E12-06-114 (DVCS) Jeopardy Proposal

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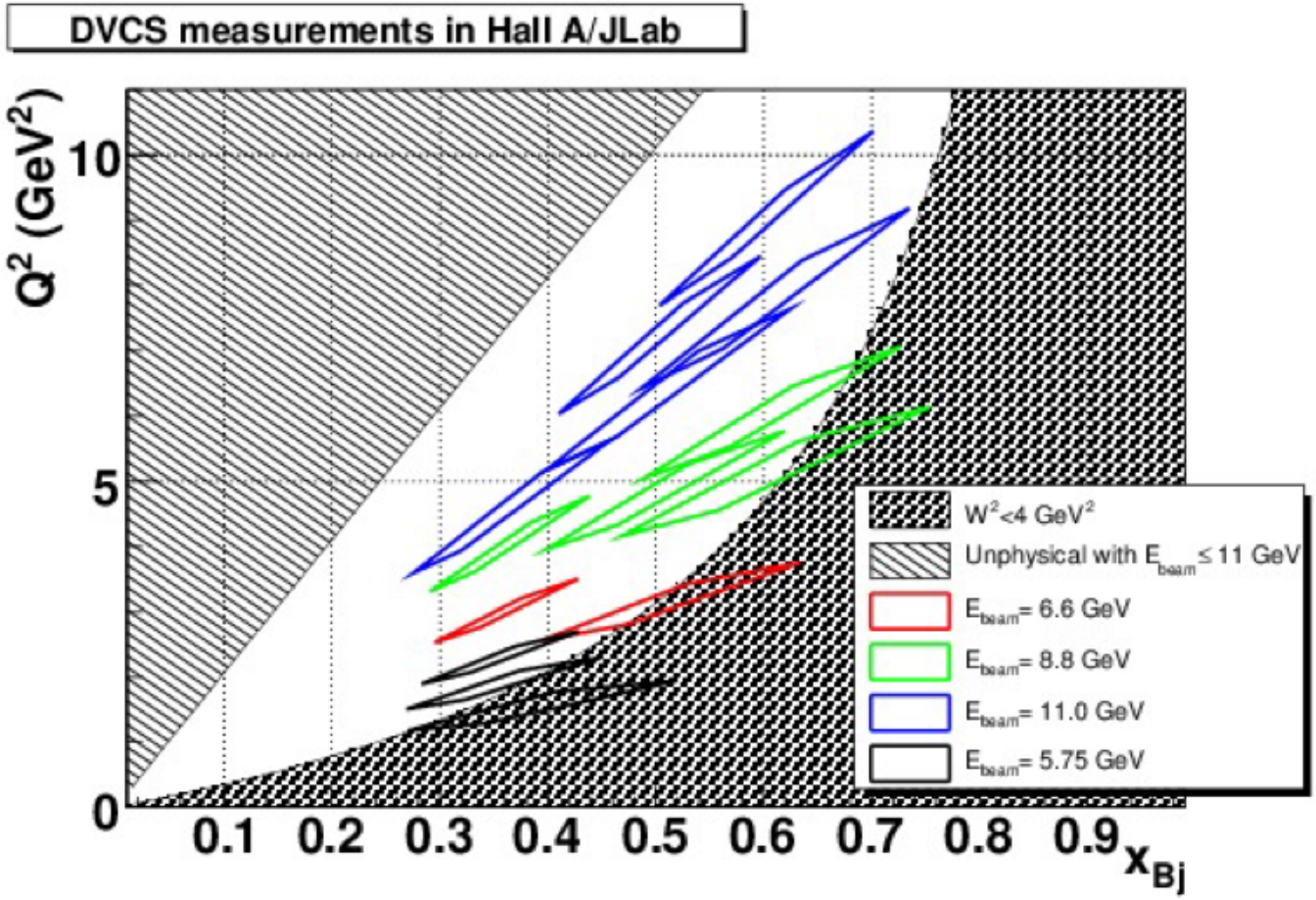
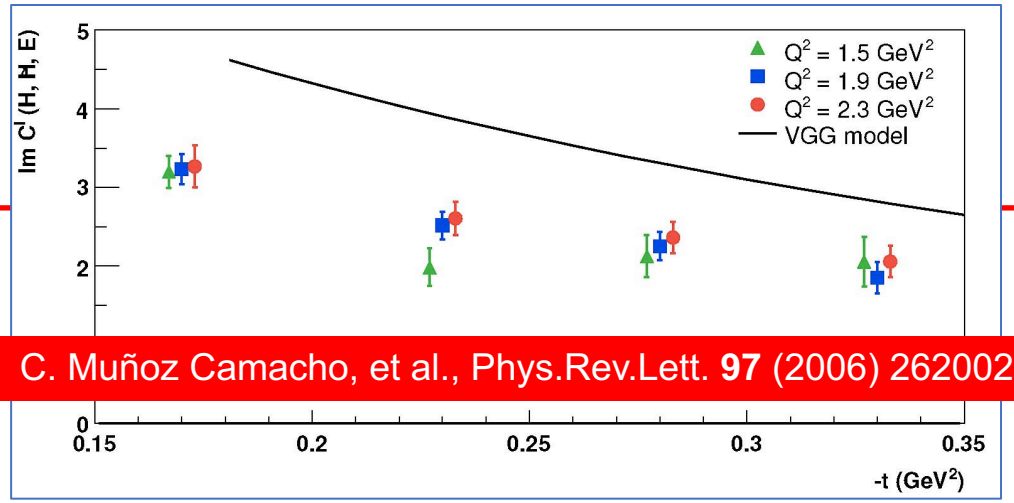
E12-06-114 (Hall A) DVCS Jeopardy Proposal

