BAND: status of analysis and calibration

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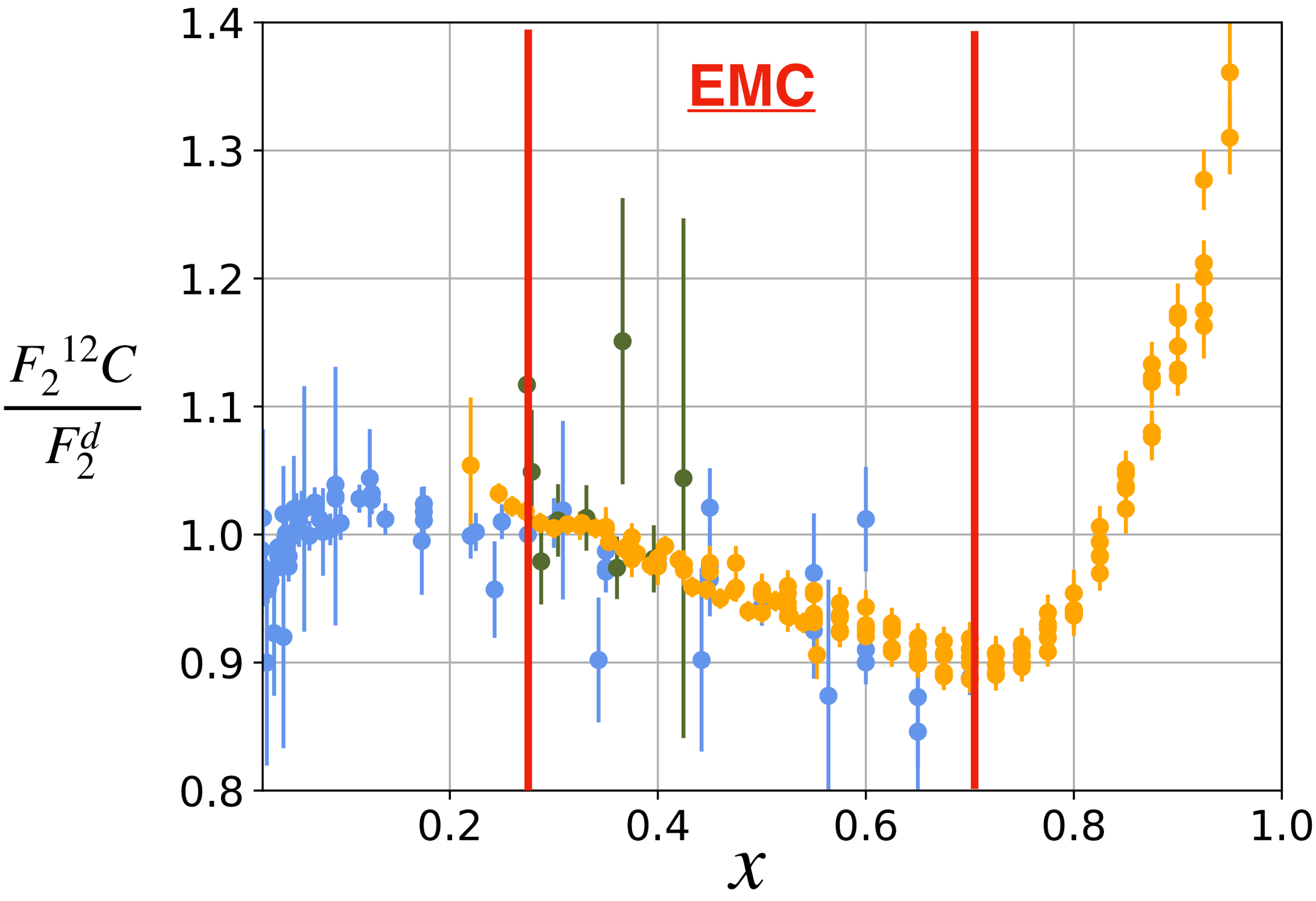
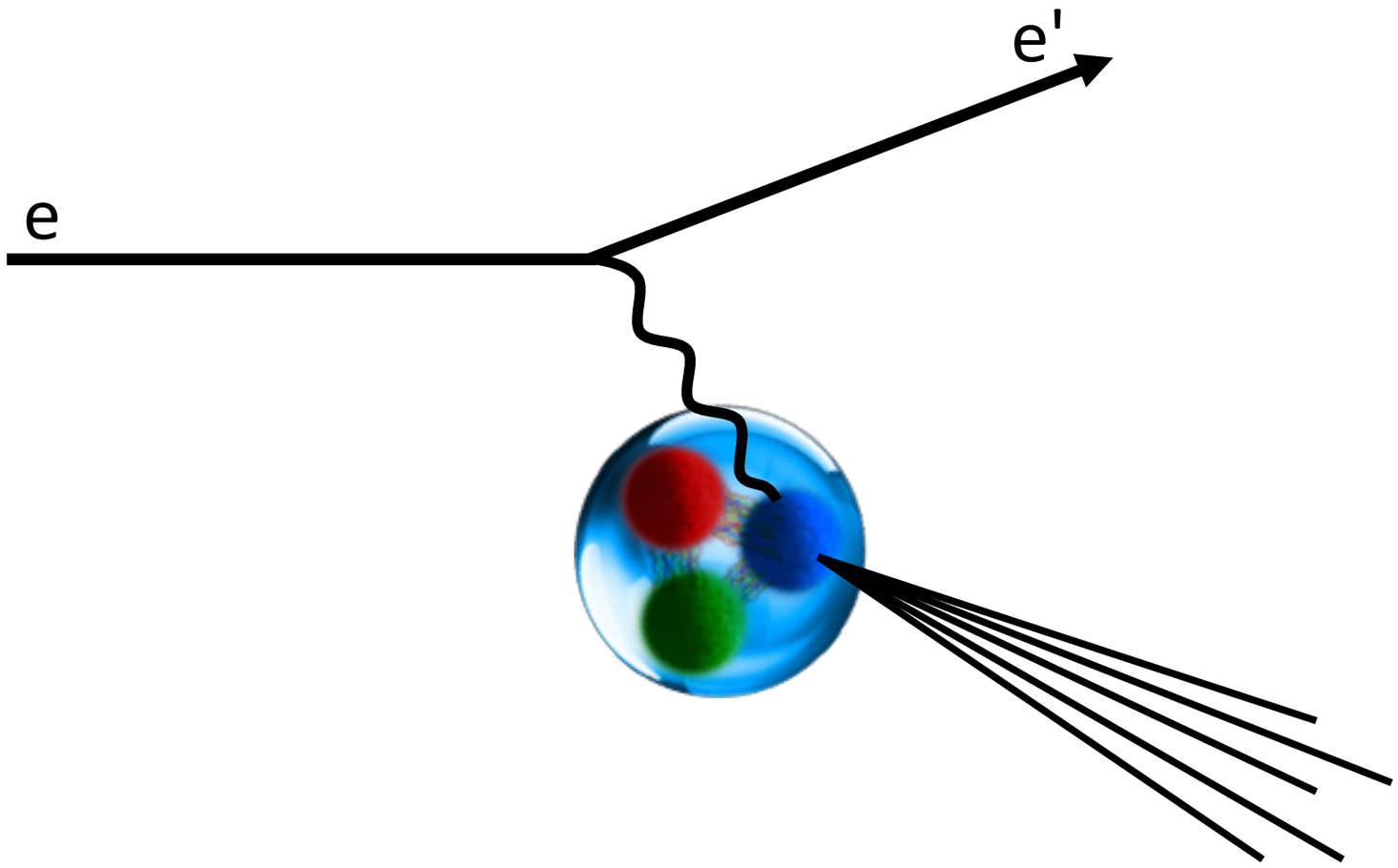
Outline

- Physics goals of BAND
- BAND Detector
- Recommissioning for RGB
- Status of analysis

