

# E12-06-144: DVCS at 12 GeV

## Hall A Collaboration Meeting

08 December 2014



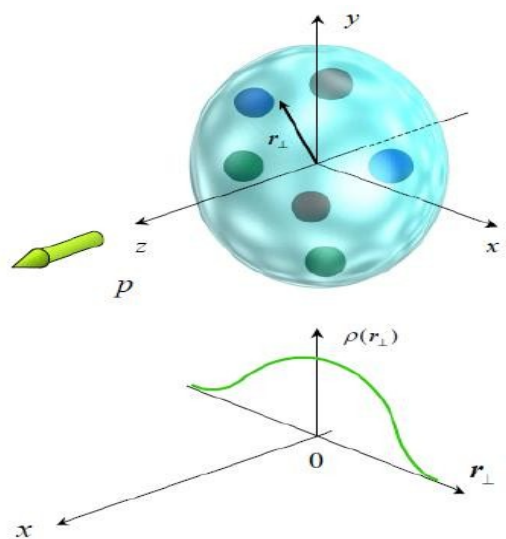
Mongi Dlamini



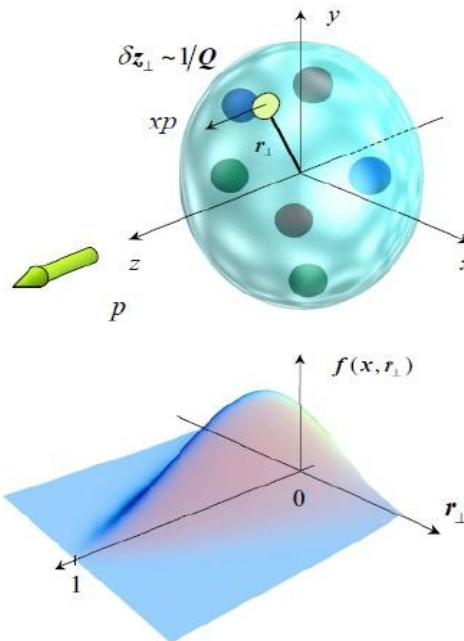
OHIO  
UNIVERSITY

1. Motivation: Nucleon structure in the GPD formalism
2. E12-06-144: Goals, Apparatus and status.
3. Progress and future(short term) plans
4. Conclusions

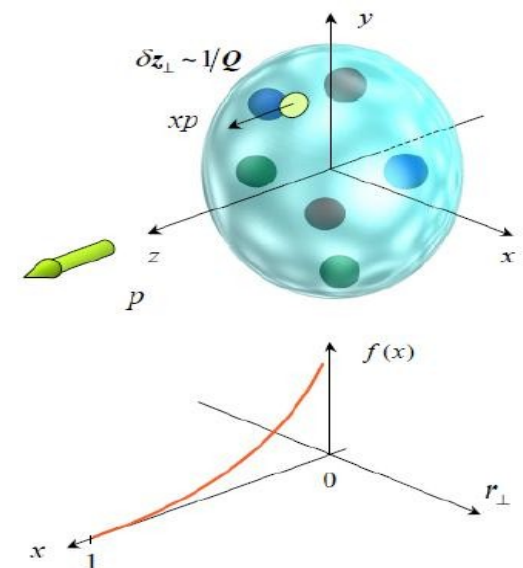
# 3D Picture of nucleon: GPDs



Form Factors – encode charge and current densities in transverse space.



GPDs – encode quark momentum in transverse space.

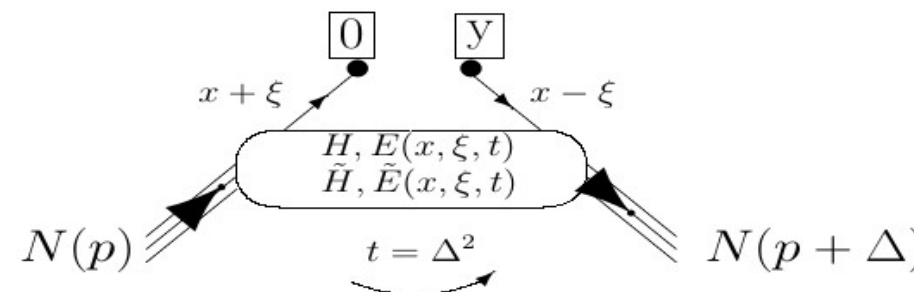


Structure functions – encode quark longitudinal Momentum.

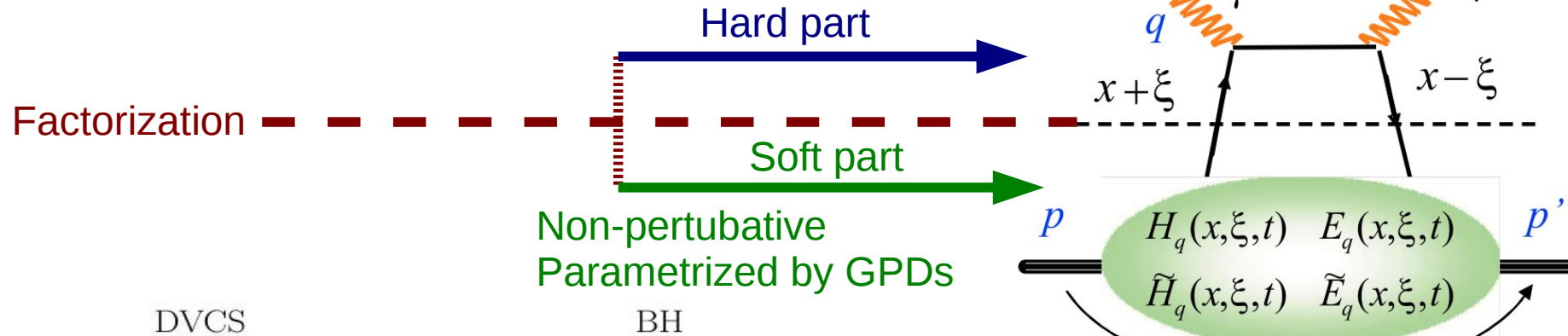
## GPDs:

<>Correspond to the amplitude of removing a parton of initial momentum fraction and restoring it with a different momentum fraction, at a later time

