

Test Beam Wrap-Up

Darin Acosta



Agenda

- **Darin/UF: General recap of runs taken, tests performed,**
- **Track-Finder issues**

- **Martin/UCLA: Summary of RAT and RPC tests, and experience with TMB2004**

- **Stan(or Jason or Jianhui)/OSU: Experience with DMB and DDU using new**
- **CCB and with new peripheral crate software**

- **Frank/Rice: Summary of DAQ code development and event-builder tests**

- **Alex/Rice (also Rick?): Status of data unpacking software packages**

- **Andrey/UF: Testbeam summary from DQM point-of-view**

- **All: Discussion of September beam test goals at H2**

- **Frank/Rice: Possible CSC, crate, cable layout at H2**



Web Page

Most
documentation
linked off here





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 Track-Finder system (self-triggering)
 - ~~◆ Use new DDU+DCC (so-called Front End Driver, FED, for DAQ)~~
 - ~~◆ 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

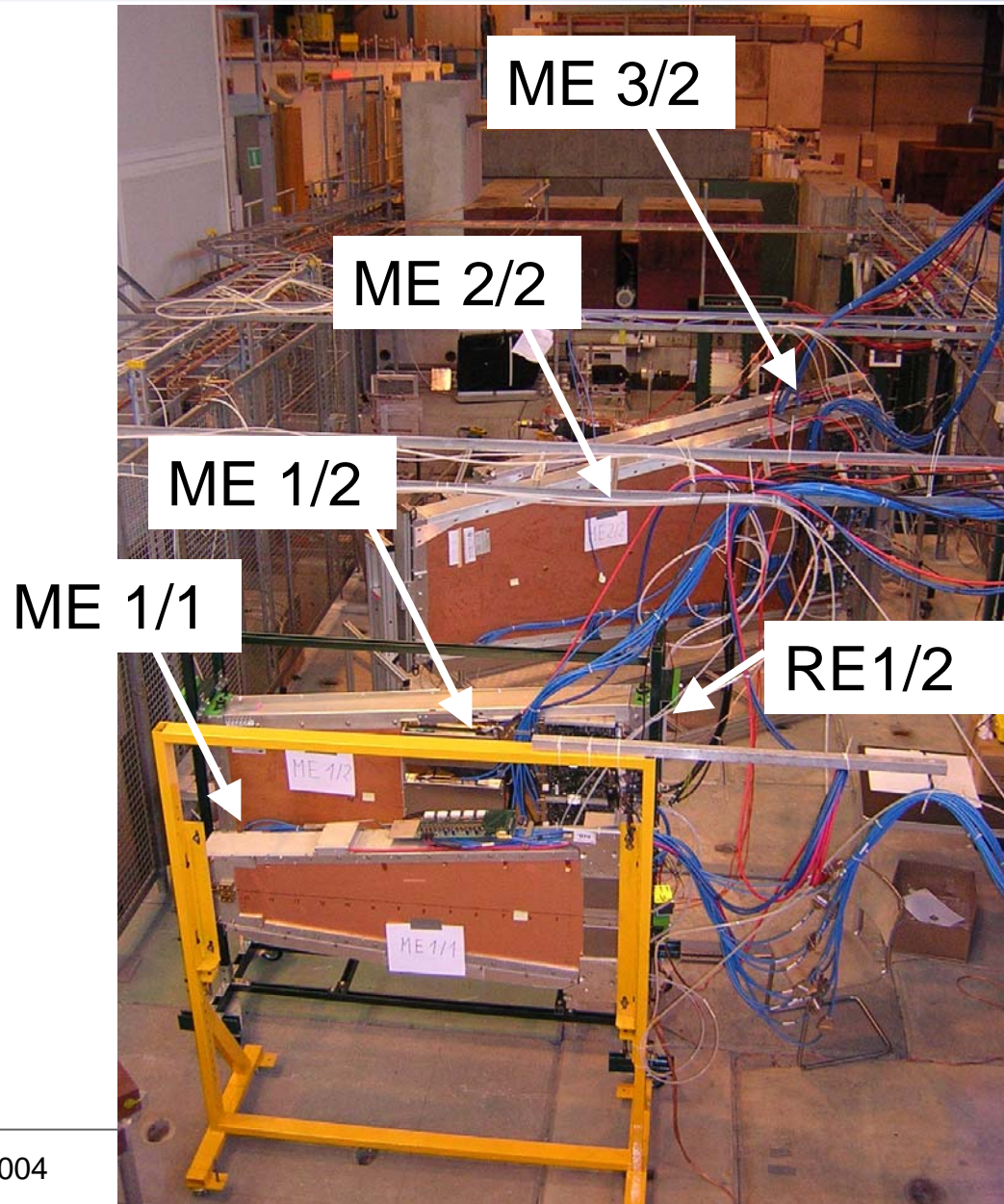


Even more goals added once started

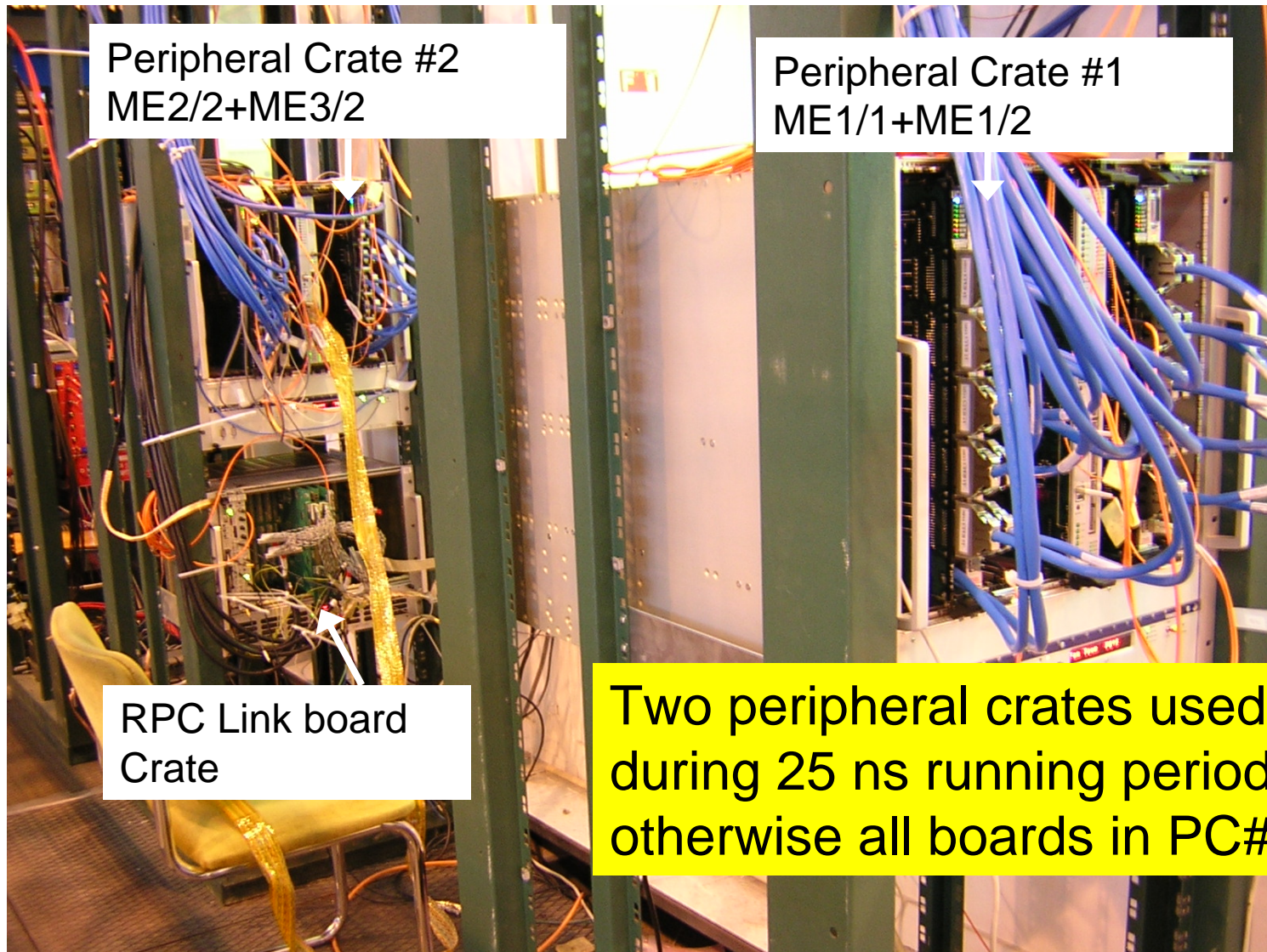
- ◆ Test slow control (DCS) prototype
- ◆ Test data quality monitoring (DQM) prototype
- ◆ Test multiple peripheral crates
 - Toward a Slice Test of the CMS Endcap Muon system, where one peripheral crate corresponds to one disk
- ◆ Test multiple Sector Processors to one Muon Sorter
 - A 1/6 trigger “data challenge” of Track-Finder crate
 - Tests SP \leftrightarrow 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
- ◆ Unify TF and PC run control
- ◆ Add automated calls to DB to log run configuration
- ◆ *Offline simulation of testbeam setup*
- ◆ *Injection of raw data into ORCA*



