SHMS Scintillator Paddles Acceptance Study: Part 3 Using H(e, e'p) Elastics SIMULATION

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JUNE 07, 2022

PURPOSE OF STUDY:

- Use SIMC (modified by Mark Jones) to turn OFF SHMS S1X and S2X paddles corresponding to SHMS momentum acceptance < +5% and study the H(e,e'p) rates with these paddles turned OFF.

- Turning OFF paddles outside the SHMS momentum acceptance (+5,+20)% will make the potentially high SHMS rates more manageable, as SHMS (e-) will be stationed at very low angles (6.8, 8.3) deg

Example of parameter INPUT to select which paddles to USE:

```
begin parm e_arm_accept
  SPedge%e%delta%min = -15.0   ;  delta min (SPECTROMETER ACCEPTANCE!)
  SPedge%e%delta%max =  25.0   ;  delta max
  SPedge%e%yptar%min = -100.0  ;  yptar min = {TF} / 1000 (mrad)
  SPedge%e%yptar%max =  100.0  ;  yptar max = {TF} / 1000
  SPedge%e%xptar%min = -100.0  ;  xptar min = {TF} / 1000 (mrad)
  SPedge%e%xptar%max =  100.0  ;  xptar max = {TF} / 1000
  shms_pad_1x_lo_num = 1
  shms_pad_1x_hi_num = 13
  shms_pad_2x_lo_num = 1
  shms_pad_2x_hi_num = 14
```

ALL PADDLES ON

```
begin parm e_arm_accept
  SPedge%e%delta%min = -15.0   ;  delta min (SPECTROMETER ACCEPTANCE!)
  SPedge%e%delta%max =  25.0   ;  delta max
  SPedge%e%yptar%min = -100.0  ;  yptar min = {TF} / 1000 (mrad)
  SPedge%e%yptar%max =  100.0  ;  yptar max = {TF} / 1000
  SPedge%e%xptar%min = -100.0  ;  xptar min = {TF} / 1000 (mrad)
  SPedge%e%xptar%max =  100.0  ;  xptar max = {TF} / 1000
  shms_pad_1x_lo_num = 1
  shms_pad_1x_hi_num = 6
  shms_pad_2x_lo_num = 1
  shms_pad_2x_hi_num = 6
```

TURN PADDLES > 6 OFF

- study heep_kin0

a) leave all paddles ON
b) turn S1X,S2X paddles 1-6 OFF
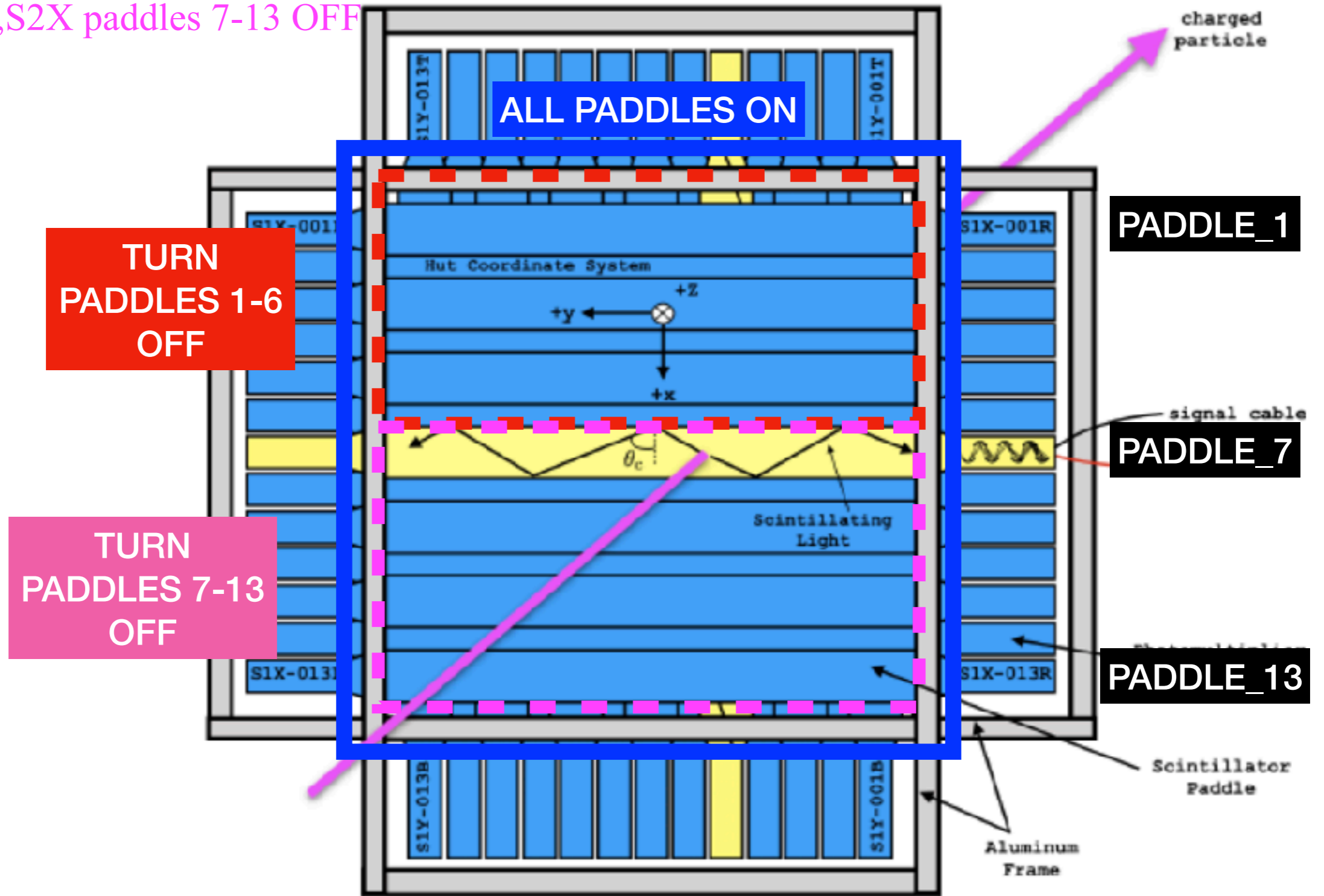c) turn S1X,S2X paddles 7-13 OFF

