^{1}H(e,e'p) kinematics for K^{+} L/T Separation Experiment

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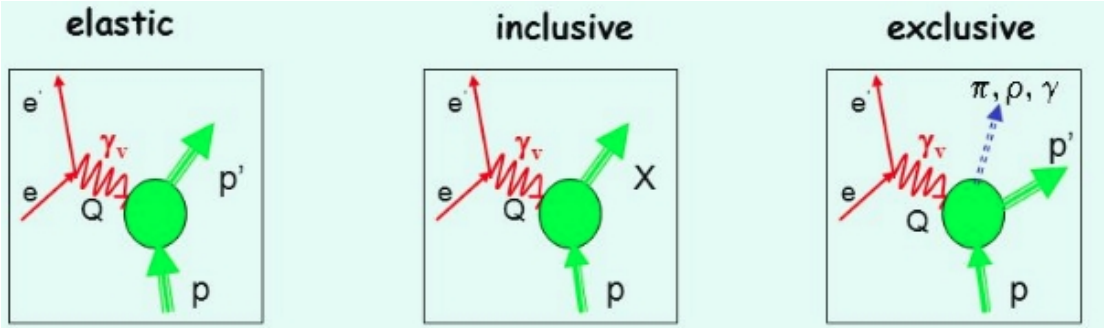
^{1}H(e,e'p)



$Q^2 = -(e-e')^2$
$\nu = E_e - E_{e'}$
$x_B = Q^2/2M\nu$
$t = -(p-p')^2$

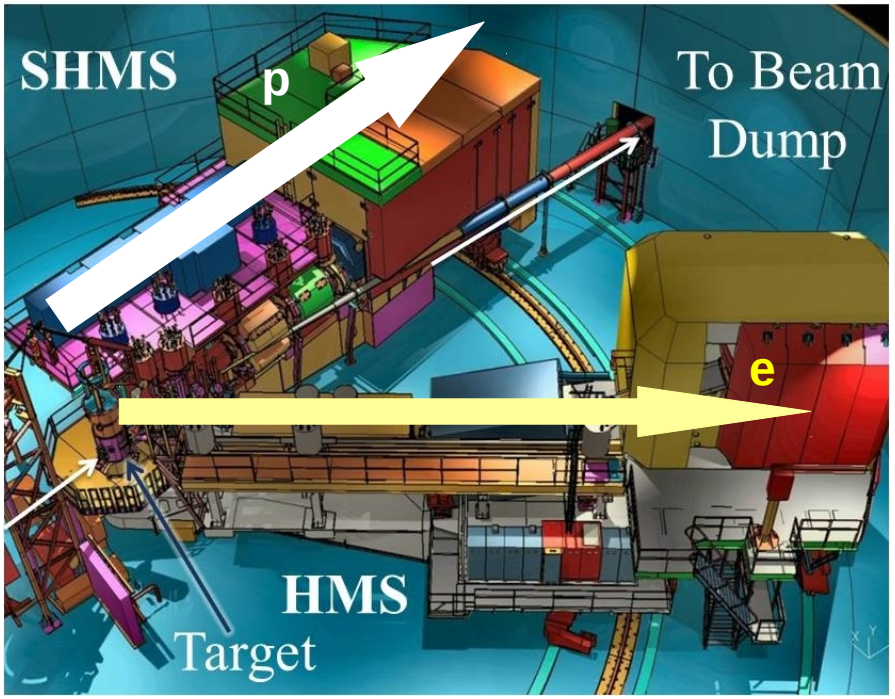
$x_B = 1$ (for elastic scattering)

- Only two particles (electron and protons in the outgoing channel)
- Both are detected
- Kinematically overconstrained reaction! (reconstructed quantities are correlated)

- Invariant mass, W, for ep elastic is the mass of the proton

$$W = \sqrt{m_p^2 + 2 m_p \nu - Q^2}$$

- Since all the particles in the final states are detected, we expect **NO** missing mass, i.e.
  - |E_miss| = 0
  - |P_miss| = 0