<>In this process, nucleon receives invariant momentum  $t = \Delta^2$



# Accessing GPDs through DVCS



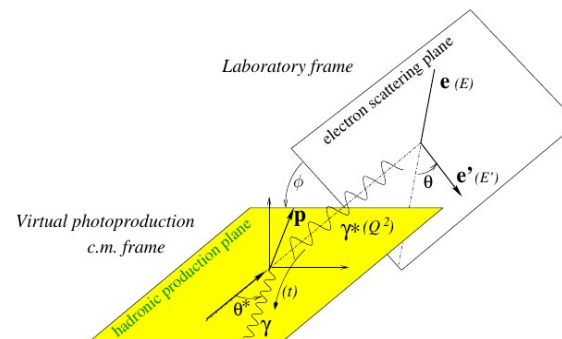
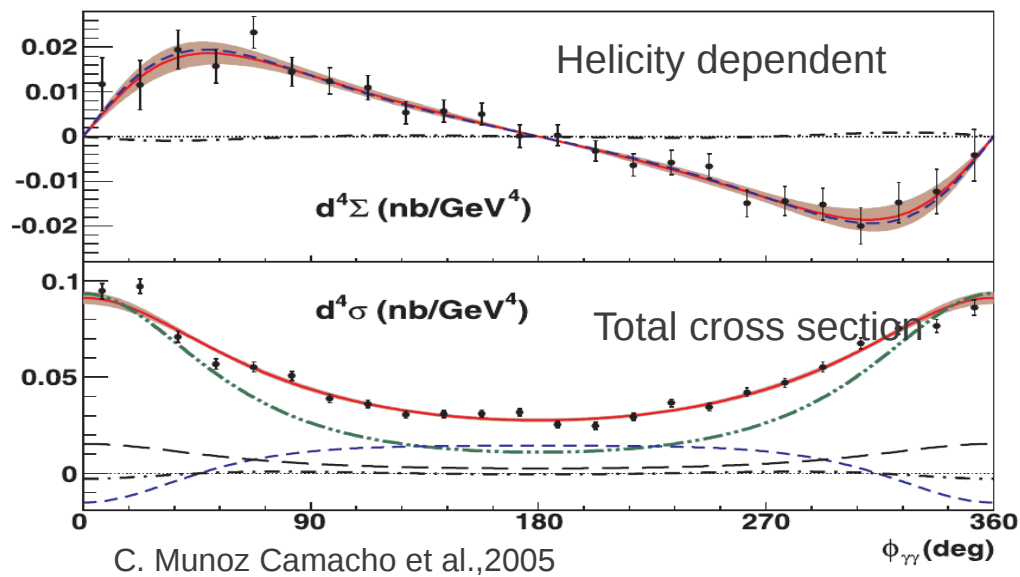
$$\sigma(ep \rightarrow ep\gamma) \propto \left| \begin{array}{c} e \\ \gamma^* \\ p \end{array} \begin{array}{c} e' \\ \gamma \\ p' \end{array} + \begin{array}{c} e \\ \gamma^* \\ p \end{array} \begin{array}{c} e' \\ \gamma \\ p' \end{array} + \begin{array}{c} e \\ \gamma^* \\ n \end{array} \begin{array}{c} e' \\ \gamma \\ n' \end{array} \right|^2$$

$$|\mathcal{T}|^2 = |\mathcal{T}_{DVCS}|^2 + |\mathcal{T}_{BH}|^2 + \mathcal{I}$$

$$\mathcal{I} = \frac{\pm e^6}{x_B y^3 \Delta^2 \mathcal{P}_1(\phi) \mathcal{P}_2(\phi)} \left\{ \mathcal{C}_0^{\mathcal{I}} + \sum_n [\mathcal{C}_n^{\mathcal{I}} \cos(n\phi) + \mathcal{S}_n^{\mathcal{I}} \sin(n\phi)] \right\}$$

$$|\mathcal{T}_{DVCS}|^2 = \frac{e^6}{y^2 Q^2} \left\{ \mathcal{C}_0^{DVCS} + \sum_{n=1}^2 [\mathcal{C}_n^{DVCS} \cos(n\phi) + \mathcal{S}_n^{DVCS} \sin(n\phi)] \right\}$$

