



CSC Test Beam 2004

Summary

Darin Acosta
(For the EMU Collaboration)

Previous Tests

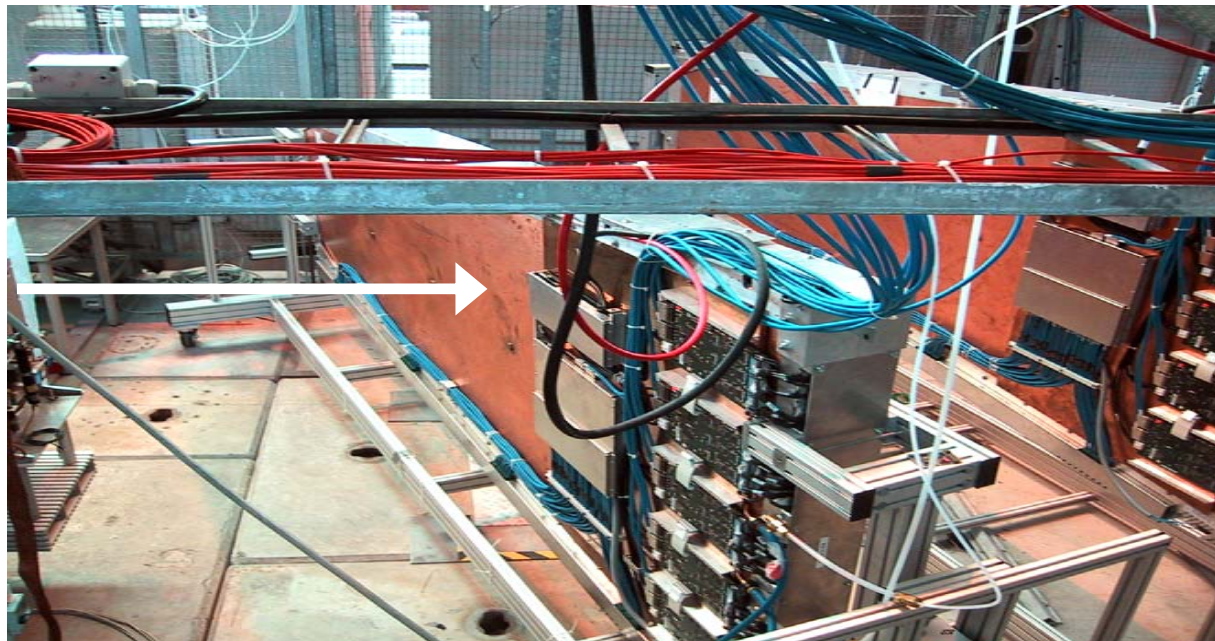
The EMU group tested CSC pre-production chambers at CERN in 1997 and 1998, along with early electronic prototypes

R&D on CSC performance was performed in beam tests even earlier

More recently, the EMU group had two test beams in 2003, with the goal of validating peripheral crate electronics and testing trigger path with LHC-like beam for first time

Two chambers tested:

μ/π





Goals for 2004

- **We know that the CSC chambers work, along with the front-end electronics and peripheral electronics**
- **What we want to do is stress-test the system with more chambers, the latest pre-production prototypes, and a new radiation tolerant clock distribution system**
 - ◆ **Trigger, DAQ, software**
- **More importantly, we are testing/developing integration and synchronization procedures, which will help us with the commissioning CMS**



2004 Beam Test Goals

■ Base goal:

(As set out in April)

- ◆ Set up pre-production system of USCMS EMU electronics and repeat prior tests using LHC-like 25 ns structured beam
 - Test new radiation tolerant clock and control timing module (CCB 2004), which is required before production

■ Additional goals:

- ◆ Test CSC trigger primitive logic with RPC and CSC Anode transition card (so-called “RAT” transition card on TMB2004)
- ◆ Use fully functional XDAQ-based run control and event builder
- ◆ Use fully functional Level-1 Tracker
- ~~◆ Use new DDU+DCC (so-called Fro~~
- ~~◆ Use new peripheral crate VME controller developed by OSU~~
- ◆ Add in ME1/1 (Dubna groups)
- ◆ Add an ME1/2 chamber (IHEP group)
- ◆ Construct and mount an endcap RPC on ME1/2 (CERN, Korea, China)
- ◆ Connect and test RPC trigger Link board to RAT (Warsaw)
- ◆ Add a small block of iron absorber between to validate OSCAR/ORCA simulation

This marks a first “slice test” in the CMS Muon community



Even more goals added once started

- ◆ Test slow control (DCS) prototype
- ◆ Test data quality monitoring (DQM) prototype
- ◆ Unify Track-Finder and Peripheral Crate run control
- ◆ Add automated calls to database to log run configuration
- ◆ Test multiple peripheral crates
 - Toward a Slice Test of the CMS Endcap Muon system, where one peripheral crate corresponds to one disk
- ◆ Test multiple Sector Processors to one Muon Sorter
 - A 1/6 trigger “data challenge” of Track-Finder crate
 - Tests SP↔MS communication with real tracks
- ◆ Test new trigger primitive logic for anodes (ALCT) with ghost-busting improvements
- ◆ Spatial and HV scan of the Dubna ME1/1 chamber
- ◆ *Offline simulation of testbeam setup*
- ◆ *Injection of raw data into ORCA*



CSC Cosmic Ray Test Facility

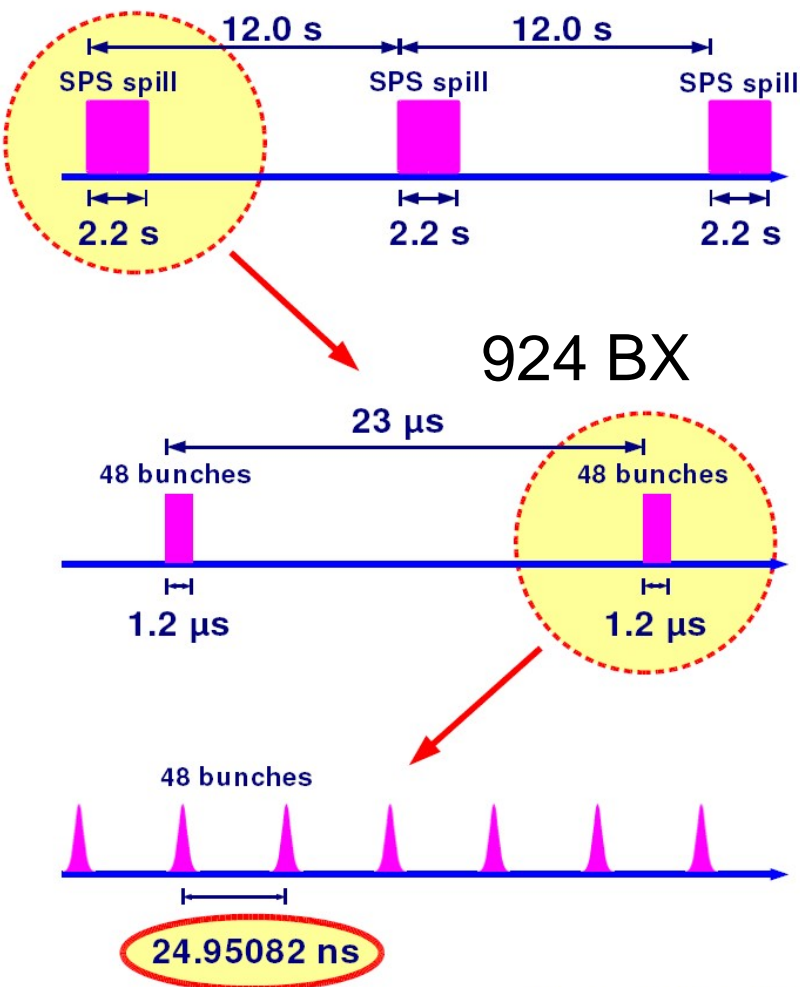


- **Much of the DAQ and trigger development can be tested (and has been tested) at a cosmic ray test stand devoted to such purposes in Florida**
 - ◆ But the cosmic rate is low (Hz), and asynchronous of course
 - ◆ Only have CSC chambers



25 ns Structured Beam

25ns Structured Beam 2004



Michael Hauschild, 10-Jun-2004

- **LHC-like bunch structure during synchronous running**
- **Trigger rates at X5A during spill**
 - ◆ Muons: 3–10 kHz
 - ◆ Pions: >100 kHz
- **CSC readout system is designed for a L1A*LCT rate at LHC design luminosity of order 5 kHz**



May/June Running Periods

3 weeks asynchronous beam

1 week asynchronous beam

SPS Operation

Period 1A 2004 May 17 to Jun 8

SPS243

Schedule issue date: 3-Jun-2004 Version 1.7 (colour code: purple (dark) = scheduling meeting, light green (light) = weekend or holiday)

		Mon 17	Tue 18	Wed 19	Thu 20	Fri 21	Sat 22	Sun 23	Mon 24	Tue 25	Wed 26	Thu 27	Fri 28	Sat 29	Sun 30	Mon 31	Tue 1	Wed 2	Thu 3	Fri 4	Sat 5	Sun 6	Mon 7	Tue 8		
		8h	8h	8h	8h	8h	8h	8h	8h	8h	8h	8h	8h	8h	8h	8h	8h	8h	8h	8h	8h	8h	8h	8h		
Machine		Setup	SPS-MC										SPS-MB										Long MD + Scrubbing			
WEST AREA	T1 -X5	8h P. Siegrist	CMS-CSC										120 GeV	8h P. Siegrist	CMS-CSC/Tracker										120 GeV	
	T1 -GIF	8h S. Zimmermann	ATLAS-RPC											8h R. Reithler	CMS-RPC											
		125 X5C (GIF)												125 X5C (GIF)												
	T1 -X7	8h W. Dulinski	CMOS											8h R. Lindner	LHCb-HCAL										8h R. Lindner	LHCb-PS
NORTH AREA	T2 -H2	8h D. Lazic												8h R. Lindner	CMS-HB/HE											
		172 H2A												097 X7B												
	T2 -H4	8h R. Wigmans	DREAM											9h M. Haguenauer	CMS-ECAL											
		134												164 H4B												
	T4 -H6	8h P. Schacht	ATLAS-EMEC/HEC/FCAL																							
		168 H6C																								
	T4 -H8	8h B. Di Girolamo	ATLAS-Tilecal/LAr/Muon										250 GeV	8h B. Di Girolamo	ATLAS-Combined										250 GeV	1-300
		168 H8A												158 H8A	168 H8B											
	T4 -P0	8h V. Kekelidze													NA48/2											
		P42 - K12																								
	T6 -M2	8h G. Mallot	COMPASS																							

For further information contact the SPS/PS-Coordinator

Status: Approved 13-May-2004, modified 23-May-2004, 24-May-2004

SPS CYCLE Protons 400 GeV
MD 26 GeV

Approximate Intensities (10¹¹ protons/pulse)

Remarks
SPS/PS-Coordinator: Michael Hauschild
E-mail: SPS.Coordinator@cern.ch
phone: 73564 (ext. +41 22 767 3564)
mobile: 160143 (ext. +41 76 487 0143)

Discussion of P1A schedule on May 13 in the SPS users meeting
Discussion of P1B schedule on Jun 3 in the SPS users meeting

T1: 20
T2: 30
T4: 30
T6: 120
Total: 200



SPS Operation

Period 1B 2004 Jun 8 to Jul 1

SPS244

Schedule issue date: 3-Jun-2004 Version 1.7 (colour code: purple (dark) = scheduling meeting, light green (light) = weekend or holiday)

