CMS
Trigger Control & Distribution System overview

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CERN-PH-ESE & CERN-PH-CMD

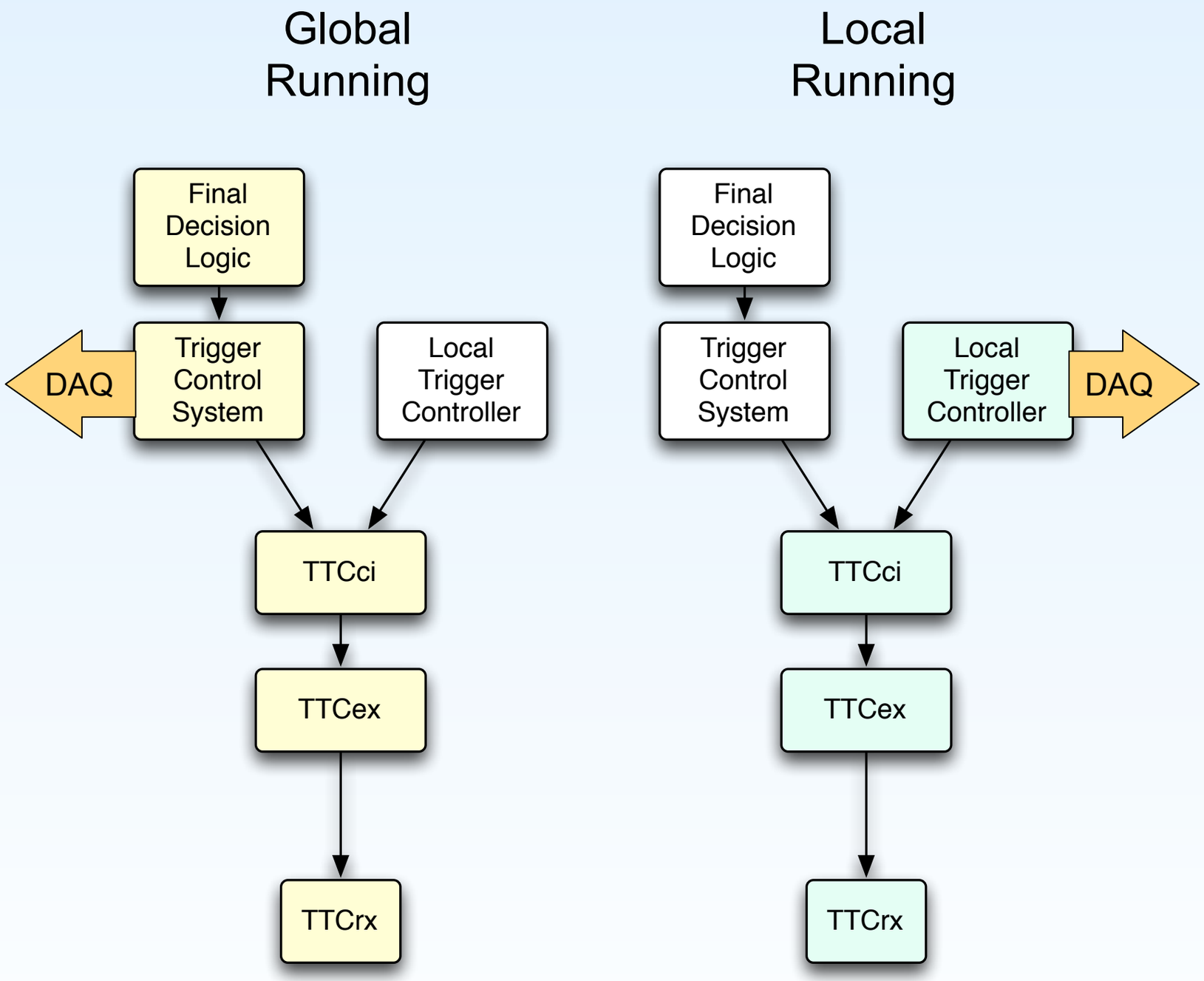
Why TCDS, why now?

- CMS does not have enough partitions available in the existing system to service all requests coming out of LS1
  - 32 currently available are all in use
  - 40 partitions requested
    - e.g. New sub-detectors, upgrades running in parallel, ...
- Upgrade of CMS Global Trigger (GT) provides opportunity to revisit functional split
  - Physics Event Selection (FINOR)
  - Trigger Control System
  - Trigger and Timing Distribution

