WBS 3.1 - Trigger

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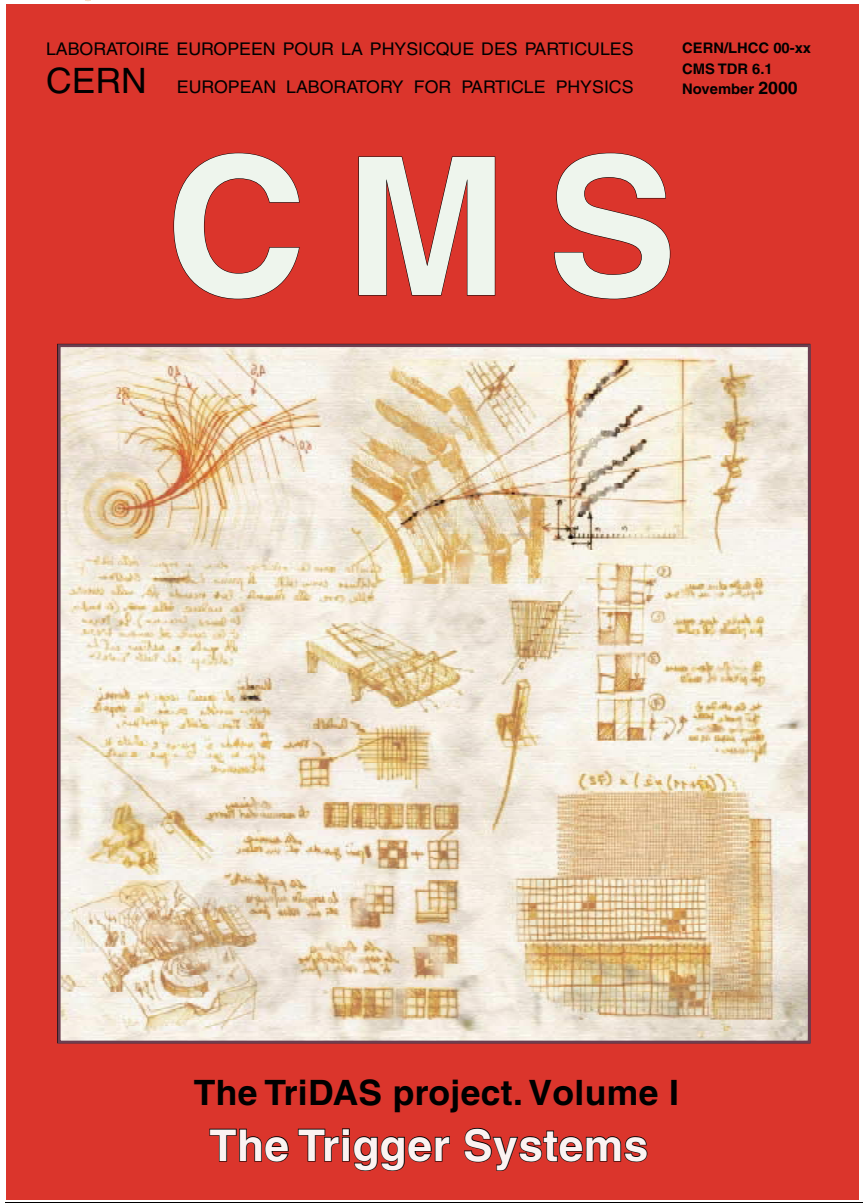
CMS Trigger Project Manager

DOE/NSF Review
May 8, 2001

Outline

- Overview of Calorimeter Trigger
- Calorimeter Trigger Status & Technical Progress
- Overview of Muon Trigger
- Muon Trigger Status & Technical Progress
- Cost & Schedule Performance
- Concerns
- Plans
- Summary and Conclusions

CMS Level -1 Trigger TDR



CMS Level 1 Milestone

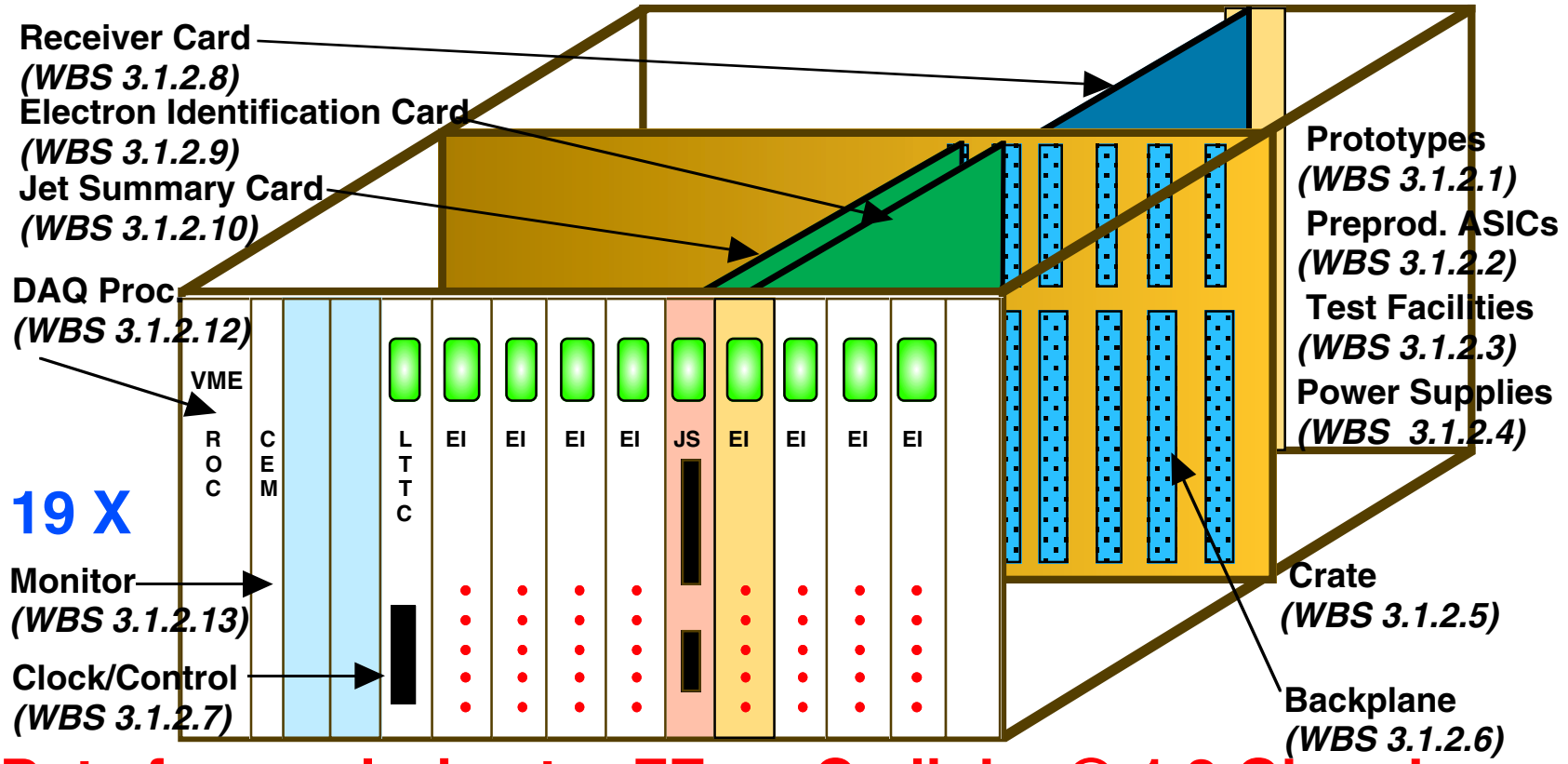
Submitted to LHCC on Nov. 28, 2000: CERN/LHCC 2000 - 38 CMS TDR 6.1