		Tue 8	Wed 9	Thu 10	Fri 11	Sat 12	Sun 13	Mon 14	Tue 15	Wed 16	Thu 17	Fri 18	Sat 19	Sun 20	Mon 21	Tue 22	Wed 23	Thu 24	Fri 25	Sat 26	Sun 27	Mon 28	Tue 29	Wed 30	Thu 1
		8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	1
Machine		25ns--25ns--25ns--25ns--										8										10			
		Long MD + Scrubbing										Scrubbing + Tech Stop										Long MD			
WEST AREA	T1 -X5	8h P. Sledd CMS-CSC/Tracker 105 X5A 115 X5B 120 GeV										8h P. Martinengo ALICE-HMPID 105 X5A 120 GeV													
	T1 -GIF	8h H. Reithler CMS-RPC 125 X5C (GIF)										8h P. Martinengo ALICE-RPC													
	T1 -X7	8h free																							
	T2 -H2	8h D. Lazic CMS-HB/HE/HO 172 H2A										8h R. Lindner LHCb-HCAL 097 X7B													
NORTH AREA	T2 -H4	8h M. Haguenauer CMS-ECAL 164 H4B										8h D. Lazic CMS-ECAL 172 H2A													
	T4 -H6	8h M. Haguenauer ATLAS-EMEC/HEC/FCAL 164 H4B										8h M. Haguenauer ATLAS-EMEC/HEC/FCAL 164 H4B													
	T4 -H8	8h P. Schacht ATLAS-Combined 126 H8A 168 H8B +180 GeV										8h M. Cobal ATLAS-Pixel 138 +180 GeV (high int.)													
	T4 -P0	8h V. Kekelidze NA48/2-calibration P42-K12										8h V. Kekelidze NA48/2													
T6 -M2		8h G. Mallot COMPASS-calibration +160GeV.mv										8h G. Mallot COMPASS +160GeV.mv													

For further information contact the SPS/PS-Coordinator

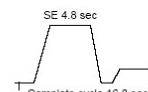
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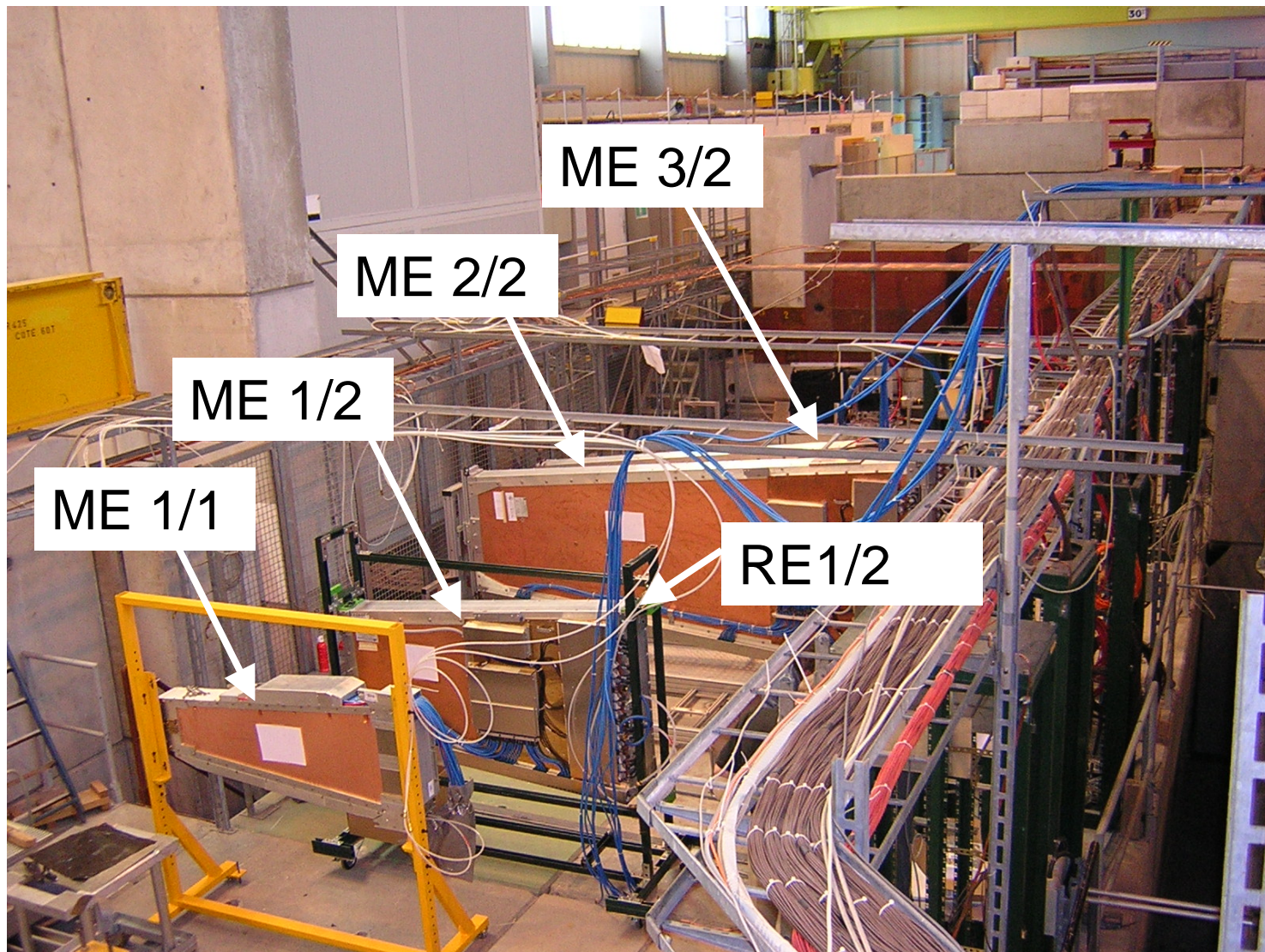
Discussion of P1B schedule on Jun 3 in the SPS users meeting
Discussion of P1C schedule on Jun 24 in the SPS users meeting
Jun 14 - Jun 21:
25ns bunched proton beam: 48 bunches, 400 GeV, 12.0 sec cycle, 2.2 sec spill length



Location of tests: x5a in CERN "West Area"



2004 CSC Beam Test (Muon Slice Test)





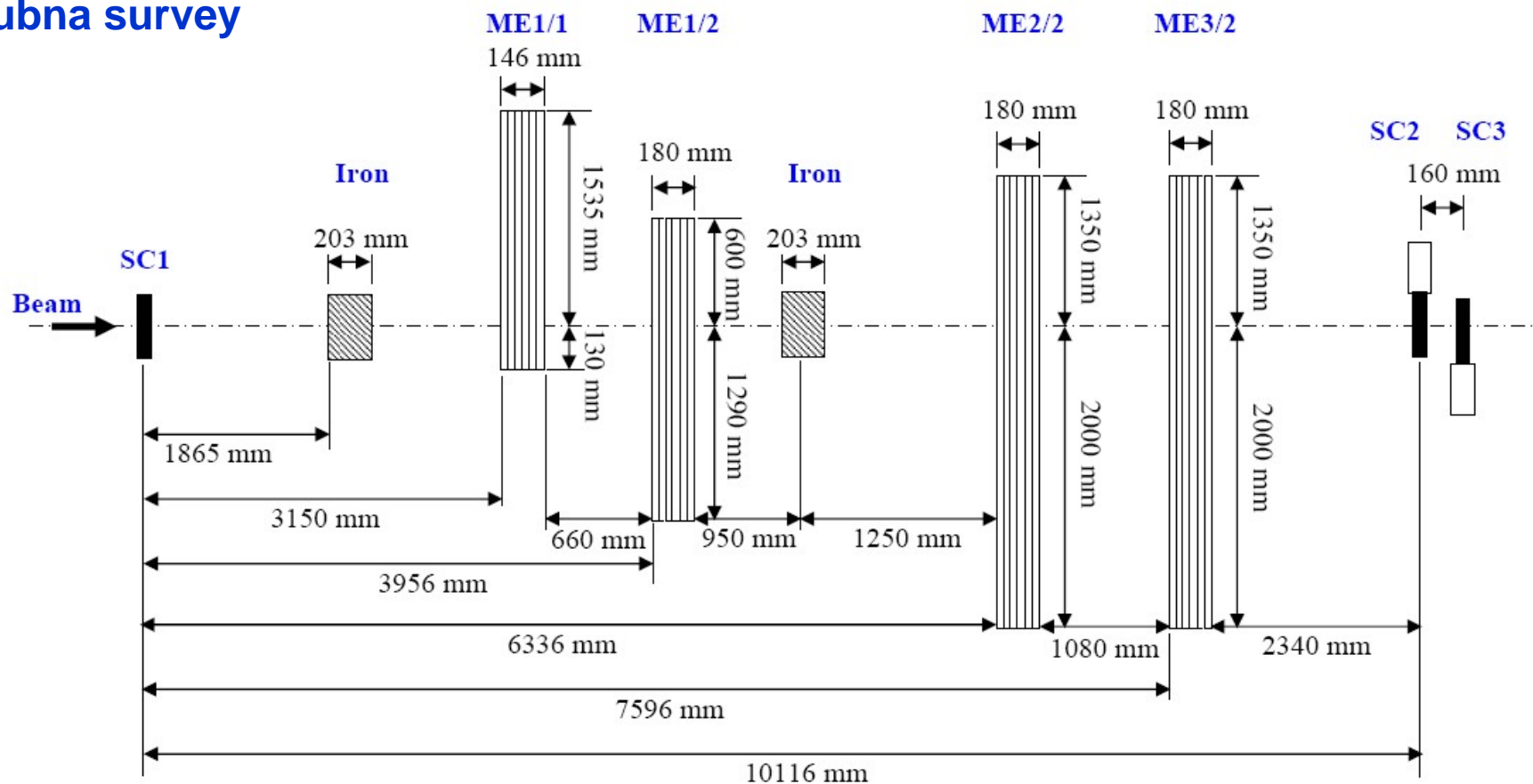
RE1/2 Installation (Endcap RPC)





