CSC Trigger Report:

Results from June 25 ns beam test
Production plans
Software

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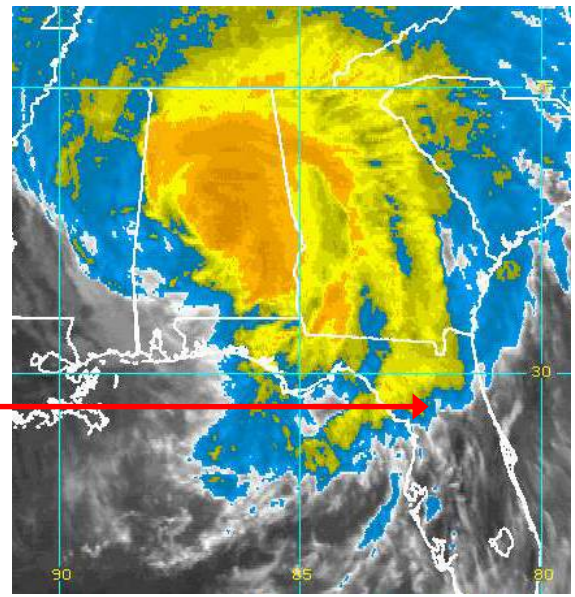
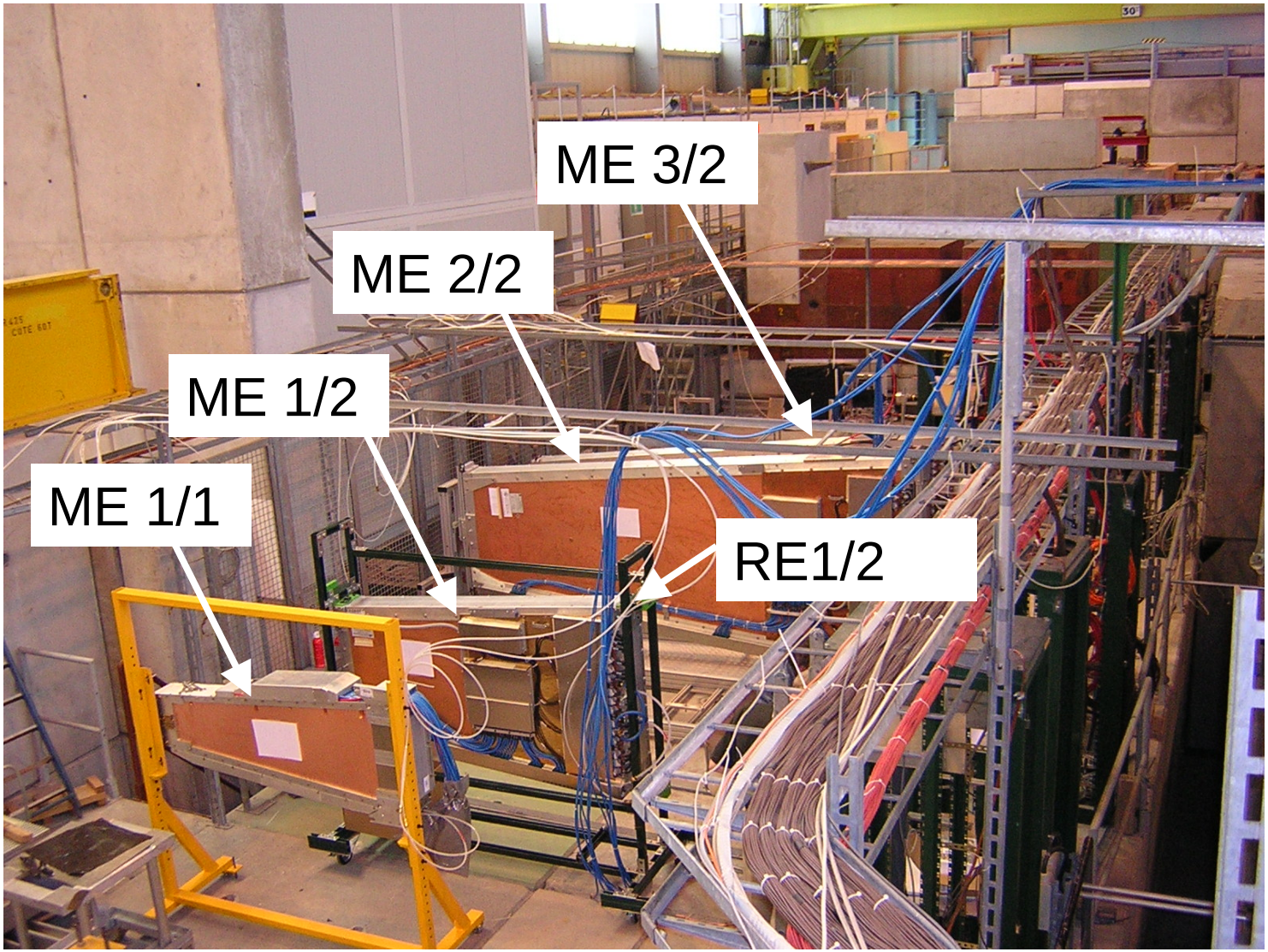