Approved in March, 2001.

http://cmsdoc.cern.ch/cms/TDR/TRIGGER-public/trigger.html

Regional Calorimeter Crate

(WBS 3.1.2)



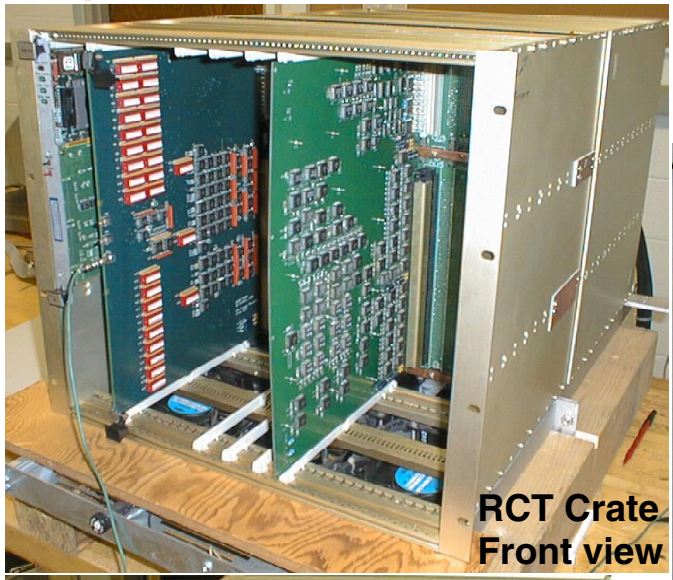
Data from calorimeter FE on Cu links @ 1.2 Gbaud (ptyp. tstd.)

- Into 152 rear-mounted Receiver Cards (ptyp. tstd. w/ ASICs)

160 MHz point to point backplane (ptyp. tstd.)

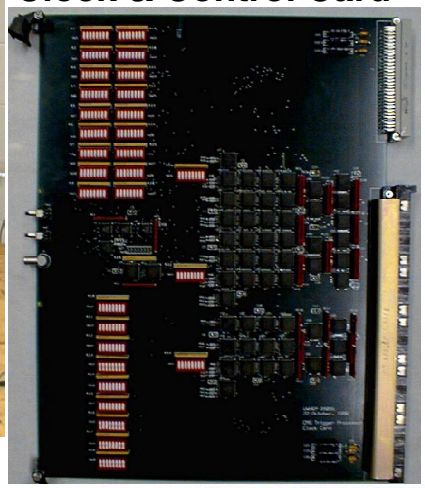
- 19 Clock&Control (ptyp. tstd.), 152 Electron ID (ptyp. tstd.)
  19 Jet/Summary, Receiver Cards operate @ 160 MHz

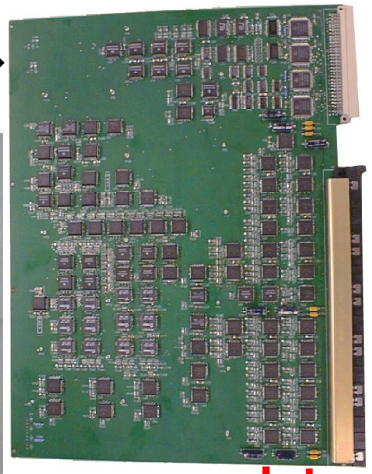
Regional Cal. Trig. Prototypes



Electron ID Card→

Clock & Control Card





All Tests Passed

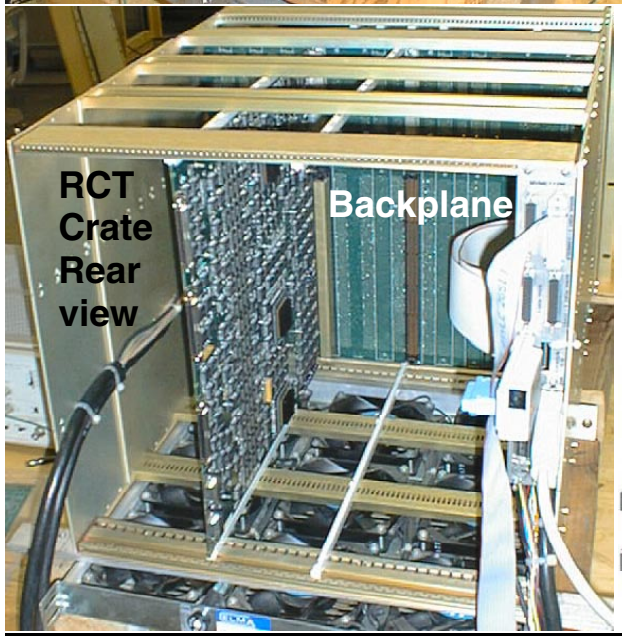
Intercrate sharing checked

Timing checked

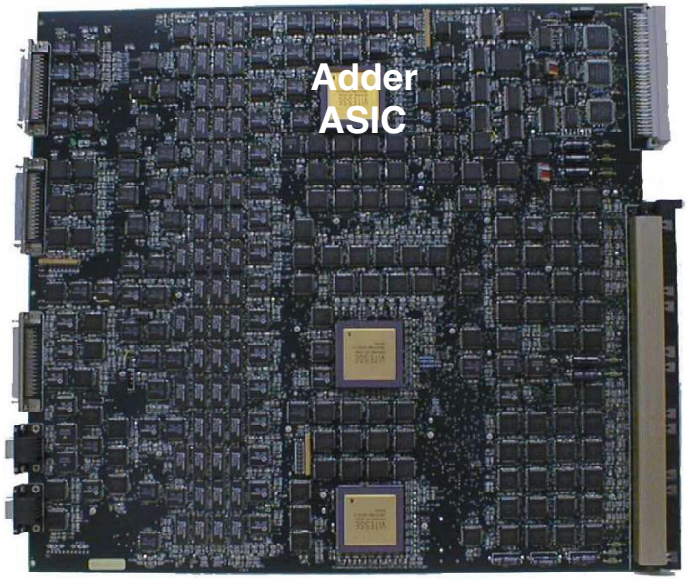
Adder ASIC fully qualified for production

Full 160 MHz dataflow verified

VME checked



Receiver Card ↓



Calorimeter Trigger Status

Successful Prototyping Program

- Crate, 160 MHz Backplane & Clock Card
- Receiver & Electron Isolation Cards tested
- Adder ASIC tested & production finished
- Links: 4x1Gbit on Cu* ECL x 20 m tested

