PVDIS Tigger Rates and Pile-ups Study

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Overview

- **Electron Generators:**

evgen_inclusive_e https://github.com/JeffersonLab/evgen_inclusive_e.git

✓ Compared with d2n and MARATHRON data

o Compare with Geant4

- **Hadron generator:**

bggen https://github.com/JeffersonLab/evgen_bggen

✓ Compared with MARATHRON data

o Compare with Geant4

✓ Got the neutron data----optimize bggen

- **EC beam test simulation**

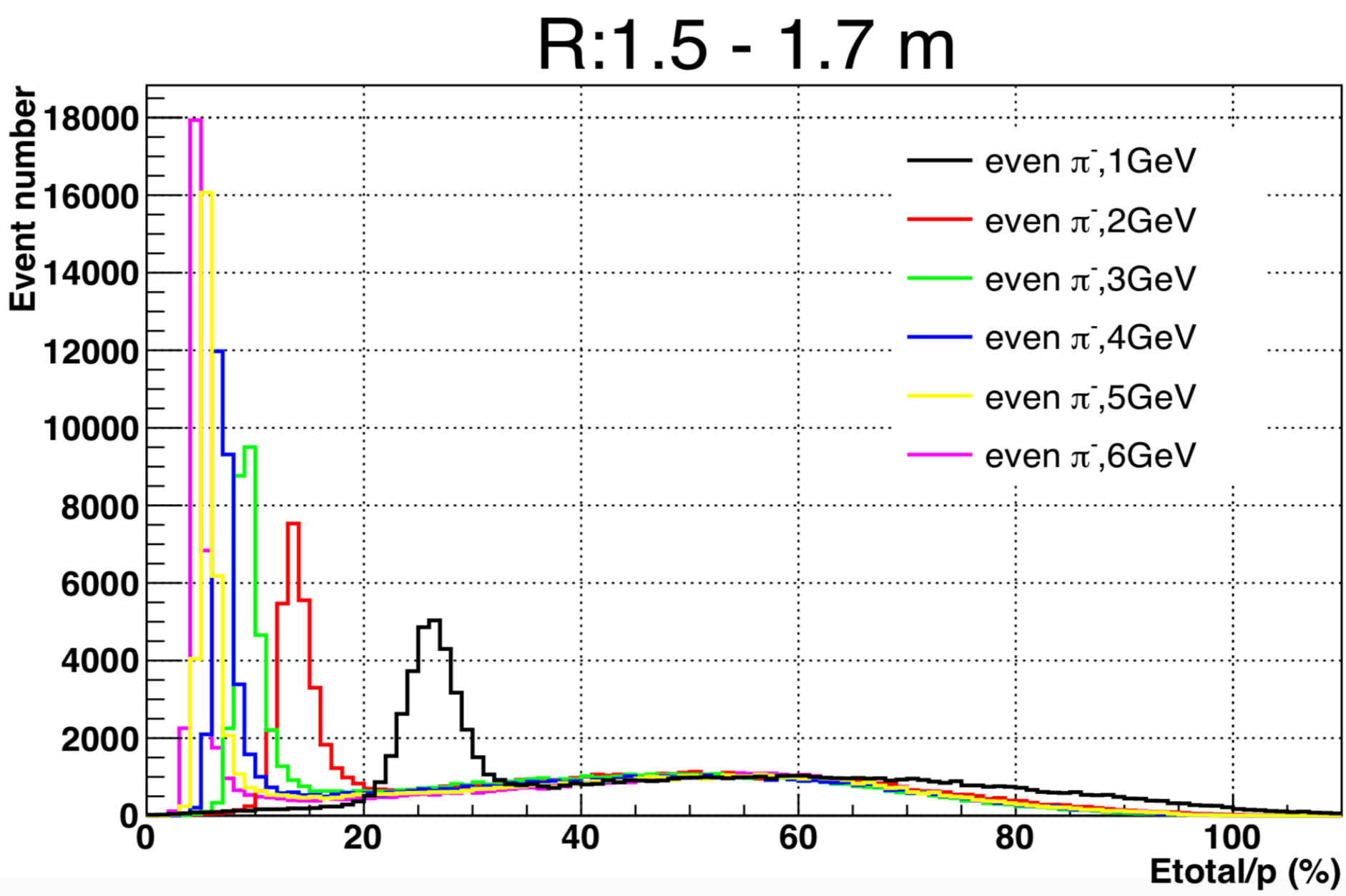
✓ FTBF

- **EC simulation study**

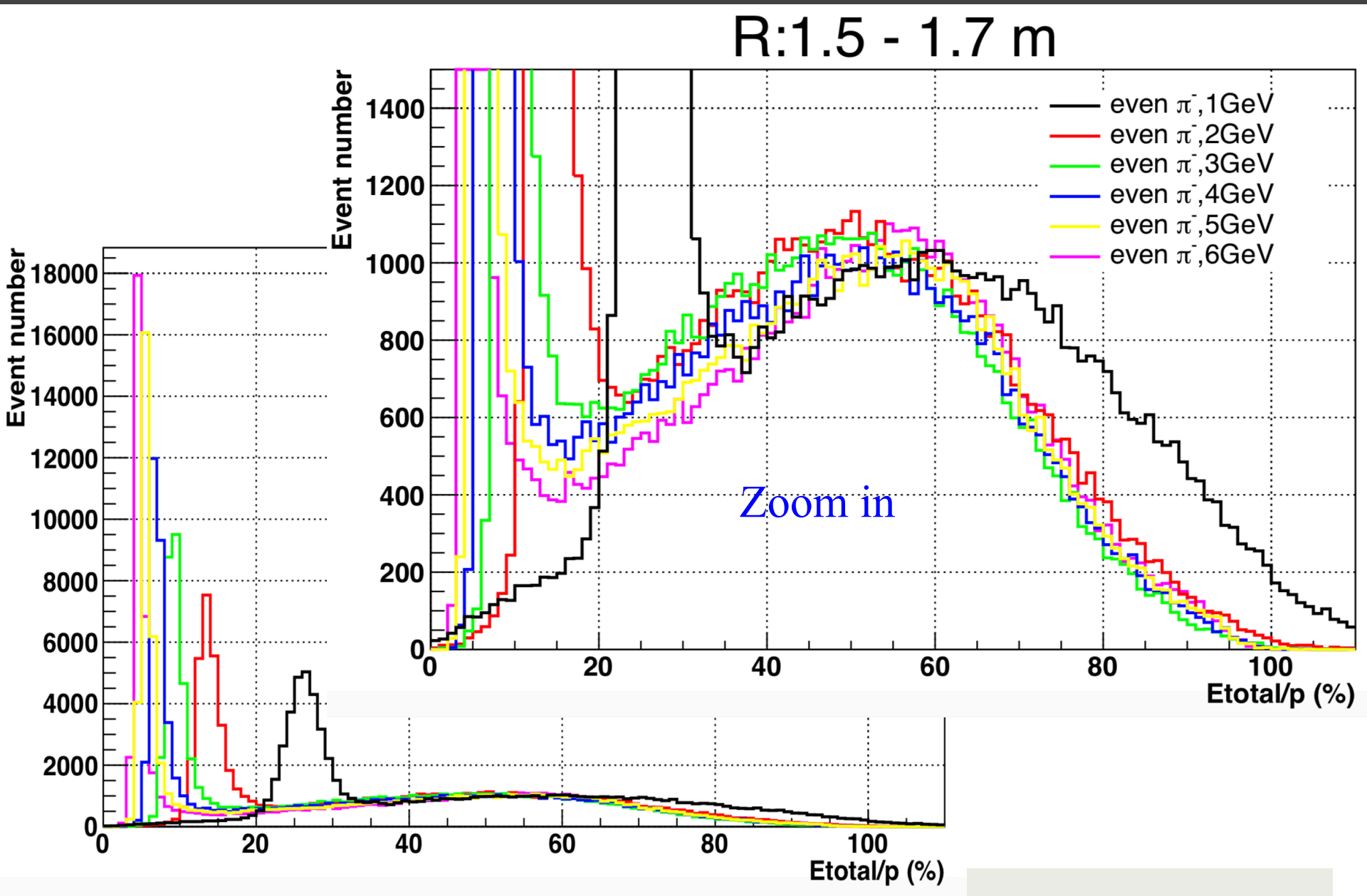
✓ SIDIS LAEC ---add preshowers at the inner radius of LAEC

