CAFe Report update: 02/18/2022

Step1: Re-optimize to determine kinematic for Ebeam = 10.6 GeV

Step2: Rate calculation for optimized kinematic from step 1

Step3: Run plan

Dien, Carlos, Holly, Florian

Step1: Re-optimize to determine kinematic for Ebeam = 10.6 GeV

PAC45: kinematic setting (For reference)

E_{Beam} GeV	E'_e GeV	θ_e	$\lvert \mathrm{p}_p \rvert$ GeV/c	θ_p	p_{miss} GeV/c	Q^2 GeV^2
11	9.85	8.0°	1.43	63.0°	0.40	2.1
11	9.85	8.0°	2.01	44.5°	0.15	1.8

Need to reoptimize to determine new kinematic for

1. Ebeam = 10.6 GeV

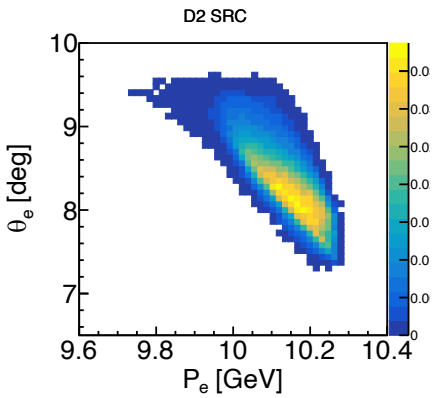
2. Pe = 8.85 GeV (For the best available optics matrix)

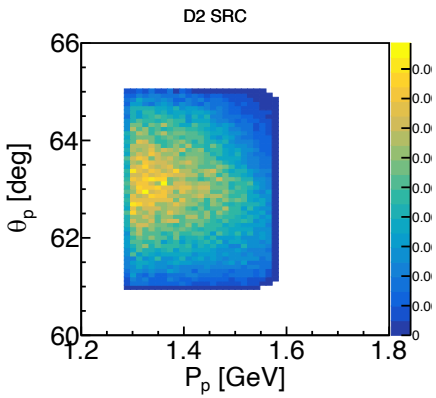
STEP0: Checking the rate calculation using D2 with PAC45 kinematic

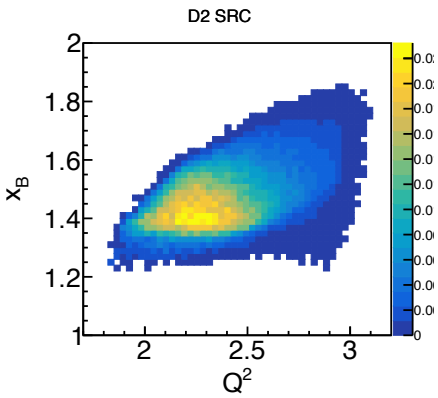
Using the same cuts, Lum, charge

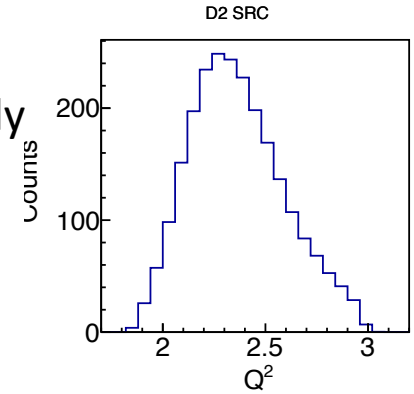
Note:

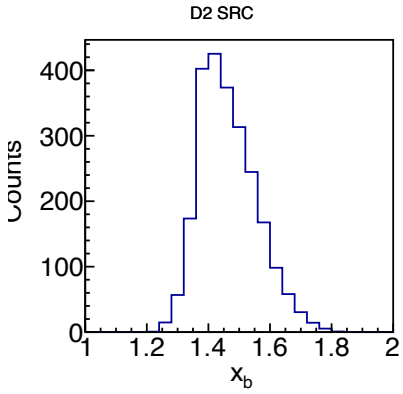
- The shoulder in the xb distribution is due to the radiative effect.
- Can be solved by apply the cut Em < 50 MeV
- Em = omega – Tp - Tn

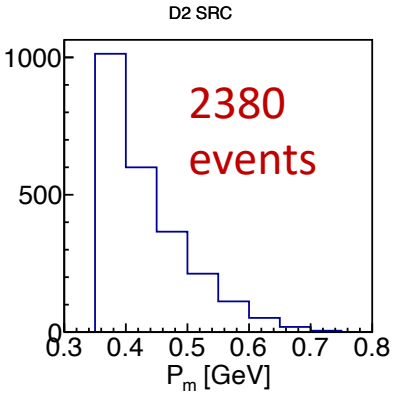




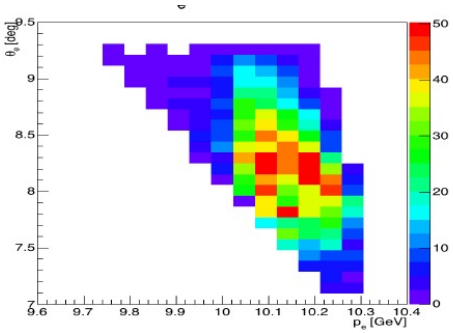


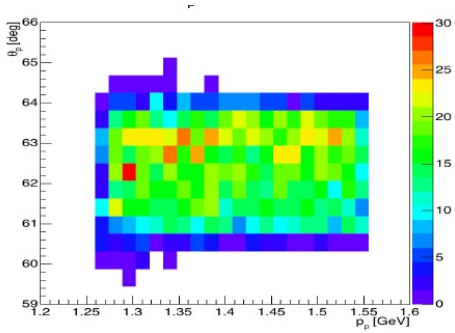


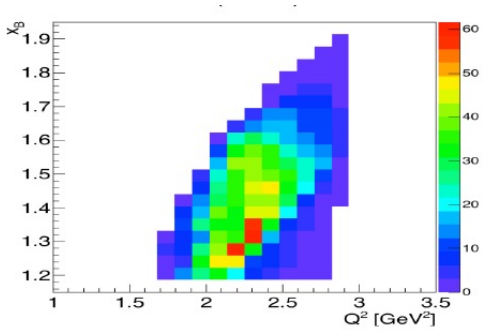


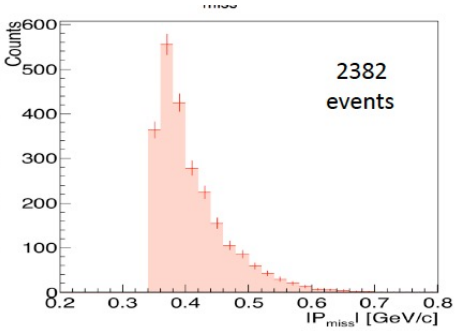


Rey and Florian report for PAC45 proposal on D2:









Step1: Re-optimize to determine kinematic for Ebeam = 10.6 GeV

Simulation parameters for optimization step:

Low Pm (MF): Using C12

E0 = 10.6 GeV
P_e_cen = 8.55 GeV
Th_e_cen = 8.3^o
P_p_cen = 1.8 GeV
Th_p_cen = 61^o

High Pm (SRC): Using D2

E0 = 10.6 GeV
P_e_cen = 8.55 GeV
Th_e_cen = 8.3^o
P_p_cen = 1.8 GeV
Th_p_cen = 53^o

Generating with open NO callorimator, wide Proton acceptance, RC on

-15% < $\delta_e < 25\%$
-40 < e_ytar < 40 mrad (Horizontal)
-60 < e_xtar < 60 mrad (Vertical)

-40% < $\delta_p < 40\%$
-250 < p_ytar < 250 mrad
-250 < p_xtar < 250 mrad

Selection cuts for optimization:

MF cuts:

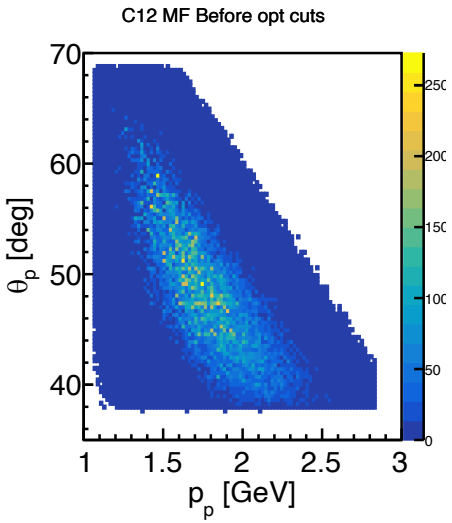
$Q^2 > 1.8$,
$P_m < 0.25$ GeV

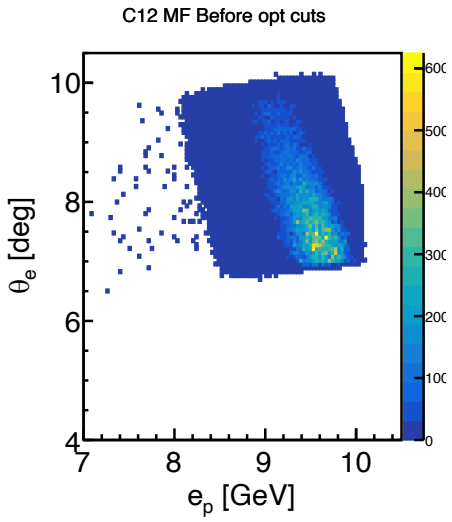
SRC cuts:

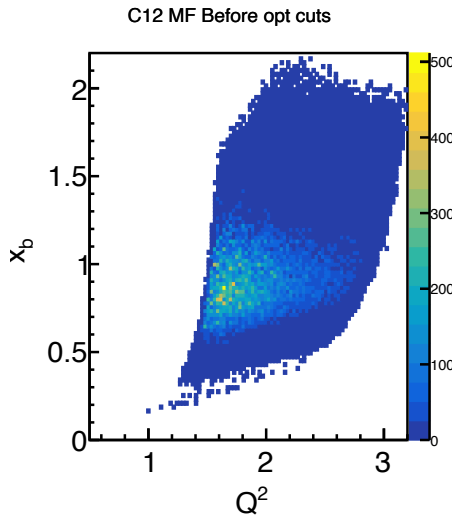
$Q^2 > 1.8$,
$\theta_{rq} < 50^o$
$P_m > 0.35$ GeV
Xb > 1.2

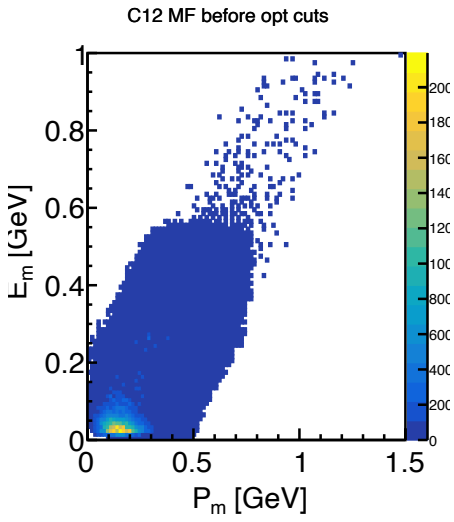
Step1: Re-optimize to determine kinematic for Ebeam = 10.6 GeV

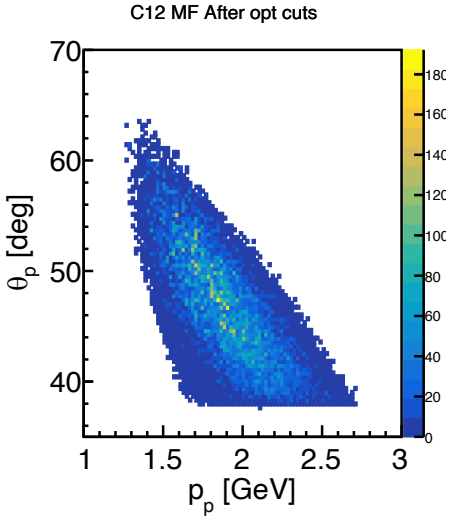
MF using C12 distribution with and W/o optimization cuts