- Approved by PAC30 (2006),
  - 100 days allocated by PAC38 (2011)
  - 70 days assigned '**High Impact**' by PAC41 (2014).
- Goals
  - High precision (4% systematic) cross sections
  - Factor of two Q^2 range
  - xB = 0.36, 0.48, 0.60
- Scheduled for 50 days during 12 GeV commissioning 2014–2016



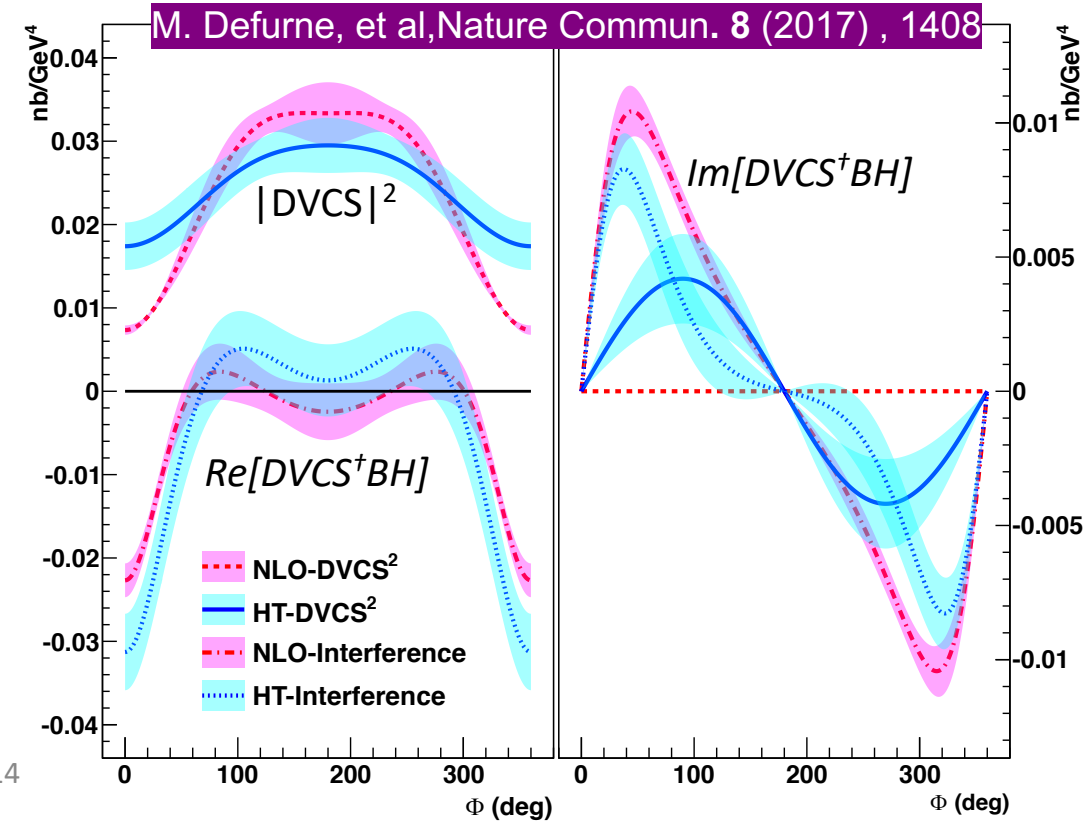
Hall A DVCS Impact

- Q^2-dependent absolute cross sections are primary proof of factorization and quantifier of higher-twist effects: "DVCS1:"