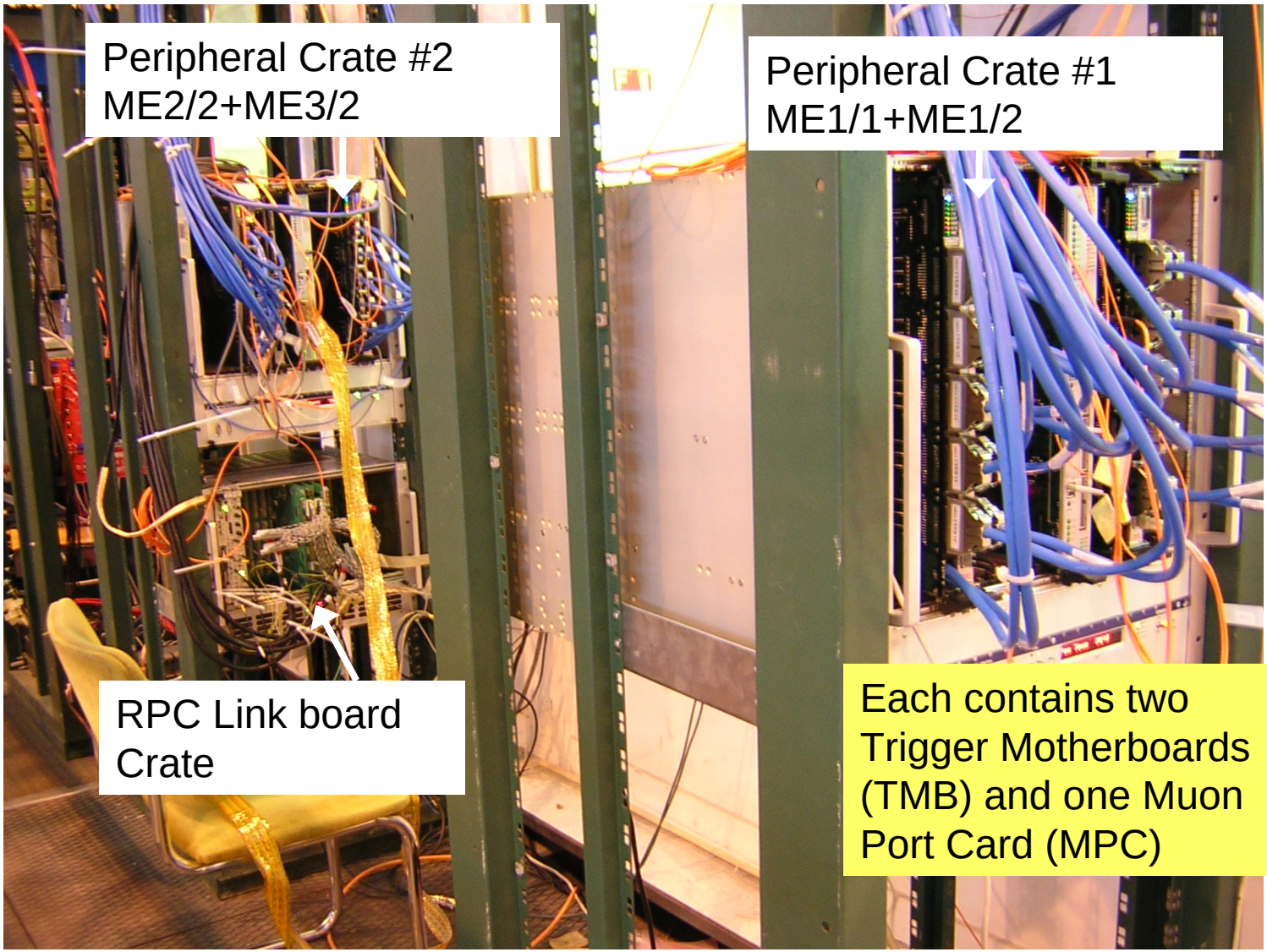
A Little Windy This Month

This is what a Category 1 hurricane did that was 200km away

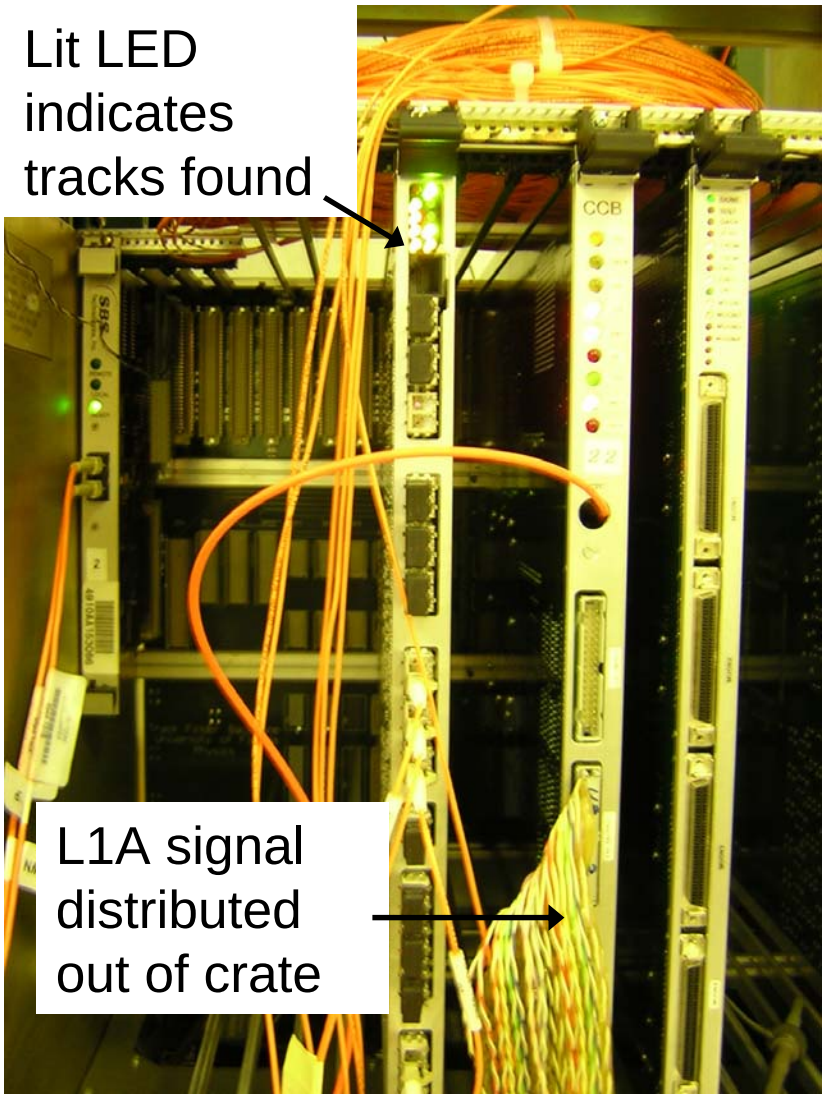
June 25ns Beam Test (Muon Slice Test)



