

CSC CRAFT09 Results and Highlights from CRAFT08 CSC Performance Paper

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Introduction

- Since CRAFT08 a large number of hardware and software improvements have taken place in the CSC system:
 - HV system upgraded
 - LV system control improved
 - Five CSC spares used for ME+4/2 commissioning
 - Trigger changed (top+bottom →bottom)
 - New version of software on all boards
 - DCS and local online software improved
 - Most of the strip channels have been calibrated
- The results shown are provided by the CSC DPG and DQM groups
- The programs used are contained in the CVS package: RecoLocalMuon/CSCValidation (Andy Kubik - Northwestern)
- The results for the express and prompt stream appear at:

<https://cms-project-csc-validation.web.cern.ch/cms-project-csc-validation>
- They produce **automatically** a vast range of comparison plots for the CSC RecHits and Segment building:
 - Occupancy,
 - Efficiency,
 - Resolutions,
 - Multiplicities,
 - Strip/Wire timing ,
 - Pedestals,
 - Segment quality,
 - Timing,
 - STA muons...
- Today's results will cover the following topics:
 - CSC chamber occupancy
 - CSC chamber efficiency
 - ME+4/2 chambers - a first look
 - CSC chamber resolutions
 - CSC trigger performance
 - CSC timing readout
 - Alignment - first results
 - Online/Offline DQM Certification
 - Results from the CRAFT08 paper

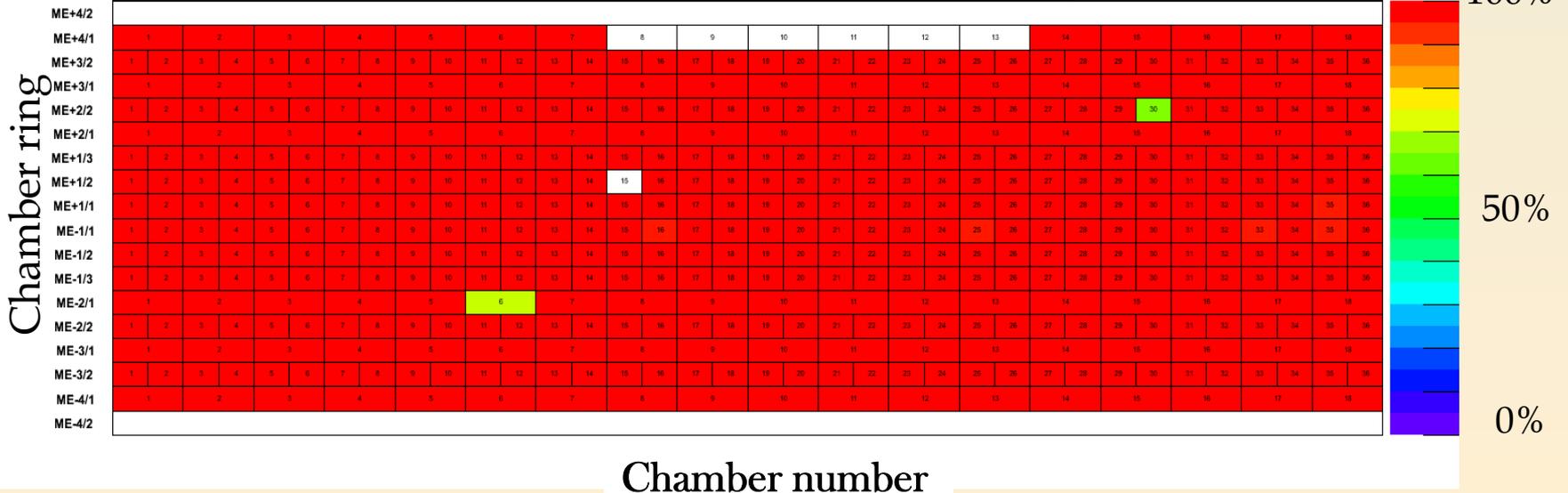
CSC CRAFT09 Detector Performance

G. Rakness (UCLA)

- ▣ Unpacker - essential tool in detecting problems
- ▣ **CSC Local DQM at**
<http://csc-dqm.cms:20550/urn:xdaq-application:lid=1450/>
- ▣ Very few chambers not unpacked, most of them switched off
 - not a real unpacker issue

Global Run 111829

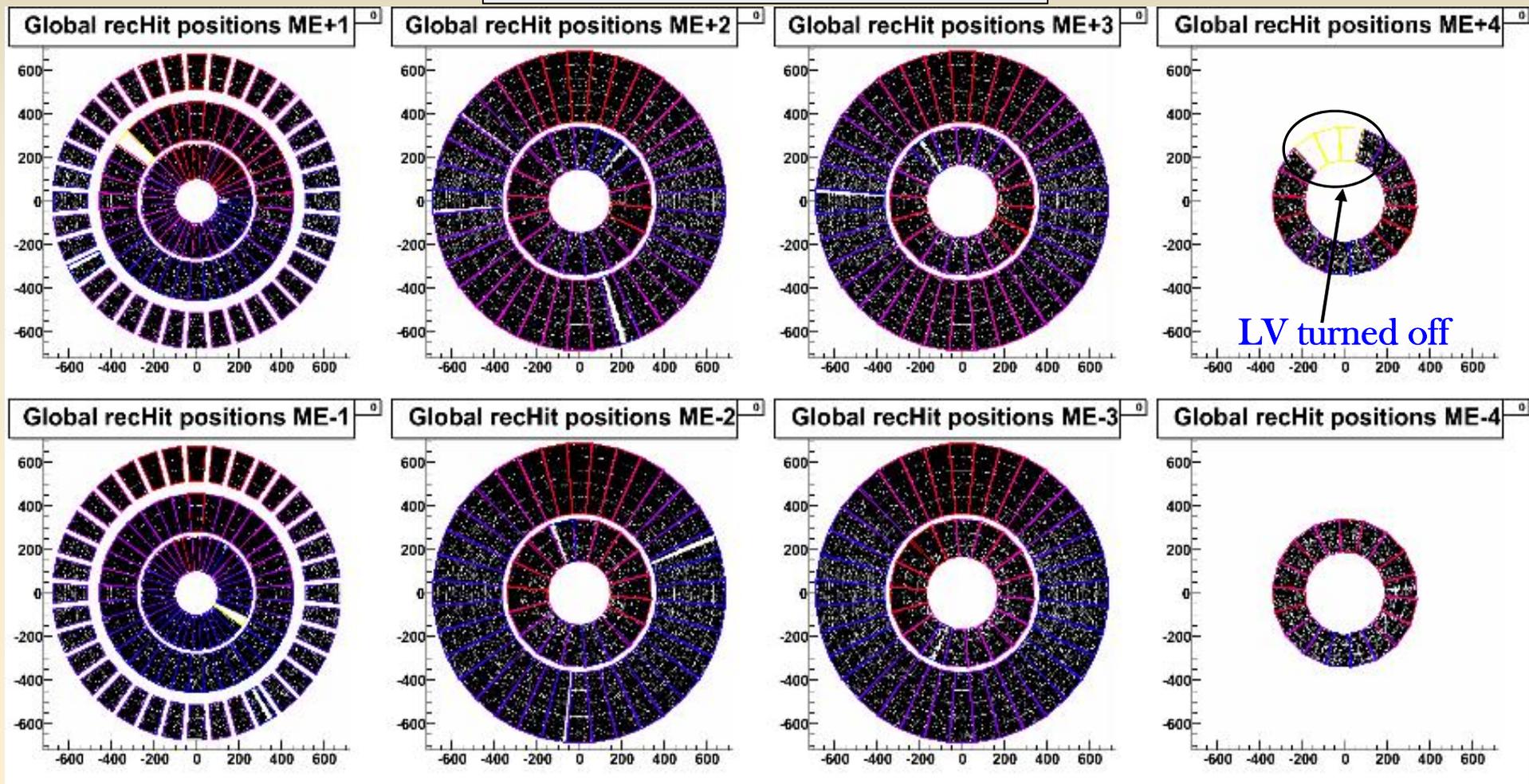
Fraction of unpacked CSC data



RecHit XY Scatter Plots: CRAFT09

A. Kubik (Northwestern)

Run110916, Aug 14 2009



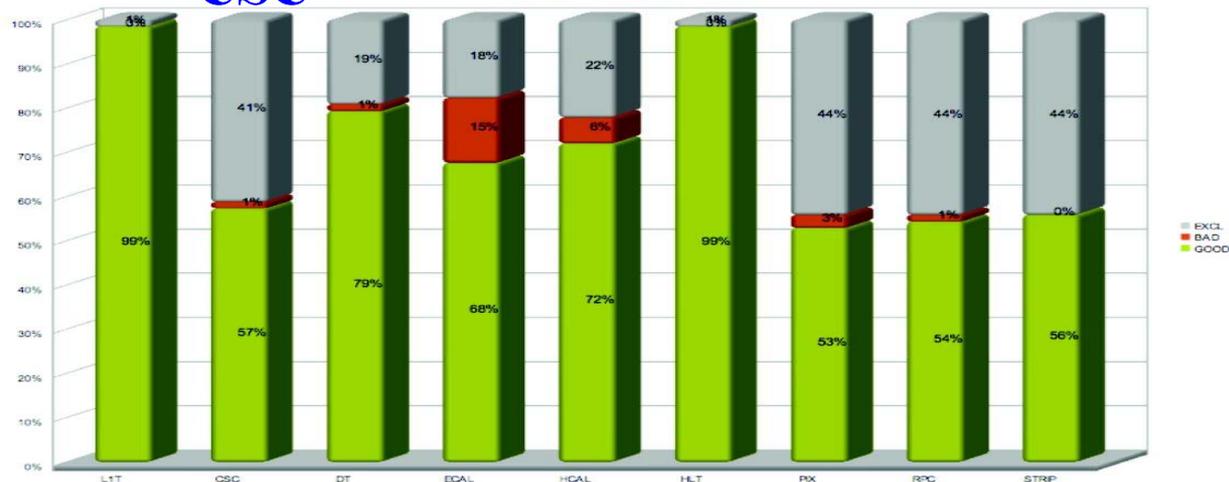
→ 99% of chambers providing data during CRAFT09 (c.f. 96% in CRAFT08)