ALL PADDLES ON

TURN PADDLES 1-6 OFF

TURN PADDLES 7-13 OFF

PADDLE_1

PADDLE_7

PADDLE_13

charged particle

signal cable

Scintillating Light

Scintillator Paddle

Aluminum Frame

Hut Coordinate System

+Z

+y

+x

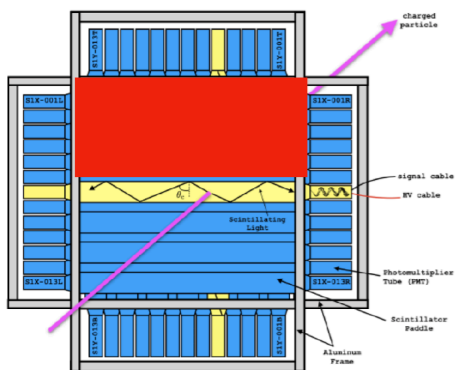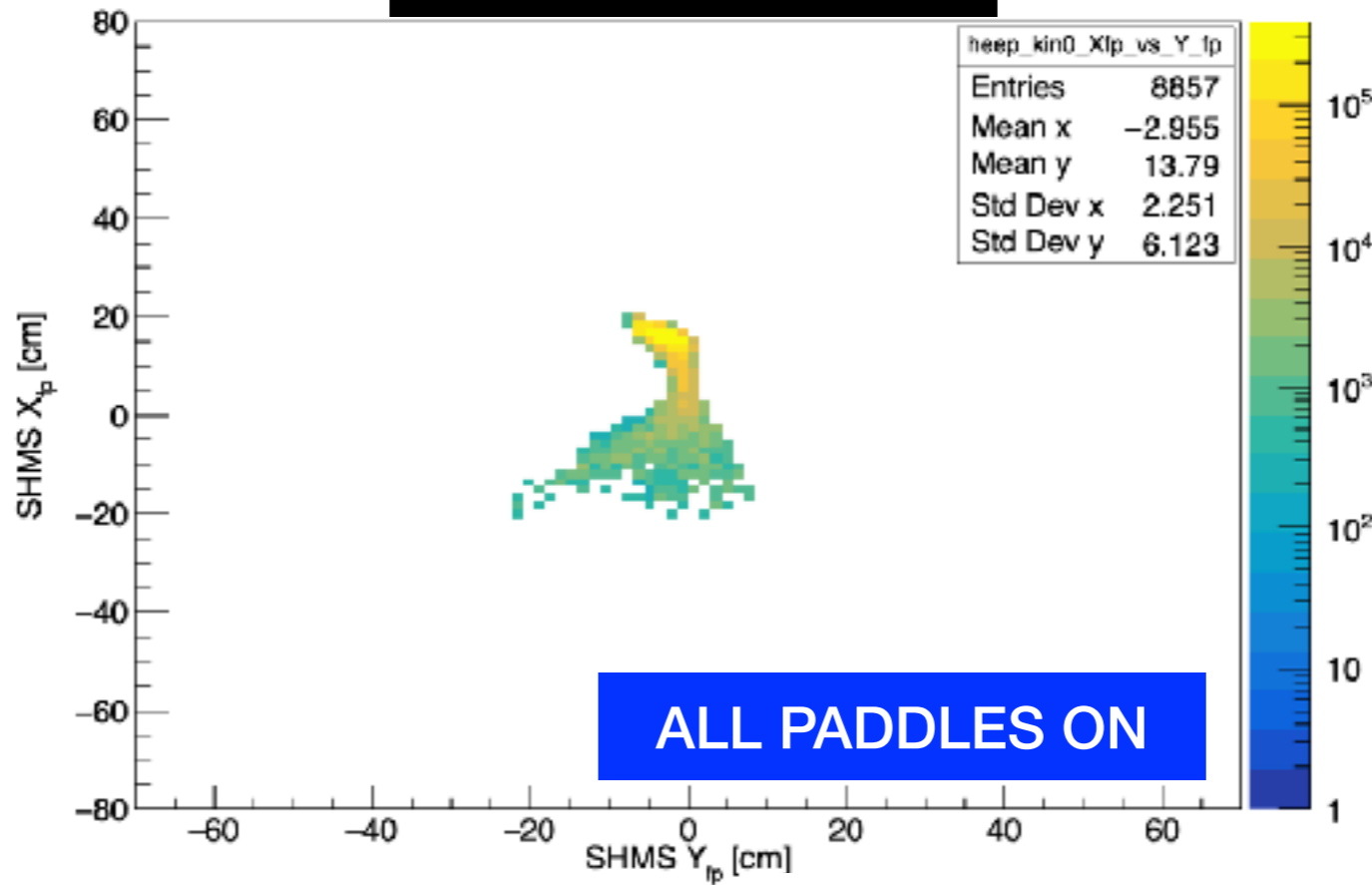Figure 3.26: Front view of the SHMS S1X (front) and S1Y (back) hodoscope planes.

SHMS Xfp_vs_Yfp

ALL PADDLES ON

heep_kin0_Xfp_vs_Y_fp	
Entries	8857
Mean x	−2.955
Mean y	13.79
Std Dev x	2.251
Std Dev y	6.123

heep_kin0_Xfp_vs_Y_fp	
Entries	8983
Mean x	−2.914
Mean y	14.51
Std Dev x	1.939
Std Dev y	4.465

TURN PADDLES 1-6 OFF

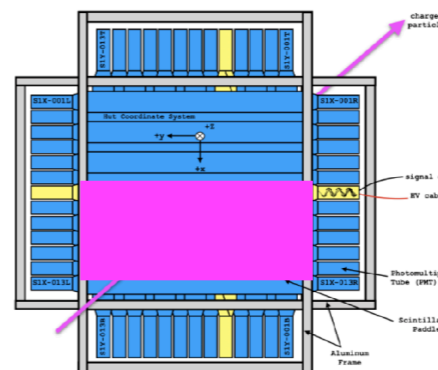| heep_kin0_Xfp_vs_Y_fp	
Entries	6947
Mean x	−4.155
Mean y	−9.394
Std Dev x	6.239
Std Dev y	4.243