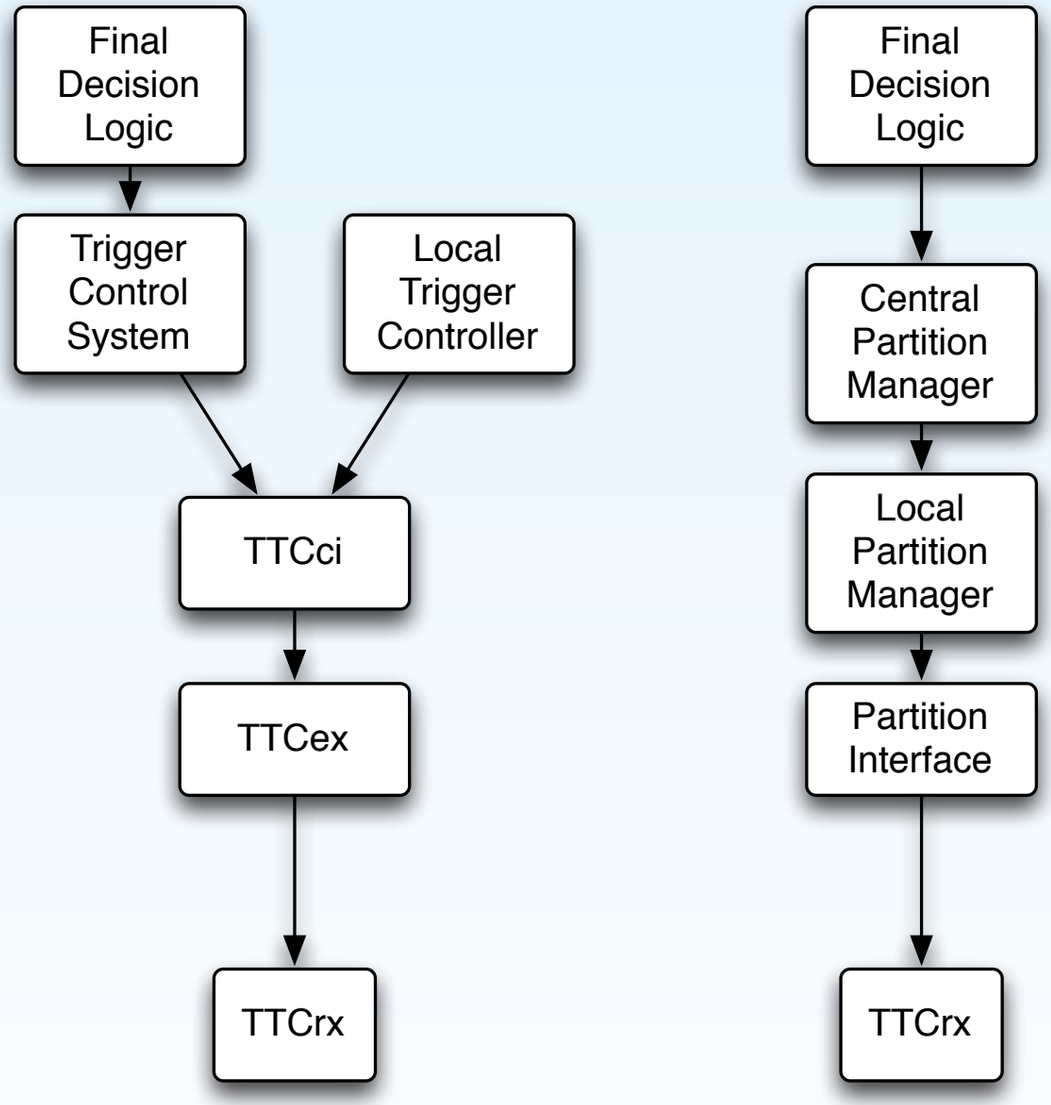
  ] Existing

  ] Upgrade
- Upgrade provides opportunity for new functionality
  - LumiDAQ (non-event data) synchronization

