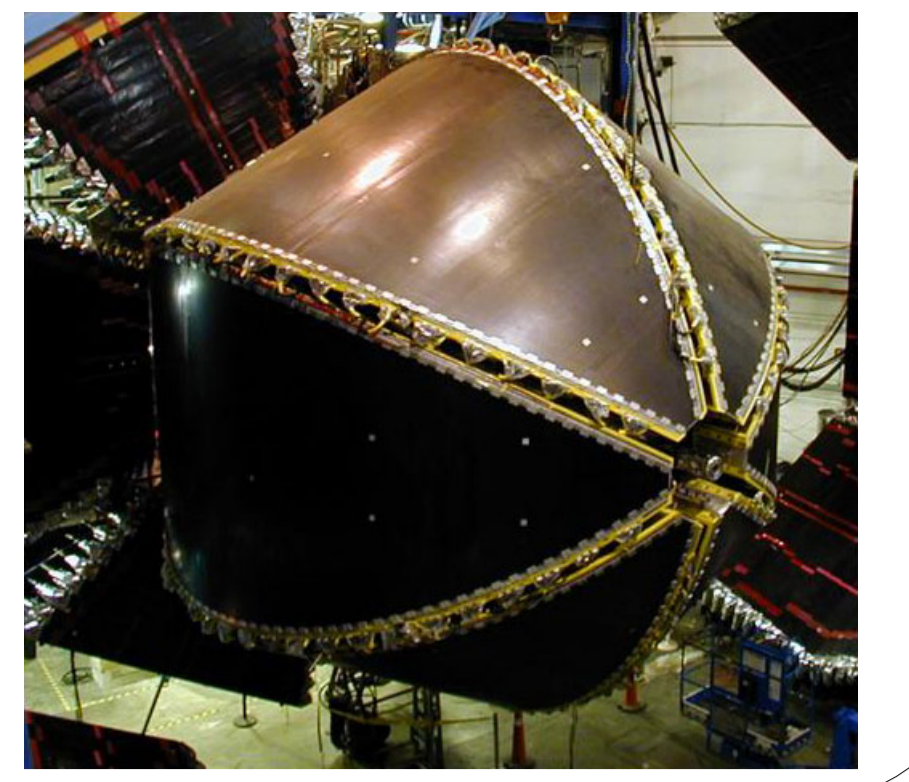# Measurements of pion production in eA with the CLAS detector

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CLAS (CEBAF Large Acceptance Spectrometer)

