Target Thickness and Cross Sections

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Formulas

Variables:

- $N(\theta)$, $N_{bg}(\theta)$: yields for production and empty runs
- N_0, $N_{0\,bg}$: live charge for production and empty runs ($|1nC| = 6.242 \cdot 10^9 e^-$)
- τ: thickness ($b^{-1} = 10^{28} m^{-2}$)

Cross Section:

$$\frac{d\sigma}{d\Omega}(\theta) = \frac{1}{2\pi \sin(\theta) \cdot \tau} \left(\frac{N(\theta)}{N_0} - \frac{N_{bg}(\theta)}{N_{0\,bg}} \right)$$

$$\frac{d\sigma}{d\Omega}(Q^2) = \frac{d\sigma}{dQ^2} \frac{dQ^2}{d\Omega}$$

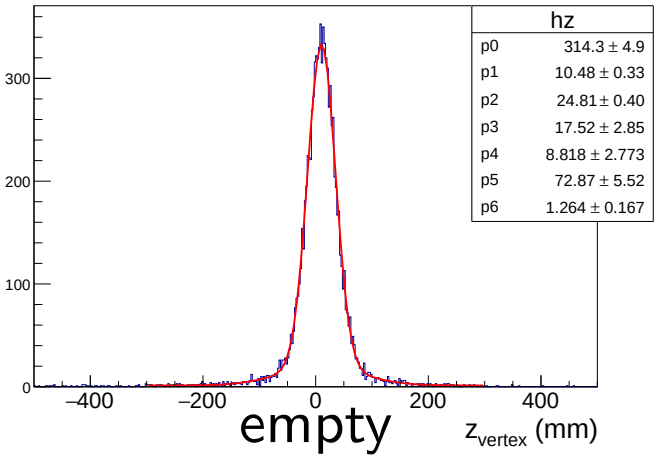
$$\frac{dQ^2}{d\Omega} = \frac{E_{beam}\, m_{e^-}}{\pi} \cdot \frac{1 - 4\alpha cos\theta + 6\alpha cos^2\theta - 2\alpha cos^3\theta - \alpha cos^4\theta}{(1 - \alpha cos^2\theta)^2}$$

with $\alpha = (E_{beam} - m_{e^-})/(E_{beam} + m_{e^-})$

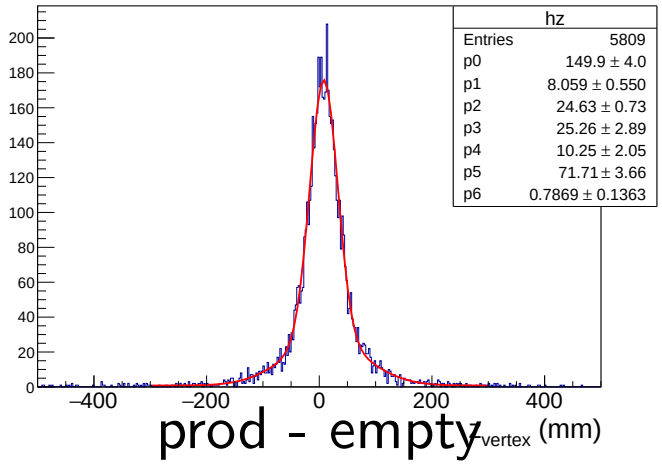
Z_{vertex} Distribution from double arm Møller