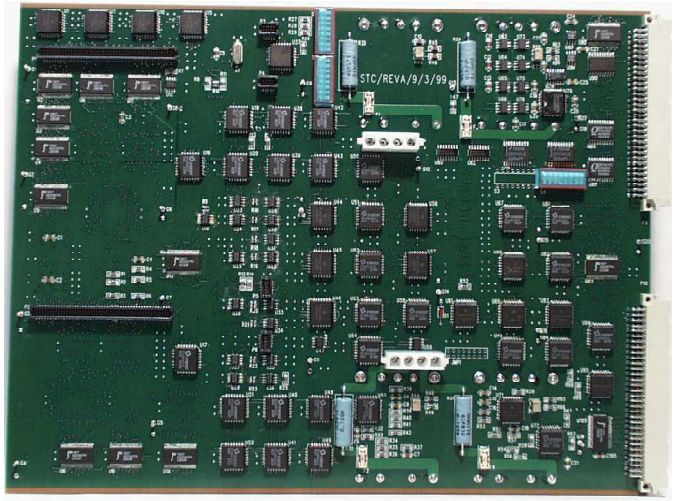
ASIC prototype development finished

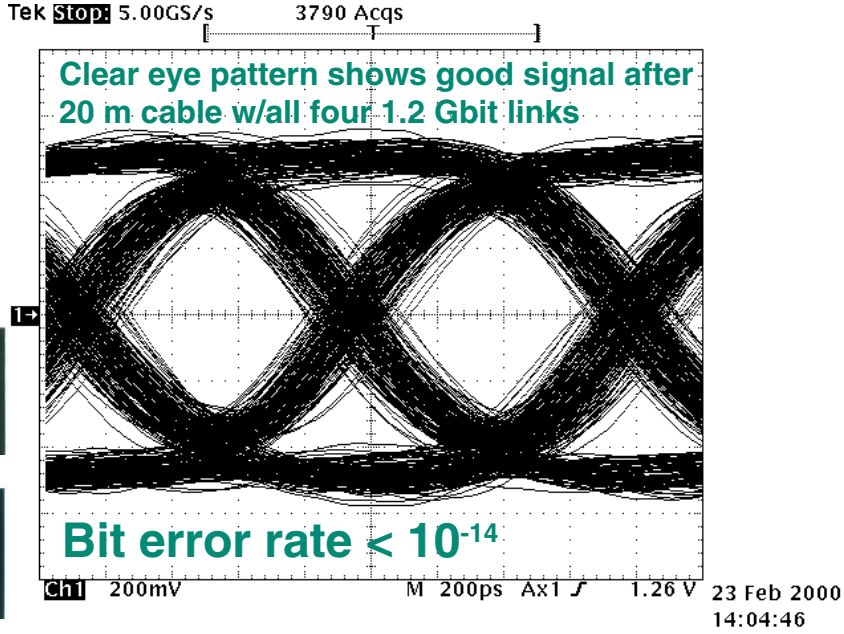
- Phase & Boundary Scan protos delivered
- Isolation & Sort protos manufactured

Testing Program Plans

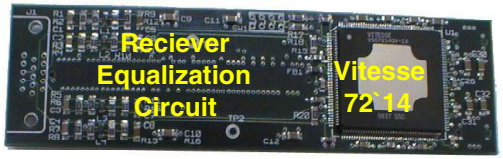
- Next generation Backplane finished
- Next generation Receiver, Elect. Iso.
- Test remaining ASIC prototypes

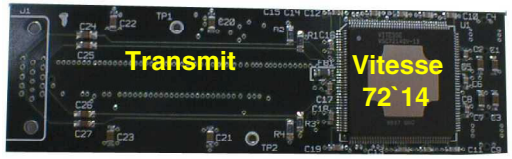
*Gbit Serial Cu Link Cards & test results:





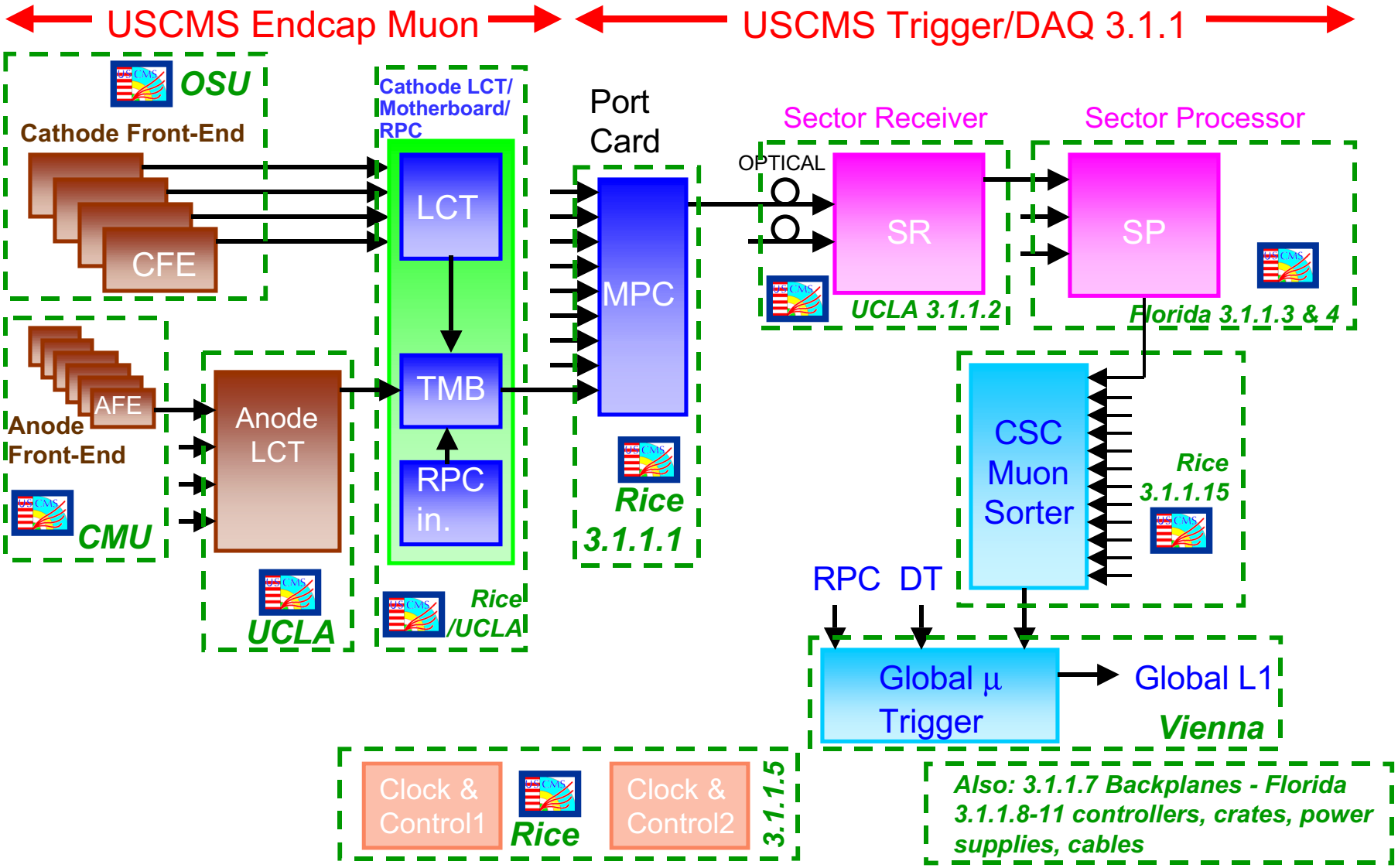
Mezzanine Card (Top view)