• CEBAF(Continuous Electron Beam Accelerator Facility) at JLAB
 - Up to 6 GeV e^- and γ beam (upgrading to 12 GeV).
• Hall B, CLAS detector
 - Liquid and/or solid target with e^- and γ beam
• CLAS Components in 6 sectors
 - Super-conducting toroidal magnet
 - Drift chambers for particle tracking
 - Cerenkov counters for e^- identification
 - TOF Scintillators for particle identification
 - EC for e^- identification
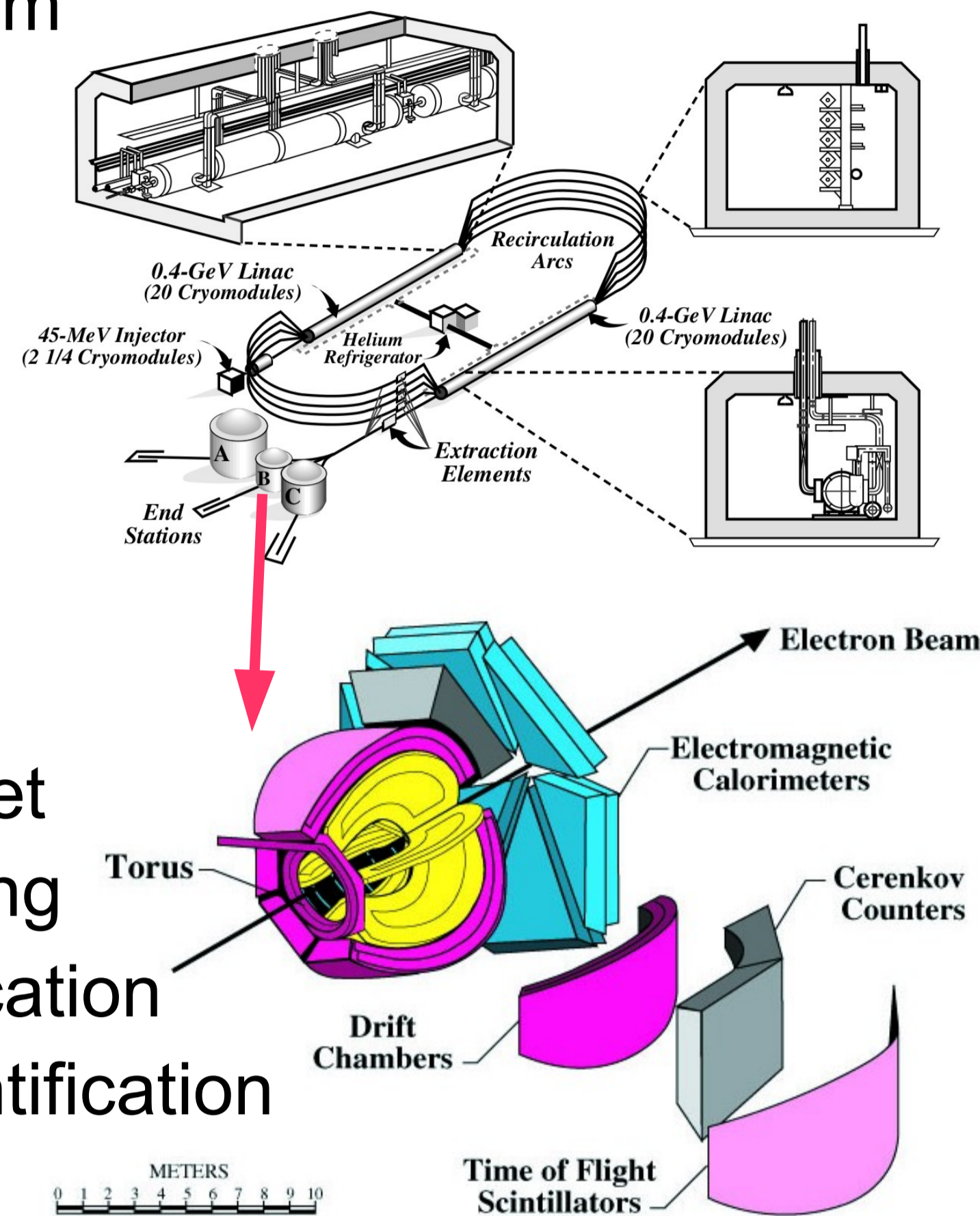
EG2 experiment with CLAS