Peripheral Electronics Configuration



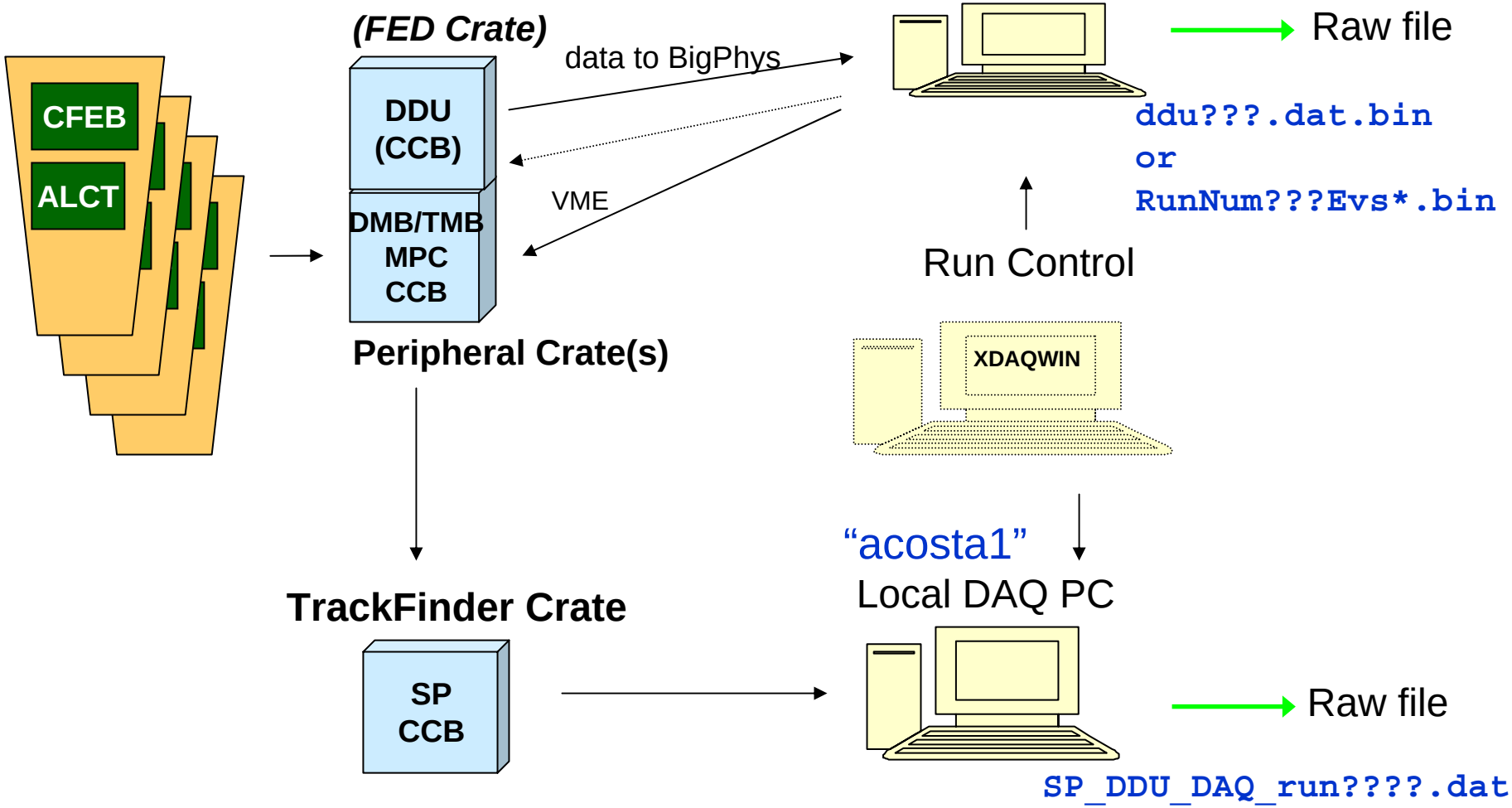
CSC Track-Finder



- 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

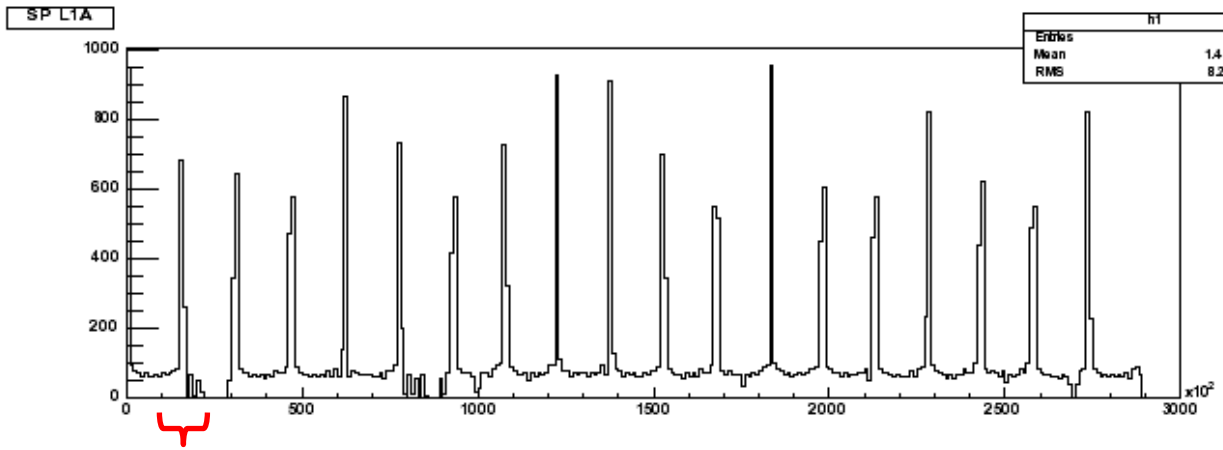
Test Beam 2004 DAQ Configuration

Configuration commands distributed via XDAQ.
Event-building tested



SP DAQ

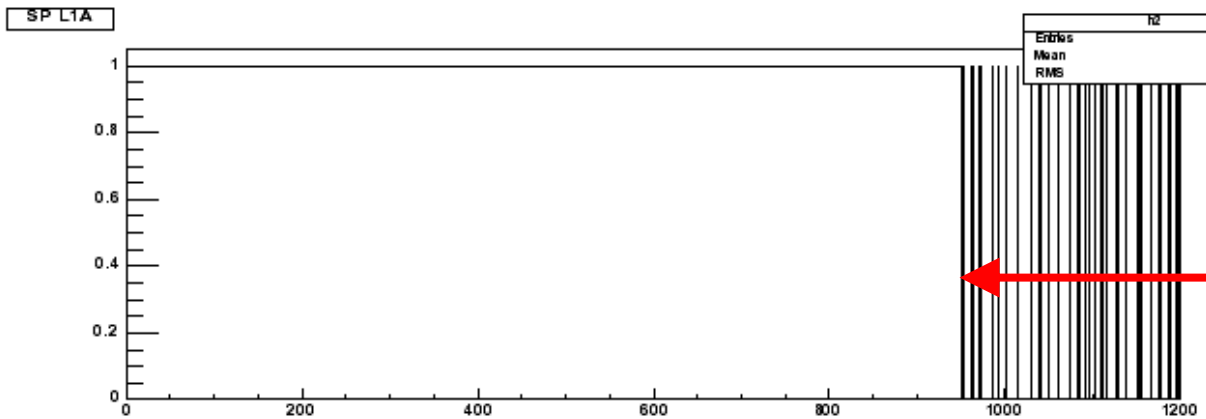
- **The Track-Finder DAQ is currently via VME read out, which is slow, since the CSC DAQ board (DDU) is still under development**



Can count spills in run!

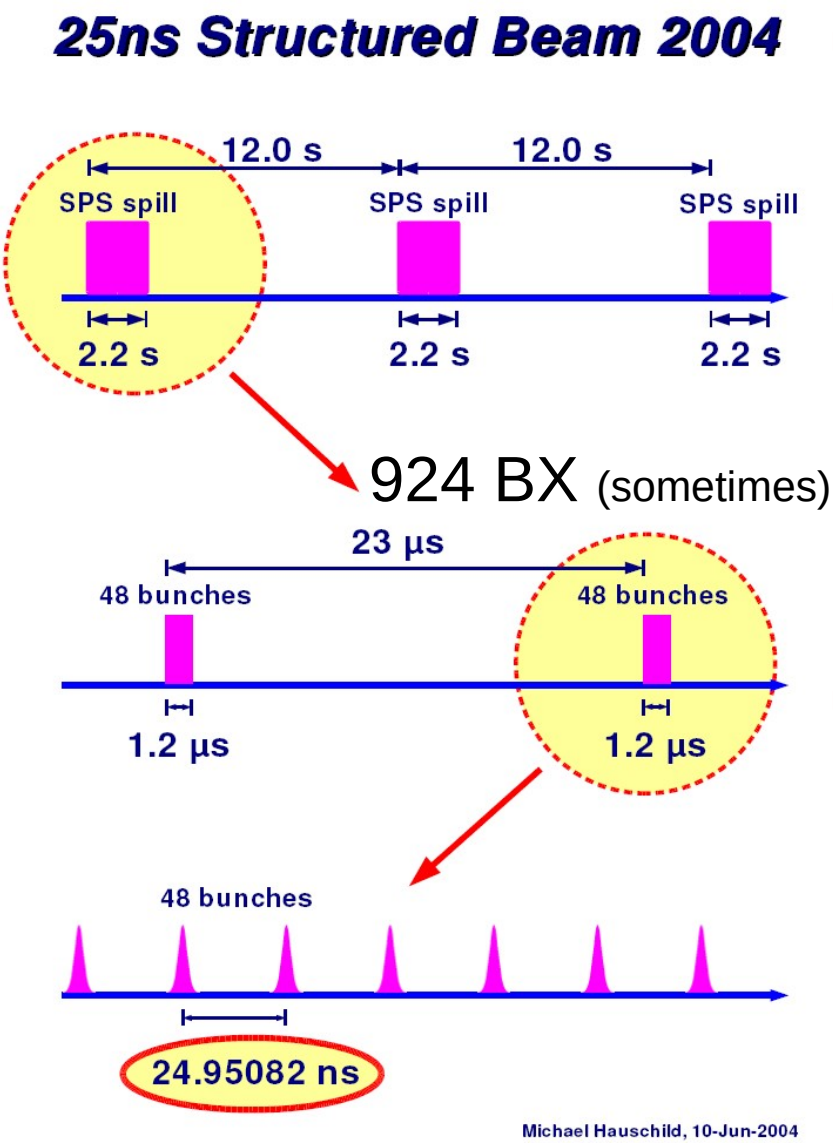
~10% caught

(Run 380, muons)



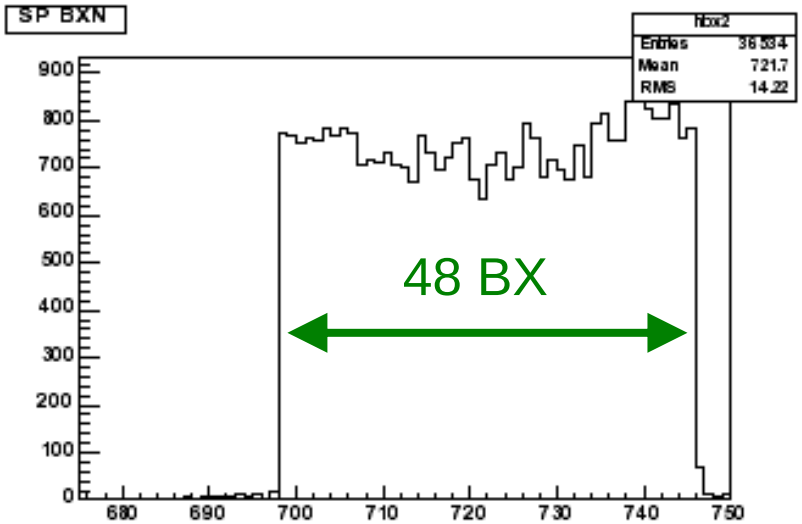
FIFO full

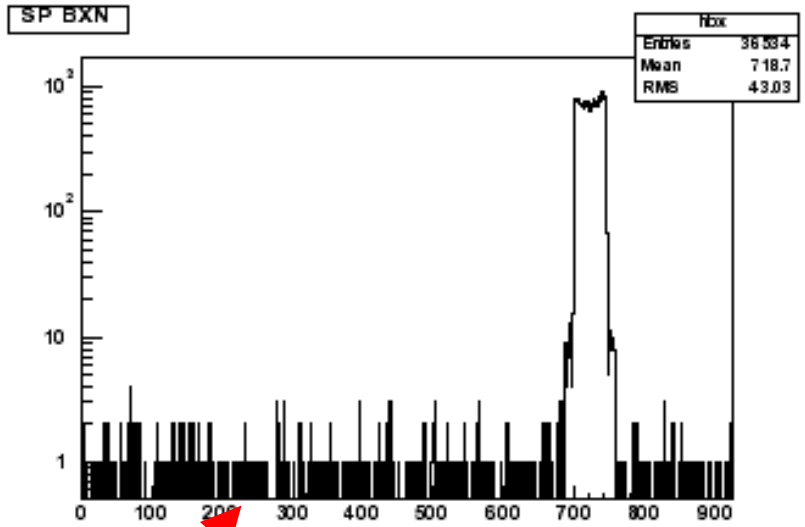
25 ns Structured Beam

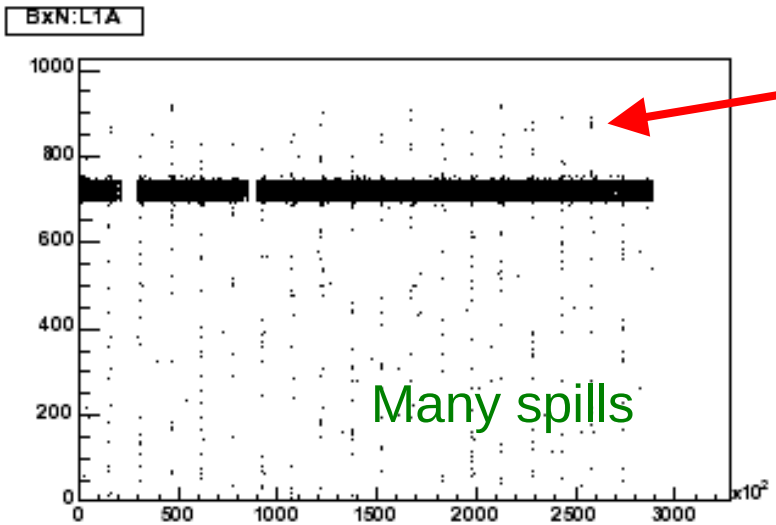


- **LHC-like bunch structure during synchronous running**
- **Trigger rates at X5A during spill**
  - **Muons: 3–10 kHz**
  - **Pions: >100 kHz**
- **CSC readout system is designed for a L1A*LCT rate at LHC design luminosity of order 5 kHz**