TURN PADDLES 7-13 OFF

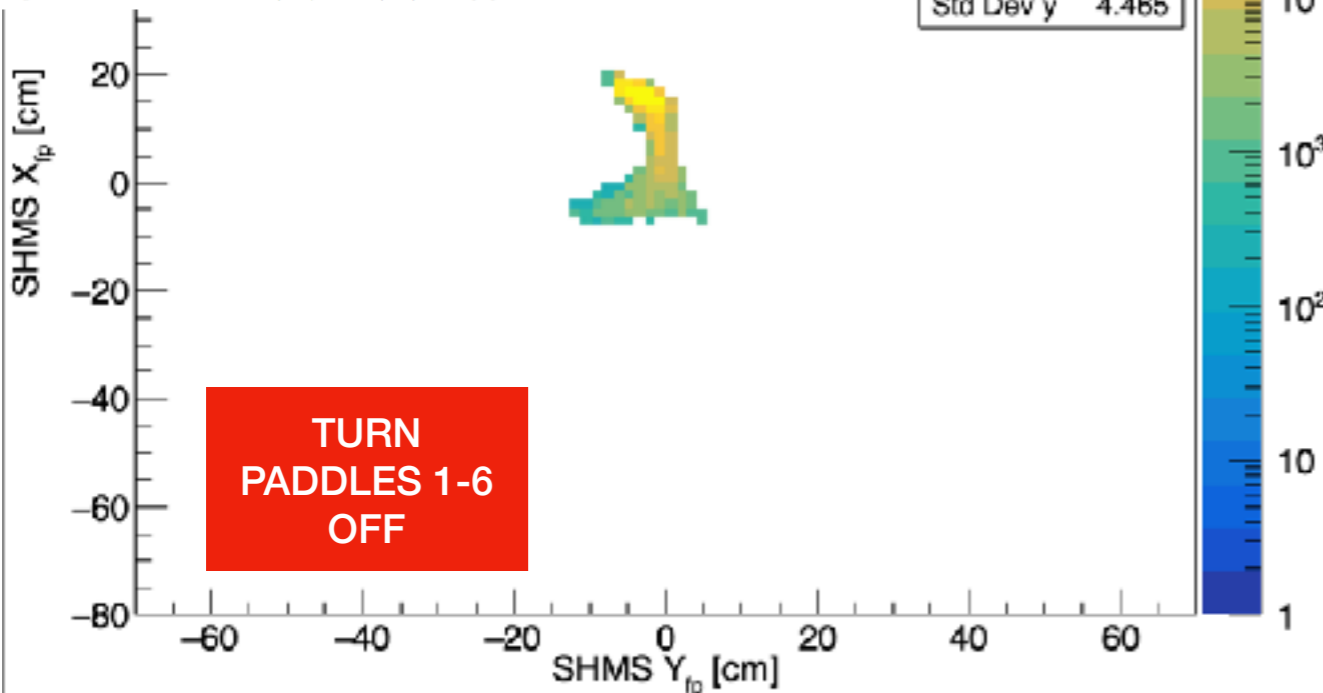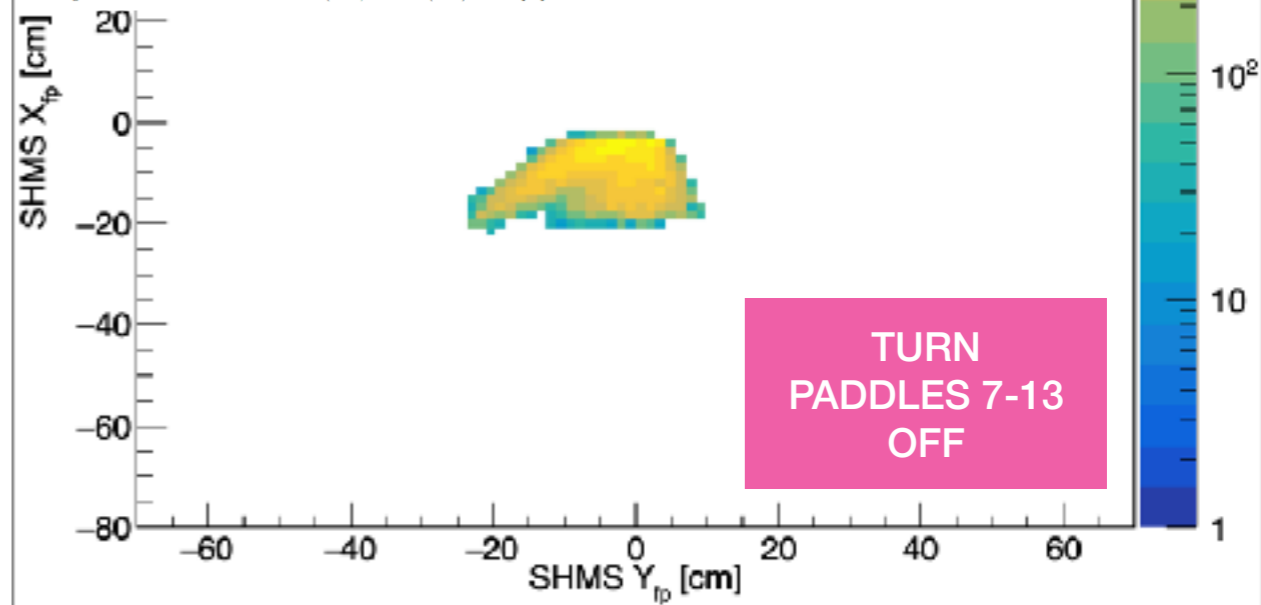