GPDs



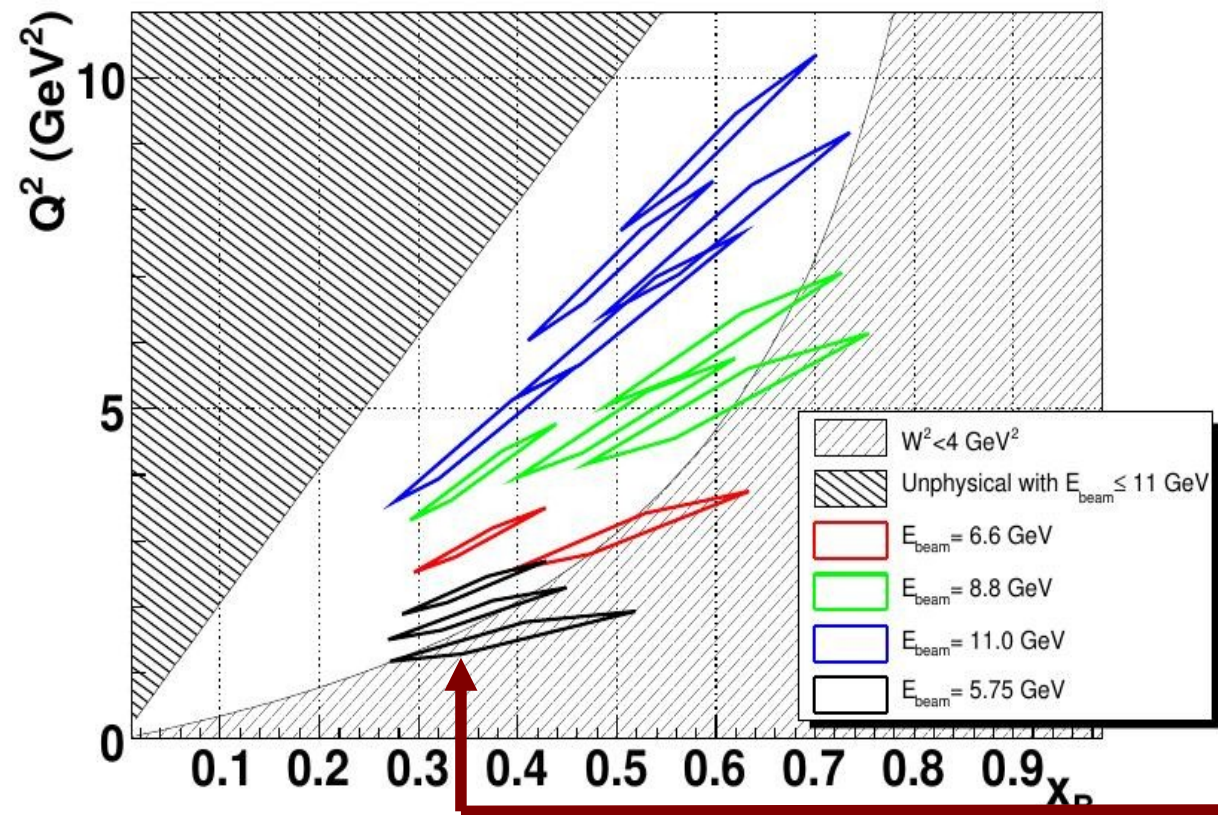
# DVCS in Hall A of Jlab: 2014/15

## GOALS:

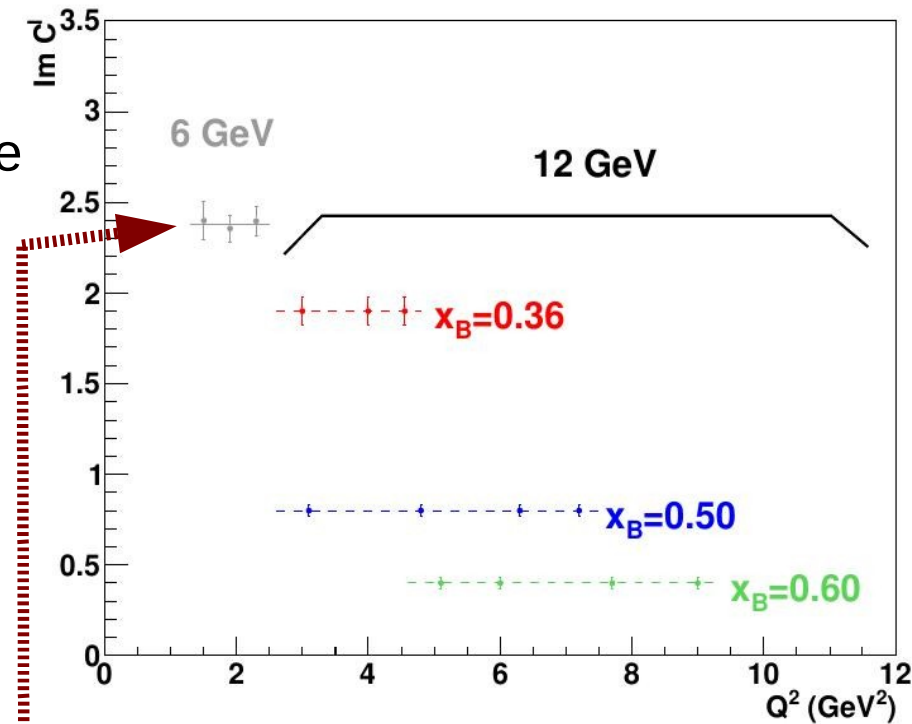
- Scaling test of DVCS cross-sections to 5% precision over large arm in  $Q^2$
- Separation of  $Re$  and  $Im$  part of DVCS amplitude (polarized and total cross section)

Proposed

DVCS measurements in Hall A/JLab



E12-06-114: DVCS scaling in Hall A



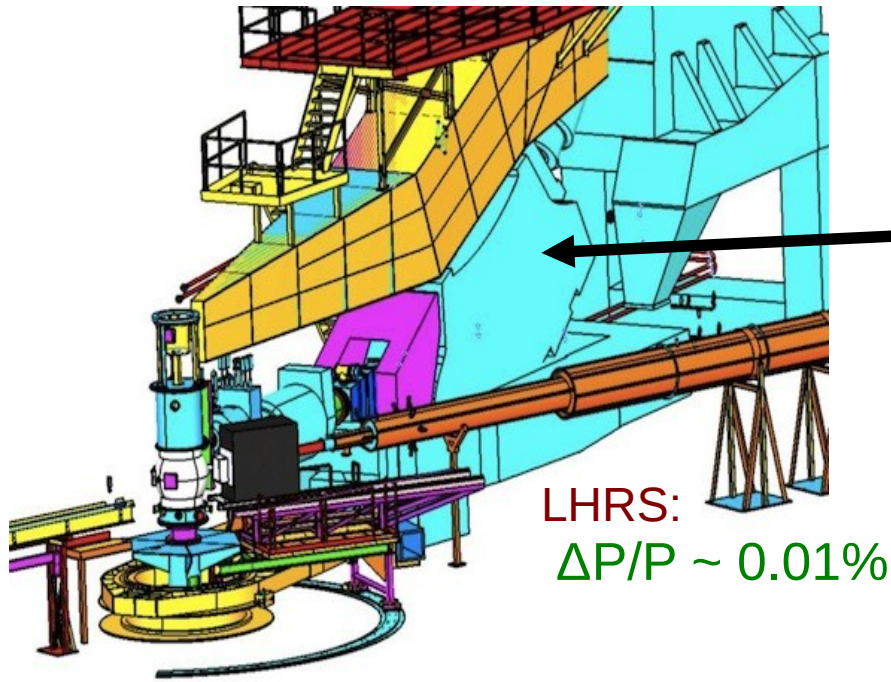
Physical insights:

→ 2005, 2010 data gave a hint for leading order domination, a wide  $Q^2$  range waits to nail that down

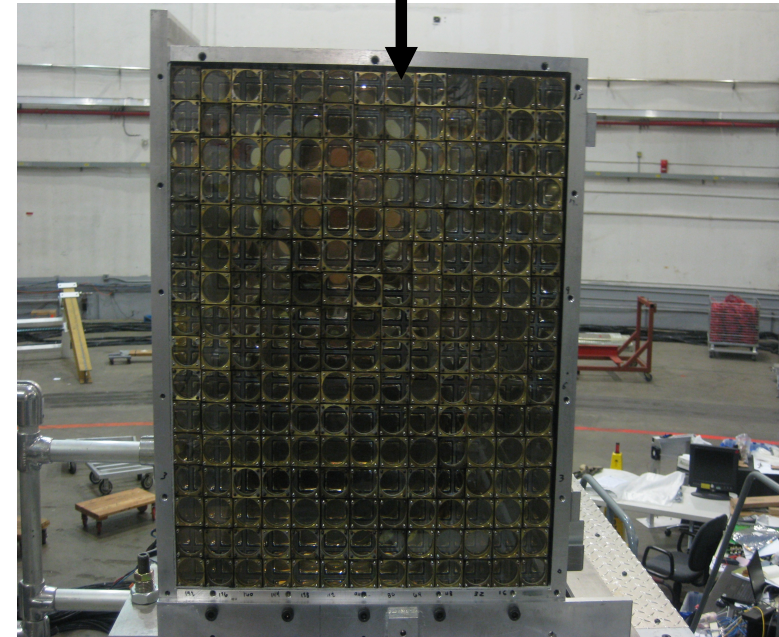
We have 100+12 approved days. Only about 50% scheduled in 2014-2015