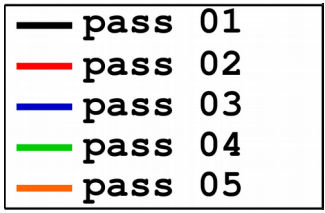


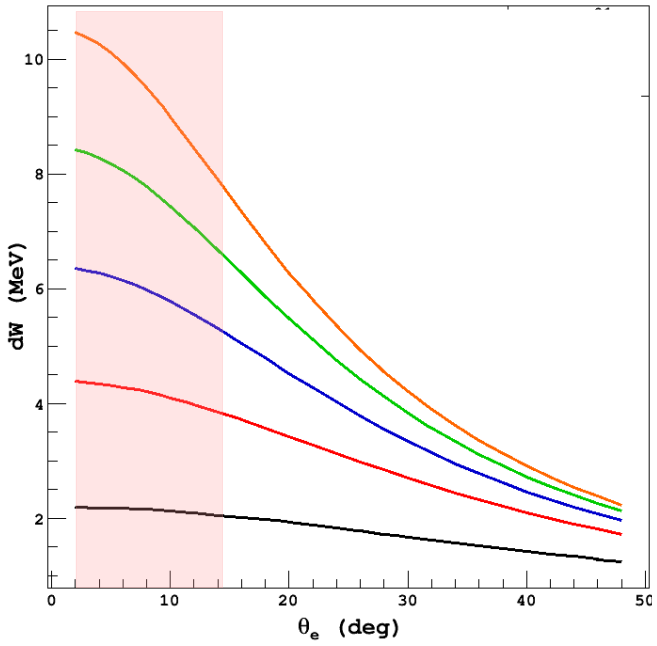
Why ^{1}H(e,e'p)?

- **Offsets calculation**
  - Any offsets in beam energy and reconstructed spectrometer quantities (x/yptar and delta) will show up as a deviation in W, Emiss, as well as, parallel and perpendicular components of Pmiss
  - Out-of-plane missing momentum only dependent on the vertical angles of the particles and thus, is decoupled from the other quantities
- **Beam energy measurement**
  - E_{beam} with heep vs arc measurment
- **Central momentum determination with delta scan**
- **One ^{1}H(e,e'p) measurement at each beam energy**

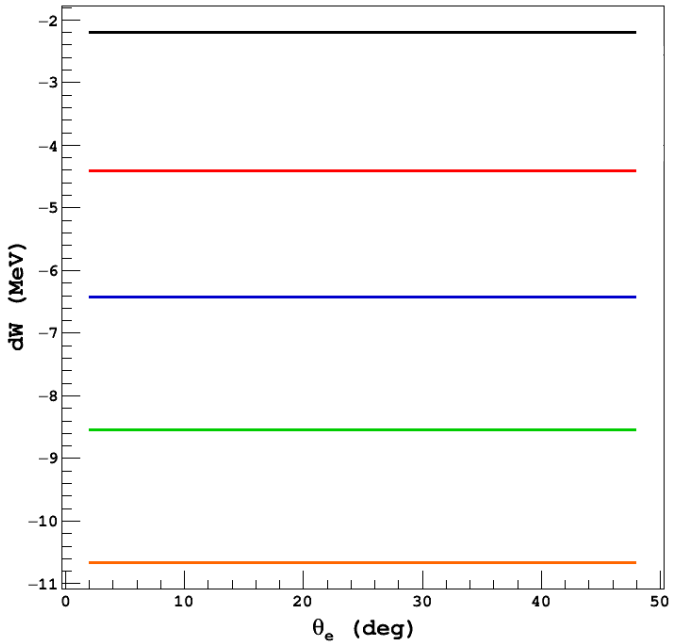
Derivatives as a function of electron angle (θ_e)