2004 CSC Beam Test Setup



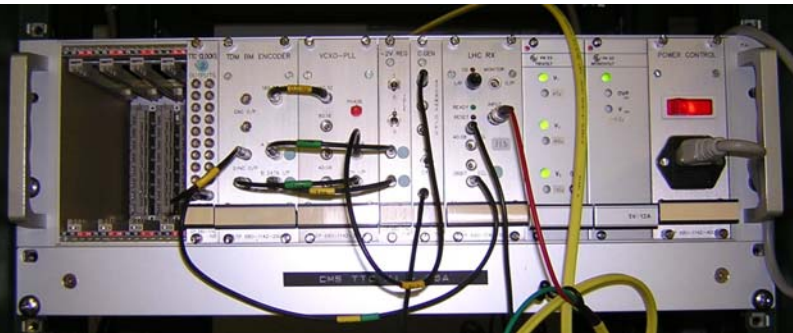
Peripheral Electronics





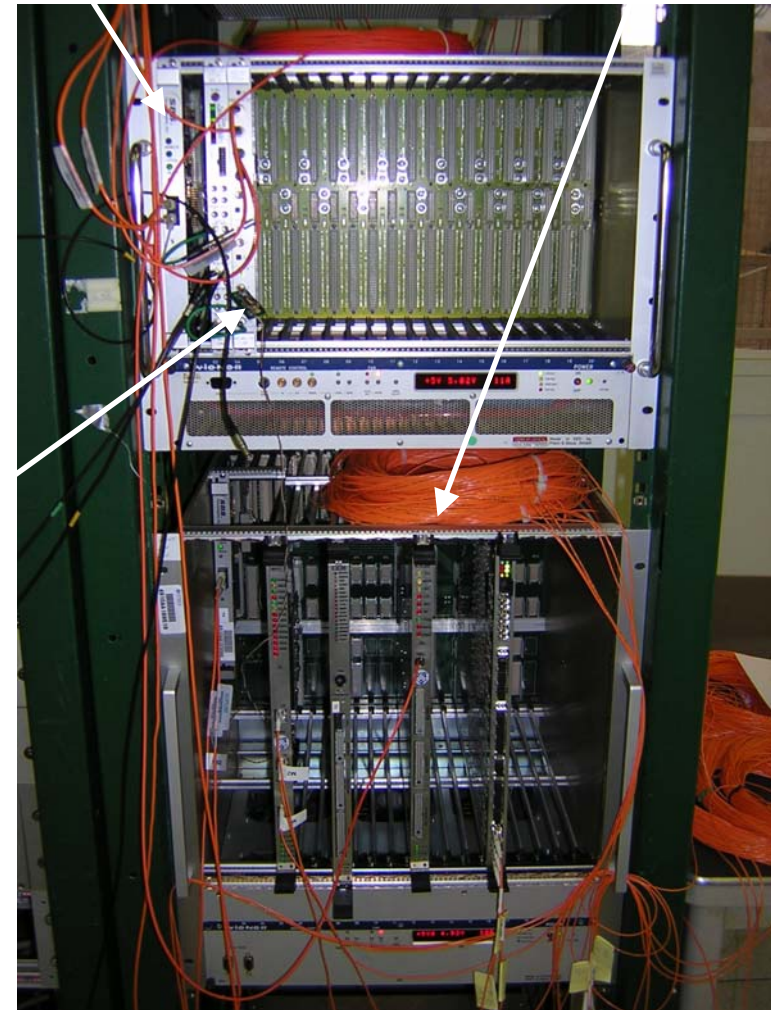
Track-Finder, TTC & Trigger Electronics

TTCmi crate
(machine interface for clock & orbit)



TTCvi crate

Level-1
Track-Finder crate



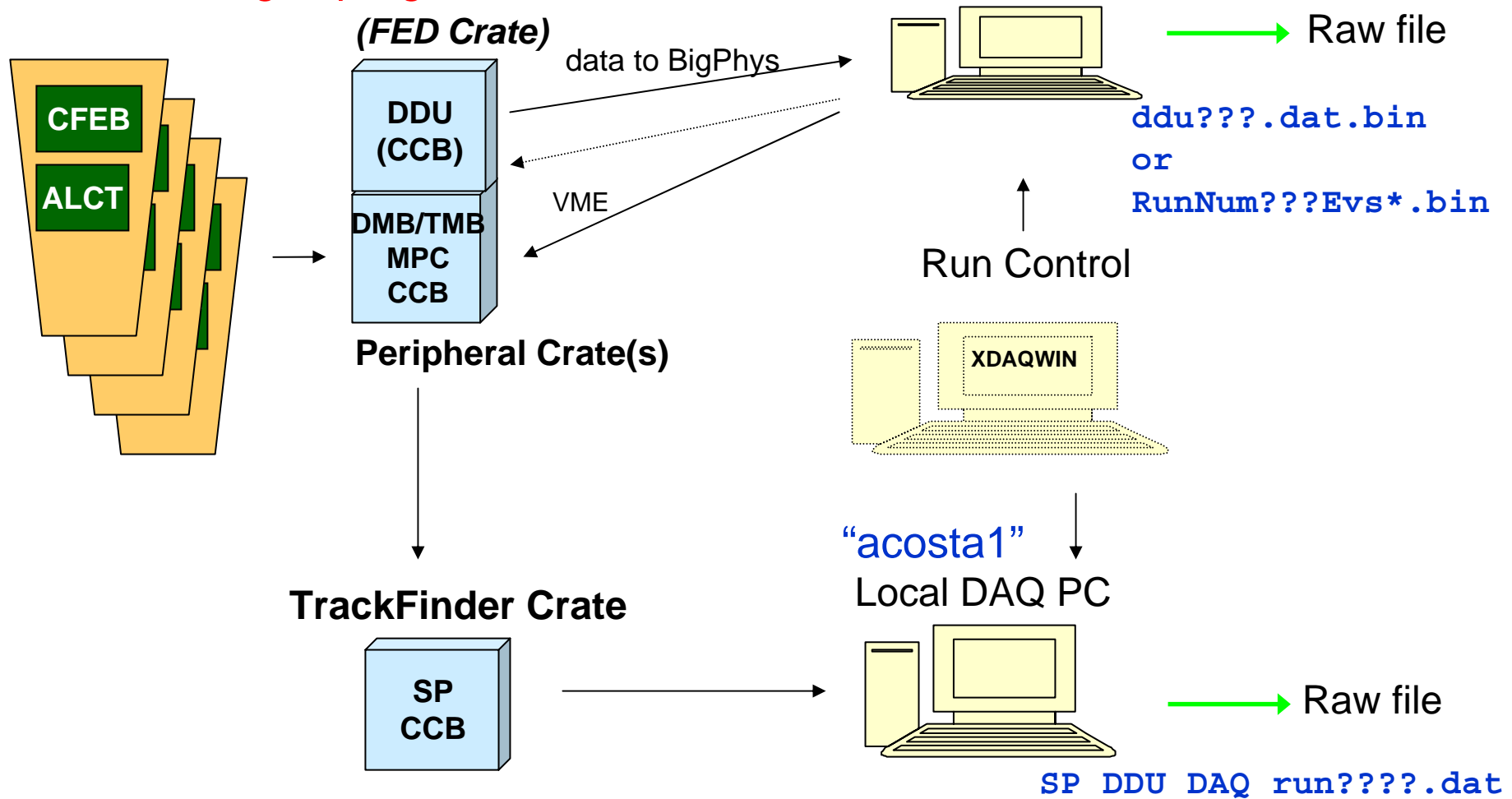
- **Machine clock and orbit signals only available during 25 ns run**
 - ◆ We used Lev's XO for asynch period
- **TTC configuration**
 - ◆ Lindsey set up sending of spill start/stop signals in TTC asynchronous mode
 - ◆ Lev & Mike set up synchronous TTC signals partway through 25 ns period



Test Beam 2004 DAQ Configuration

Configuration commands
distributed via XDAQ.

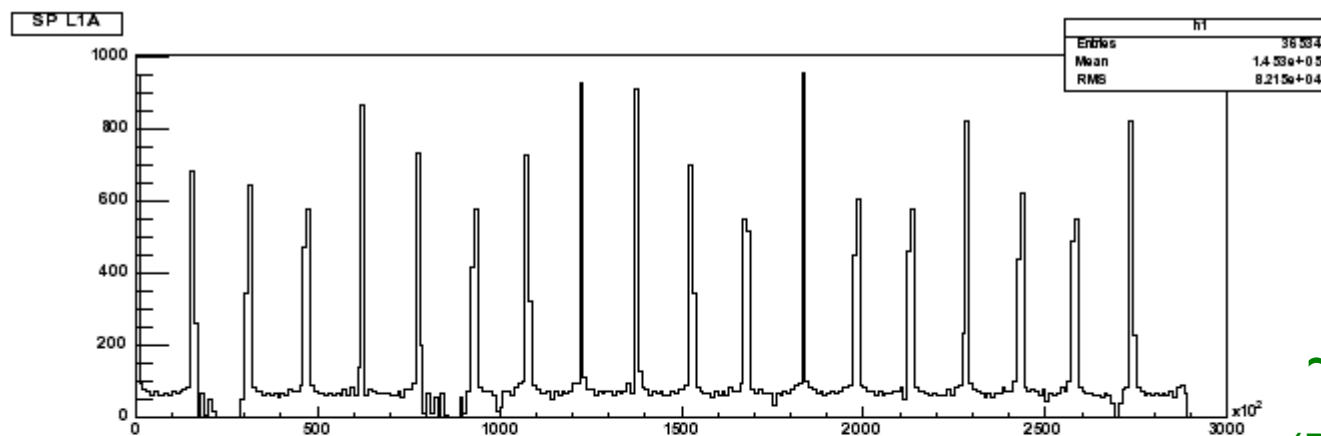
Event-building in progress



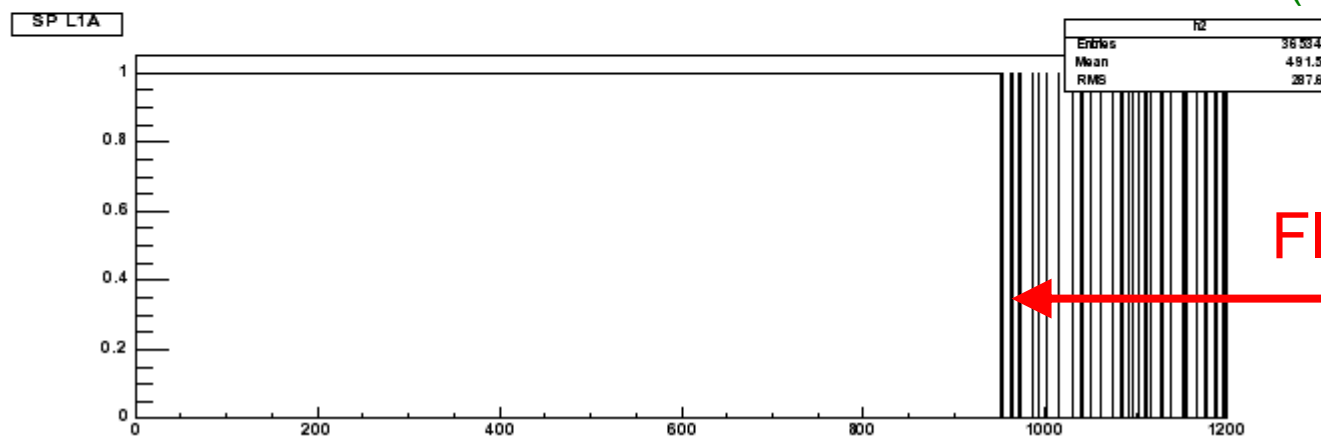


SP DAQ

- The Track-Finder DAQ FIFO fills up because of slow VME readout (but complete record @ start of each spill)**