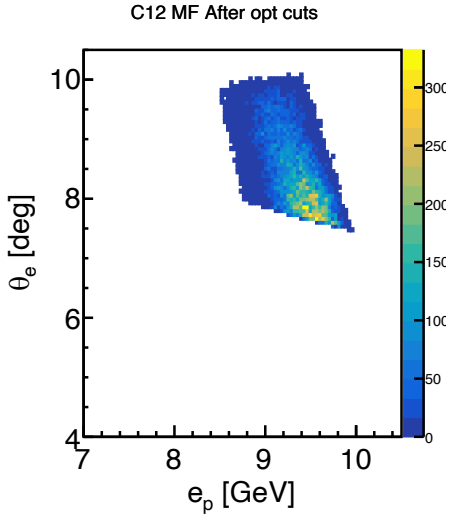


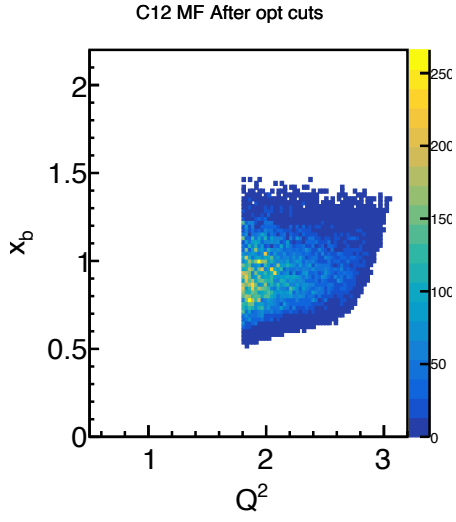


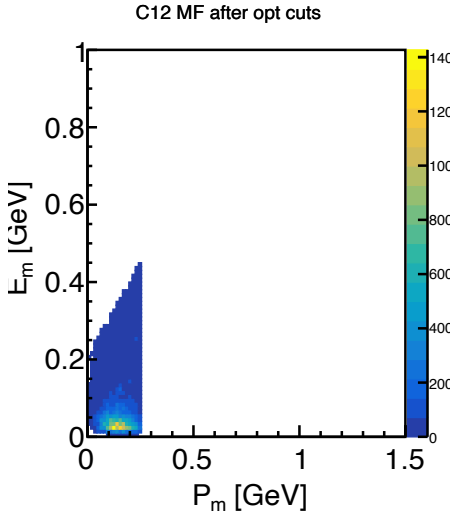












Step1: Re-optimize to determine kinematic for Ebeam = 10.6 GeV

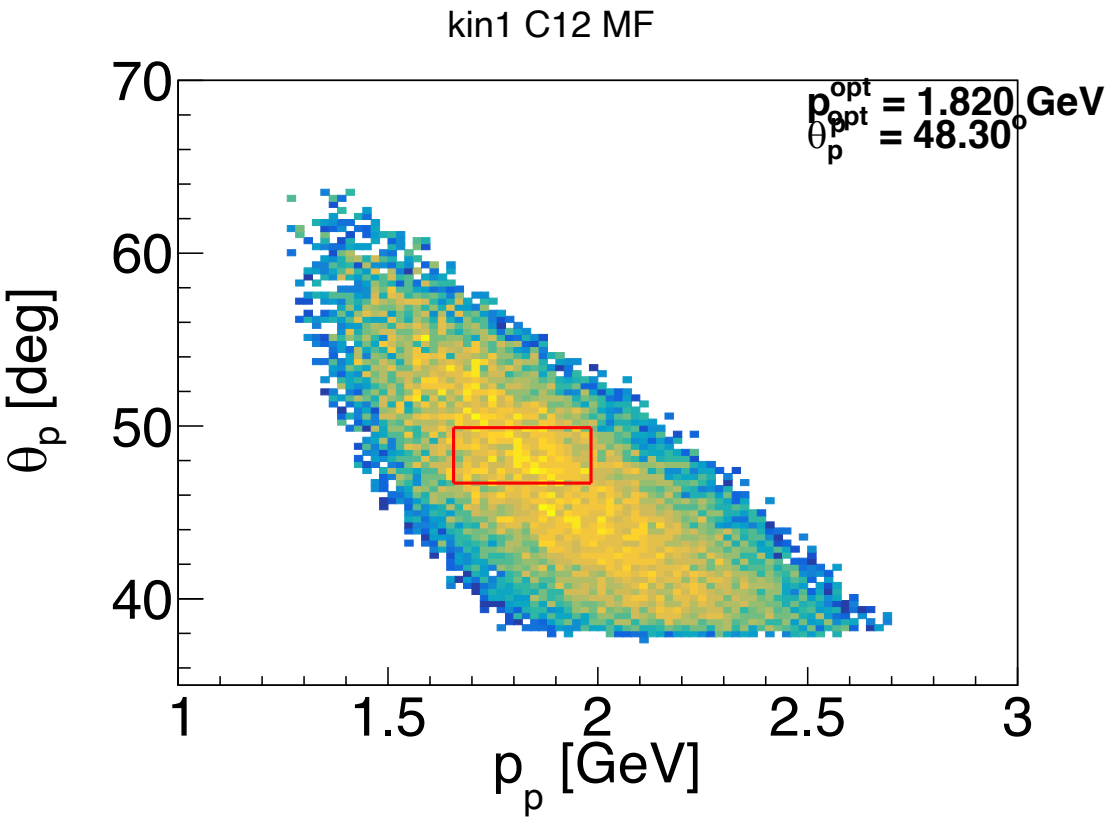
MF using C12: Proton arm Optimization

Red-box is defined as:

Optimization window side:

$\delta_p = \pm 9\%,\ \theta_p = \pm 28\ mrad$

Optimized kinematic is determined by the red-box with the largest count



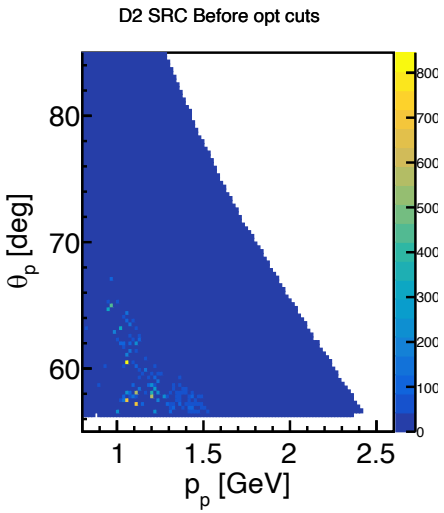
Results:

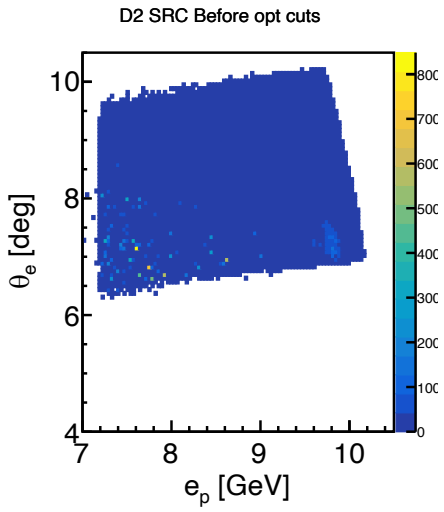
$\theta_p = 48.3^o$

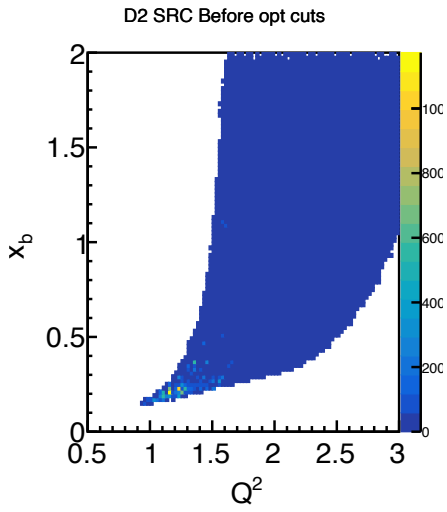
Pp = 1.82 GeV

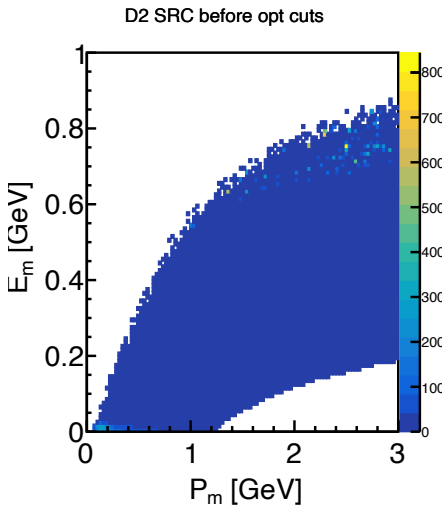
Step1: Re-optimize to determine kinematic for Ebeam = 10.6 GeV

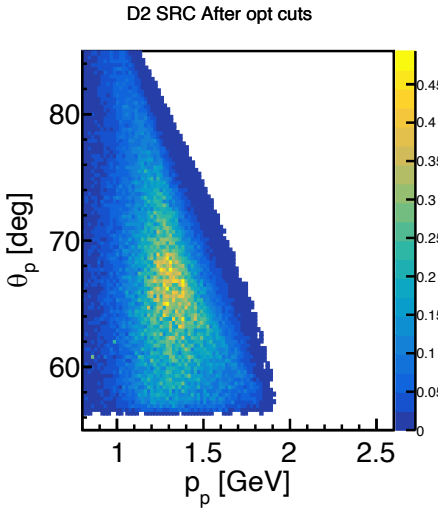
SRC using D2 distribution with and W/o optimization cuts