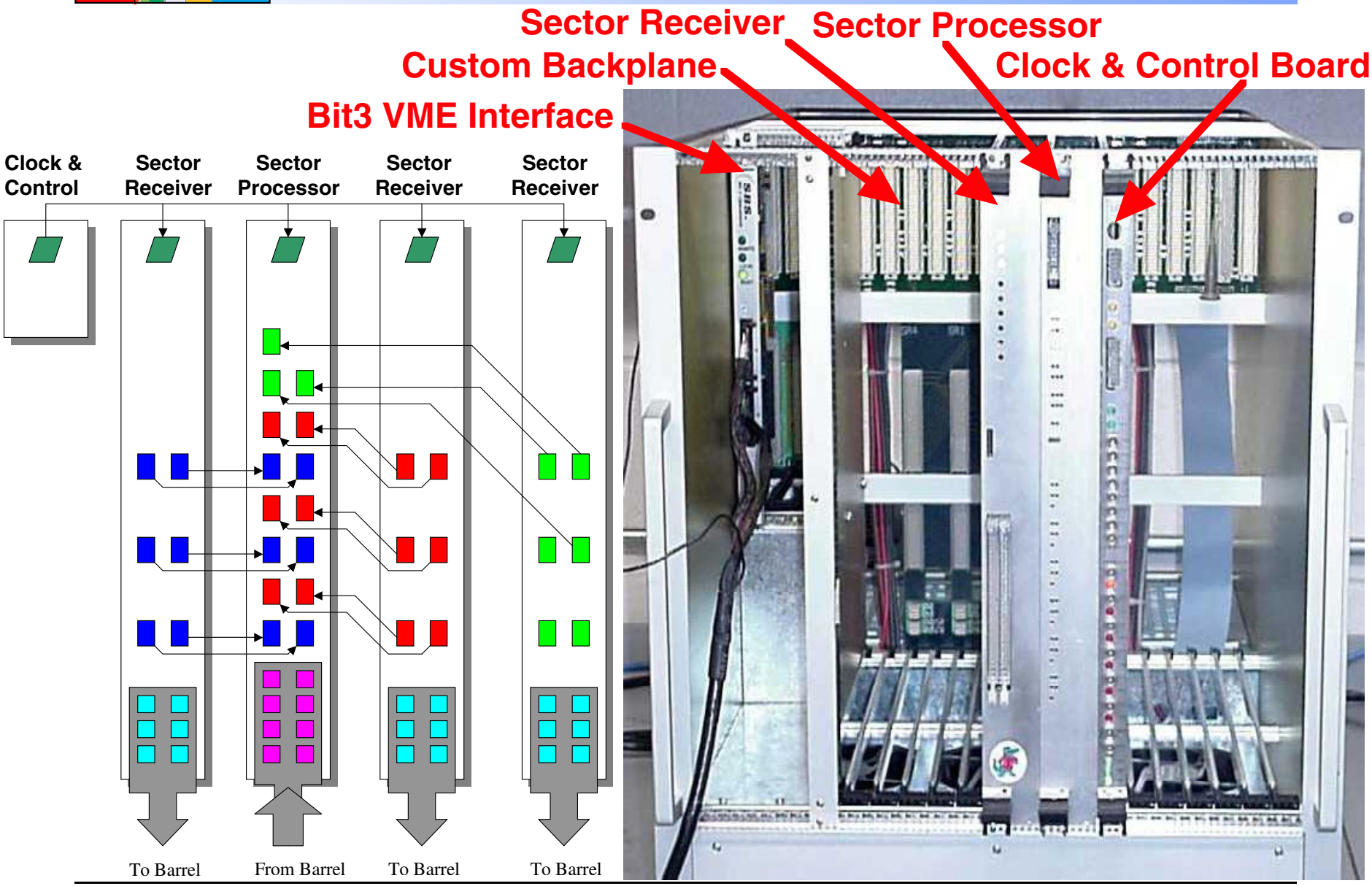


Mezzanine Card (Bottom view)

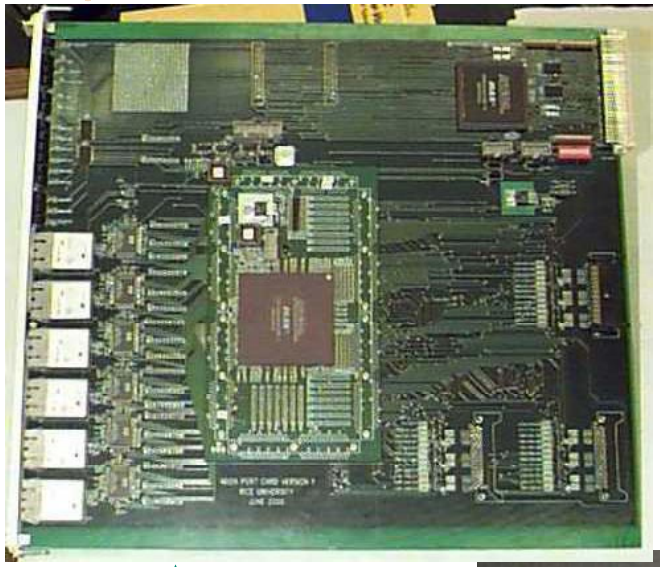
CSC Muon Trigger
(WBS 3.1.1)