DQM Run Certification

- Each Wednesday at the PVT meeting roughly 30-60 runs are signed off as **GOOD/BAD** by a dedicated team: V. Rapsevicius (UF), I. Segoni (CERN), A. Meyer (DESY), S. Bolognesi (CERN). Results appear at <http://pccmsdqm04.cern.ch/runregistry/>

CSC

CRAFT09: runs 110998 - 111949

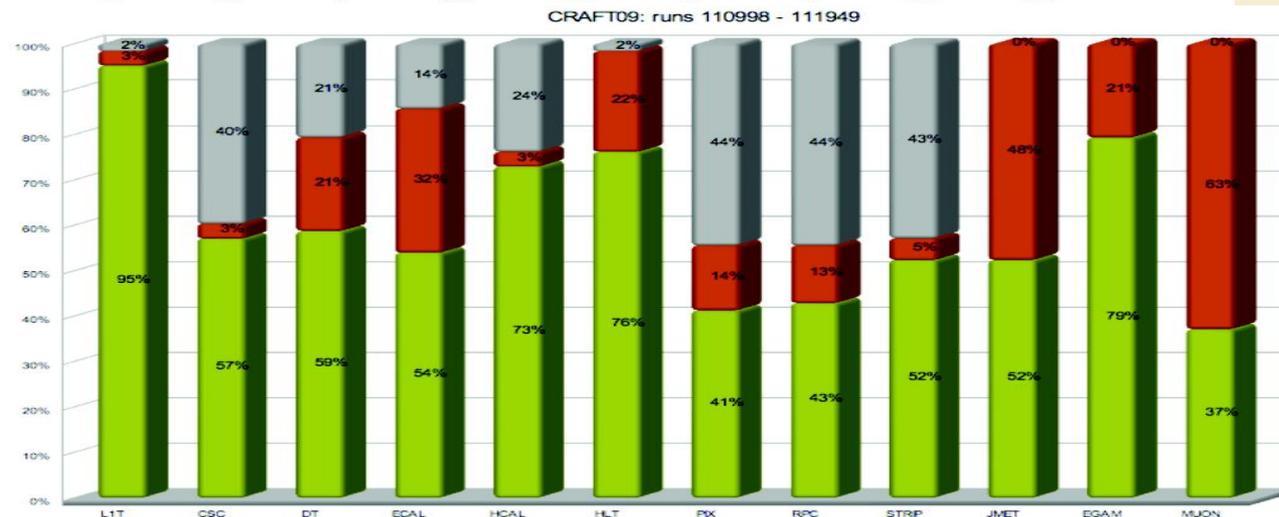


I. Segoni (CERN)

Online DQM Report

Very good agreement

Offline DQM Report



68 Runs certified:

39 → Good

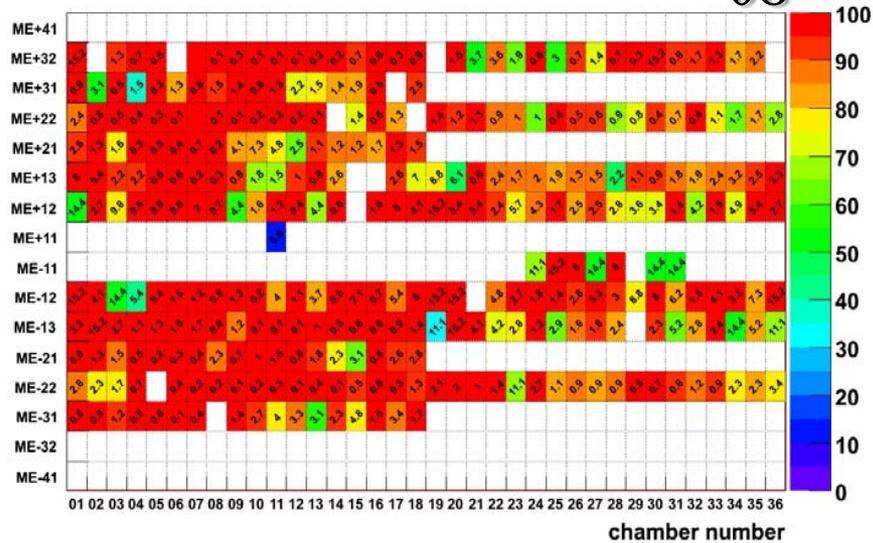
1 → Bad

28 → Excluded (due to nature of run)

CSC Efficiency: CRAFT08 vs CRAFT09

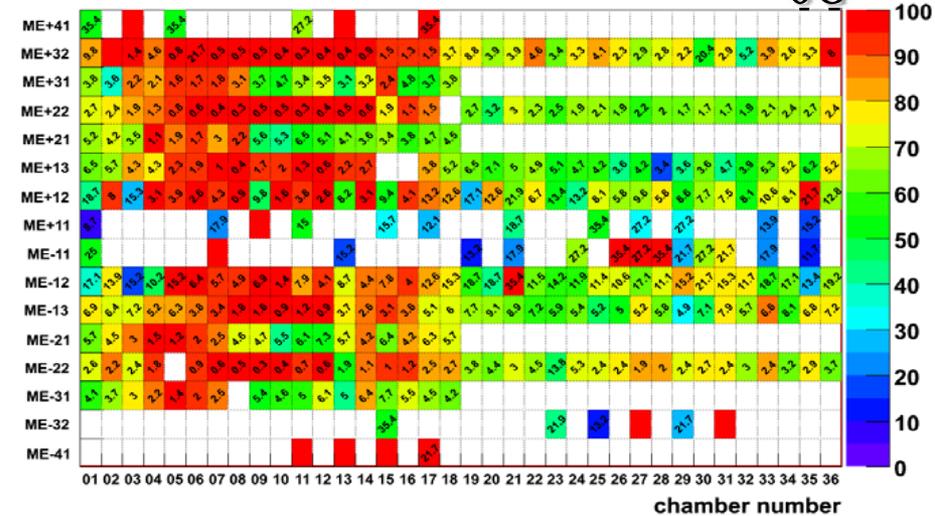
RecHit efficiency (in %), errors represented by text

'08



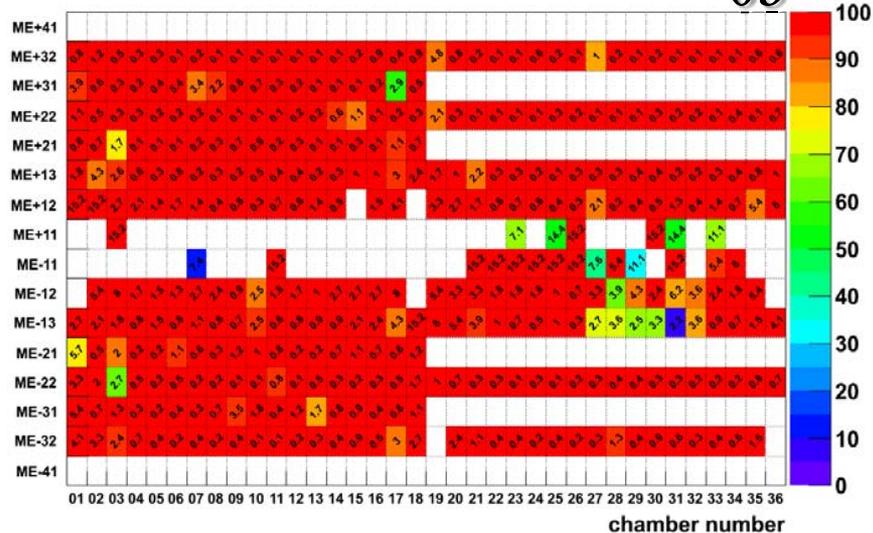
CLCT efficiency (in %), errors represented by text