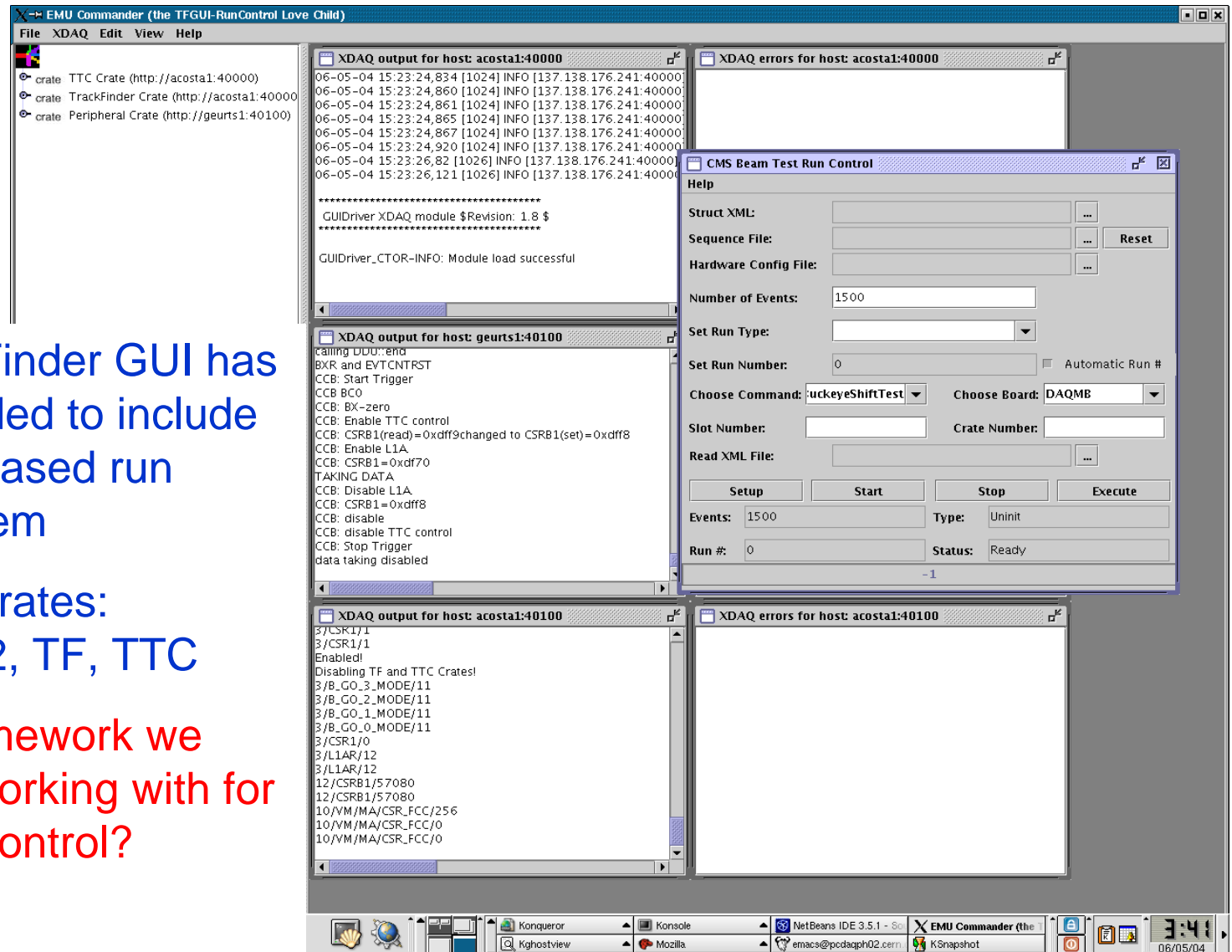


~10% caught
(Run 380, muons)





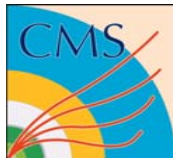
The Integrated EMU GUI



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

Controls 4 crates:
PC#1, PC#2, TF, TTC

Is this a framework we should be working with for EMU Run Control?



May Test Beam Schedule

Period 1A 2004 May 17 to Jun 8

SPS243

n 1.7

(colour code: purple (dark) = scheduling meeting, light green (light) = weekend or holiday)

Beam delivered early
14 May

		Mon 17 Wk21	Tue 18 May	Wed 19 May	Thu 20 May	Fri 21 May	Sat 22 May	Sun 23 May	Mon 24 Wk22	Tue 25 May	Wed 26 May	Thu 27 May	Fri 28 May	Sat 29 May	Sun 30 May	Mon 31 Wk23	Tue 1 Jun	Wed 2 Jun	Thu 3 Jun	Fri 4 Jun	Sat 5 Jun	Sun 6 Jun	Mon 7 Wk24	Tue 8 Jun		
Machine		8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8		
		Setup	Beam lost!										EMU Experts lost!													
			CPS M										CPS MD										Long MD + Scrubbing			
WEST AREA	T1 -X5	8h P Siegrist 105 X5A	CMS-CSC										120 GeV	8h P Siegrist 105 X5A 115 X5B	CMS-CSC/Tracker										120 GeV	
	T1 -GIF	8h S Zimmermann 125 X5C (GIF)	ATLAS-RPC											8h H Reithler 125 X5C (GIF)	CMS-RPC											
	T1 -X7	8h W Dulinski 077 X7A	CMOS											8h R Lindner 097 X7B	LHCb-HCAL										8h R Lindner 097 X7B	LHCb-PS
NORTH AREA	T2 -H2	8h D Lazic 172 H2A	CMS-HB/HE																							
	T2 -H4	8h R Wigmans 134	DREAM											9h M Haguenauer 164 H4B	CMS-ECAL											
	T4 -H6	8h P Schacht 166 H6C	ATLAS-EMEC/HEC/FCAL																							
	T4 -H8	8h B Di Girolamo 158 H8A 168 H8B	ATLAS-Tilecal/LAr/Muon										250 GeV	8h B Di Girolamo 158 H8A 168 H8B	ATLAS-Combined										250 GeV	-300
	T4 -P0	8h V Kekelidze P42 - K12	NA48/2																							
	T6 -M2	8h G Mallot	COMPASS																							
																									+160GeV mu	

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	Approximate Intensities
MD	26 GeV	(10^{11} protons/pulse)
		T1: 20
		T2: 30
		T4: 30
		T6: 120
		Total: 200



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



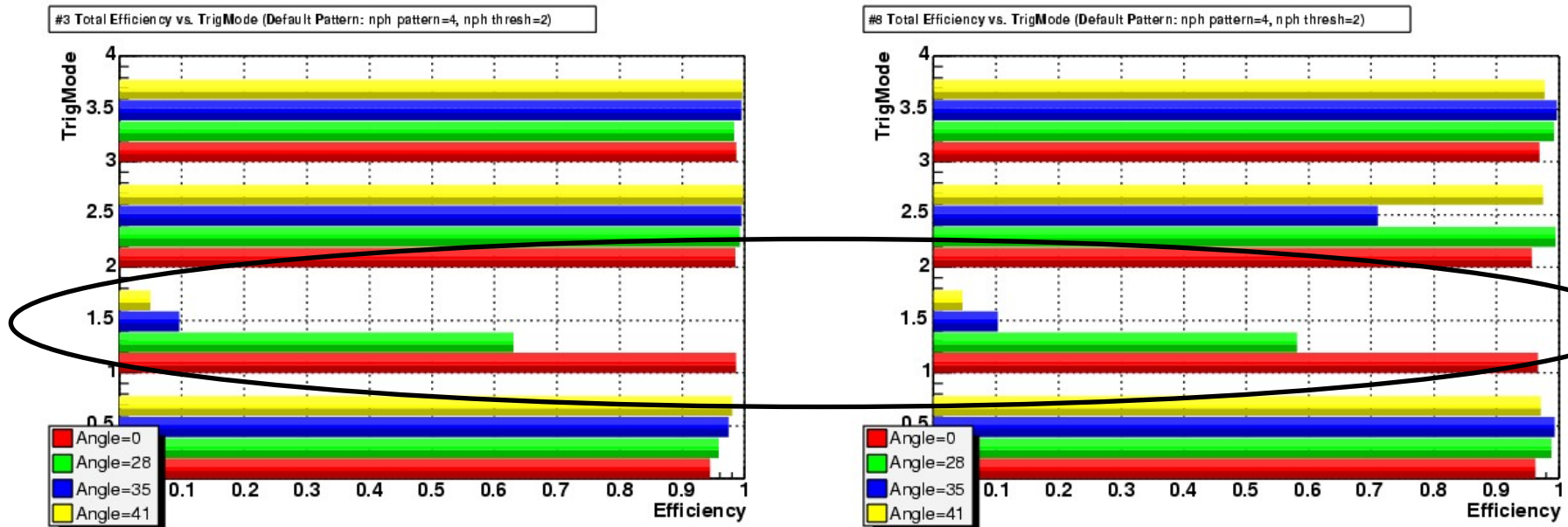
Configuration During Asynch Period

- **Single peripheral crate configuration for all four TMB's + DMB's (+ DDU)**
- **CCB2004 in FPGA mode**
- **Scintillator-based L1A**
- **Muon beam only**
- **Most runs were ALCT studies varying chamber angles and ALCT parameters**
 - ◆ **Early runs recorded only by Track-Finder**