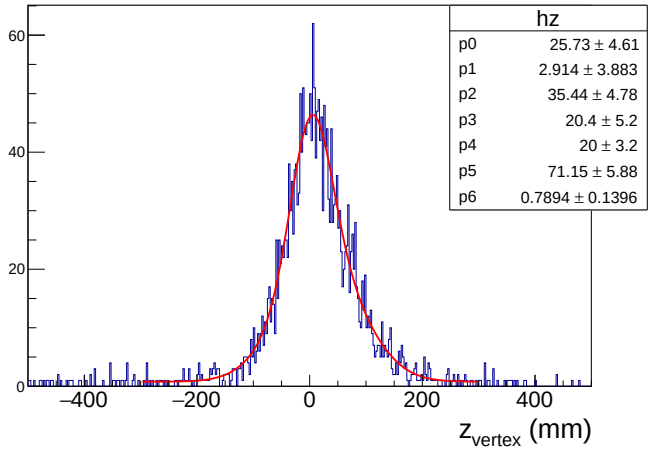
PRadius

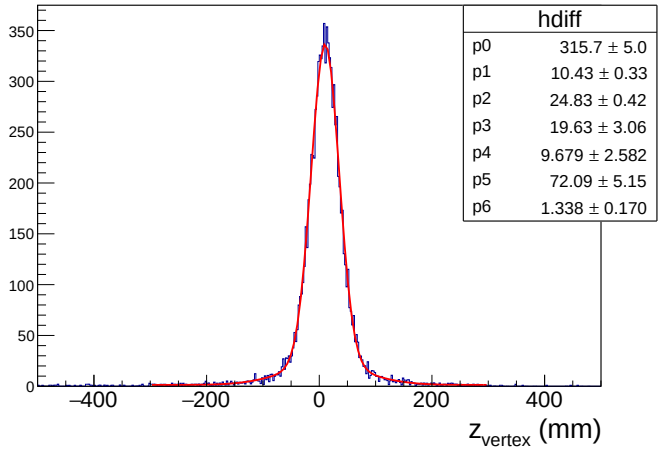
production



carbon







- Double gaussian fit
  $g2(z) \approx 300e^{-z^2/(2*0.025^2)} + 20e^{-z^2/(2*0.07^2)}$

Target Thickness

- Assuming uniform density distribution (P and T averaged for each run):

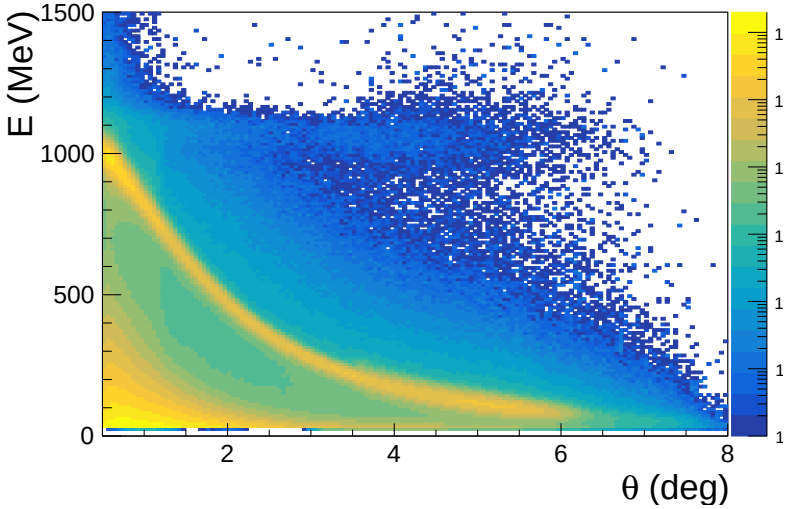
$$\begin{aligned}
\tau_0 &= \rho_0 \cdot \Delta z \\
\rho_0 &= 2 * P(Torr)/0.76(Torr) * 273.15(K)/T(K) \\
&\quad *8.988 \cdot 10^{-5}(g/m^3) * N_A/2.0159(g/mol) \\
\rho_0 &\approx 4.65 \cdot 10^{23} H/m^3 \text{(for P=0.47 Torr and T=19.5 K)}
\end{aligned}$$

- Assuming double gaussian profiles :

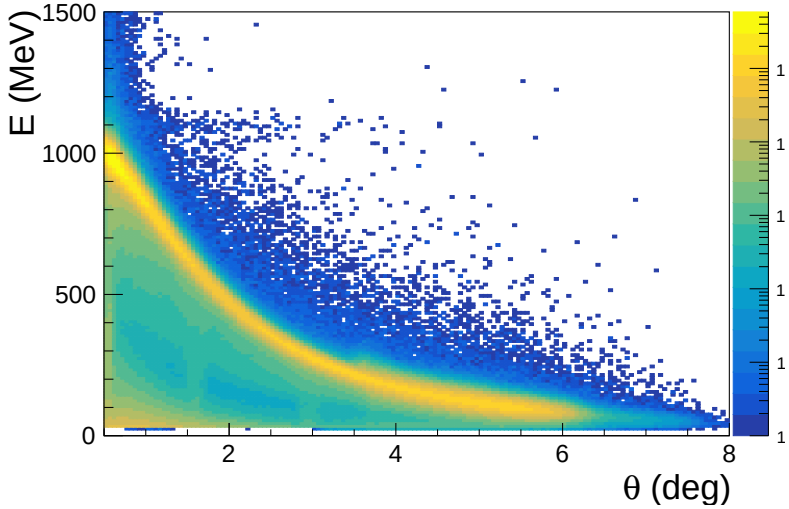
$$\begin{aligned}
g2(z) &= 300e^{-z^2/(2*0.025^2)} + 20e^{-z^2/(2*0.07^2)} \\
\rho &= \frac{\rho_0}{g2(0)} \int_{-0.05}^{0.05} g2(z)dz \\
|\tau/\tau_0 - 1| &\approx 10\%
\end{aligned}$$