• 4 GeV, 5 GeV e^- beam
• 2 targets(liquid & solid) in the beam simultaneously in CLAS.
 - [LD2, LH] + [C, Fe, Pb, Sn, Al(2 thicknesses)]
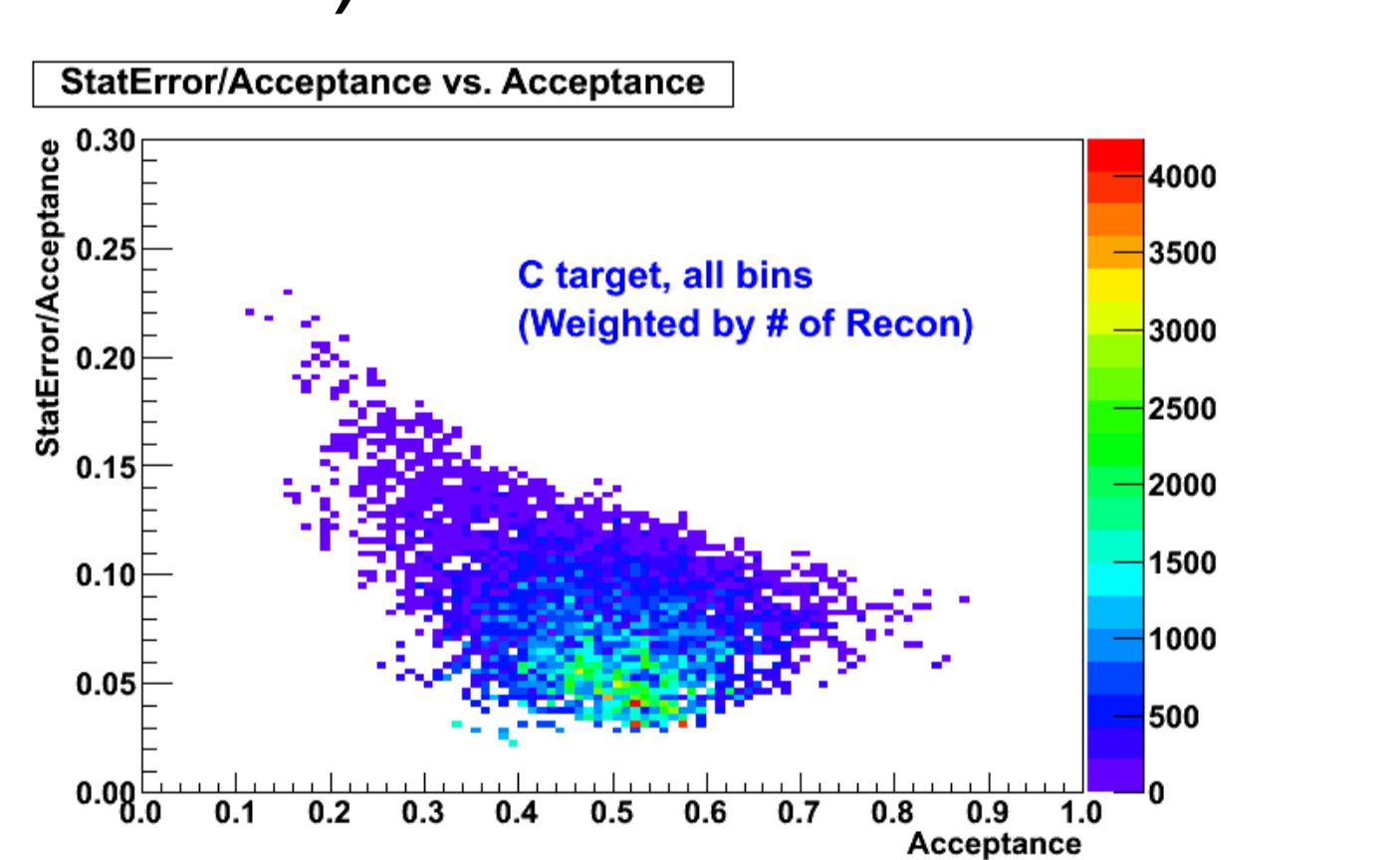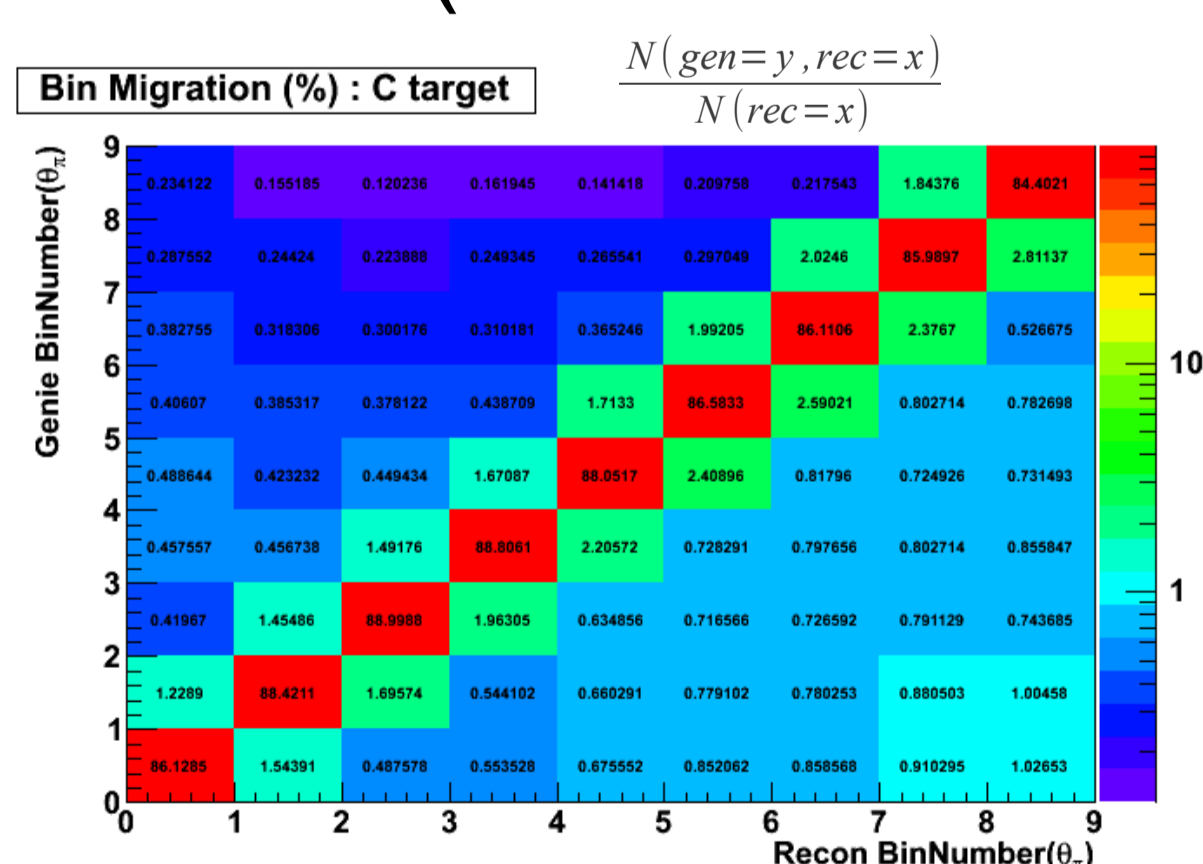• 