USCM



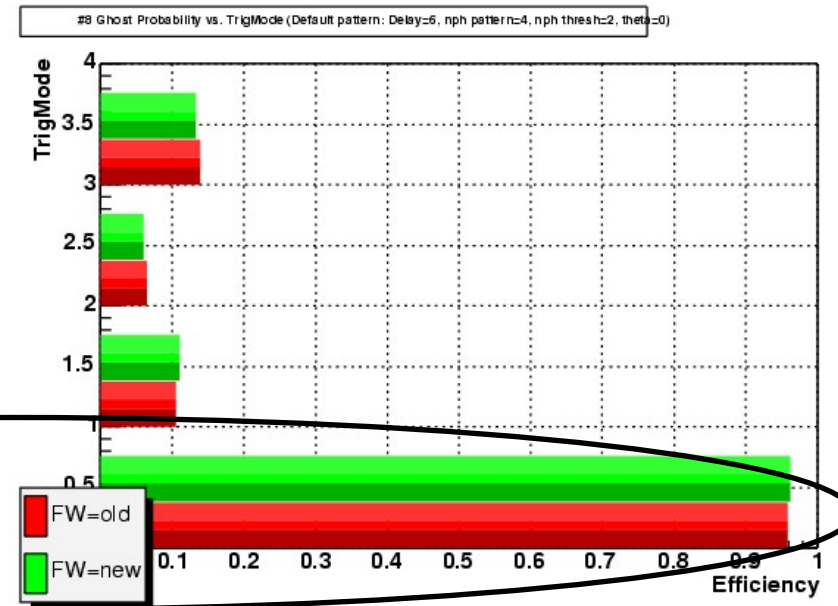
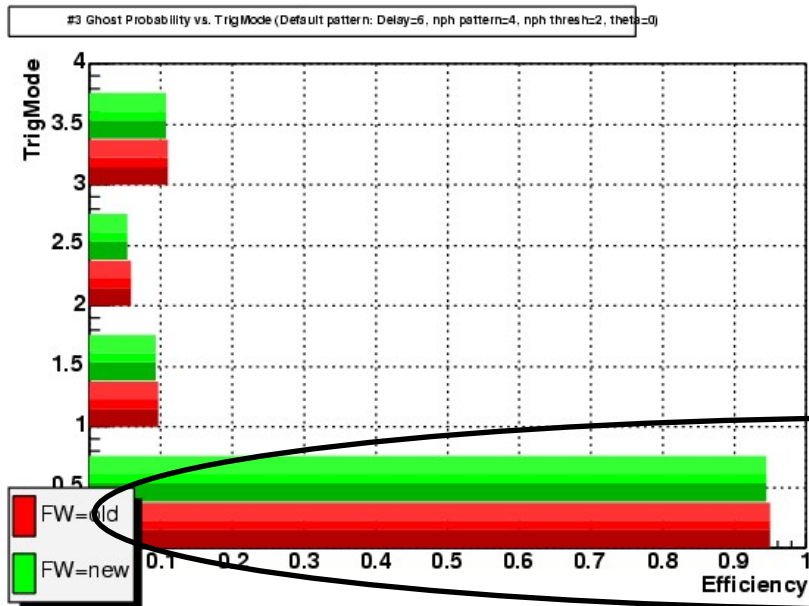
ALCT Efficiency



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



ALCT Ghost Rate



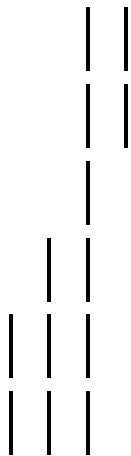
- Ghost rate very high if accelerator patterns and collision patterns both enabled without ghost cancellation mode (would flood MPC)



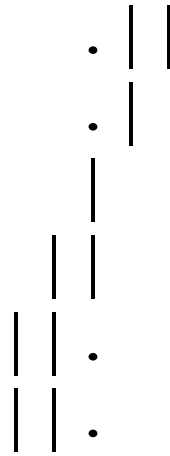
More ALCT Studies

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

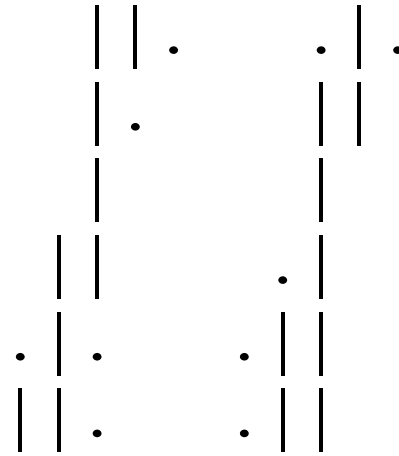
◆ Default



“Miss4”



“Andrey” Pat A and Pat B

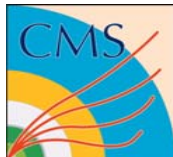


- Goal is to achieve high efficiency, low ghost rate, and good discrimination between collision and accelerator patterns



Trigger Validation

- **Can check MPC winner bits recorded by TMB in DDU data with that expected by MPC simulation**
 - ◆ e.g. I wrote some code to do this check, putting LCT data on correct relative BX and running an MPC simulation based on 4 chamber input:
 - Conclusion: only 193 mismatches in 79408 events (0.25%)
 - Stale LCT data bug might have affected this
 - **Check LCTs reported by TMB in DDU data with that received by SR/SP, after running through MPC simulation**
 - ◆ Last year had ~99.7% agreement
 - ◆ Still needs to be done for this year's data
 - Early check found ~97% agreement
 - **SP Track-Finding logic validation**
 - **Muon Sorter logic validation**
- } Use 25 ns run data



June Test Beam Schedule (25 ns)

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 Jun	Wed 9 Jun	Thu 10 Jun	Fri 11 Jun	Sat 12 Jun	Sun 13 Jun	Mon 14 Jun	Tue 15 Jun	Wed 16 Jun	Thu 17 Jun	Fri 18 Jun	Sat 19 Jun	Sun 20 Jun	Mon 21 Jun	Tue 22 Jun	Wed 23 Jun	Thu 24 Jun	Fri 25 Jun	Sat 26 Jun	Sun 27 Jun	Mon 28 Jun	Tue 29 Jun	Wed 30 Jun	Thu 1 Jul
Machine		8 Long MD + Scrubbing						8-25ns---25ns---25ns---25ns-8						8 Scrubbing + Tech Stop						10 Long MD					
WEST AREA	T1 -X5							8h P Siegel 105 X5A 115 X5B 120 GeV						8h P Martinengo 105 X5A 120 GeV						ALICE-HMPID					
	T1 -GIF	8h H Reithler 125 X5C (GIF)						8h P Martinengo 125 X5C (GIF)						ALICE-RPC											
	T1 -X7							8h free												8h R Lindner 097 X7B LHCb-HCAL					
NORTH AREA	T2 -H2							8h D Lazic 172 H2A CMS-HB/HE/HO						8h D Lazic 172 H2A CMS-HF											
	T2 -H4							8h M Haguenaue 164 H4B CMS-ECAL						8h M Haguenaue 164 H4B CMS-ECAL											
	T4 -H6							8h TIS-RP 126 ATLAS-EMEC/HEC/FCAL						8h P Schacht 166 H6C ATLAS-EMEC/HEC/FCAL											
	T4 -H8							8h B Di Girolamo 158 H8A 168 H8B +180 GeV ATLAS-Combined						8h M Cobal 138 +180 GeV (high int.) ATLAS-Pixel											
	T4 -P0							8h V Kekelidze P42 - K12 NA48/2-calibration						8h V Kekelidze P42 - K12 NA48/2											
	T6 -M2							8h G Mallot +160GeV mu COMPASS-calibration						8h G Mallot +160GeV mu COMPASS											

For further information contact the SPS/PS-Coordinator

Status: Approved 3-Jun-2004

SPS CYCLE

Protons 400 GeV

Approximate Intensities
(10^{11} 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)



T1: 2
T2: 2
T4: 2
T6: 2
Total: 8

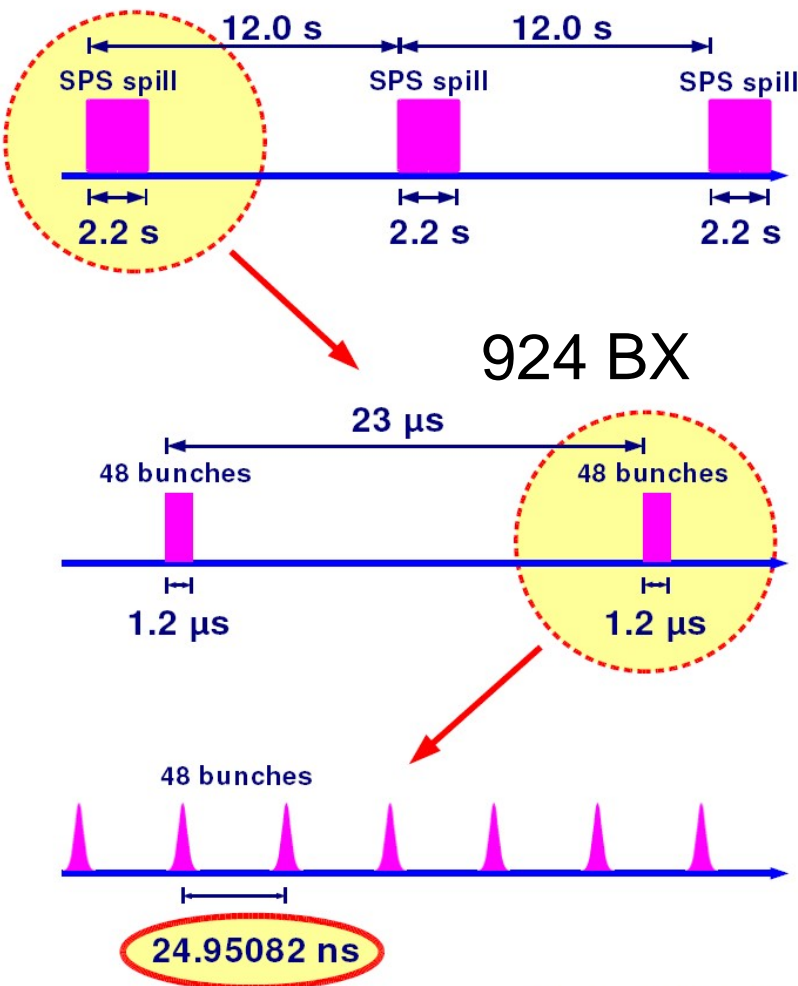
Discussion of P1B schedule on Jun 3 in the SPS users meeting
Discussion of P1C schedule on Jun 24 in the SPS users meeting