✓ PVDIS trigger rates and pile-ups------this talk

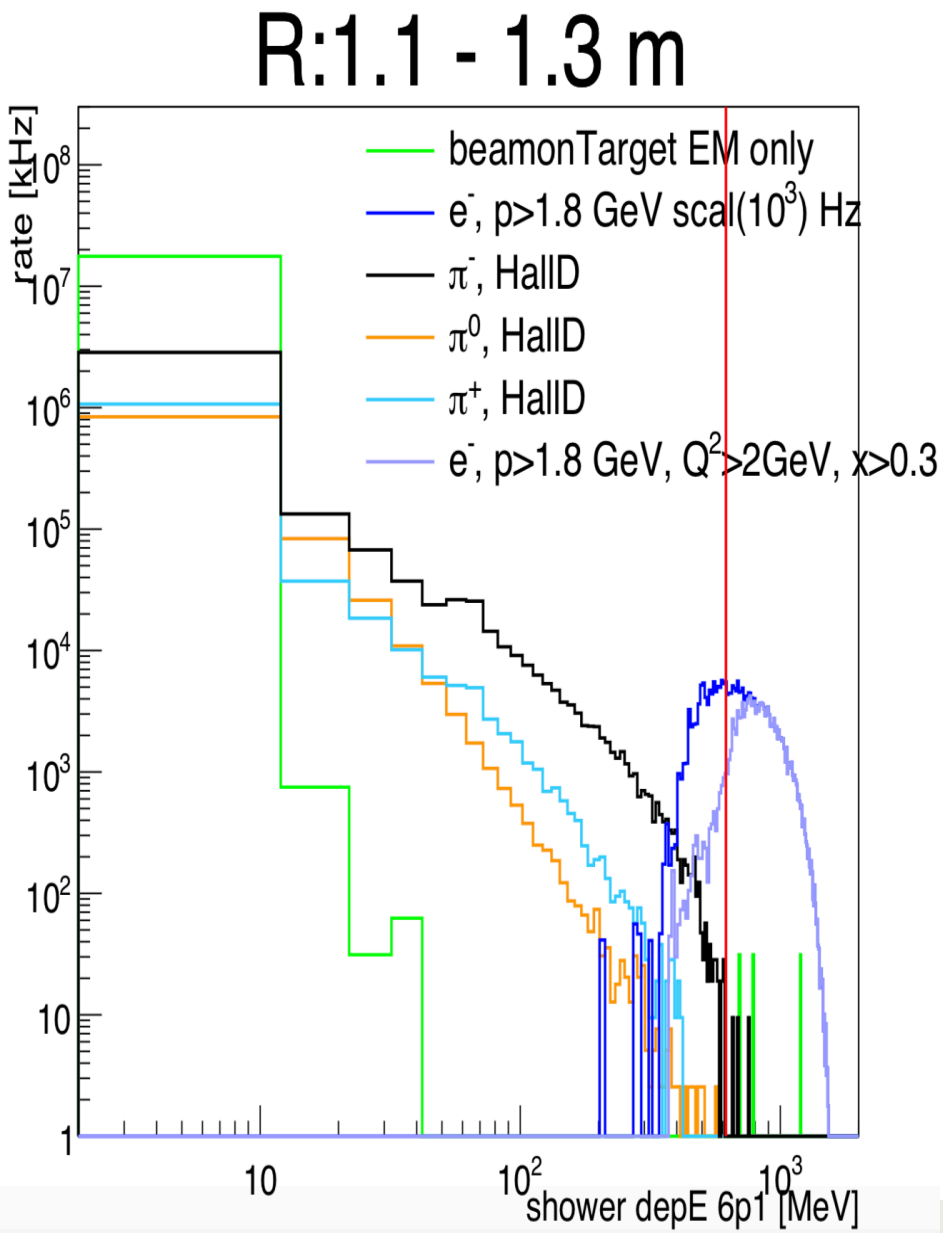
π− in EC

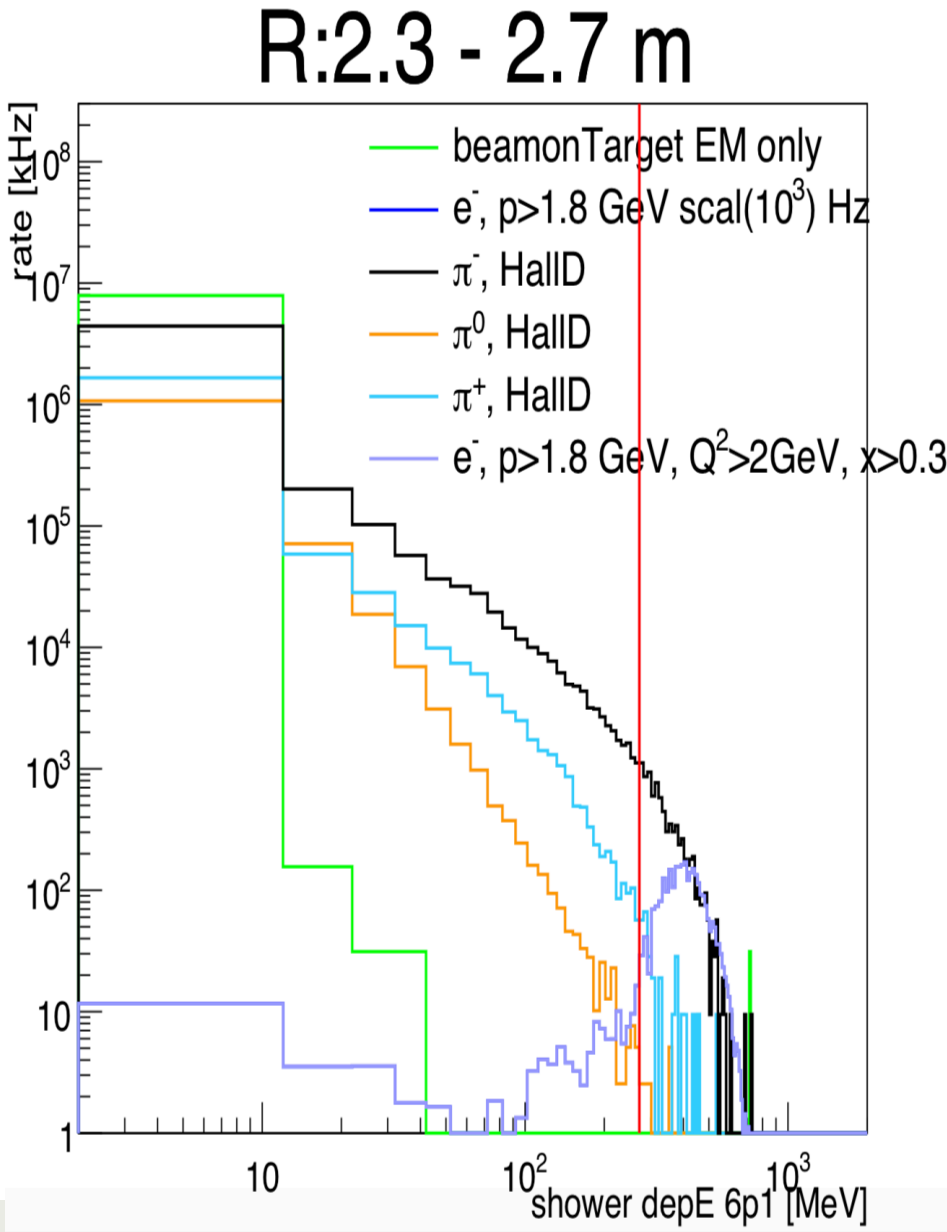

R:1.5 - 1.7 m
Event number
18000
16000
14000
12000
10000
8000
6000
4000
2000
0
0
20
40
60
80
100
Etotal/p (%)
even π⁻,1GeV
even π⁻,2GeV
even π⁻,3GeV
even π⁻,4GeV
even π⁻,5GeV
even π⁻,6GeV

π− in EC

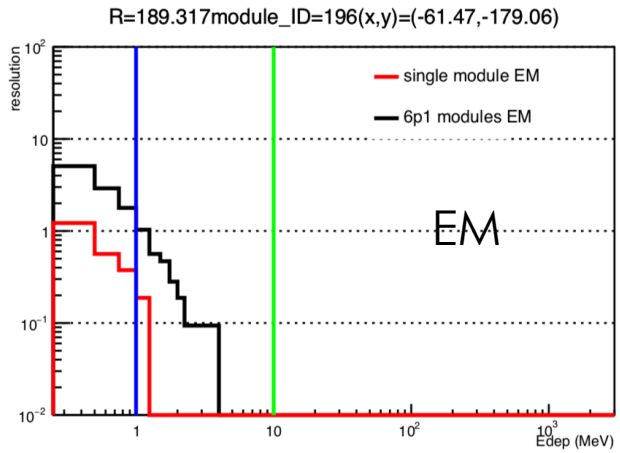

R:1.5 - 1.7 m
Event number
Etotal/p (%)
even π⁻,1GeV
even π⁻,2GeV
even π⁻,3GeV
even π⁻,4GeV
even π⁻,5GeV
even π⁻,6GeV
Zoom in

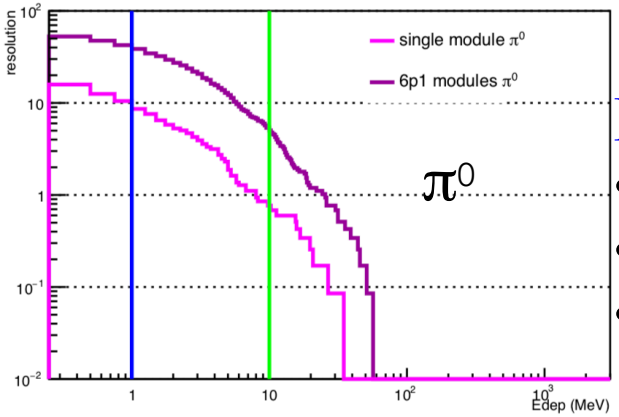
PVDIS EC Shower Deposit Energy Maximum E6p1

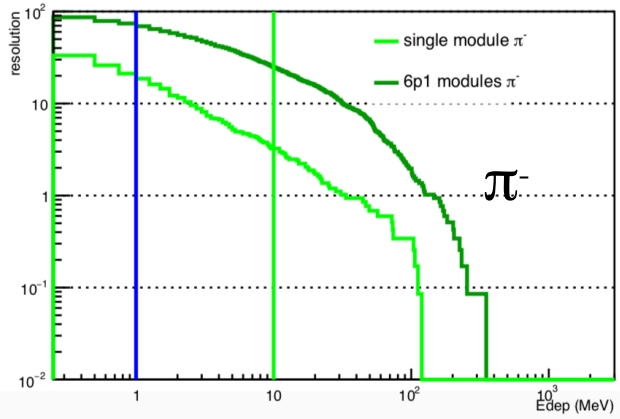


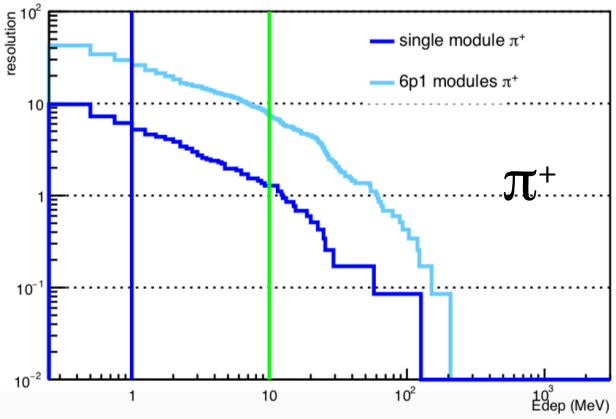


Pile-ups Comparison @ 30ns TW









Effects of pile-ups

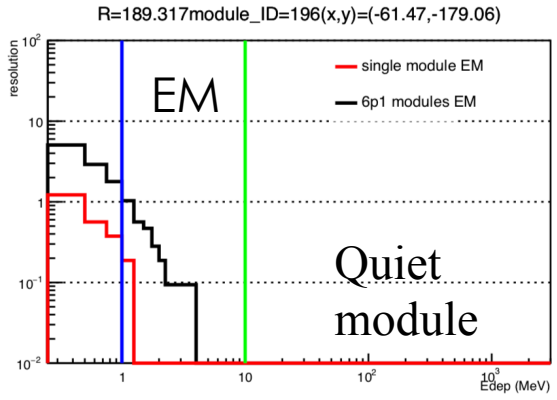
- Energy Resolution
- Trigger rates
- π-/e- seperation

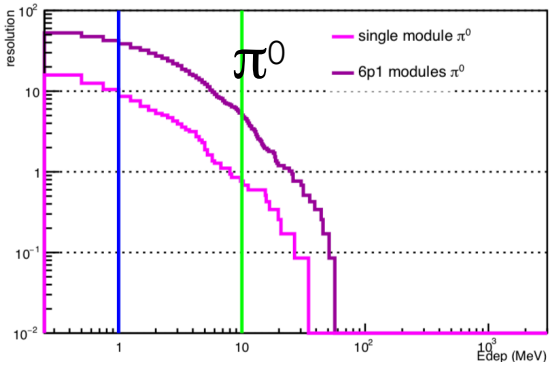
EM: Geant4
VERSION_1.3/Pass5/
BeamOnTargetEM.root