Initial Geometry

Dubna survey

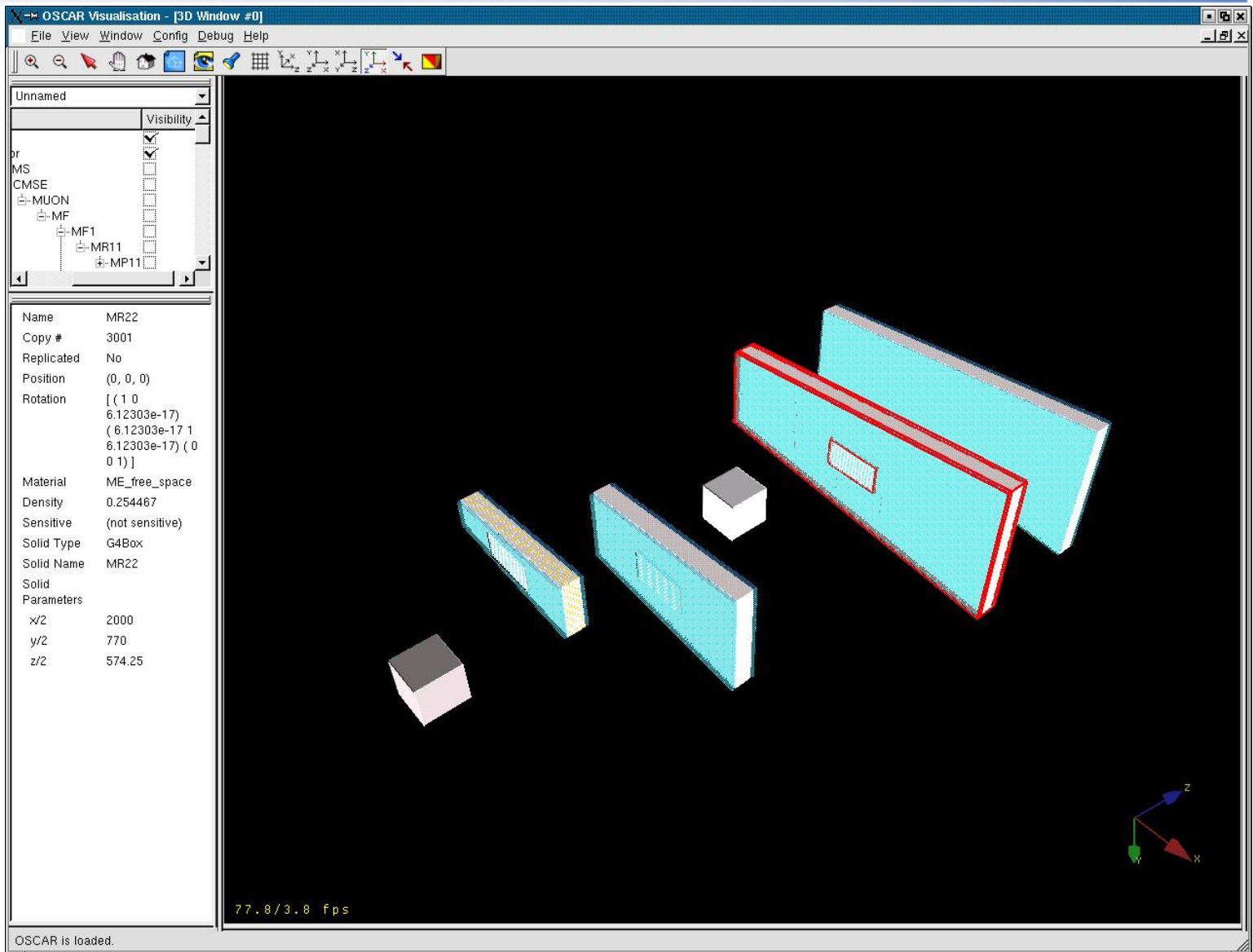


X5A counting room

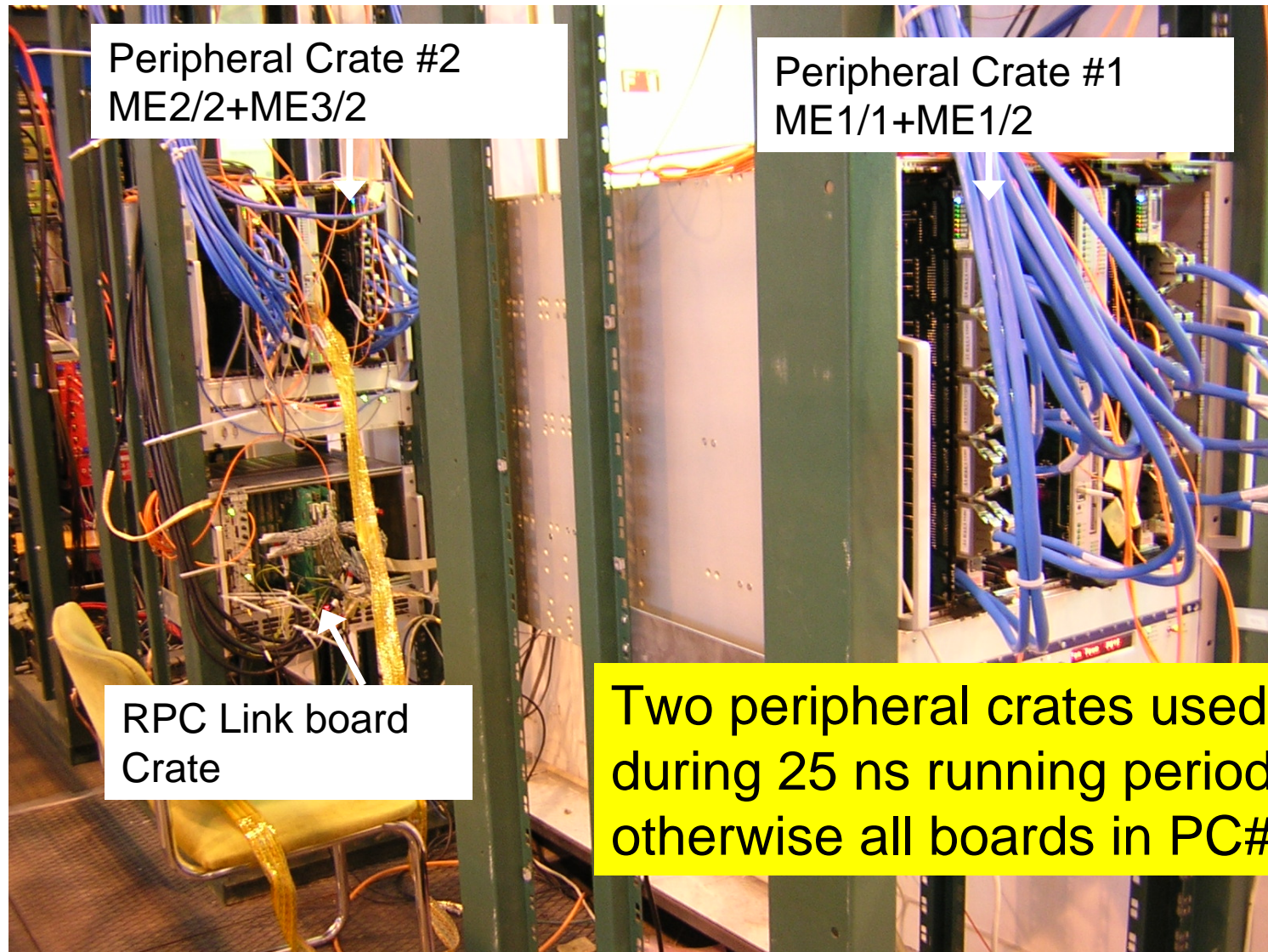


XML Geometry Description

XML version
created by
Michael
Case



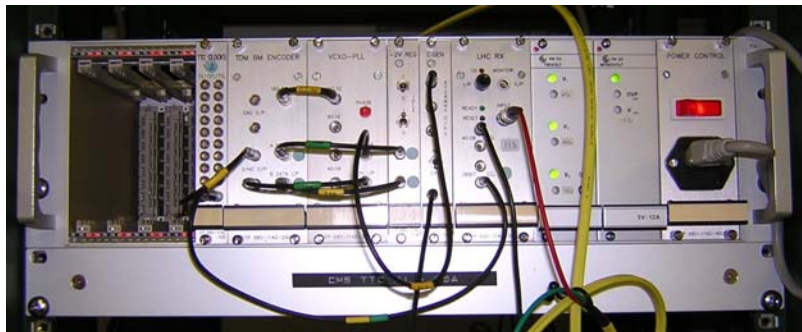
Peripheral Electronics





Track-Finder, TTC & Trigger Electronics

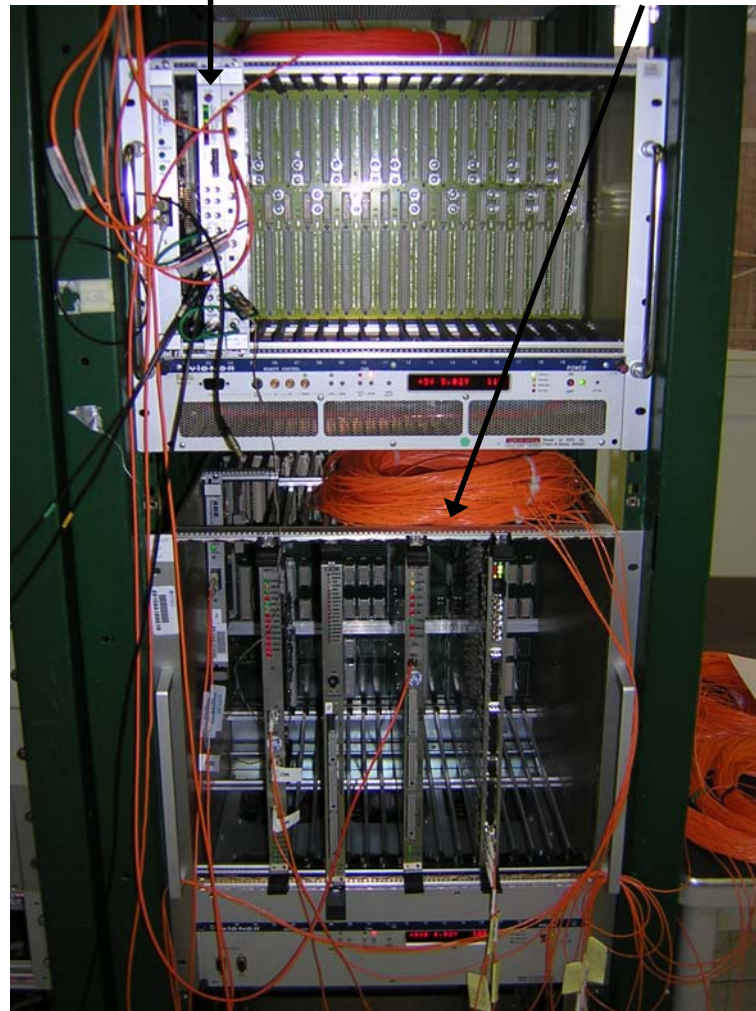
TTCmi crate
(machine interface for clock & orbit)