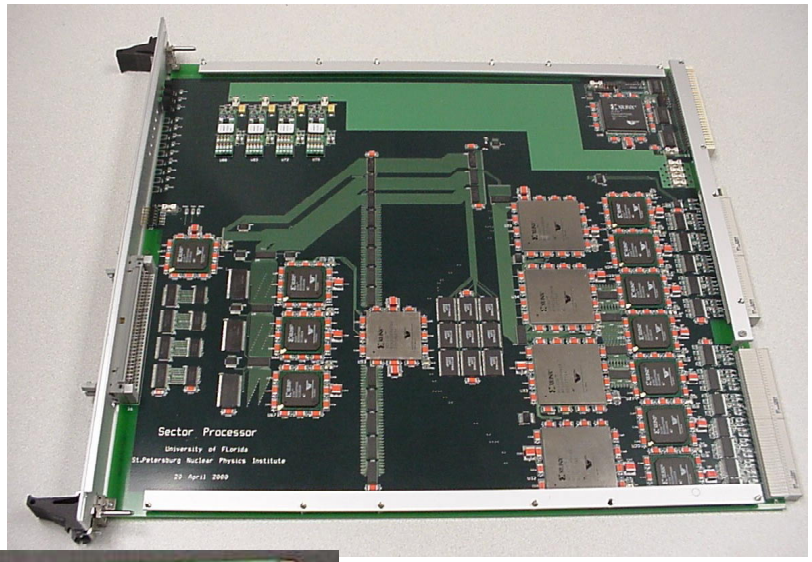


CSC Track Finder Crate



CSC Trigger Protos Tested

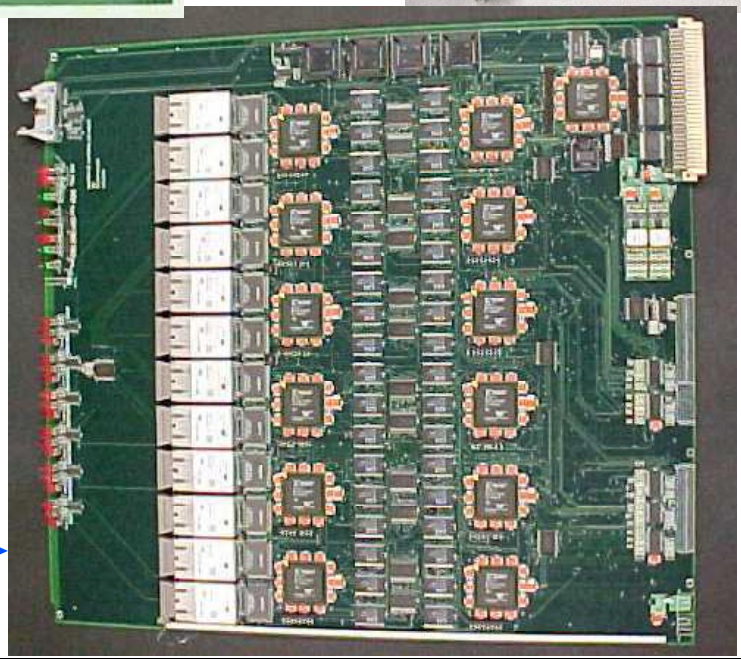




Muon Port Card (Rice)

Dataflow verified, incl. optical link

Sector Receiver (UCLA)



Sector Processor (U. Florida)

All logic tested & agrees with ORCA simulation

CSC Trig.Conclusions & Plans

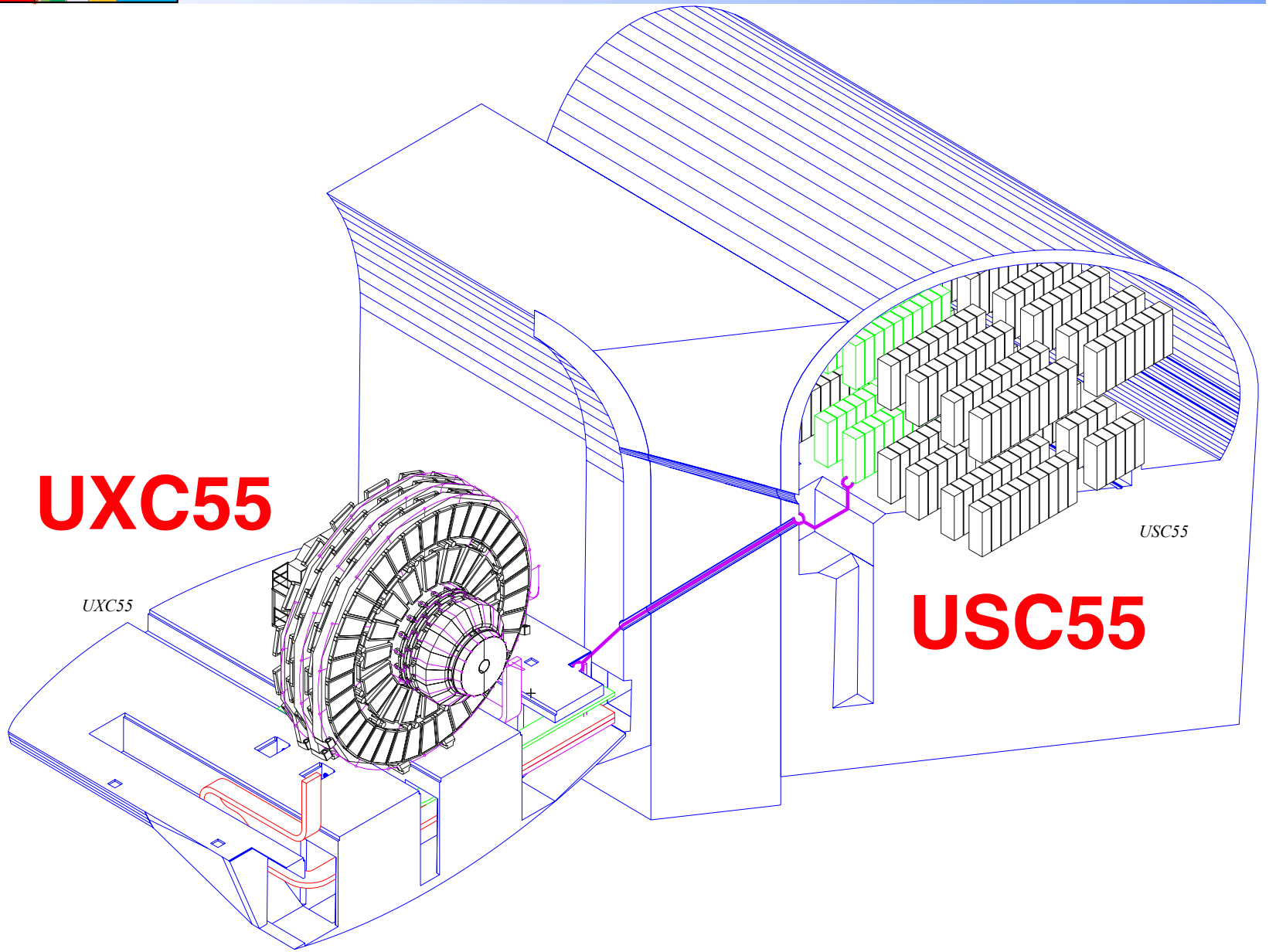
Conclusions from Test

- **Conceptually Sound Design**
- **Need to reduce latency**

Plans for This Year (review at end of May)