'08



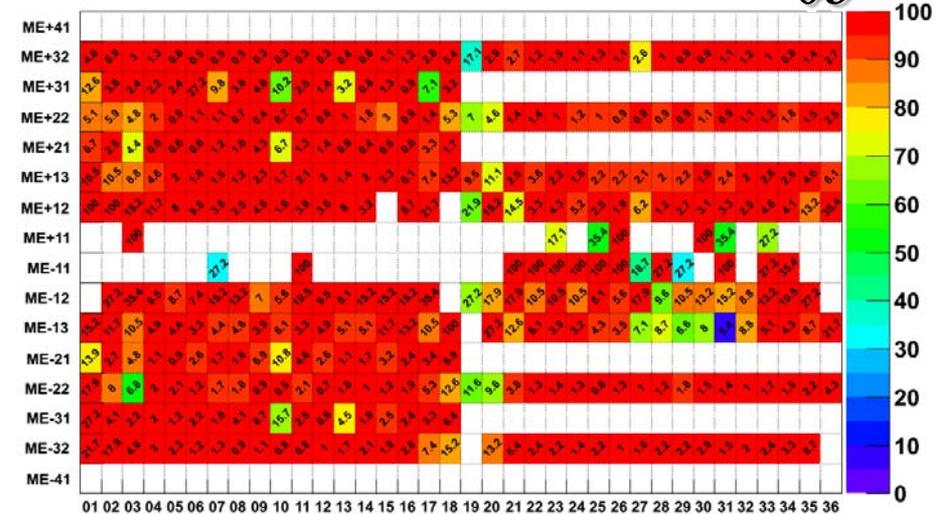
RecHit efficiency (in %), errors represented by text

'09



CLCT efficiency (in %), errors represented by text

'09



CSC's contributing to a good stand-alone muon track

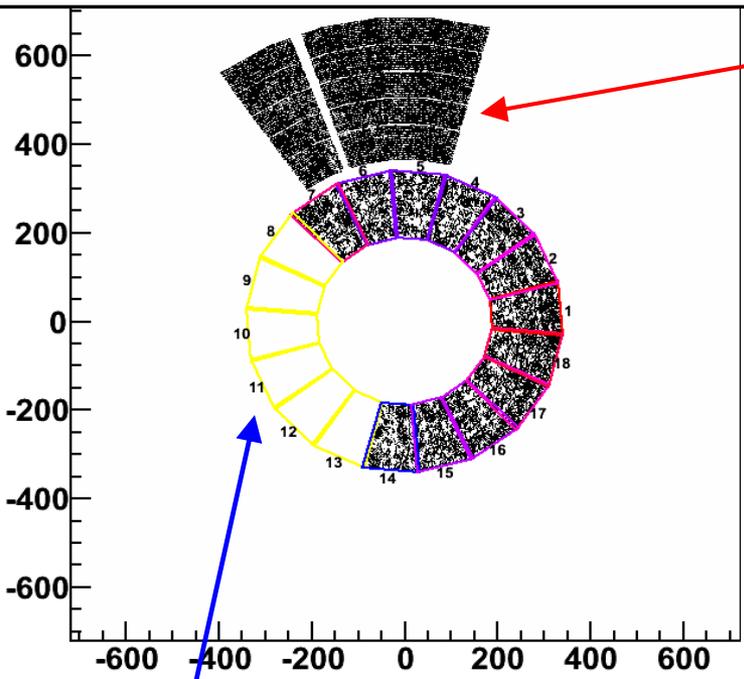
(|dx/dz| < 0.2 and -0.8 < |dy/dz| < -0.1)

RecHit efficiency is generally > 99%

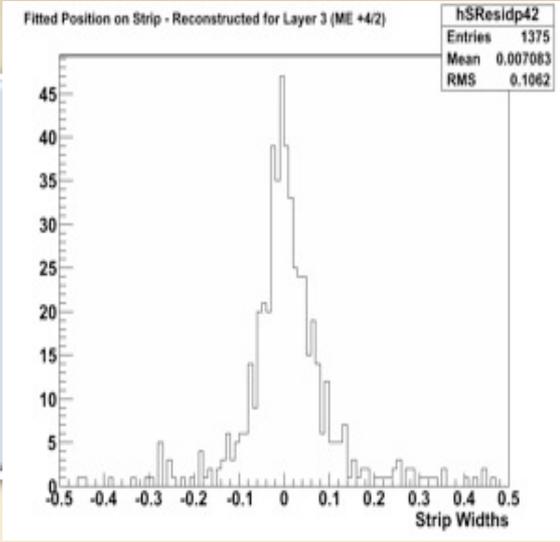
ME+4/2 Chamber Commissioning

Run 112076

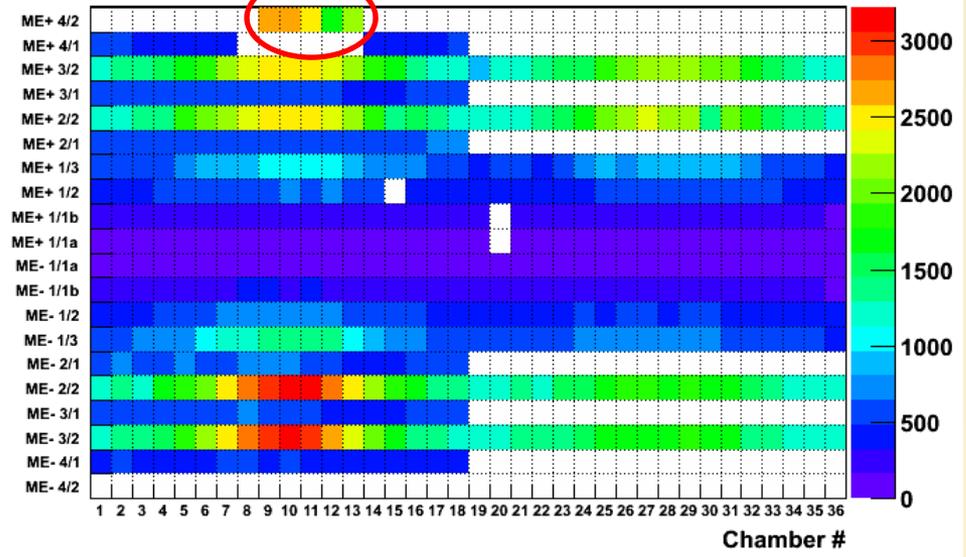
Global rechit positions ME+4



- 5 ME4/2 chambers are being commissioned at present
- We see rechits and segments from them with the CSCValidation tools



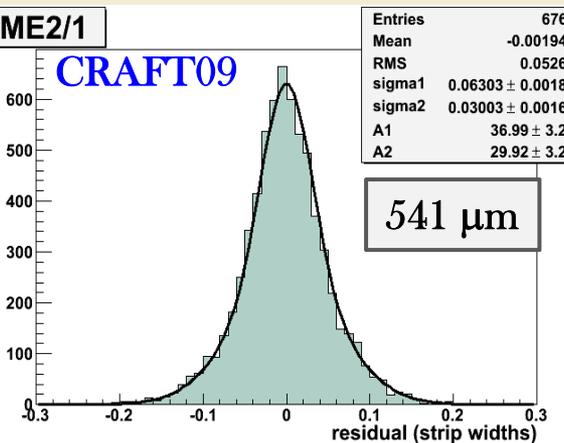
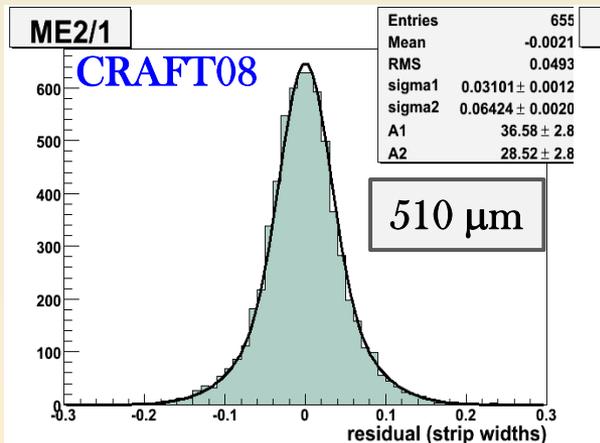
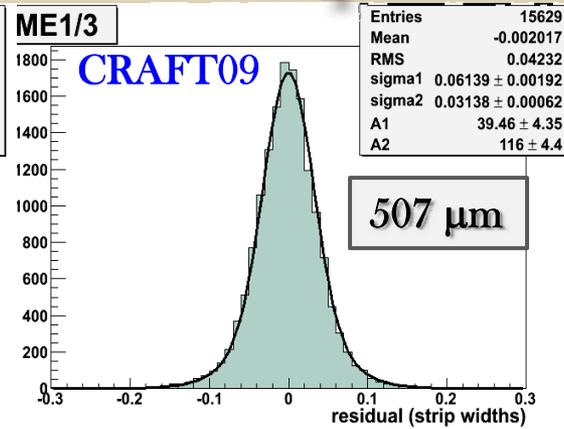
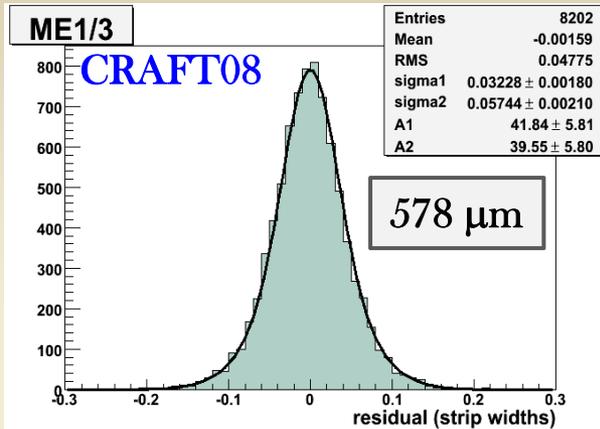
Segments Occupancy



Some ME4/1 chambers temporarily powered off to enable ME4/2 commissioning.