dW

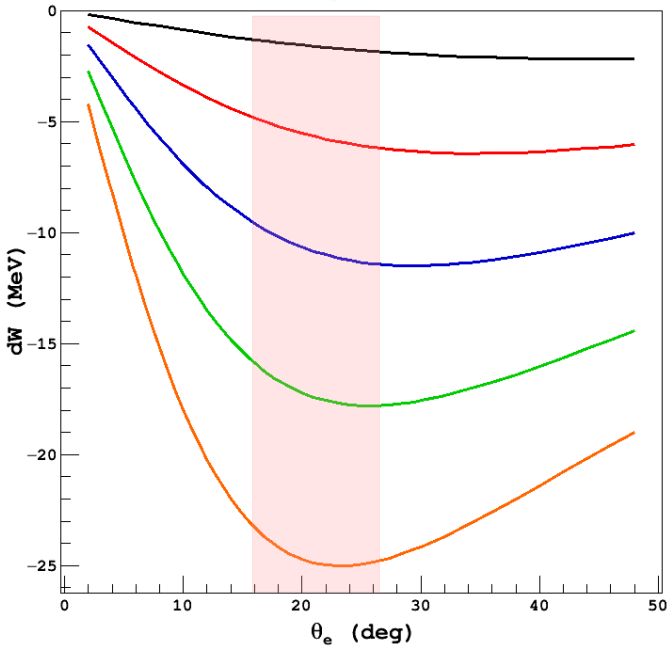




With +0.1% variation in E_{beam}

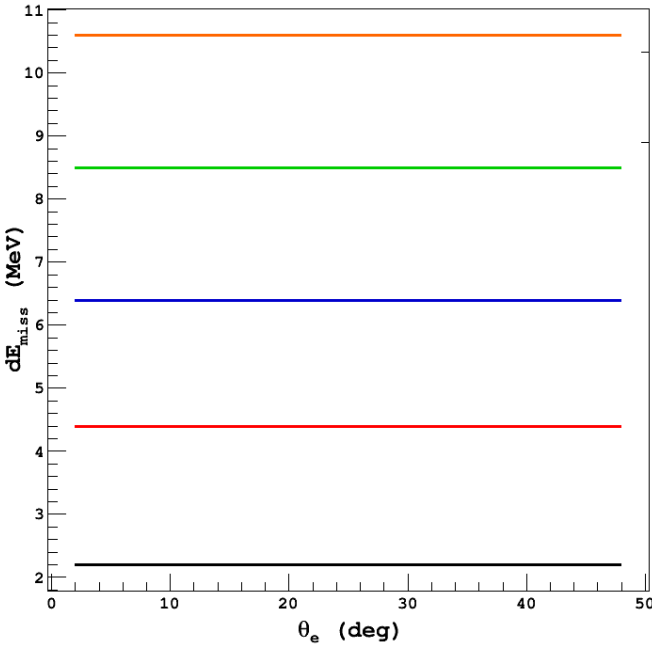


With +0.1% variation in $E_{e'}$

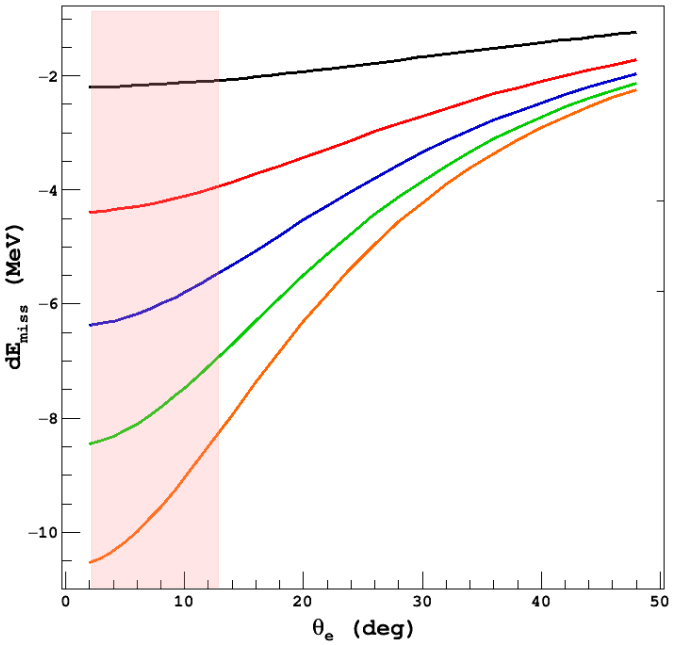


With +0.1 mrad variation in θ_e

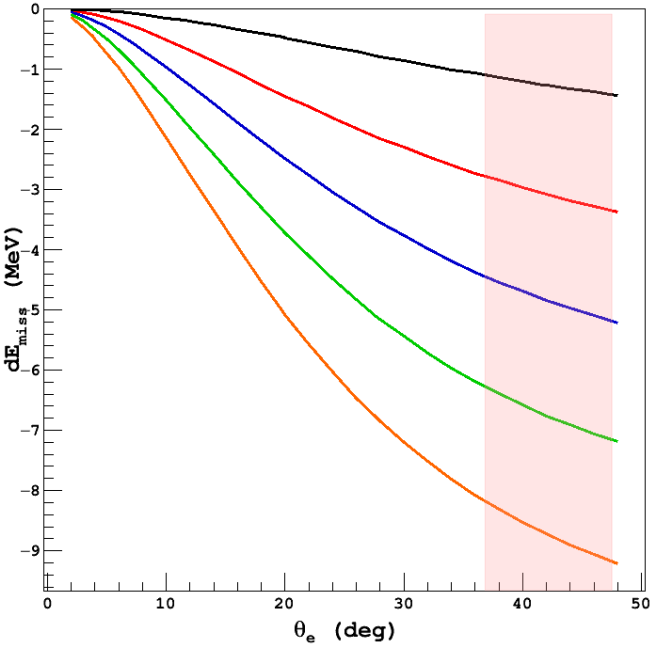