Quarks behave differently in bound nucleon

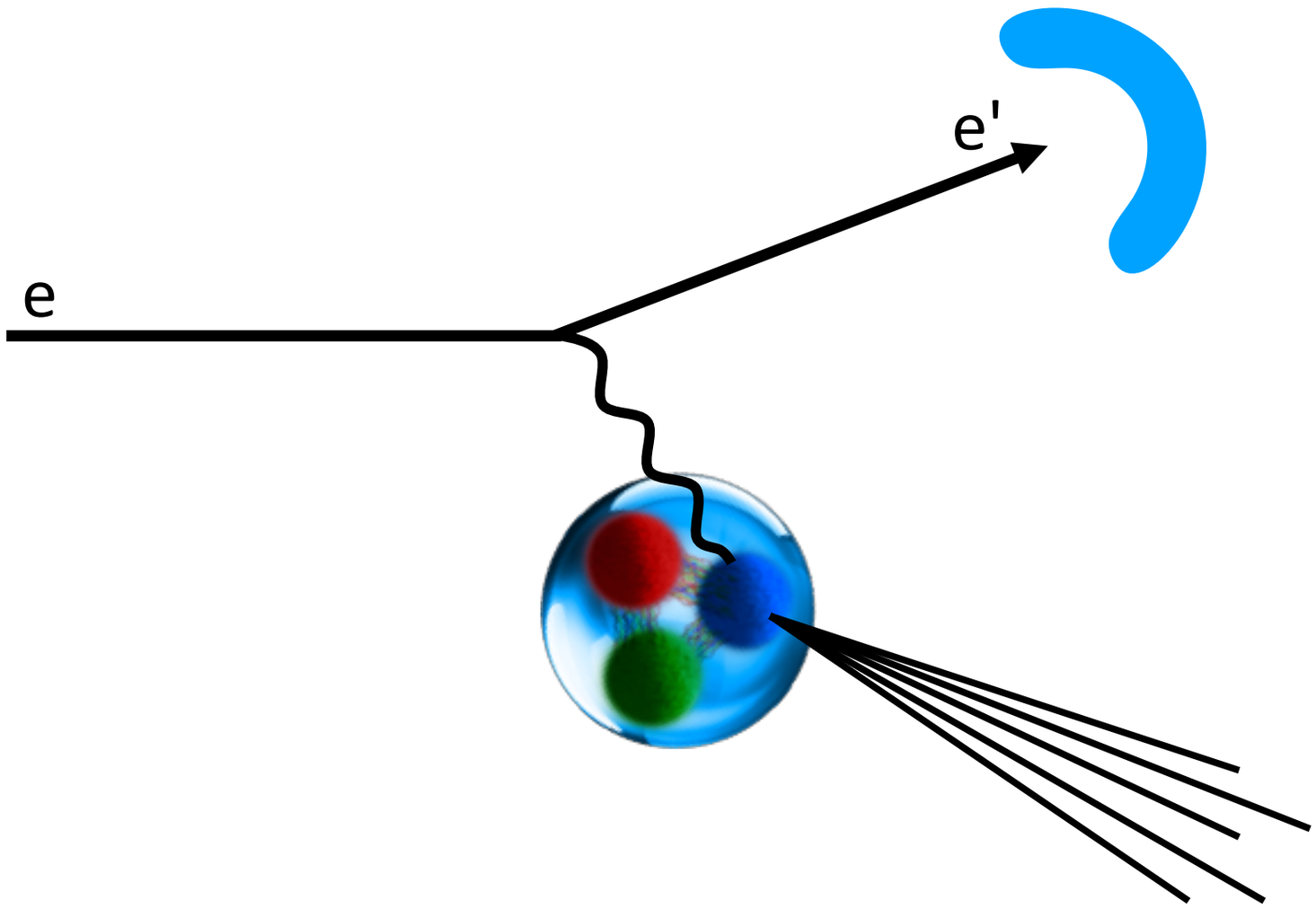


Inclusive DIS off proton



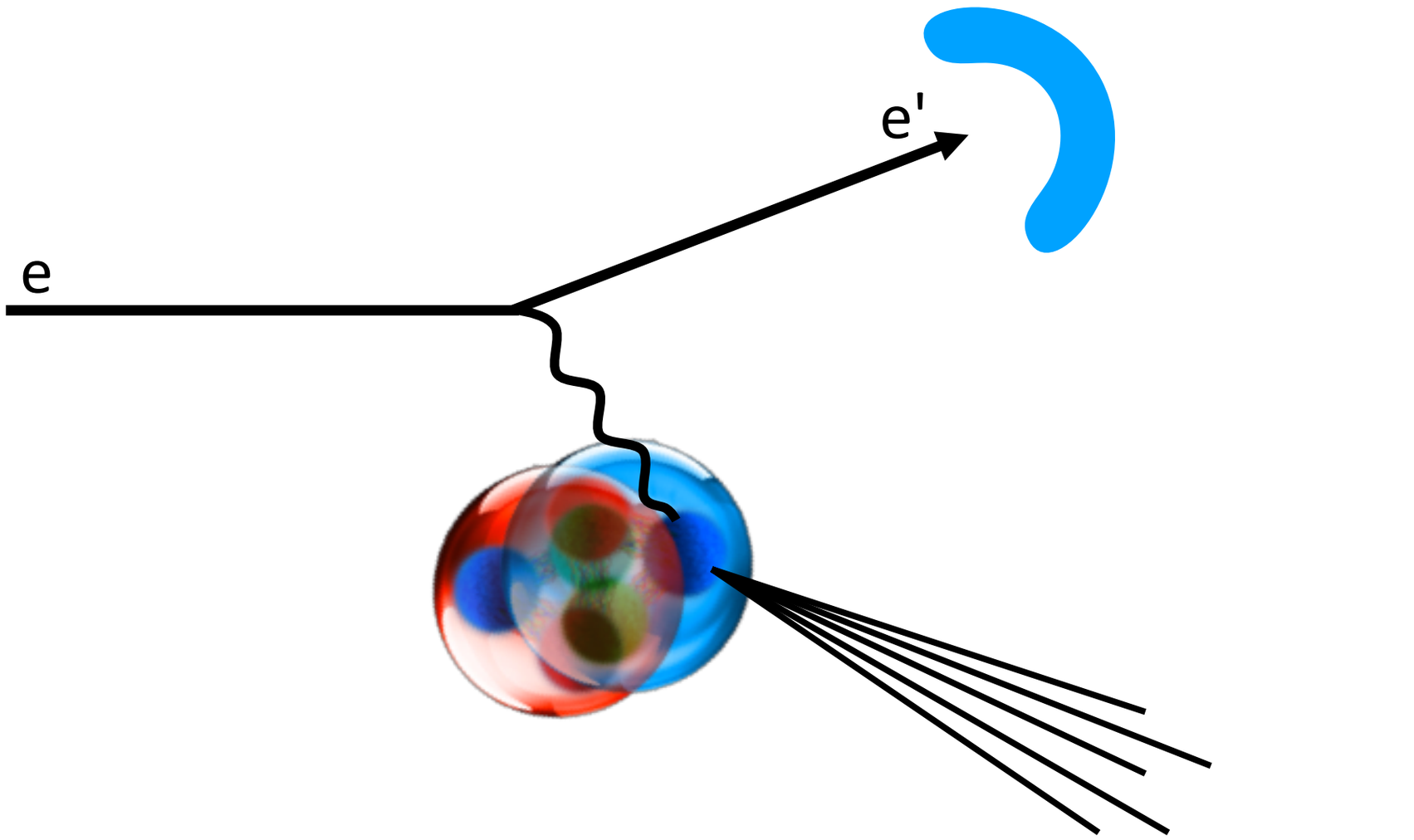
x

Inclusive DIS off proton



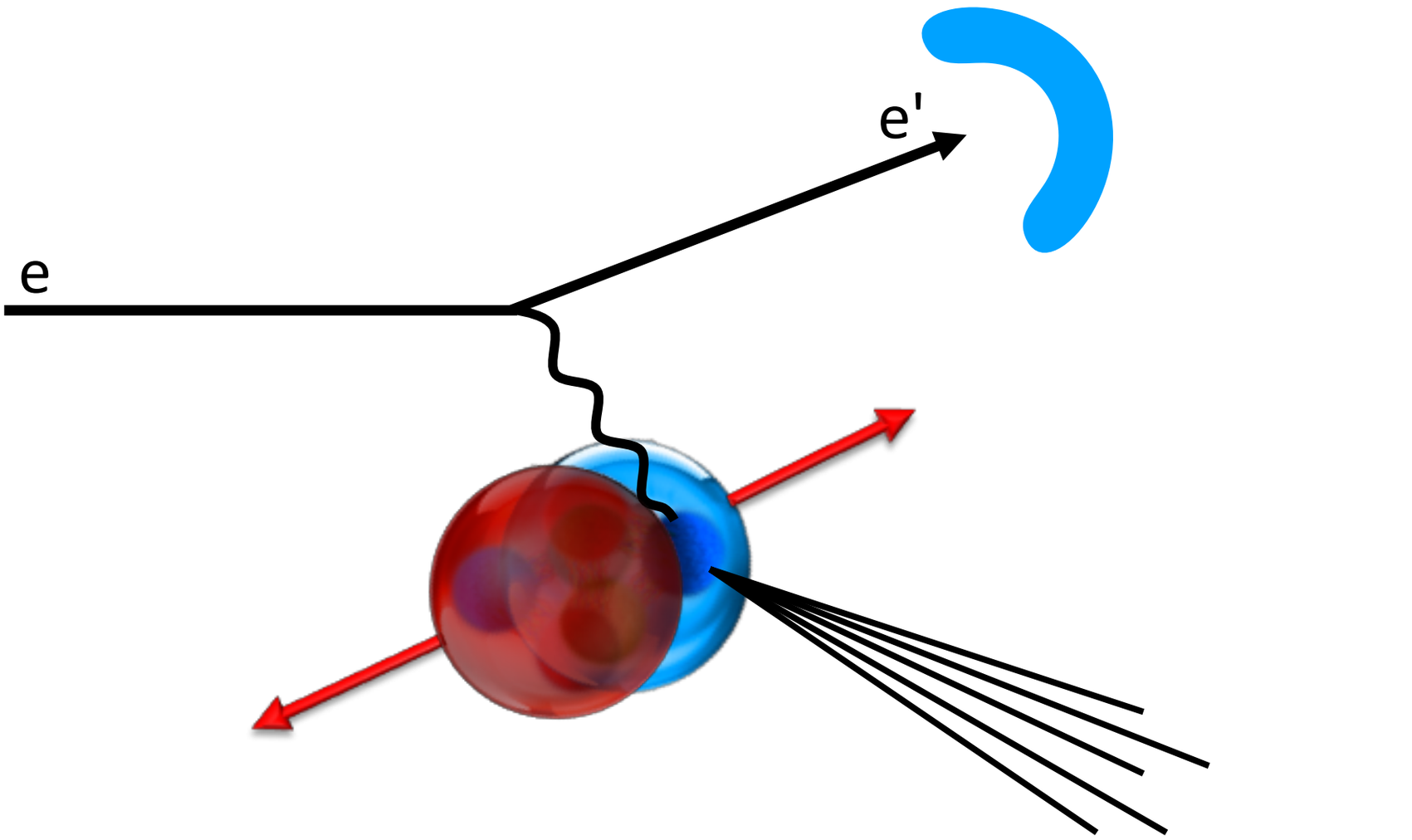
- Partonic-state

DIS off bound nucleon in deuterium



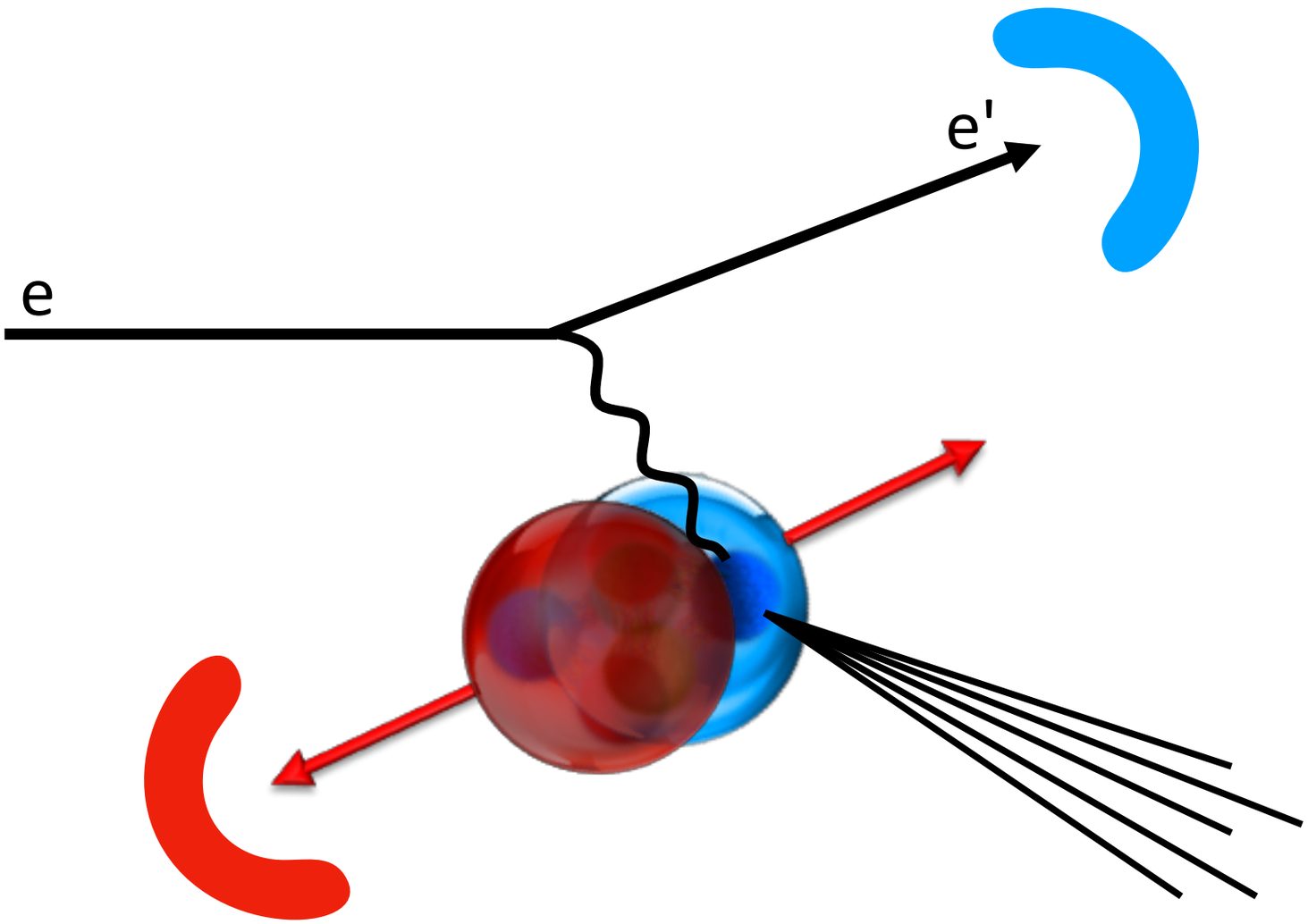
- Partonic-state

DIS off bound nucleon in deuterium



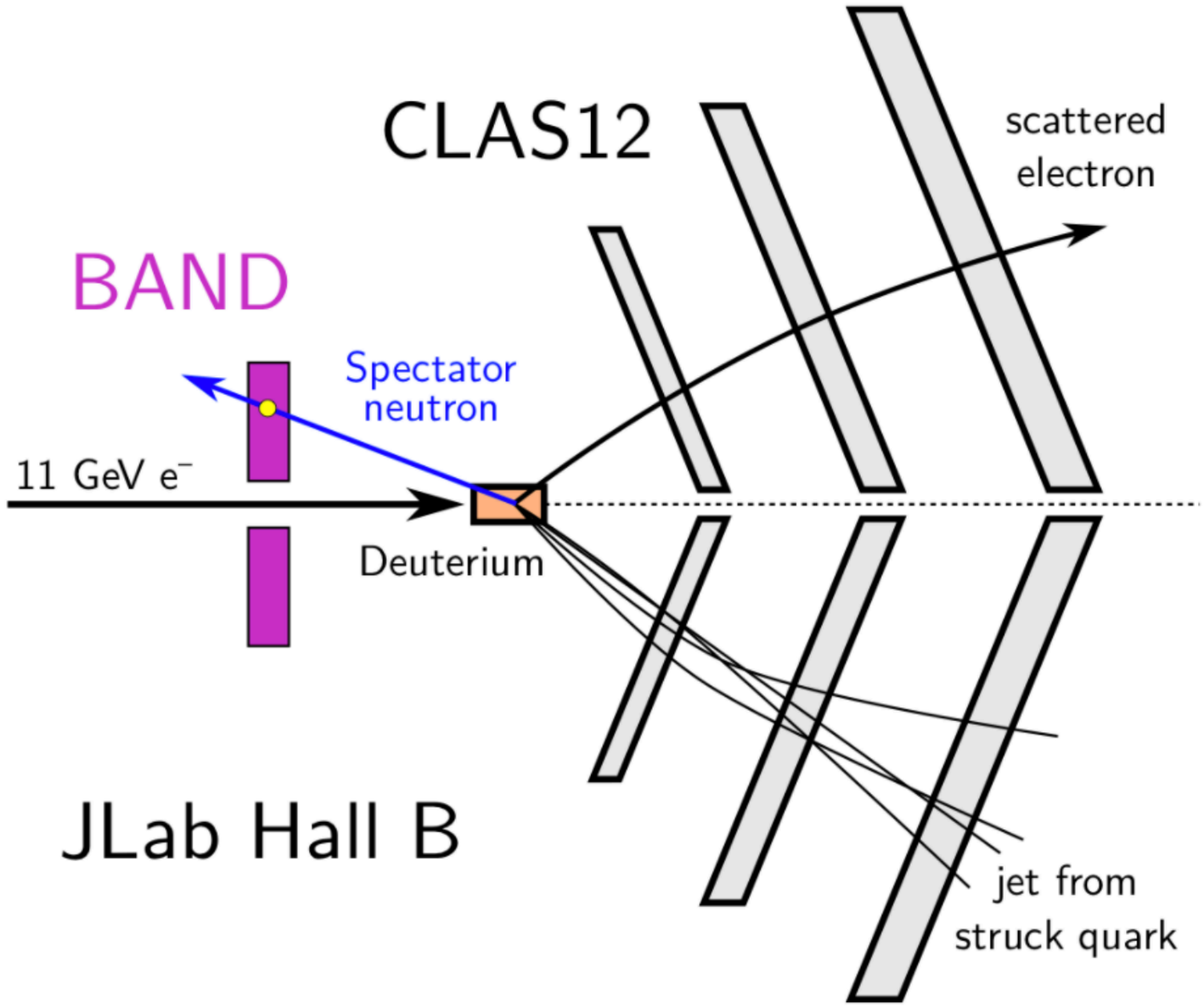
- Partonic-state

Modification of structure with spectator-tagging