TTCvi crate

Level-1

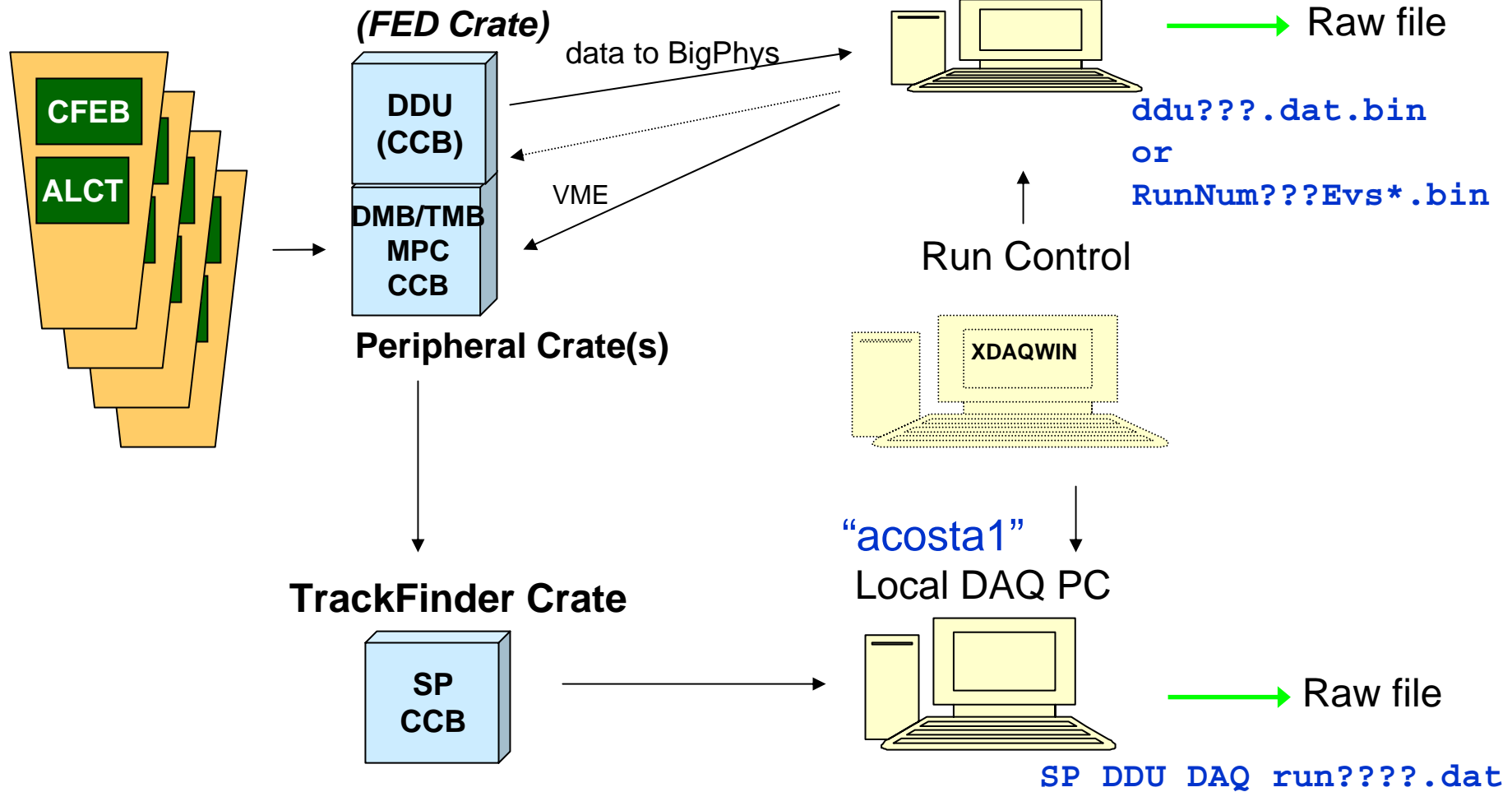
Track-Finder crate





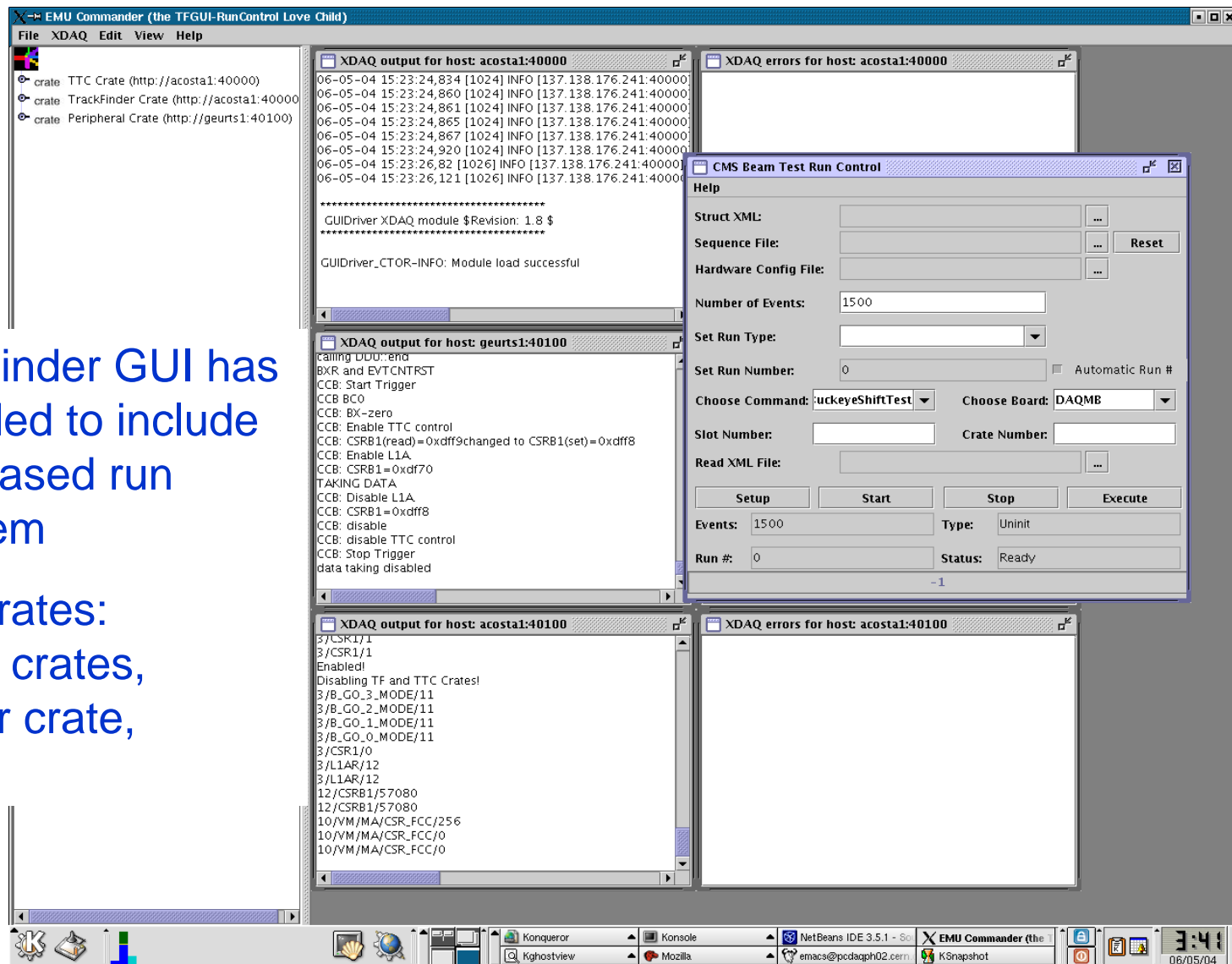
Test Beam 2004 DAQ Configuration

Configuration commands
distributed via XDAQ.
Event-building tested





The Integrated EMU GUI



The Track-Finder GUI has been extended to include the XDAQ-based run control system

Controls 4 crates:
2 Peripheral crates,
Track-Finder crate,
TTC crate



EmuDAQ TB2004 Data

- **130GB of data collected in various DAQ modes**

- ◆ raw reader from bigphysarea device
 - debugging purposes
- ◆ EmuFED-based standalone reader
 - debugging purposes
- ◆ EventBuilder based EVB output
 - official output
- ◆ Standalone Track-Finder output

- **data sample sizes:**

- ◆ ddudumper (raw reader):
 - 64GB
- ◆ hardwareDumper:
 - 57.4GB
- ◆ EVBOutput:
 - 11GB
- ◆ SPFed data:
 - 0.5GB

Trigger data volume is much smaller than CSC data (as expected)

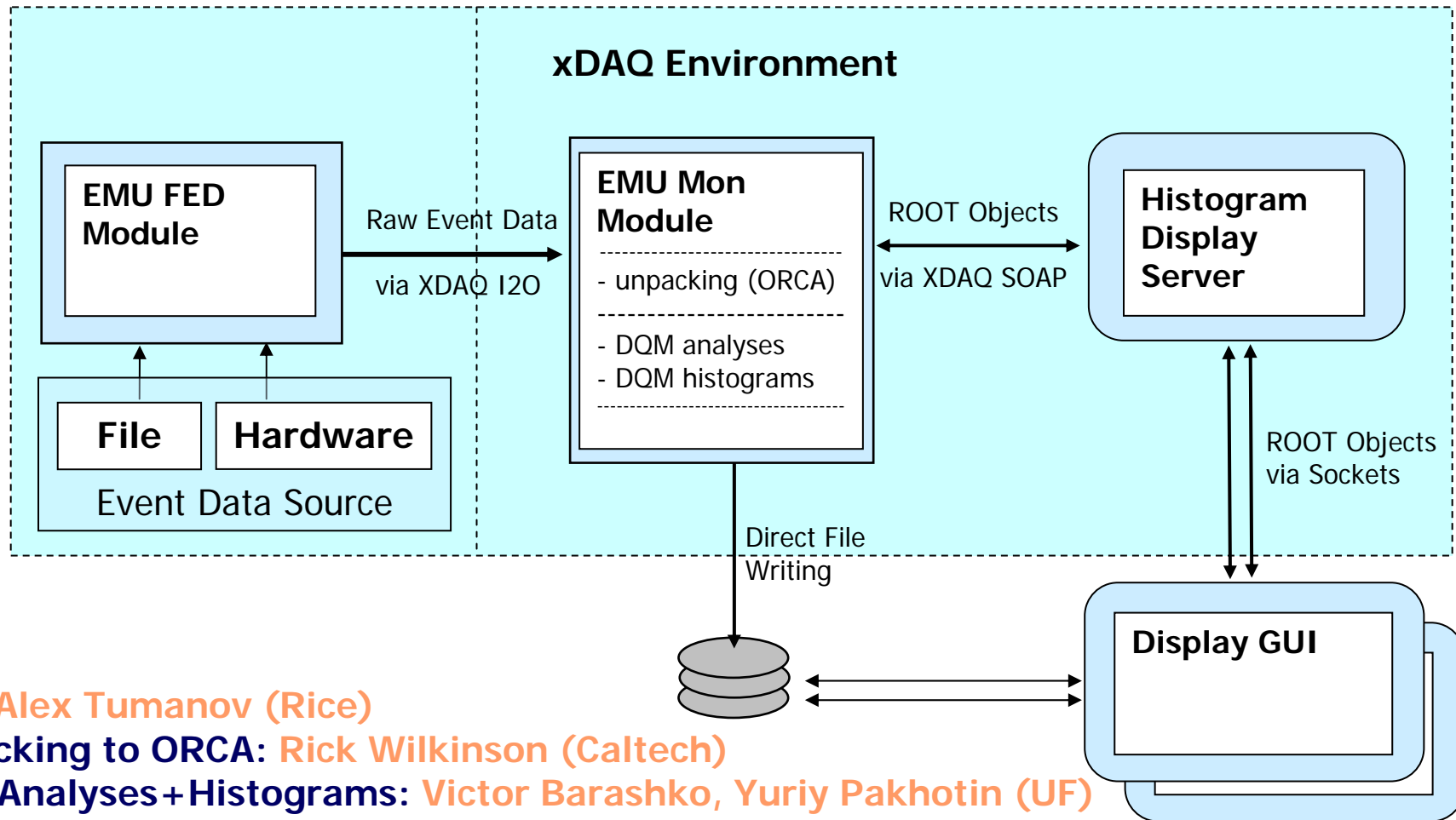


Accomplishments

- **Using new Peripheral Crate (XDAQ) software to control 4 chambers and multiple crates**
- **Single column of event builder tested**
- **Monitoring prototype working offline**
- **DCS prototype working**
- **CCB2004 with radiation-tolerant discrete logic capable of driving all electronics**
 - ◆ **Drives gigabit optical links on trigger path, for example**
- **Level-1 Track-Finder is successfully finding tracks and self-triggering the experiment**
 - ◆ **Became default mode of triggering for the last week**
- **RPC signals seen in coincidence with the CSC trigger**