Jun 14 - Jun 21:
25ns bunched proton beam: 48 bunches, 400 GeV, 12.0 sec cycle, 2.2 sec spill length



25 ns Structured Beam

25ns Structured Beam 2004

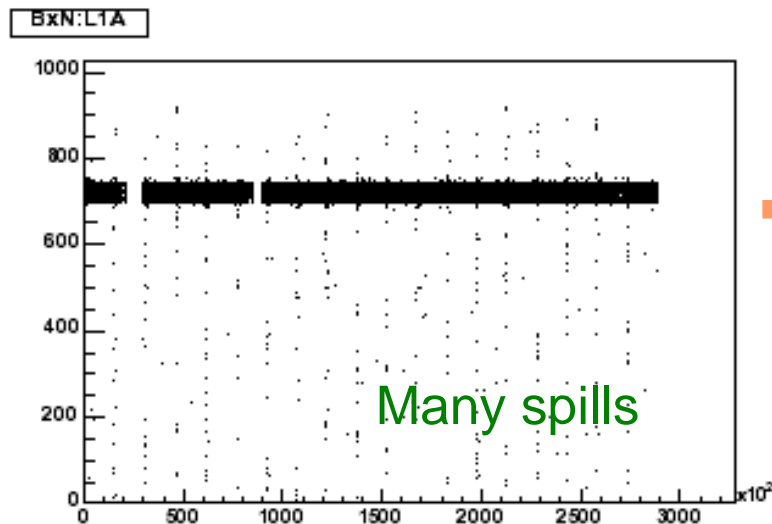
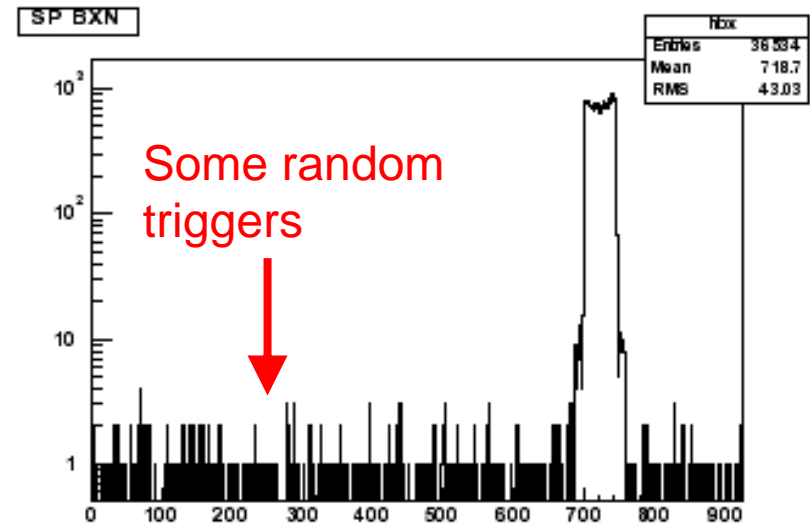
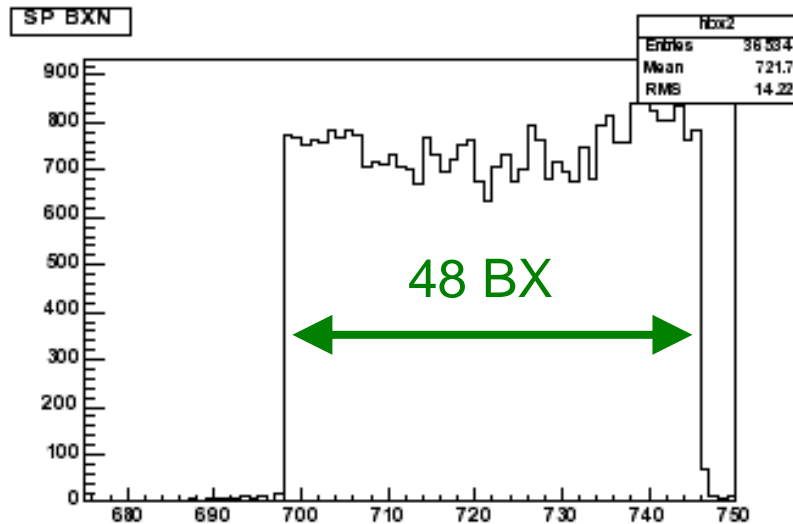


Michael Hauschild, 10-Jun-2004

- **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**



Sector Processor BX Distribution



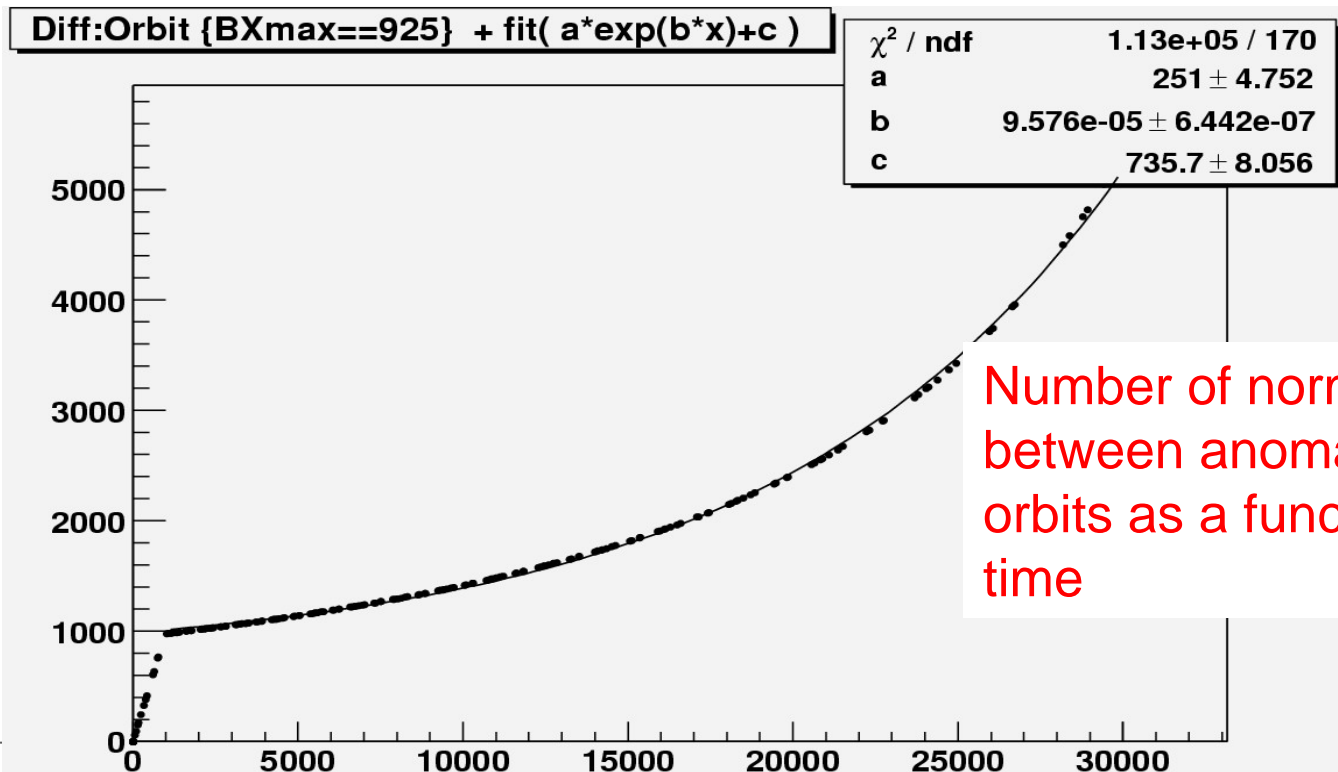
- **BX counter blindly resets every time BC0 arrives**

Run 380, muons



Orbit Signal Varies?