CRAFT08/09 Layer Resolution Comparison

M. Schmitt (Northwestern)



chamber type	2008	2009
ME 1/1b	144 μm	122 μm
ME 1/2	285	277
ME 1/3	578	507
ME 2/1	510	541
ME 2/2	487	578
ME 3/1	633	n/a
ME 3/2	534	n/a
ME 4/1	648	n/a

ME3/1, ME3/2, ME4/1 not available due to BFieldSkims requirements.

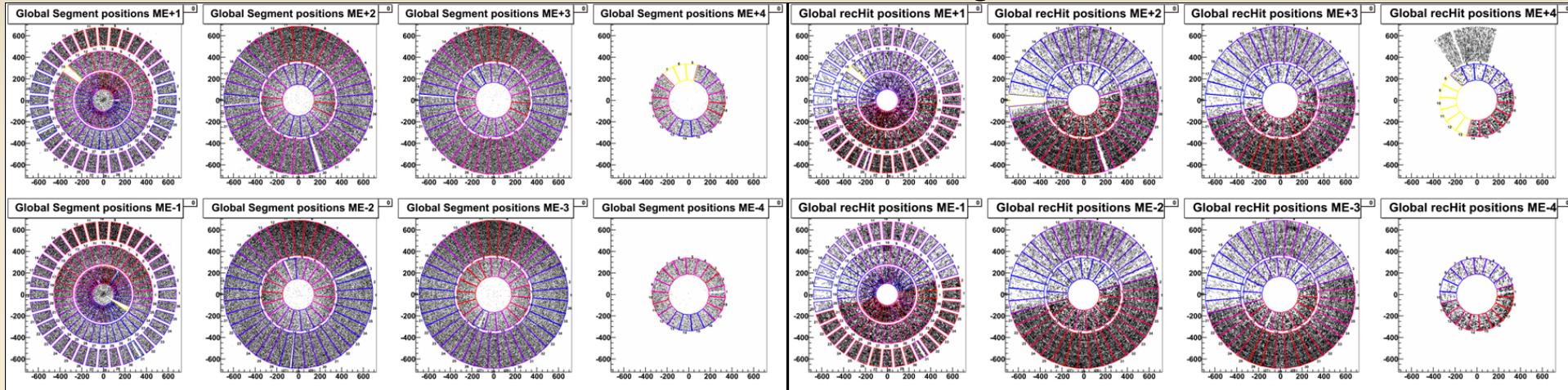
Several chambers show better resolutions, exceptions ME2/1 and ME2/2 .

CSC Trigger - Segment Global XY

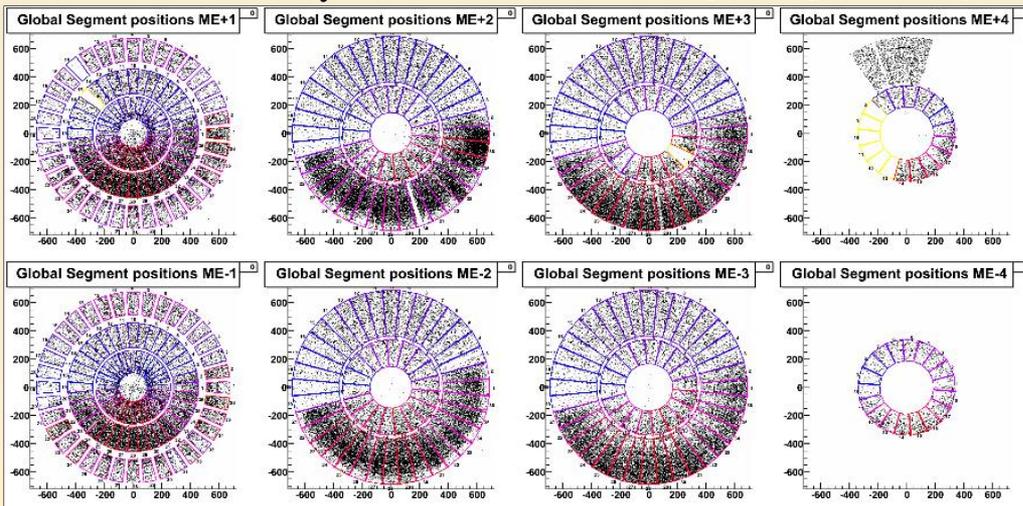
Three types of runs in CRAFT09

1. "Normal" (top and bottom) triggering

2. "Bottom Only": DT "closed" LUTs [50Hz] + CSC (singles+coincidence) [30Hz]



3. "Bottom Only": DT "closed" LUTs [50Hz] + CSC (coincidence) [4Hz]



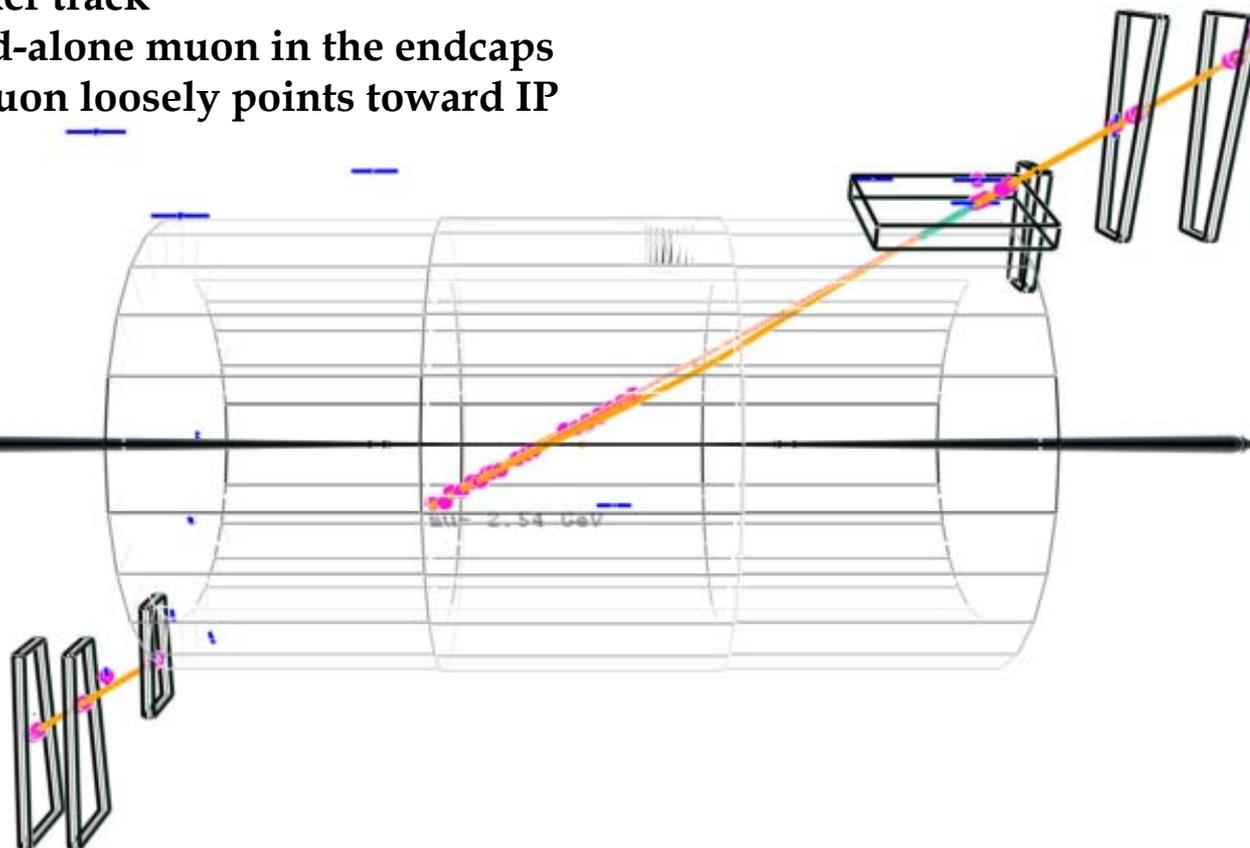
- One long run for each category analyzed and compared results from the prompt analysis (CSCValidation, Prompt Reco data stream).
- The higher density areas move to greater r as we get farther from the interaction point, consistent with IP-like muons.
- In (3) events analyzed were filtered to include events with *only* a CSC L1A trigger and events with a DT or RPC barrel L1A were excluded.