Sector Processor BX Distribution







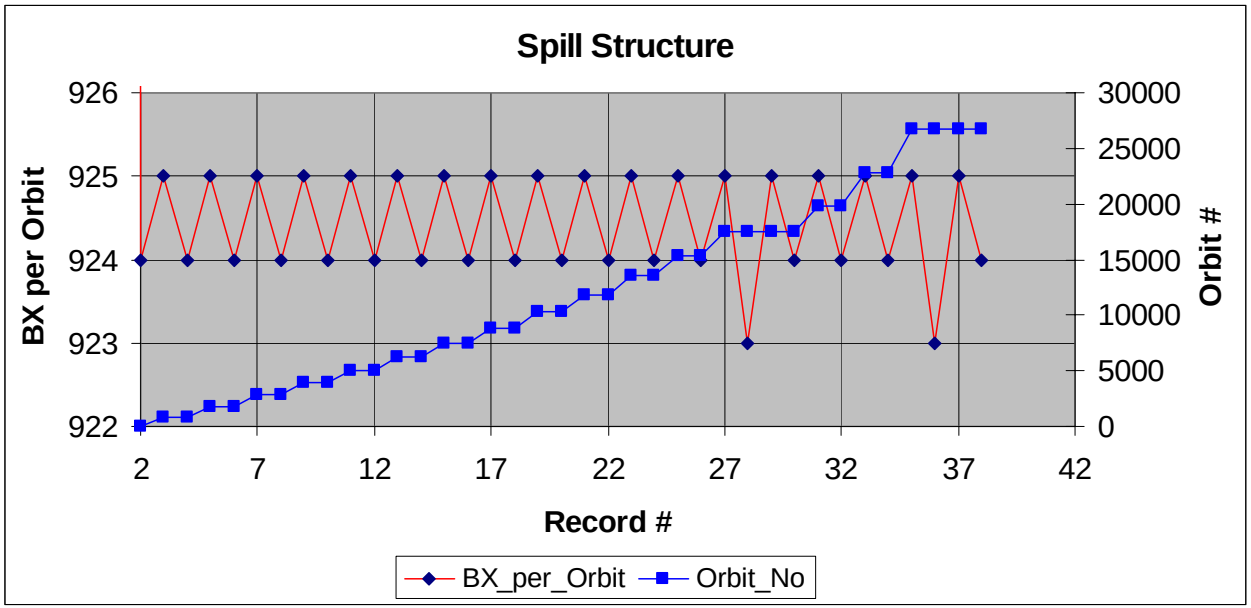
Some random triggers, mostly @ spill start

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

Run 380, muons

Spill structure

Plot below shows a single spill structure and looks like a ladder with narrow and wide steps.
Record 1 is omitted, since it serves only as a begin-of-spill mark.
Each narrow step represents two successive orbits:
a 925bx orbit period immediately reverts to a 924bx orbit period.
Each wide step represents four successive orbits, orbit period oscillates:
925bx -> 923bx -> 925bx -> 924bx.



Spill Structure continue

Plots below show:

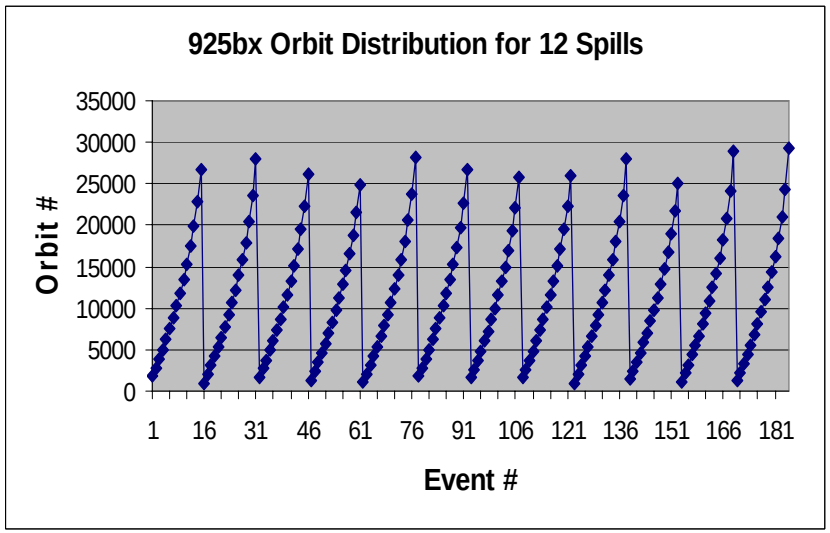
- ➔ **Distribution of orbit disturbances versus orbit # (versus time!)**
- ➔ **Distribution of orbits elapsed since previous orbit disturbance versus orbit number (versus time!), superimposed for 12 spills.**

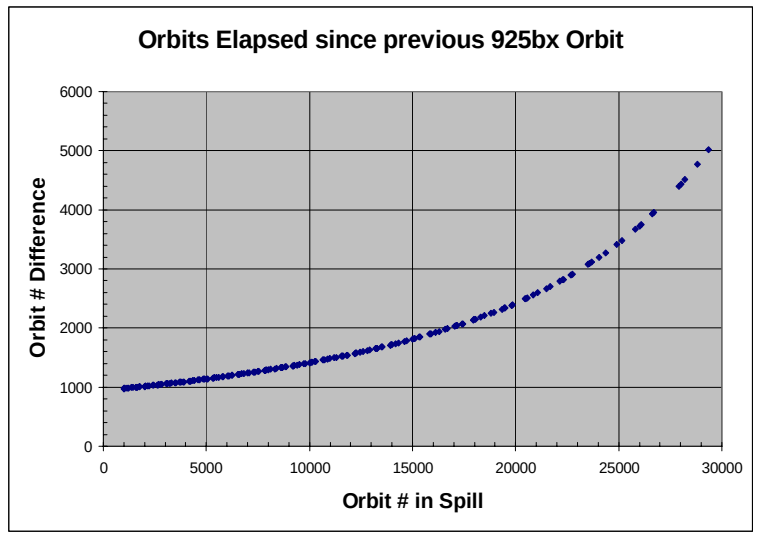
Only first orbit of the "ladder step" is plotted
(remember, a disturbance always begins with a 925bx orbit).

Conclusion:

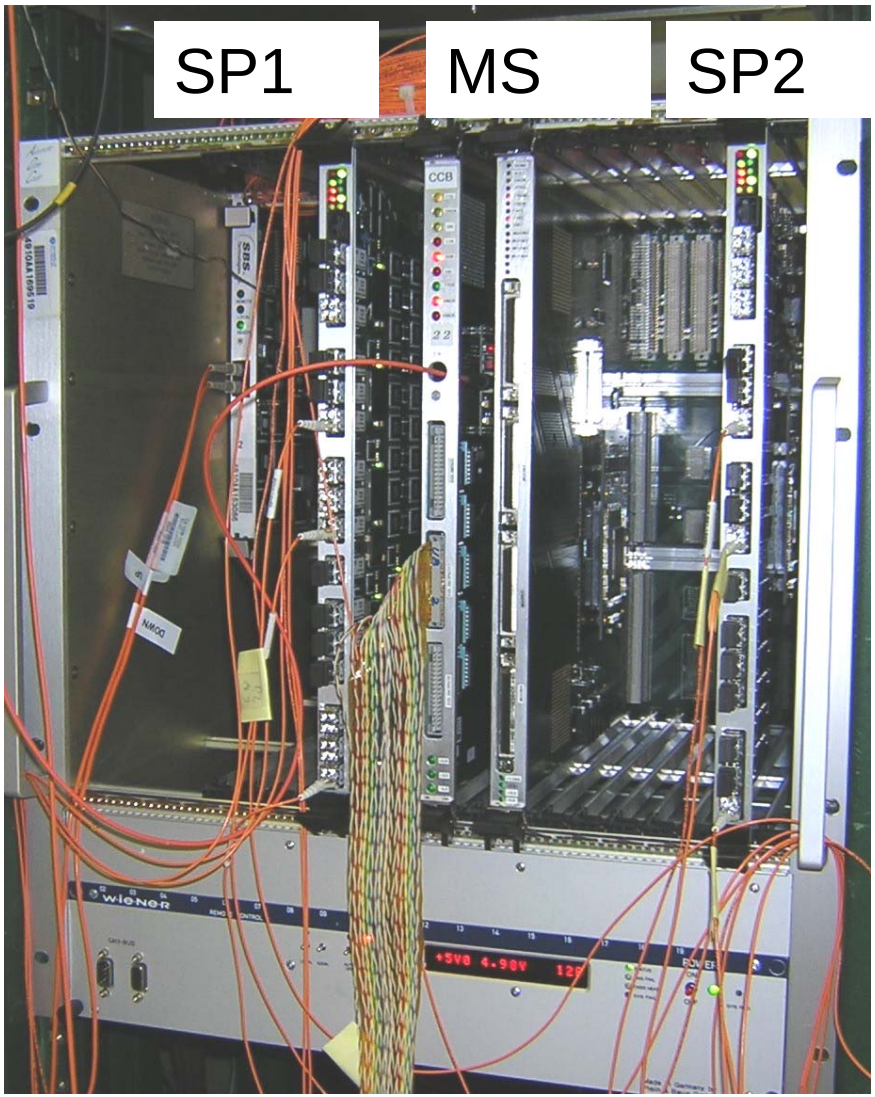
Orbit disturbances occur 15-16 times during first 0.7 sec (23 us * 30000) of spill.