Double Arm Selection

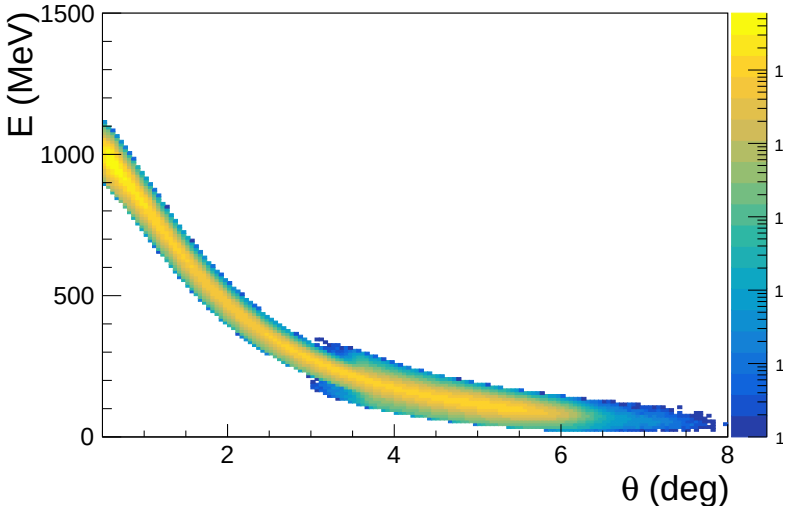
raw



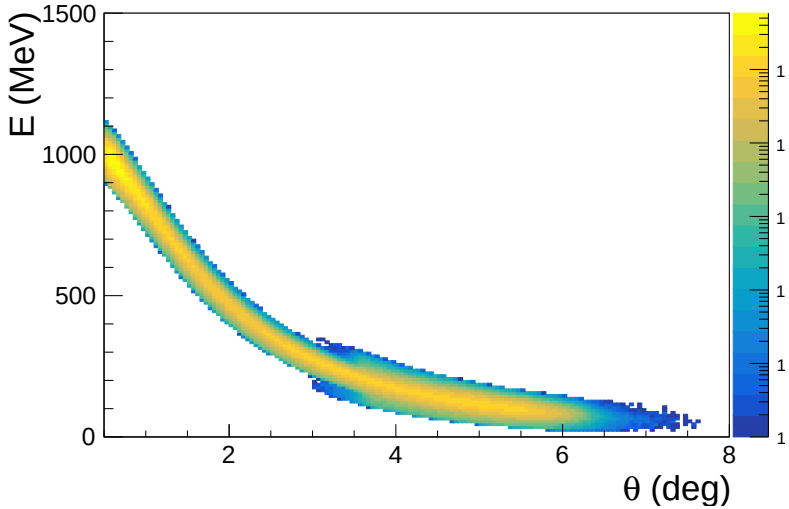
$\Delta\phi$ cut



elasticity cut