1. Run 111047
2. Run 112222
3. Run 112281

Typical event display: Tight CSC Skim

0.5M in CSCSkim_BFieldStudies...

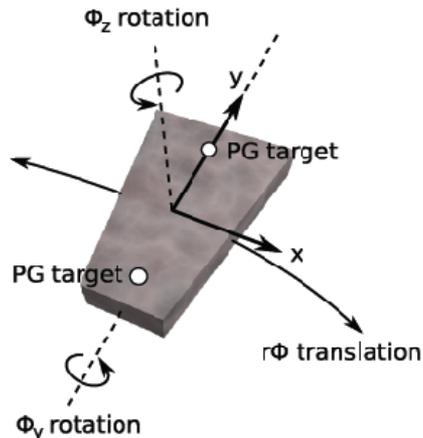
- for endcap alignment and measurements of B-field
- one good tracker track
- one good stand-alone muon in the endcaps
- stand-alone muon loosely points toward IP



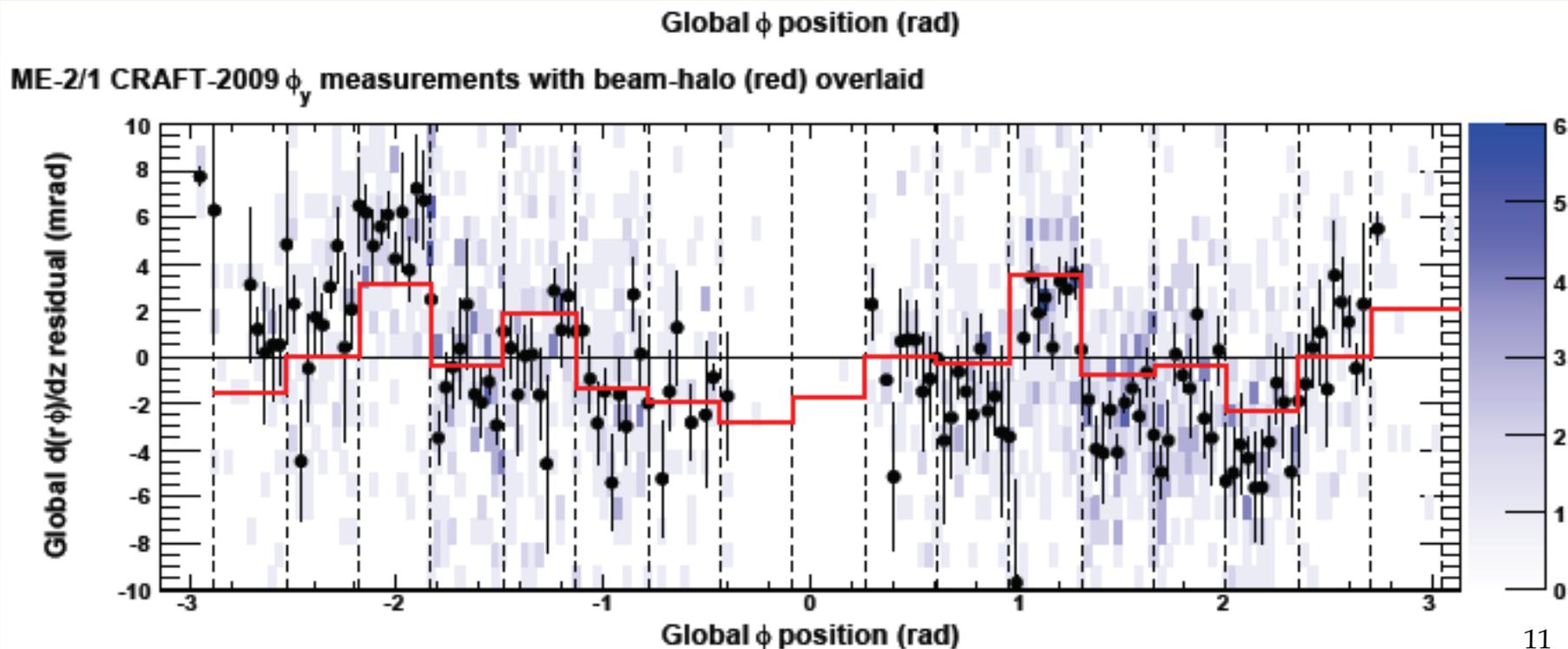
Event display:

http://www.nuhep.northwestern.edu/~schmittm/CMS/WORK/130809_event_displays/cscskim_tight.html

Track based CSC alignment



- Chamber-by-chamber angle rotation measured in CRAFT09 (from matching between extrapolated tracker track and CSC track) → black dots
- Compares well with 2008 beam-halo data! → red line



CRAFT 08
Results
(Paper in preparation)

Simulated vs Real CRAFT08 Events Comparison

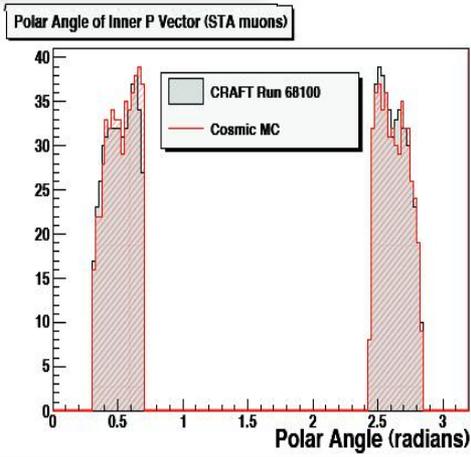
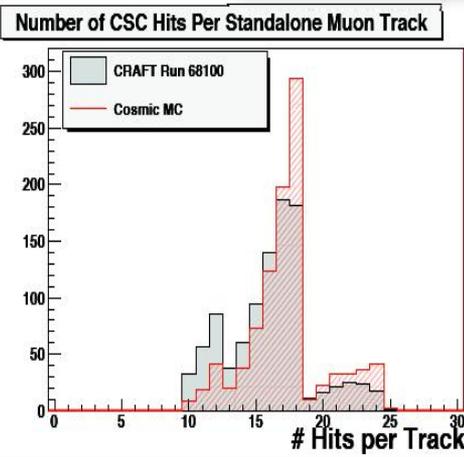
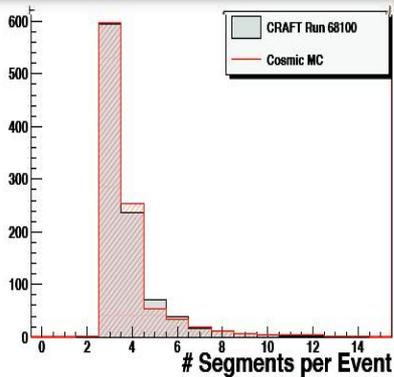
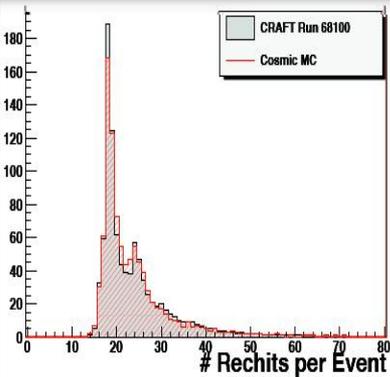
CSCSkim :

≥ 3 chambers with hits

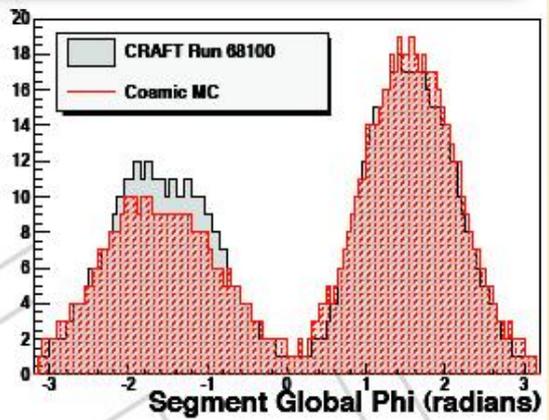
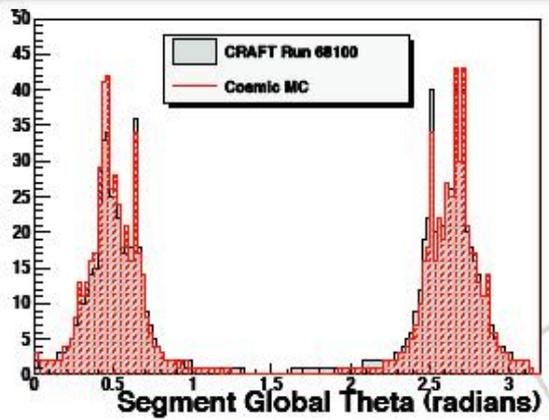
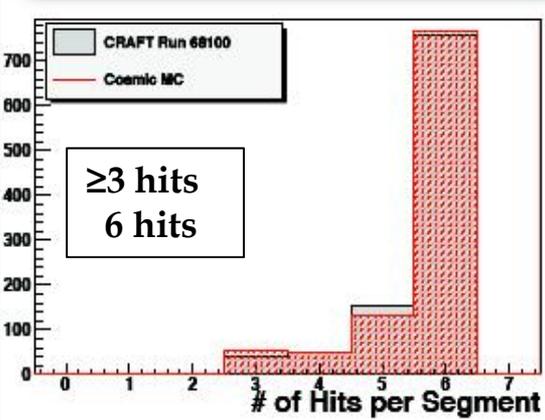
≥ 2 segments reconstructed