If BC is synchronized to BC0 only at the beginning of spill, it will be apart from BC0 by 15-16bx to the end of spill -> BXN distribution of the events gets wider.





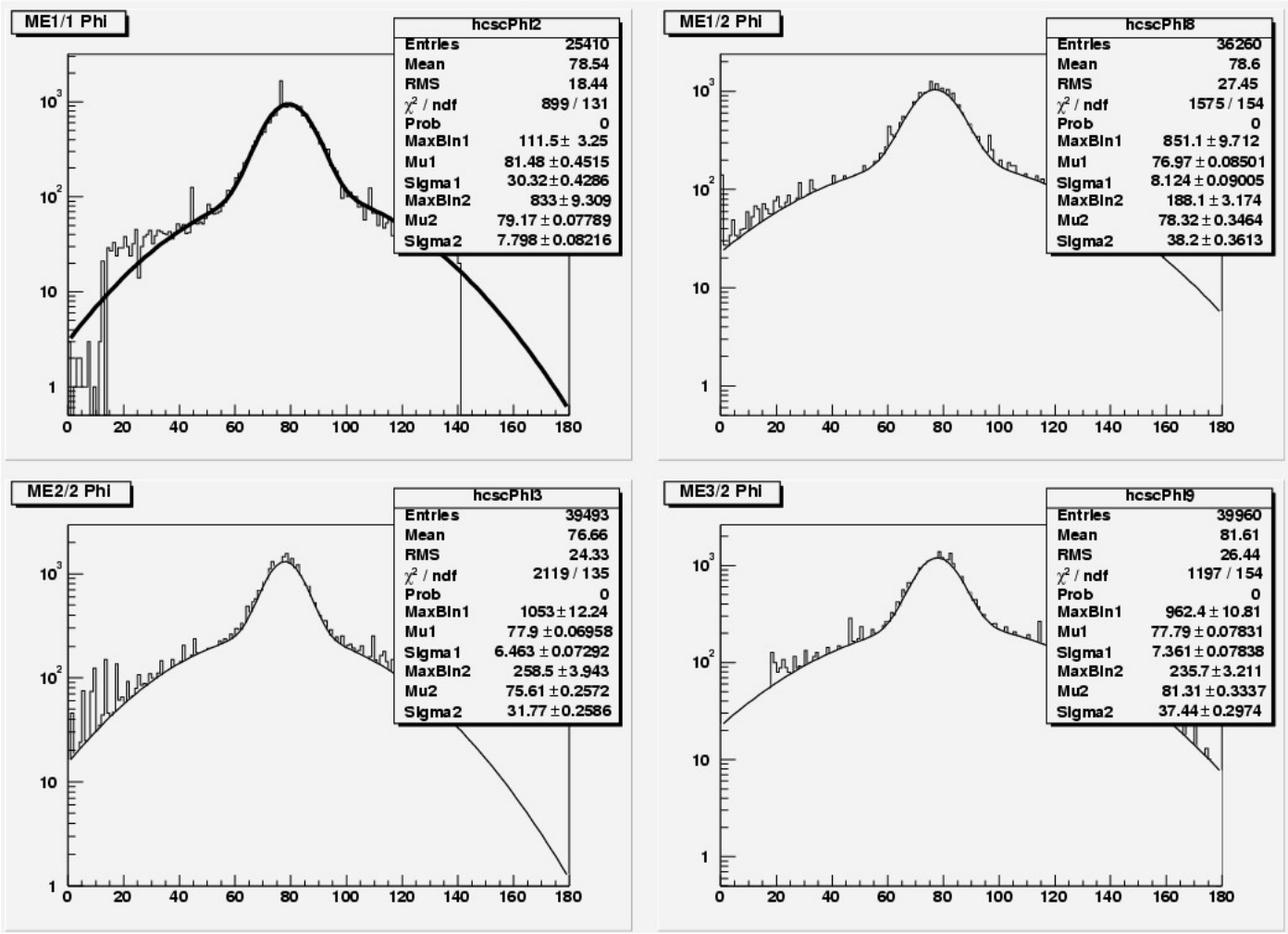
Track-Finder Crate Tests



- **First test of multiple peripheral crates (multiple MPC) to TF crate**
  - **Synchronization test**
- **Various clocking solutions tried to test robustness of optical links**
  - **MPC used QPLL 80 MHz clock on backplane for all 25 ns runs**
- **First test of multiple Sector Processors (SP) to one Muon Sorter (MS)**

Spatial Alignment in Phi of TF Data

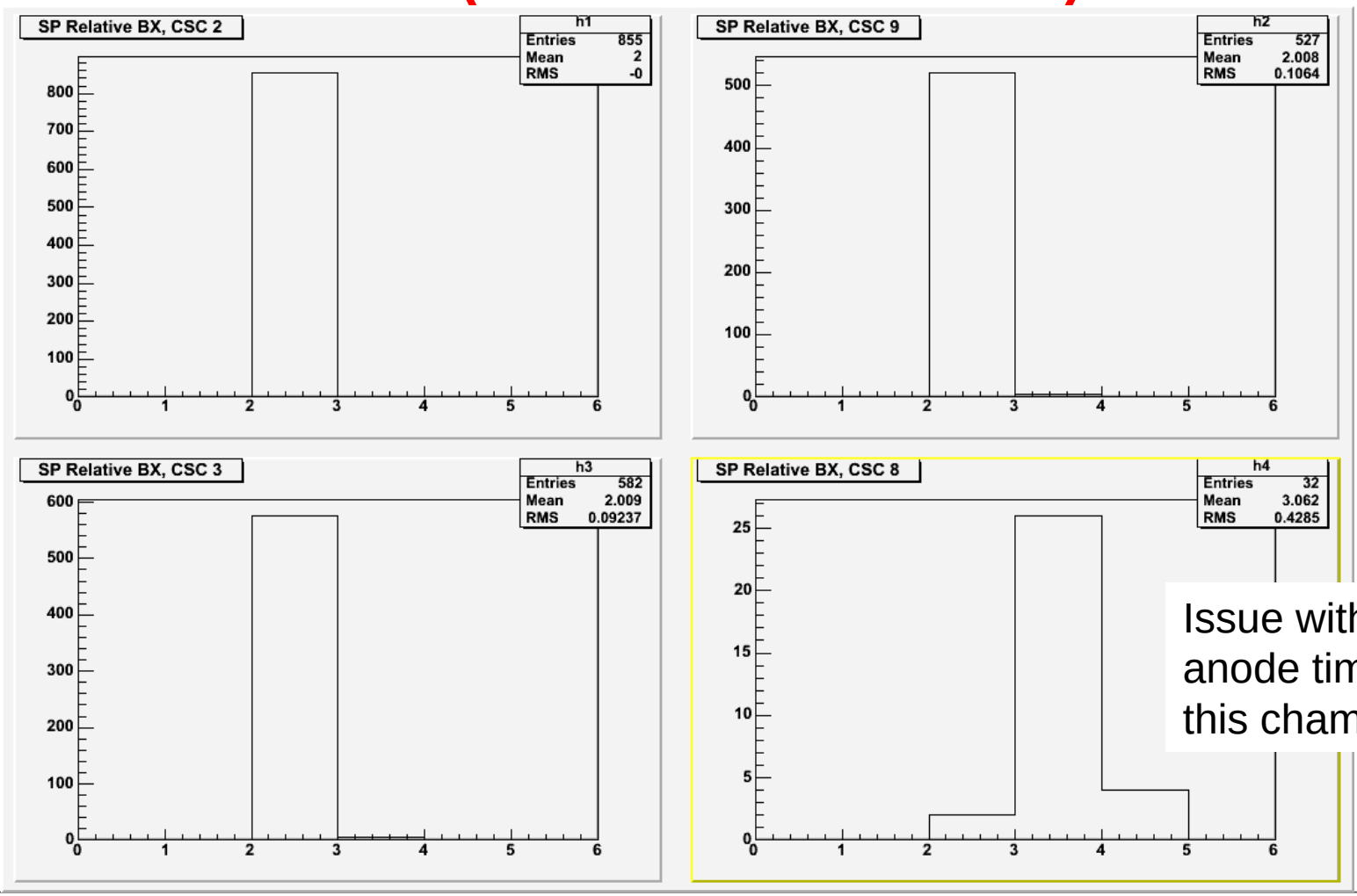
Run 380



"Phi" was set equal to ½-strip units in each CSC, with alignment corrections applied in the SP LUTs