- Lev's BX counter in SP initially did not blindly reset on each BC0 as did all other boards. Instead, he checked if BC0 came when counter rolled over to BX0.
 - ◆ This was not always the case! Sometimes orbit is 923 or 925 BX
 - ◆ Seen simultaneously in two SP's



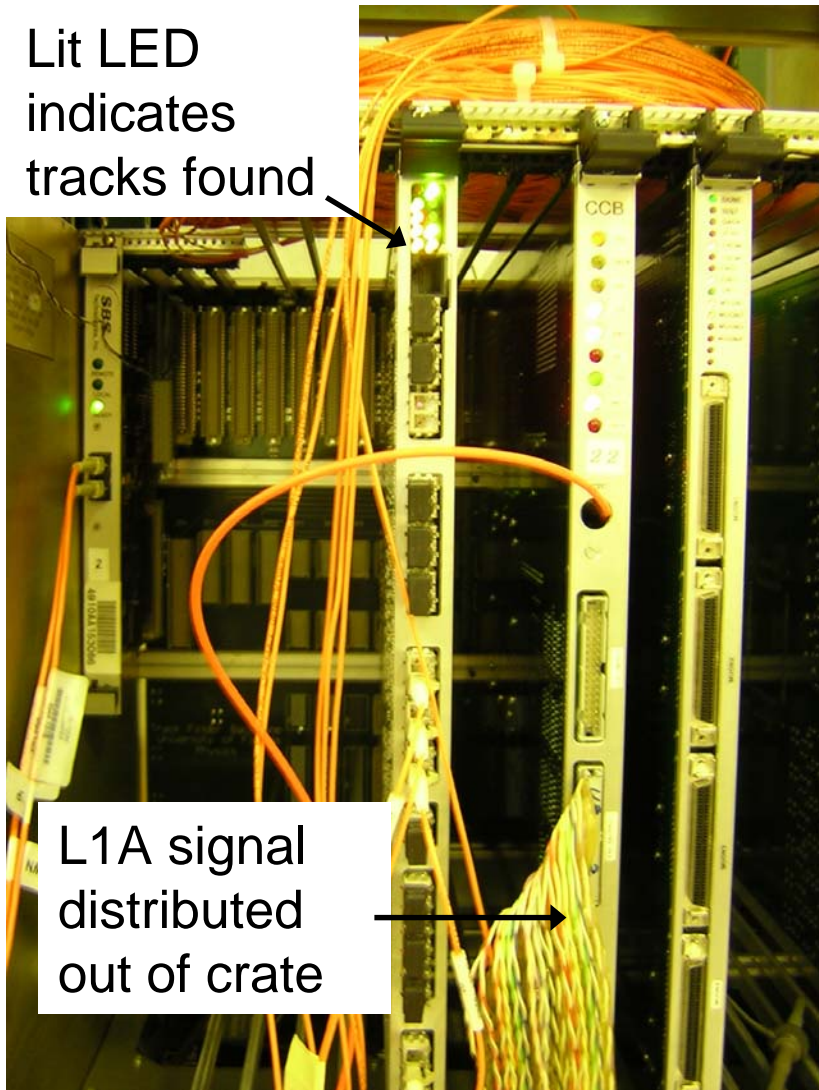


Configuration During 25 ns Period

- **Went to 2 Peripheral Crate setup**
 - ◆ PC #1: ME1/1 + ME1/2 (with RAT)
 - ◆ PC #2: ME2/2 + ME3/2
- **TMB logic updated \Rightarrow New data format!**
 - ◆ Accommodates RPC data, fixes stale data bug
 - ◆ Breaks RootEventDisplay?
- **Went to discrete logic mode on CCB (runs > 293)**
 - ◆ No programmable L1A delay (done in CCB2001 for TF L1A)
- **Went to Track-Finder trigger (runs > 291)**
 - ◆ Generally triggered on ME2/2+ME3/2
 - ◆ Aligned chambers in SR LUTs, but some features:
 - Can trigger on 1 chamber with ghost segment on second link
 - Accidentally had η offset in ME1
 - ◆ Never tried “transparent” mode of MPC (routing of specific MPC inputs to MPC outputs)
 - ◆ Sensitive to entire beam profile \otimes CSC coverage:
 - Muon trigger rate increases from ~6500/spill to ~17000/spill
 - Pion trigger rate decreases from 240K/spill to 175K/spill (effect of η offset problem?)

Track-Finder Tests

Lit LED
indicates
tracks found

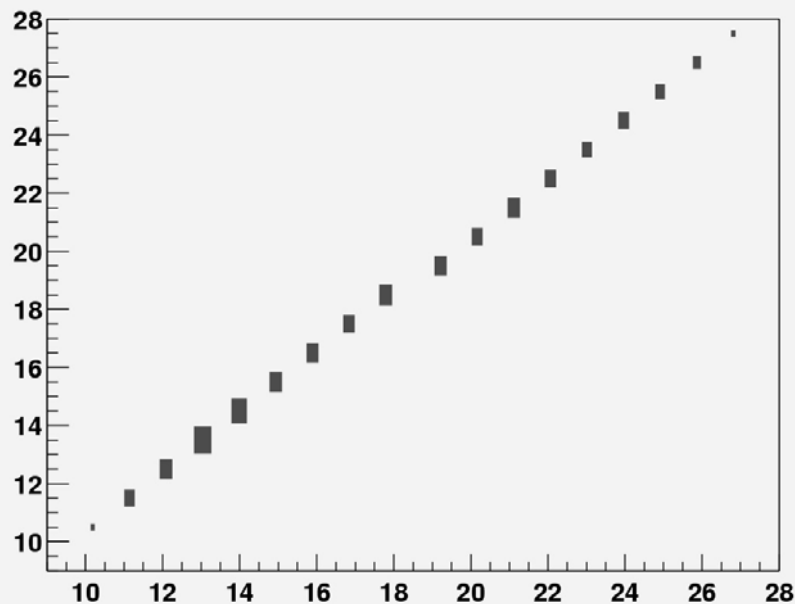


- **First time we tested with full Track-Finding logic to identify tracks in data**
- **Full DAQ logging of inputs and outputs for offline comparisons**
 - ◆ Can compare with data sent by Peripheral Crates as well as internal TF logic
- **L1A generation a major synchronization accomplishment for trigger**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

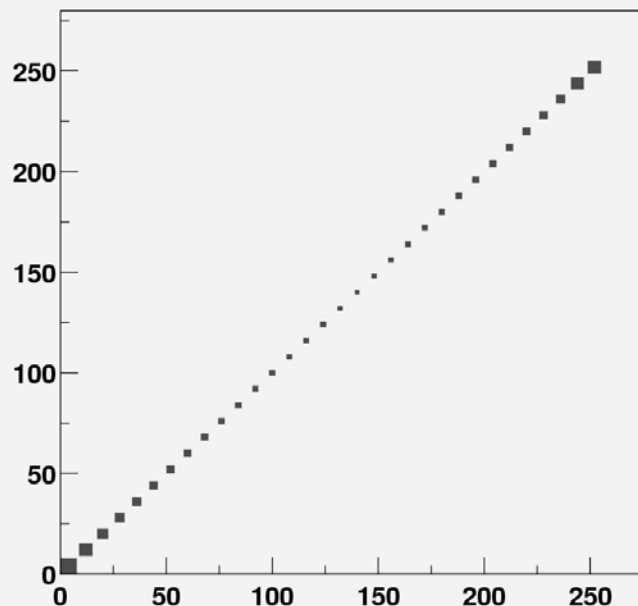


SP: ORCA vs. Hardware Check

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



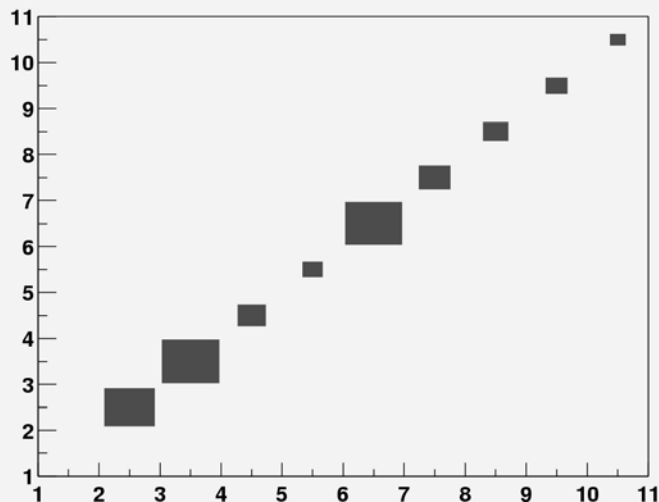
SPDphi12:OSPDphi12 {SPmode>-1}



Run 366,
Scurlock

64K events

SPmode:OSPMode {SPmode>-1}

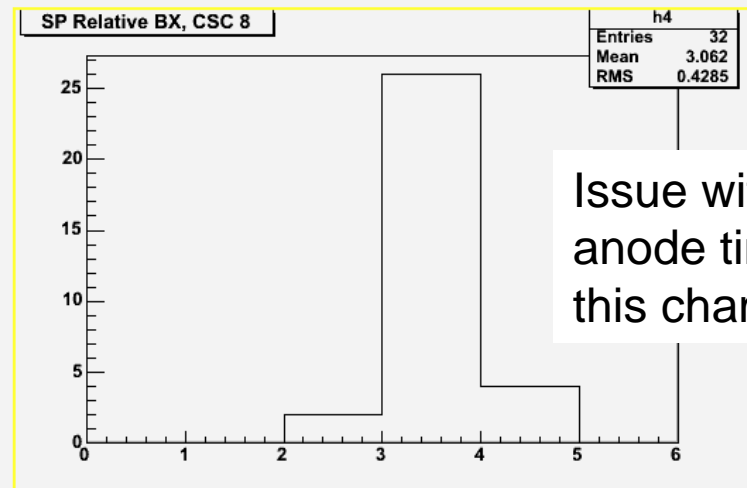
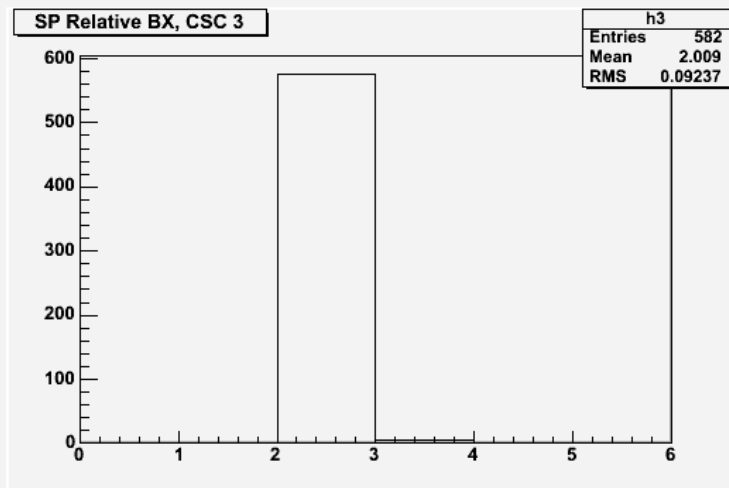
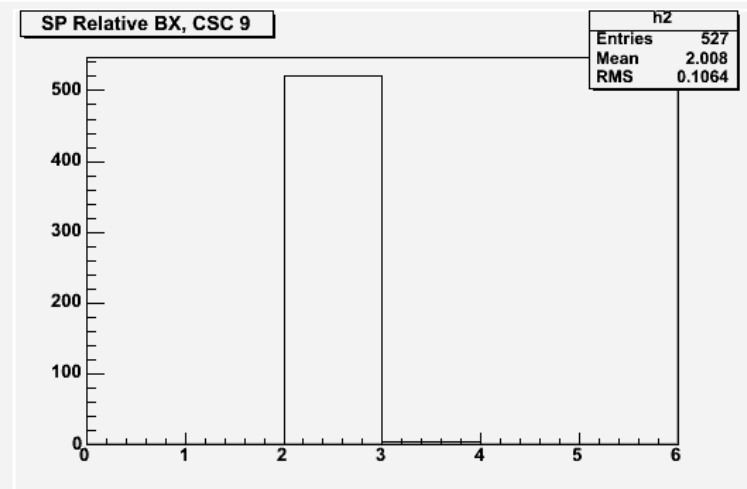
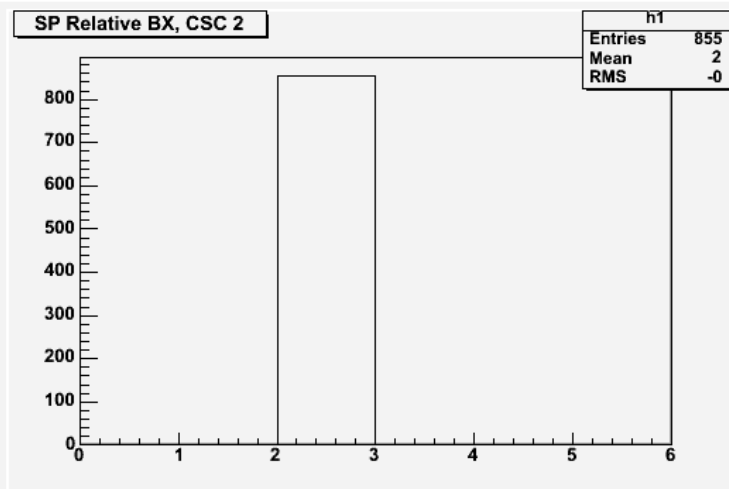