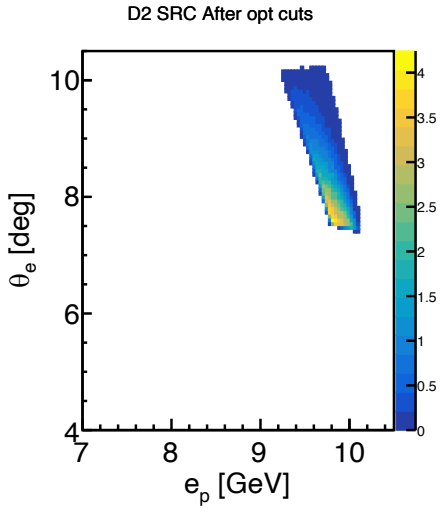


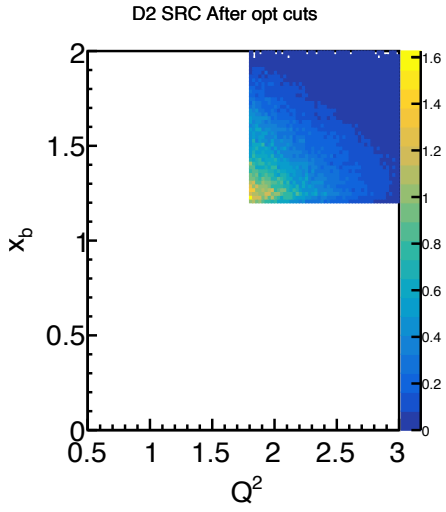


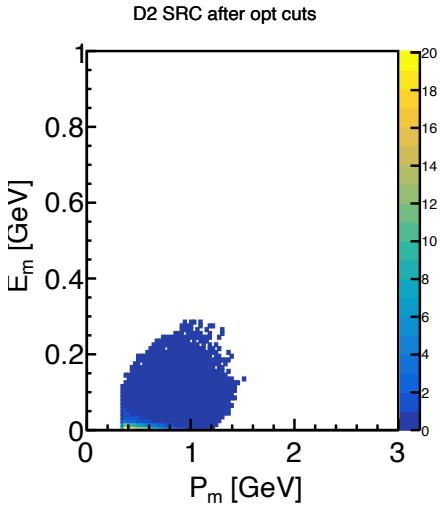












Step1: Re-optimize to determine kinematic for Ebeam = 10.6 GeV

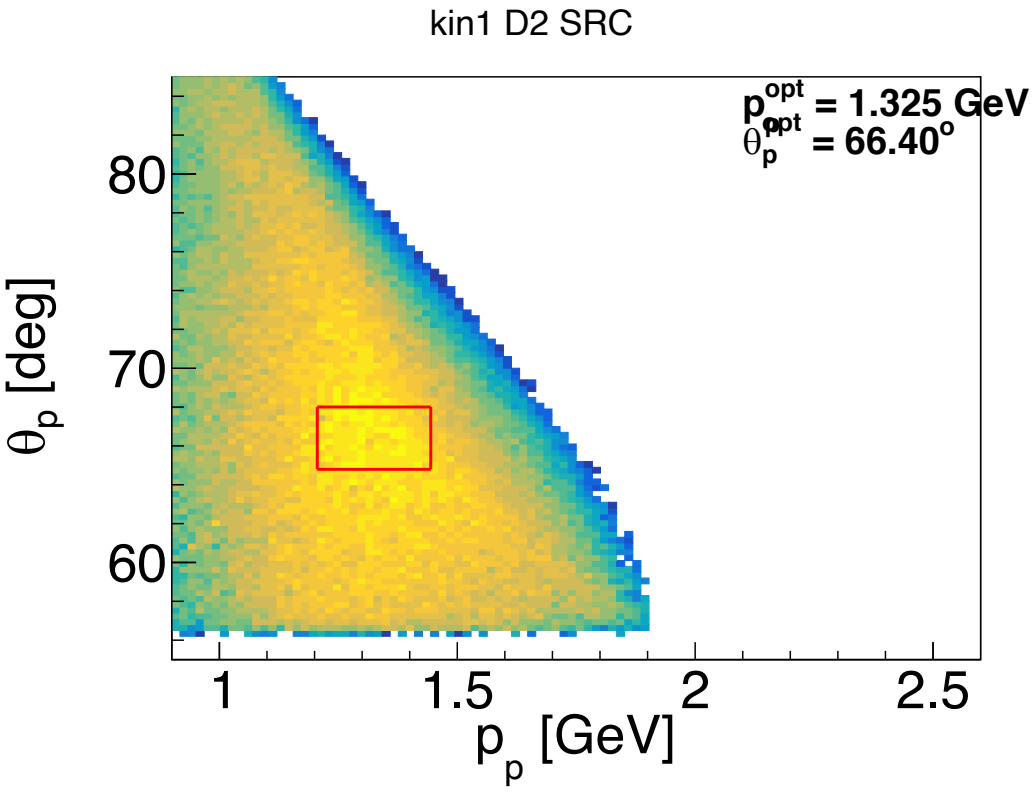
SRC using D22: Proton arm Optimization

Red-box is defined as:

Optimization window side:

$\delta_p = \pm 9\%,\ \theta_p = \pm 28\ mrad$

Optimized kinematic is determined by the red-box with the largest count



Results:

$\theta_p = 66.4^o$

Pp = 1.325 GeV

Step1: Re-optimize to determine kinematic for Ebeam = 10.6 GeV

PAC45: kinematic setting (For reference)

E_{Beam} GeV	E'_e GeV	θ_e	$\lvert p_p \rvert$ GeV/c	θ_p	p_{miss} GeV/c	Q^2 GeV^2
11	9.85	8.0°	1.43	63.0°	0.40	2.1
11	9.85	8.0°	2.01	44.5°	0.15	1.8

New optimized kinematic settings:

Ebeam (GeV)	E' (GeV)	θ_e Degree	$\lvert P_p \rvert$ GeV	θ_p Degree	Pm GeV	Q2_center	<Q2> GeV2
10.6	8.85	8.3	1.325	66.4	0.4	2.1	
10.6	8.85	8.3	1.820	48.3	0.15	2.1	

Step2: Rate calculation for New optimized kinematics

- Charge: 1152 mC (one 8-hour shift for 40 uA beam current)
- Area density = 1 g/cm2
- Callorimator in, RC on

SHMS (electron) acceptance cuts:

1) $-10 < \delta_e < 22\ \%$
2) $-0.040 < \theta_e < 0.040$ rad
3) $-0.024 < \phi_e < 0.024$ rad

HMS (proton) acceptance cuts:

1) $-10 < \delta_p < 10\ \%$
2) $-0.060 < \theta_p < 0.060$ rad
3) $-0.035 < \phi_p < 0.035$ rad

Convention: In-plane = yptar (MC) = ϕ (Horizontal)
Out-plane = xptar (MC) = θ (Vertical)

MF cuts:

Pm < 0.25 GeV/c
Q2 > 1.8

SRC cuts:

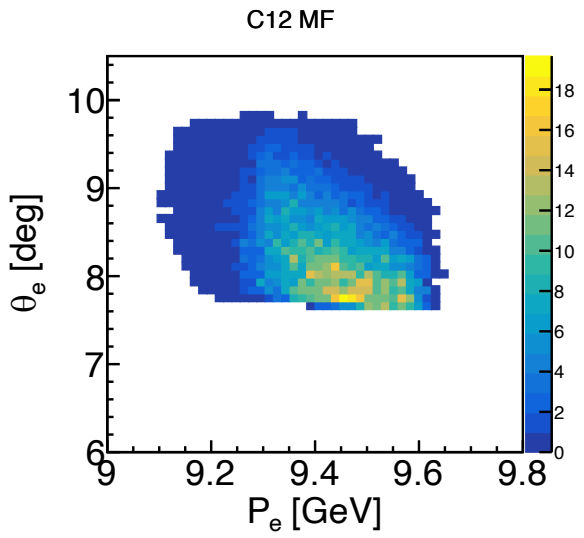
Q2 > 1.8
Pm > 0.35 GeV/c
Xb > 1.2
Theta_rq < 40
Em < 0.05 GeV (cut RC tail)