Stand-alone muon quantities
 • alignment not completed

Total number of rechits and segments per event



Reconstructed segment quantities: number of hits (left), polar angle (middle) and azimuthal angle (left)



LCT Efficiencies: Stand-Alone Muons

Efficiency calculation method:

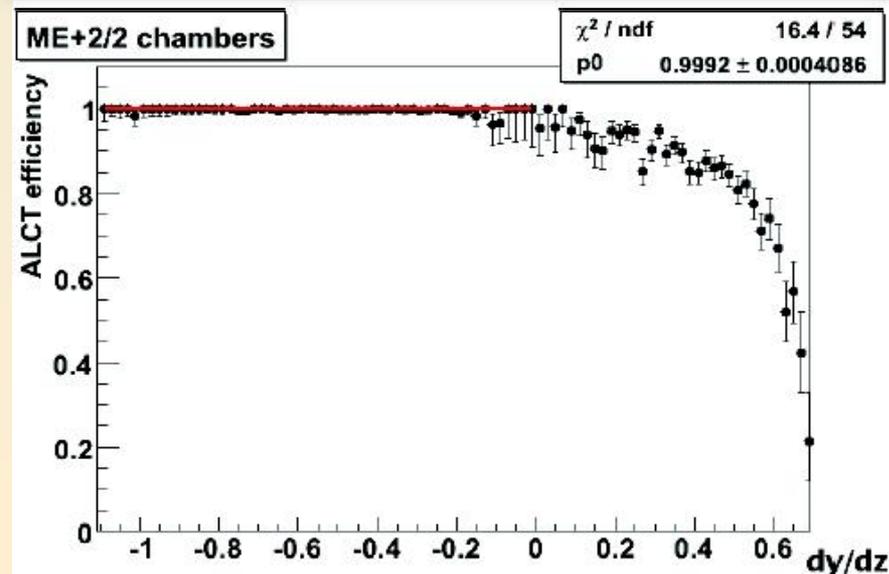
- use two chambers to 'tag' a muon that passes through a designated 'probe' chamber
- reconstructed stand-alone muons are used
- chamber tracked only if it lies between the endpoints of the track

ME±1/1, ME±4/1, ME-3/2 not covered by this study.

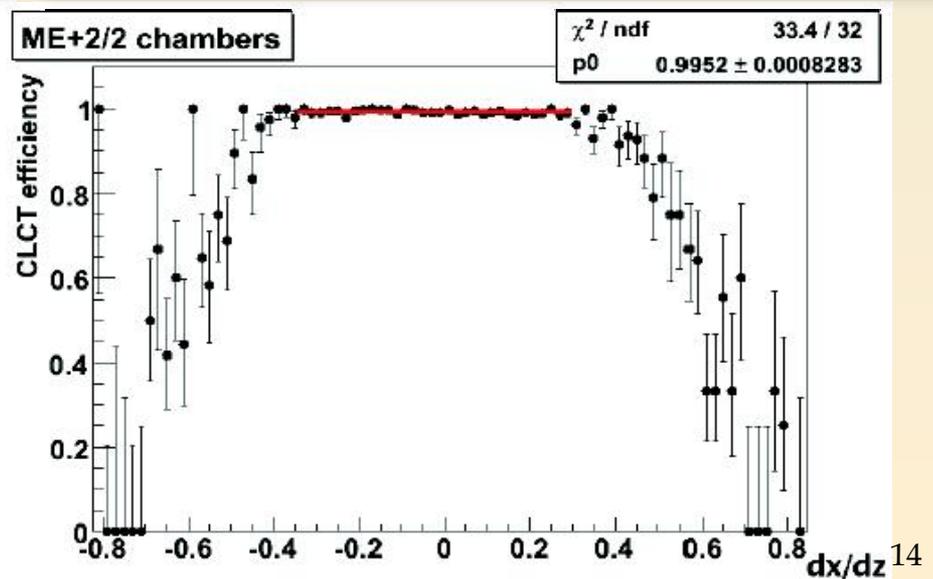
Stand-alone tracks selection cuts:

- only one muon track in an endcap with minimum number of hits and is well reconstructed (χ^2 cut)
- $25 < p_{T\mu} < 100$ GeV
- $-0.8 < dy/dz < -0.1$ & $|dx/dz| < 0.2$ regions chosen for cosmic rays

ALCT efficiency as a function of track inclination



CLCT efficiency as a function of track inclination



RecHit & Segment Efficiency per Ring

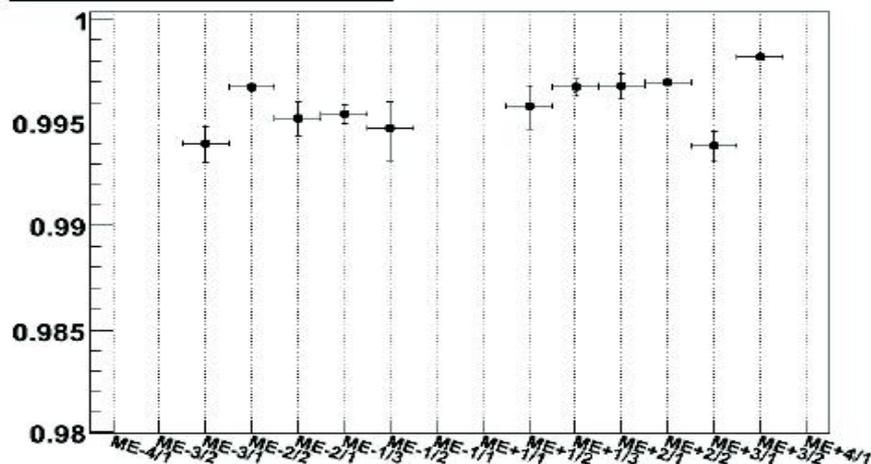
A chamber is efficient if rechits are found in a given layer:

→ Rechit efficiency > 99% for all CSC chambers

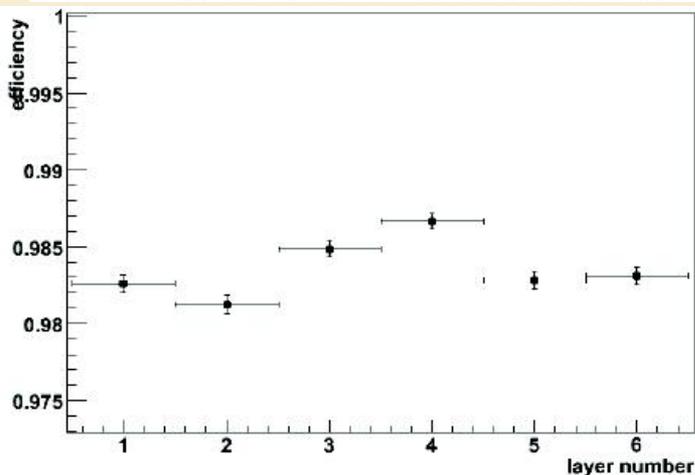
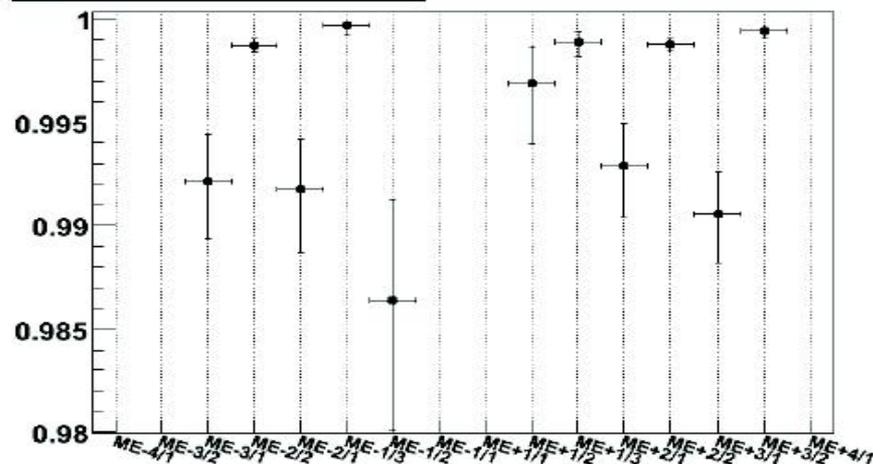
At least 3 good rechits must lie along the muon trajectory; a chamber is efficient if a segment is reconstructed.

→ Segment efficiency > 99% for all CSC chambers.