5 GeV Beam + (D2, C, Fe, Pb) used for this study.
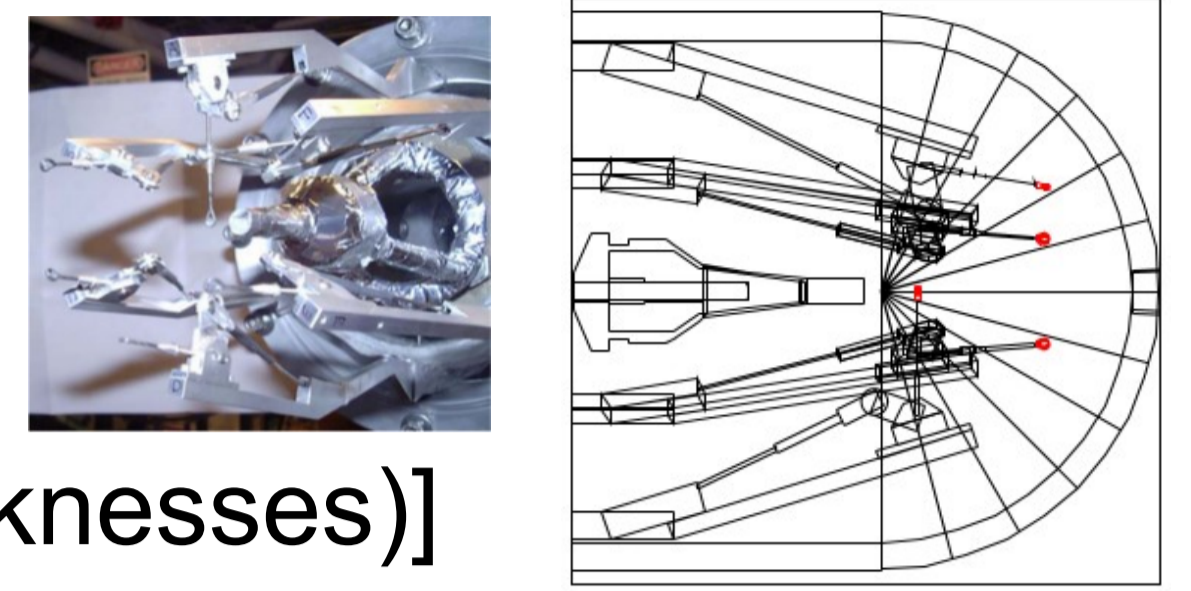
GENIE with eA mode