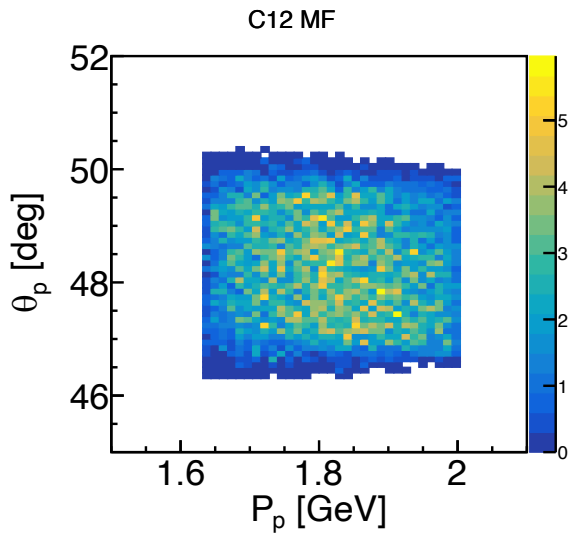
NOTE:

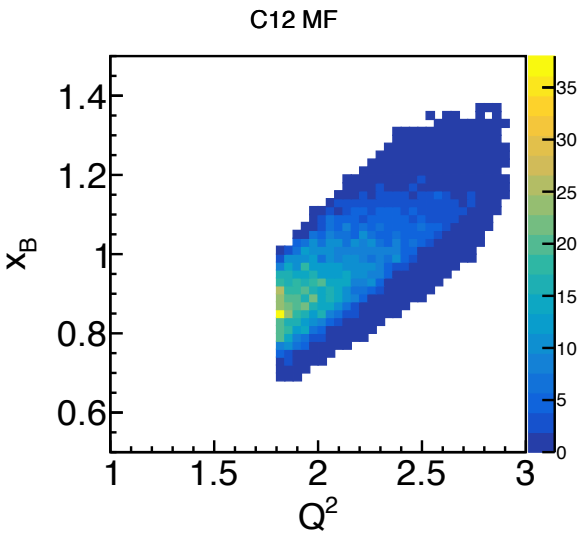
These cuts are the same as PAC44 proposal, the PAC45 have typo in the cut on table II in case you get confused

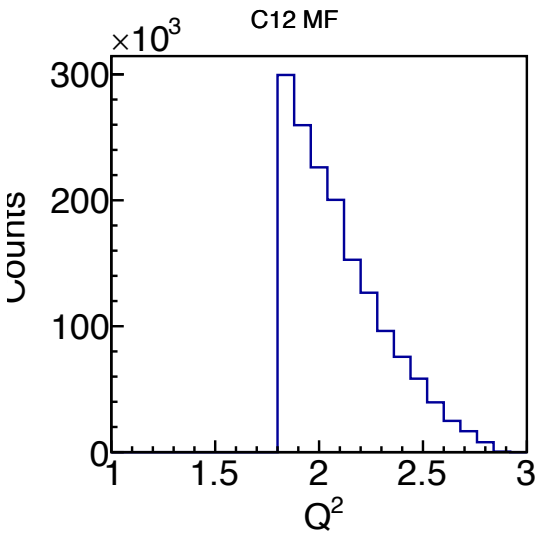
Step2: Rate calculation for New optimized kinematics

