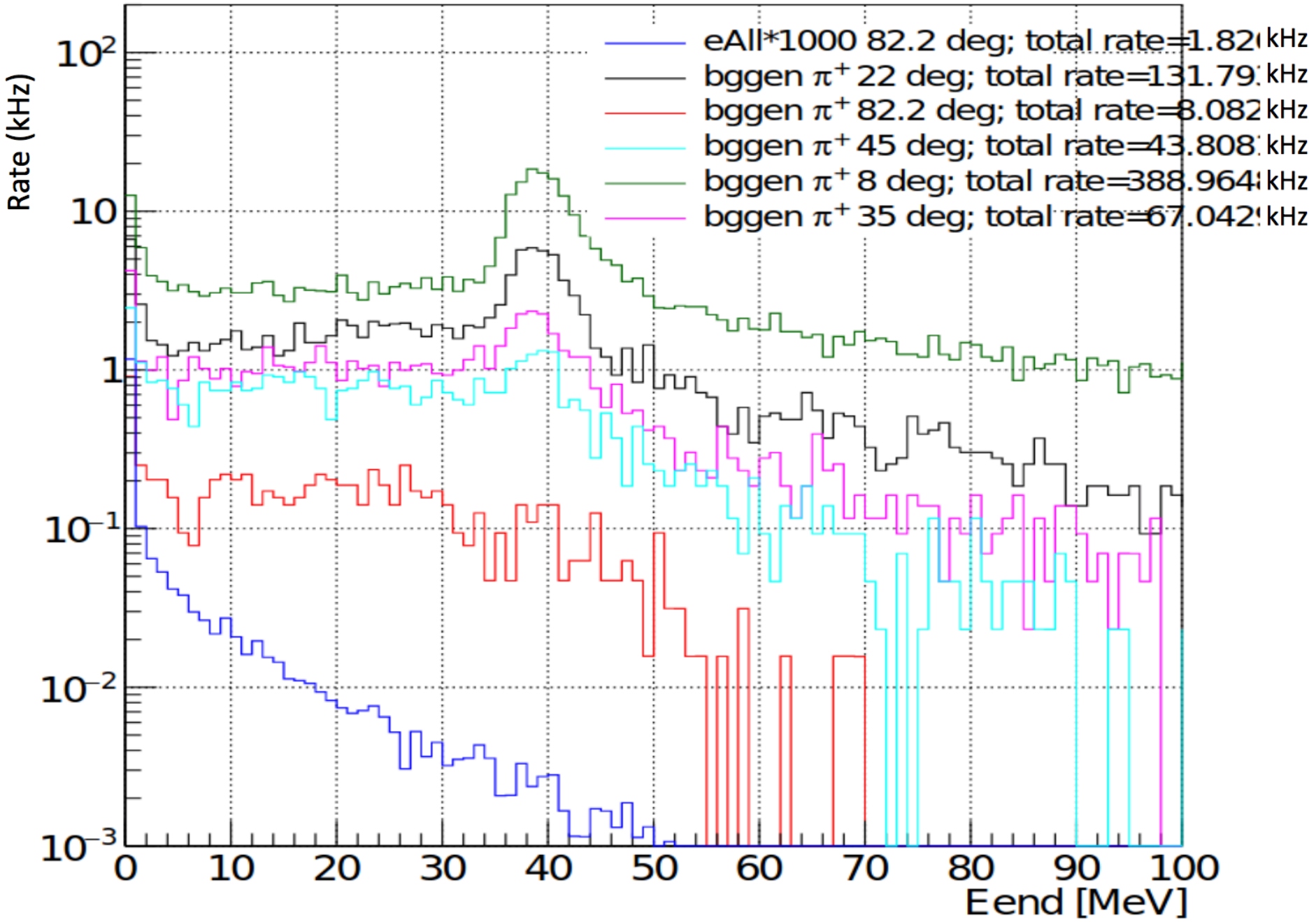
- 5uA LASPD rate is comparable with the SoLID LASPD rate. The 5uA waveform looks reasonable, and the photon rejection is ~54%. It could be improved by narrowing the LASPD timing peaks.

- ~18 % γ converted before they hit the LASPD.

- Mostly we see γ in the TS4 data (besides the threshold 15 mV runs).

- A well defined LASPD analysis task: look at low current (including beam trip) LASPD data with high energy shower cuts (Shower_ADC>5000) to study LASPD performance. (C-hole runs)

Backup


eAll*1000 82.2 deg; total rate=1.82(kHz
bggen π+ 22 deg; total rate=131.79 kHz
bggen π+ 82.2 deg; total rate=8.082 kHz
bggen π+ 45 deg; total rate=43.808 kHz
bggen π+ 8 deg; total rate=388.964 kHz
bggen π+ 35 deg; total rate=67.042 kHz
Rate (kHz)
10²
10
1
10⁻¹
10⁻²
10⁻³
0
10
20
30
40
50
60
70
80
90
100
Eend [MeV]