Rechit efficiency per ring



Segment efficiency per ring



Attachment efficiency → probability of the segment to use a rechit from a given layer if there are rechits in that layer.

GOAL: Efficiency should be flat as a function of the layer number!

If not flat → indication of a possible problem.

Resolution and Timing

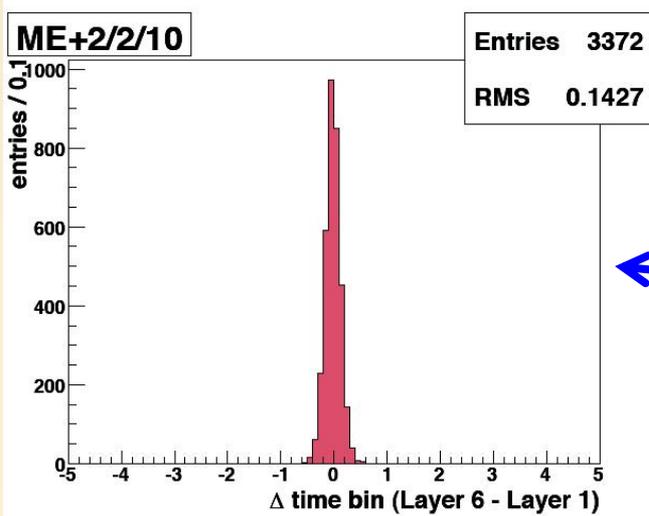
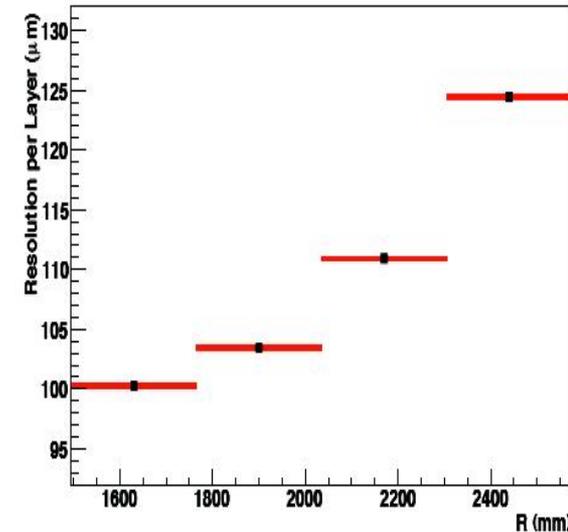
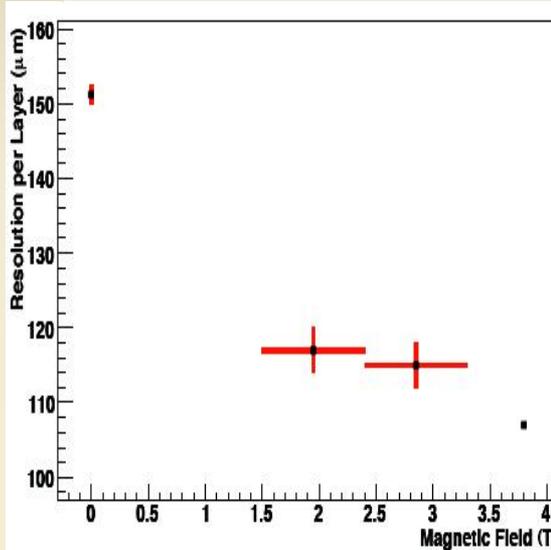
ME±1/1b resolution as a function of the magnetic field (left) and distance from the beam line (right)

Clean sample of events:

- containing at least one good segments with 6 rechits and $\chi^2 < 200$
- several other requirements related to rechits errors, strip charges and coordinates, segment inclination were applied.

Resolution:
$$\bar{\sigma} = \sqrt{\frac{A_1\sigma_1^2 + A_2\sigma_2^2}{A_1 + A_2}}$$

Resolution is best at full magnetic field!!



Difference in measured times for layer 1 and 6 in units of 50ns.
 RMS = 0.1427 corresponds to 5ns per layer.
 With 6 rechits per segments → one segment has a time resolution of ≈ 2 ns → transit time of muons from interaction point to the CSC's ≈ 30 ns.

Summary

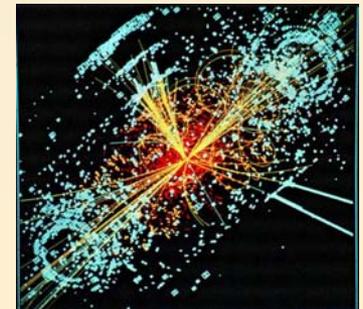
CRAFT09 SUMMARY

- ▣ **300 million events have been recorded in CRAFT09**
 - little to no downtime due to CSC's
- ▣ **Very high efficiencies observed in both CRAFT08/09**
 - from local charged tracks to reconstruction of rechits and segments
- ▣ **Resolutions improved in CRAFT09 for most chambers**
- ▣ **Bottom trigger only tested and giving excellent results**
- ▣ **Alignment improved using CRAFT09 data**
- ▣ **The CSC system is in excellent working condition**

CRAFT08 PAPER SUMMARY

- ▣ **Agreement of distributions between real data and simulation of basic segment and track quantities**
 - ▣ very good
- ▣ **Efficiencies, resolutions, timing**
 - all very good according to design
- ▣ **CSC CRAFT08 paper to be posted to iCMS soon**

We are ready for COLLISIONS!



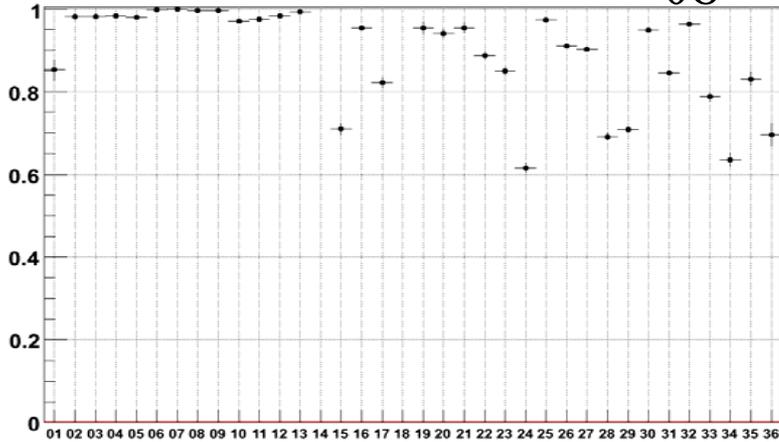
Backup

RecHit Efficiency ME+2/2

S. Stoynev (Northwestern)

RecHit efficiency

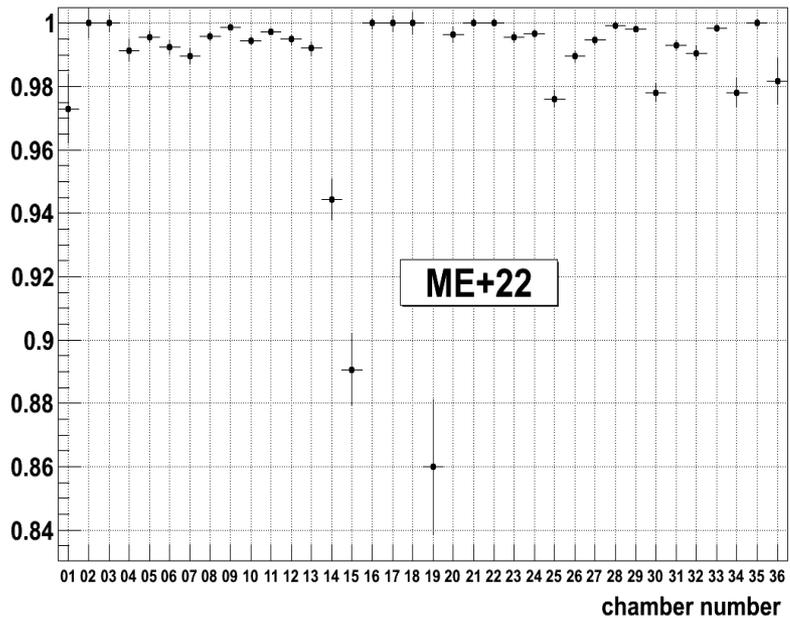
'08



Scales are different.
Bottom only trigger delivers superior data.