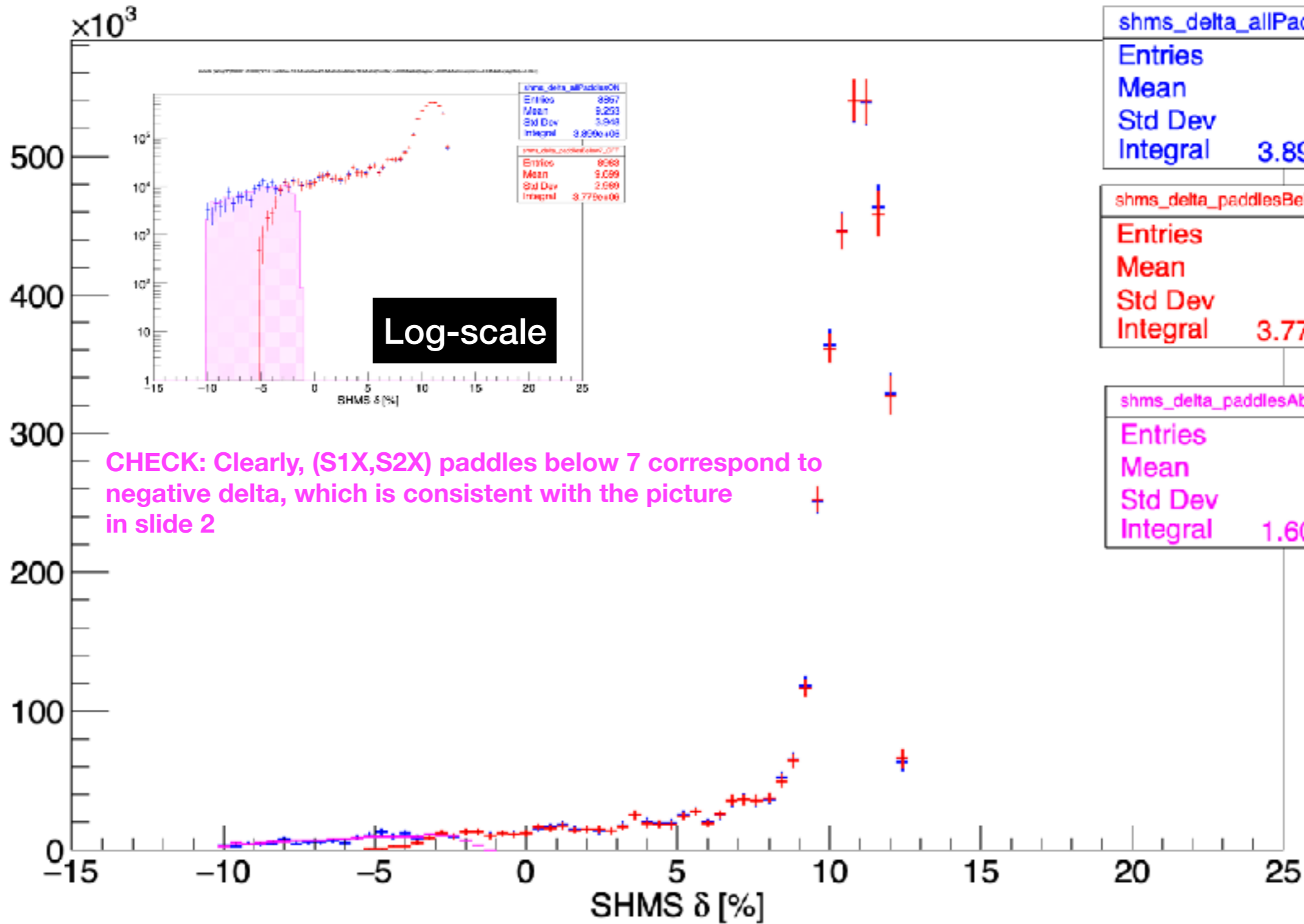Figure 3.26: Front view of the SHMS S1X (front) and S1Y (back) hodoscope planes.