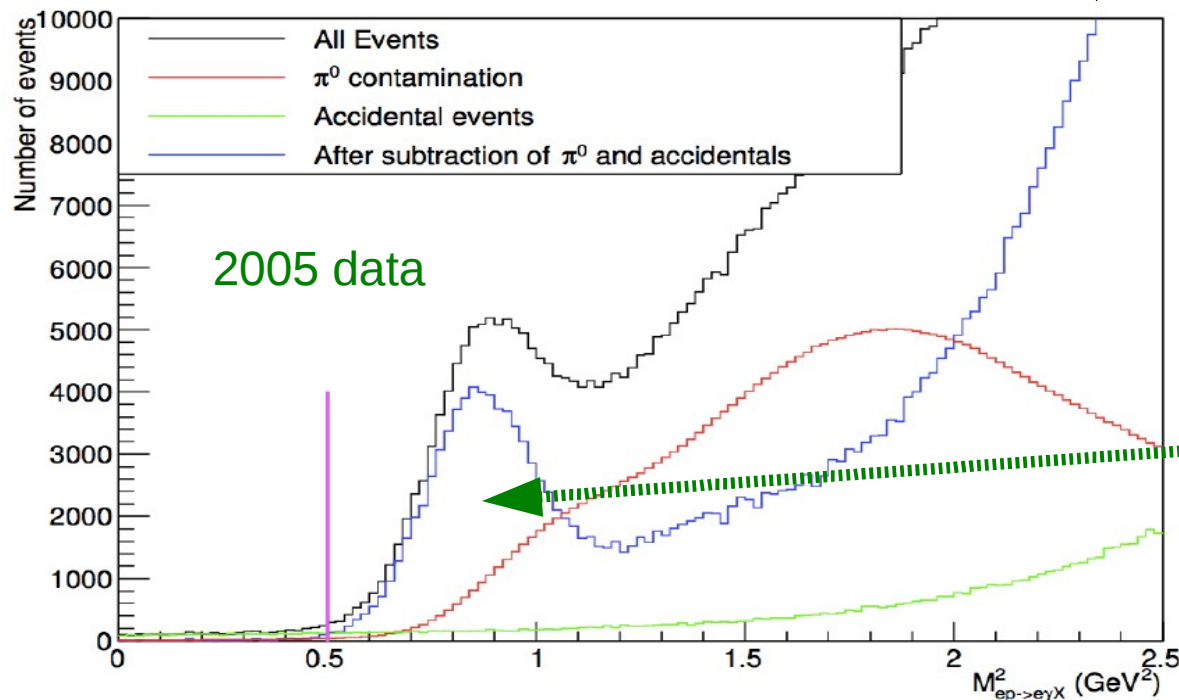
# Apparatus



$p(e, e'\gamma)p'$



208 PbF2 blocks calorimeter



Missing mass squared ensures exclusivity

$\Delta q/q \sim 3\% \sim \text{modest}$

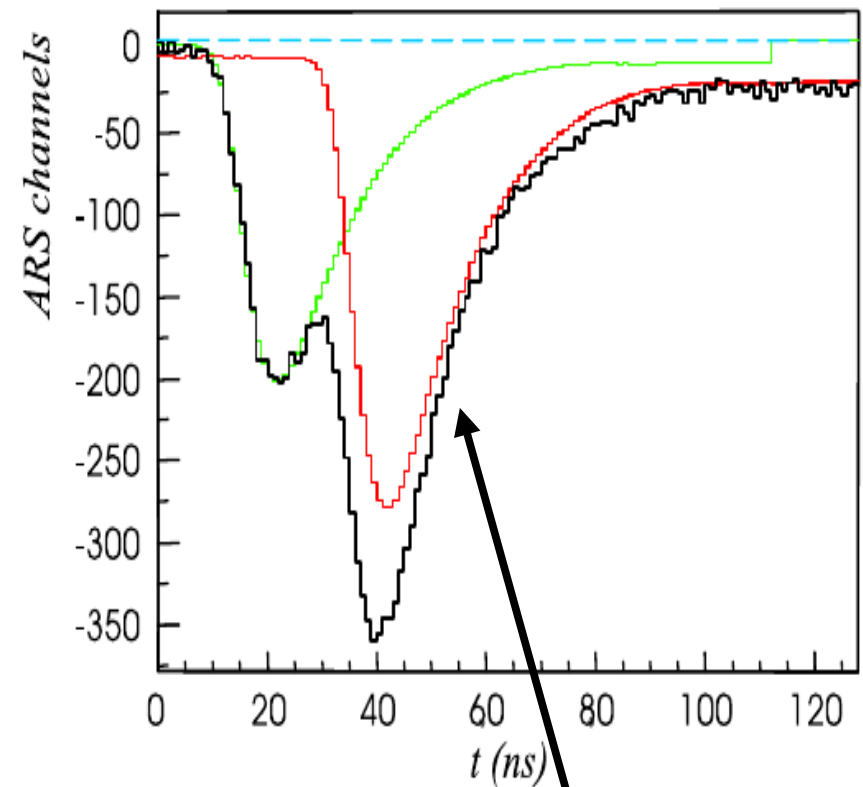
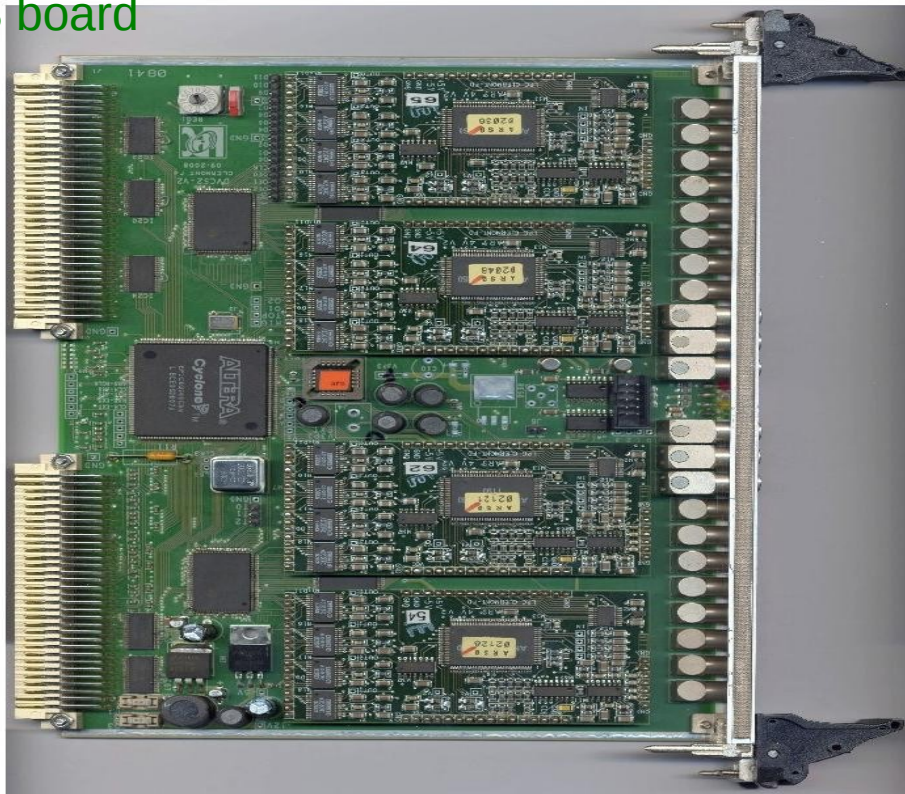
=> Calorimeter photon energy resolution is our limiting factor in the missing mass reconstruction