Operation of existing system



TCDS system Board overview



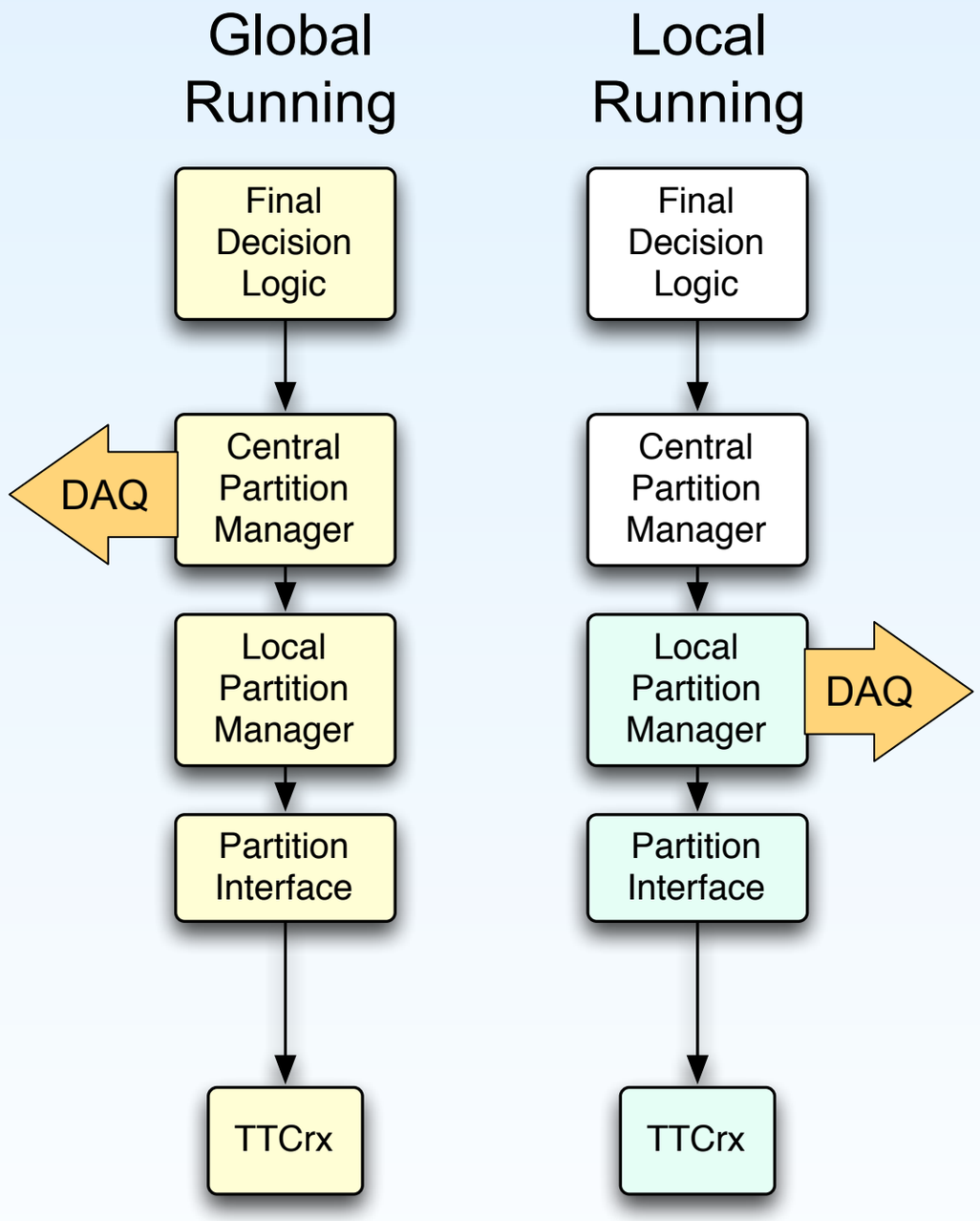
Takes Functionality of TCS

Combines Functionality of LTC and TTCci

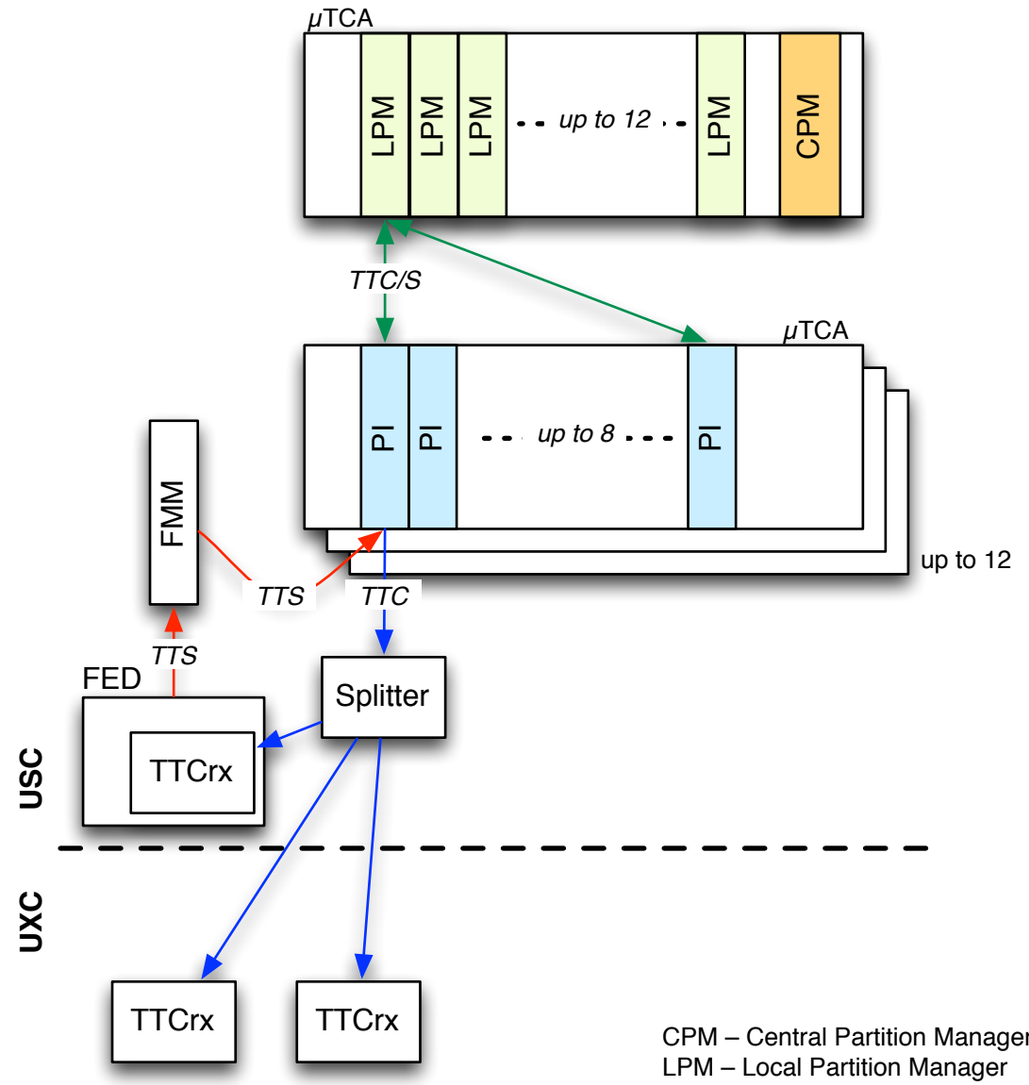
Bi-directional TTCex and FMM

TCDS to leverage µTCA system features