- Bggen generator π^-

https://github.com/JeffersonLab/evgen_bggen/
commit: 227c7

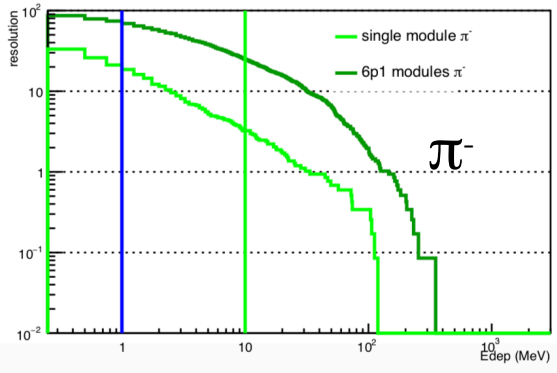
Pile-ups comparison @ 30ns TW

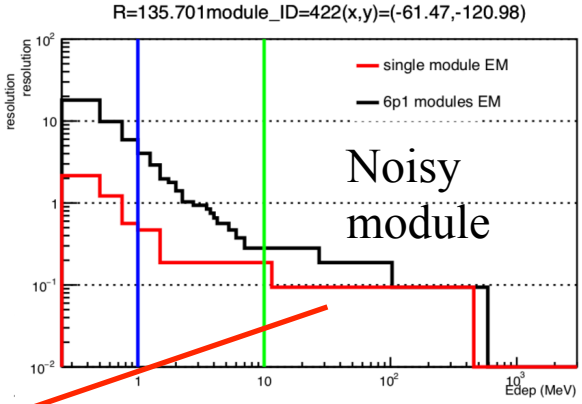


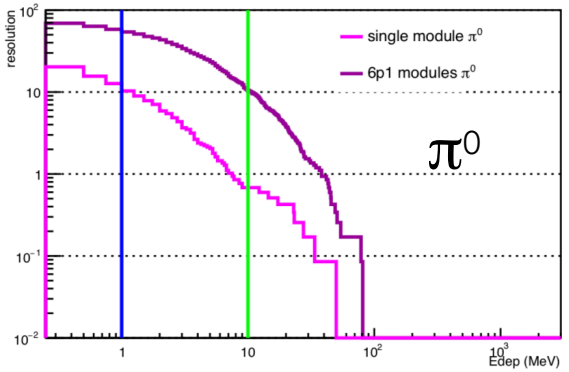


- Resolution online
- Trigger
- preshow

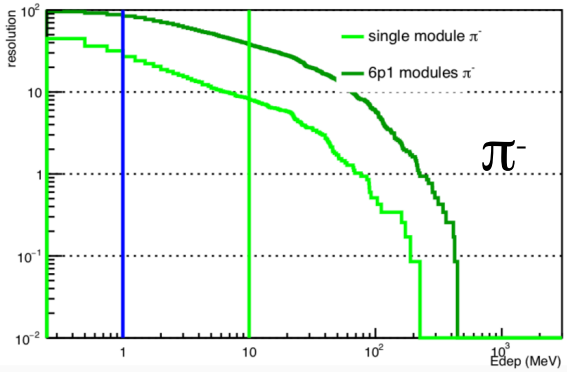
Pion dominates the pile-up

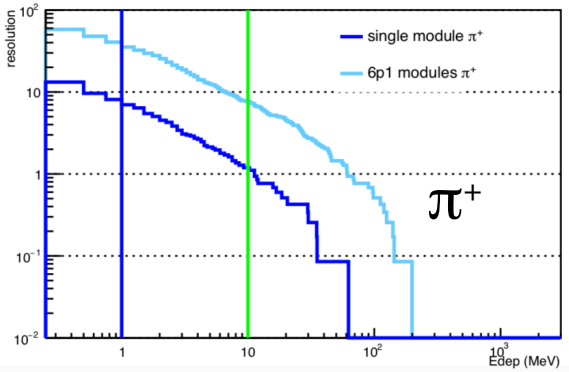




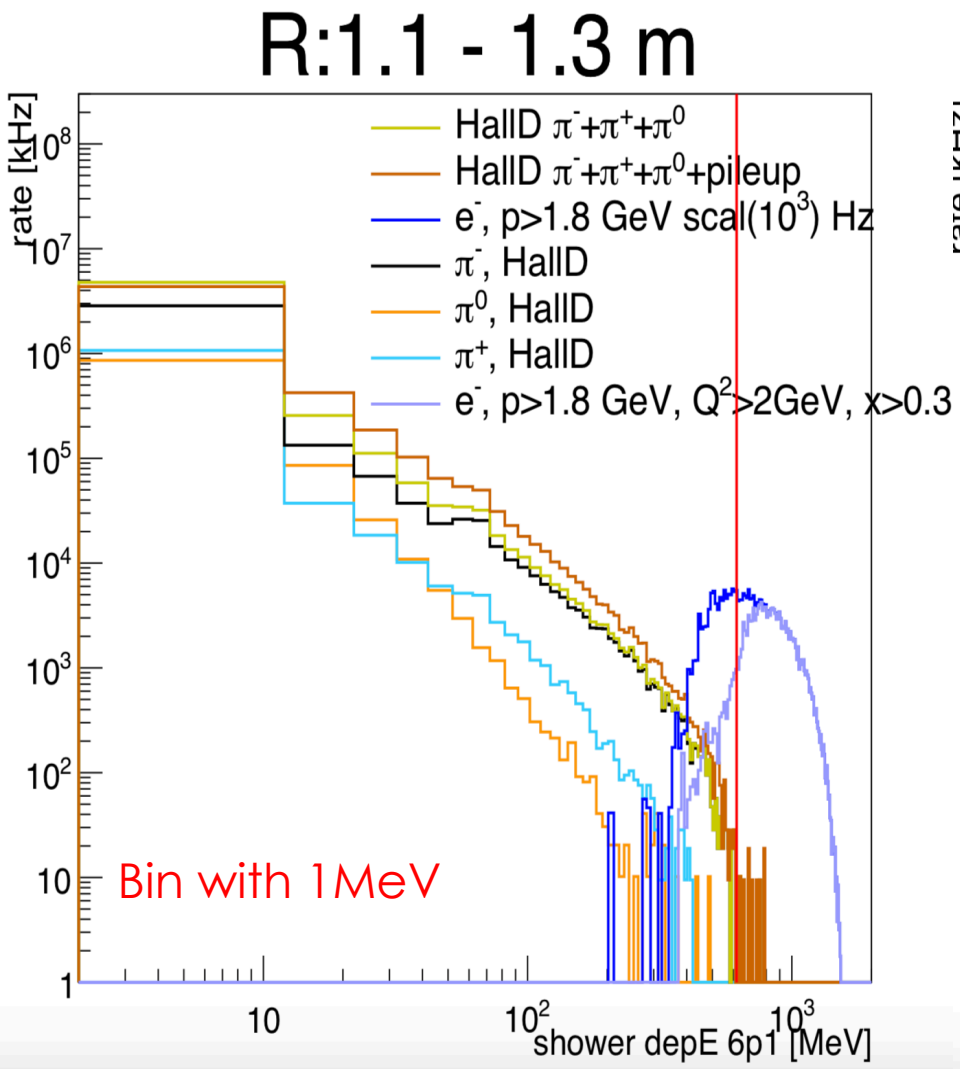


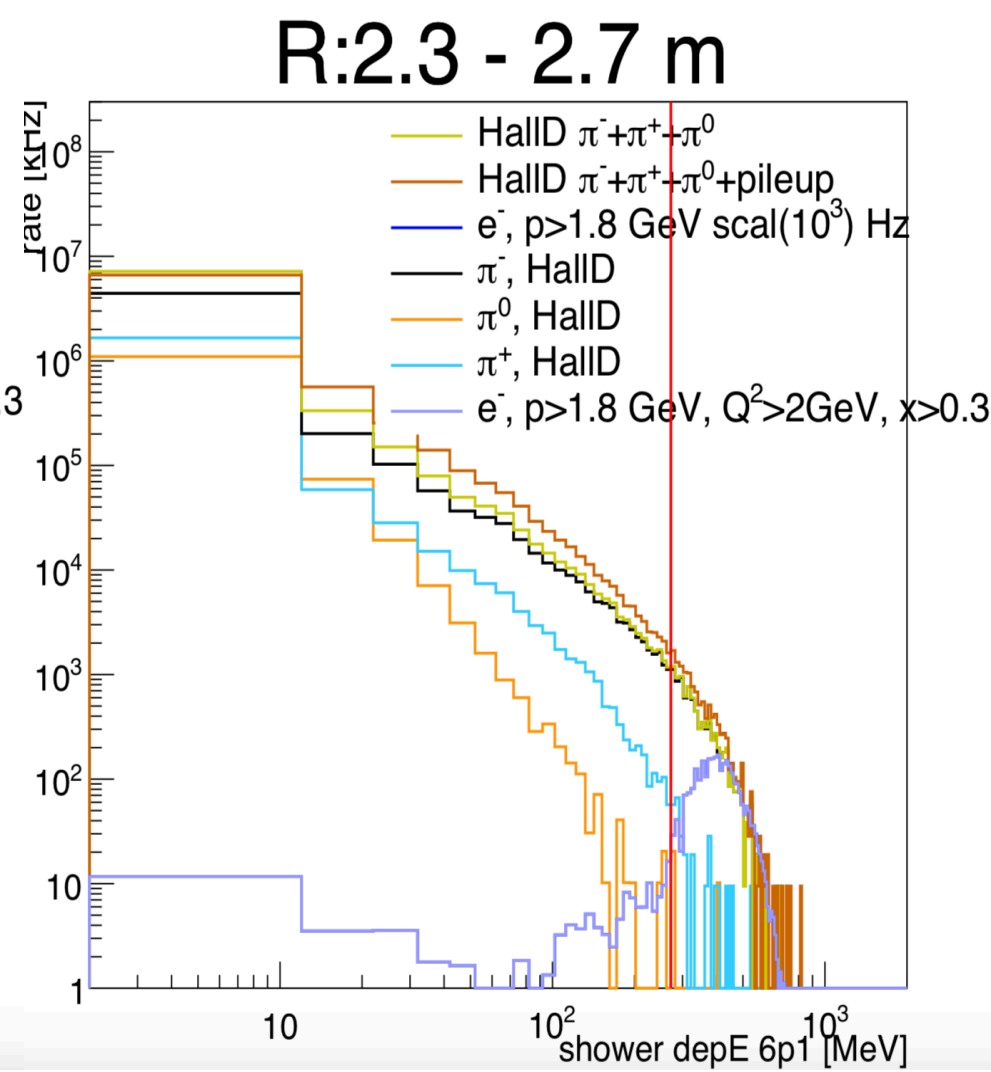
Geant4 radiated DIS cross section is too high.



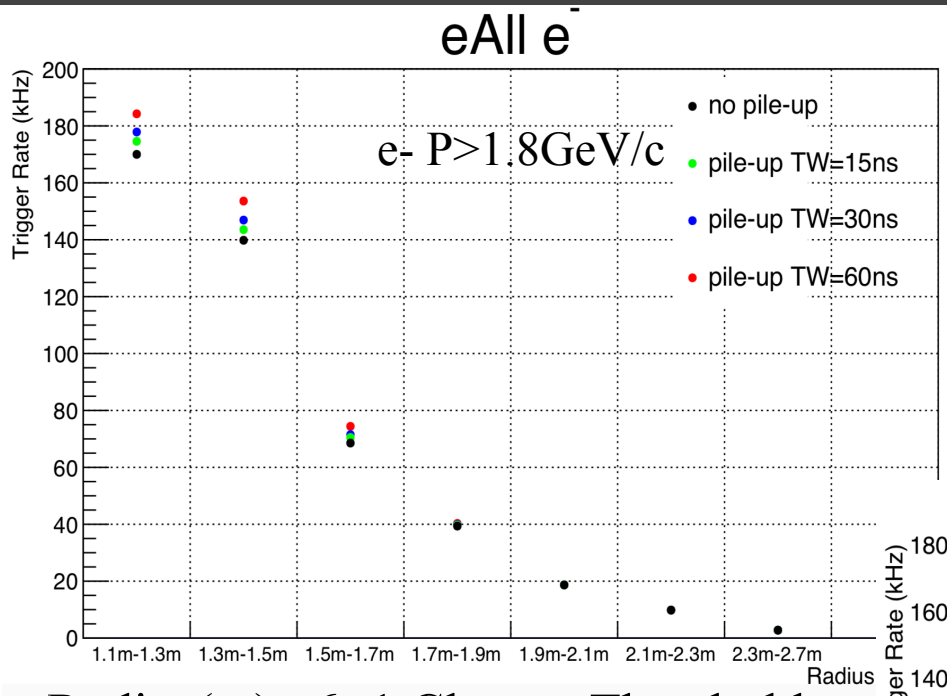


EC Shower Deposit Energy maximum 6p1





PVDIS EC Online Trigger Rate with Pile-ups (kHz)



- eAll e- generate ---Eric Christy's 2021 fit

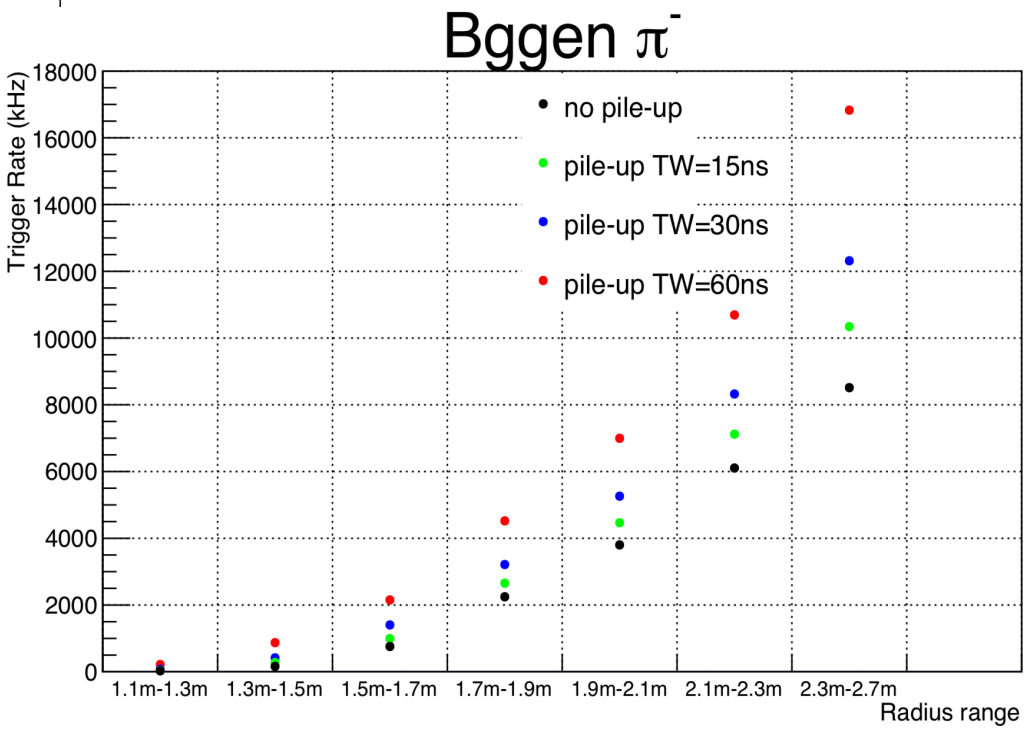
The W^2 <24 GeV ^{2} and all Q^2 <30 GeV^2