TB2004 DQM Architecture

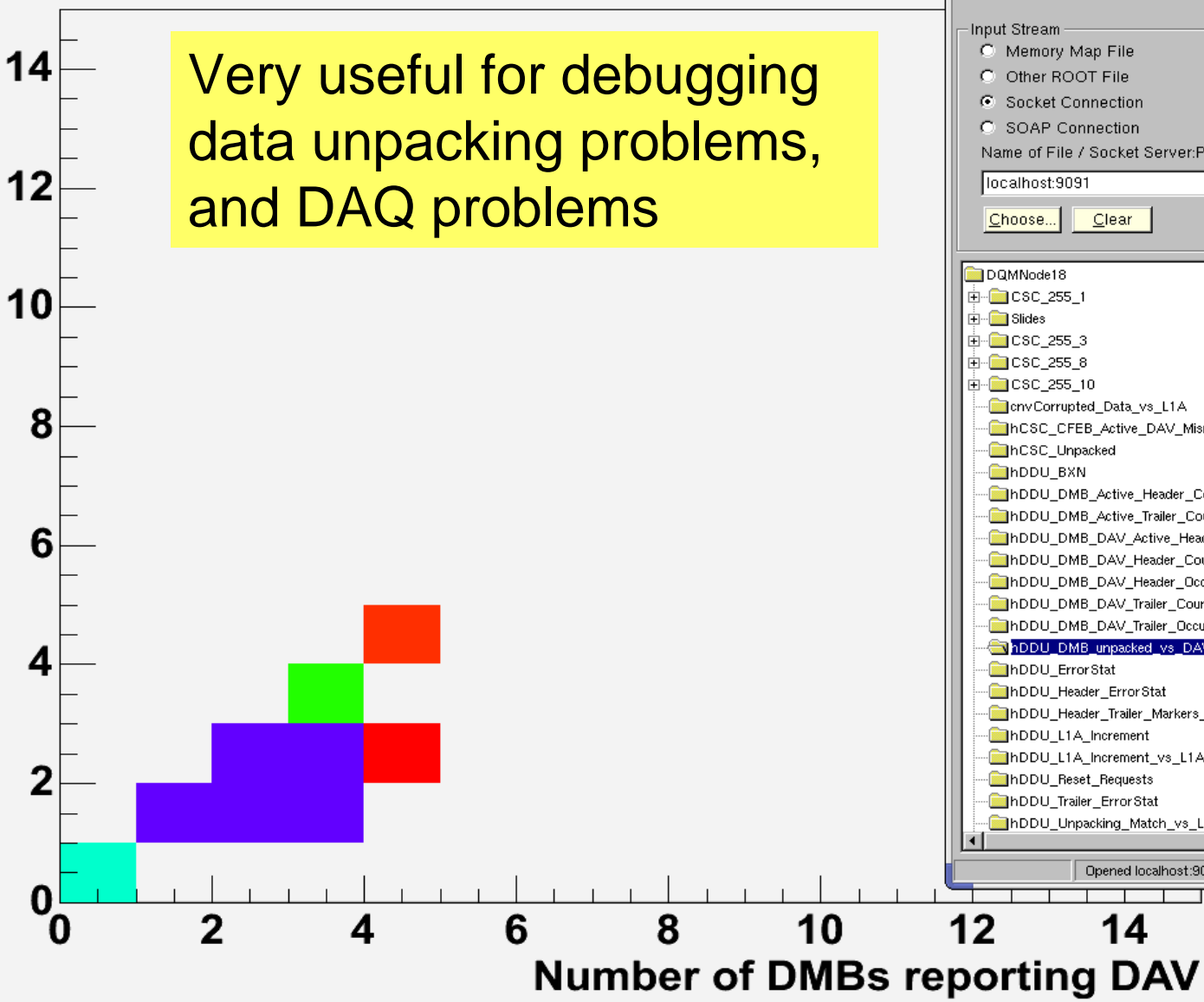


- **FED:** Alex Tumanov (Rice)
- **Unpacking to ORCA:** Rick Wilkinson (Caltech)
- **DQM Analyses+Histograms:** Victor Barashko, Yuriy Pakhotin (UF)
- **CDF Display Server:** Hans Wenzel (FNAL)
- **Display Server adaptation for xDAQ:** Victor Barashko (UF)
- **CDF Display GUI:** Kaori Maeshima (FNAL)
- **Integration:** Victor Barashko (UF)

Number of unpacked DMBs vs. number of DMBs reporting DAV

Number of unpacked DMBs

Very useful for debugging data unpacking problems, and DAQ problems



CMS DQM Consumer Display Main Frame

File List Tree Connection Help

CMS DQM Consumer Display

Input Stream

☐ Memory Map File
☐ Other ROOT File
☒ Socket Connection
☐ SOAP Connection

Name of File / Socket Server:Port

localhost:9091

Open

Choose... Clear

DQMNode18

CSC_255_1

Slides

CSC_255_3

CSC_255_8

CSC_255_10

cnvCorrupted_Data_vs_L1A

hCSC_CFEb_Active_DAV_Mismatch

hCSC_Unpacked

hDDU_BXN

hDDU_DMB_Active_Header_Count

hDDU_DMB_Active_Trailer_Count

hDDU_DMB_DAV_Active_Header_Count_vs_DMB

hDDU_DMB_DAV_Header_Count_vs_DMB_Active

hDDU_DMB_DAV_Header_Occupancy

hDDU_DMB_DAV_Trailer_Count_vs_DMB_Active_1

hDDU_DMB_DAV_Trailer_Occupancy

hDDU_DMB_unpacked_vs_DAV

hDDU_ErrorStat

hDDU_Header_ErrorStat

hDDU_Header_Trailer_Markers_Check

hDDU_L1A_Increment

hDDU_L1A_Increment_vs_L1A

hDDU_Reset_Requests

hDDU_Trailer_ErrorStat

hDDU_Unpacking_Match_vs_L1A

☒ Auto Update
☐ Multi Canvas Update

Delay (msec) 5000

Update

Pause

Clear

Print...

Reset All

Histogram

Zero

Restore

Content

Opened localhost:9091



DCS

- Valeri Sytnik has working DCS prototype using PVSS II for EMU peripheral crate electronics
- Upgraded to handle TMB2004 and CCB2004 at beam test, and demonstrated to work
- Will need to resolve issues with sharing access to peripheral crate

The screenshot displays the DCS interface with the following components:

- System Status:** Shows 'System: CMS' and 'State: ERROR' (indicated by a red bar).
- Sub-System Status:** A table listing sub-systems and their states:

Sub-System	State
DT	PHYSICS
CSC	ERROR
ECAL	PHYSICS
HCAL	PHYSICS
Tracker	PHYSICS
- 3D Model:** A 3D rendering of the CMS detector structure, showing the central solenoid and various endcap components.
- Device Details (CSCdm4r2c01LV_1):** A window showing the device state as 'ERROR'. It includes a 'CFEB currents' table:

parameter	value
Cfeb#1 current 3.3	0.33665
Cfeb#1 current 5.0	5.12926
Cfeb#1 current 6.0	0.66323
- Power Status:** A section with 'ON' and 'OFF' buttons.
- Messages:** A log showing an alarm at 'CSC/ME-4/2,CH#1,LV_1'.
- Modes:** A small window indicating 'CSCdm4r2c01LV_1 is Included' with an 'Exclude' button.

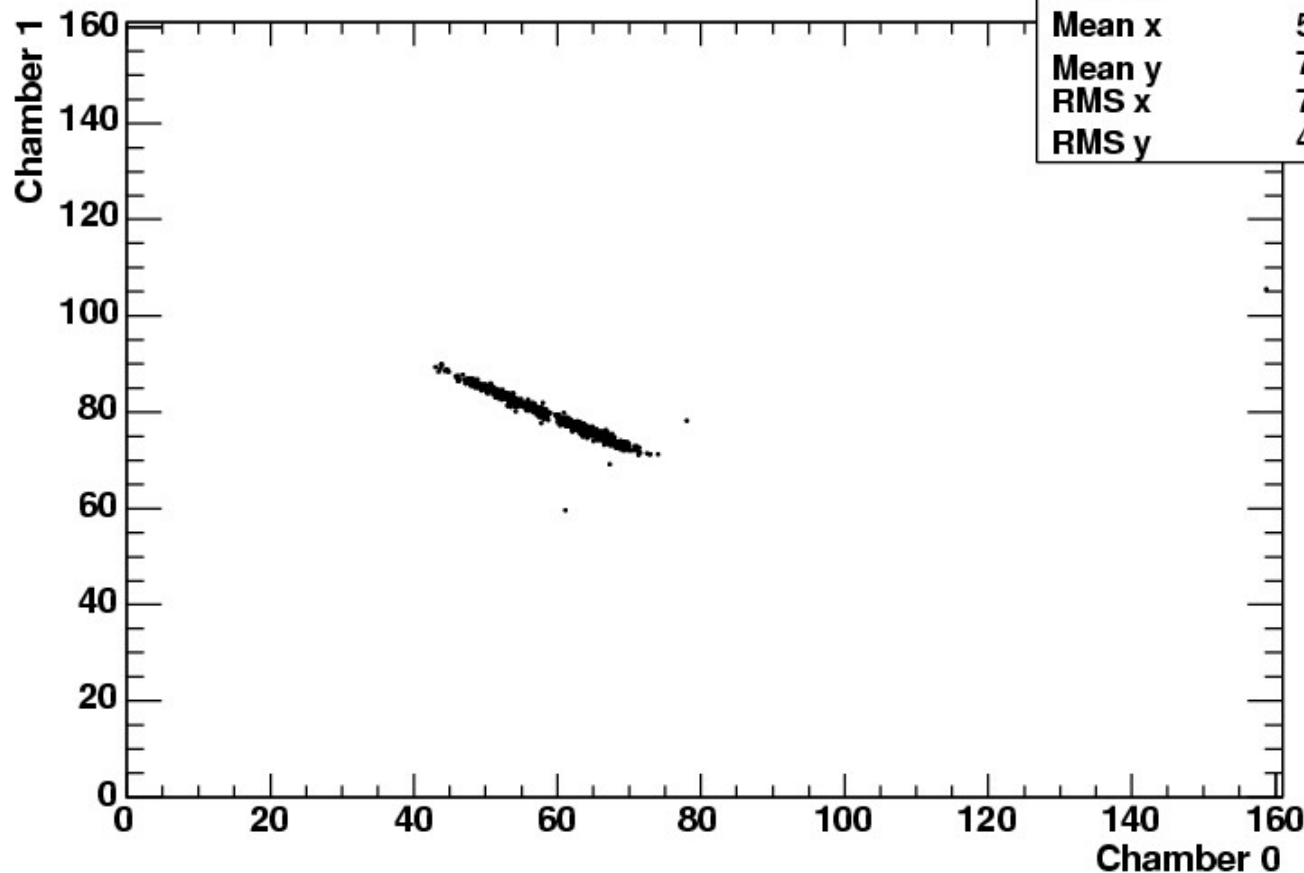


Data analyses: Trigger Primitives

J.Mumford (UCLA)

Strip vs Strip

half vs half

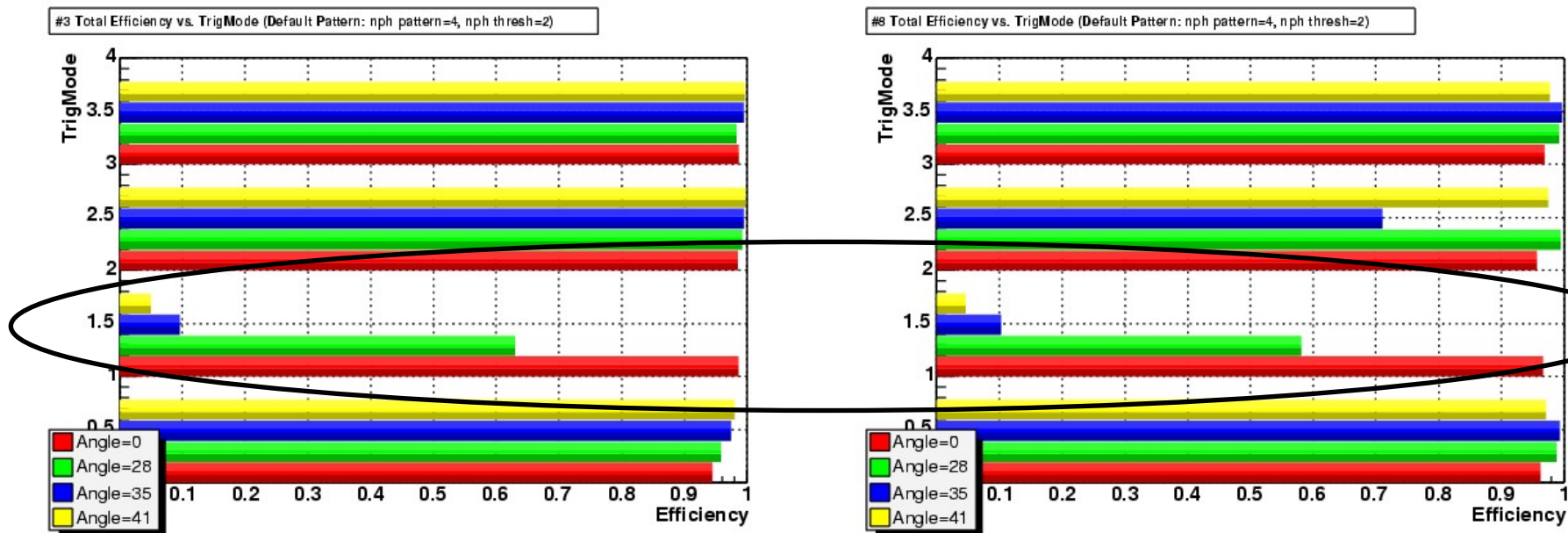


Several offline programs were run to validate data immediately after run taken for trigger efficiency and any strange effects



Anode Trigger Primitive Study (ALCT)