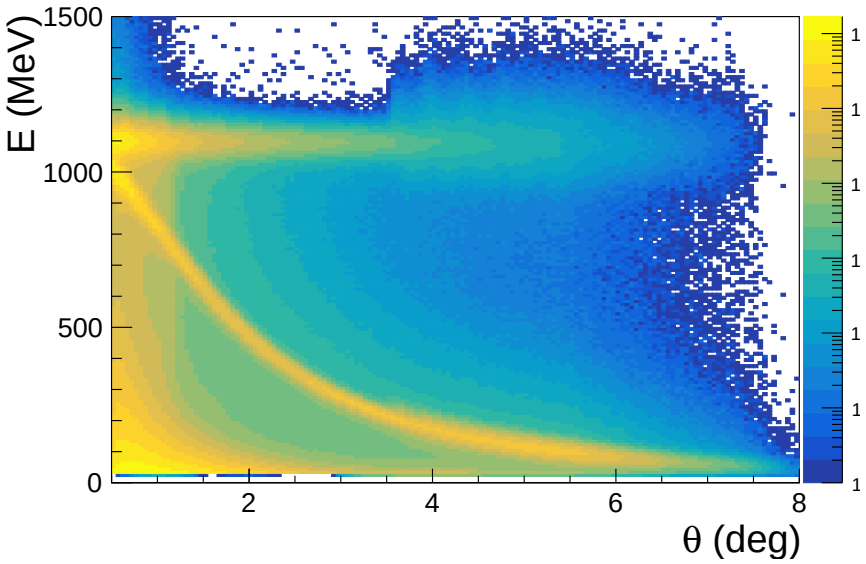


all cuts

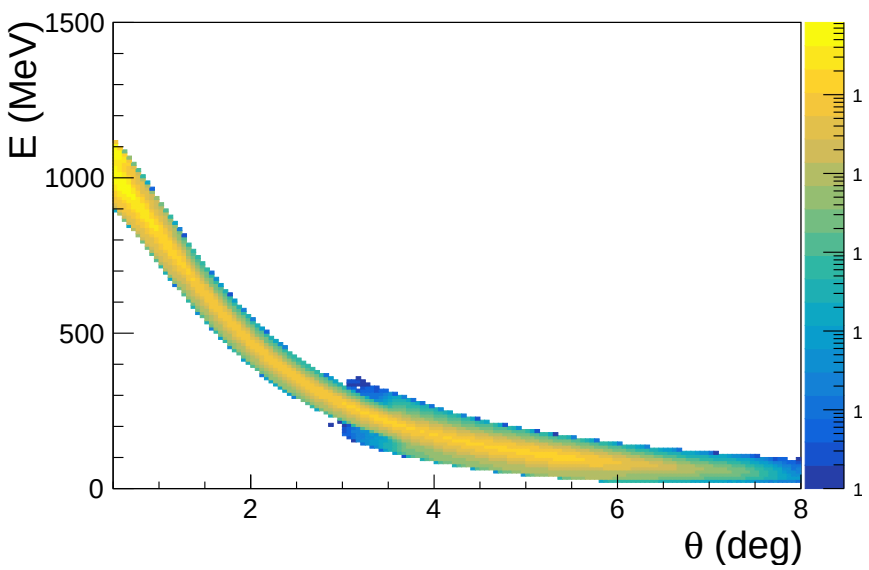


Single Arm Selection

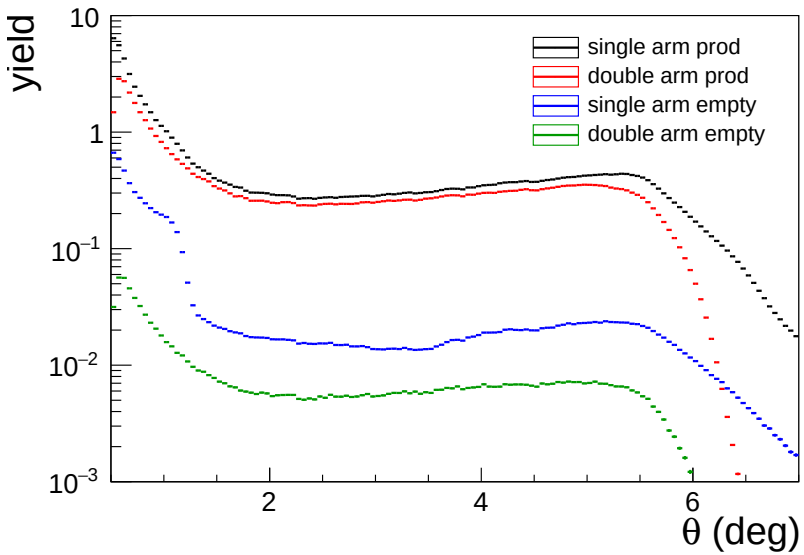
raw