- Bggen generator π^-

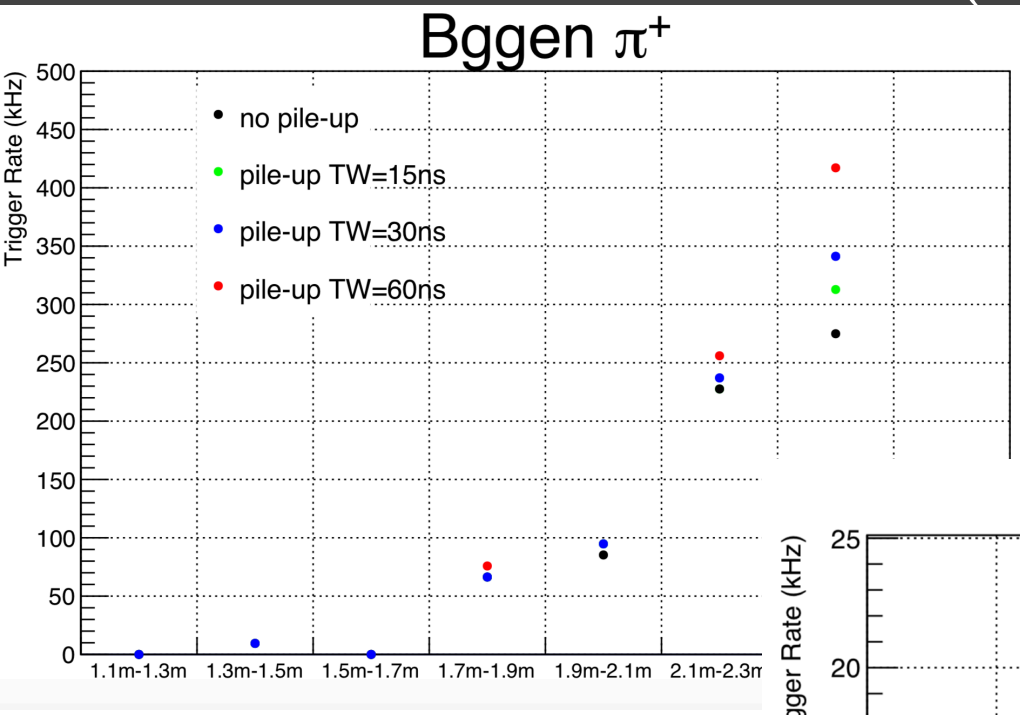
https://github.com/JeffersonLab/evgen_bggen/

commit: 227c7

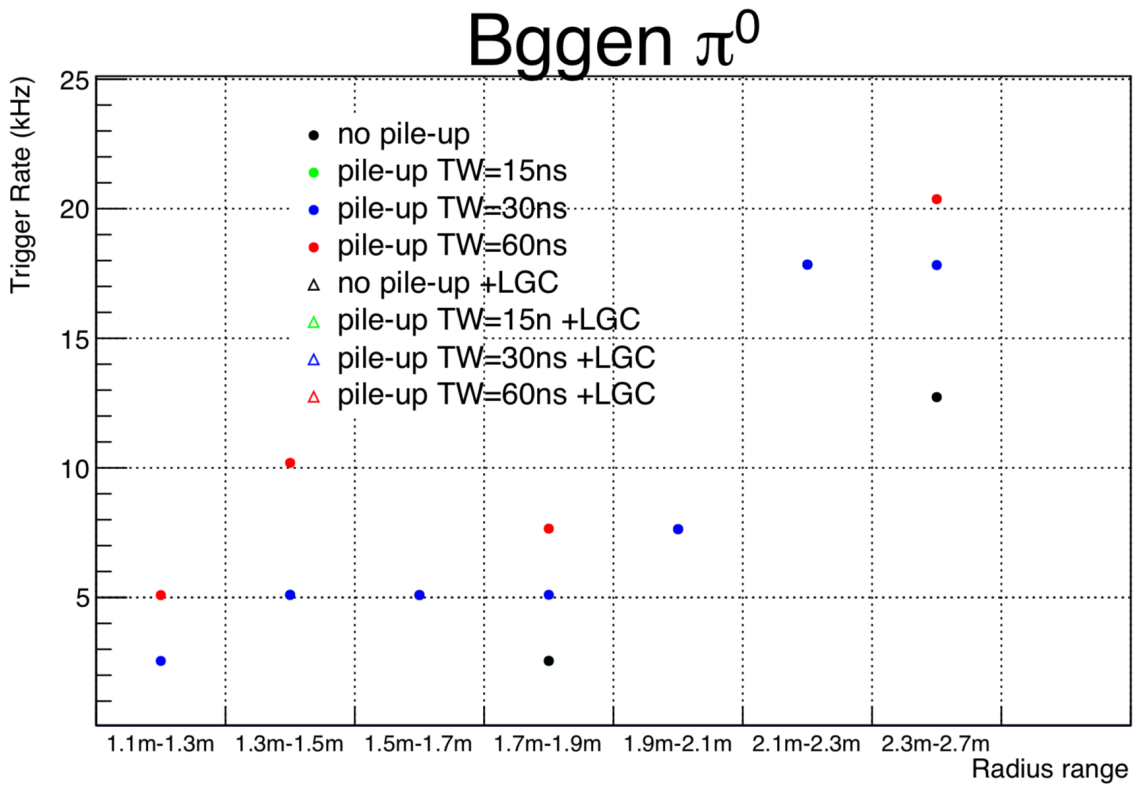
Radius(m)	6+1 Cluster Threshold (MeV) X_{jb}>0.35
1.1 – 1.3	**617.9**
1.3 – 1.5	**531.0**
1.5 – 1.7	**460.0**
1.7 – 1.9	**389.8**
1.9 – 2.1	**331.0**
2.1 – 2.3	**287.6**
2.3 – 2.7	**272.0**



PVDIS EC Online Trigger Rate with Pile-ups (kHz)

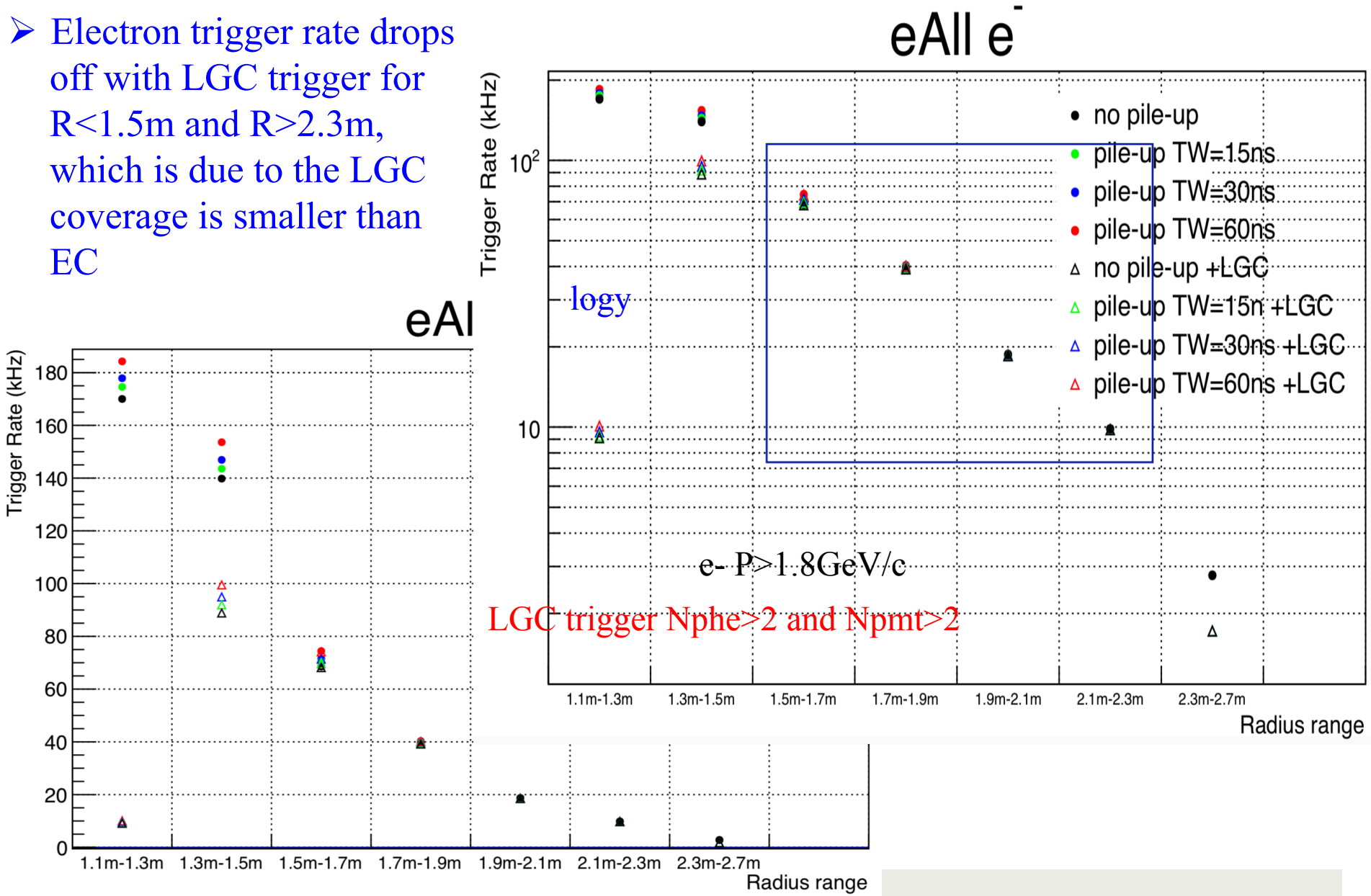


$\pi+$, π^0 rates are irrelevant

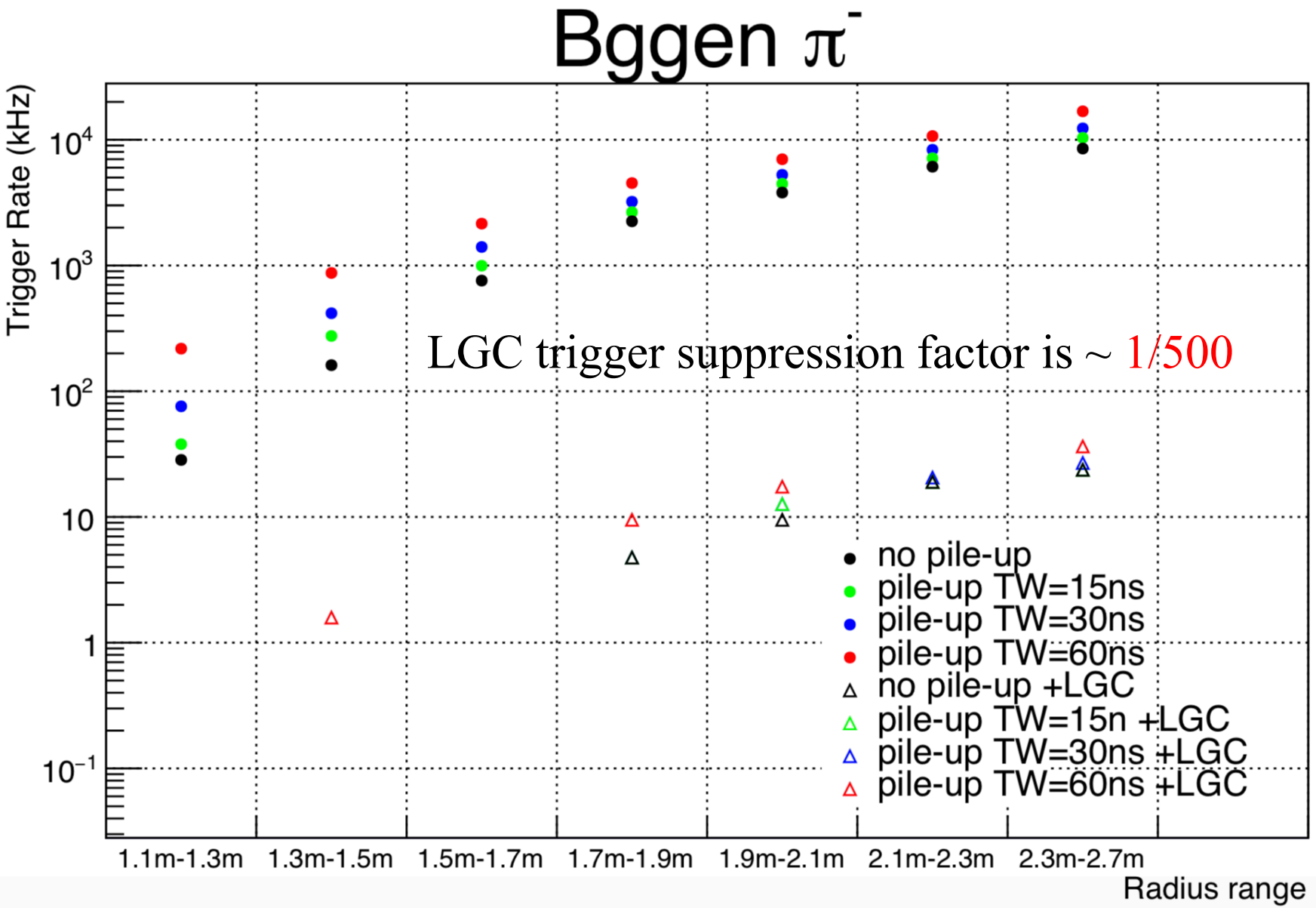


PVDIS EC +LGC Online Trigger Rate with Pile-ups (kHz)