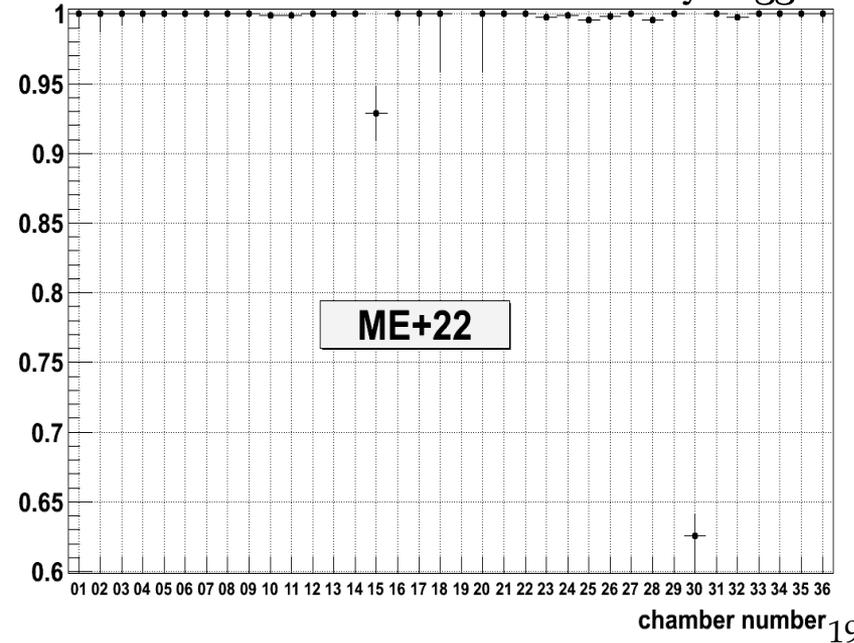
RecHit efficiency

'09



RecHit efficiency

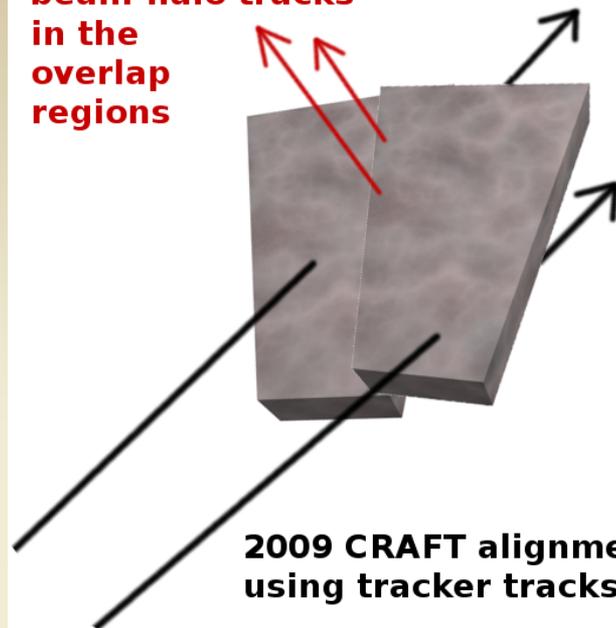
Bottom only trigger



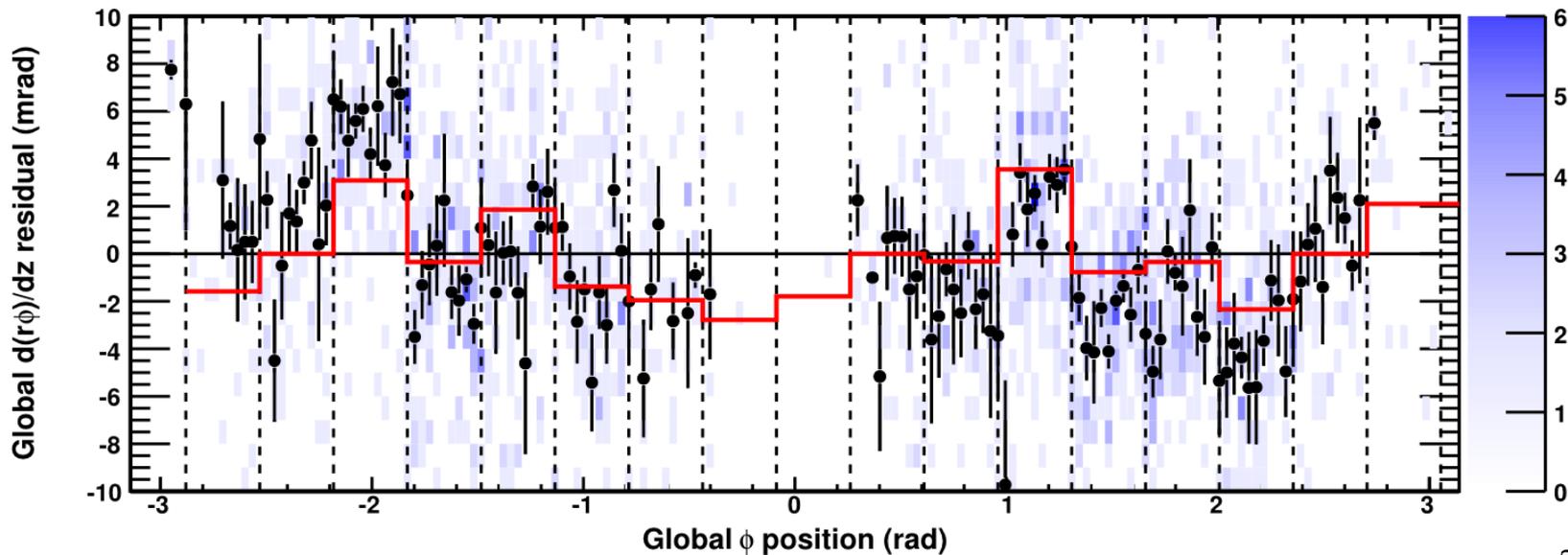
Track based CSC alignment

- Small fraction of cosmic rays pass through tracker and CSC chambers: apply tracker-to-muon chamber alignment technique
- Diagnostic plot below: angular residuals vs. phi:
 - 2D distribution is blue, profile is black, dashed lines separate CSC chambers
 - Alignment results from 2008 beam-halo overlaid in red for comparison
- Cross-check of very different alignment techniques

2008 alignment using beam-halo tracks in the overlap regions



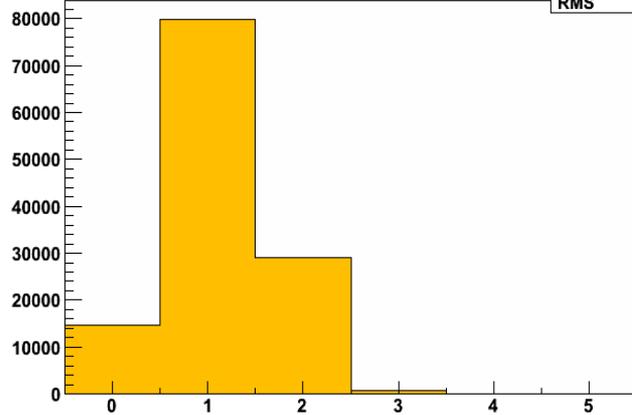
ME-2/1 CRAFT-2009 ϕ_y measurements with beam-halo (red) overlaid



Bottom Only Trigger: STA Muons Distributions

Number STA Muons per Event

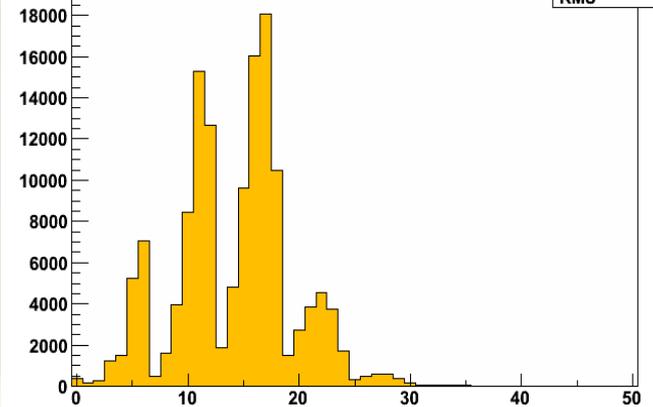
Entries	124368
Mean	1.127
RMS	0.6003



- Almost all events have at least 1 track reconstructed and the number of hits per track is overall high.
- The CSCs are getting almost exclusively high quality events using this trigger configuration.

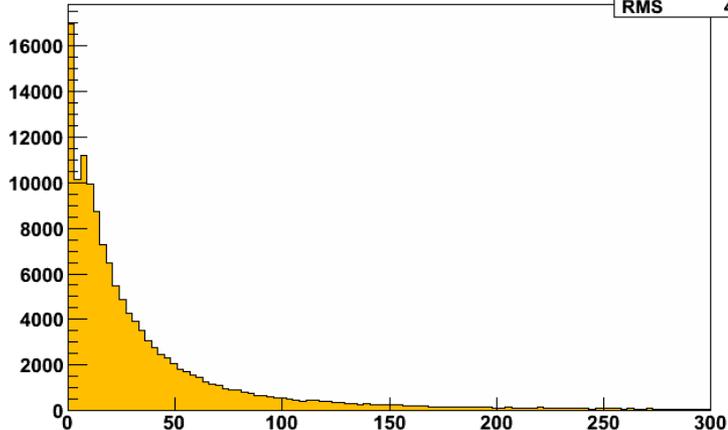
Number CSC hits per STA Muons

Entries	140151
Mean	14.25
RMS	5.28



Momentum of STA Muons

Entries	140151
Mean	36.78
RMS	48.26



Transverse Momentum of STA Muons

Entries	140151
Mean	10.87
RMS	9.649