TCDS system operation



TCDS System Diagram

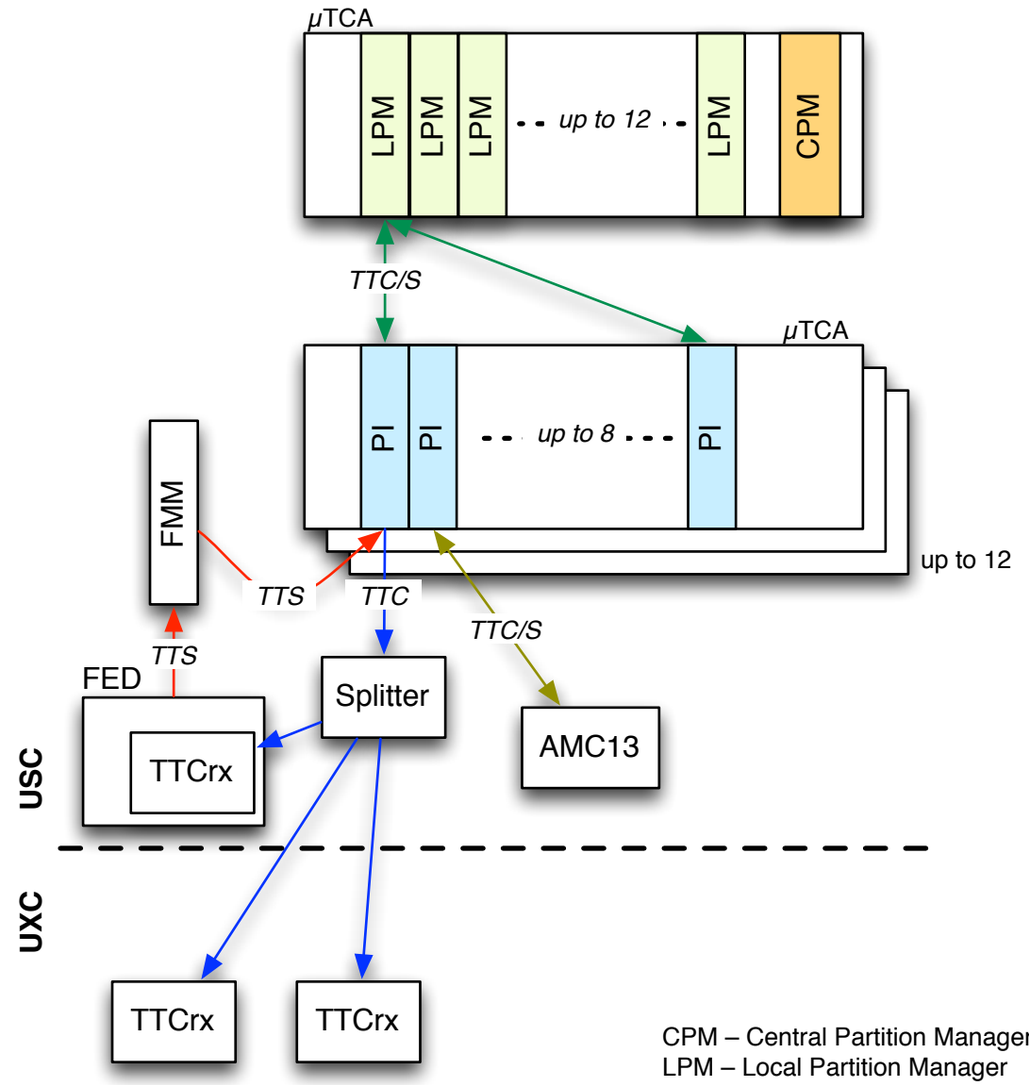


FMM – Fast Merging Module

CPM – Central Partition Manager
LPM – Local Partition Manager
PI – Partition Interface

TTC – Timing, Trigger & Control
TTCrx – TTC Receiver ASIC
TTS – Trigger Throttling System