SHMS Momentum Acceptance

ssdelta {'Weight'*(890001./10000)*216.*(ssdelta>-10.6&&ssdelta<22.&&abs(hsdelta)<10.6&&abs(hsxptar)<=0.08&&abs(hsyptar)<0.035&&abs(ssxptar)<=0.04&&abs(ssyptar)<=0.024)}
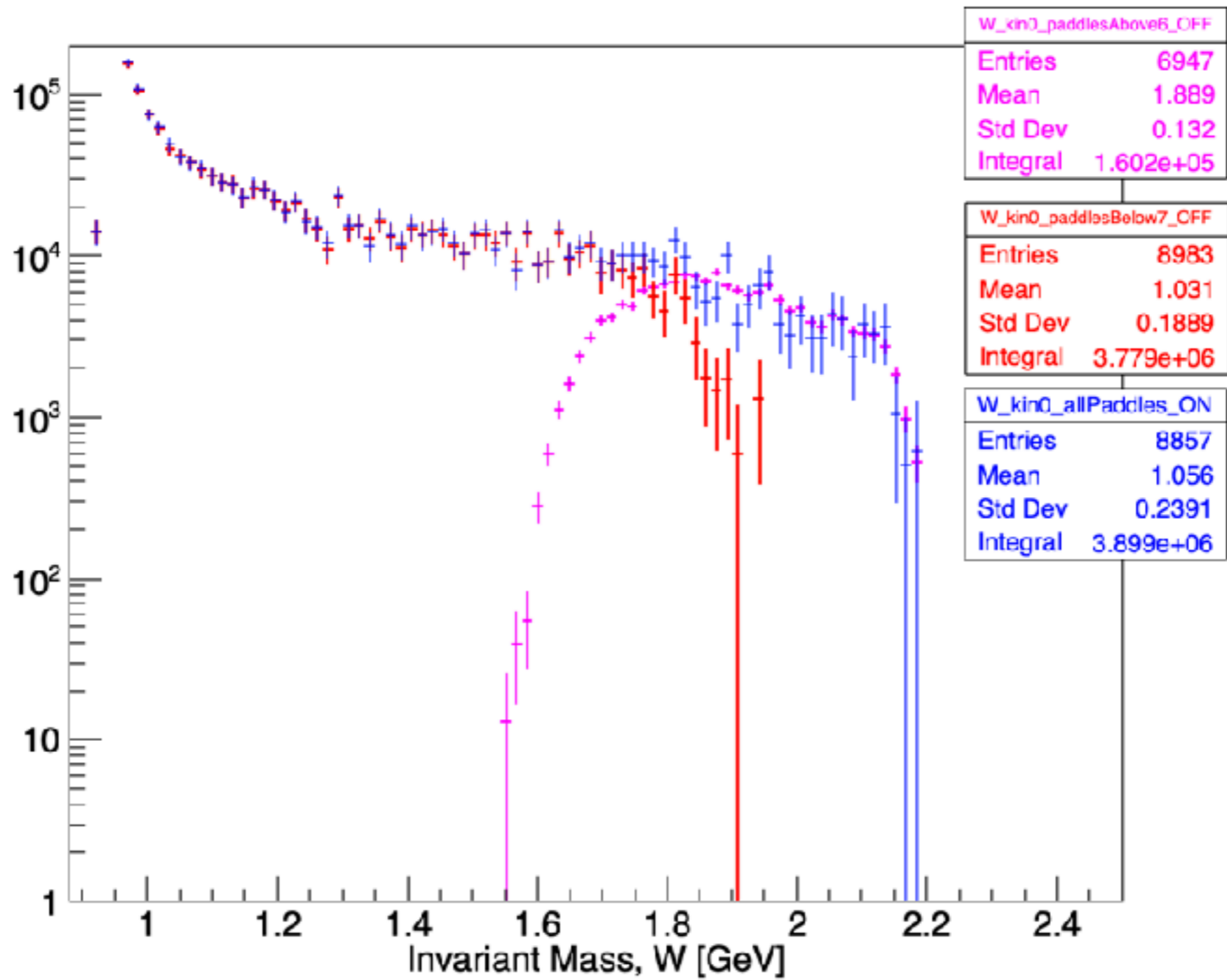
Log-scale