Time Alignment of CSC data in Track-Finder

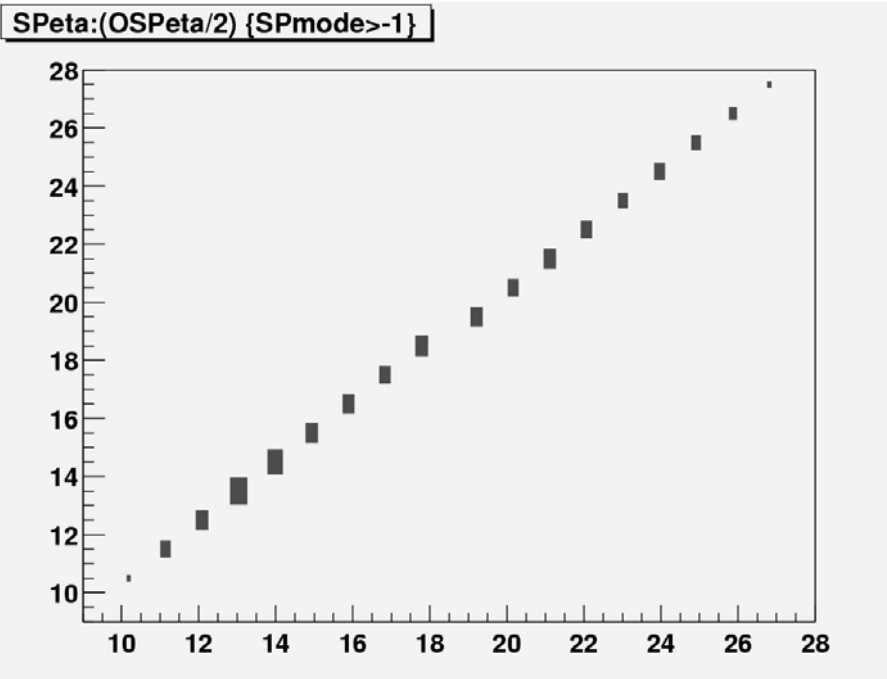
- **Able to get all trigger data from multiple chambers and crates on same BX (at least for some runs):**

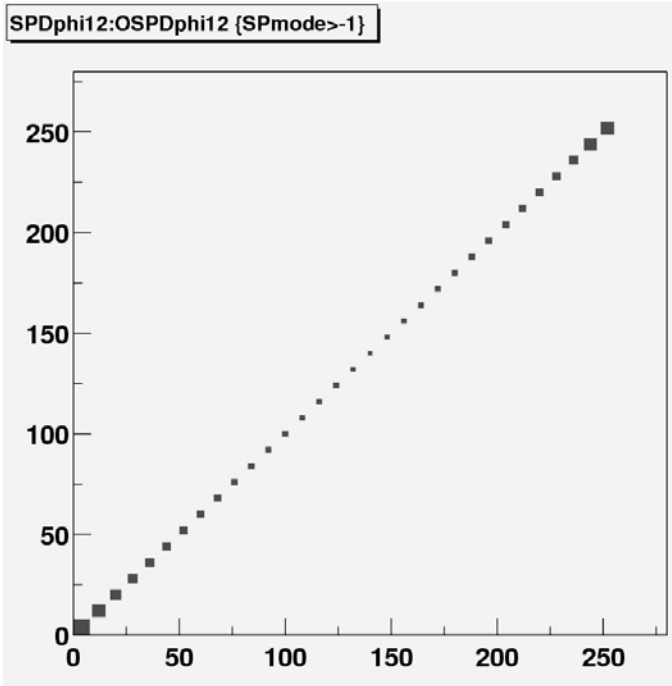


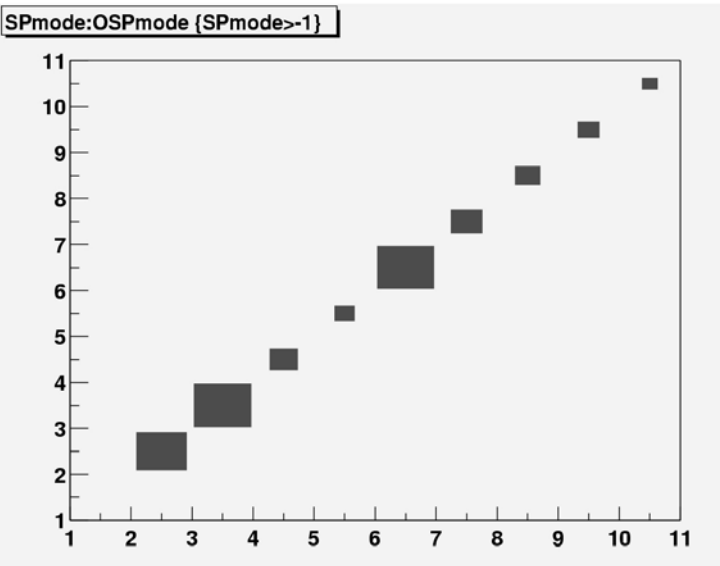
Issue with anode timing for this chamber

Run 293

SP: ORCA vs. Hardware Check







- **Check logged outputs of SP with ORCA emulation based on inputs**
- **Correlation of track η, $\Delta\phi$ between 2 stations, and track type agrees perfectly**
- **Checked with 150K events**

Track-Finder Beam Test Results

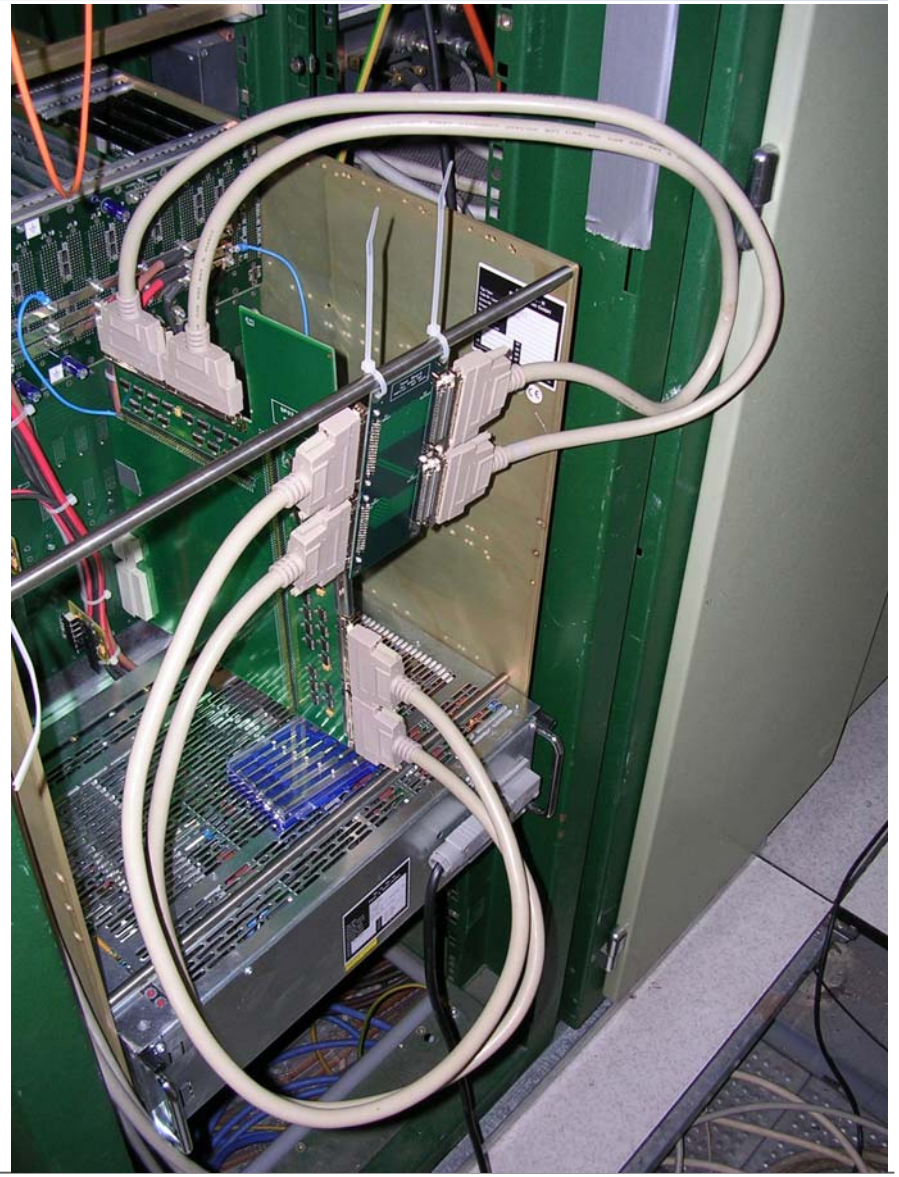
- Fully operational CSC TF tested with full data format
- Agreement between the output of the SP with a simulation based on the logged inputs is 100%
- Agreement between the recorded trigger primitive data (TMB) and received SP data is at the level of 99.7%, but worse for some chambers and runs
  - Same level of agreement as obtained from the Sep.'03 beam test
  - Likely to be due to DAQ issues from peripheral crates (data corruption from high rates)
- The SP in conjunction with a specially modified CCB was able to self-trigger the experiment (including RPC)
- Muon Sorter winner bits appear to be properly recorded
- New DT/CSC transition card works