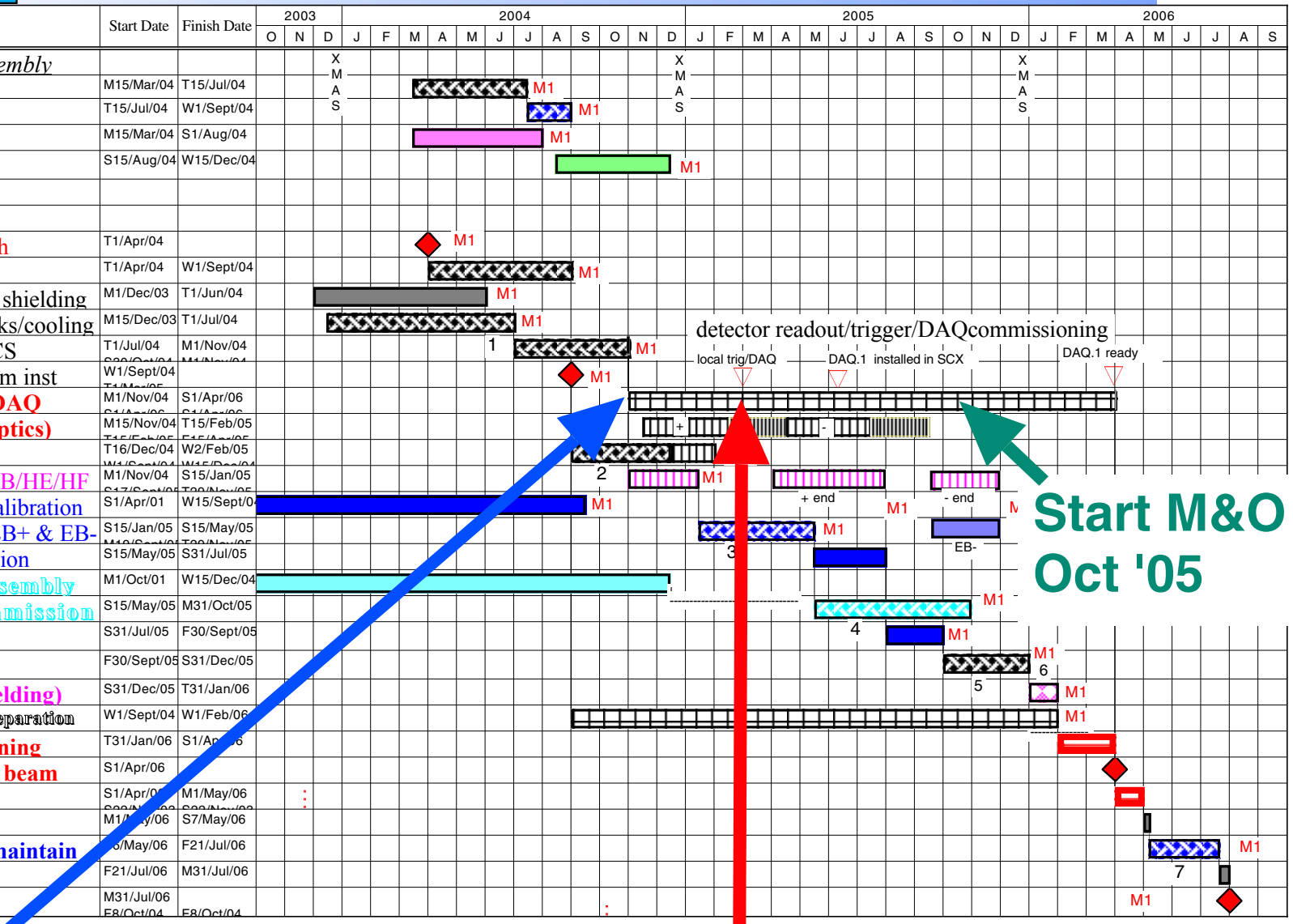
- **Replace Backplane technology with faster**
  - Channel Link -> GTLP at 80 MHz
  - New prototype backplane tested at Florida
- **New Compact Single Crate Design**
  - Merge all 17 FPGAs of baseline design into one
  - Possible due to new FPGA technology
  - Merge Sector Receiver & Sector Processor Boards
- **New Optical Link Technology**
  - Use new 1.6 Gbit/s links with 80 MHz clock
  - Tested at Rice and Works

Trigger System Installation



CMS V31 Schedule & Trigger

Activity Name	Start Date	Finish Date
Critical path from SX assembly		
Magnet test	M15/Mar/04	T15/Jul/04
Install EB +	T15/Jul/04	W1/Sept/04
Assemble HF	M15/Mar/04	S1/Aug/04
YB-,YE- mu install (SX)	S15/Aug/04	W15/Dec/04
UX Installation		
UX Civil Engineering finish	T1/Apr/04	
Prepare UX area	T1/Apr/04	W1/Sept/04
Install floor plates & CMS shielding	M1/Dec/03	T1/Jun/04
Prepare US area (infra/racks/cooling	M15/Dec/03	T1/Jul/04
Equip US with crates, DCS	T1/Jul/04	M1/Nov/04
SCX ready for control room inst	W1/Sept/04	
Commission detectors/ DAQ	M1/Nov/04	S1/Apr/06
Cabling (heavy + fibre optics)	M15/Nov/04	T15/Feb/05
Lower major elements	T16/Dec/04	W2/Feb/05
Install HB. Commission HB/HE/HF	M1/Nov/04	S15/Jan/05
EB supermod. assembly/calibration	S1/Apr/01	W15/Sept/04
EB- install. Commission EB+ & EB-	S15/Jan/05	S15/May/05
EE/SE+ install & commission	S15/May/05	S31/Jul/05
TK manufacture & assembly	M1/Oct/01	W15/Dec/04
TK install & commission	S15/May/05	M31/Oct/05
SE- install/commission	S31/Jul/05	F30/Sept/05
Install beampipe	F30/Sept/05	S31/Dec/05
Close expt (yoke/HF/shielding)	S31/Dec/05	T31/Jan/06
Online/Offline Computing preparation	W1/Sept/04	W1/Feb/06
LHC 1-beam commissioning	T31/Jan/06	S1/Ap[illegible]6
CMS ready for colliding beam	S1/Apr/06	
LHC pilot run	S1/Apr/[illegible]	M1/May/06
Open detector	M1/[illegible]y/06	S7/May/06
Install EE-, pixels, T1 +maintain	[illegible]/May/06	F21/Jul/06
Close detector	F21/Jul/06	M31/Jul/06
Complete CMS ready	M31/Jul/06	F8/Oct/04



Trigger Tasks

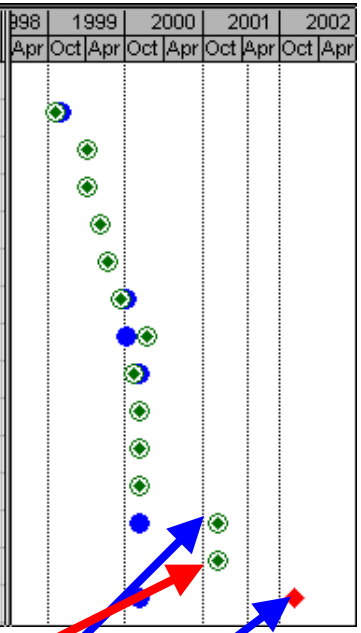
Tasks	start	finish:	
• Produce TDR	8/00	12/00	✓
• Design Final Prototypes	11/00	12/01	
• Construct Final Prototypes	6/01	6/02	
• Test/Integrate Final Prototypes	12/01	12/02	
• Pre-Production Design & Test	6/02	6/03	
• Production	12/02	6/04	
• Production Test	6/03	11/04	
• Trigger System Tests	5/04	5/05	←
• Trigger Installation	11/04	11/05	←
• Integration & Test w/DAQ & FE	3/05	9/05	←
• Maintenance & Operations	10/05	-------	←

Impact of delayed access to USC55 & UXC55:

- US EDIA cost increased by $200K -- CMS cost unchanged
  - 100K each for CSC & Regional Cal Trigger