- E07-007: run in 2010 *"DVCS2"*
  - Energy Dependence at fixed Q^2, x_B, t → Generalized Rosenbluth separation of $|DVCS|^2$ and $Re[DVCS^{\dagger}BH]$
  - $\sigma_T \gg \sigma_L$ for Deep Virtual π^0 production Chiral Sym. Break. ⊗ Transversity GPDs
- 7 publications, 1 submitted (6 GeV)
  - 1 in preparation (12 GeV, "DVCS3")



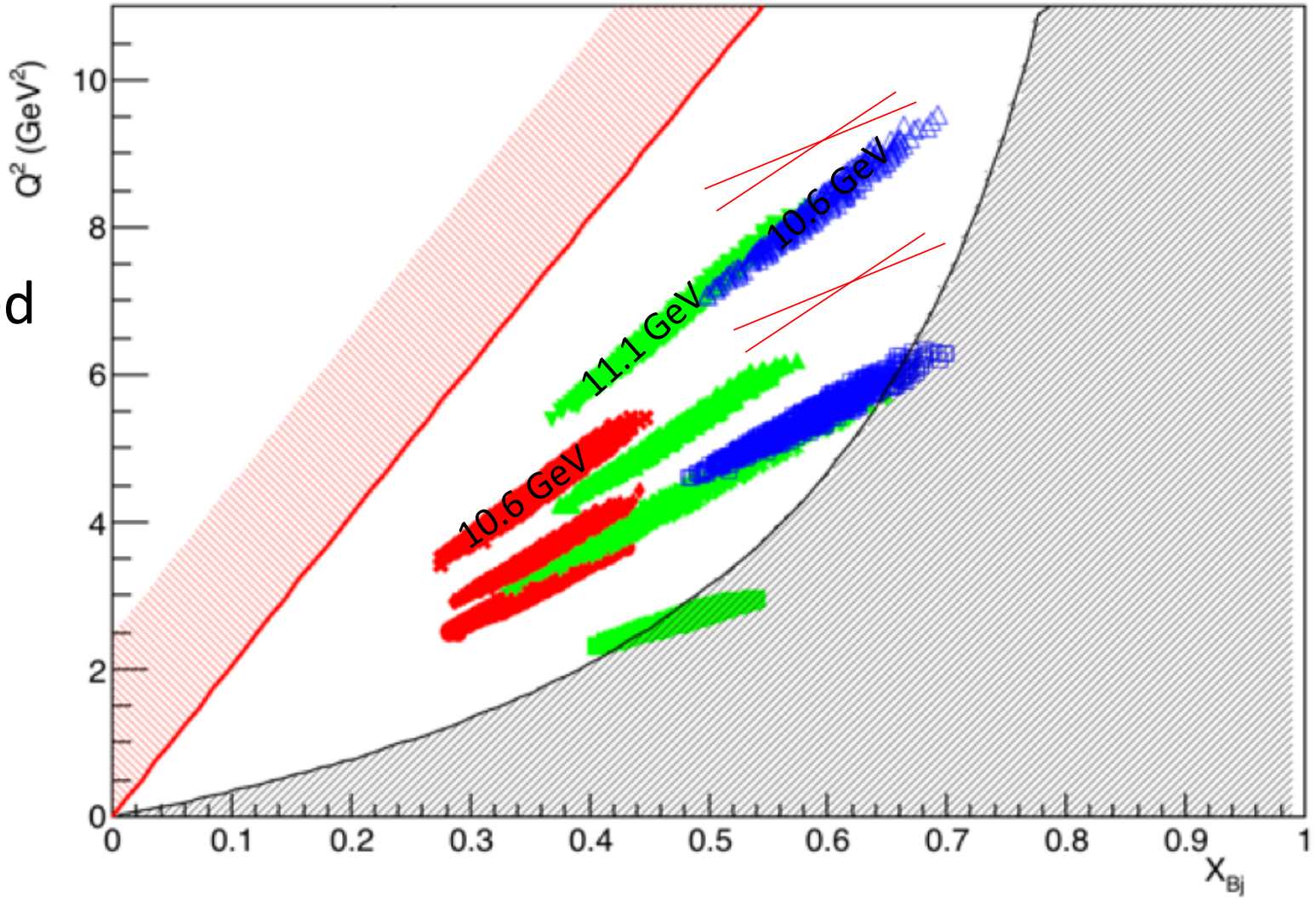
C. Muñoz Camacho, et al., Phys.Rev.Lett. **97** (2006) 262002