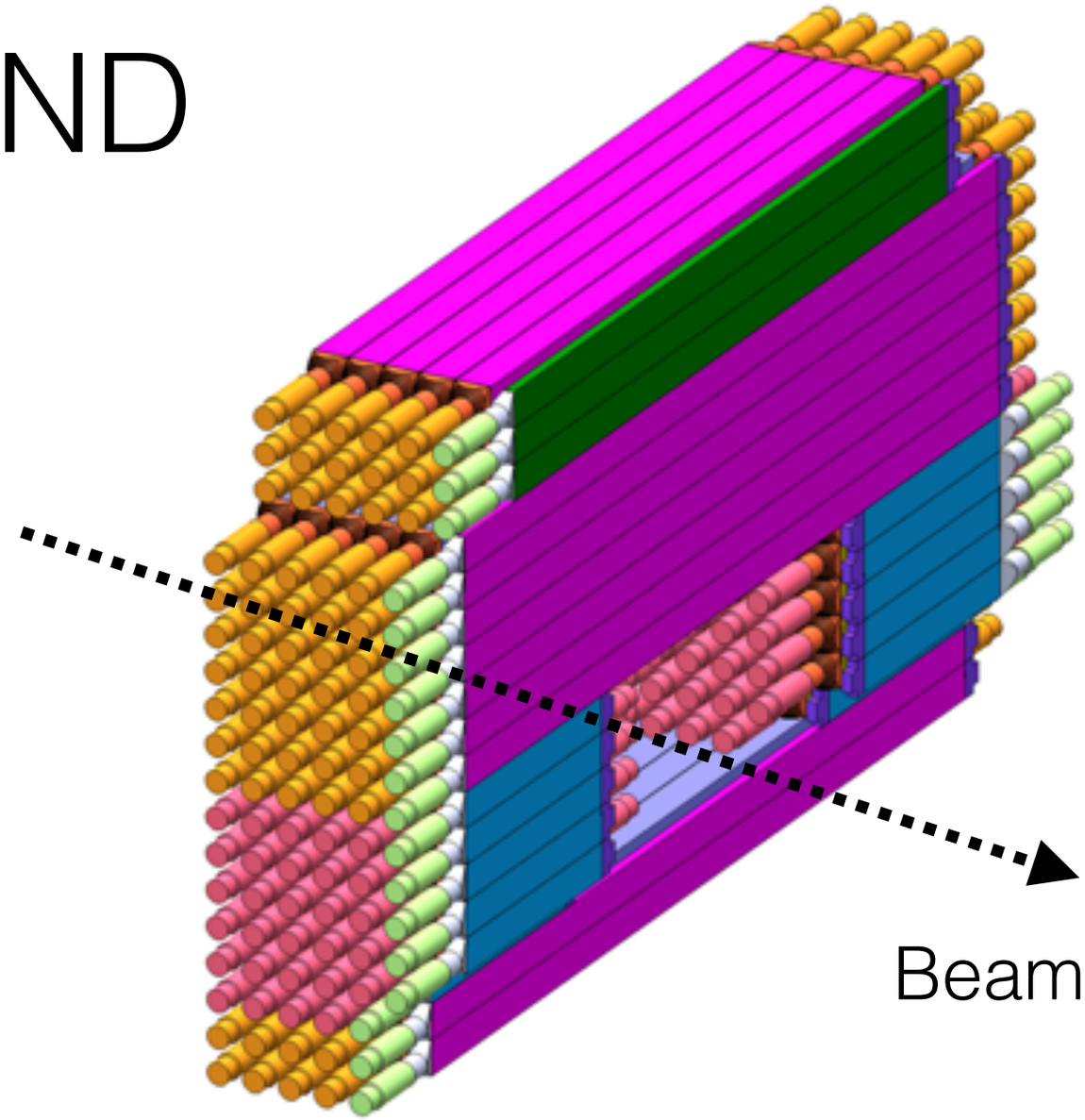
- Partonic-state
- Nucleonic-state

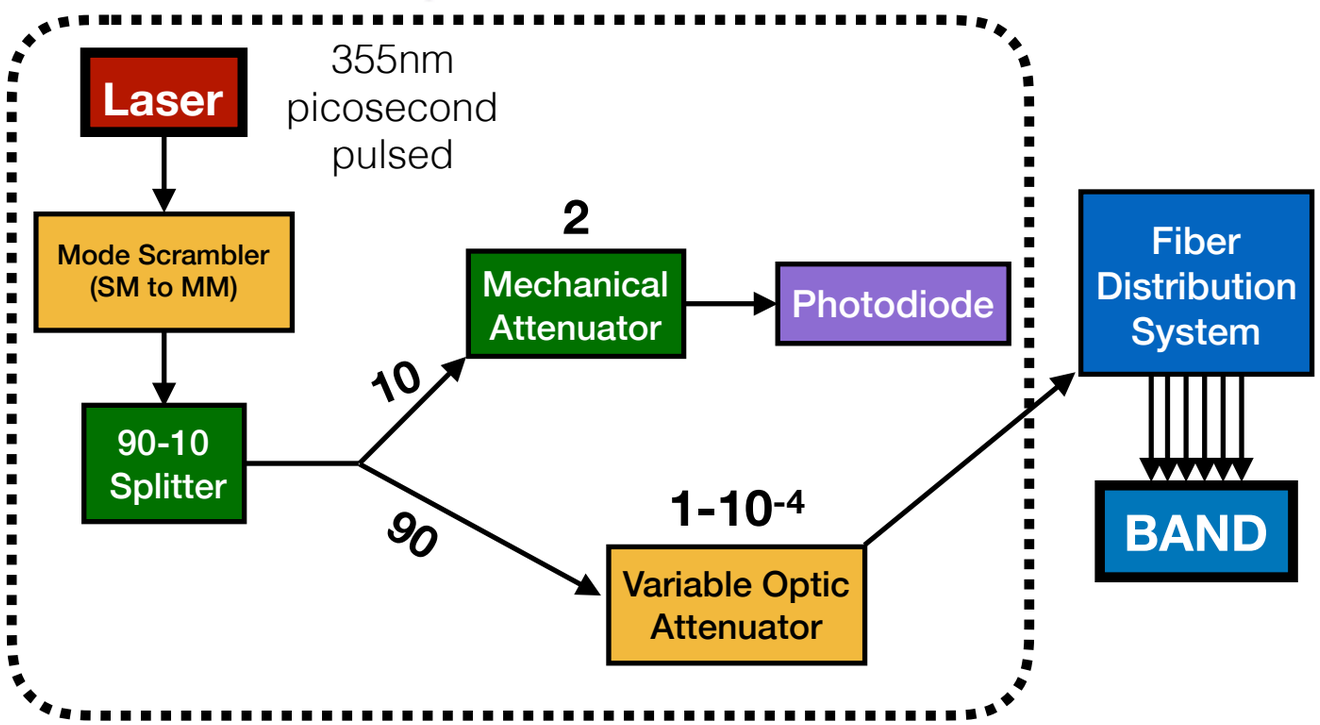
Modification of structure with spectator-tagging

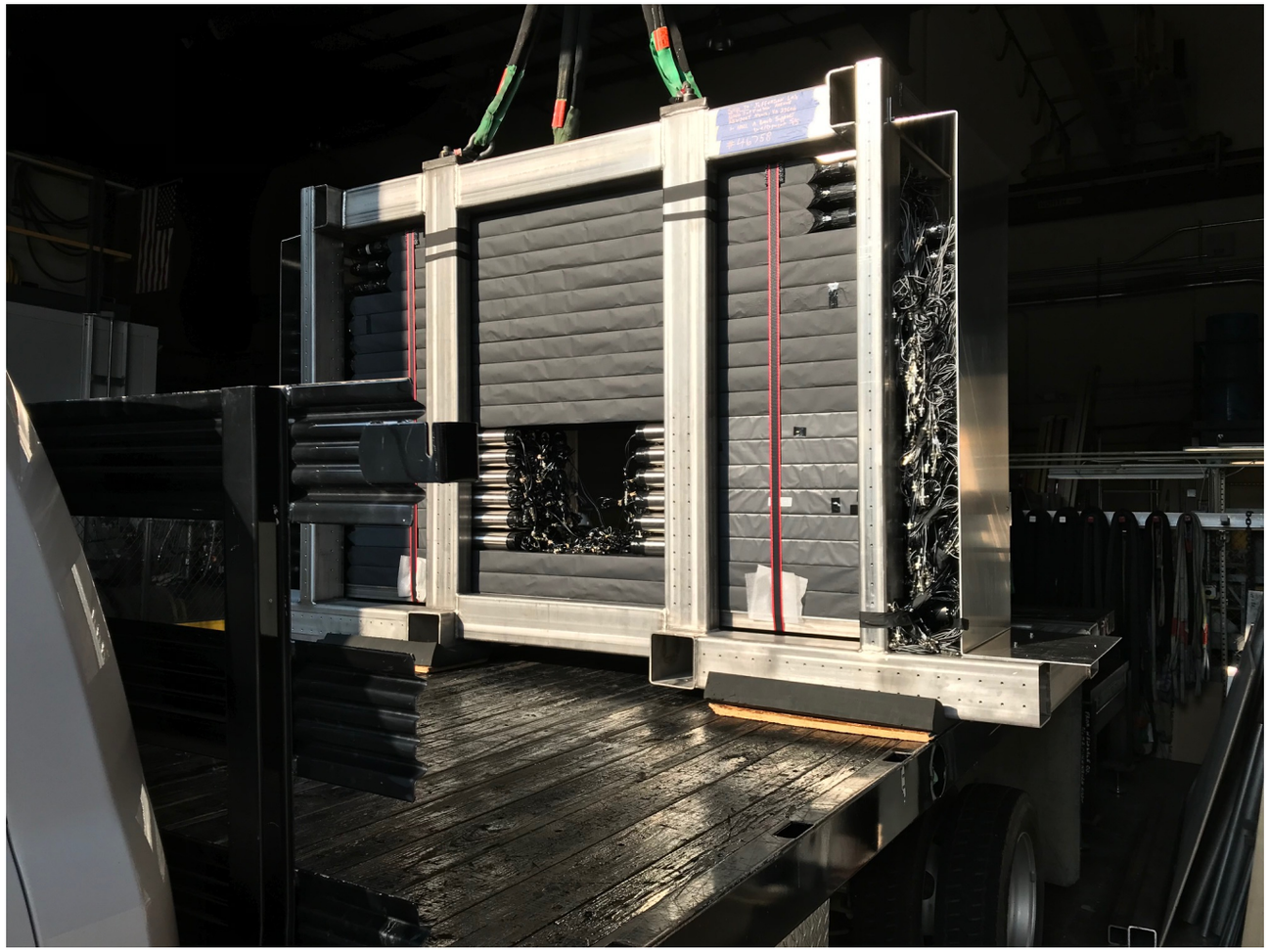


BAND

- 140 scintillator bars
- 5 layers thick (36cm total) with veto layer (2cm thick)
- ToF resolutions < 250 ps
- 3 meters upstream of target, coverage in θ ~ 155-176°
- Design neutron efficiency ~35% and momentum resolution ~1.5%
- Laser system for calibrations