• v2.5.1 with $Q^2 > 0.5$ GeV^2 are used for this study.
• eA mode uses charged lepton cross sections from Rein-Sehgal and Bodek-Yang and includes small modifications to account for the probe charge in the hadronization model and resonance event generation.
 - Ref. AIP Conf. Proc. 1405, 21 (2011).

Event Selection and Cuts

• Event Sample
 - Data : D2-C(1.1×10^9), D2-Fe(2.2×10^9), D2-Pb(1.5×10^9) triggers
 - MC : $4 \times (100 \times 10^6)$
• Event Selection : e^- and "at least one charged π"
• Variables for differential x-sections
 - Q^2 (1~5 GeV^2), W (1~2.9 GeV)
 - Choose the leading charged pion for pion variables.
 - π charge, π momentum (0.1~4 GeV), π angle[w.r.t. beam direction] (5 ~ 55 °)
• $y < 0.872$ ($P_e > 0.64$ GeV) ← EC threshold for trigger
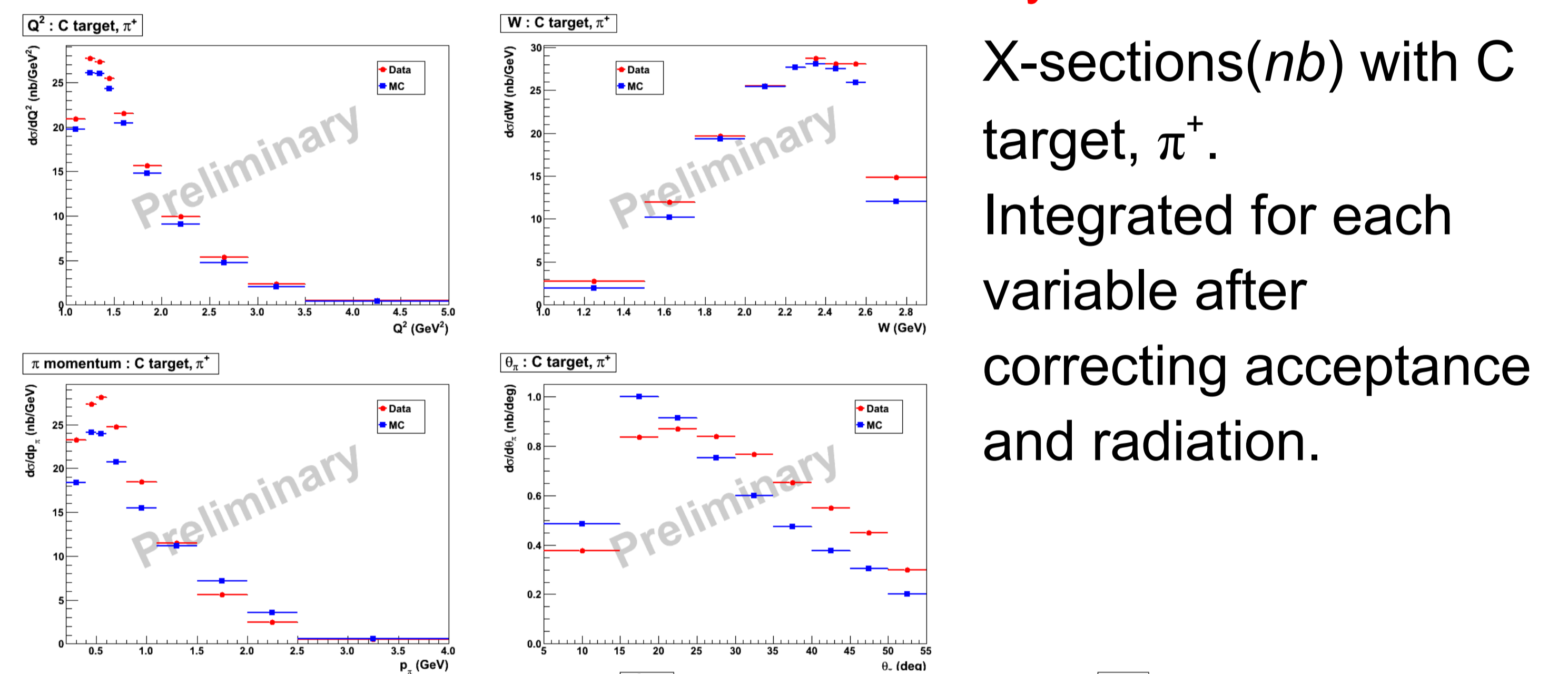• Fiducial Cut(depending on momentum and 2 angles)