M. Defurne, et al,Nature Commun. **8** (2017) , 1408



2014–2016 Hall A Run E12-06-114 (50 PAC days)

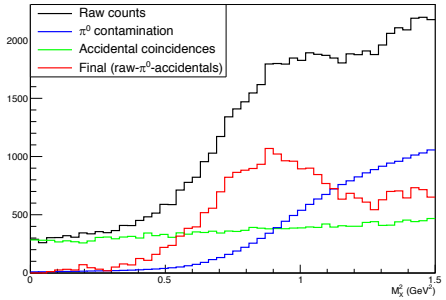
- 1 setting @ full 11.1 GeV
- Reduced momentum of HRS
  - Less optimal kinematics
- Two settings ($x_B = 0.6$) omitted
- *Single energy at each (Q^2, x_B)* point.
- $x_B = 0.48$
  - Beam time reduced by 50 day cap.
  - Q1 Detuning problem



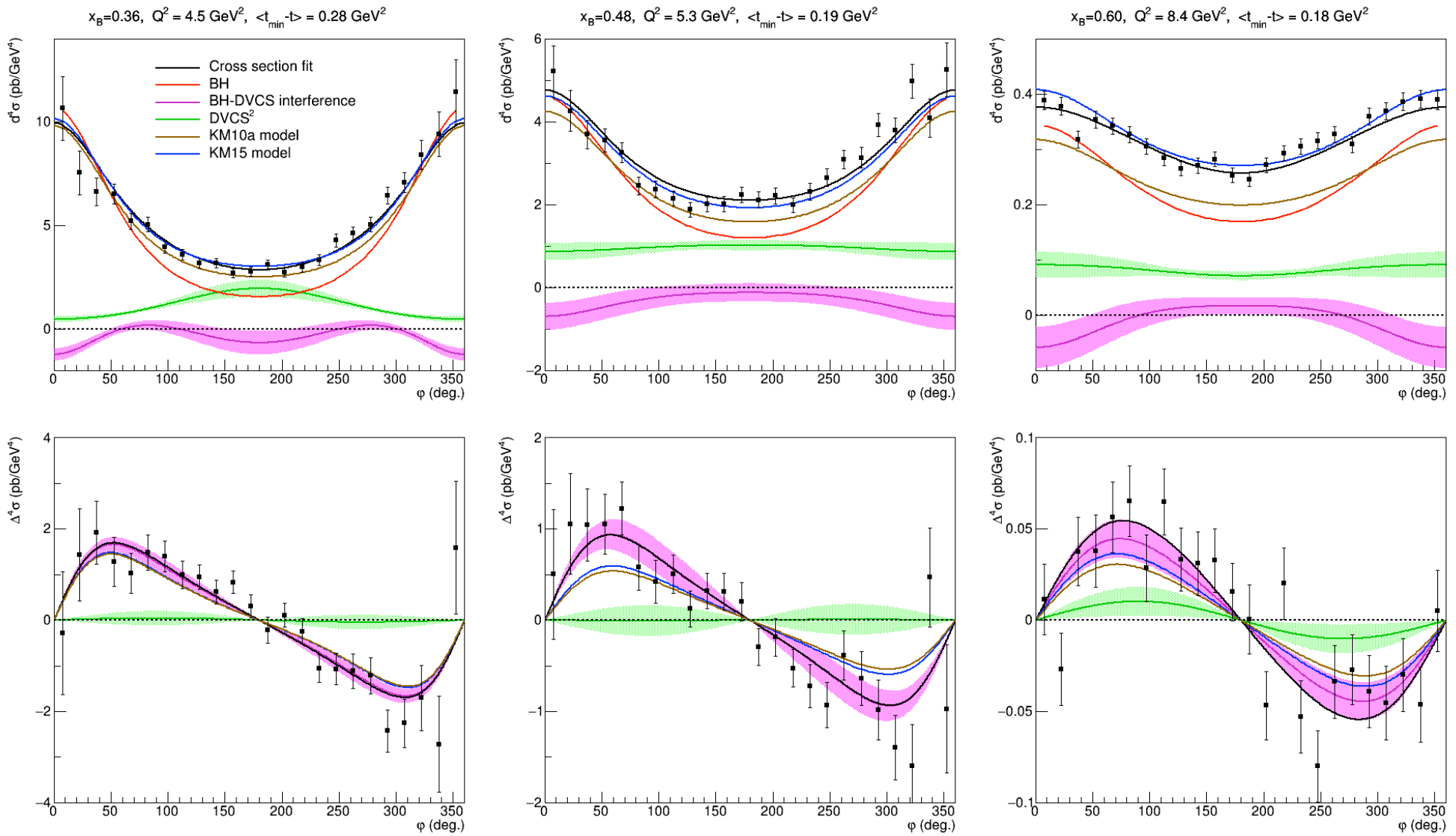
HRS-Left troubles

- 2014-Spring 2016:
  - First Quadrupole (Q1) limited to equivalent of 2.5 GeV/c
    60% of full setting at p= 4.0 GeV/c
- Fall 2016
  - New (warm) Q1, but iron saturation affects optics
- Data taken at nine (Q^2, x_B) points:
  - Different Target ⇆ Focal-plane transport matrix for each setting
- Biggest impact on *x=0.48* settings
  - 4% acceptance systematic
  - Reduction in acceptance roughly proportional to detuning
  - Uncertainty in optics affects $(t, \phi_{\gamma\gamma})$ *reconstruction*

Hall A DVCS run 2014—2016: H(*e,e'γ*)X



- Global fits to all Q^2 at fixed *(x,t)*
  - 1 of 3 *t*-bins
  - 3 of 9 (Q^2, x)
- Leading Order CFF + plus Kinematic Twist-4 fits