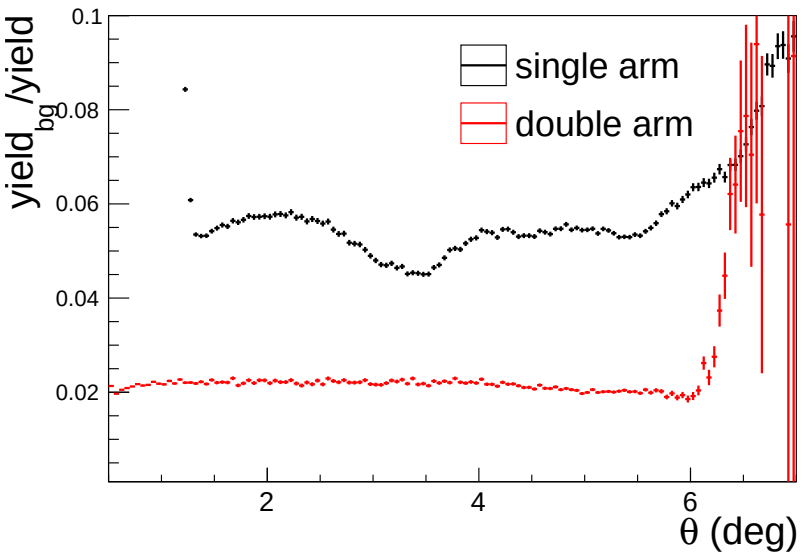


elasticity cut

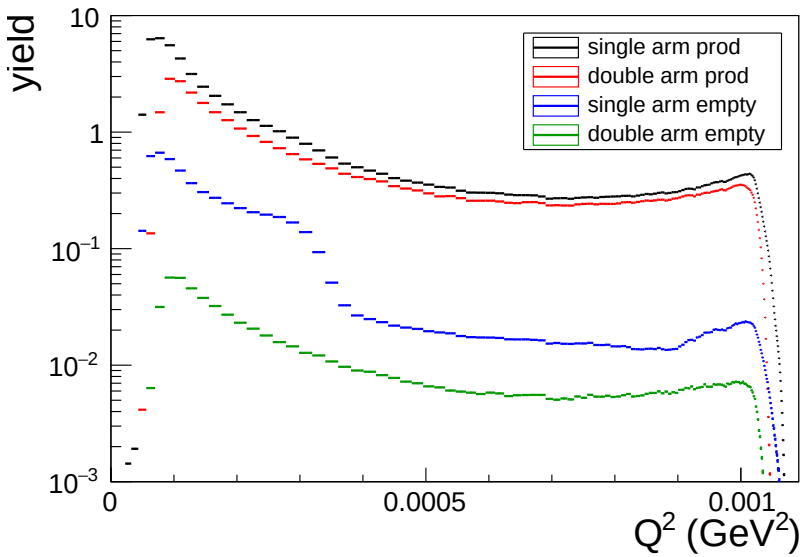


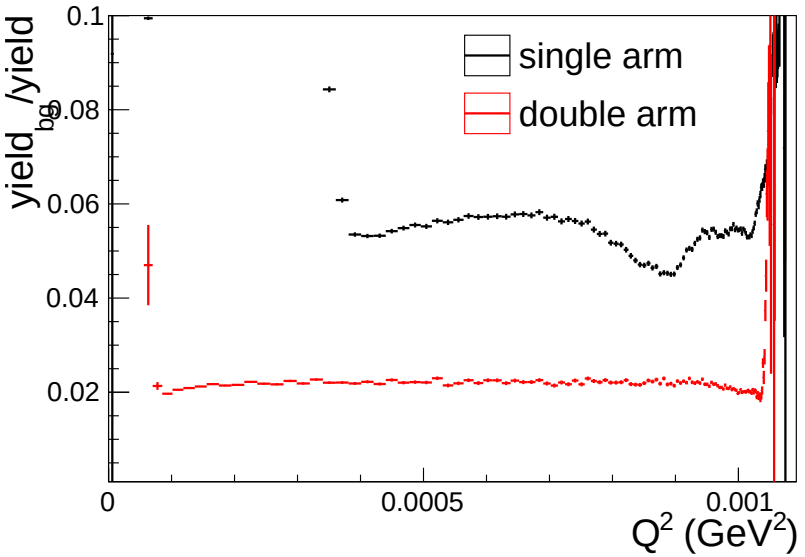
Yields (θ)