TCDS System Diagram



AMC13 – CMS µTCA readout board

FMM – Fast Merging Module

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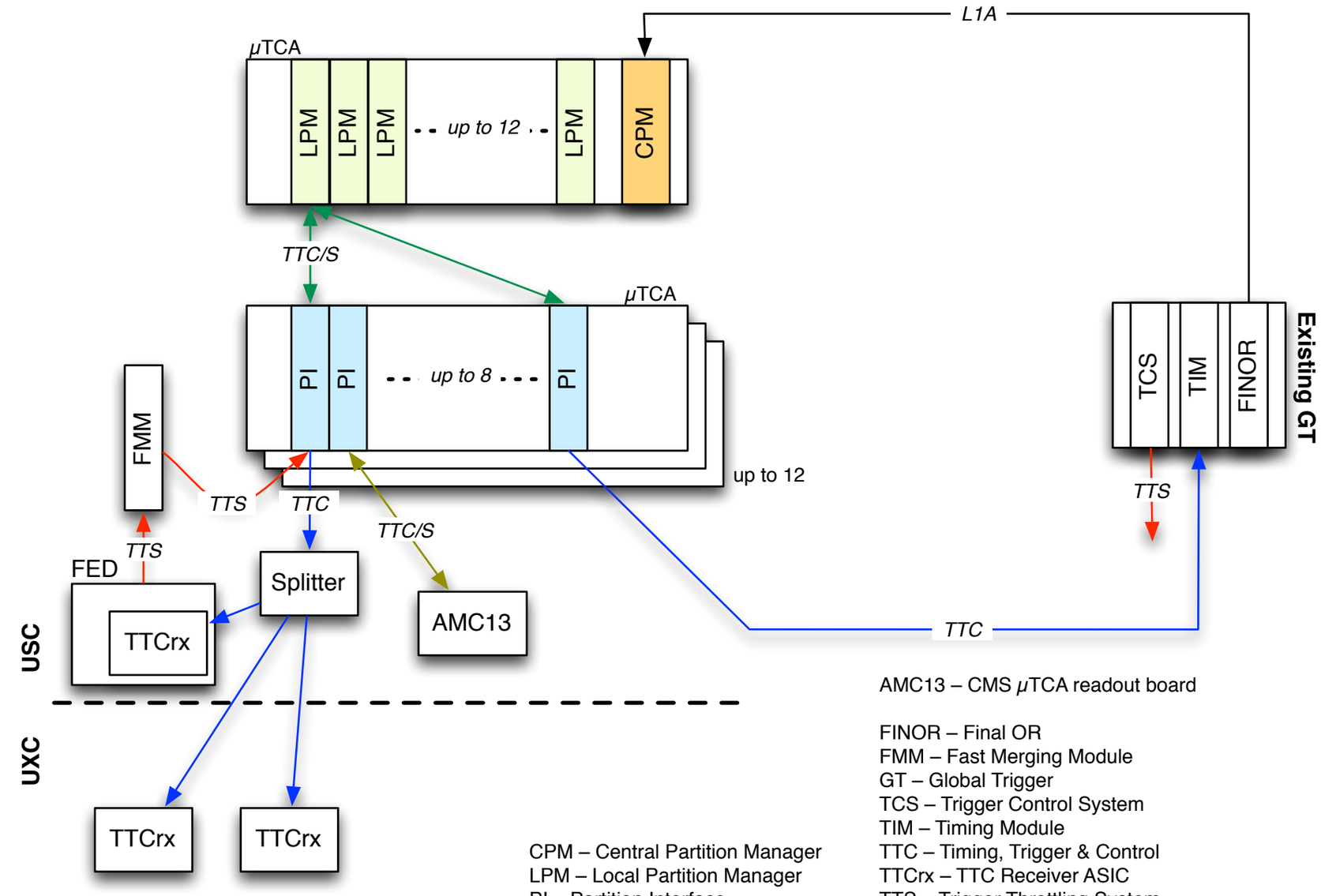

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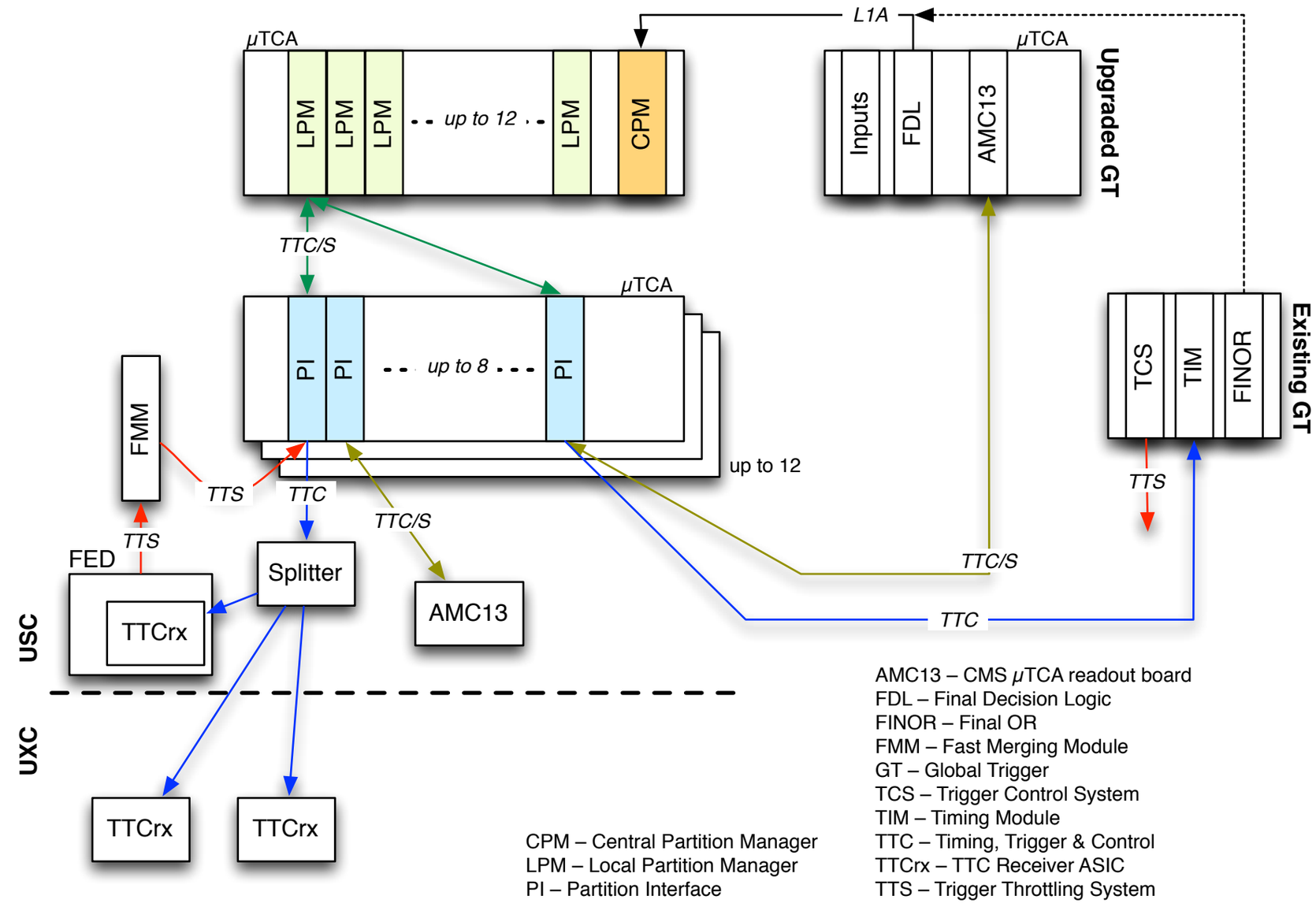