- **Correlation of track η , $\Delta\phi$ between 2 stations, and track type agrees perfectly between hardware and ORCA simulation**



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):



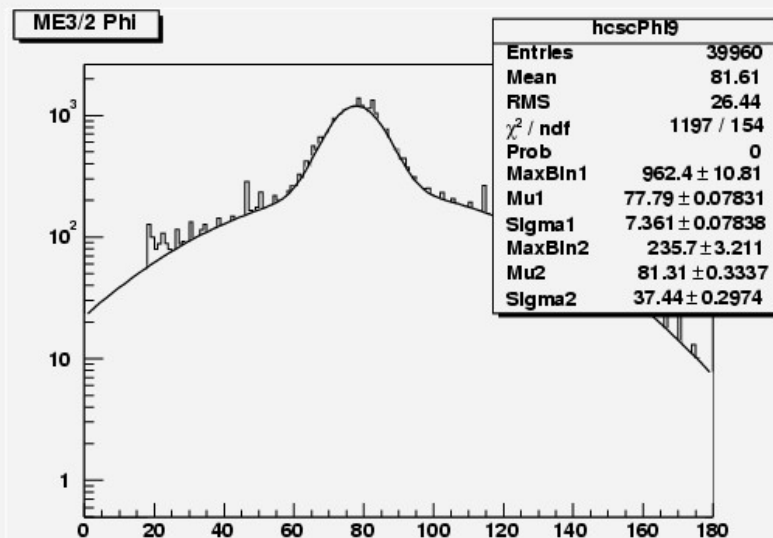
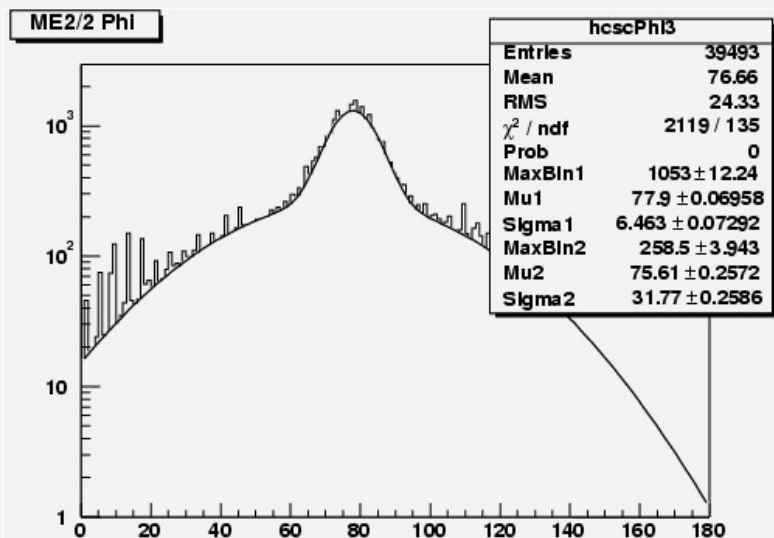
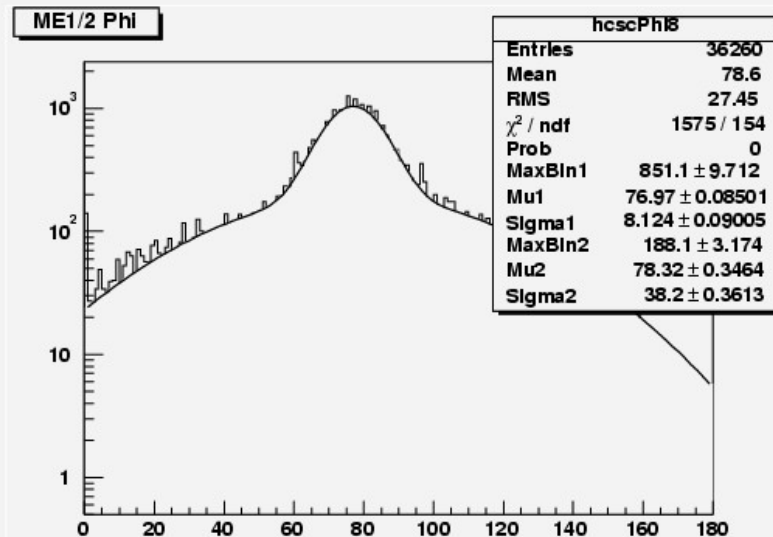
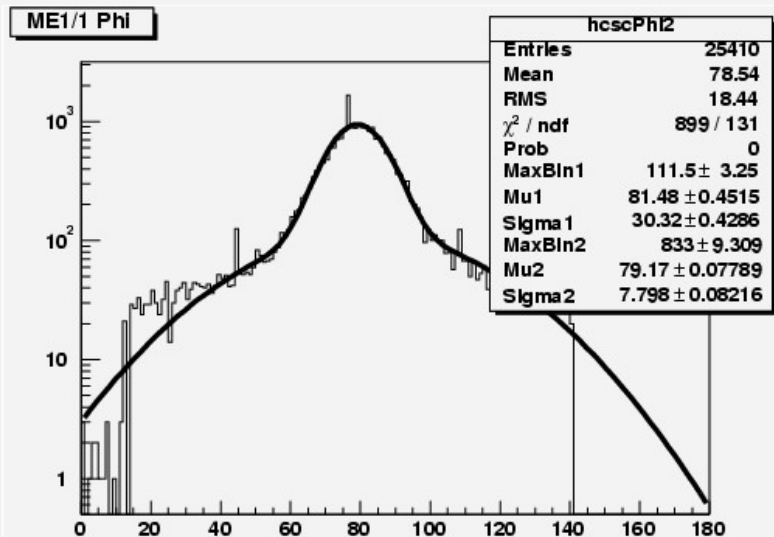
Issue with
anode timing for
this chamber

Run 293



Spatial Distribution in ϕ of Beam

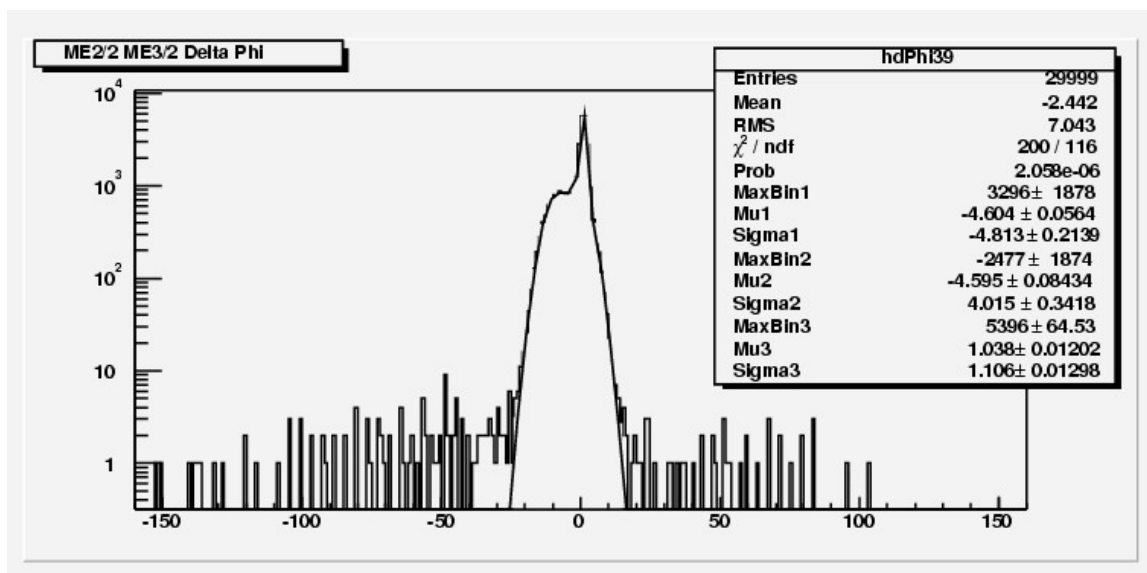
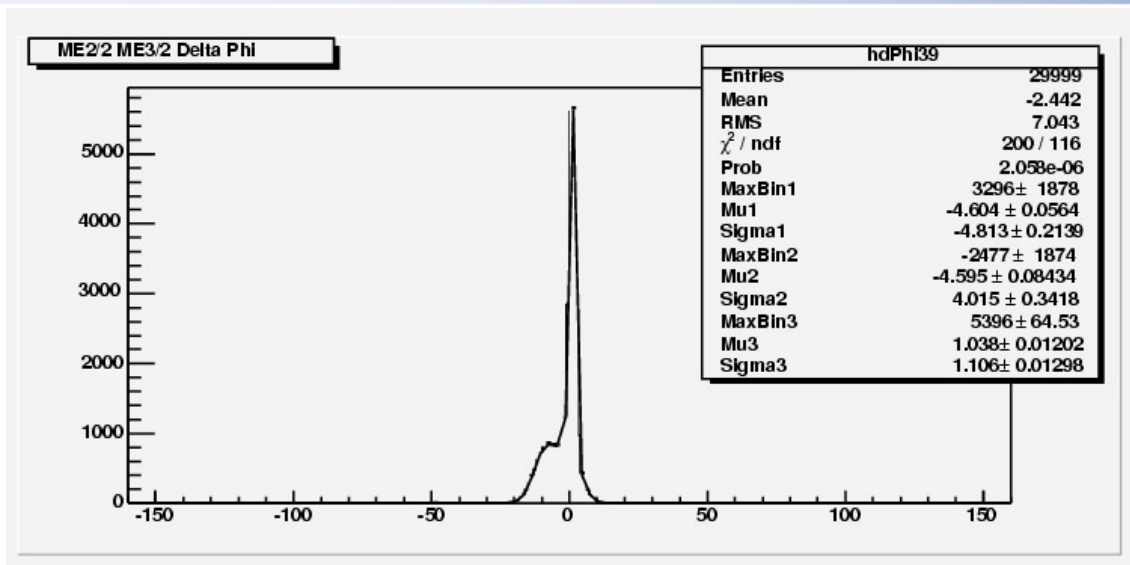
380