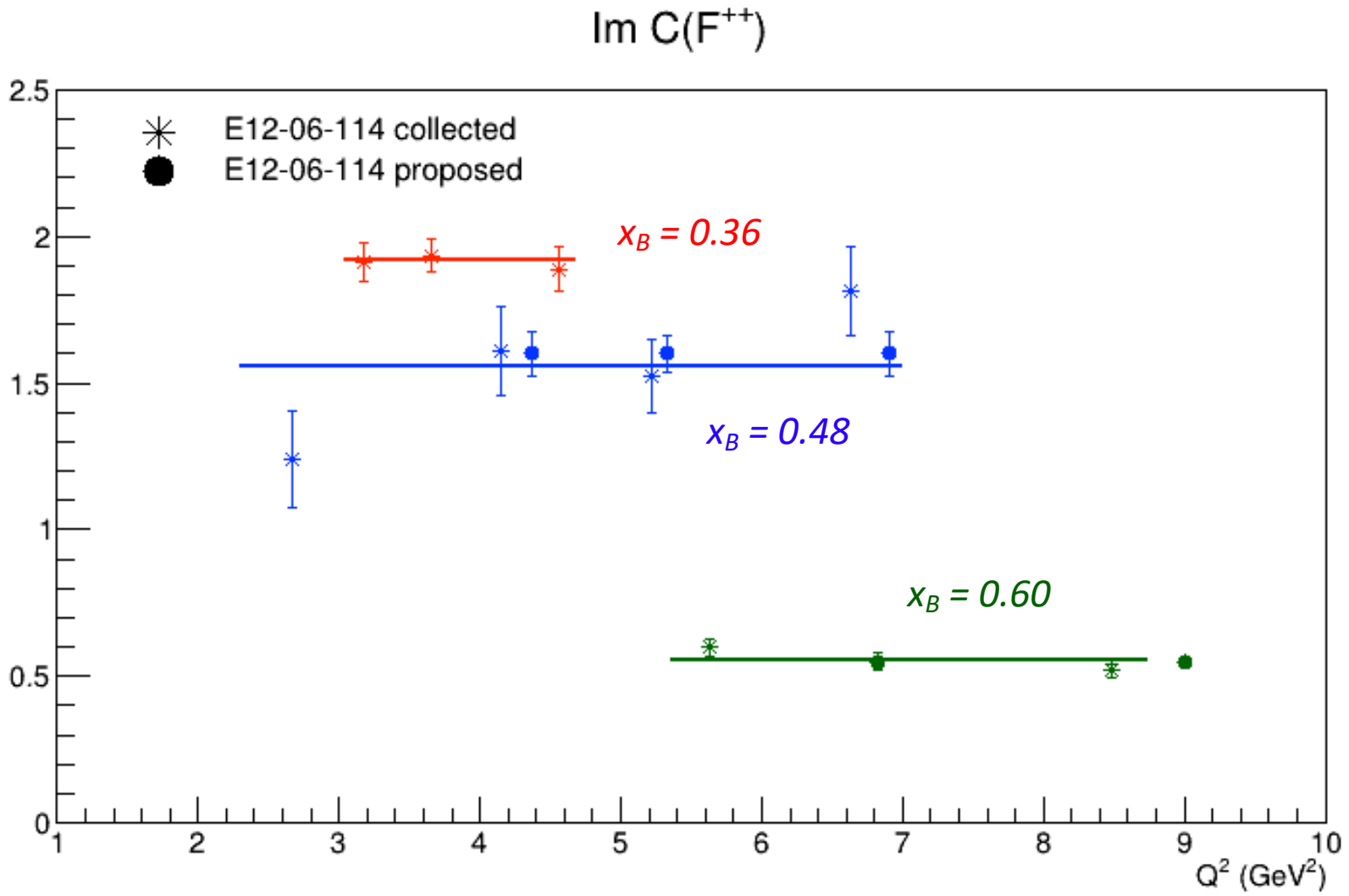


Jeopardy Proposal

- Beam energy-dependence essential to separation of $|DVCS|^2$ from $Re[DVCS^{\dagger}BH]$
- Precision $\phi_{\gamma\gamma}$-dependence required for discrimination between Leading Order and dynamic Higher-Twist scenarios.
  - Flattening of unpolarized dσ distribution observed in 6 GeV, x_B =0.36 data.