CPM – Central Partition Manager
LPM – Local Partition Manager
PI – Partition Interface

AMC13 – CMS µTCA readout board
FDL – Final Decision Logic
FINOR – Final OR
FMM – Fast Merging Module
GT – Global Trigger
TCS – Trigger Control System
TIM – Timing Module
TTC – Timing, Trigger & Control
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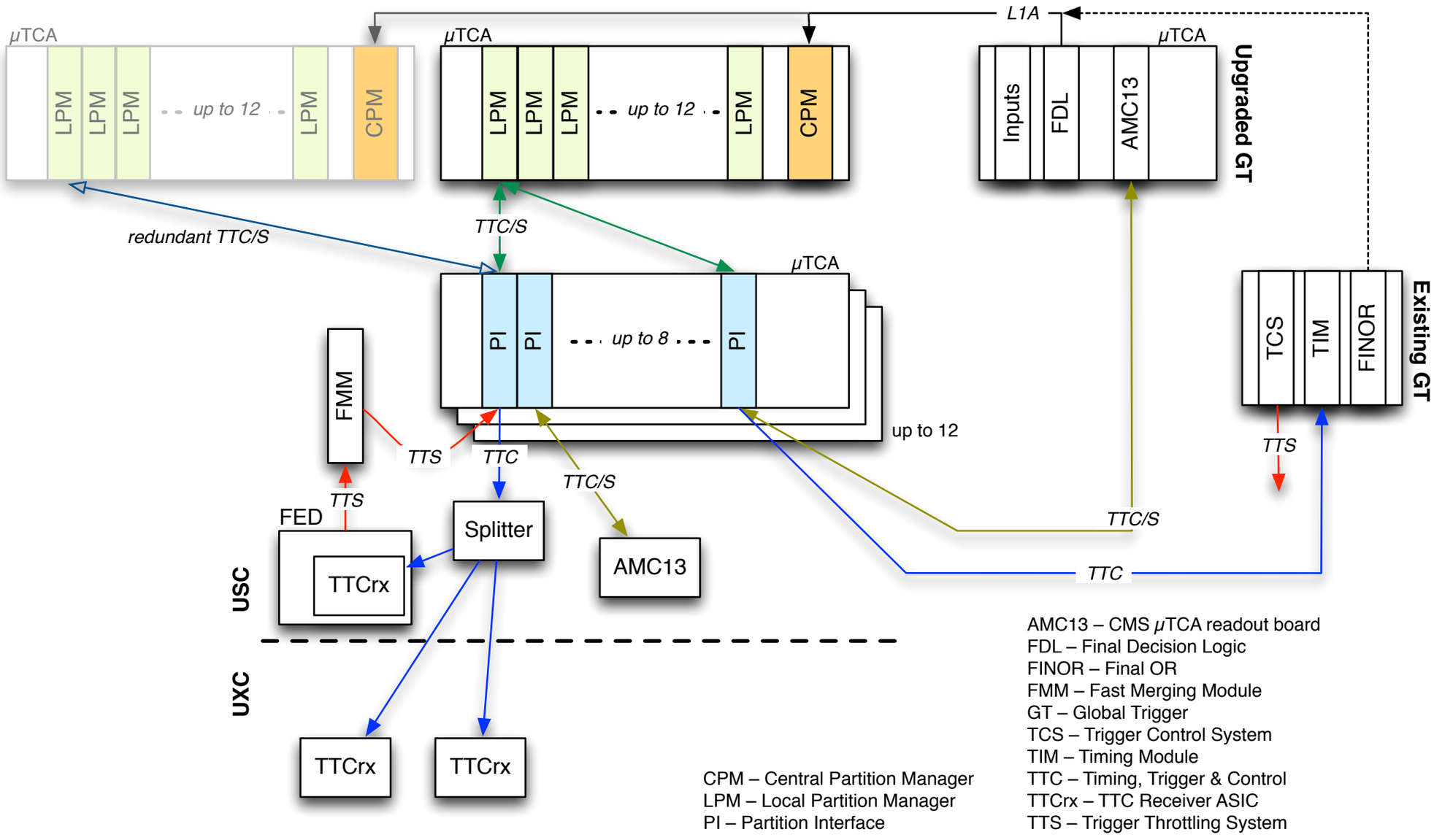
TTS – Trigger Throttling System