BAND @ CLAS12

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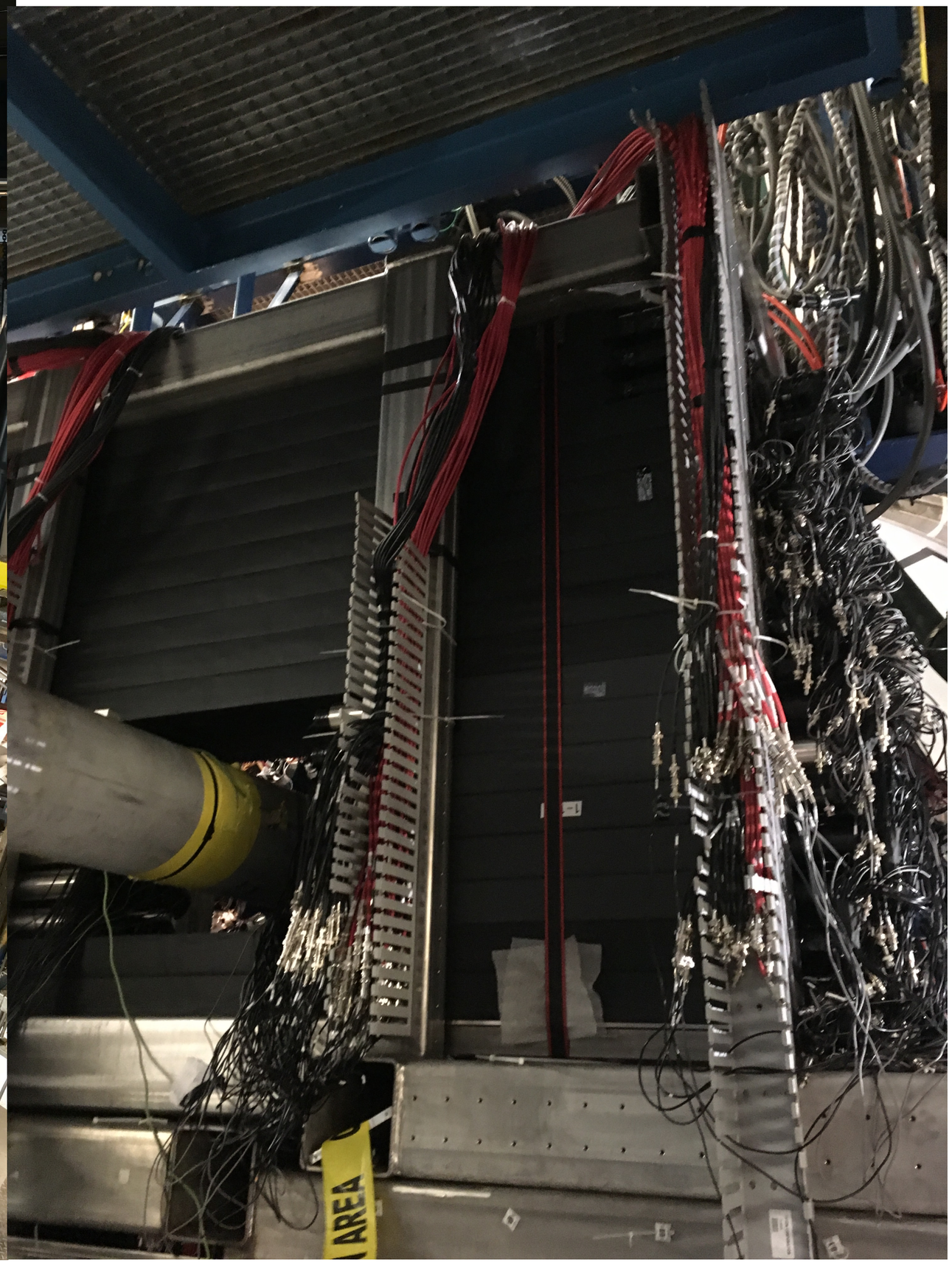


Recommissioning for RGB

Cosmic Data

Source Data

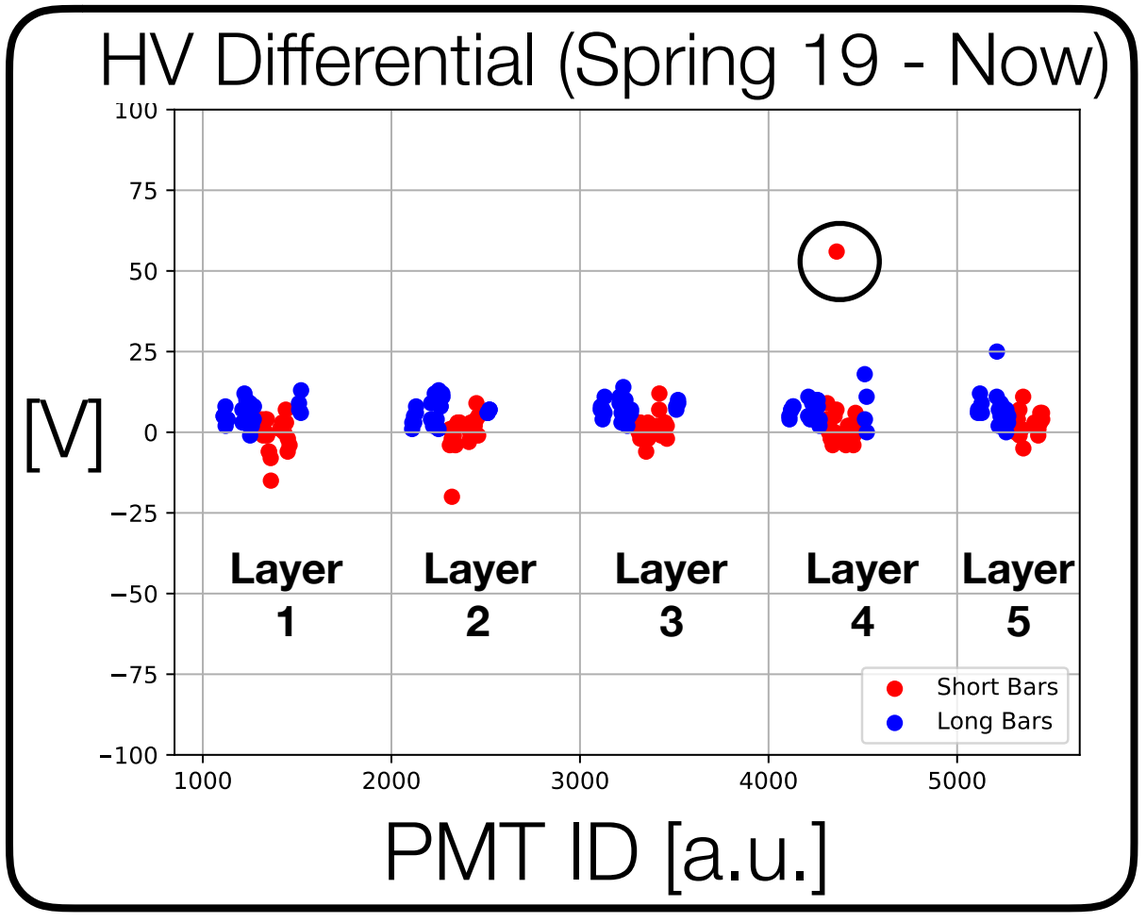
Laser Data

- HV Gain Curves
- ADC to MeV conversion
- Time walk
- Bar effective velocity
- Bar attenuation
- Global bar offsets

Prod Data

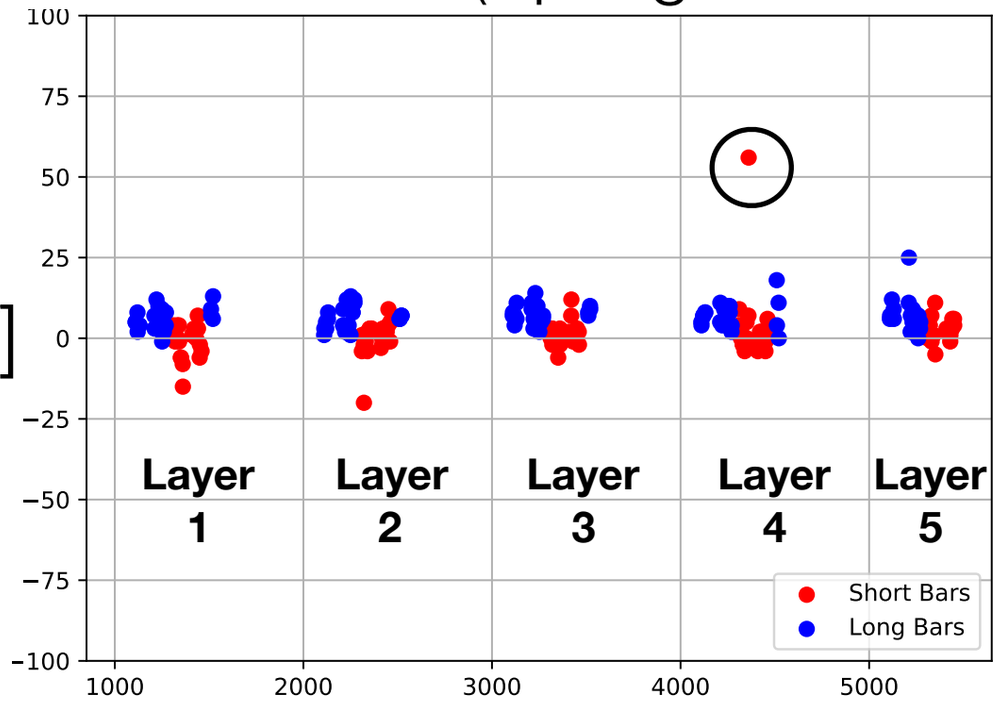
- Neutron efficiency
- Neutron momentum resolution

Recommissioning for RGB



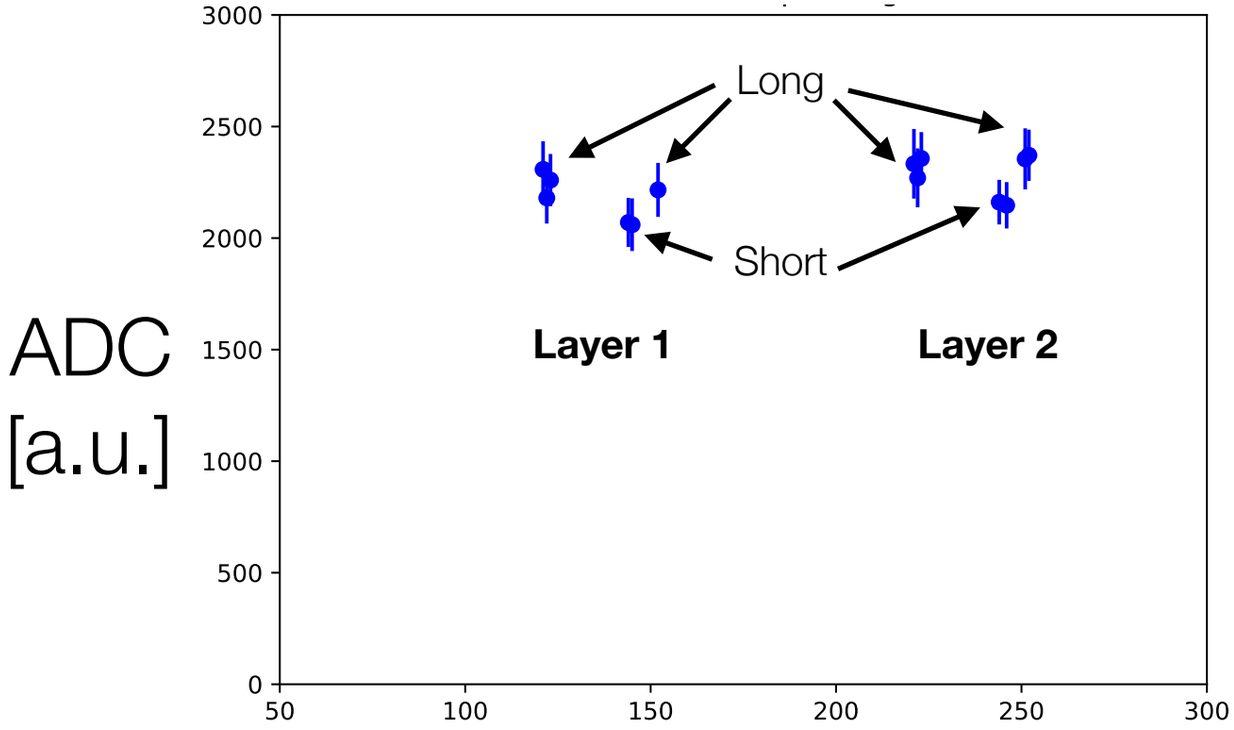
Recommissioning for RGB

HV Differential (Spring 19 - Now)



PMT ID [a.u.]