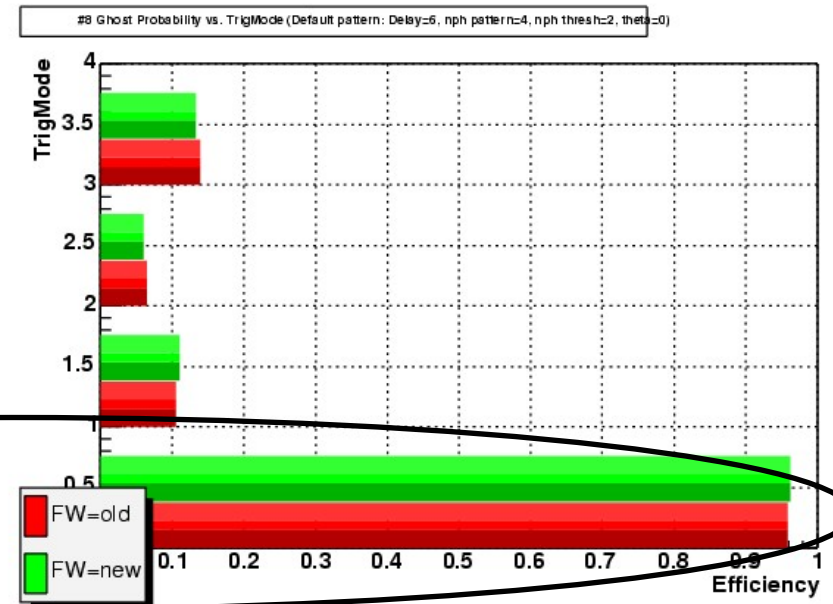
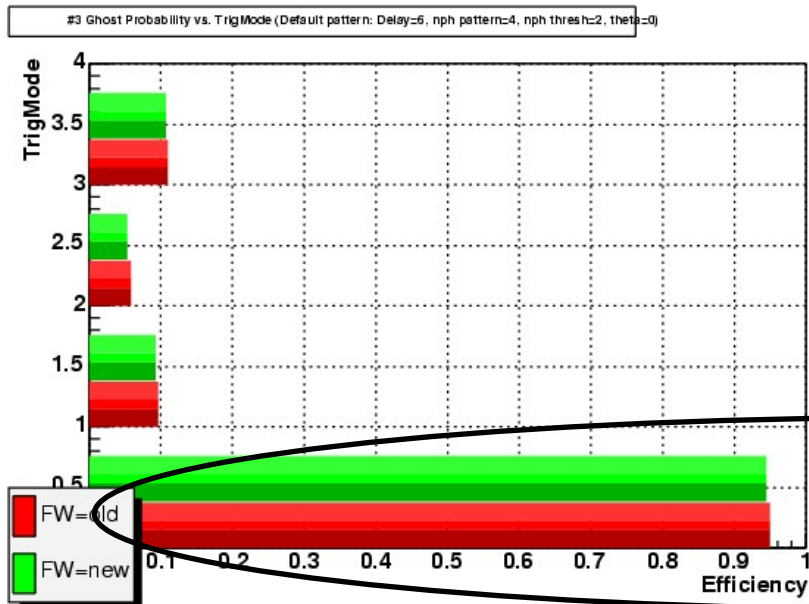
Offline analyses continuing as well...



- Accelerator muon pattern efficiency (straight tracks in wires) decreases with angle as you would expect



ALCT Ghost Rate



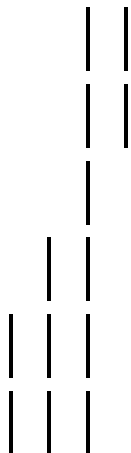
- Ghost rate very high if accelerator patterns and collision patterns both enabled without ghost cancellation mode (would flood trigger links)



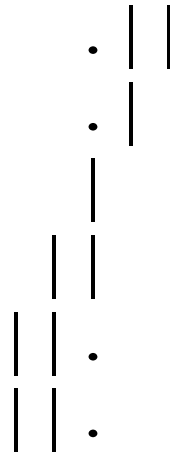
ALCT Pattern Studies

- Several other ALCT parameters were varied and will be studied by summer student
- For example, ALCT Patterns:

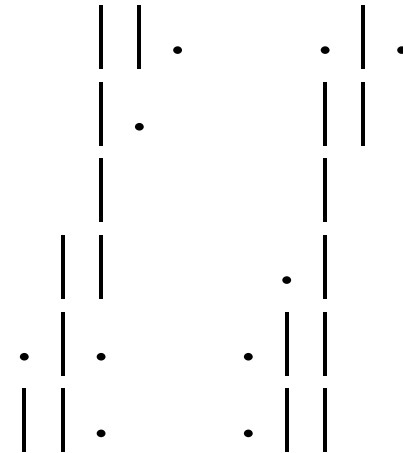
◆ Default



“Miss4”



“Andrey” Pat A and Pat B

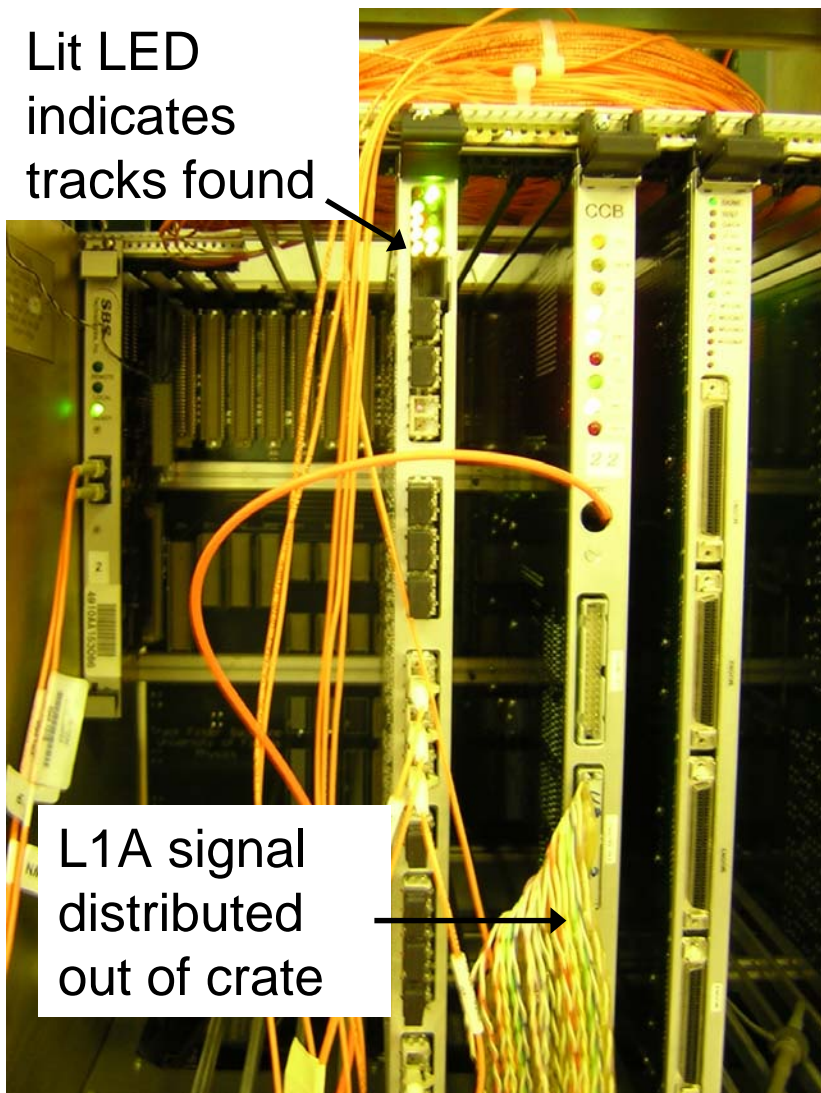


- Goal is to achieve high efficiency, low ghost rate, and good discrimination between collision and accelerator patterns
- Hardware results should be validated against ORCA



Track-Finder Tests

Lit LED
indicates
tracks found

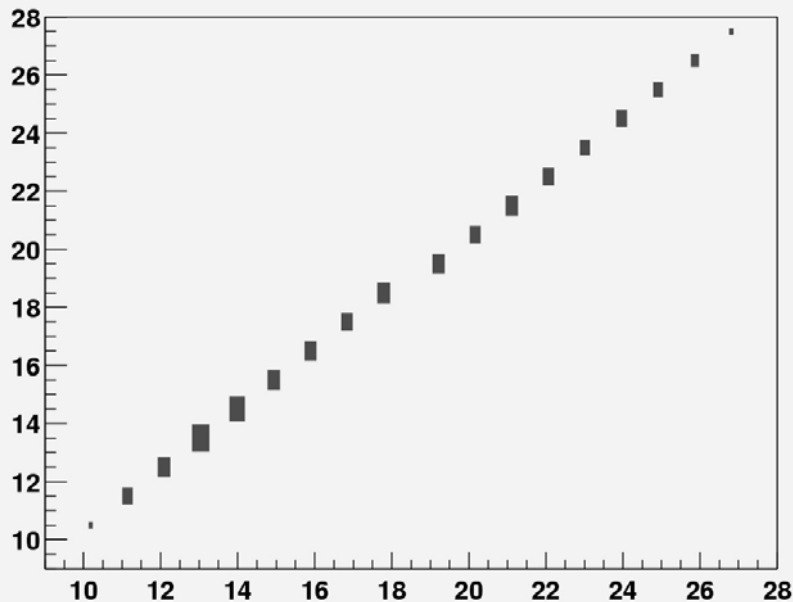


- **First time we tested with full Track-Finding logic to identify tracks in data**
- **Full DAQ logging of inputs and outputs for offline comparisons**
 - ◆ Can compare with data sent by Peripheral Crates as well as internal TF logic
- **L1A generation a major synchronization accomplishment for trigger**
 - ◆ Data must be aligned spatially and temporally
 - ◆ Very useful for slice tests