Difference in ϕ Between ME2/2 + ME3/2

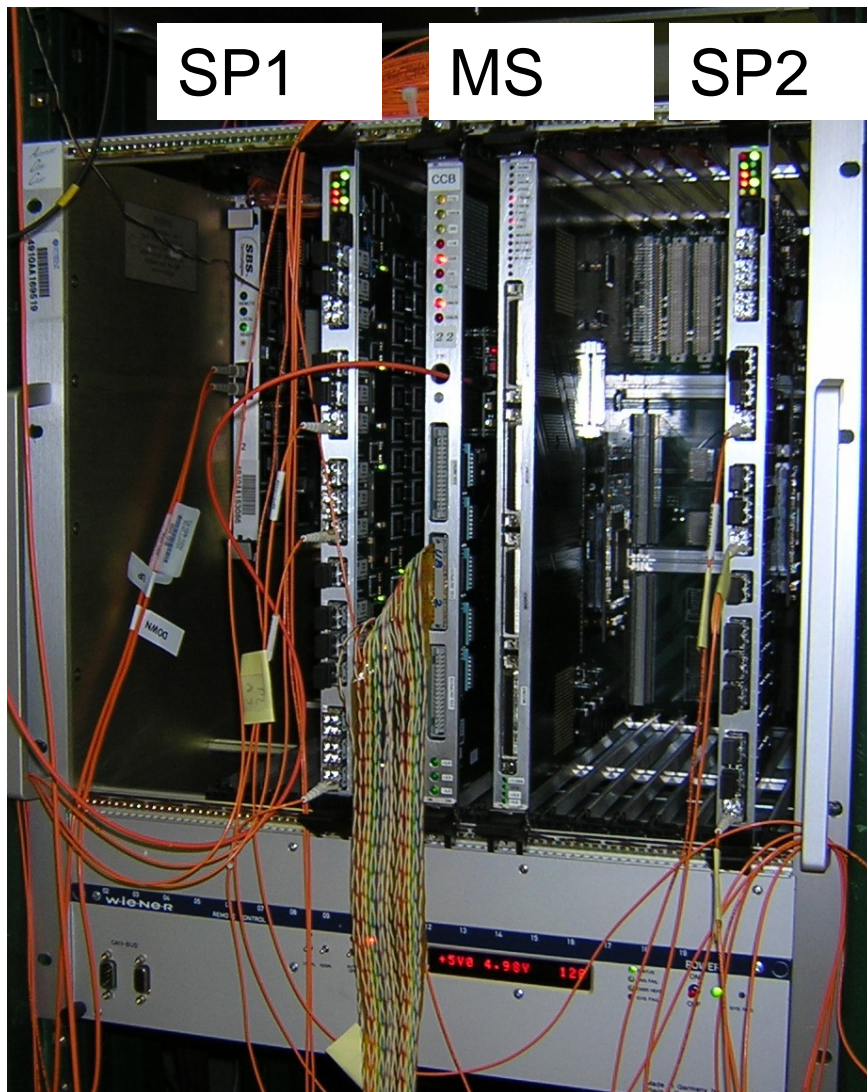
380



Looks like a
narrow core
plus halo



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



System Issues

- **Integration of DCS with Run Control system**
 - ◆ Both systems tested are incompatible with each other
 - ◆ Eventually a common framework is needed
- **Synchronization**
 - ◆ Still more of an art than a science
 - For example, if I change the ALCT delay, LCT data moves on trigger path but is lost on DAQ path!
 - ◆ Eventually need a system-wide understanding and agreement on how this is done
 - BX counters: does software keep tracks of offsets, or does firmware synch-in so that BC0 means the 0th BX on each board?
 - Can procedure be automated?



System Issues (Cont'd)

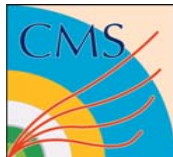
■ **DAQ data integrity**

- ◆ The problems we have in unpacking software reflect that we sometimes have unexpected (corrupted) event data
- ◆ Rate dependent, but still observed at low rates
- ◆ Is this a feature of our DAQ?
- ◆ Eventually should have ways to monitor these problems



Beam Test @ H2

- **Fall beam test offers a chance to correct some problems we had with May/June tests, and re-run**
- **Should be careful not to re-do too much, or 1 week may not be enough time to get everything working**
- **Should be careful not to get too distracted with HCAL synchronization**
 - ◆ **I think two separate subsystems, triggered by TF, and separately logging data is achievable**
 - **We do it already between PC and TF crates, and also with RPC system**
 - ◆ **Merging run control and DAQ systems should be done inasmuch as we think is on path for EMU development**
- **Next test beam coordinator ought to be someone responsible for some of the overall system issues**



Fall Schedule

SPS Operation

Period 2C 2004 Sep 7 to Oct 4

SPS247

Schedule issue date: 30-Jun-2004

Version 1.10

(colour code: purple (dark) = scheduling meeting, light green (light) = weekend or holiday)

		Tue 7 Sep	Wed 8 Sep	Thu 9 Sep	Fri 10 Sep	Sat 11 Sep	Sun 12 Sep	Mon 13 Sep	Tue 14 Sep	Wed 15 Sep	Thu 16 Sep	Fri 17 Sep	Sat 18 Sep	Sun 19 Sep	Mon 20 Sep	Tue 21 Sep	Wed 22 Sep	Thu 23 Sep	Fri 24 Sep	Sat 25 Sep	Sun 26 Sep	Mon 27 Sep	Tue 28 Sep	Wed 29 Sep	Thu 30 Sep	Fri 1 Oct	Sat 2 Oct	Sun 3 Oct	Mon 4 Oct
Machine		SPS MD				SPS MD				CPS MD				T18 + Long MD				24-25ns---25ns---25ns---8				Long MD				TOTEM			
WEST AREA	T1 -X5	16h P Martinengo 105 X5A				ALICE-Muon				120 GeV				8h Siegrist 105 X5A 115 X5B				CMS-CSC/Tracker											
	T1 -GIF	16h free 125 X5C (GIF)				8h P Martinengo 125 X5C (GIF)				ALICE-TOF				8h S Zimmermann 125 X5C (GIF)				ATLAS-RPC											
	T1 -X7	16h R Lindner 097 X7B				LHCb-VELO				8h H Kagan 077 X7A				9h R Lindner 097 X7B				LHCb-PS				0h R Lindner 097 X7B				LHCb-xCAL			
NORTH AREA	T2 -H2	16h J Mitchell 172 H2A				ACCESS				8h G Bashinsky 172 H2A				NUCLEON				8h D Lazic 172 H2A				CMS-HB/HE/HO/DT							
	T2 -H4	16h M Haguenauer 164 H4B												CMS-ECAL															
	T4 -H6	16h P Schacht 166 H6C				ATLAS-EMEC/HEC/FCAL								6-100 GeV								0h TIS-RP 126				16h ATLAS-xEC/FCAL 166 H6C			
	T4 -H8	16h B Di Girolamo 158 H8A 168 H8B												ATLAS-Combined															
	T4 -P0	16h C Lourenco P41								NA60												0h C Lourenco P41				50-300 GeV NA60-calibration			
	T6 -M2	16h G Mallot				COMPASS								+160 GeV mu								0h COMPASS-calibration G Mallot							

For further information contact the SPS/PS-Coordinator

Status: Preliminary

SPS CYCLE

Protons 400 GeV
MD 26 GeV
Approximate Intensities (10^{11} protons/pulse)



Remarks

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Discussion of P2C schedule on Sep 2 in the SPS users meeting
Discussion of P2D schedule on Sep 30 in the SPS users meeting

Aug 30 - Sep 24:

CNGS parasitic MD, 4.8 sec spill length, 18.0 sec cycle length

Sep 28 - Oct 4:

25ns bunched proton beam: 48 bunches, 400 GeV, 2.2 sec spill length

X5 (Sep 7 - Sep 22): ALICE-HMPID parasitic to ALICE-Muon

X7 (Sep 15 - Sep 20): CMOS (W Dulinski) parasitic to RD42