  - Systematic and statistical uncertainties at x_B =0.48 need to be reduced
- Hall A
  - HRS Q1 now `stable' with new warm Cu-coil magnet
  - Some saturation effects in optics remain
- Hall C
  - Improved Calorimeter
  - Sweep magnet allows for higher luminosity, shorter run time.
  - HMS has broader momentum range ➔ multiple energy settings at fixed (Q^2,x_B)

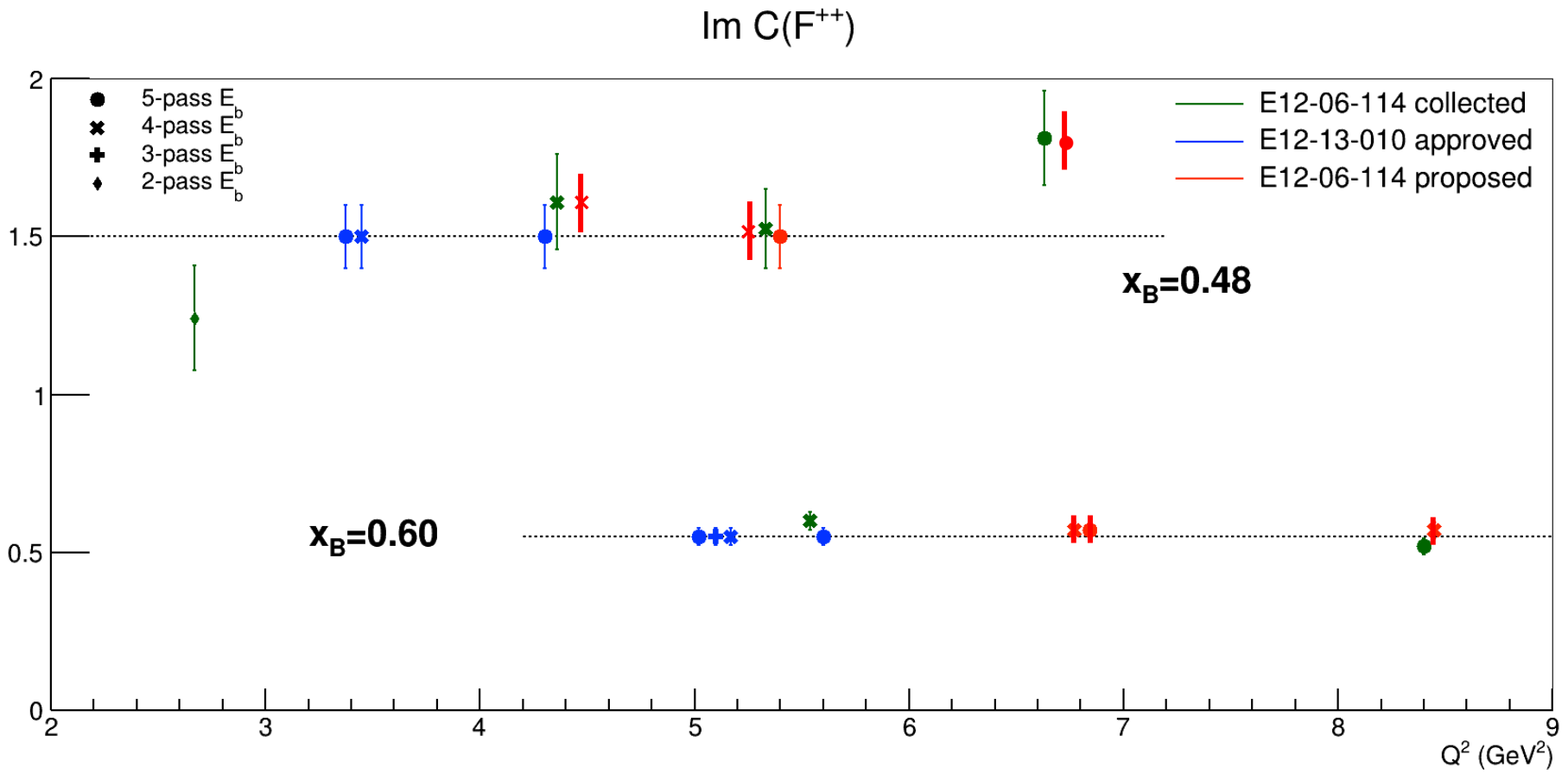
Hall A option (50 Jeopardy Days)