Apparatus:

DVCS DAQ

- Analog Ring Sampler(ARS) system
- DVCS Trigger Module

ARS board



ARS system(for calorimeter signals):

- 1 GHz sampling
- Digitizes PMT signals, allowing off-line pile-up removal
- Readout time = 128  $\mu\text{s}$

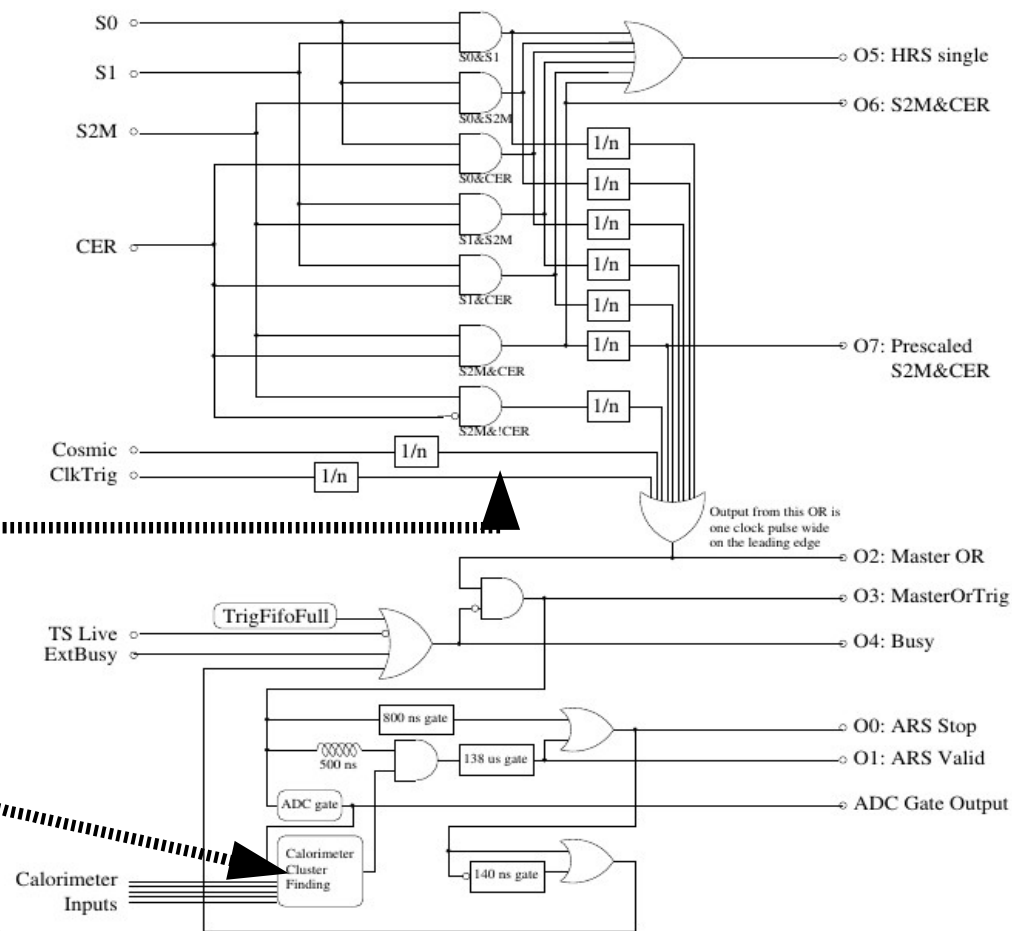
FULLY TESTED AND OPERATIONAL

Apparatus:

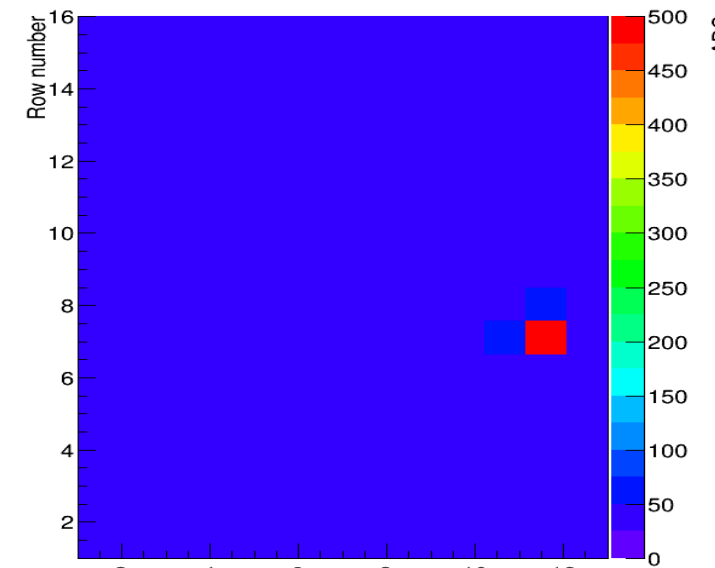
# DVCS DAQ

## 2. DVCS coincidence trigger module: (NEW FOR 2014-2015)

- Is a second level trigger module  
~800 ns decision time
- HRS triggering in DVCS trigger module.
- Selects a 2x2 block cluster above a programmable calorimeter energy threshold.
- Can bypass cluster finding(autoval.)  
, to take DIS
- Simultaneous multiple triggers