- Electron trigger rate drops off with LGC trigger for R<1.5m and R>2.3m, which is due to the LGC coverage is smaller than EC



PVDIS EC+LGC Online Trigger Rate with Pile-ups (kHz)



	Trigger Rate EC (MHz)				Trigger Rate EC+LGC (MHz)			
	Without pile-up	With Pile-up 15ns	With pile-up 30ns	With Pile-up 60ns	Without pile-up	With Pile-up 15ns	With pile-up 30ns	With Pile-up 60ns
e^-	0.449	0.460	0.467	0.484	0.235	0.240	0.246	0.254
π^-	21.615	25.89	31.01	42.28	0.048	0.048	0.048	0.076
π^+	0.663	0.710	0.739	0.853	0.0095	0.0095	0.0095	0.0095
π^0	0.061	0.061	0.071	0.061	0.02	0.02	0.02	0.02
All pions	22.339	26.66	31.821	43.20	0.077	0.077	0.077	0.106

- electron with EC&LGC = 235 KHz = 7.8 KHz/sector=8.5kHz/sector @ 60ns TW
- pions with EC&LGC = 77KHz = 2.6 KHz/sector DAQ <15kHZ/sector
- total rate = (7.8+2.6)KHz/sector = 10.4KHz/sector
- = (12.1KHz/sector with pile-ups @ 60ns TW)

Some Thoughts about PVDIS trigger

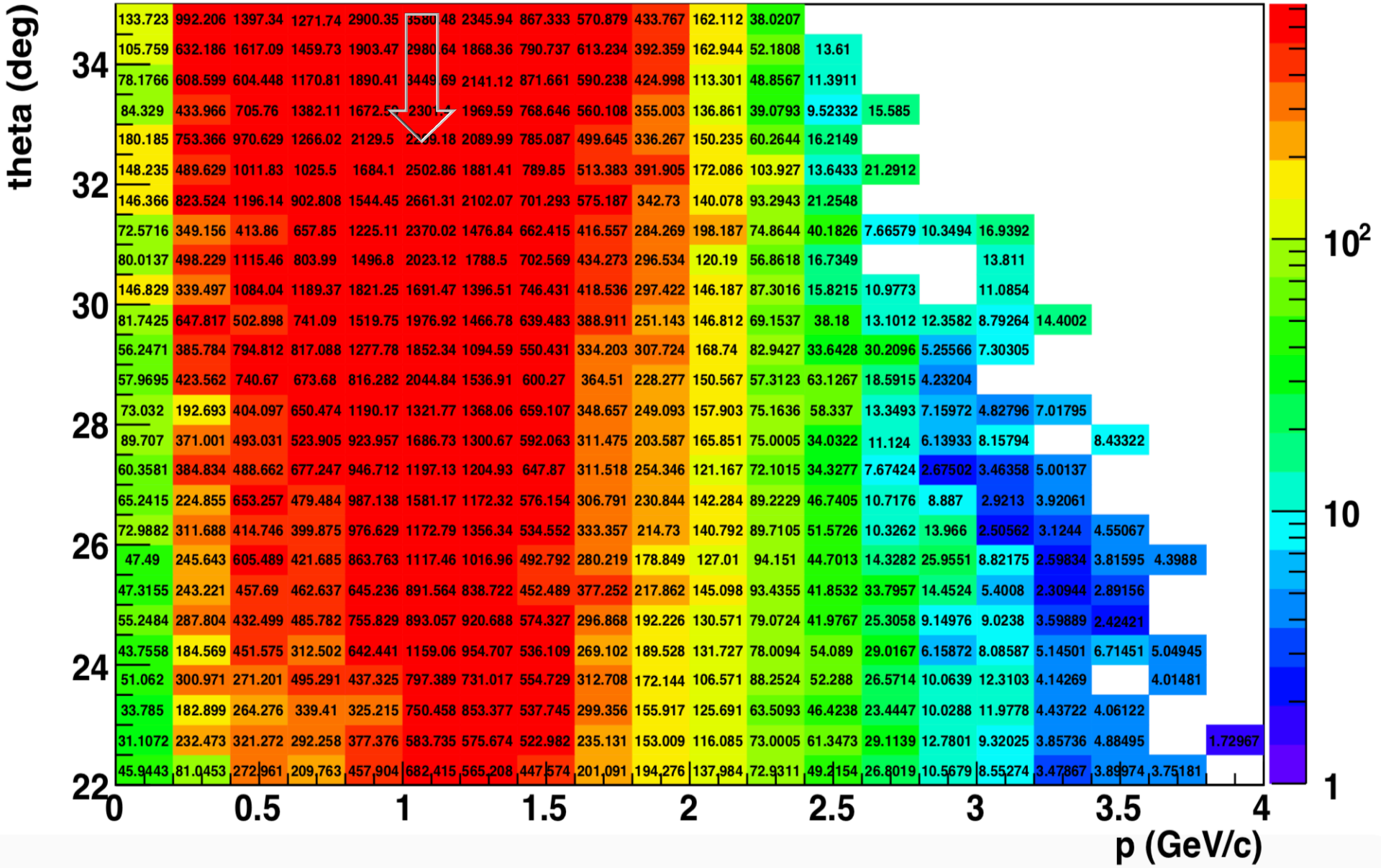
- π^- dominates the pile-ups
- LGC coverage is smaller than EC---purpose?
- DAQ can handle the trigger rates with pile-ups
- For large radius (R>2.3m), it triggers on π^- with very low e^- rates.

- Re-check the offline PID performance with the latest configuration and simulation events.
- If we need to increase the EC trigger threshold to eliminate the pion backgrounds at R>2.3m, we have to study the physics influence on loosing high X_{jb} electrons.