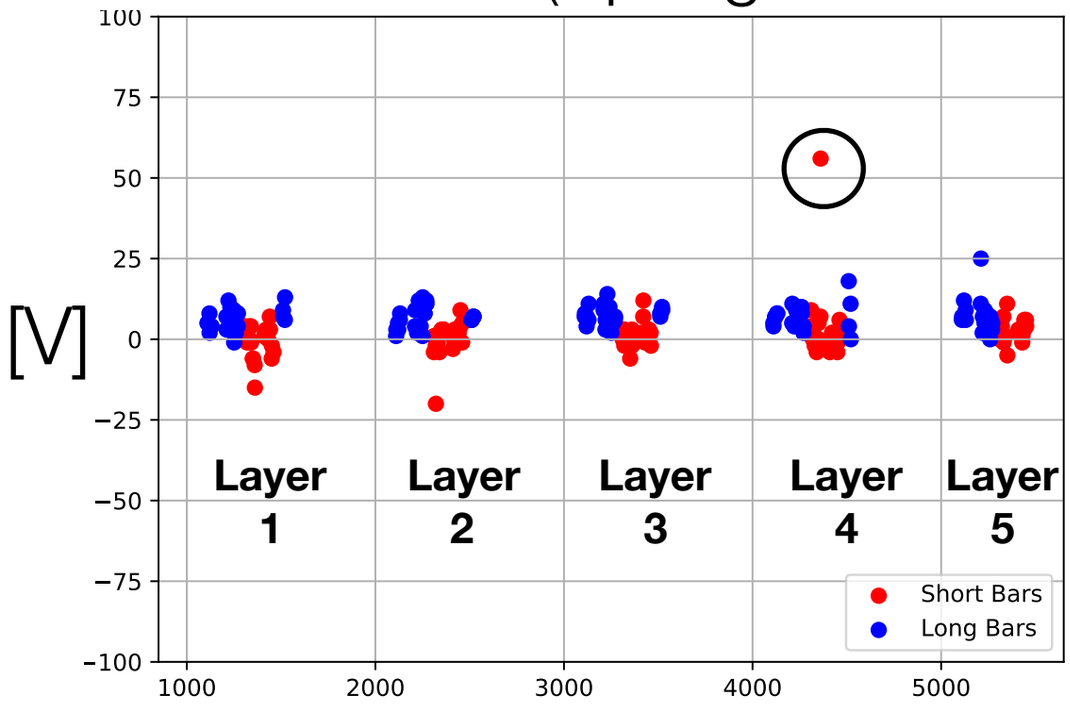
Compton Edge of Co-60 (~1 MeV)



Bar ID [a.u.]

Recommissioning for RGB

HV Differential (Spring 19 - Now)



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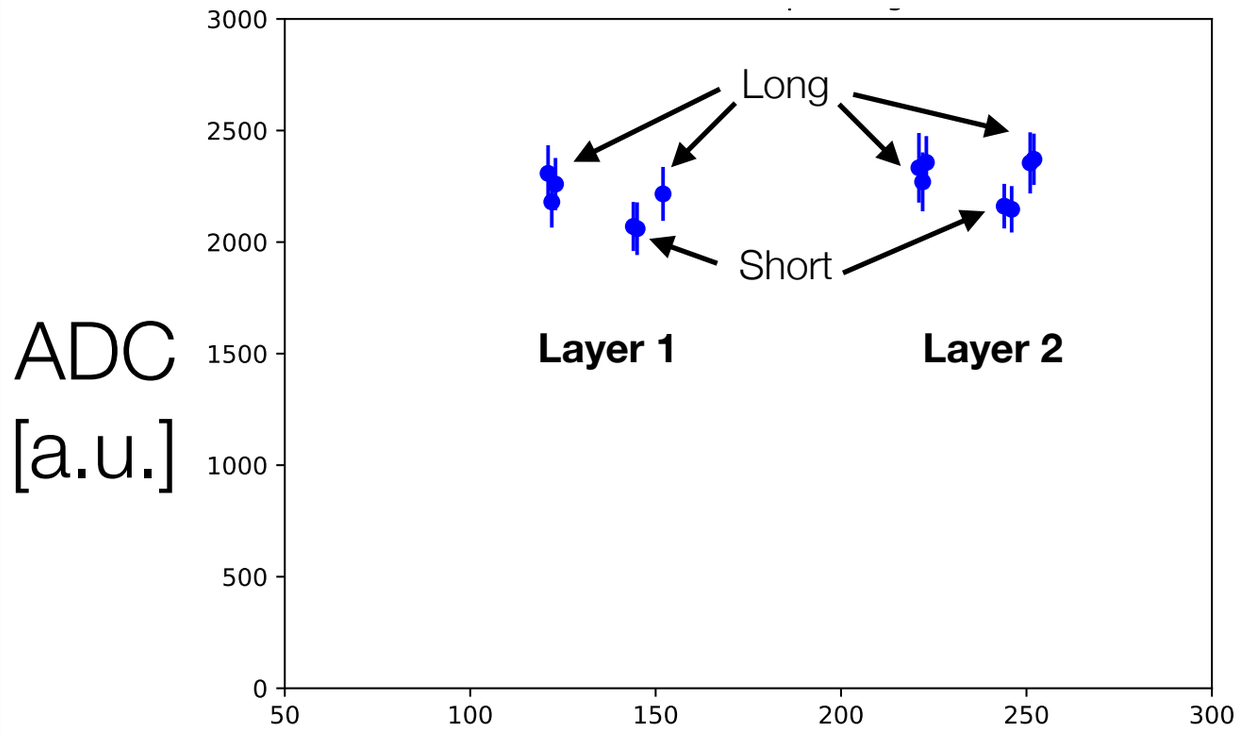
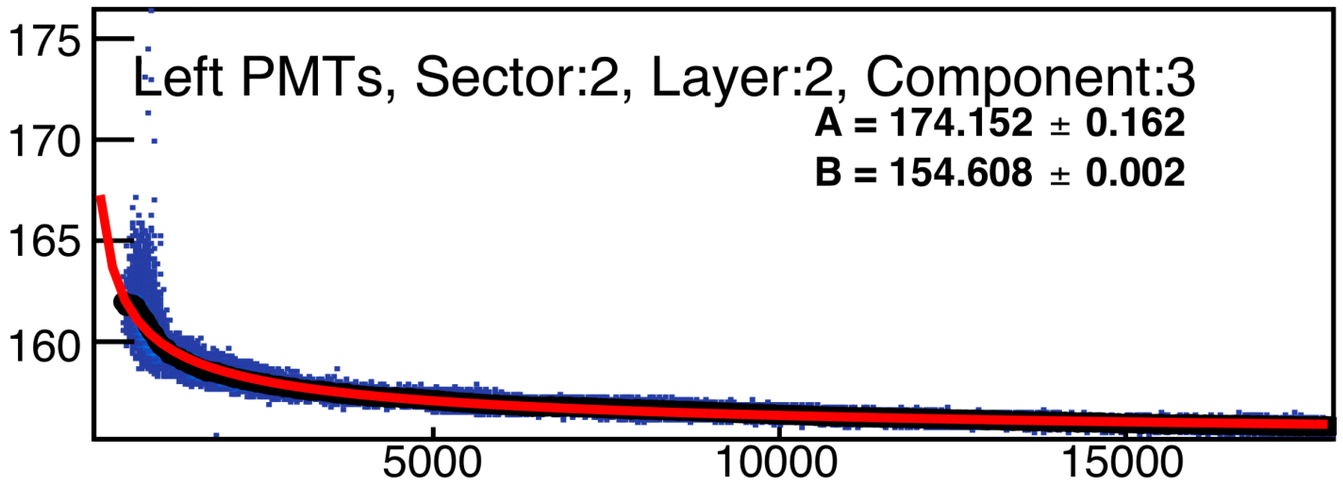
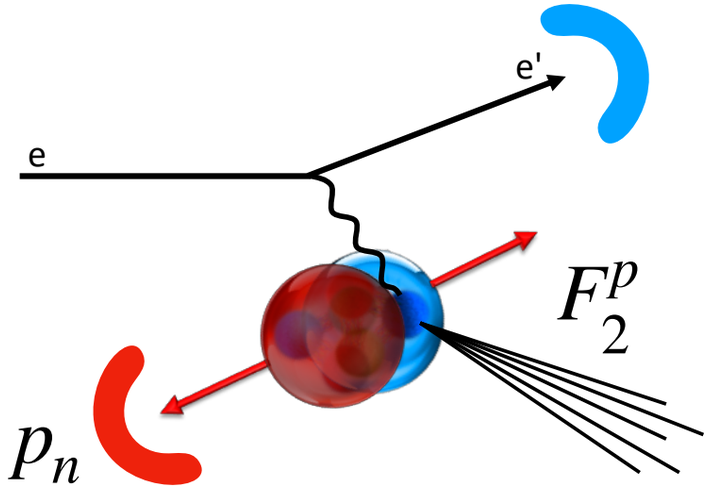
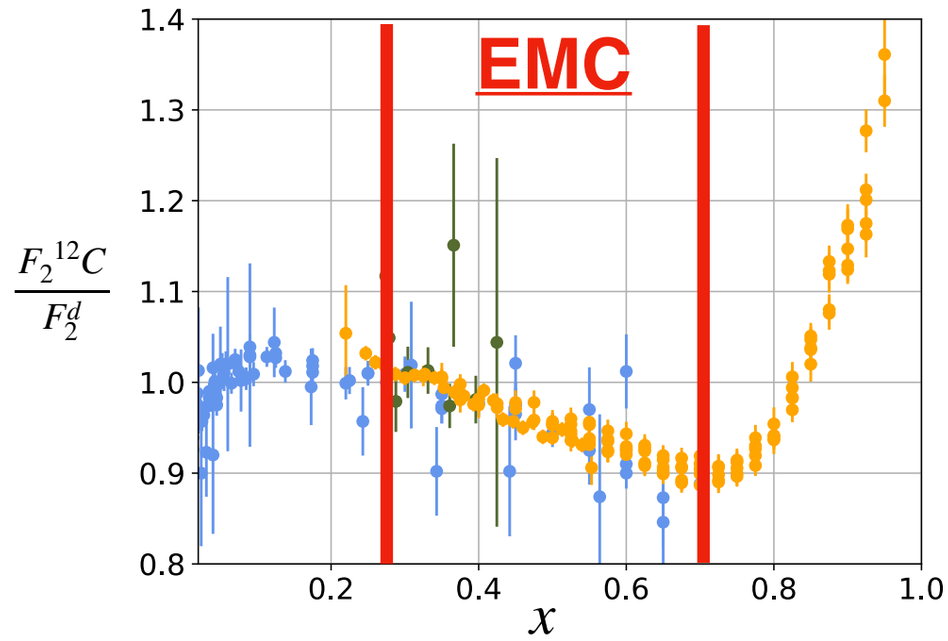


$t_{PMT} - t_{photodiode}$ [ns]