October Beam Tests

- **Will repeat and further refine system tests during October 25 ns beam test period at the H2 beam line**
- **Combined HCAL/EMU beam test**

DT/CSC Transition Card Test

- **In June '04 we tested a new DT/CSC transition card for the Track-Finder**
  - **New design solves connector space problem**
  - **Tester board allows loopback test without DT Track-Finder**
  - **Data pumped from input FIFO to output FIFO on SP**
- **Data test succeeded, except for 1 broken backplane pin**
- **Next step:**
  - **Second integration test with DT TF (Oct.'04 or later)**



SP Production and Test Schedule

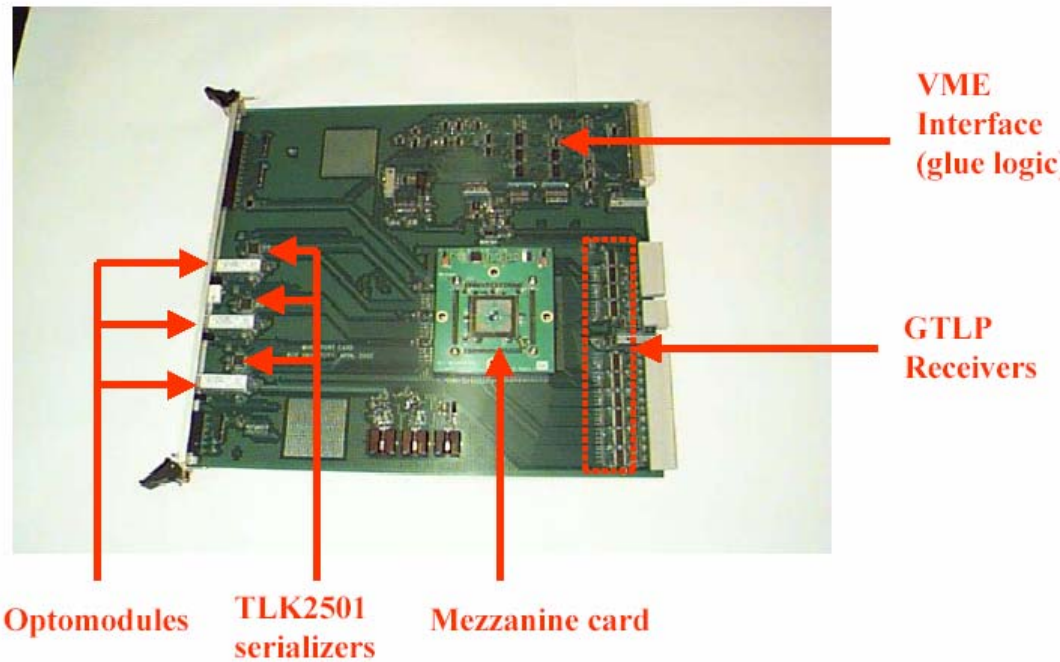
- Schematics for final design modifications completed
- Routing modifications submitted to vendor, about 2 weeks to complete
- Production to commence in October:
  - Will assemble 2 boards first as pre-production prototypes and test before launching full production
    (12 SR/SP + 4 spares + parts for 3)
  - Tests of initial samples expected to take 1 month
  - Rest of production completed by Feb.'05
- Testing of SP production boards completed by Apr.'05
- Full TF crate integrations tests (with Muon Sorter) completed by June '05
- Ready for tests at CERN June '05
  - 6 months later than milestone

SP Cost Estimate

- **Detailed cost estimate performed**
  - **FPGAs: $4.1K/board**
    - **Main FPGA: $1.1K/chip, 20 procured with TMB order**
    - **Others + EPROMs: $3.0K**
  - **Optics: $1.4K/board**
    - **Working on ordering remaining quantity of original part # (Pin compatible replacement also available, but not tested)**
    - **TLK included**
  - **Misc: $2.0K/board**
    - **Includes LUTs, mezzanine and transition cards**
  - **Setup, Fab., Ass.: $2.5K/board**
    - **Main board + mezzanine + transition cards**
- **Estimated total: $10K/board, $190K total**

MPC Status and Test Results

- 6 boards were built in 2002, all equipped with FPGA mezzanines
- Have been tested on the bench
- Have been tested with 7 Trigger Motherboards and one Sector Processor
- Have been checked in the peripheral crates at the beam test at CERN in September 2003 and June 2004
- Have been tested under irradiation at UC Davis cyclotron



MPC Production and Testing Plans

- Need to make ~20 changes in schematic/layout, add 4-5 small chips to VME interface. List of changes is being prepared

- Design documentation is available on the web at
  http://bonner-ntserver.rice.edu/cms/projects.html#mpc, including
  - specification
  - schematics
  - configuration file for EPROM

- 70 MPC motherboards will be built and assembled (including 15% spare)
  - will order ~5% more components for future repairs

- In-house testing (Matveev, Lee, Tumanov)
  - will use two crates and run testing patterns from TMBs through MPC to SP
  - software is under development (including convenient GUI)

- Burn in 24 hours at 60..70 C then test again (intend to use OSU oven)

MPC Cost and Production Plans

MPC main board

- **Components …… $1025 x 70 = $71,750**
- **Services (PCB & front panel fabrication, assembly)... $500 x 70 = $35,000**

Mezzanine card

- **Components and services for 70 cards (assembly, test at UCLA) ... $65,970**

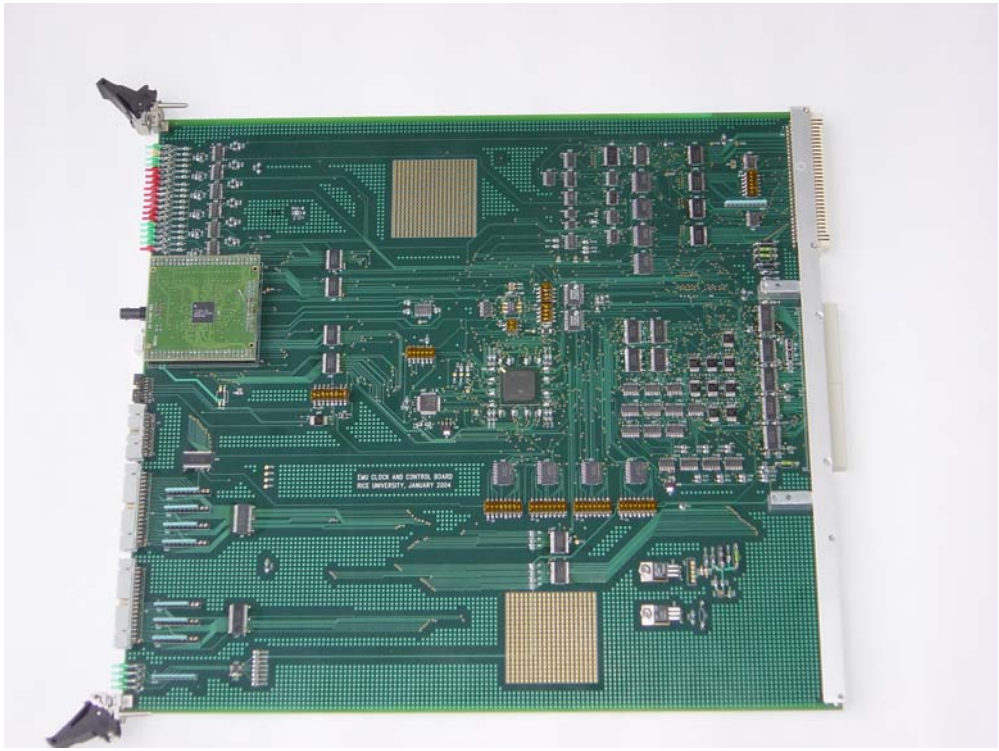
Total…… $172,720

Make schematic/layout changes and build 3 sample boards… Oct - Dec 2004
Order all components …… Oct - Dec 2004
Assemble/Test 3 sample boards …… Jan - Feb 2005
Need to test this sample with 9 TMB's in the production peripheral crate
If OK fabricate the rest 67 boards …… March 2005
Assemble and test 67 boards …….. April – Aug 2005

8 months later than milestone

CCB Status and Test Results

- 6 boards were built in spring of 2004, all equipped with the TTCrq mezzanines
- Have been tested on the bench
- Have been tested with (almost) fully loaded peripheral crate
- Have been checked in the peripheral crates at the beam test at CERN in June 2004
- Have been tested under irradiation at UC Davis cyclotron



CCB Production and Testing Plans

- Need to make ~10 minor changes in schematic/layout. Do not expect to add or remove any active components on board.