- Im[DVCS*BH]
  - "sinϕ"
- x = 0.48
  - Full statistics at full acceptance
- x=0.60
  - High statistics run at two additional Q^2 values



Hall C option (35 Jeopardy days)

- 35 Jeopardy days
- x_B=0.6
  - Relax statistics slightly
  - Energy Dependence
- x_B=0.48
  - Full statistics @ full acceptance
  - Energy Dependence



Summary Tables

Hall A Option

	48_2	48_3	48_4	60_2	60_4
x_B	0.48	0.48	0.48	0.60	0.60
Q^2 (GeV^2)	4.365	5.334	6.90	6.82	9.00
E_{Beam} (GeV)	8.52	8.52	10.62	8.52	10.62
Lumi (10^{37}/cm^2/s)	3.3	5.2	5.2	3.3	7.4
Days (50 Total)	4	4	6	16	20

Hall C Option

	x_B	Q^2 (GeV^2)	E_{Beam} (GeV)	Lumi (10^{37}/ cm^2/s)	Days
48_2	0.48	4.365	8.52	7.5	3
48_3	0.48	5.334	8.52	7.5	3
48_J1	0.48	5.334	10.62	7.5	3
48_4	0.48	6.900	10.62	10	4
60_J1	0.60	6.822	8.52	7.5	7
60_J2	0.60	6.822	10.62	7.5	6
60_J3	0.60	8.400	8.52	13.	9
Total					35

Modified following questions/comments from M.Diehl

High Impact Request

- Essential to calibrate various GPD → DVCS formalisms
- Quark/Gluon Imaging is the subject of the Center for Nuclear Femtography, which has attracted strong interest from interdisciplinary Data Science, Computer Science, Data Vistualization communities.
- JLUO Annual Meeting Colloquium: Black Hole Imaging by Kazunori Akiyama illustrated the common challenge of forming images from sparse data:
  - Astrophysics
  - Femtography
  - Medical Imaging

Backup

The Hall A/C DVCS Program (circa 2013)

- Hall C / NPS adds reach
  - Low x, hi-Q^2,
  - Variable energy at fixed *(x,Q^2, t)*
  - New Calorimeter
    - $PbWO_4$: Higher resolution
    - Mounted on SHMS carriage
  - Sweep magnet
    - Replaces SHMS Horizontal Bender
    - Enables smaller angles, higher luminosity
  - Ready by FY2021