Path towards bound nucleon structure

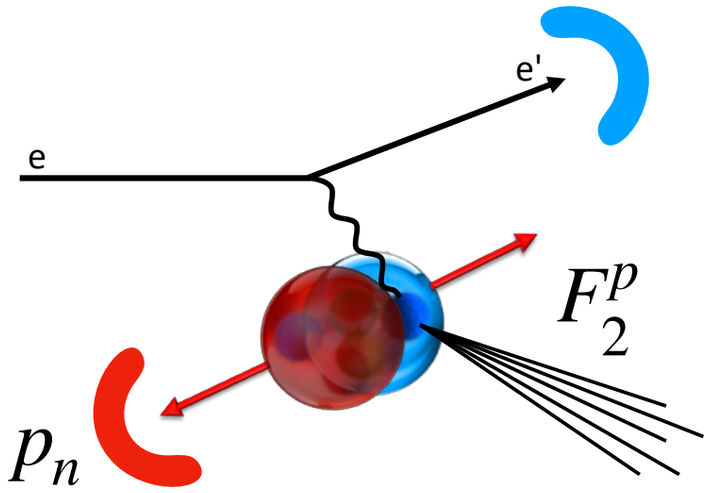


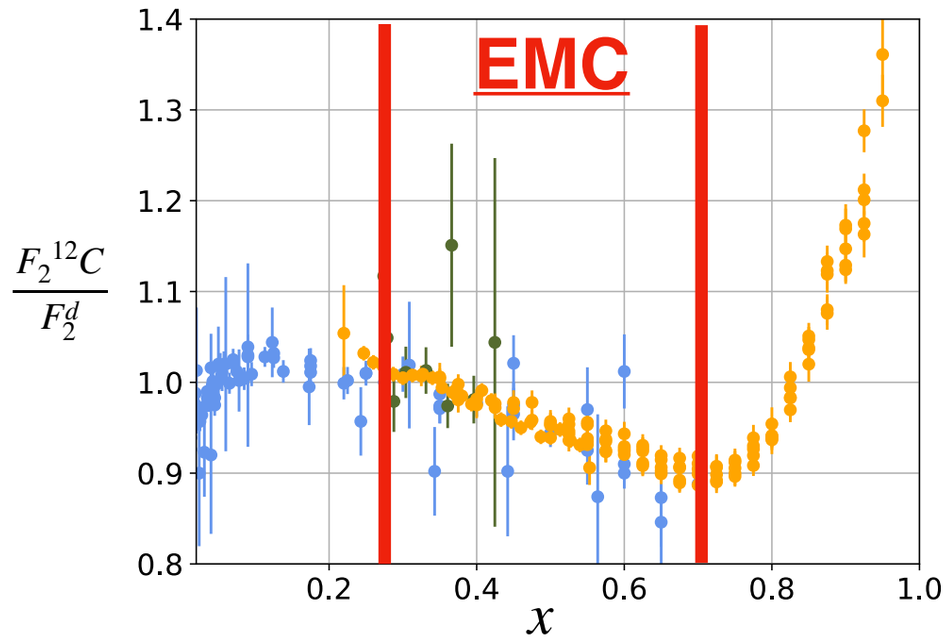


Path towards bound nucleon structure

$$d\sigma^{bound}(Q_2^2, x_2', \theta_{nq}, p_n) \Big/ d\sigma^{free}(Q_2^2, x_2)$$

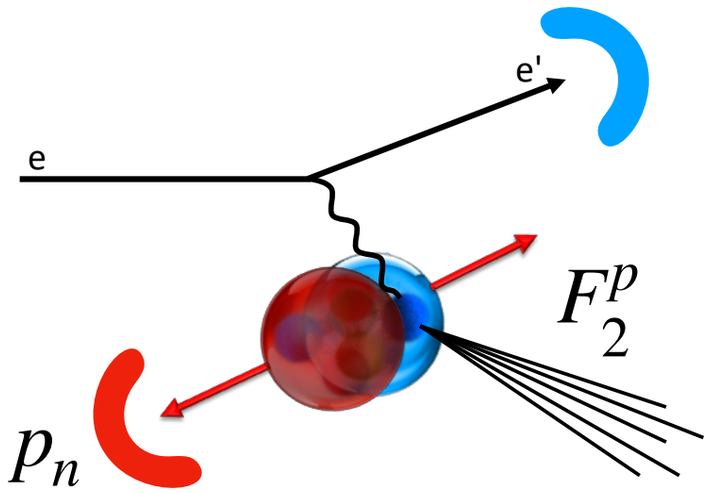
$$x' = \frac{Q^2}{2\left(\nu(m_D - E_n) + \vec{p}_n \cdot \vec{q}\right)}$$

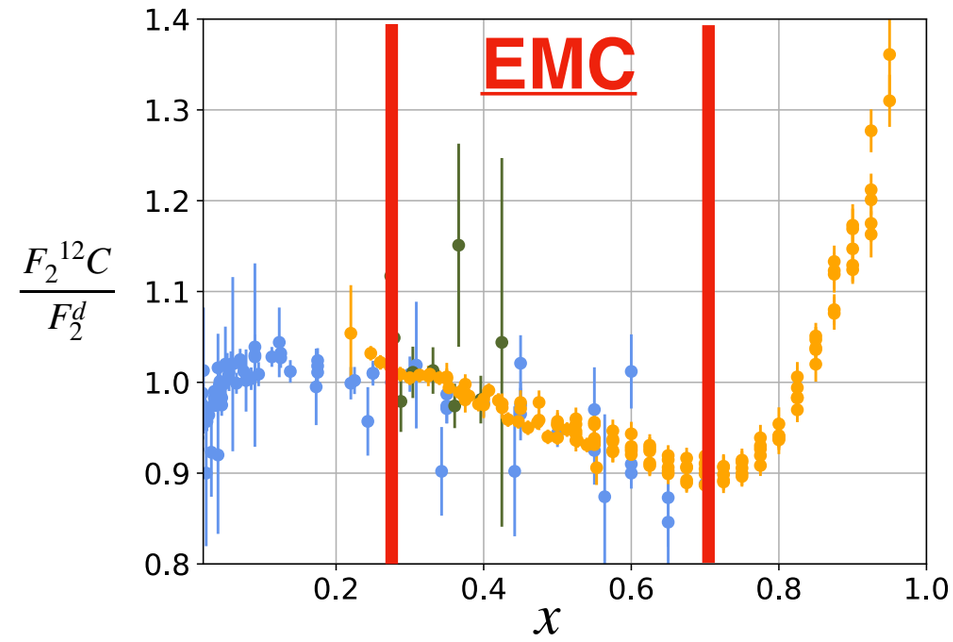




Path towards bound nucleon structure

$$\frac{d\sigma^{bound}(Q_2^2, x_2', \theta_{nq}, p_n)}{d\sigma^{bound}(Q_1^2, x_1', \theta_{nq}, p_n)} \Big/ \frac{d\sigma^{free}(Q_2^2, x_2)}{d\sigma^{free}(Q_1^2, x_1)}$$





Path towards bound nucleon structure

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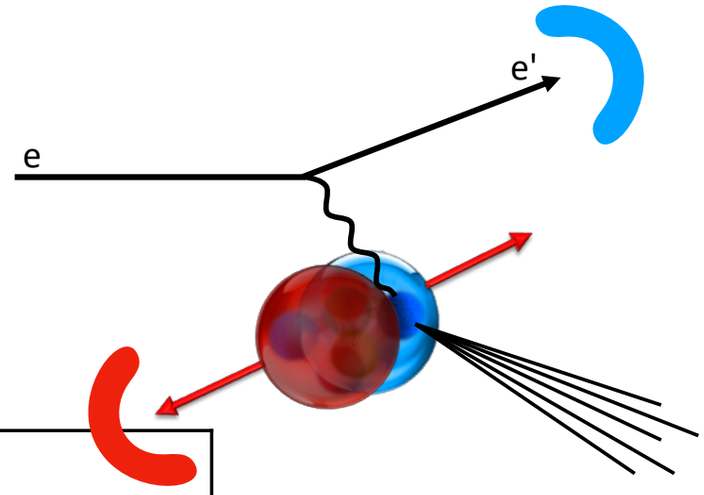
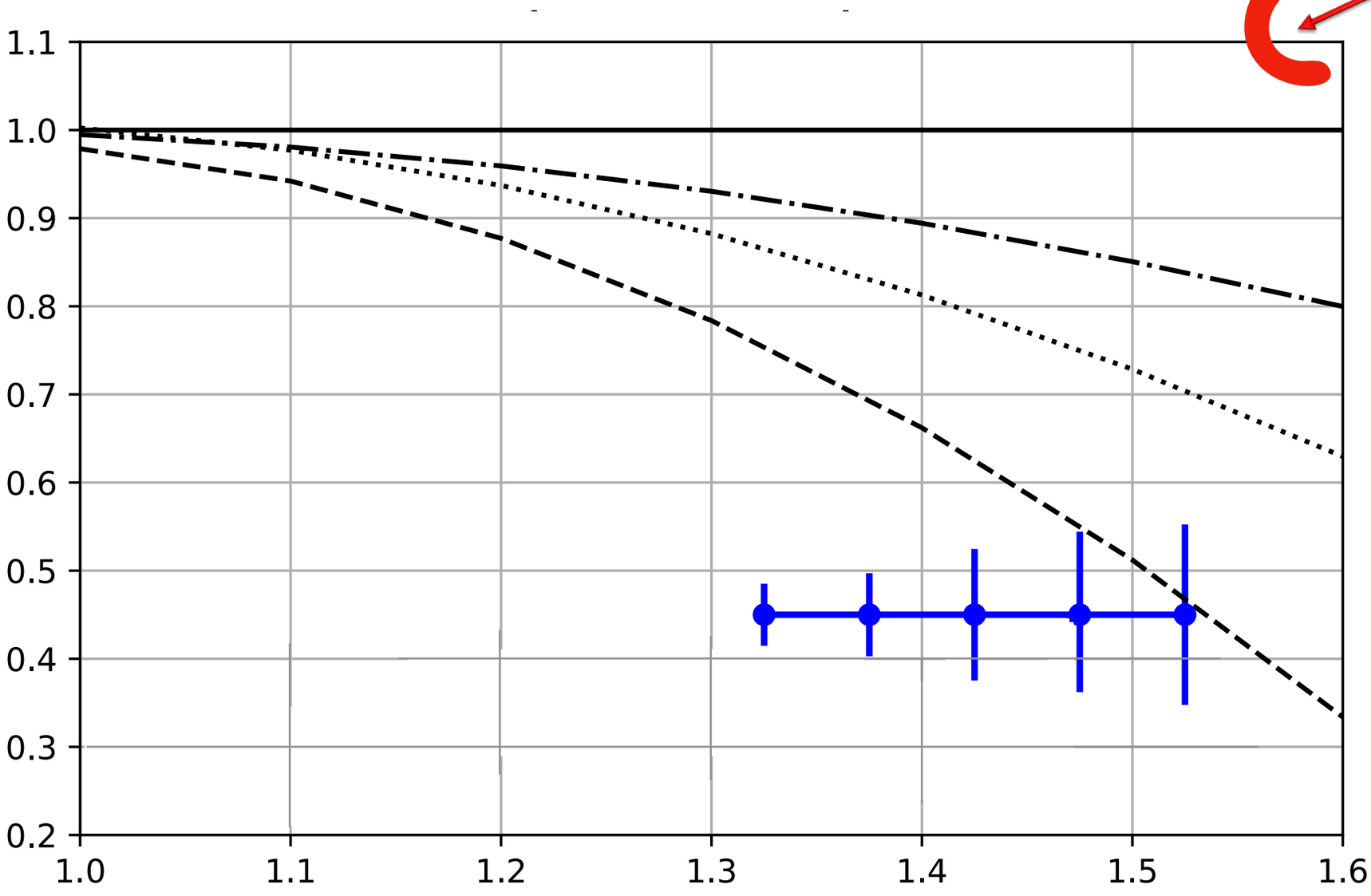