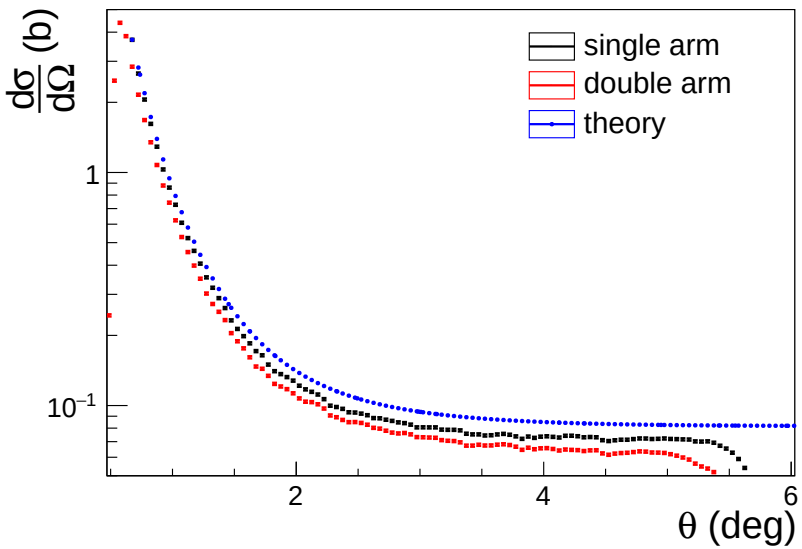


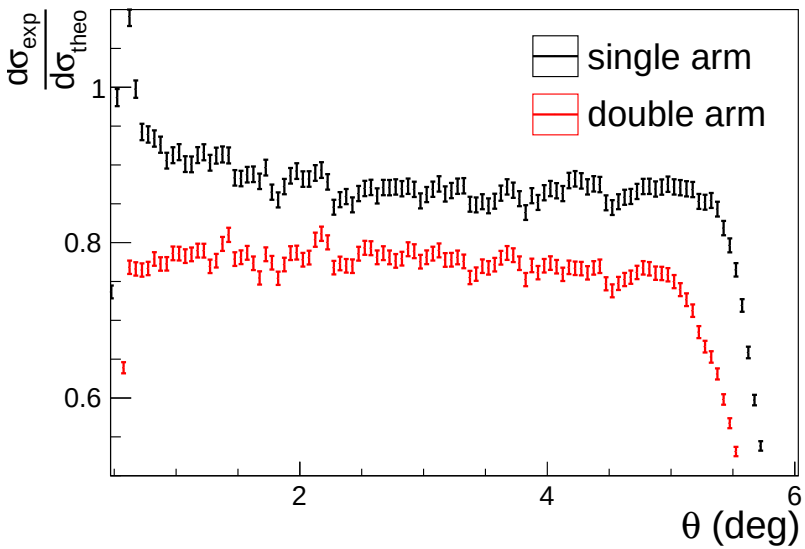
Yields (Q^2)


yield
10
1
10^{-1}
10^{-2}
10^{-3}
0
0.0005
0.001
Q^2 (GeV^2)
single arm prod
double arm prod
single arm empty
double arm empty

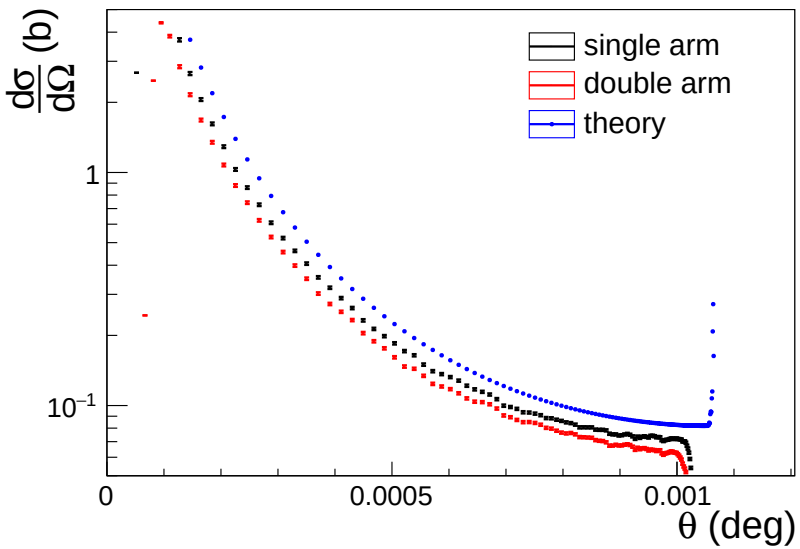

yield$_{bg}$ /yield
0.1
0.08
0.06
0.04
0.02
0
0.0005
0.001
Q^2 (GeV^2)
single arm
double arm

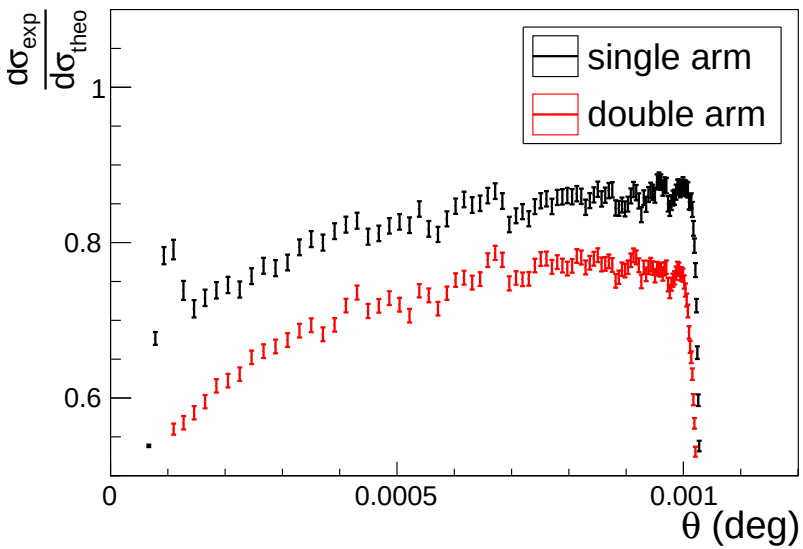
Raw Cross Sections (without acceptance) (θ)