US CMS Trigger
L1, L2, L3 Milestone Performance

System	Level?	CMS ID	Milestone	Variance	Baseline Start	Start
			Trigger System (WBS 1.3.1)	**0 days**	**NA**	**Nov 03 '98**
TRIG	ML2	D-001	Complete Initial Muon, Calorimeter, & Global Trigger Design	-19 days	Nov 30 '98	Nov 03 '98
TRIG	ML3	D-387	CSC: Sector Receiver Initial System Design Document (UCLA)	0 days	Mar 31 '99	Mar 31 '99
TRIG	ML3	D-331	TK: Sector Processor Initial System Design Document (Florida)	0 days	Mar 31 '99	Mar 31 '99
TRIG	ML3	D-388	CSC: Muon Port Card Prototype Design (Rice)	0 days	May 31 '99	May 31 '99
TRIG	ML3	D-390	CSC: Sector Receiver Prototype Design (UCLA)	-1 day	Jun 30 '99	Jun 30 '99
TRIG	ML3	D-332	TK: Sector Processor Prototype Design (Florida)	-22 days	Sep 30 '99	Aug 31 '99
TRIG	ML3	D-389	CSC: Muon Port Card Prototype Delivery (Rice)	59 days	Sep 30 '99	Dec 31 '99
TRIG	ML2	D-002	Complete Phase 1 Prototype Design	-20 days	Nov 30 '99	Nov 02 '99
TRIG	ML3	D-212	Review of Test of Trigger Primitives - 2 Tower Proto Board	0 days	Nov 30 '99	Nov 30 '99
TRIG	ML3	D-221	Review of Test of Regional Trigger - Proto Board and ASICs	0 days	Nov 30 '99	Nov 30 '99
TRIG	ML3	D-240	Review of Calorimeter Trigger Control and Readout Software	0 days	Nov 30 '99	Nov 30 '99
TRIG	ML3	D-231	Design of Final Sort ASIC	251 days	Nov 30 '99	Nov 30 '00
CMS1	ML1	D-004	Submit Trigger Technical Design Report (TDR)	0 days	Nov 30 '00	Nov 30 '00
TRIG	ML3	D-250	Review of Integration of Calorimeter Trigger Prototypes (Palaise	502 days	Nov 30 '99	Nov 30 '01

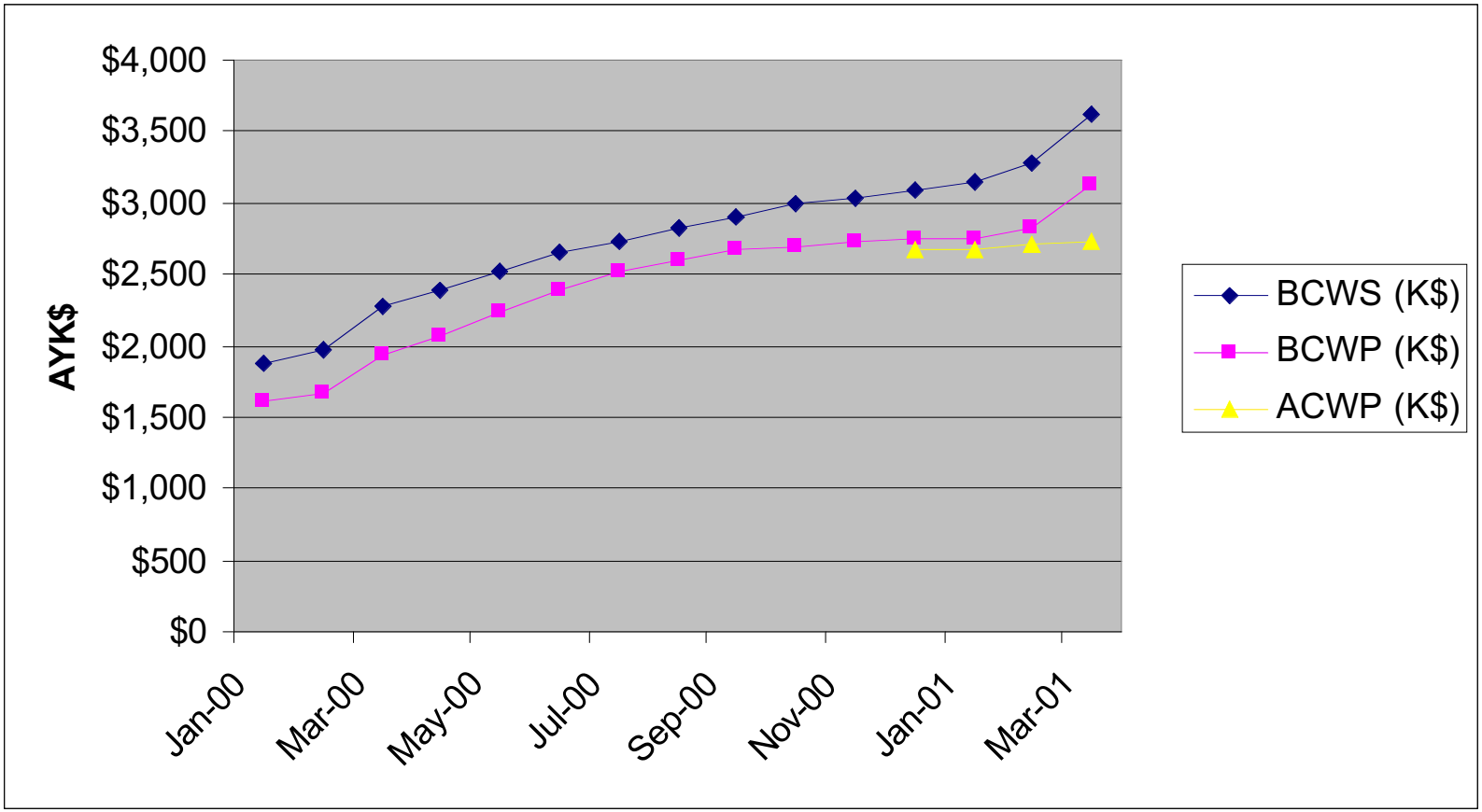


Comments:

Major L1 Milestone: Trigger TDR on Time!

- **Milestone for SORT ASIC start compensated by faster finish**
- **Integration waiting for ECAL electronics**
- **Extra slack in schedule due to delayed installation**