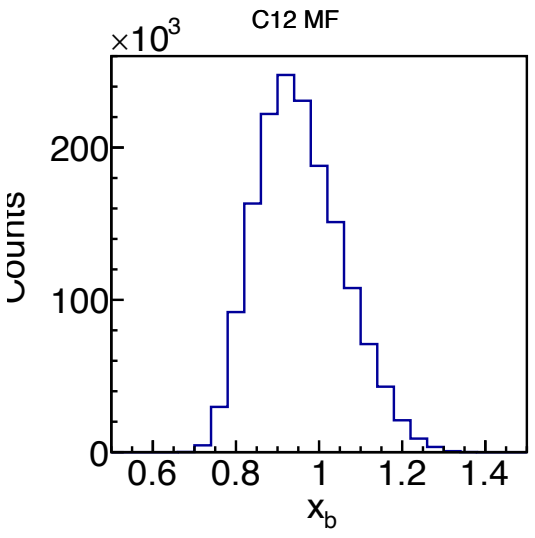
MF using C12: Rate estimation

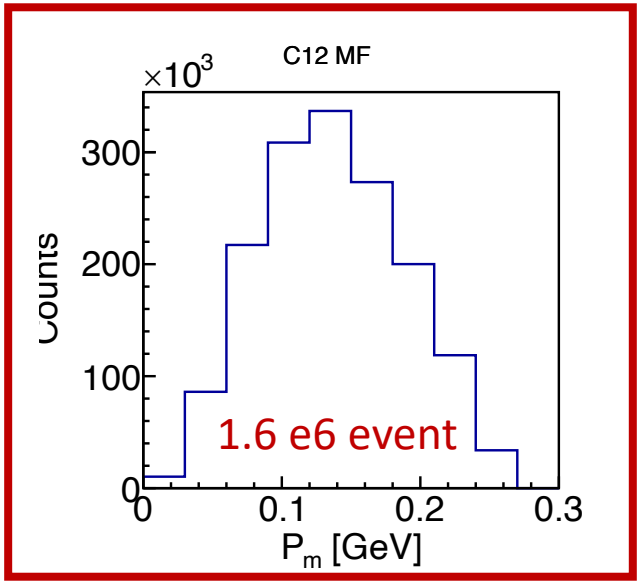






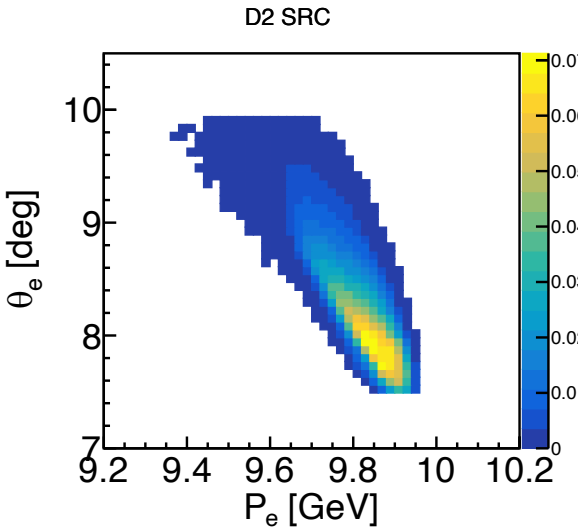


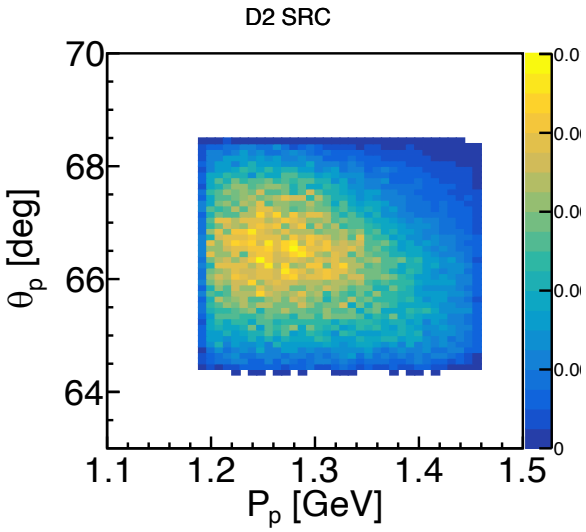


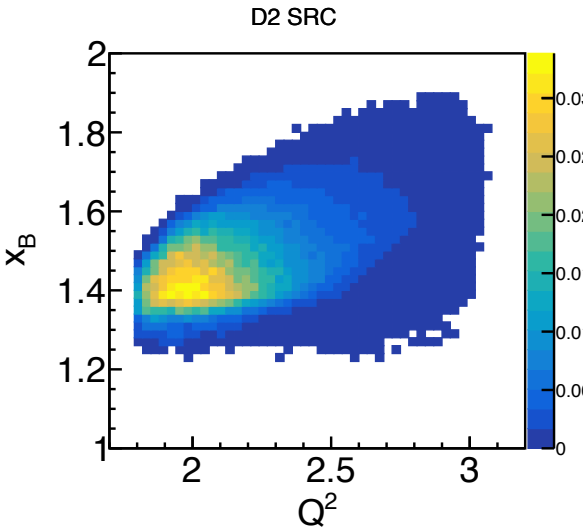


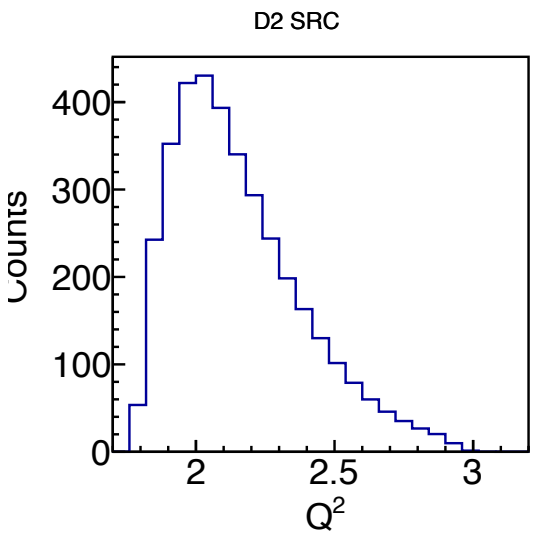
Step2: Rate calculation for New optimized kinematics