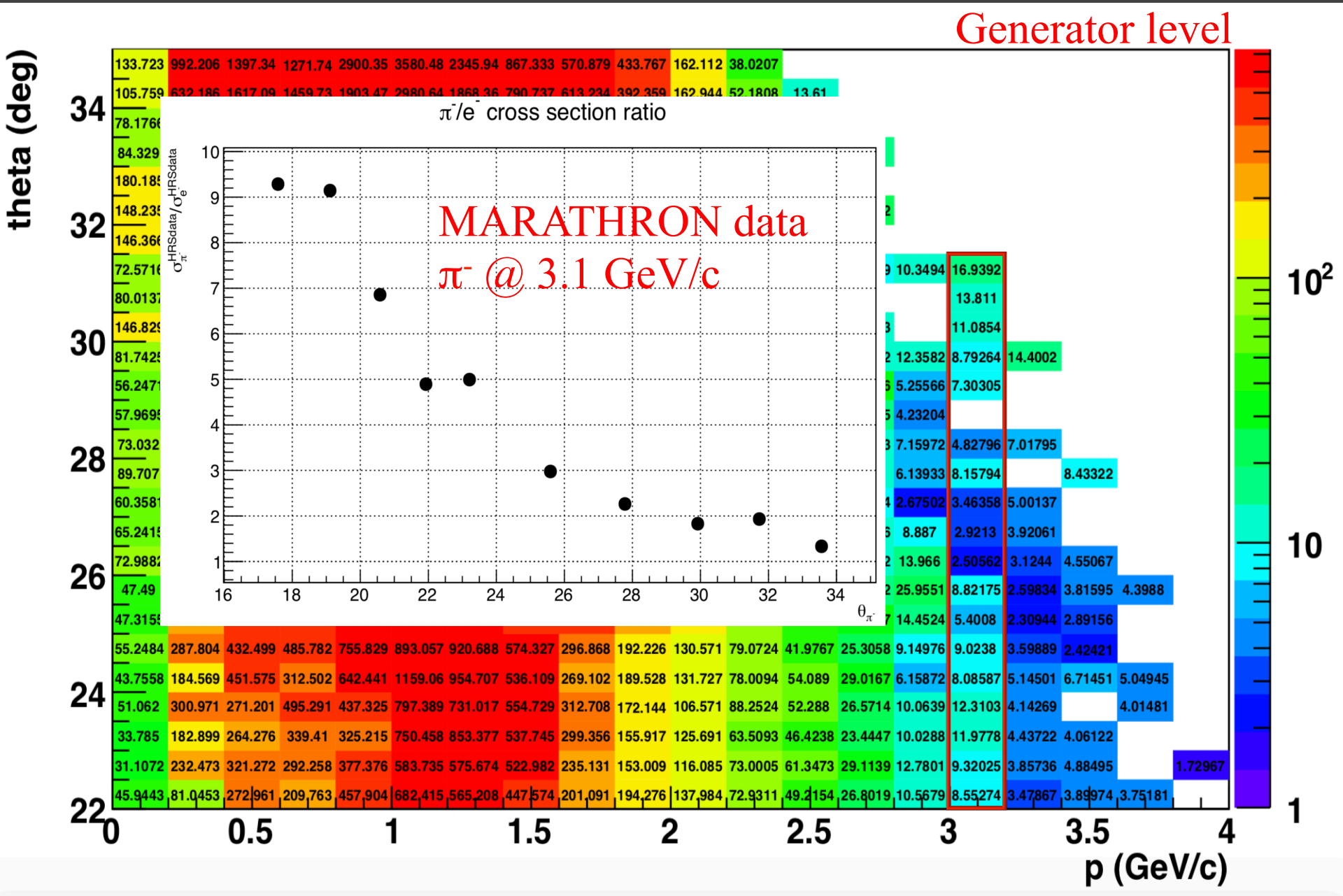
π−/e- Ratio

Larger radius----trigger on low momentum π^-

Generator level

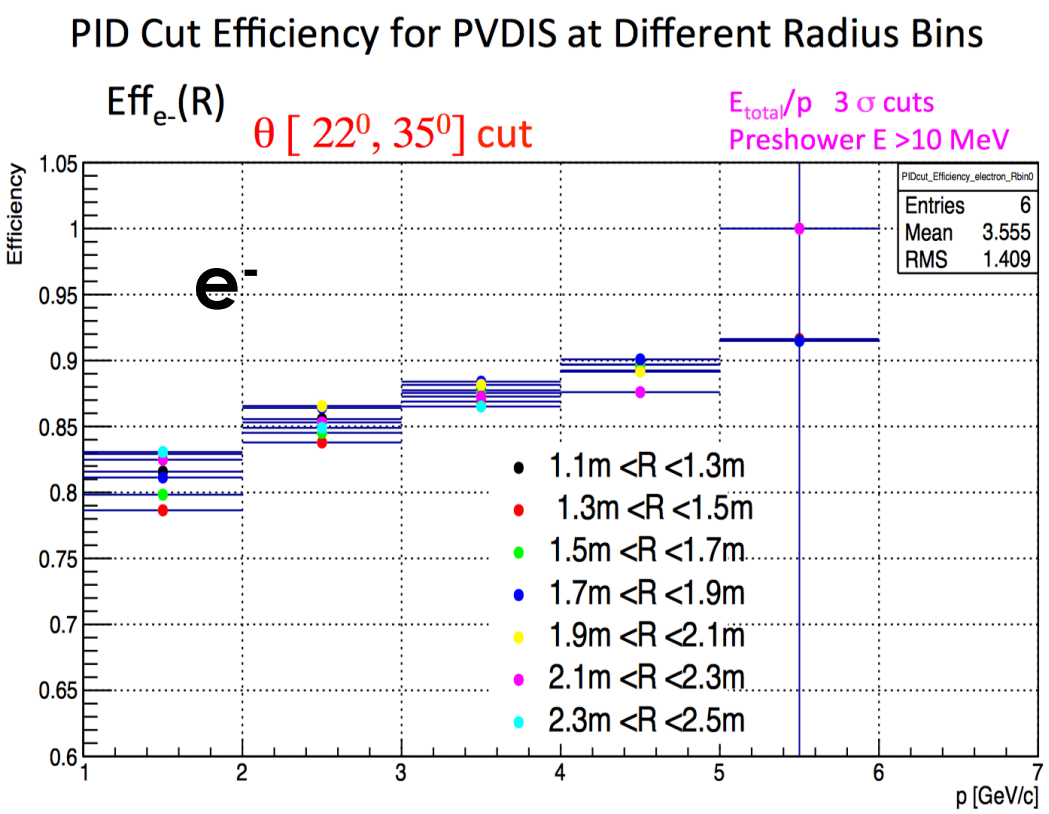


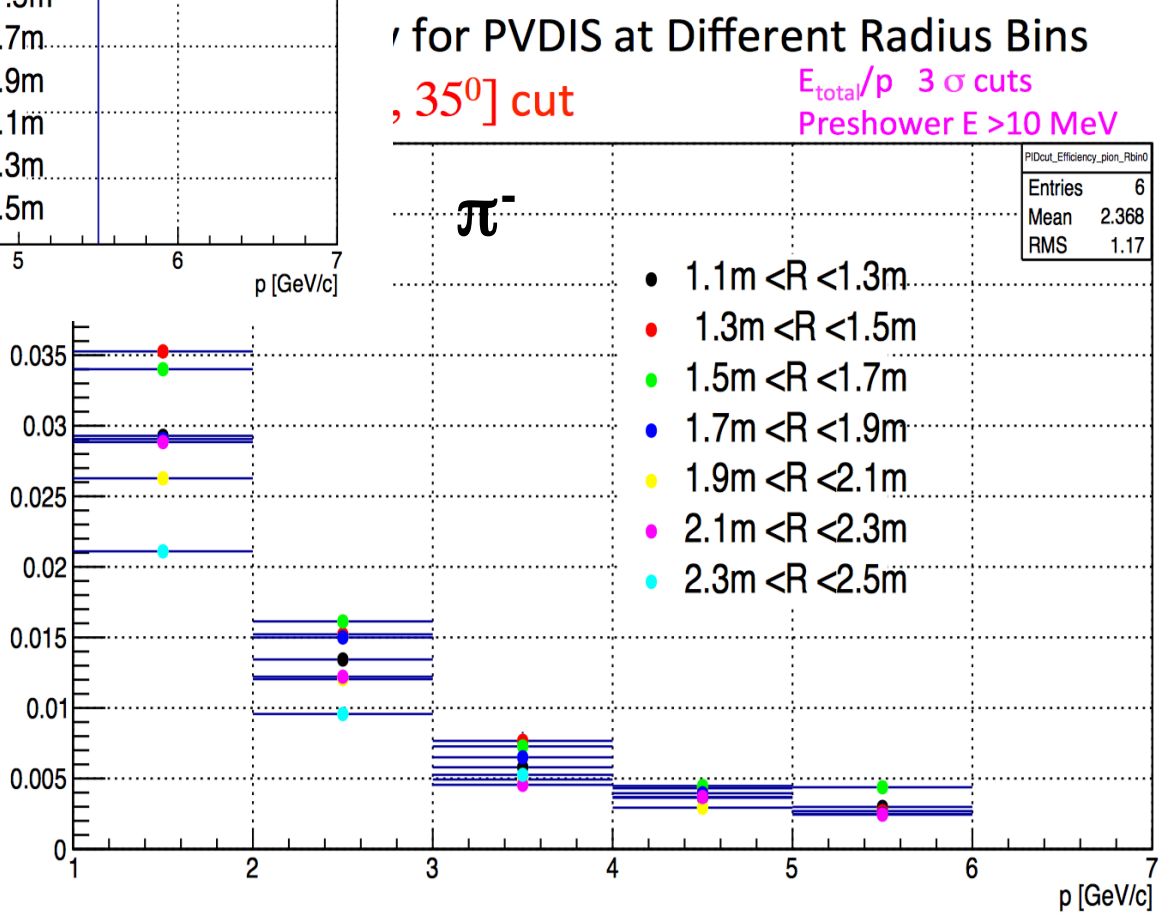
π−/e- Ratio


Generator level
theta (deg)
p (GeV/c)
π⁻/e⁻ cross section ratio
MARATHRON data
π⁻ @ 3.1 GeV/c

Old PID offline study ----no pile-ups

The ability of EC to seperate e- and π- offline





e- and π- are evenly distributed based on the geant4 simulation.

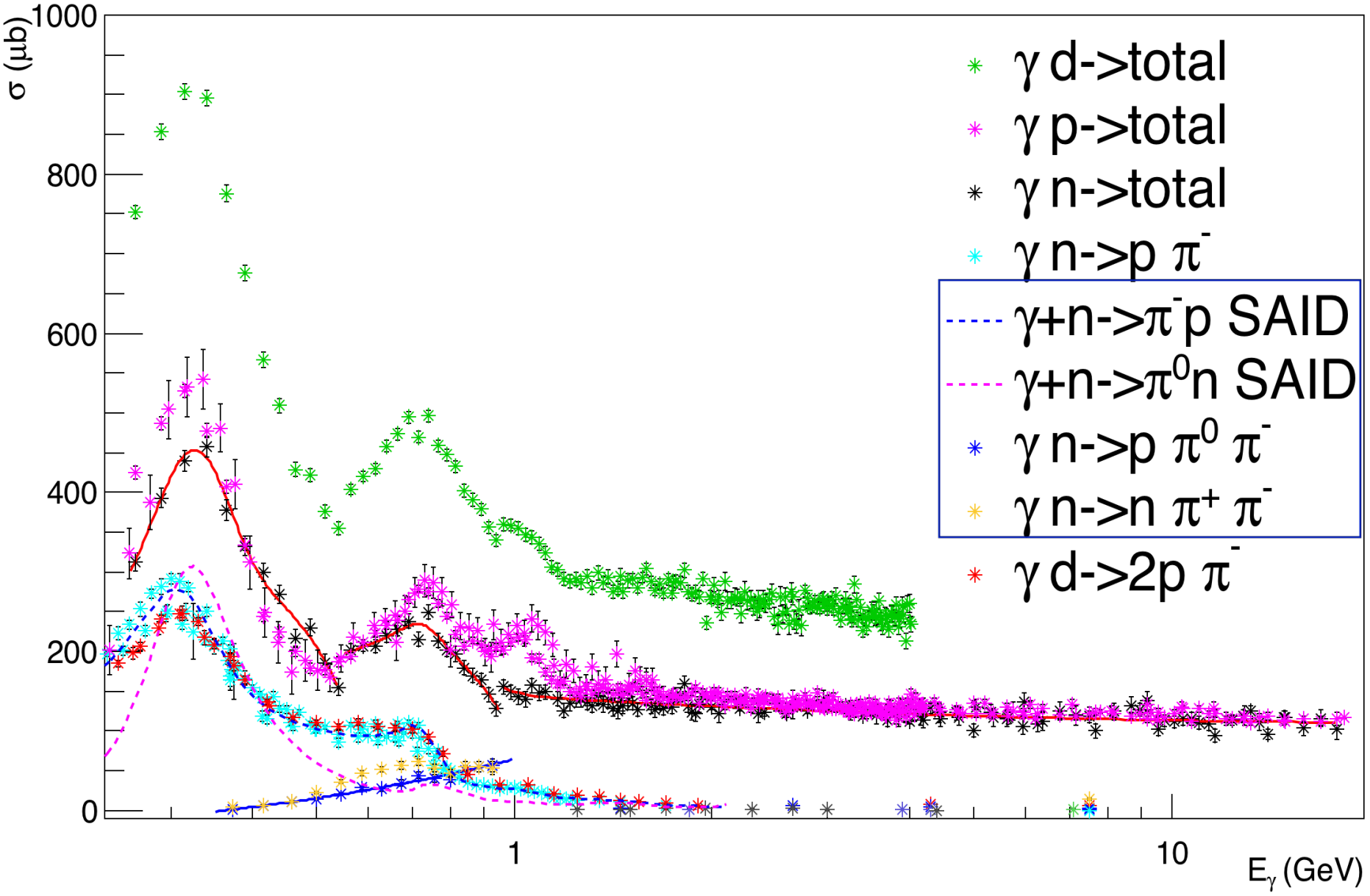
- vacuum
- EC only

Summary

- PVDIS trigger rate with pile-ups is under DAQ limit 15kHZ/sector.
- On the trigger level, the pile-ups mostly affect the larger radius.
- Need to understand the π^-/e^- ratio @ the larger radius by consider the trigger condition
- The document of this study is under preparing, and will be uploaded to SoLID DocDB.

Thanks!

Back up



Baldini, A., Flaminio, V., Moorhead, W.G., & Morrison, D.R.O. Schopper, H. (Ed.). (1988). Total cross-sections for reactions of high energy particles (including elastic, topological, inclusive and exclusive reactions) Subvol b. Germany:

- E<3GeV

$\gamma + n \rightarrow \pi^- p$ SAID
$\gamma + n \rightarrow \pi^0 n$ SAID
$\gamma\, n \rightarrow p\, \pi^0\, \pi^-$
$\gamma\, n \rightarrow n\, \pi^+\, \pi^-$