- Design documentation (specification, schematics, configuration file for EPROM) is available on the web at
  http://bonner-ntserver.rice.edu/cms/projects.html#ccb

- 70 boards will have to be built and assembled (including 15% spare)
  - will order ~5% more components for future repairs
  - TTCrq mezzanines have been ordered from CERN, expect by December

- In-house testing (Matveev, Lee, Tumanov)
  - need just a short chain (TTCvi/vx+CCB+MT) to test the functionality
  - may use small 9U crate and run a program similar to irradiation test
  - need to enhance this program including convenient GUI

- Burn in 24 hours at 60..70 C then test again (intend to use OSU oven)

CCB Cost and Schedule for Production

- **Components (including TTCrq mezzanine)…….. $530 x 70 = $37,100**
- **Services (PCB & front panel fabrication, assembly)…. $500 x 70 = $35,000**

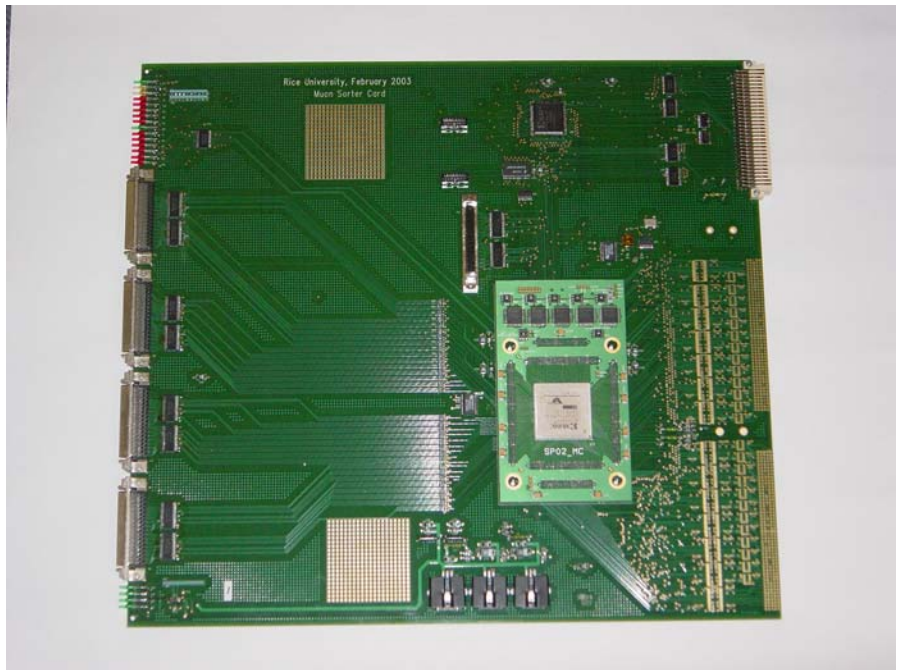
Total……. $72,100

Make schematic/layout changes and build 3 sample boards… Sept - Nov 2004
Order all components ……. Sept - Nov 2004
Assemble/Test 3 sample boards ……. December 2004
Would like to test this sample with the production peripheral backplane and crate
If OK fabricate the rest 67 boards ……. January 2005
Assemble and test 67 boards …….. Feb – June 2005

6 months later than milestone

Muon Sorter Current Status and Tests

- 4 boards were built in 2003, 3 boards are completely assembled
  - Need only 1 in final system
- Have 2 mezzanines assembled
- Two MS boards with mezzanines have been tested on the bench
- Have been tested with Sector Processor prototype
- Have been checked in the Track Finder crate during beam test at CERN in June 2004
- Do not require irradiation test



MS Production and Testing Plans

- **Design documentation is available on the web at**
  http://bonner-ntserver.rice.edu/cms/projects.html#ms, including
  - **specification**
  - **schematics**
  - **configuration file for EPROMs**

- **Need more tests with at least 2 SP and/or 12 Muon Tester cards (until December of 2004)**

- **Need to test with the GMT receiver card (never been done before). This fall or early next year?**

- **Plan to complete all tests by summer 2005.**

- **Based on results, we should decide if the final PCB should be built (currently have 5-6 minor PCB fixes).**

MS Cost Estimate

MS main board

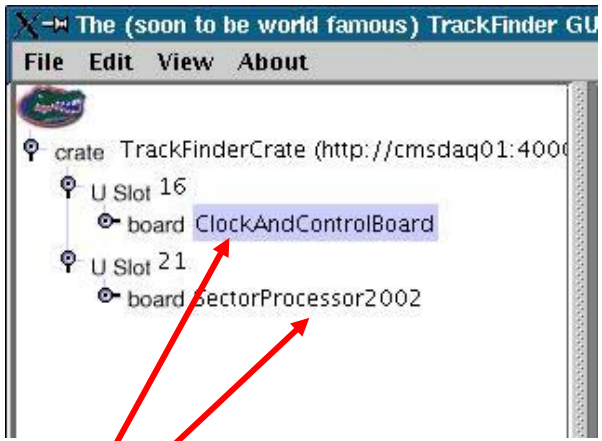
- **Components …….. < $1000**
- **Services (PCB & front panel fabrication, assembly)…… < $1000**

Mezzanine card

- **Components and services (FPGA, assembly) …… $2500**

CSC Track-Finder Configuration & Testing

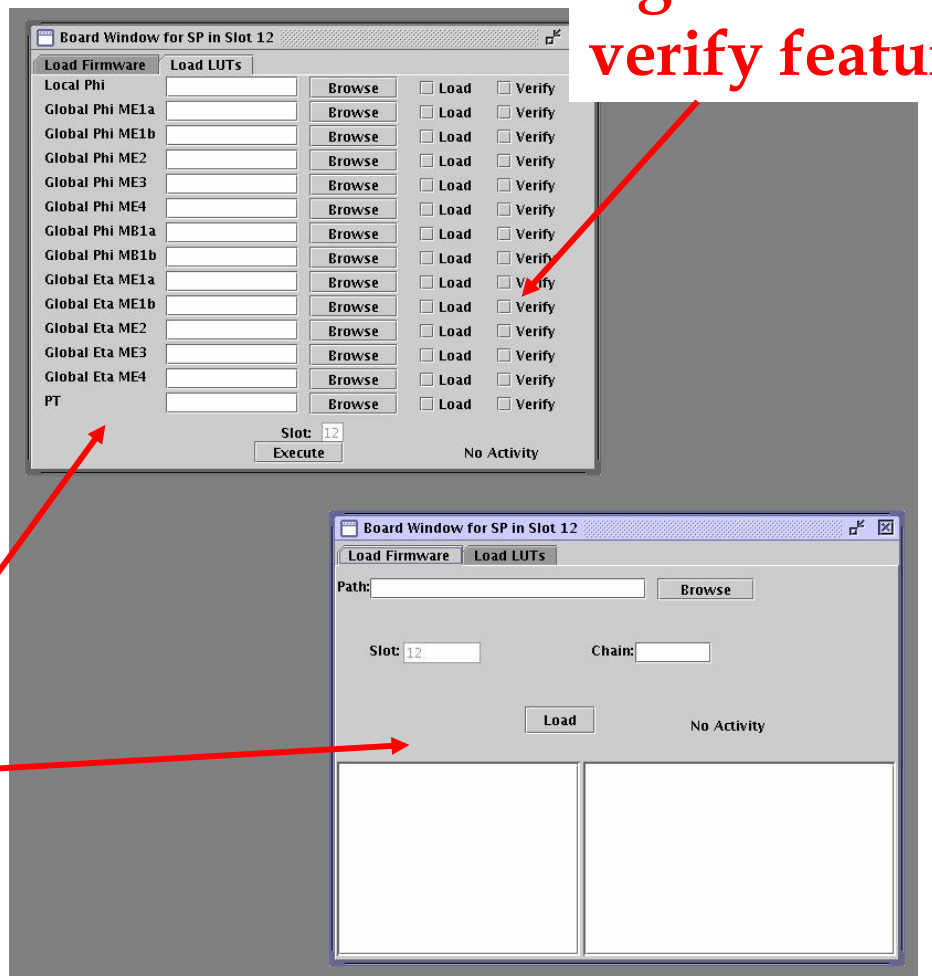
Java interface to XDAQ-based software framework



Boards

Higher level SP02 command panel windows

e.g. LUT tests have verify feature



The Integrated EMU GUI

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

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

DB calls to store configuration parameters

Evolving to become a Slicetest control