TCDS System Diagram



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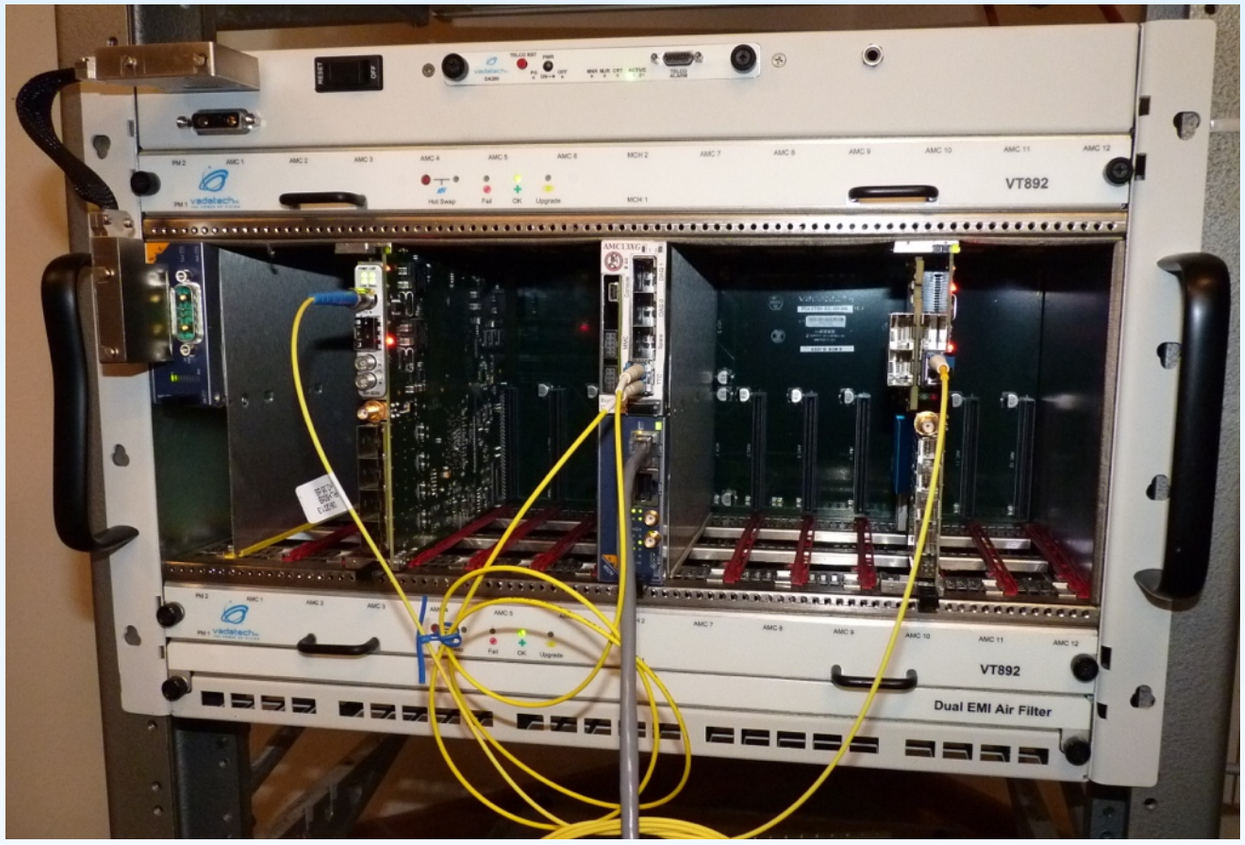
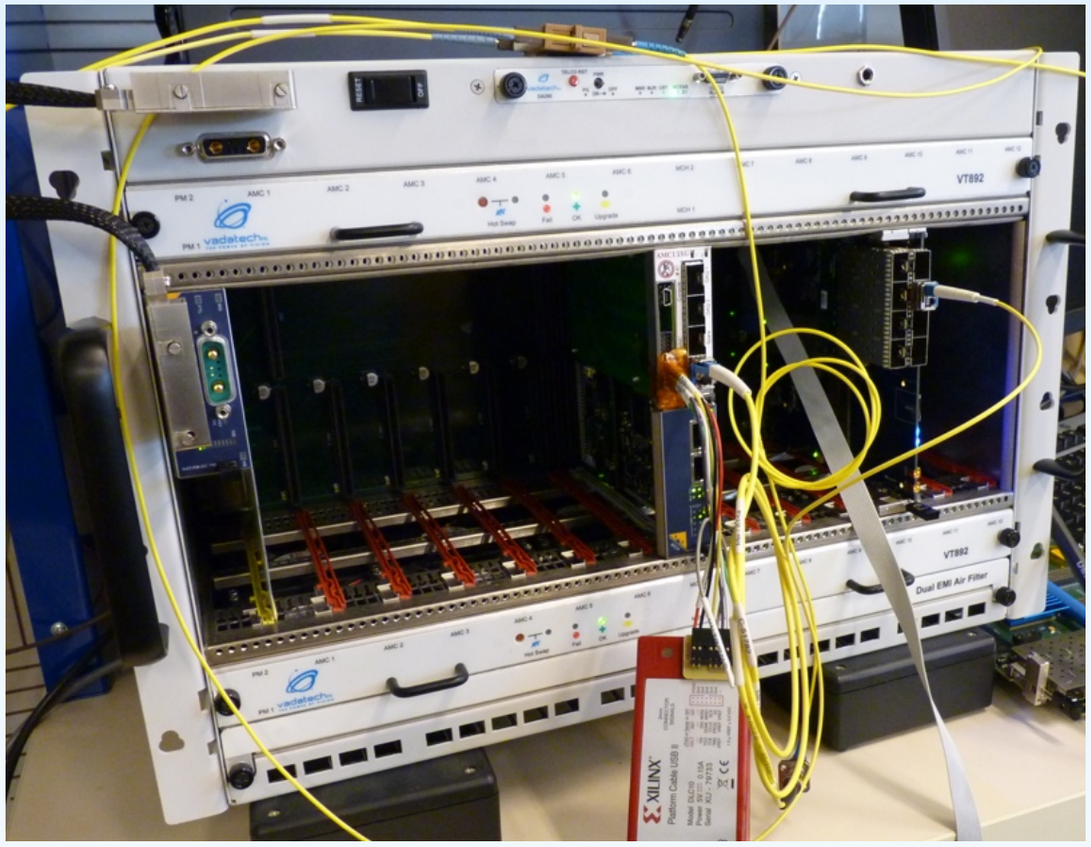
Project overview