CHECK: Clearly, (S1X,S2X) paddles below 7 correspond to negative delta, which is consistent with the picture in slide 2

shms_delta_allPaddlesON	
Entries	8857
Mean	9.253
Std Dev	3.948
Integral	3.899e+06

shms_delta_paddlesBelow7_OFF	
Entries	8983
Mean	9.699
Std Dev	2.989
Integral	3.779e+06

shms_delta_paddlesAbove6_OFF	
Entries	6947
Mean	−5.28
Std Dev	2.253
Integral	1.602e+05

SHMS δ [%]

H(e,e'p): 1 hr beam-on-target @ 60 uA

W_kin0_paddlesAbove6_OFF	
Entries	6947
Mean	1.889
Std Dev	0.132
Integral	1.602e+05

W_kin0_paddlesBelow7_OFF	
Entries	8983
Mean	1.031
Std Dev	0.1889
Integral	3.779e+06

W_kin0_allPaddles_ON	
Entries	8857
Mean	1.056
Std Dev	0.2391
Integral	3.899e+06

Invariant Mass, W [GeV]

ALL PADDLES ON: FULL W_integral = 3.899x10^6

TURN PADDLES 1-6 OFF: FULL W_integral = 3.779x10^6

TURN PADDLES 7-13 OFF: FULL W_integral = 1.602x10^5

ACTUAL H(e,e'p) GOOD EVENT RATES

W_kin0_allPaddlesON	
Entries	8857
Mean	0.9524
Std Dev	0.02316
Integral	3.052e+06

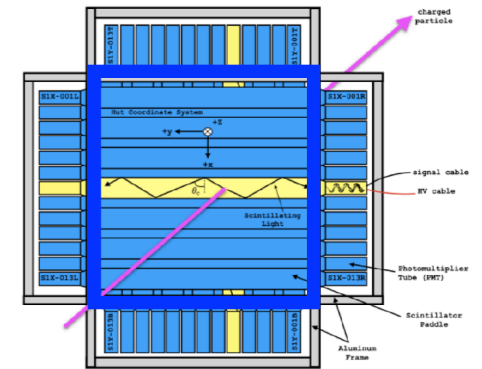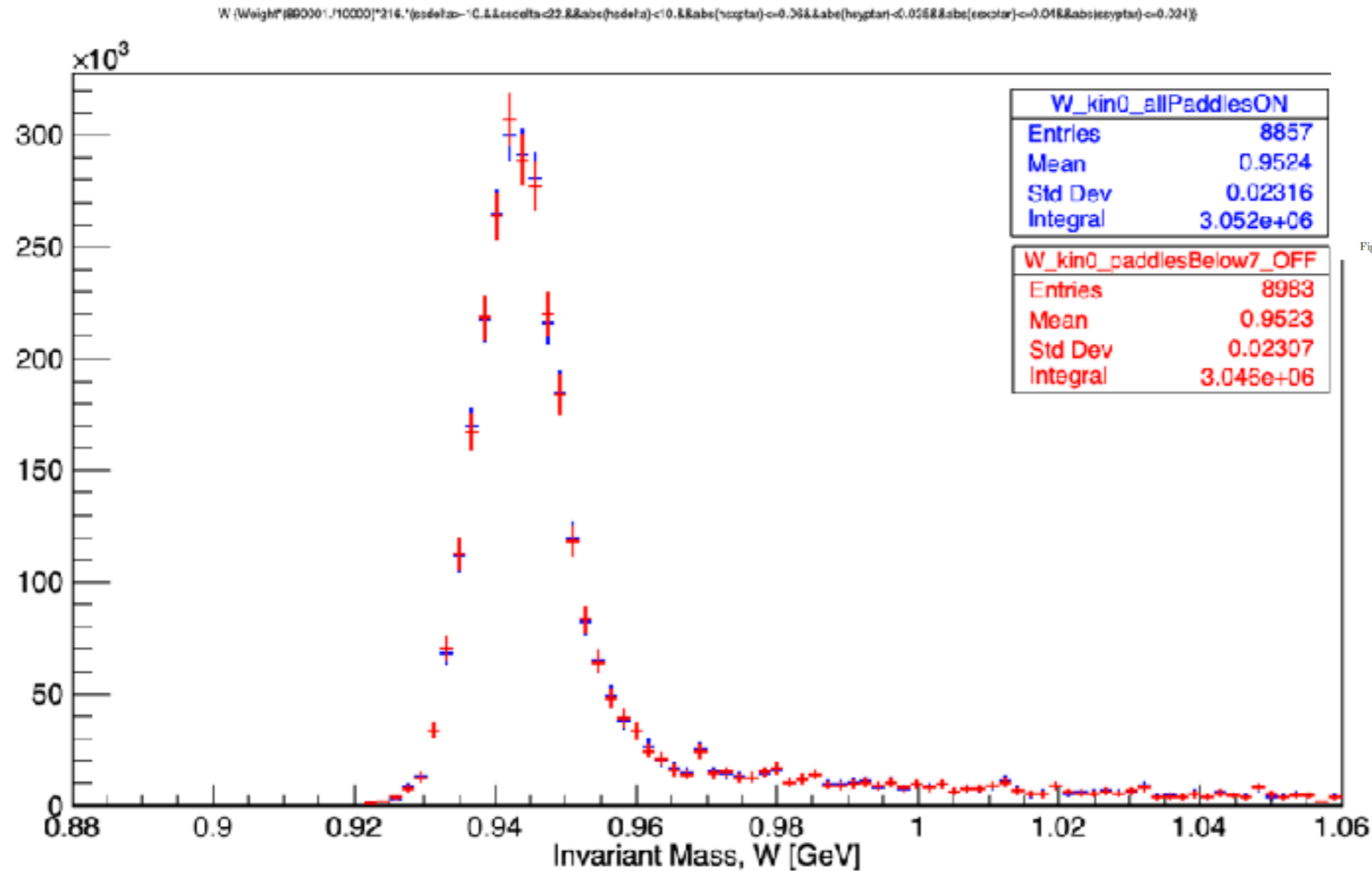| W_kin0_paddlesBelow7_OFF	
Entries	8983
Mean	0.9523
Std Dev	0.02307
Integral	3.046e+06