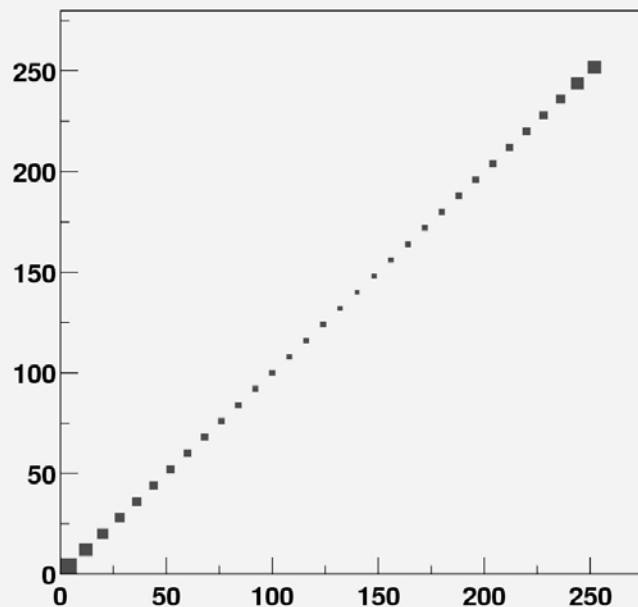


TF: ORCA vs. Hardware Check

SPeta:(OSPeta/2) {SPmode>-1}



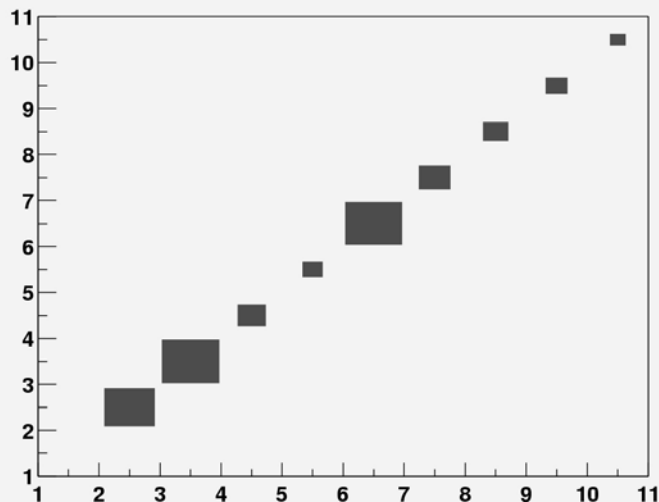
SPDphi12:OSPDphi12 {SPmode>-1}



Run 366,
Scurlock

64K events

SPmode:OSPmode {SPmode>-1}

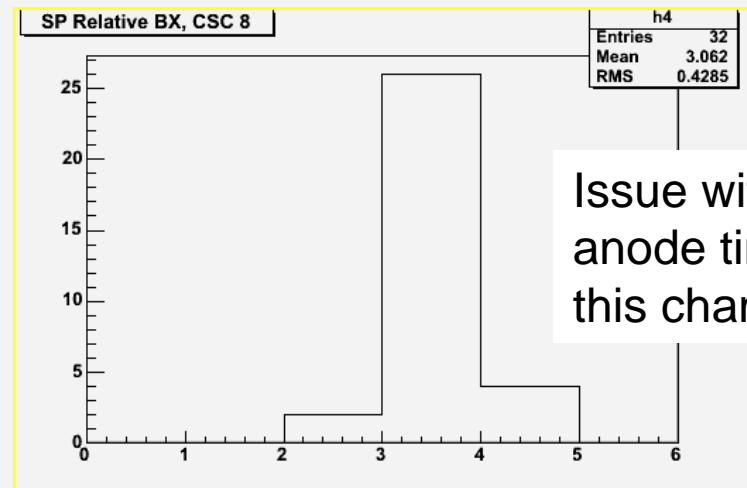
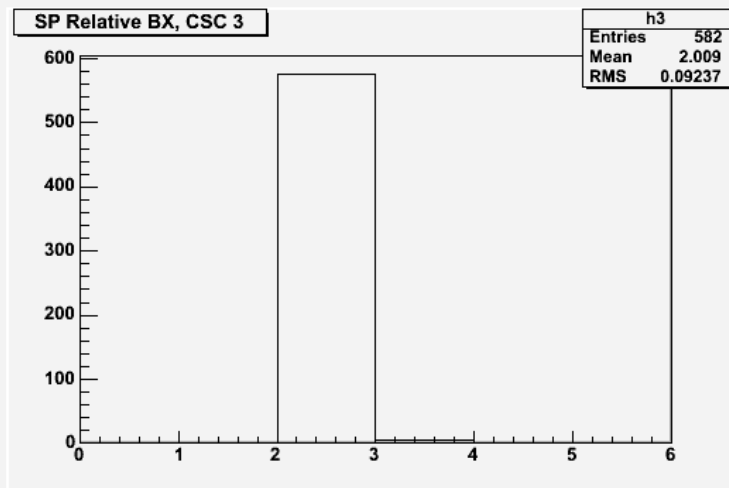
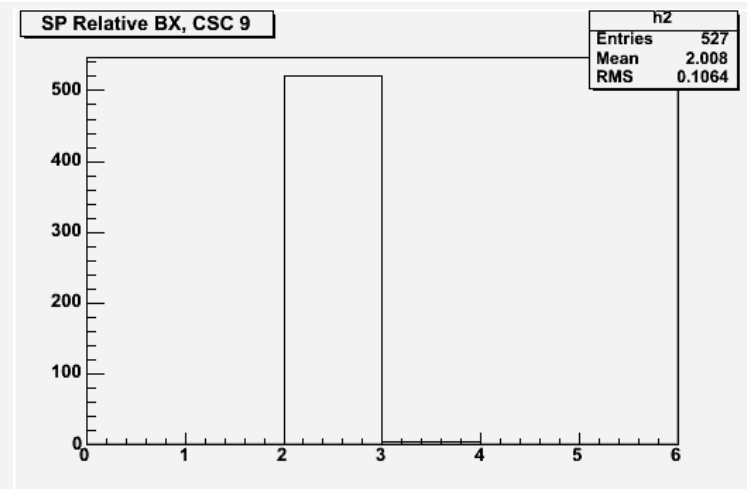
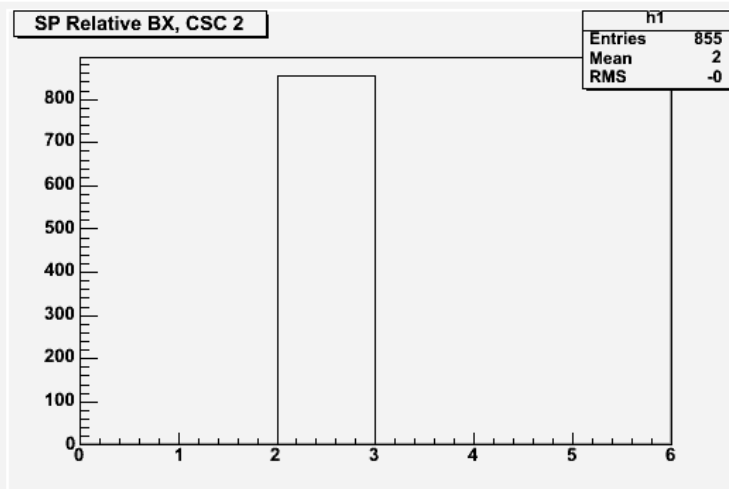


- **Correlation of track η , $\Delta\phi$ between 2 stations, and track type agrees perfectly between hardware and ORCA simulation**
 - ◆ n.b. Some aspects of the standalone ORCA trigger package still must be incorporated into CERN repository



Time Alignment of CSC data in Track-Finder

- Able to get all trigger data from multiple chambers and crates on same BX (at least for some runs):

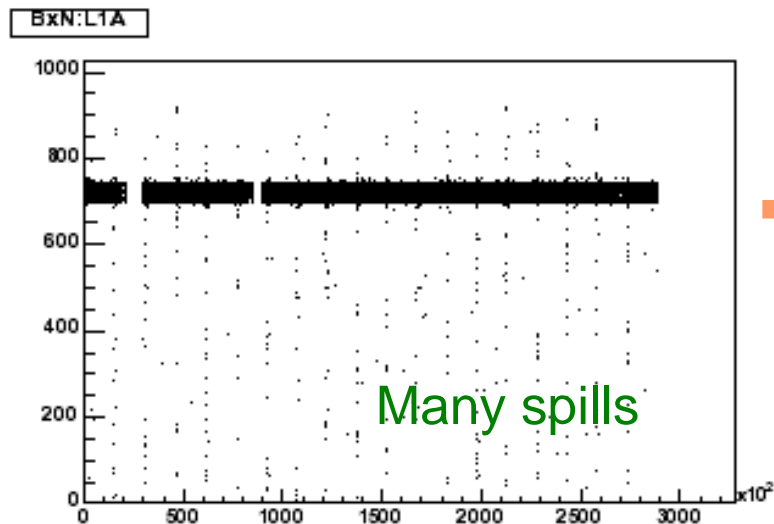
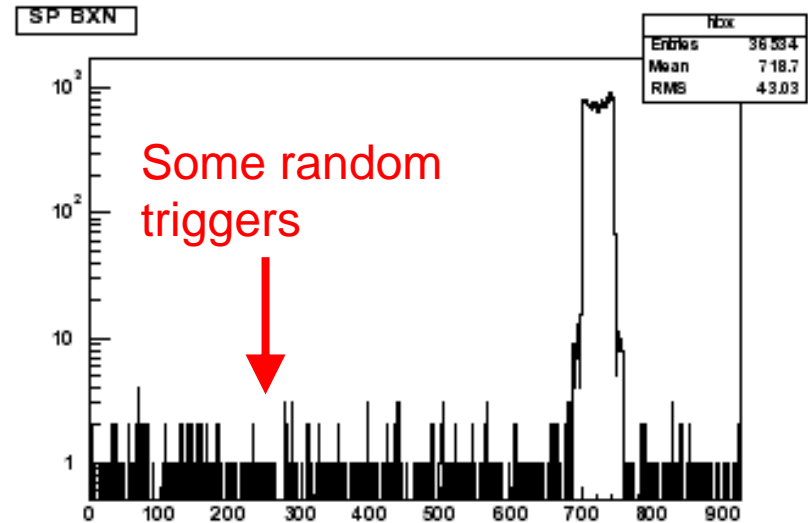
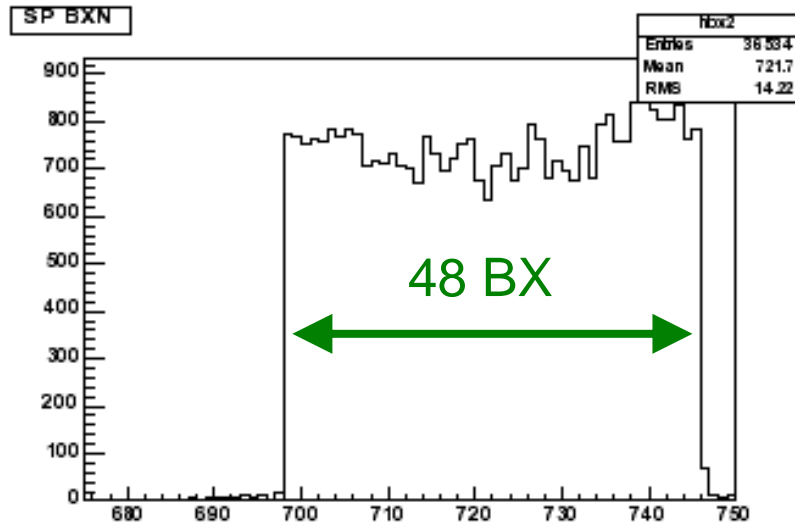