Run 10371 - event 29341



FULLY TESTED AND OPERATIONAL



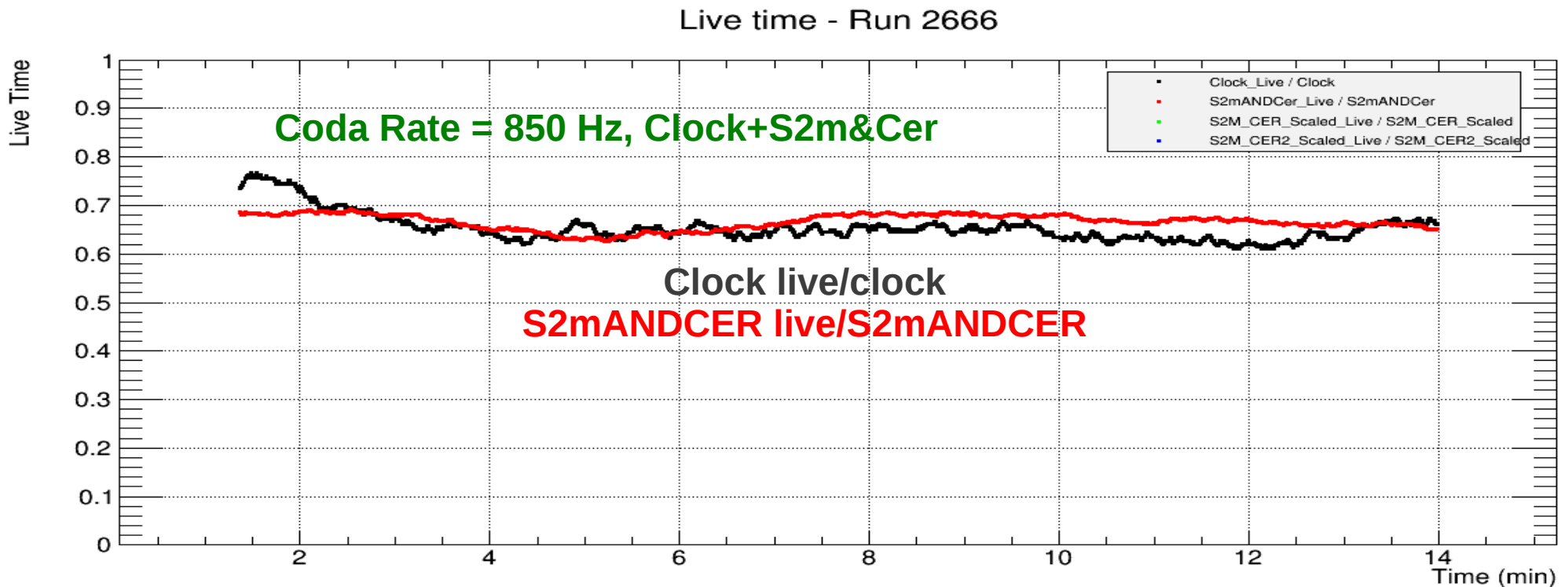
# Preparations for data taking since in Hall(I)

## DVCS stress test(Final Tests for DAQ):

- we ran the DAQ at high rates ~kHz to check for any “breaking points” in DAQ.
- we tested the performance of analysis machines in handling heavy runs.
- we monitored data transfer to the tape and disk space.
- we monitored deadtime with and without prescales

## Conclusions:

- we can take events up to around 45 MBytes/s with smooth DT behavior
- At higher rates, we see unstable DT and rates, network seems to be bottleneck
- data rate does not seem to be affected by number of jobs, or writing on the disk