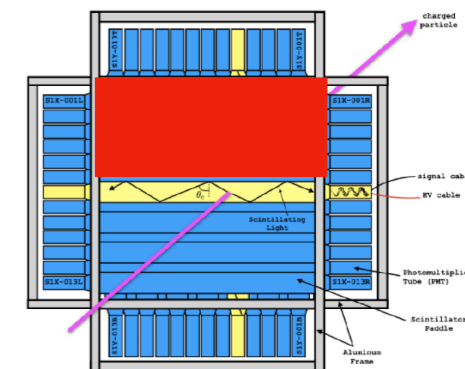Figure 3.26: Front view of the SHMS S1X (front) and S1Y (back) hodoscope planes.

Figure 3.26: Front view of the SHMS S1X (front) and S1Y (back) hodoscope planes.

ALL PADDLES ON: W_integral_rates = 3.052x10^6 / 3600 sec = 847.8 Hz

TURN PADDLES 1-6 OFF: FULL W_integral = 3.046x10^6 / 3600 sec = 846.1 Hz

CONCLUSION: The plot above shows it is safe to turn OFF S1X, S2X paddles Below 7 without having a significant effect on RATES

**For comparison, and as a sanity check, here are the H(e,'p) rate estimate
I made in Feb 24, 2022 (using deut_simc, our specialized version of SIMC for deuteron)**

Beam Energy = 10.6 GeV   beam current = 60 uA   beam time = 1 hr   total charge = 1 mC

CaFe Special Studies	SHMS P (e-) (GeV/c)	SHMS Angle (e-) (deg)	HMS P (p) (GeV/c)	HMS Angle (p) (deg)	DAQ coin. rates (Hz)	# H(e, e'p) Count Rates (Hz)	Beam-on-target time
heep @ kin-0 Optim MF CaFe Kin.	8.55	8.3	1.82	48.3	1192	818	1 hr

Rate Estimates TODAY (using simc_gfortran): June 07, 2022

ALL PADDLES ON: $W_{integral\_rates}$ = 3.052x10^6 / 3600 sec = 847.8 Hz

TURN PADDLES 1-6 OFF: FULL $W_{integral}$ = 3.046x10^6 / 3600 sec = 846.1 Hz