No modification

Various theoretical models

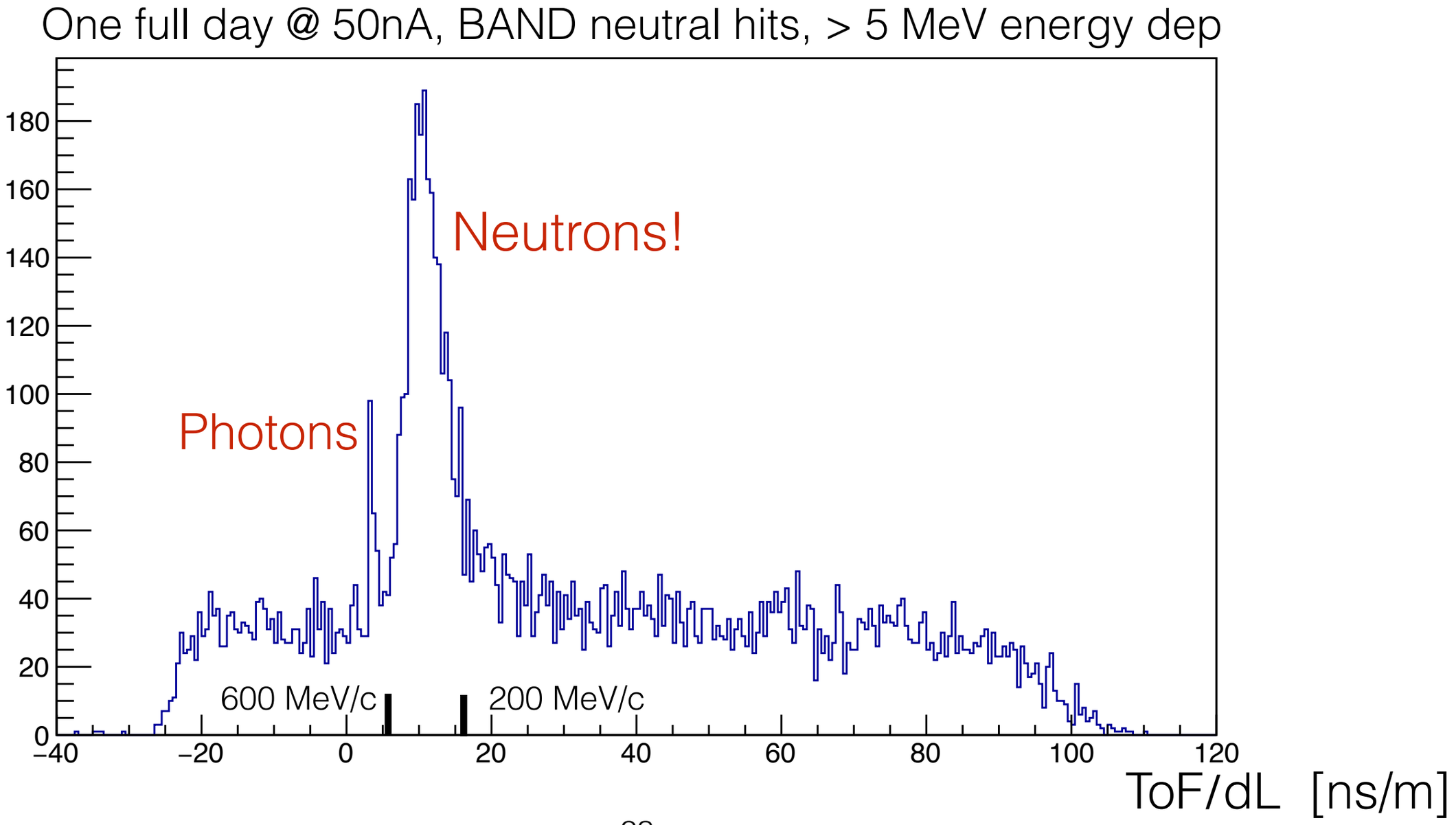
$\alpha_s = (E_s - p_s^z)/m_s$ (Virtuality)

What we need

- “Good” electron
- “Good” neutron

What we need

- “Good” electron
- “Good” neutron

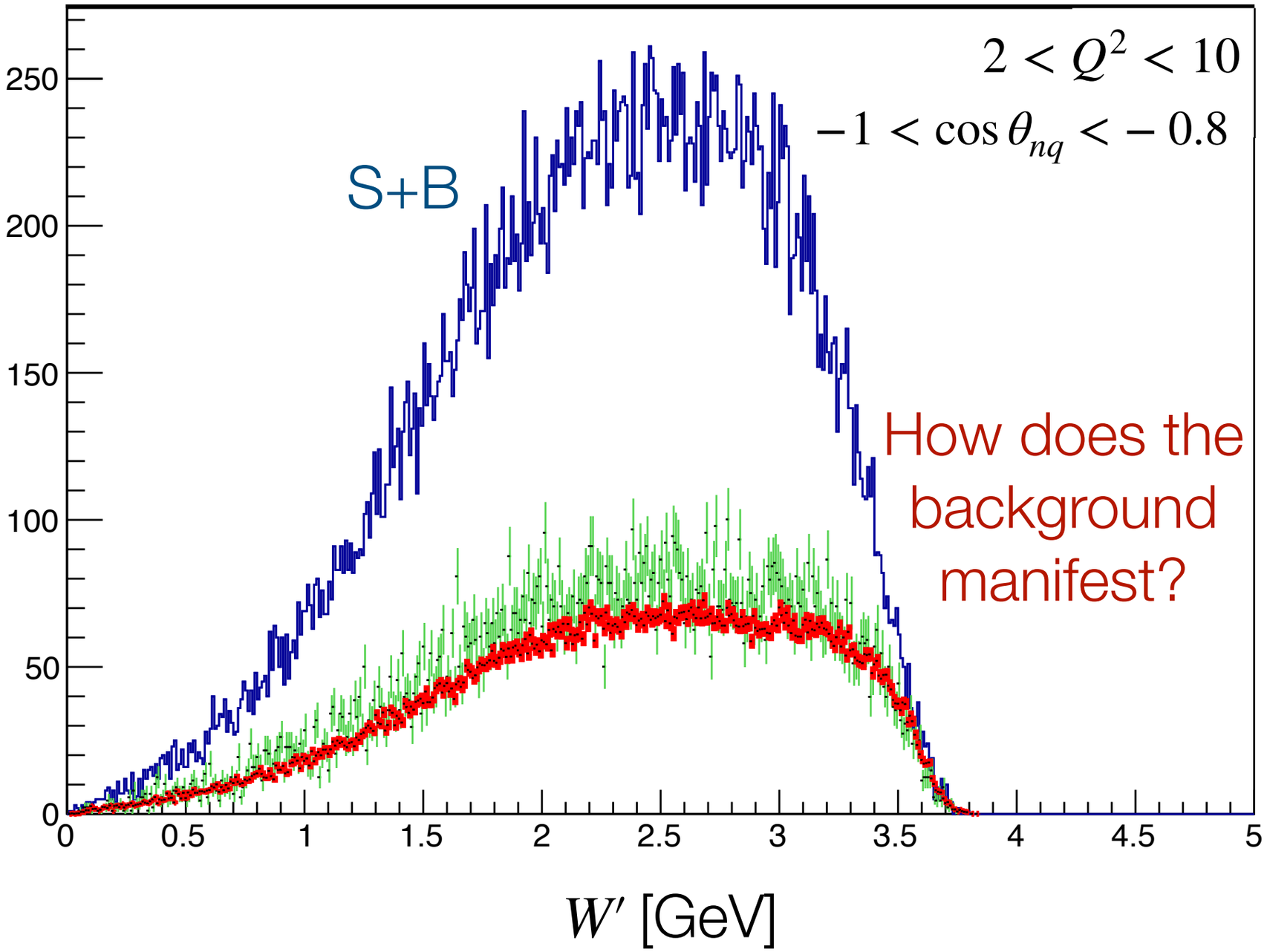


Ingredients for physics results

$$\frac{d\sigma^{bound}(Q_2^2, x_2', \theta_{nq}, p_n)}{d\sigma^{bound}(Q_1^2, x_1', \theta_{nq}, p_n)} \Big/ \frac{d\sigma^{free}(Q_2^2, x_2)}{d\sigma^{free}(Q_1^2, x_1)}$$

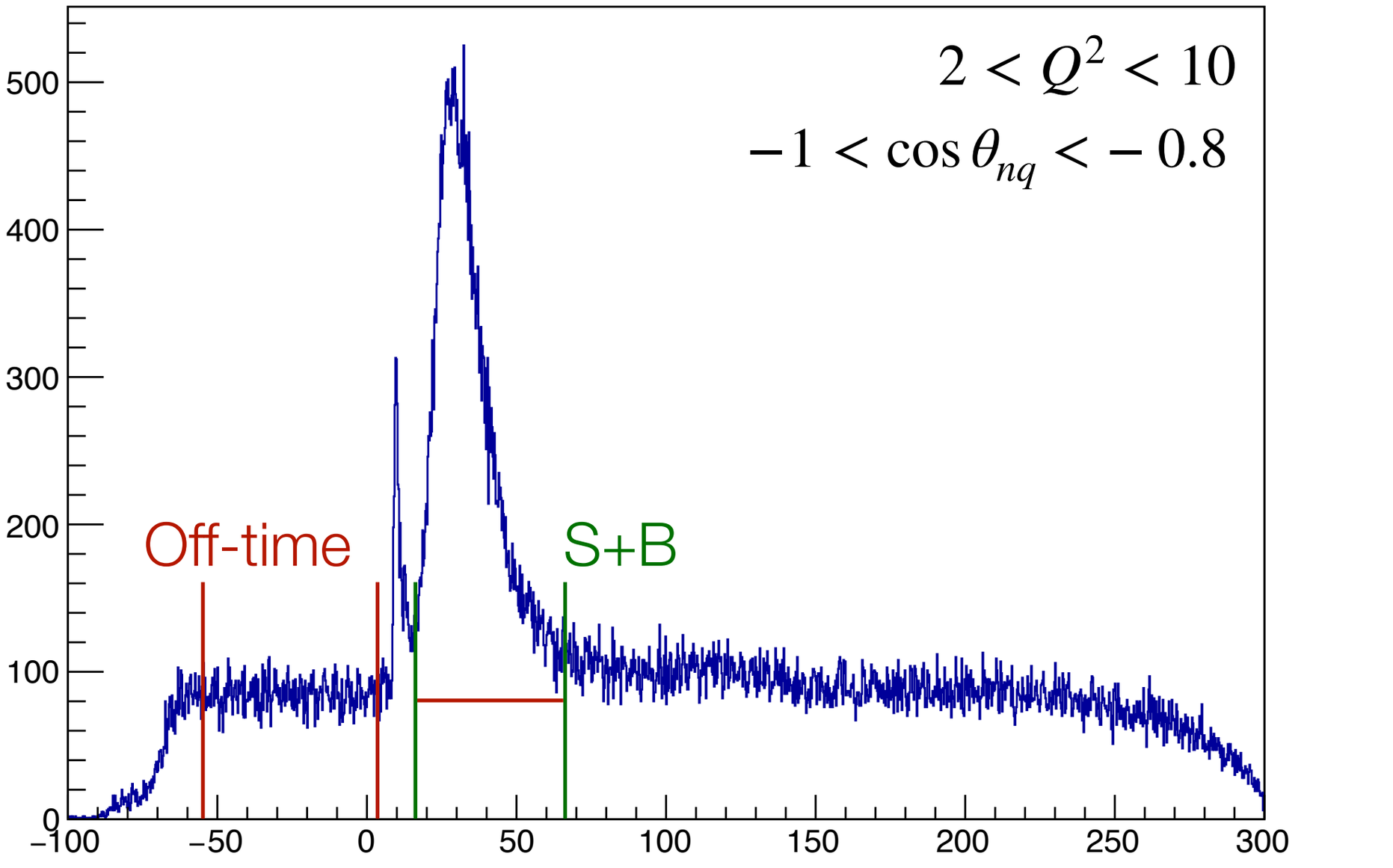
- Count up events above background in 4D bins $\left(Q^2, x', \theta_{nq}, p_n\right)$
- Acceptance correction per event for $d\sigma$ integration over ϕ_e, ϕ_{nq}