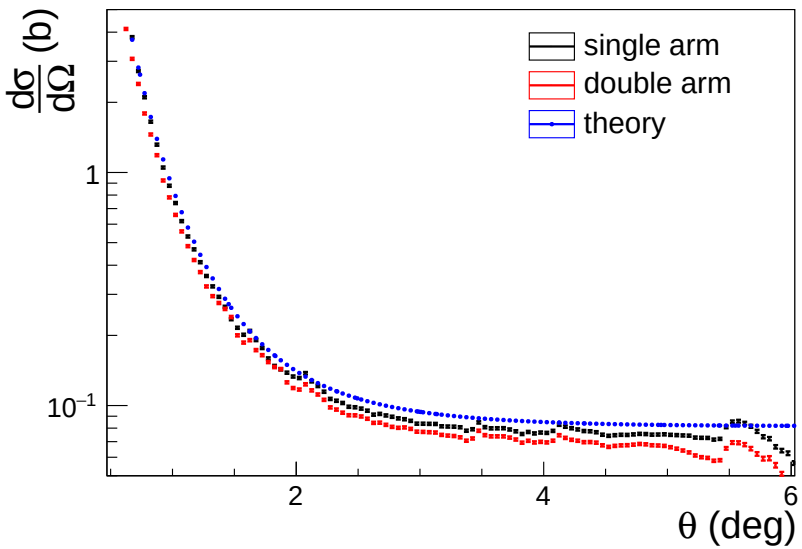


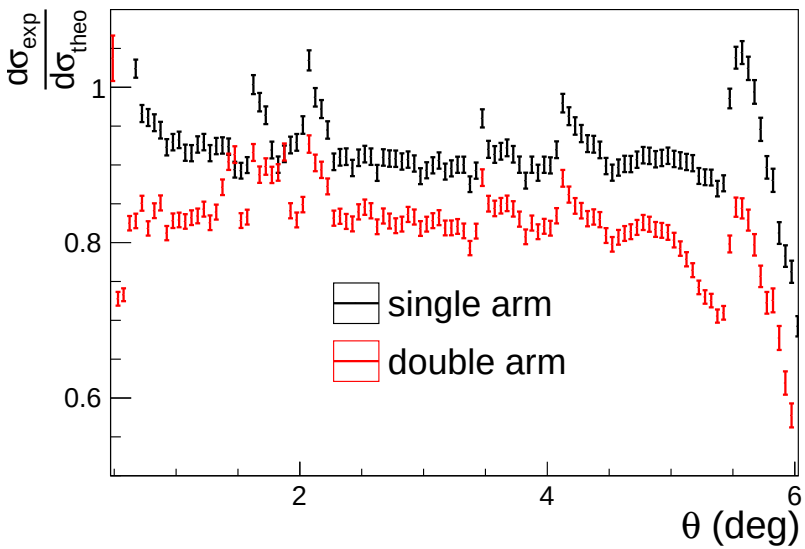
Raw Cross Sections (without acceptance) (Q^2)



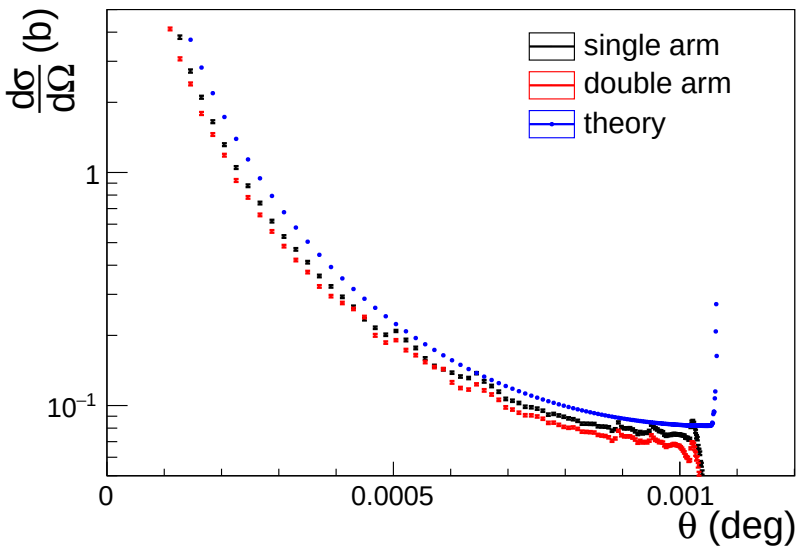


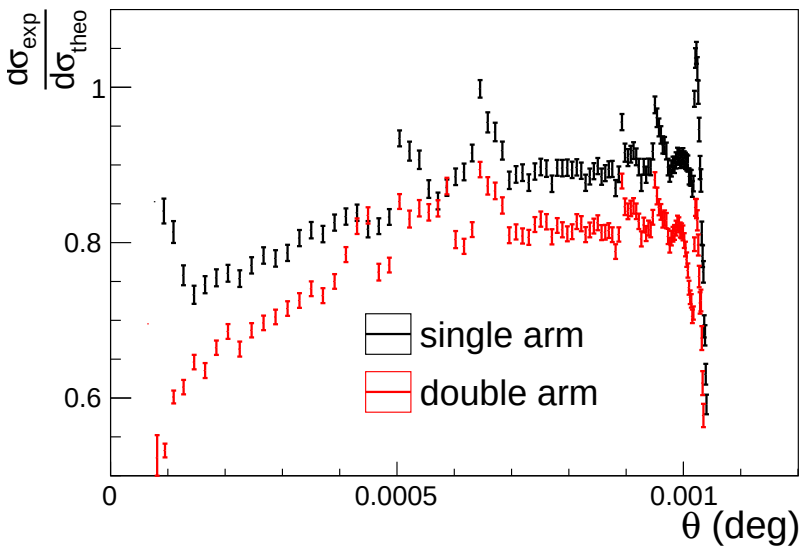
Cross Sections (with geometrical acceptance)