dE_{miss}



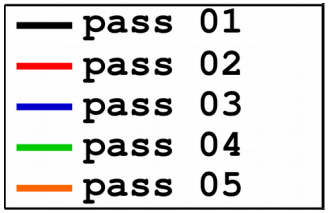
With +0.1% variation in E_{beam}



With +0.1% variation in $E_{e'}$



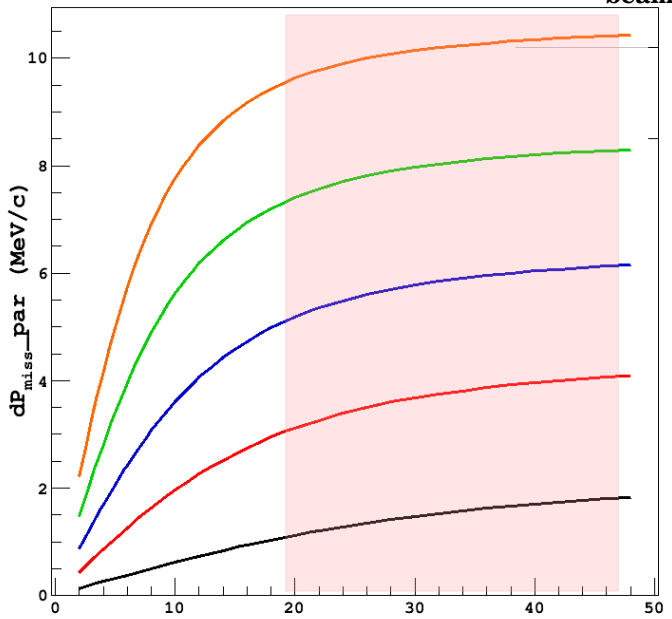
With +0.1% variation in P_p



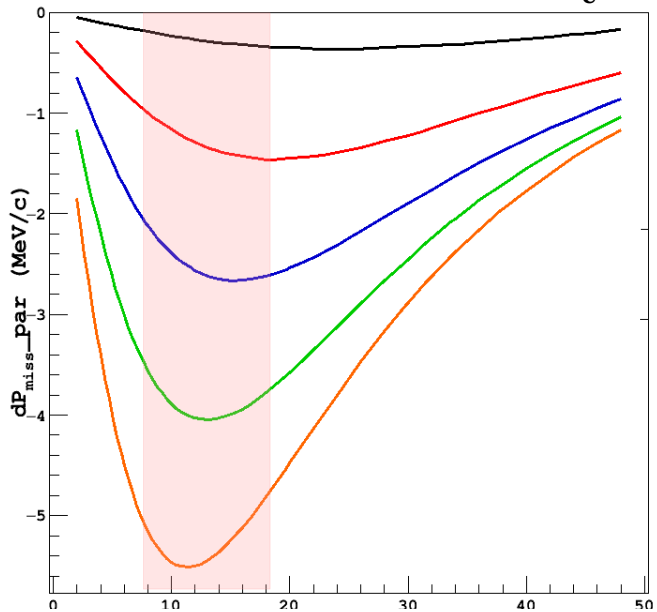
dP_{miss} (parallel)