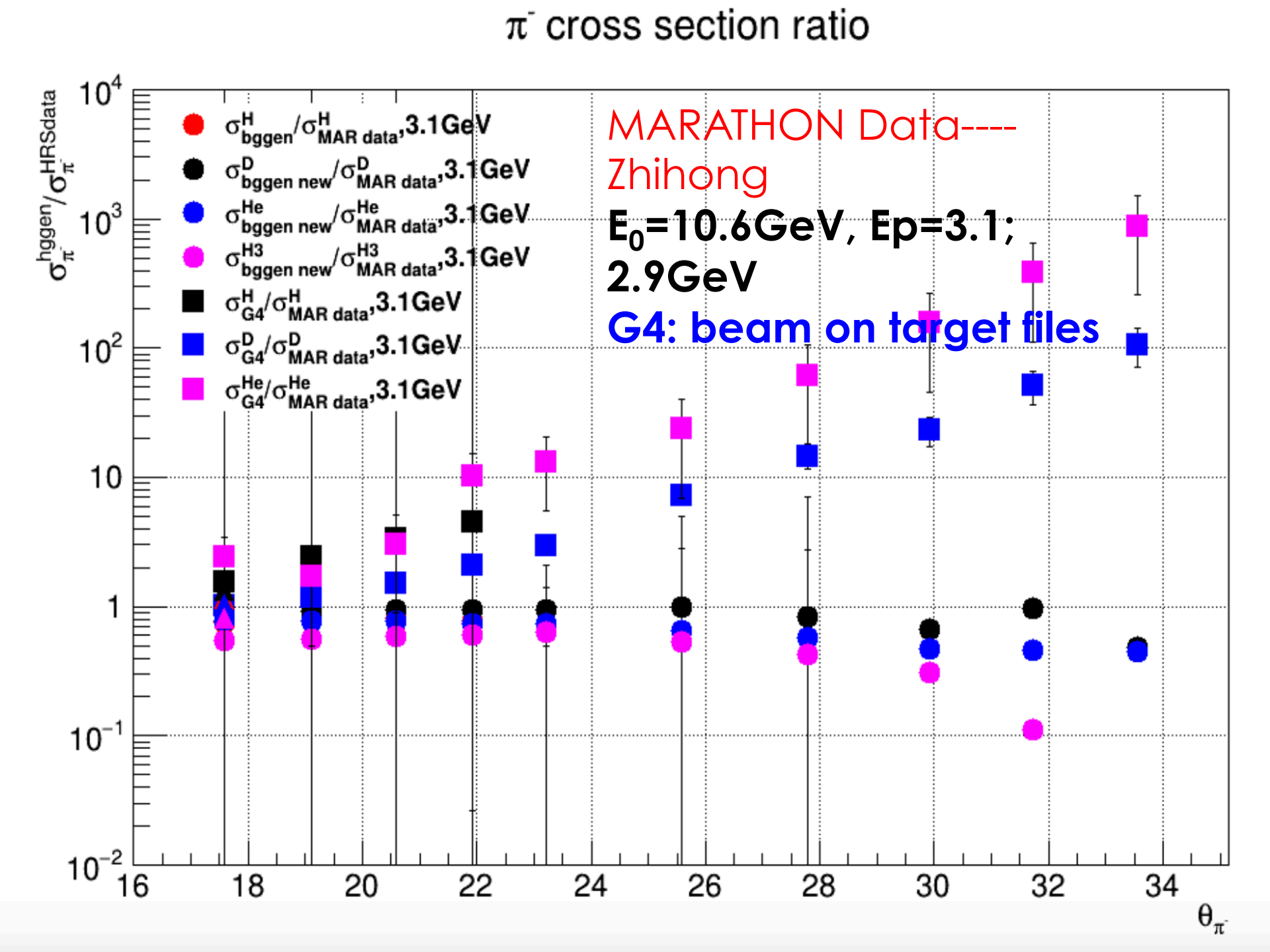
E>3GeV --PYTHIA

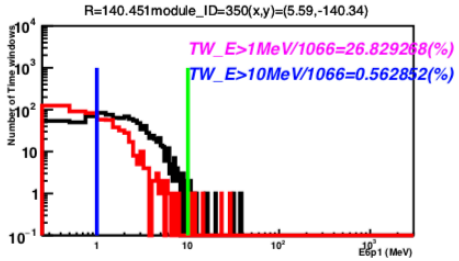
can use protons and neutrons for the target, and can be adapted to a light nuclear target by hand

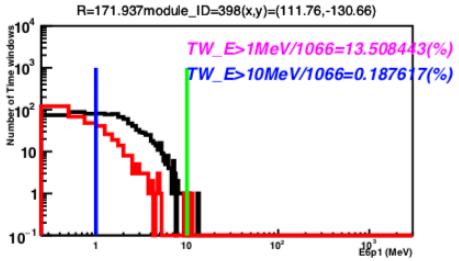
- Provide the right mixture of interactions with protons and neutrons (approximately the same cross section)--- easy
- Apply the Fermi motion, or the nucleons spectral functions --- relatively easy
- Consider re-scattering - it may be small or unimportant--- not easy

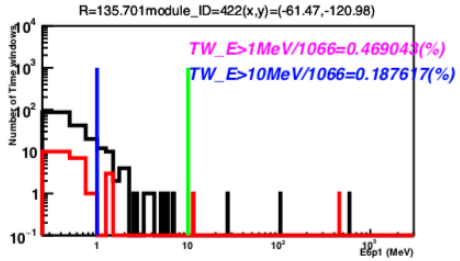
----program FRITIOF

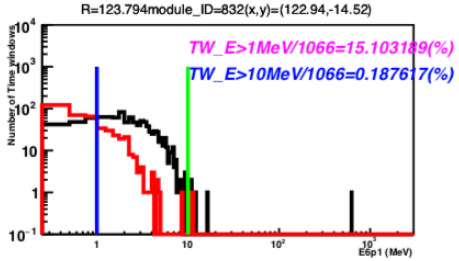
A word of caution: bggen (and PYTHIA in particular) can be used to describe a bulk
of the the photoproduced final states, but can hardly predict properly ra
events

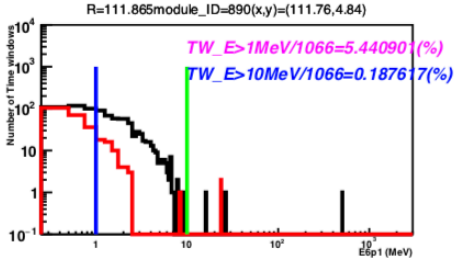

π⁻ cross section ratio
$\sigma^{hggen}_{\pi^-}/\sigma^{HRSdata}_{\pi^-}$
$\sigma^{H}_{bggen}/\sigma^{H}_{MAR\ data}$,3.1GeV
$\sigma^{D}_{bggen\ new}/\sigma^{D}_{MAR\ data}$,3.1GeV
$\sigma^{He}_{bggen\ new}/\sigma^{He}_{MAR\ data}$,3.1GeV
$\sigma^{H3}_{bggen\ new}/\sigma^{H3}_{MAR\ data}$,3.1GeV
$\sigma^{H}_{G4}/\sigma^{H}_{MAR\ data}$,3.1GeV
$\sigma^{D}_{G4}/\sigma^{D}_{MAR\ data}$,3.1GeV
$\sigma^{He}_{G4}/\sigma^{He}_{MAR\ data}$,3.1GeV
MARATHON Data----Zhihong
E_0=10.6GeV, Ep=3.1; 2.9GeV
G4: beam on target files
10^4
10^3
10^2
10
1
10^{-1}
10^{-2}
16
18
20
22
24
26
28
30
32
34
θ_{π^-}

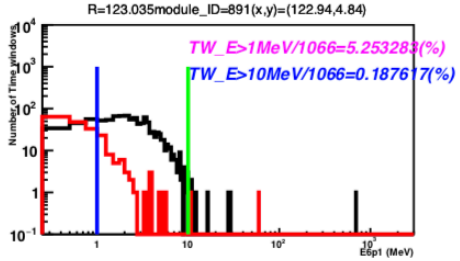

R=140.451module_ID=350(x,y)=(5.59,-140.34)
TW_E>1MeV/1066=26.829268(%)
TW_E>10MeV/1066=0.562852(%)
Number of Time windows
Eep1 (MeV)

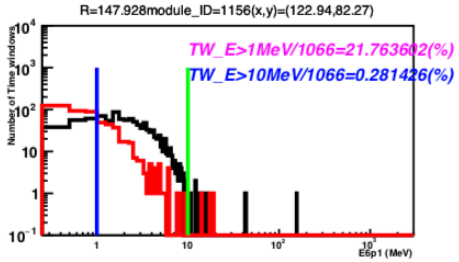

R=171.937module_ID=398(x,y)=(111.76,-130.66)
TW_E>1MeV/1066=13.508443(%)
TW_E>10MeV/1066=0.187617(%)
Number of Time windows
Eep1 (MeV)

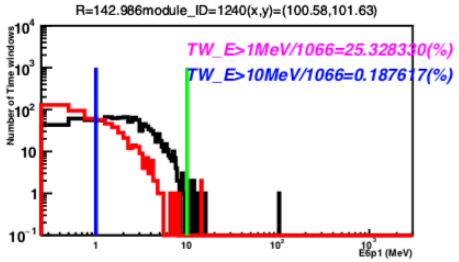

R=135.701module_ID=422(x,y)=(-61.47,-120.98)
TW_E>1MeV/1066=0.469043(%)
TW_E>10MeV/1066=0.187617(%)
Number of Time windows
Eep1 (MeV)

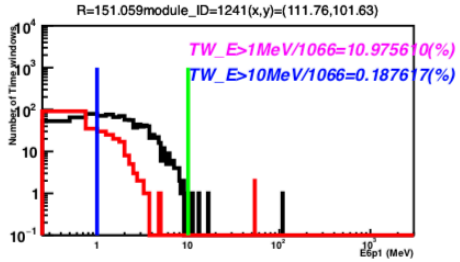

R=123.794module_ID=832(x,y)=(122.94,-14.52)
TW_E>1MeV/1066=15.103189(%)
TW_E>10MeV/1066=0.187617(%)
Number of Time windows
Eep1 (MeV)

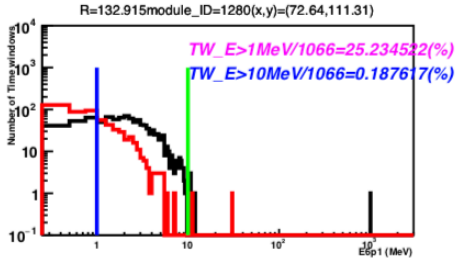

R=111.865module_ID=890(x,y)=(111.76,4.84)
TW_E>1MeV/1066=5.440901(%)
TW_E>10MeV/1066=0.187617(%)
Number of Time windows
Eep1 (MeV)

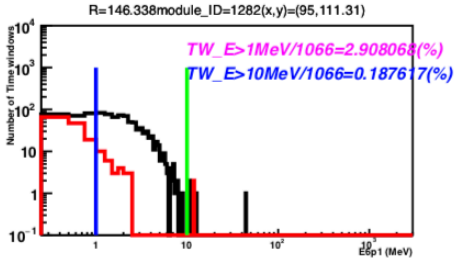

R=123.035module_ID=891(x,y)=(122.94,4.84)
TW_E>1MeV/1066=5.253283(%)
TW_E>10MeV/1066=0.187617(%)
Number of Time windows
Eep1 (MeV)

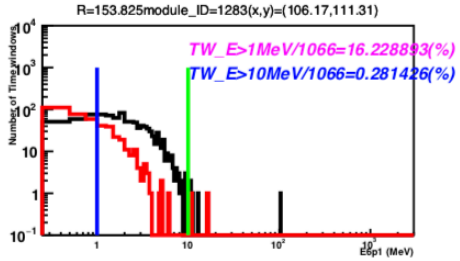

R=147.928module_ID=1156(x,y)=(122.94,82.27)
TW_E>1MeV/1066=21.763602(%)
TW_E>10MeV/1066=0.281426(%)
Number of Time windows
Eep1 (MeV)

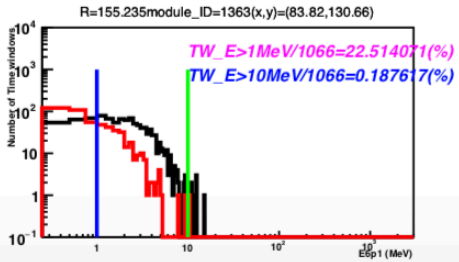

R=142.986module_ID=1240(x,y)=(100.58,101.63)
TW_E>1MeV/1066=25.328330(%)
TW_E>10MeV/1066=0.187617(%)
Number of Time windows
Eep1 (MeV)

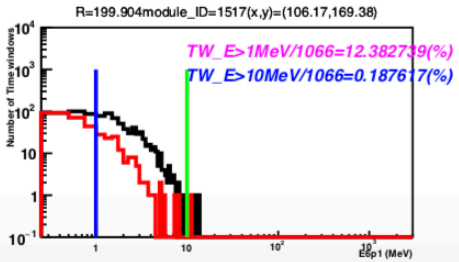

R=151.059module_ID=1241(x,y)=(111.76,101.63)
TW_E>1MeV/1066=10.975610(%)
TW_E>10MeV/1066=0.187617(%)
Number of Time windows
Eep1 (MeV)


R=132.915module_ID=1280(x,y)=(72.64,111.31)
TW_E>1MeV/1066=25.234522(%)
TW_E>10MeV/1066=0.187617(%)
Number of Time windows
Eep1 (MeV)