Acceptance & Bin Migrations

• Multi-dimensional acceptance for (π charge)+4 variables.
 - total 10(Q^2)x9(W)x2(Q_π)x9(P_π)x9(θ_π)] bins.
• For each variable, have ~10% bin migration.
 - Use MC to correct for acceptance. This largely removes bin migration. Migration taken into account for statistical error calculation. (Ref. CLAS-Note 2004-03)
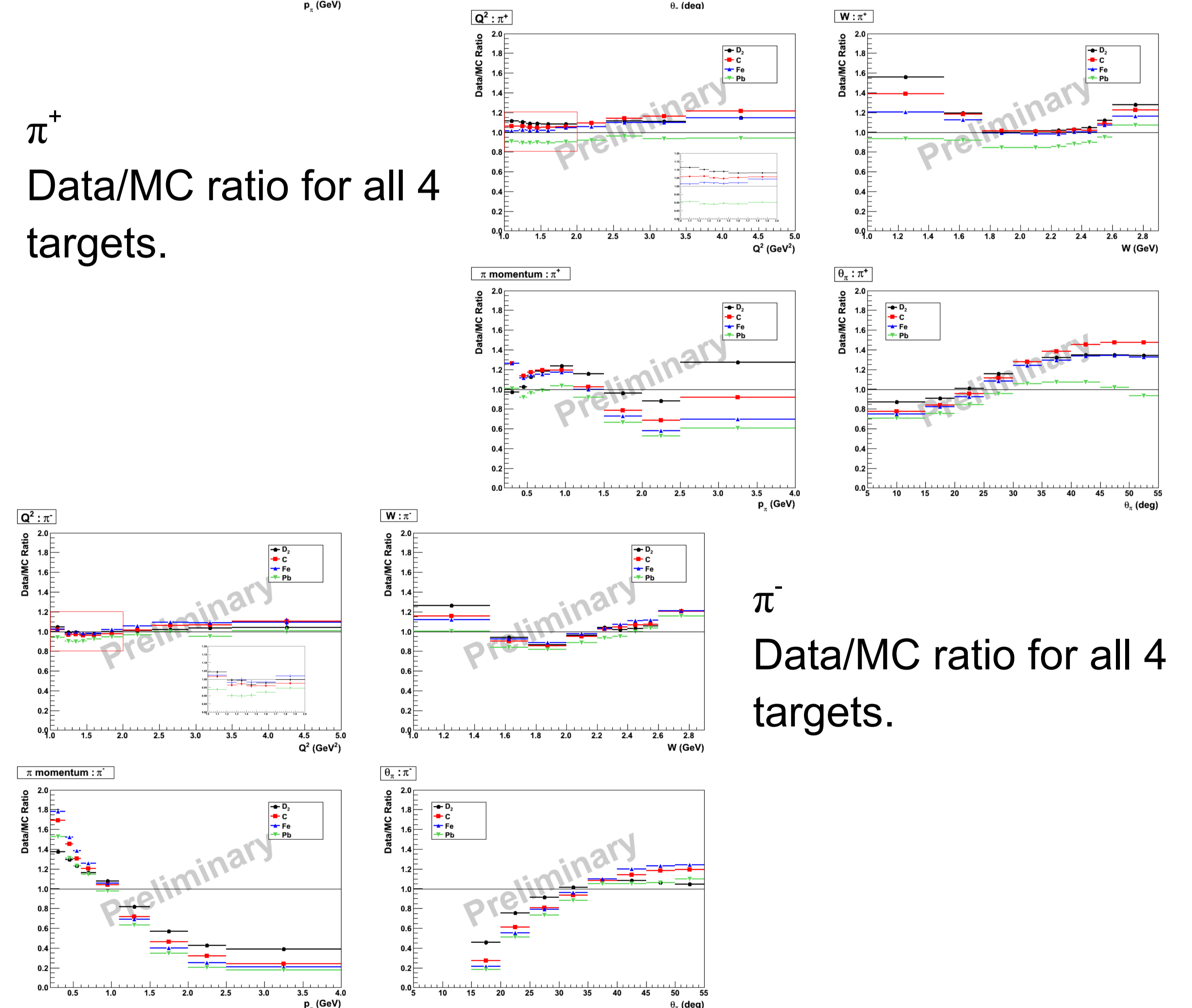
Bin Migration (%) : C target

$\frac{N(gen=y, rec=x)}{N(rec=x)}$

StatError/Acceptance vs. Acceptance

C target, all bins
(Weighted by # of Recon)

Radiative Corrections

• **Externals_all** (Ref. EG1-DVCS-TN-005)
 - Calculate differential X-sections(W, Q^2) with/without QED radiative effects in the process of inclusive electron scattering.
 - It is designed for eg1-dvcs and used for eg1 & eg4.
 - Contribution from (Quasi-)elastic parts are excluded.

W vs. Q^2 : C target

Radiative Correction Factor (σ_R/σ_{Born}) : C target
CLAS data

X-sections (Acceptance & Radiative Corrected)