pass 01
pass 02
pass 03
pass 04
pass 05

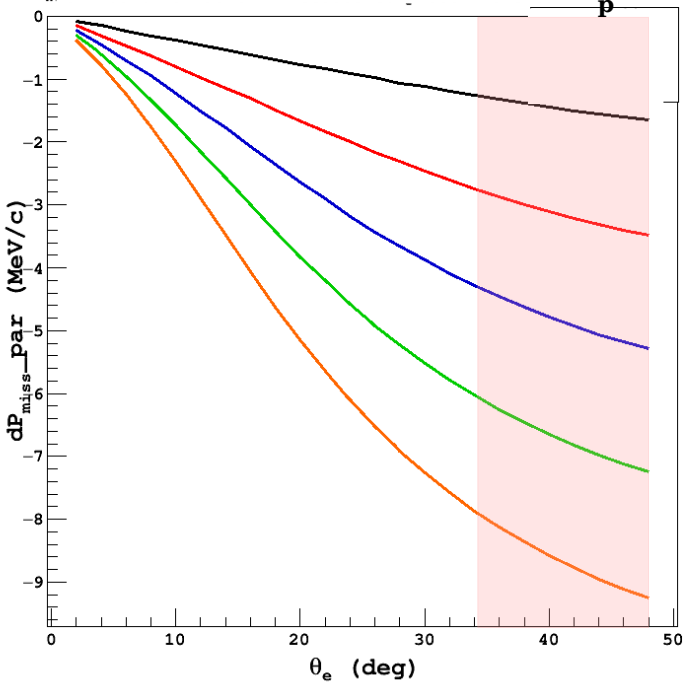
With +0.1% variation in E_{beam}



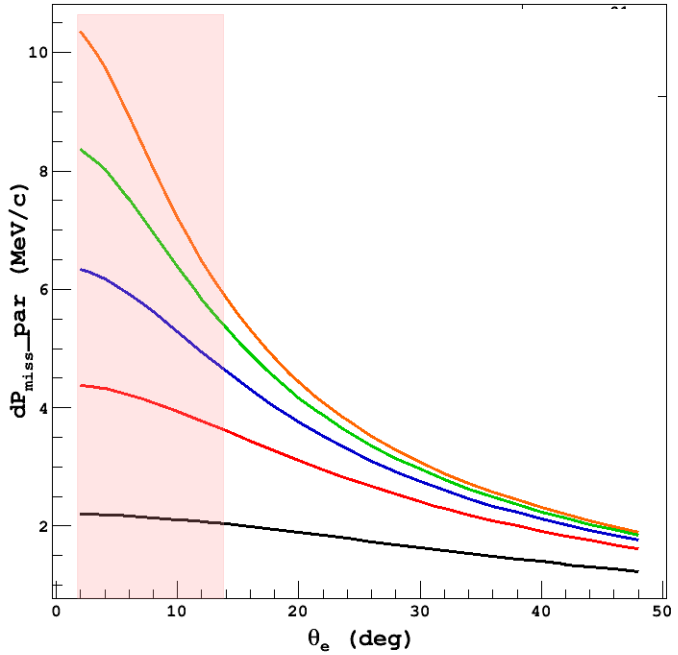
With +0.1% variation in E_e'