Accessing background in 4D bin



Accessing background in 4D bin

Signal + Background

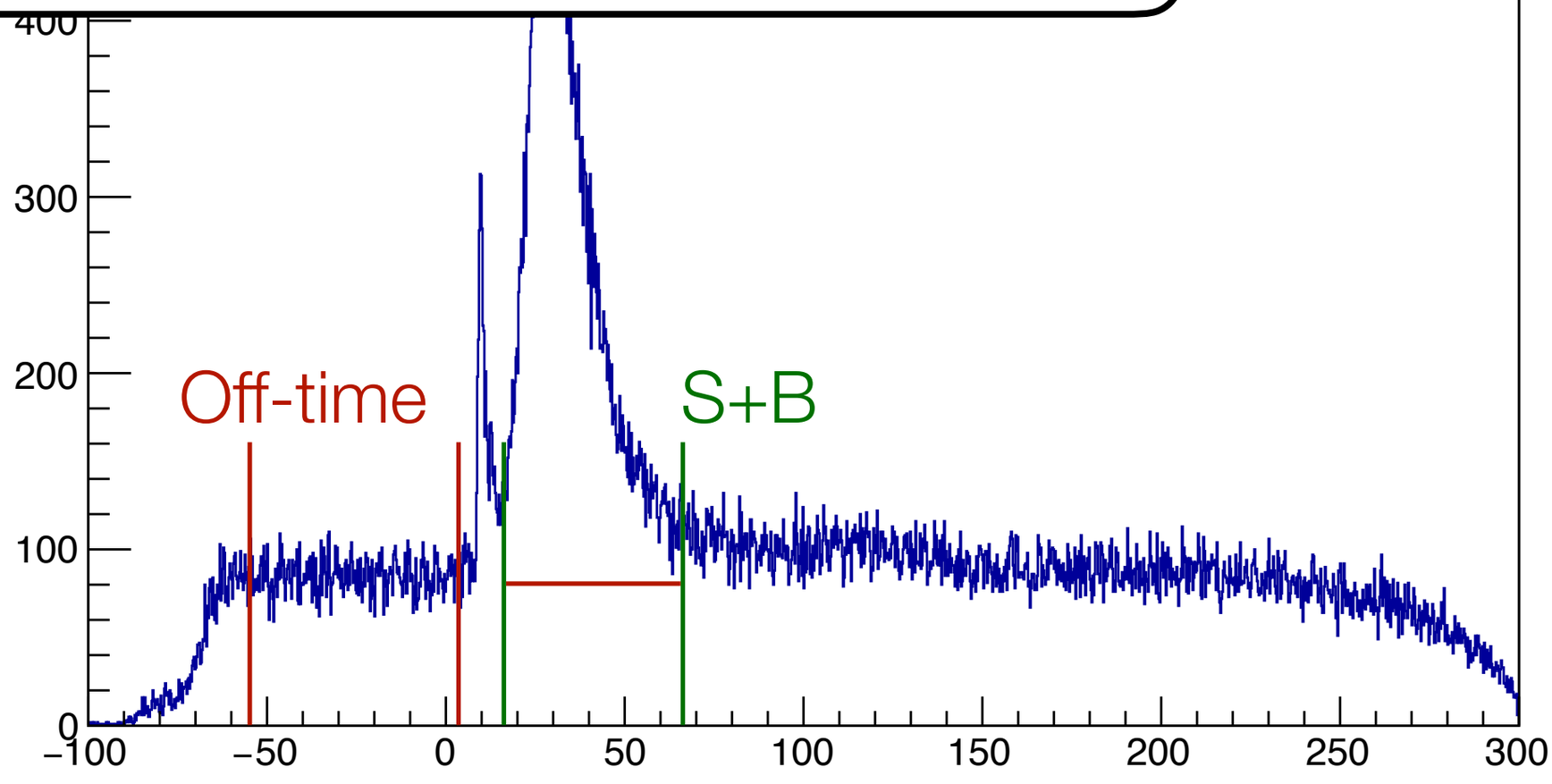


Accessing background in 4D bin

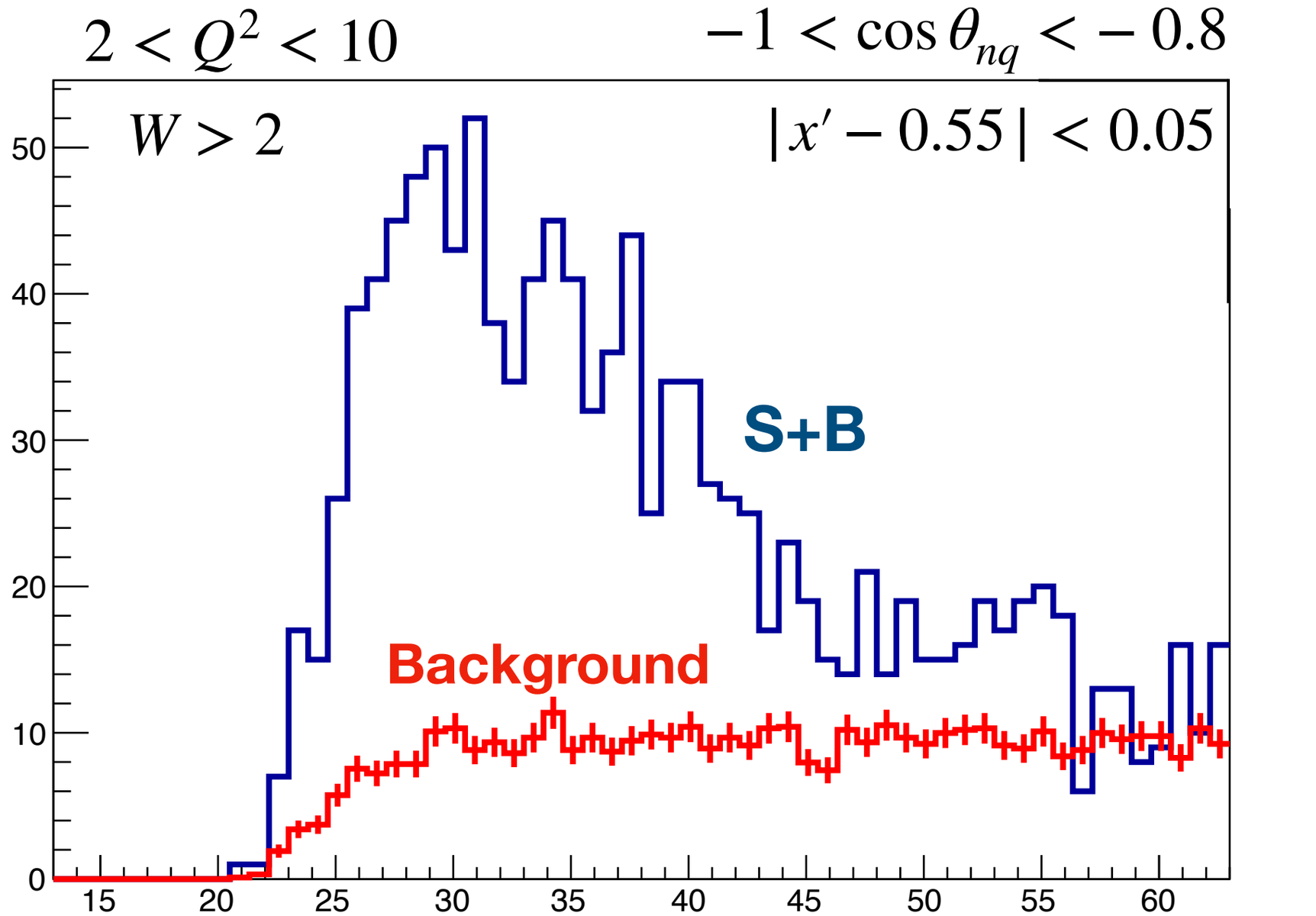
1. Use off-time neutron kinematics with re-drawn ToF in S+B region
2. Mix event (i) off-time neutron with event (j) electron and re-drawn ToF in S+B region

$< Q^2 < 10$

$\theta_{nq} < -0.8$



Currently we have good statistics in high x region



~3.5% of data*

Acceptance corrections

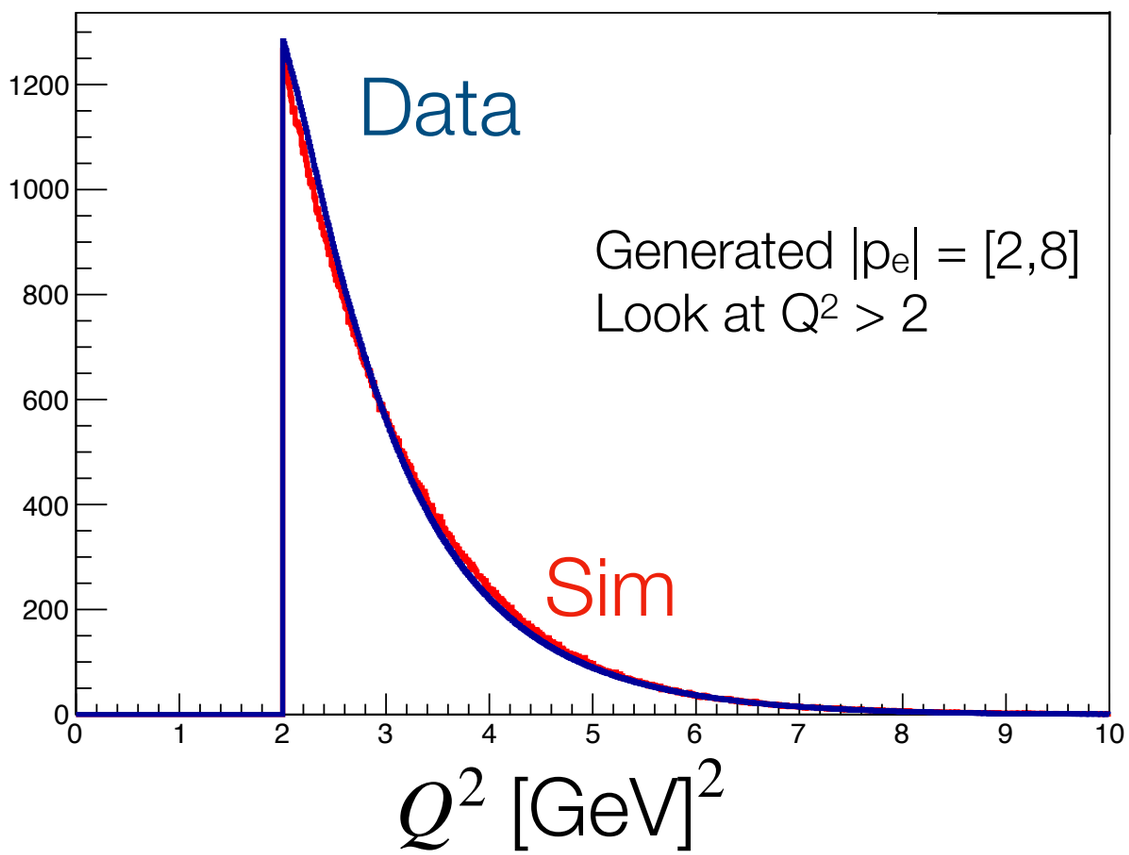
- Use uniform monte carlo generator
- For each (x, Q^2, θ_{nq}) event, draw new events with random ϕ_e, ϕ_{nq} and count how many detected

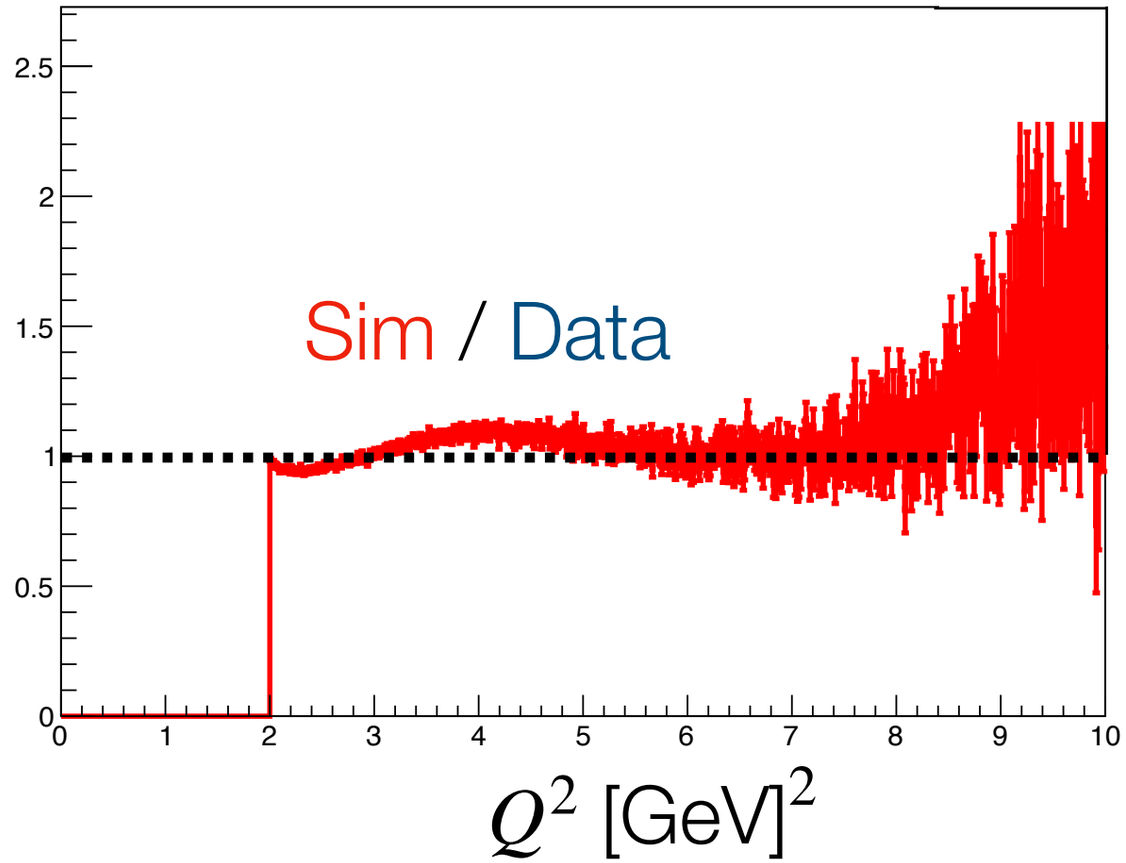
$$A(x, Q^2, \theta_{nq}) = \frac{N_{detected}\left(x, Q^2, \theta_{nq}\right)}{N_{generated}\left(x, Q^2, \theta_{nq}\right)} \leq 1$$

Simulation progress

- Stand-alone package exists with tagged deuteron DIS generator from Wim Cosyn

- Working on implementation of BAND into GEMC





What I talked about today

- Physics goals of BAND
- BAND Detector
- Recommissioning for RGB
- Status of analysis

Thank you!

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