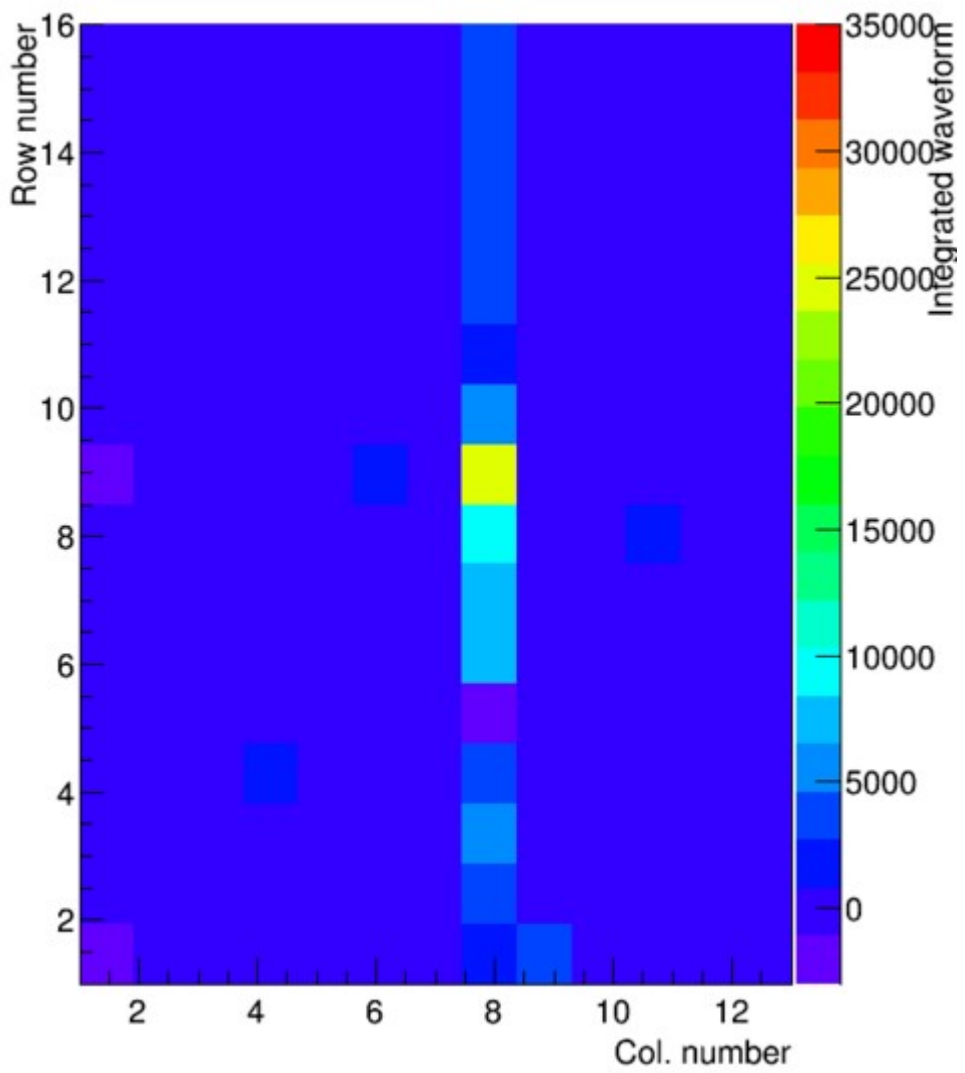




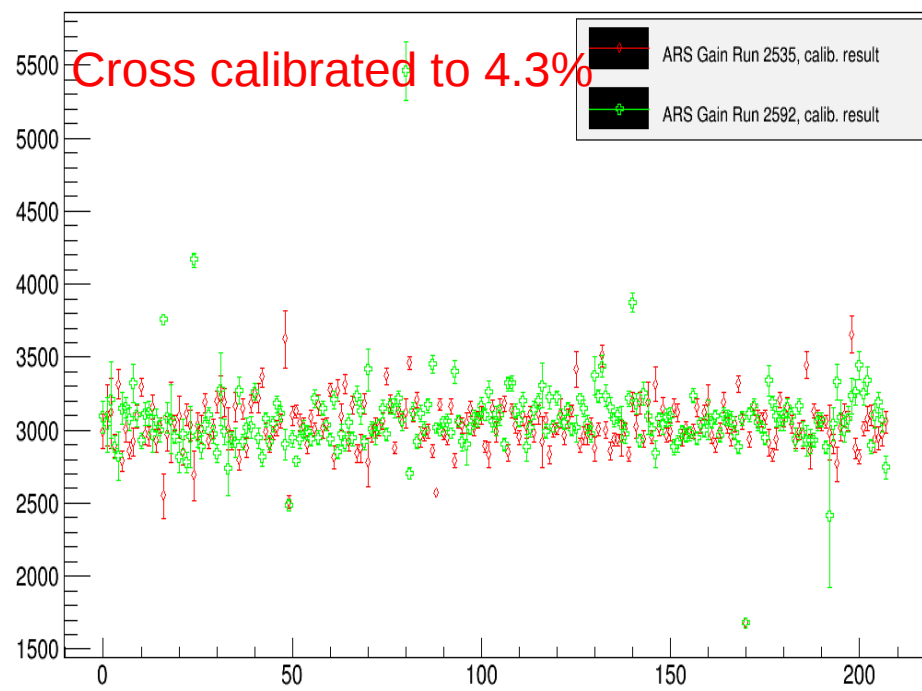
Preparations(II):

Cosmic calibration of calorimeter:  
Vertical cosmic selected  
Calo HV already set for production

Run 2091 - event 1997



ARS Gain 2535 2592 per Block



Last cross calibration result

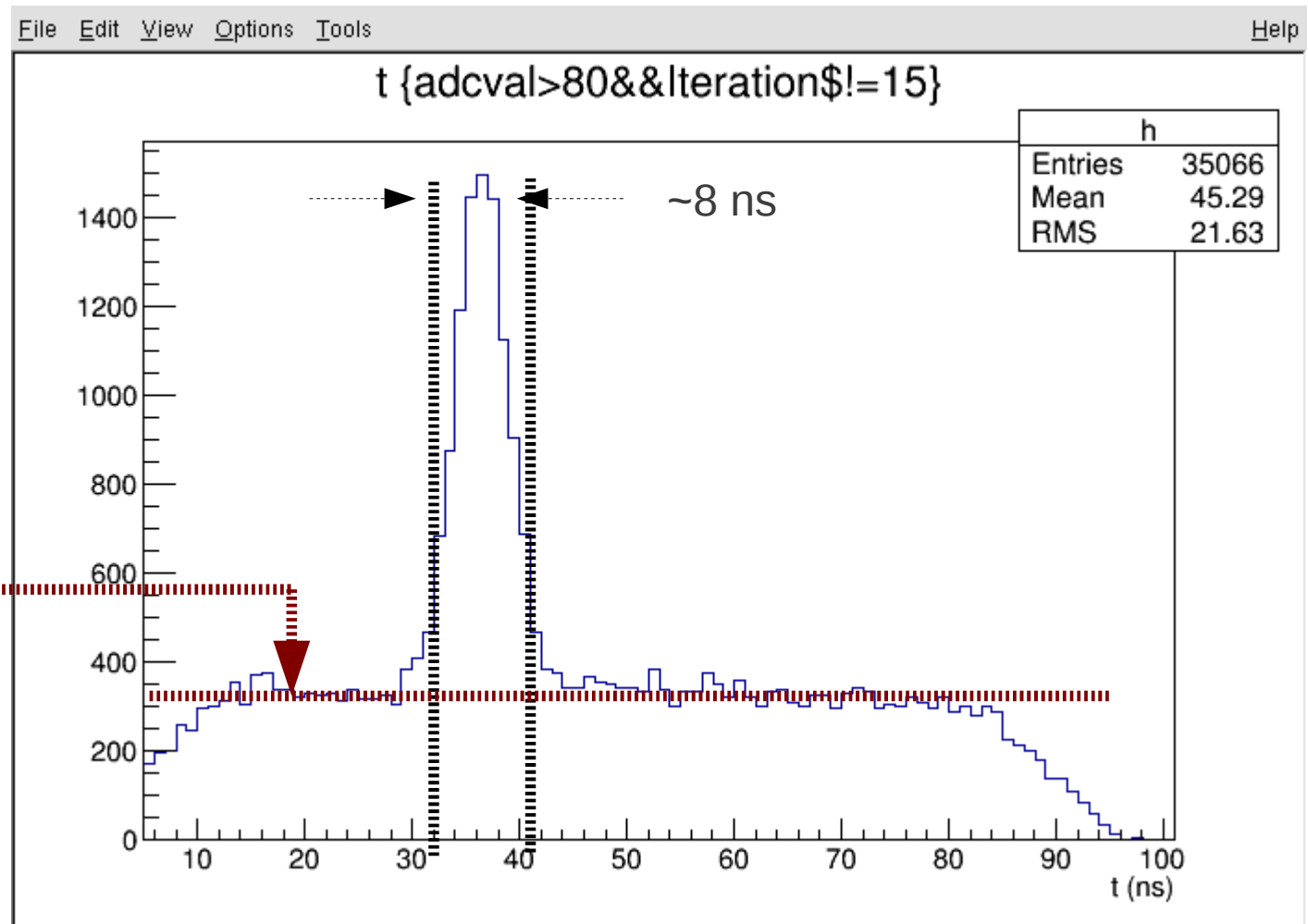
# What we did so far since getting beam(after thanks giving)