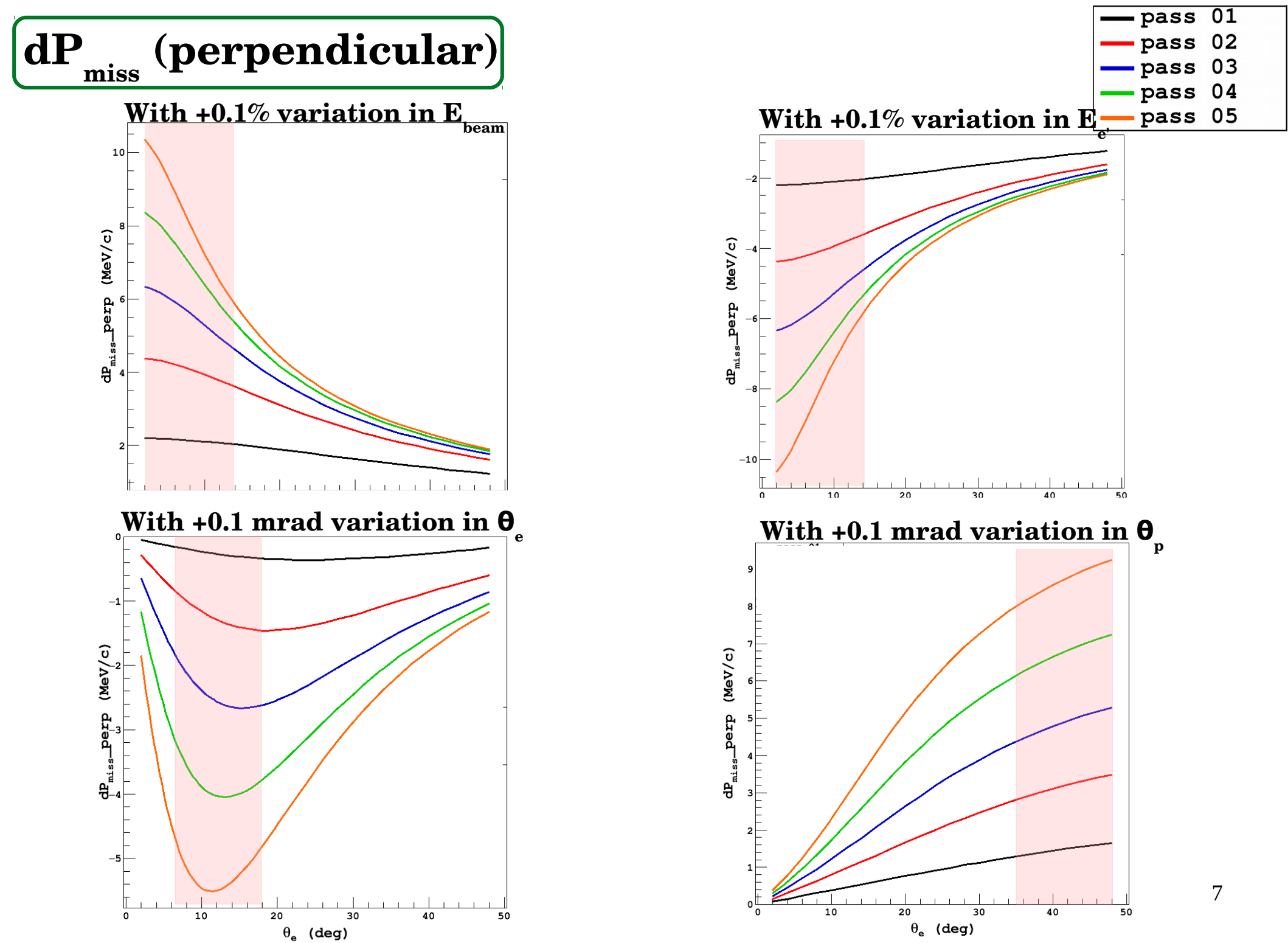
With +0.1% variation in P_p



With +0.1 mrad variation in θ_e



dP_{miss} (perpendicular)



Real Coincidence Rates for $^{1}H(e,e'p)$

Desired rate for ~25000 good ep coincidence events in ~ 3hrs

- Data simulated using SimC
- **ONLY** spectrometer acceptance cuts and missing mass cut applied
- Spectrometer acceptance cuts:

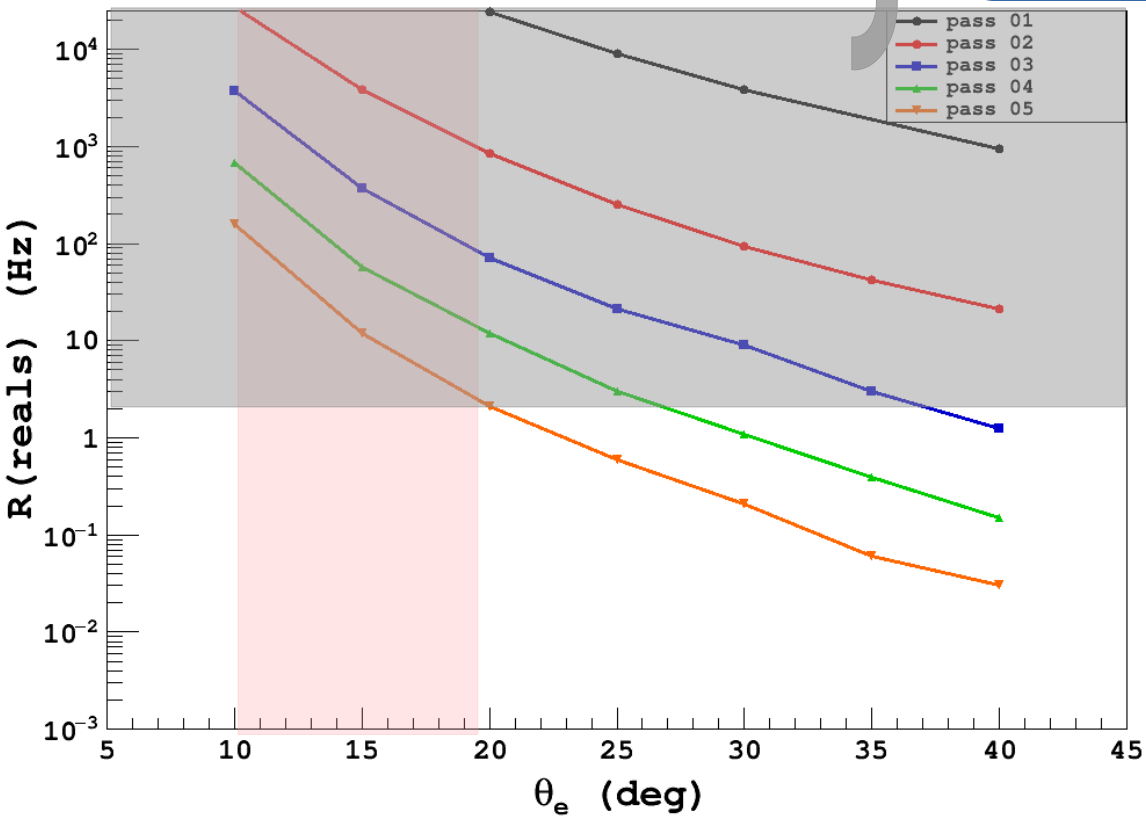
For HMS:
|hsdelta| < 8.0; |hsxptar| < 0.08;
|hsyptar < 0.035