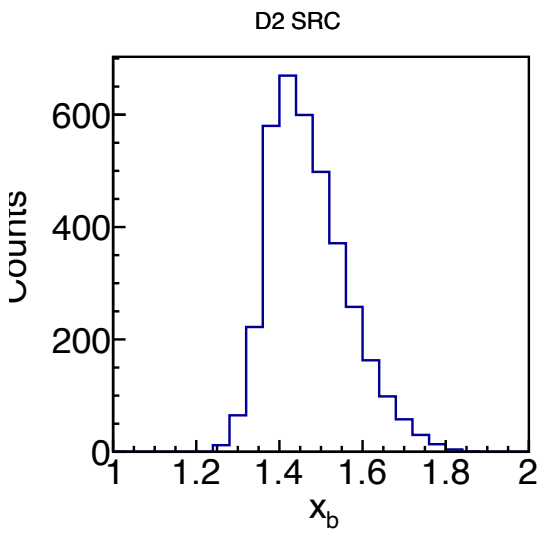
SRC using D2: Rate estimation

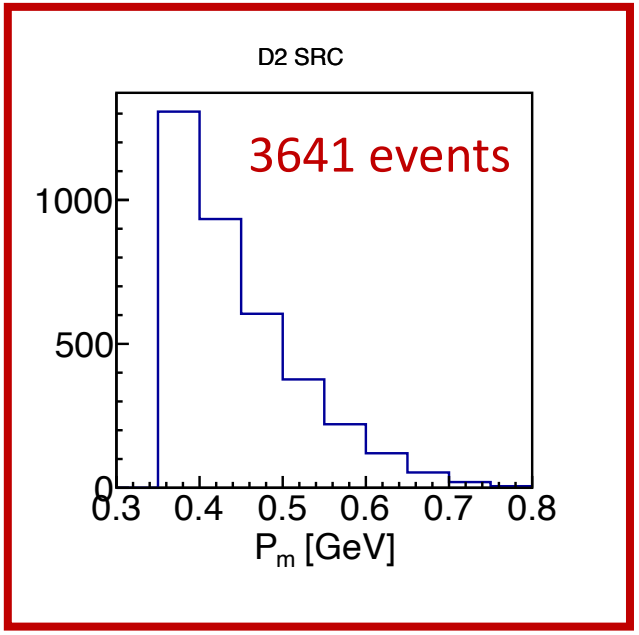






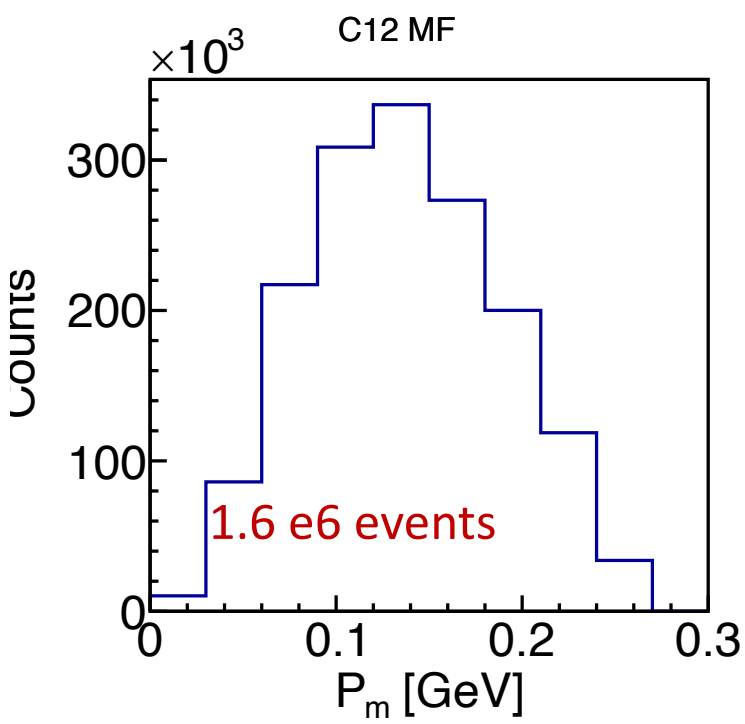




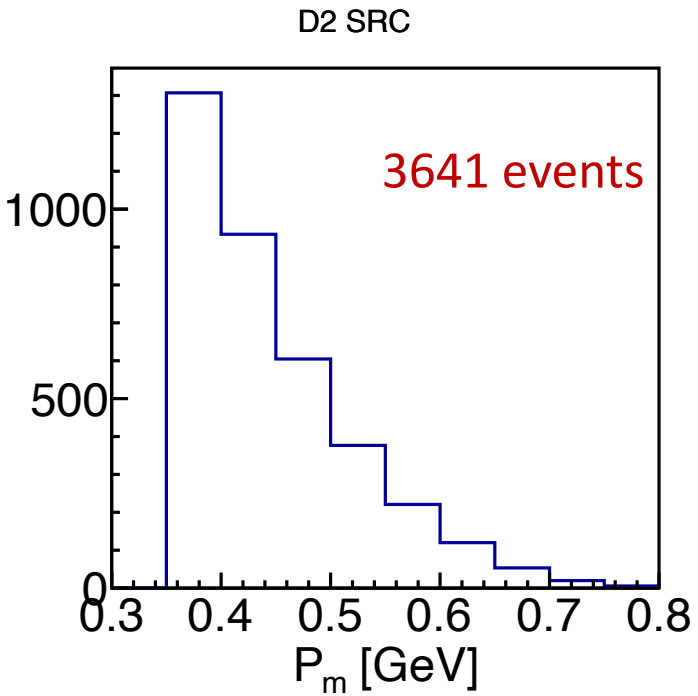


Step2: Rate calculation for New optimized kinematics

MF using C12: Rate estimation



SRC using D2: Rate estimation



NOTE:

This number of events are for C12 (MF) and D2 (SRC) corresponding to:

- Charge = 1152 mC (8 PAC hours of 40 uA beam)
- Target area density: 1 g/cm2
- Transparency factor (TF): C12 (0.56) and D2 (1.0)

Step3: Initial Run plan

MF & SRC event count for each target have to:

- Scale to transparency factors for different target (TF)
- Scale to corresponding target areal density (Den)
- Scale to corresponding maximum current (Cur)
- Scale down to factor of 2 for conservative rate estimation (2)
- Only For SRC: scale to a2 factor A/D2 (a2)

Conservative estimation

#event_A_SRC = #event_D2_SRC (3641) * TF * Den * Cur *a2 /2

Note: Proposal 45 apply additional factor:

Hall A simulation D2 => #C12_SRC_MC =#D2_SRC *TF *Den *Cur * a2/2
Hall A Data C12 => #C12_SRC_data

Additional factor = #C12_SRC_data/#C12_SRC_MC ~ 2.5

=> Optimistic run plan will include this additional factor

Step3: Initial Run plan

Target information used in calculation

Target	Max current (uA)	Areal Density (g/cm2)
D2	80	1.67
Ca40	80	0.8
Ca48	80	0.8
Fe54	35	0.2768
C12	80	0.5244
Be9	80	0.978
B10	80	0.5722
B11	80	0.6344

Step3: Initial Run plan

- Beam setup/checkout/MF kinematics — 4h PAC
- Calibration (BCM, boiling?, Optics, livetime, hydrogen?) — 4h PAC
- SRC kinematics (HMS move and magnet change) — 2h PAC
- SRC kinematics checkout — 2h PAC
- Overall target changes (MF and SRC) — 2h PAC

Com + Calib Time
14 PAC hours

Conservative Run plan

Target	SRC-runtime (PAC hour)	SRC #Event	MF-runtime (PAC hour)	MF #event	Total-runtime (PAC hour)
D2	5	3.8k	0.5	250k	
C12	0	0k	0.5	52k	
Ca48	10	7.2k	0.5	53k	
Ca40	10	7.2k	0.5	53k	
Fe54	36	4.6k	3.5	56k	
Be9	3.5	4.0k	0.5	98k	
B10	5.5	3.8k	0.5	52k	
B11	5	3.8k	0.5	63k	
Total	75		7		82

TOTAL: 14 + 82 = 96 PAC hours = 4 PAC days

Step3: Initial Run plan

- Beam setup/checkout/MF kinematics — 4h PAC
- Calibration (BCM, boiling?, Optics, livetime, hydrogen?) — 4h PAC
- SRC kinematics (HMS move and magnet change) — 2h PAC
- SRC kinematics checkout — 2h PAC
- Overall target changes (MF and SRC) — 2h PAC

Com + Calib Time
14 PAC hours

Optimistic Run plan

Target	SRC-runtime (PAC hour)	SRC #Event	MF-runtime (PAC hour)	MF #event	Total-runtime (PAC hour)
D2	5	7.6k	0.5	250k	
C12	5	7.1k	0.5	52k	
Ca48	7	10.1k	0.5	53k	
Ca40	7	10.1k	0.5	53k	
Fe54	35	8.9k	3.5	56k	
Be9	4	9.0k	0.5	98k	
B10	6.5	9.0k	0.5	52k	
B11	5.5	8.4k	0.5	63k	
Total	75		7		82

TOTAL: 14 + 82 = 96 PAC hours = 4 PAC days