→ We had a very good previous week in terms of beam and started with DAQ checkout.

Calo-HRS coincidence Time.

- using DVCS setting
- raw, not optimized
- goal is ~ 1 ns width (with better offline analysis)

Accidentals

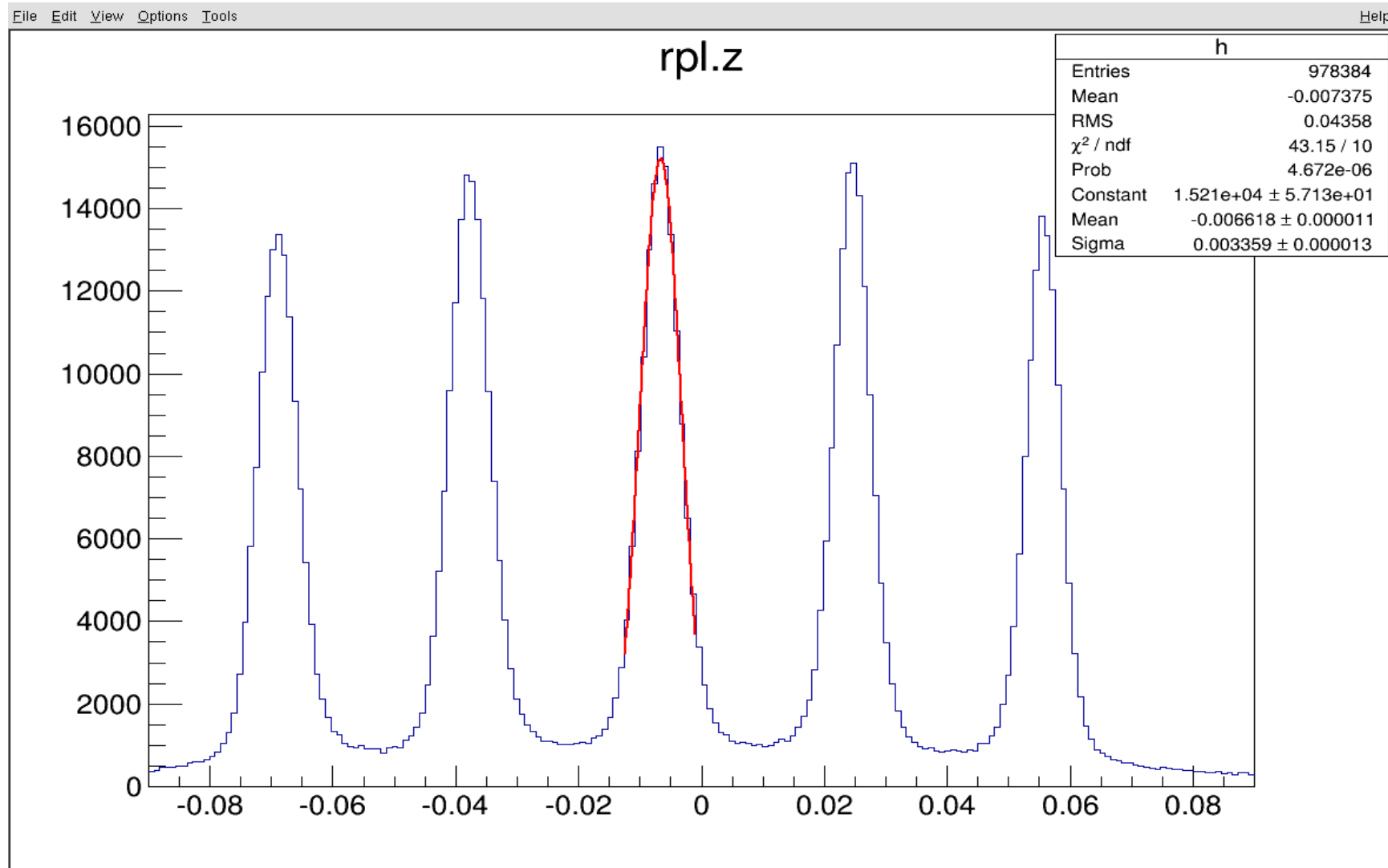


So far

Run with 5 carbon foil and vertex reconstruction

Resolution  
of central  
foil ~ 3.4 mm

Expected is  
3.1 mm



So far

Yesterday, we did energy calibration of our calorimeter  
Analysis is in progress



# Looking ahead for this Fall

## Things we would like to do[~14 days]:

Item	status
→ BCM calibration	upcoming
→ BPM calibration	difficulties: harp not very sensitive, difficulty moving beam without tripping
→ Moeller data taking	upcoming
→ Raster commissioning	under analysis, strange pattern on dump
→ Trigger efficiency studies	upcoming
→ Beam Energy calibration	arc measurement to be commissioned
→ Production	$x \sim 0.36$ , $Q^2 \sim 2-3 \text{ GeV}^2$

## Difficulties/concerns:

- Feedback in positions and energy not working(maybe yet?)
- Only one cryo cell in target ladder (2 were found to be leaking)
- Commissioning the beam dump has been difficult
- LHRS capted at 3.2 GeV/c - restricting our kinematics(see Barak's talk)
- We're not getting the "promised" 11 GeV –we are forced to modify proposed kinematics
- When are we coming back for second half of our experiment?

## Conclusion

Deployed equipment properly functioning

We recently(last week) started getting beam and rolled off with DAQ and detector checkout

We are looking forward to continuing with our plans in the remaining weeks

The DVCS Collaboration

Please sign up for shifts

Thank you