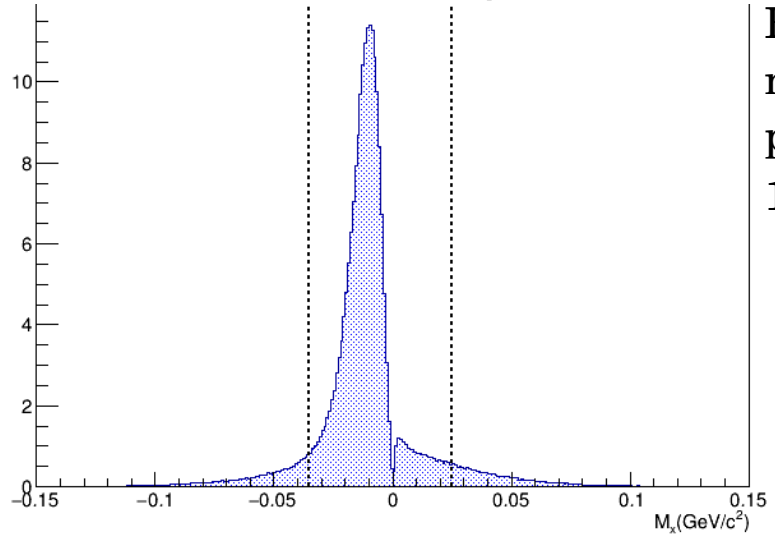
For SHMS:
|ssdelta| < 15.0; |ssxptar| < 0.04;
|ssyptar < 0.024

- Missing mass cut:

$-0.035 < M_x < 0.025$ GeV

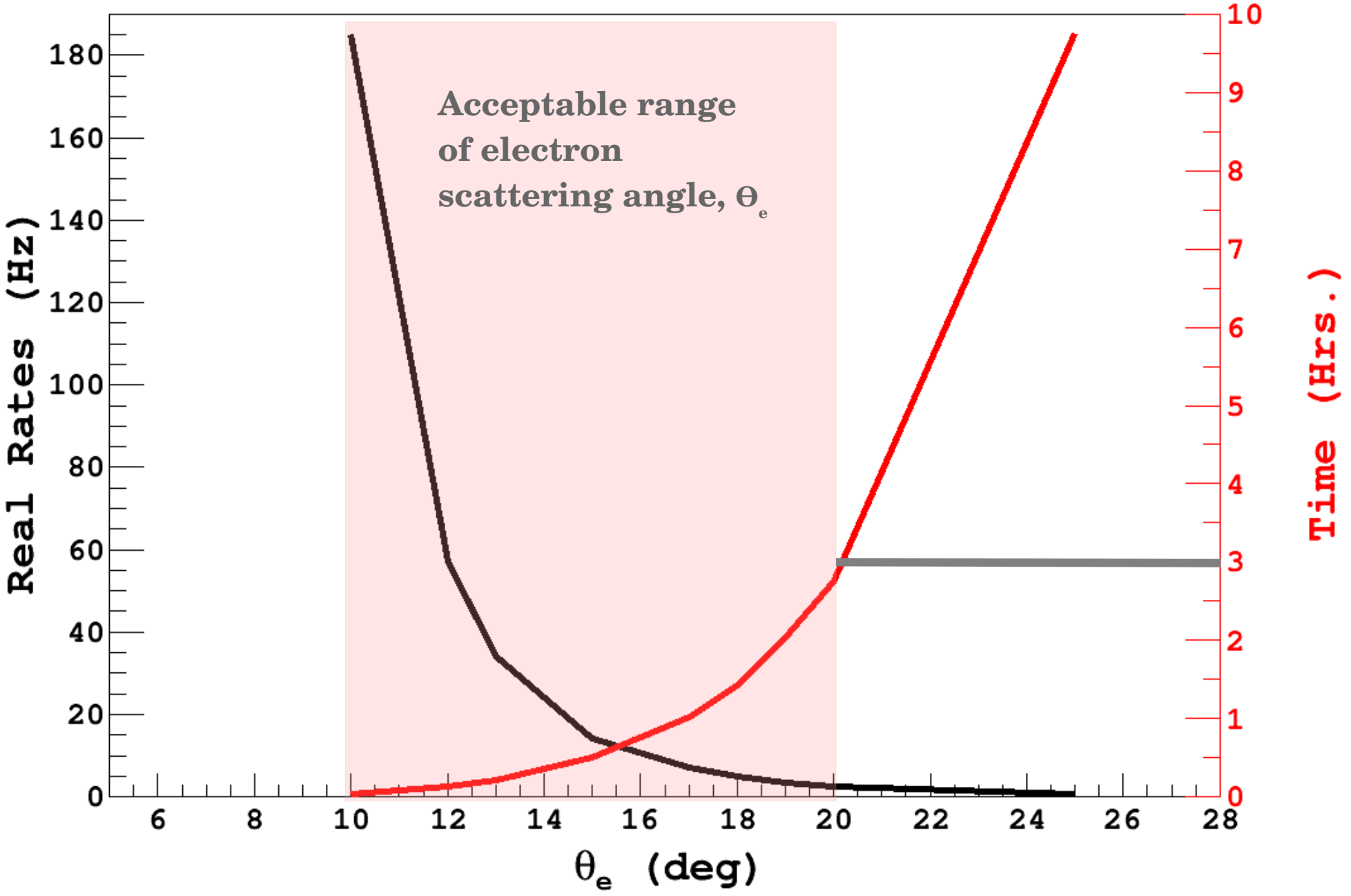
- 70 uA beam current with 10 cm liquid hydrogen assumed for real rates estimation





Example heep missing mass for pass 05 @ Θ_e = 15.0°

Pass 05


Acceptable range
of electron
scattering angle, θ_e
Real Rates (Hz)
Time (Hrs.)
θ_e (deg)
0
20
40
60
80
100
120
140
160
180
0
1
2
3
4
5
6
7
8
9
10
6
8
10
12
14
16
18
20
22
24
26
28

Pass 05

Θ_e (°)	$E_{e'}$ (GeV)	Θ_q (°)	P_p (GeV/c)	Real Rates (Hz)	Time (Hrs)
10.00	9.047	42.91	2.308	185	0.04
12.00	8.513	37.69	2.895	57	0.12
13.00	8.231	35.47	3.190	34	0.20
15.00	7.654	31.70	3.770	14	0.49
17.00	**7.105**	**28.51**	**4.351**	**7**	**1.06**
18.00	**6.833**	**27.14**	**4.629**	**5**	**1.47**
19.00	**6.568**	**25.88**	**4.899**	**3.5**	**2.00**
20.00	**6.305**	**24.76**	**5.149**	**2.6**	**2.64**
25.00	5.149	20.14	6.320	0.73	9.44

- Pass 05 kinematic ranges for E12-09-011
  $E_{e'}$ = 3.00 – 6.70 GeV; Θ_e = 11.00° – 23.00°
  P_p = 3.40 – 6.90 GeV/c; Θ_q = 8.50° – 19.00°
- 2-4 hrs for ~25000 good ^{1}H(e,e'p) events
- Negligible accidental coincidences => 70 mHz to 59 nHz
- **To do: similar projections for 03 and 04 passes**