Issue with
anode timing for
this chamber

Run 293



Sector Processor BX Distribution

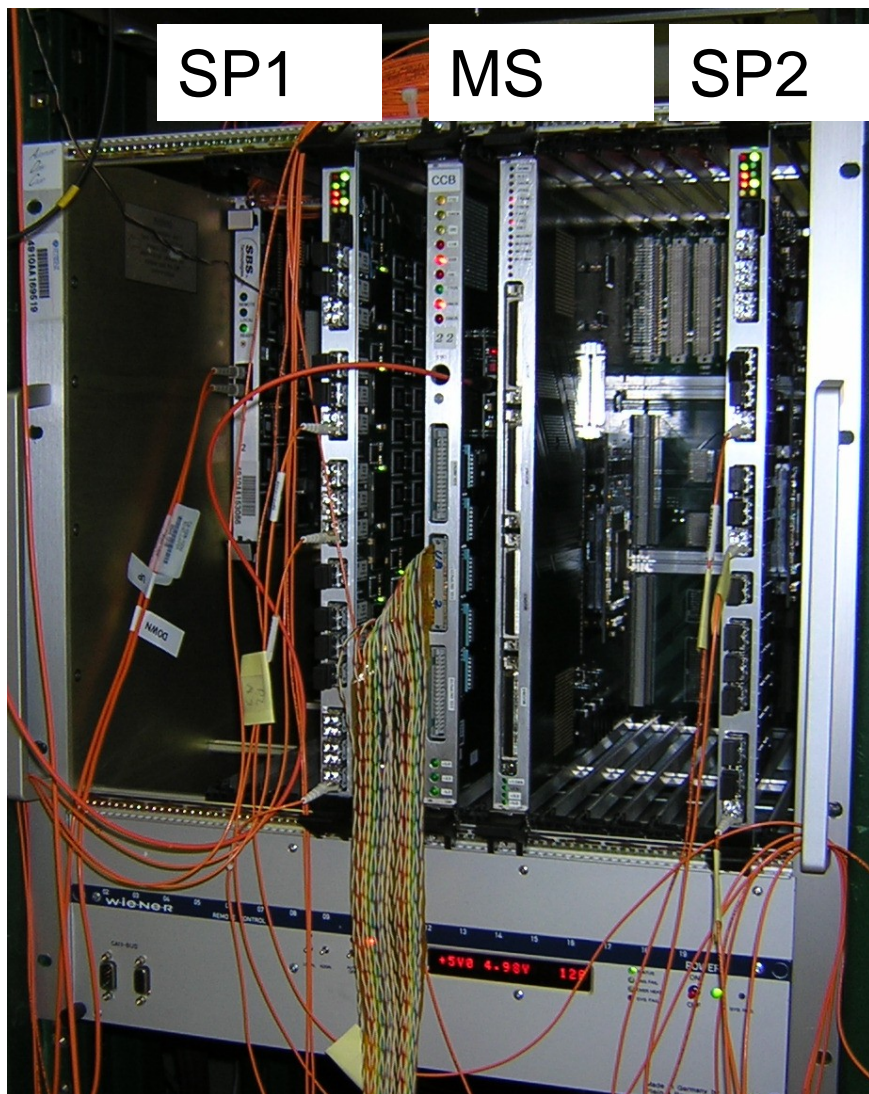


- BX counter resets every time BC0 arrives

Run 380, muons



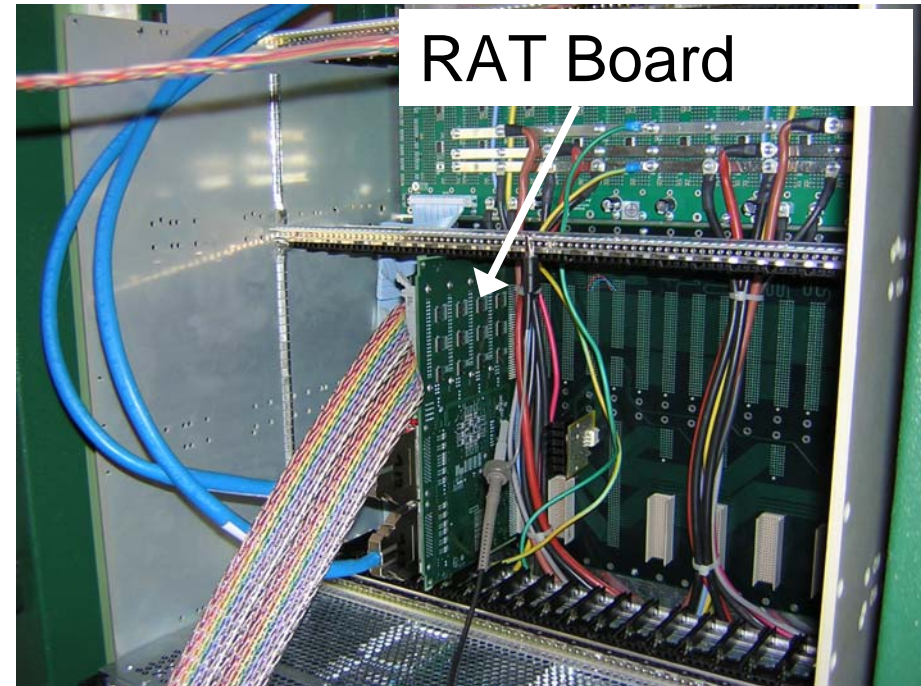
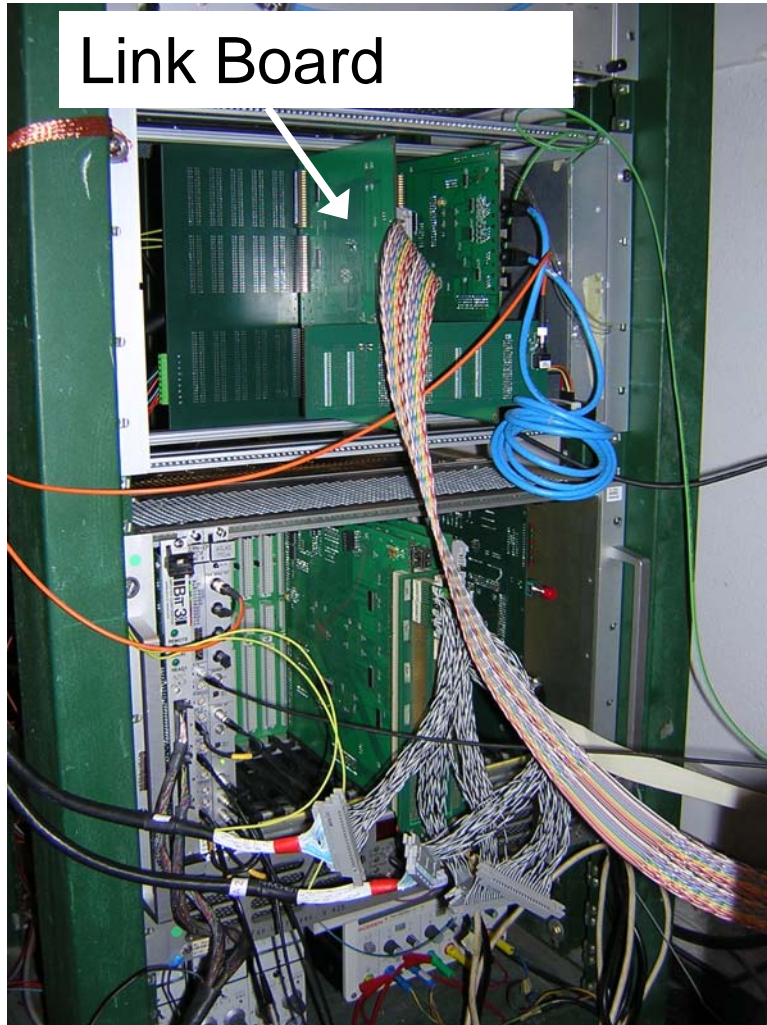
Track-Finder Crate Tests Cont'd



- **First test of multiple peripheral crates to TF crate**
 - ◆ Synchronization test
- **Various clocking solutions tried to test robustness of optical links**
 - ◆ MPC used QPLL 80 MHz clock on backplane for 25 ns runs?
- **First test of multiple Sector Processors to one Muon Sorter**
 - ◆ Detailed offline checks of exchanged data should follow to validate boards



RPC ↔ CSC Interface Test





Preliminary RPC/CSC Results

- **RPC chamber operating efficiently at 9.1 kV**
 - ◆ Both single gap and double gap modes tested
- **RPC signals seen in coincidence with Track-Finder trigger by Link Board monitoring package**
- **Correlated RPC data seen in CSC trigger motherboard (local trigger primitive logic for cathodes)**
- **Detailed quantitative checks must still be done**
- **Problem: the RPC and Anode Transition card (RAT) seems to be significantly reducing ALCT efficiency**



Continuation of Integration Tests

- **Plans are underway to move our Muon “slice test” to the H2 beam line to integrate with HCAL in September**
 - ◆ **Will be crowded: DT also will there, as maybe Tracker**
- **This extends the integration to another CMS subsystem**
- **Main objective would be to synchronize the two systems with respect to each other, possibly triggering from CSC's**
- **Possible to merge to some degree the run control and DAQ software, since based on a common framework**
 - ◆ **Degree to which this is done depends on remaining amount of time**



Offline: Data Unpacking

A.Tumanov, R.Wilkinson

- **Two CSC packages exist:**
- **DataFormat**
 - ◆ Standalone package that reads raw CSC data
 - ◆ Has been used extensively for over a year, including 2003 CSC TB
 - ◆ Still widely used in analyses (e.g. trigger studies)
- **METBRawFormat**
 - ◆ It is integrated with official CERN ORCA, at least for earlier ORCA versions (but private CVS version kept as well)
 - ◆ Constraint: ORCA/Muon cannot depend on ORCA/Trigger
 - Need to think where to put trigger primitive data classes
 - ◆ Needs updating to the latest ORCA FED redesign by G.Bruno
 - Max Chertok (UC Davis) volunteers to work on this
- **Problems:**
 - ◆ Both packages frequently crash on recent data, and must be made more robust
 - Due to data corruption, subtleties in CSC data format



Offline: Simulation

- **Michael Case created first XML geometry file for CSC beam test**
 - ◆ Initial geometry only, chambers were moved around during tests
- **Next step is to run OSCAR job around this geometry**
 - ◆ Tim Cox volunteers to work on this
- **Ultimately should inject raw data into ORCA for reconstruction, and compare with simulation**
 - ◆ Validate CSC digitization
 - ◆ Verify multiple scattering in iron
 - ◆ Check possible impact of RPC operation on CSC
- **Need more volunteers, at least for ORCA-based analyses!**



Conclusion

- **130 GB of data logged**
 - ◆ Many analyses still to be done!
- **May-June 2004 test beam program had many accomplishments**
 - ◆ New fully XDAQ-based run control and data acquisition system tested
 - ◆ Pre-production prototypes working well
 - ◆ Trigger system synchronized and self-triggering
 - ◆ RPC interface tests performed
- **Some problems crept up:**
 - ◆ Data unpacking robustness (more thorough studies required)
 - ◆ Anode LCT interface through RAT card
- **Will return to CERN in September/October at H2**
 - ◆ Continue progress toward a CMS slice test



<http://www.phys.ufl.edu/~acosta/tb/tb.html>

Most
documentation
linked off here

The screenshot shows a Netscape browser window with the address bar displaying <http://www.phys.ufl.edu/~acosta/tb/tb.html>. The page title is "The CSC Beam Test Page, 2004". The page content includes a CMS logo, a photo of the beam test setup, and a section titled "Test Beam May-June 2004". This section contains a list of links for various reports and data. At the bottom, there is a section titled "Test Beam September 2003".

The CSC Beam Test Page, 2004

Test Beam May-June 2004

- [Goals for June 25 run](#)
- [What was achieved during the May asynchronous run](#)
- Overall goals [\[PDF, PPT\]](#)
- [Daily reports on 25 ns run](#)
- [Previous reports from May](#)
- [Status Report as of 18 June](#) ([Status report as of 6 June](#))
- [Scanned copy of log book](#) ([New](#))
- Trigger/Track-Finder run description [\[XLS\]](#) ([New](#))
 - Asynchronous period [\[PDF\]](#)
 - 25 ns period [\[PDF\]](#)
- [2004 Run Database](#)
 - [Online logbook](#)
 - [Interface to technical database with specific XML configuration parameters of run](#)
- 2004 CSC beam test configuration [\[PDF, PPT\]](#)
- Initial beam test geometry (as of 28 May 2004) [\[PDF, DOC\]](#)
- [Photos](#)
- [Plot directory](#)
- [SPS Users Schedule 2004](#)
- [SPS Machine display](#)
- Equipment manifest [\[PDF, XLS\]](#)
- People's schedules and contact numbers at CERN [\[PDF, XLS\]](#)
- Testbeam task list and schedule [\[PDF, MPP\]](#)
- Testbeam data is archived at CERN here: [/castor/cern.ch/user/t/tbx5ccdr/tb2004/](#)
- Locally, DDU data is on `geurts1:/data/DDU/` and TF data is on `acosta1:/home/daq/testbeamdata/`
- [How to use the CERN Castor data storage system](#)
 - Use "rfdir" for ls, and "rfcp" to copy
 - You can also use "ftp wacdr.cern.ch" to get direct access to castor
- [Mapping of DDU input to CSC ID to chamber type](#) ([updated for 25 ns run](#))
- [TMB quality code definition](#)
- [Greg Pawloski's TTC code for 2003](#)

Test Beam September 2003

Acosta, Darin	UF
Barashko, Victor	UF
Bondar, Nikolai	PNPI
Breedon, Richard	UCD
Case, Michael	UCD
Chertok, Max	UCD
Cox, Tim	UCD
Drozdetzki, Alexei	UF
Durkin, Stan	OSU
Geurts, Frank	Rice
Gilmore, Jason	OSU
Golovtsov, Victor	PNPI
Golunov, Alexander	Dubna
Gray, Lindsey	UF
Gu, Jianhui	OSU
Karjavine, Vladimir	Dubna
Khabarov, S.	Dubna
Korytov, Andrey	UF
Kotov, Kostya	UF
Kraemer, Tami	USCMS
Lanaro, Armando	UW
Lee, Sang-Joon	Rice
Levchenko, Peter	UF
Matveev, Mike	Rice
Moissenz, Peter	Dubna
Movchan, Sergei	Dubna
Mumford, Jason	UCLA
Pakhotin, Yury	UF
Roberts, Jay	Rice
Scurlock, Bobby	UF
Sharma, Archana	CERN
Stoeck, Holger	UF
Sytnik, Valeri	UCR
Tsesmelis, Emmanuel	CERN
Trevino, Andrea	Rice
Tumanov, Alex	Rice
Uvarov, Lev	PNPI
Von der Mey, Martin	UCLA
Wilkinson, Rick	CIT
Yang, Xiofeng	UCLA

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+ RPC chamber
(CERN, China, Korea)
and electronics
(Warsaw) groups
(apologies to anyone
I left off)