Cross Sections (with geometrical acceptance)





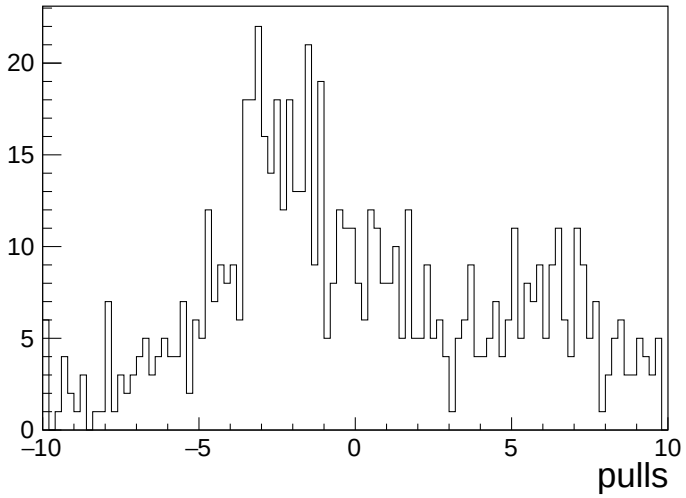
Yield Stability with Pulls Distribution

- Definition

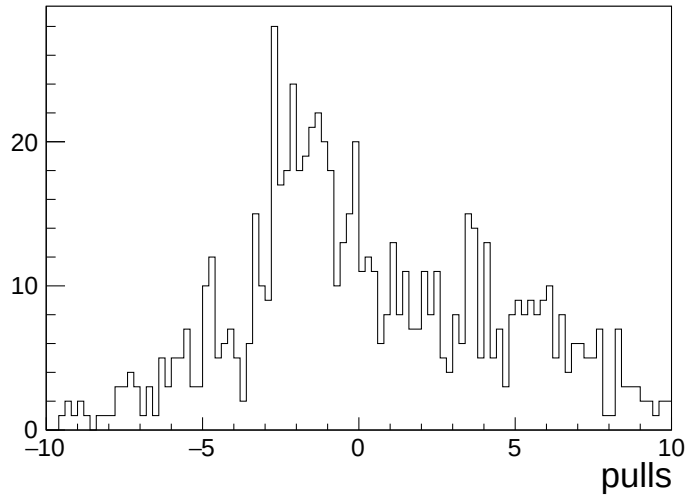
$$
\begin{aligned}
p(\theta)_{run} &= \frac{x_{run}(\theta) - < x > (\theta)}{\sqrt{\sigma^2_{x_{run}}(\theta) - \sigma^2_{<x>}(\theta)}} \\
x_{run}(\theta) &= N_{run}(\theta)/N_{0\,run}/\tau_{run} \\
< x > (\theta) &= \sum_{run} N_{run}(\theta) / \sum_{run} N_{0\,run}/\tau
\end{aligned}
$$

Pulls Distributions: production

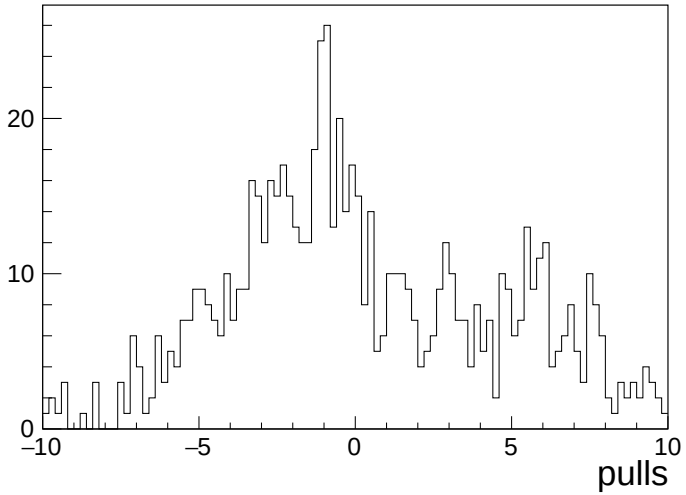
1 - 2 degree



2 - 3 degree



3 - 4 degree



4 - 5 degree