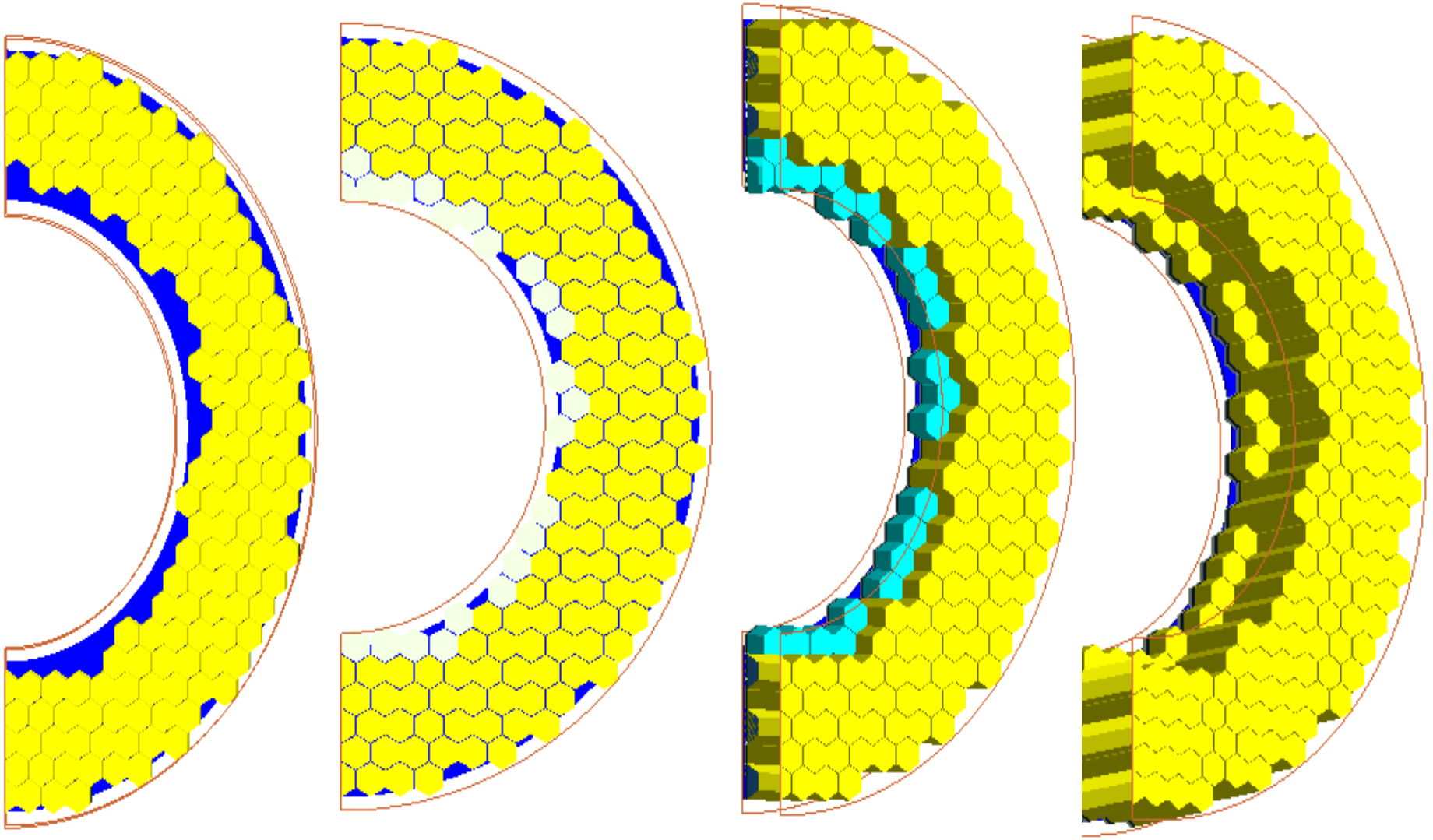

R=146.338module_ID=1282(x,y)=(95,111.31)
TW_E>1MeV/1066=2.908068(%)
TW_E>10MeV/1066=0.187617(%)
Number of Time windows
Eep1 (MeV)


R=153.825module_ID=1283(x,y)=(106.17,111.31)
TW_E>1MeV/1066=16.228893(%)
TW_E>10MeV/1066=0.281426(%)
Number of Time windows
Eep1 (MeV)


R=155.235module_ID=1363(x,y)=(83.82,130.66)
TW_E>1MeV/1066=22.514071(%)
TW_E>10MeV/1066=0.187617(%)
Number of Time windows
Eep1 (MeV)


R=199.904module_ID=1517(x,y)=(106.17,169.38)
TW_E>1MeV/1066=12.382739(%)
TW_E>10MeV/1066=0.187617(%)
Number of Time windows
Eep1 (MeV)

LAEC 1748 modules

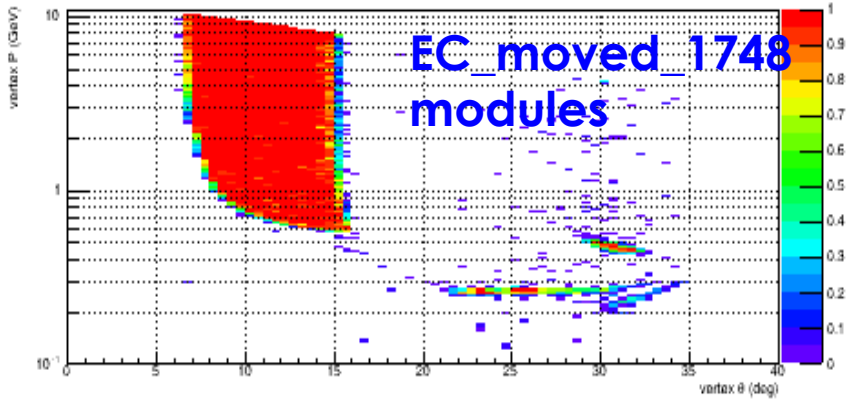


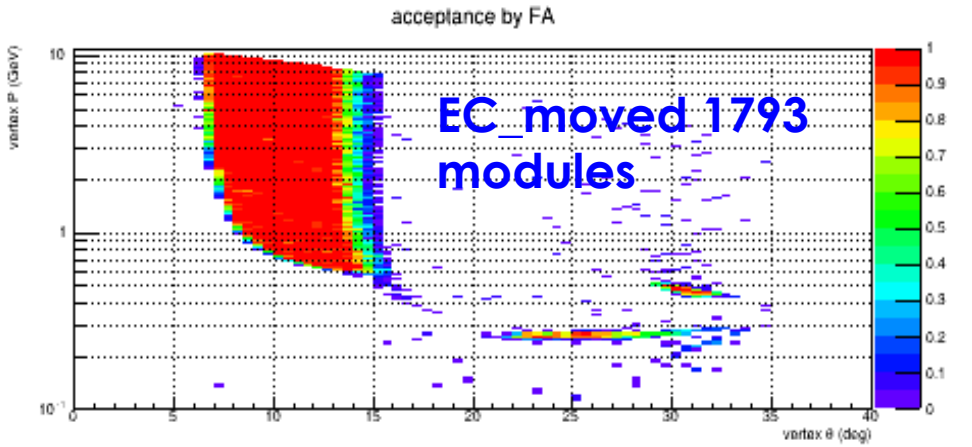
+Al and pre-scintillator
45 inner modules

+1/2 length
45 inner modules

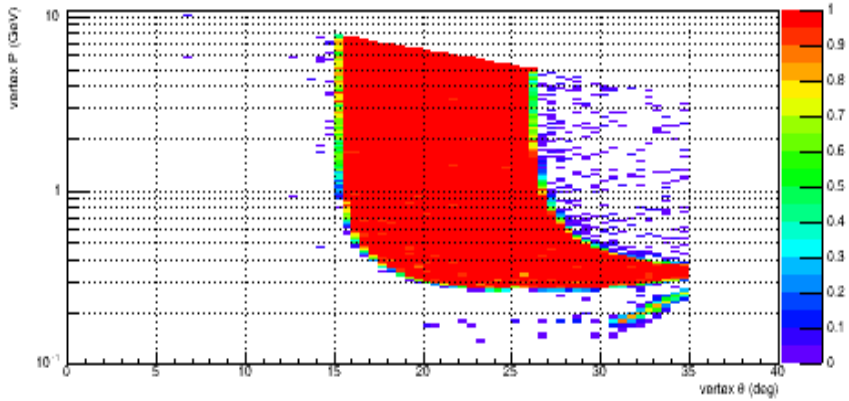
+1/4 length
45 inner modules

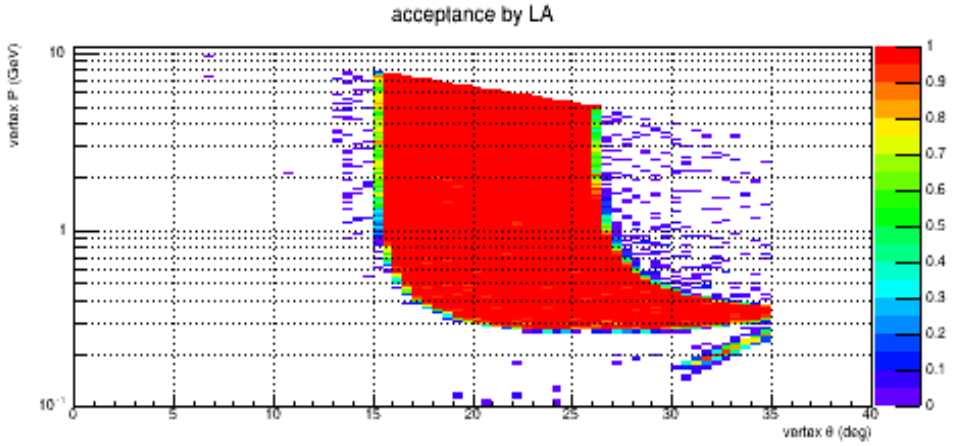
FA



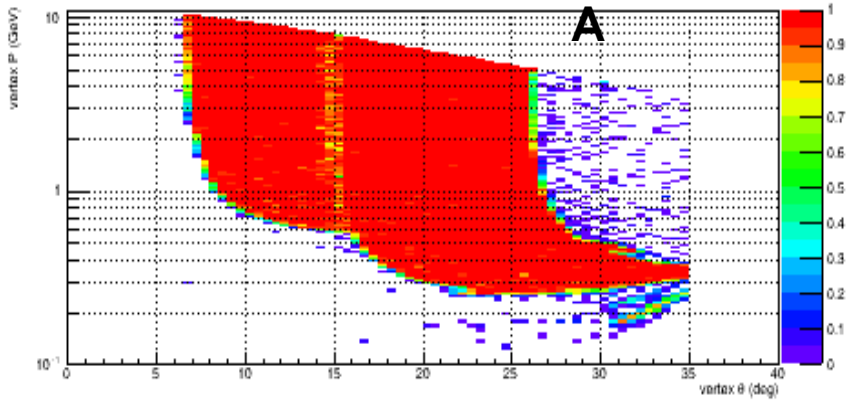


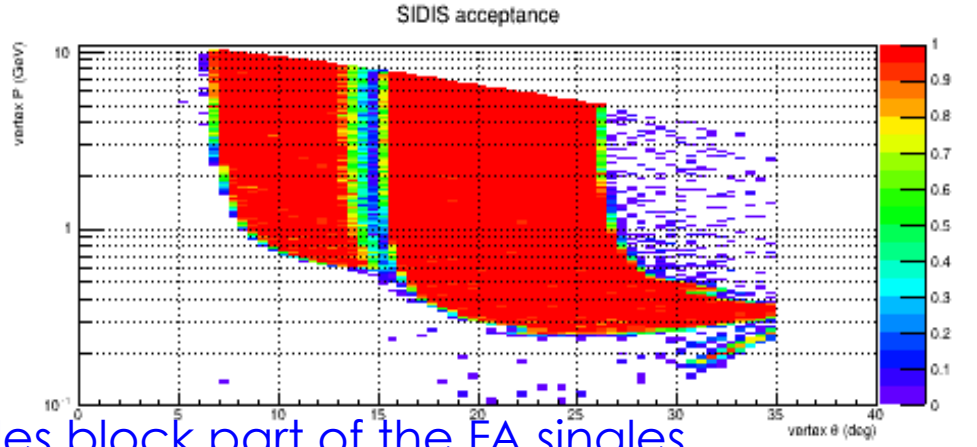
LA





LA+FA





Additional whole modules block part of the FA singles.

Preshower 10MeV cut	1748 modules	1748+45 preshowers	1793	1748+45modules 1/4 length	1748+45modules 1/2 length
e-	14%	65%	60%	61%	62%
π^-	20%	18%	24%	23%	24%

Etotal cut	1748 modules	1748+45 preshowers	1793	1748+45modules 1/4 length	1748+45modules 1/2 length
e-	22%	26%	86%	27%	50%
π^-	0.3%	0.086%	0.82%	0.46%	0.17%

Compare with Previous Resutls

P>1 GeV------current			
(MHz)	Total Rate	Trigger Rate	Trigger Rate with pile-up 30ns
eAll e^-	0.6	0.449	
π^-	124.0	2.711	3.261
π^+	2.872	0.01	0.076

Previous	P > 1 GeV	
PID	Total Rate (MHz)	Trigger Rate (MHz)
Pi-	85.971	4.539
Pi+	11.377	0.328
DIS	0.437	0.26
Total ECAL Trigger		5.127