Statistical Error Only

X-sections(nb) with C target, π^+.
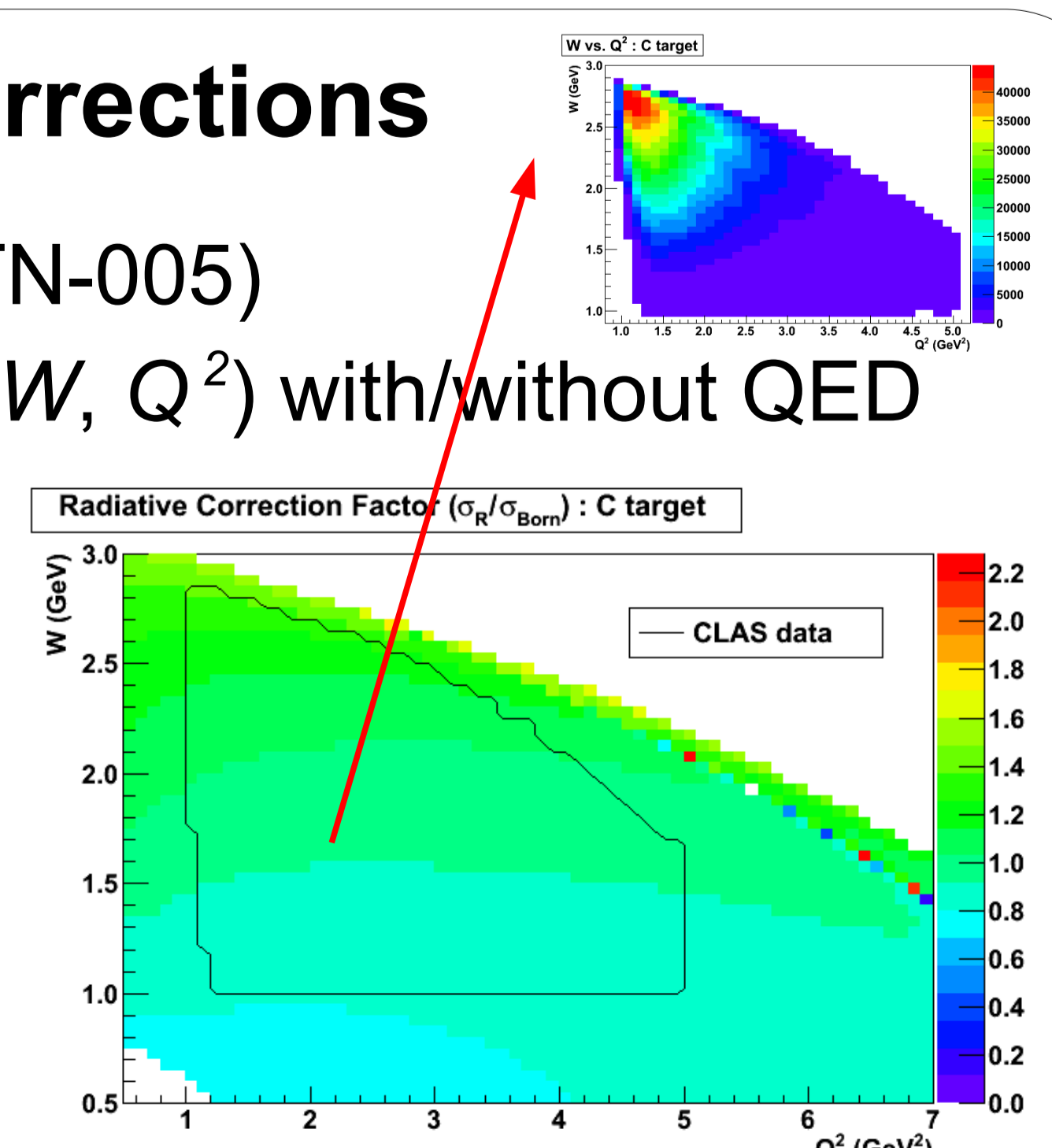Integrated for each variable after correcting acceptance and radiation.

Q^2 : C target, π^+
W : C target, π^+
π momentum : C target, π^+
θ_π : C target, π^+

π^+
Data/MC ratio for all 4 targets.

π^-
Data/MC ratio for all 4 targets.

Total X-sections

• Error analysis have not finished yet. Just for sanity check.
• Data [D2/C/Fe/Pb]
 7.14 / 36.9 / 145.7 / 412.6 (nb)
• Applying same cut as data for MC original and weighted by x-sections calculated from GENIE.
 6.63 / 34.82 / 140.6 / 451.8 [-7 % / -6 % / -4 % / 10%] (nb)