US CMS Trigger
BCWS, BCWP, & ACWP

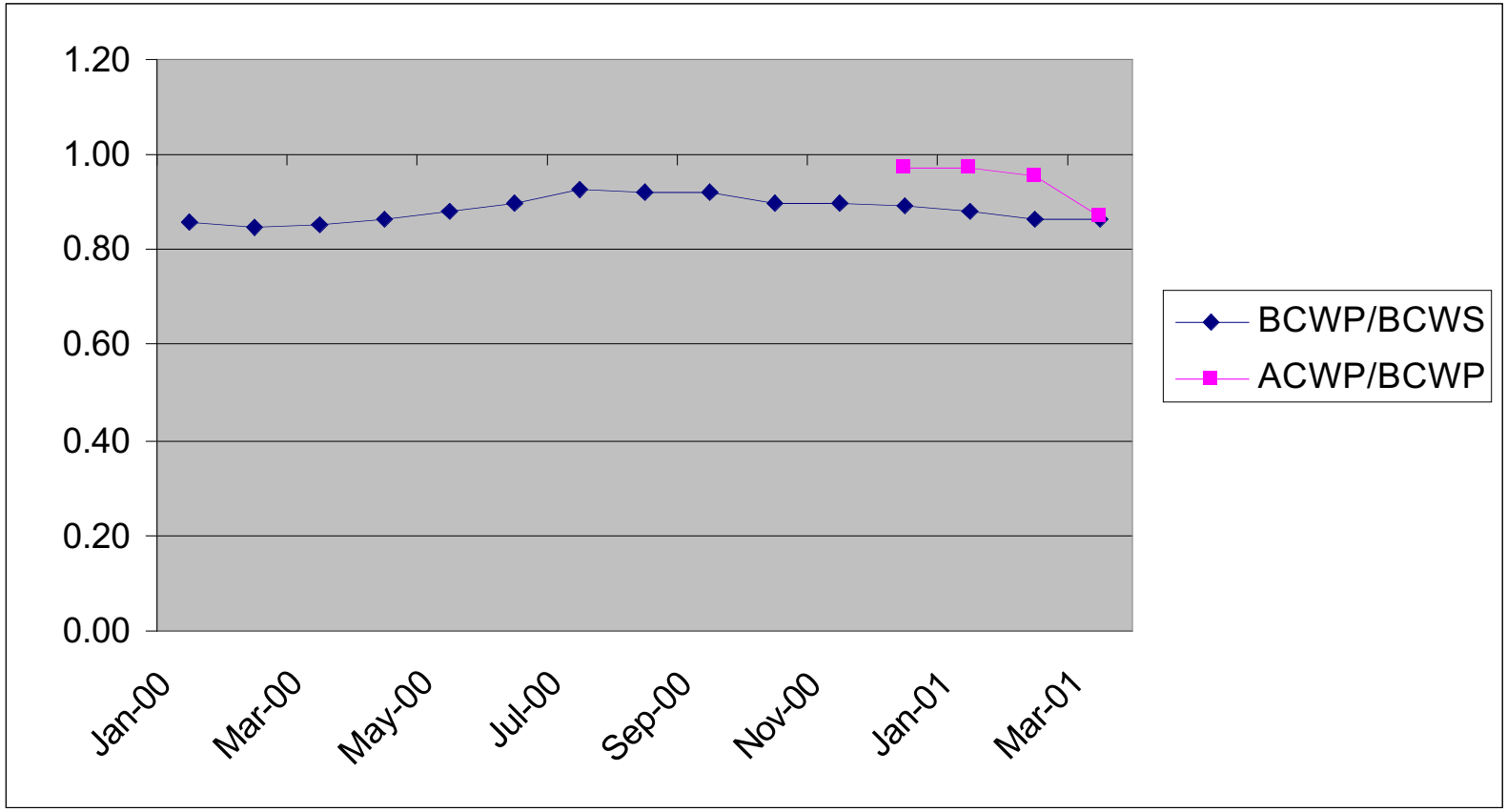


Project tracking tools in place and in use

Consistent with overall schedule picture

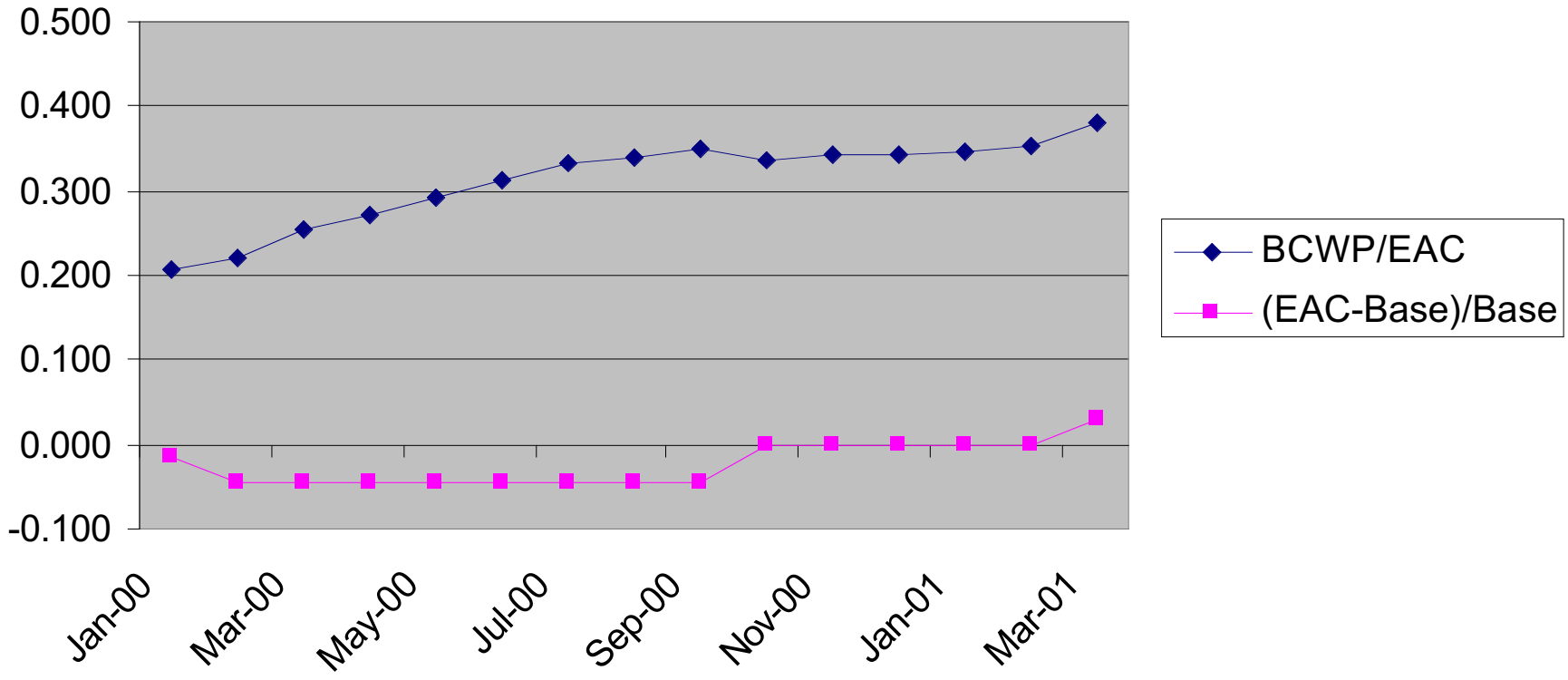
(see next slide)

US CMS Trigger Sch. & Cost Performance



- **New Compact Muon track-finder design**
  - Will be built faster
- **Need for new Serial Link Design**
  - Replace Vitesse 7214 with 7216 -- Done

US CMS Trigger (% Comp., Cont. Use)



Negligible contingency use thus far

- **Some ASICs purchased early**

Concerns

Installation Schedule

- New schedule has reduced installation time
- Significant time needed for integration in a synchronous pipelined system.

Base Program Manpower

- Major effort on trigger software required
  - Tasks include monitoring/controls, diagnostics, configuration downloading and documentation, modeling, physics simulation, etc.
- Major effort on testing & installation
  - Planned as activity of base program manpower

Plans for this year

Muon Trigger:

- **Assuming successful review of new technology:**
  - Excellent results from all tests thus far
- **Develop new compact single crate design**
- **Design 2nd generation prototype boards based on successful prototype boards already tested.**

Calorimeter Trigger

- **Next generation Receiver, Elect. Iso. Cards**
- **Test with already built next generation backplane**
- **Test remaining ASIC prototypes**
  - Mounted on Receiver, Elect. Iso. Cards

Conclusions - Trigger

Calorimeter Trigger Prototype Program

- Serial Link tests successful and final serial link card designed
- New Backplane built for revised algorithms
- New Clock Board & Receiver Card Designed

Muon Trigger Prototype Program

- Successfully tested Port Card, Sector Receiver, Sector Processor, Backplane, Clock Board
- Track-finder integration test works with all the above boards using detailed CMS simulation data