- System Definition
  - Description and specification of new system
- Demonstrator System
  - Hardware and Software with minimal functionality of complete heirarchy (CPM, LPM, & PI)
  - Using existing hardware where possible (AMC13, GLIB)
  - Design and fabricate FMCs needed to enable functionality of LPM and PI
- Final Hardware
  - Design and fabrication of AMC with required interfaces (modification of existing GLIB board)
- Final Software
  - Full functionality for control and configuration of full system
- Installation & commissioning

Hardware Implementation



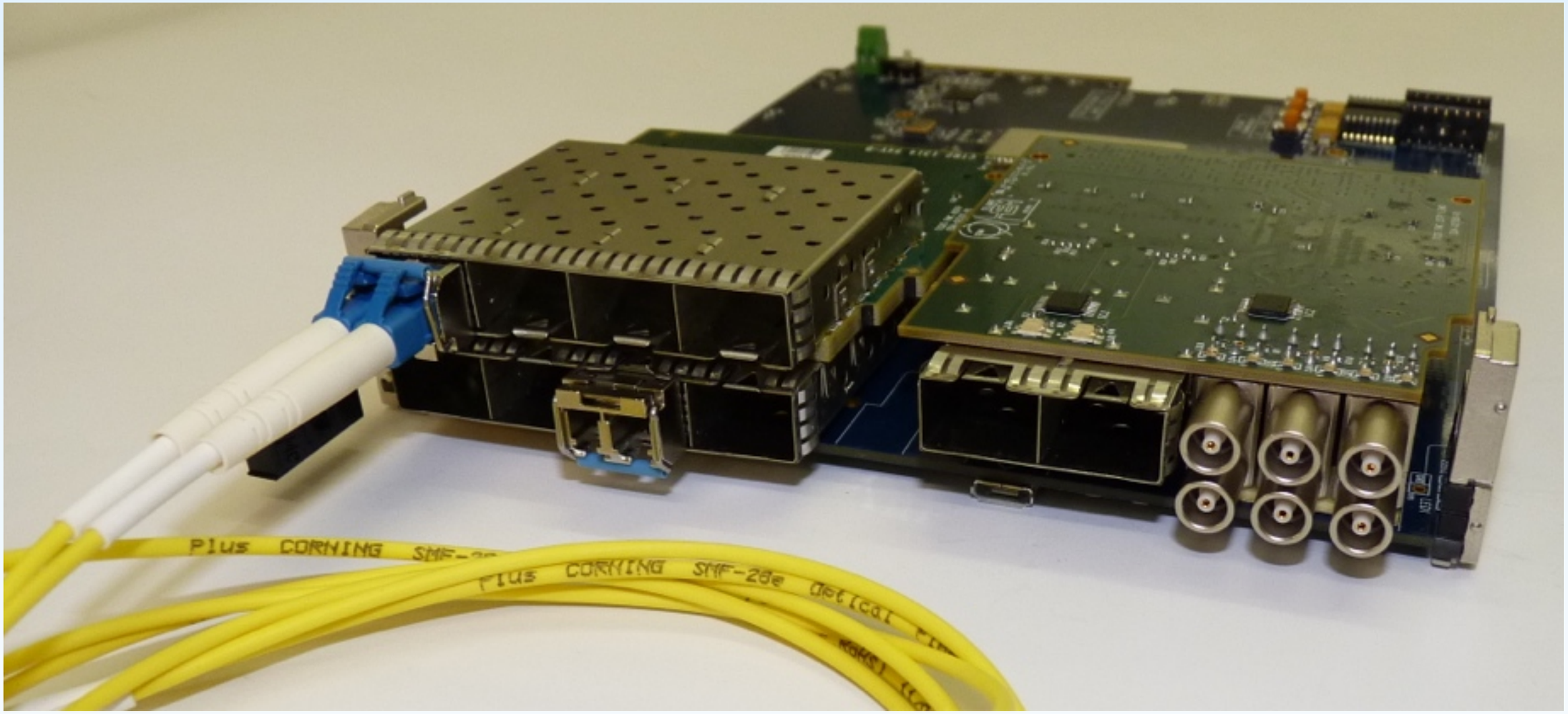
Spy CPM LPM (GLIB)



CPM LPM (FC7)

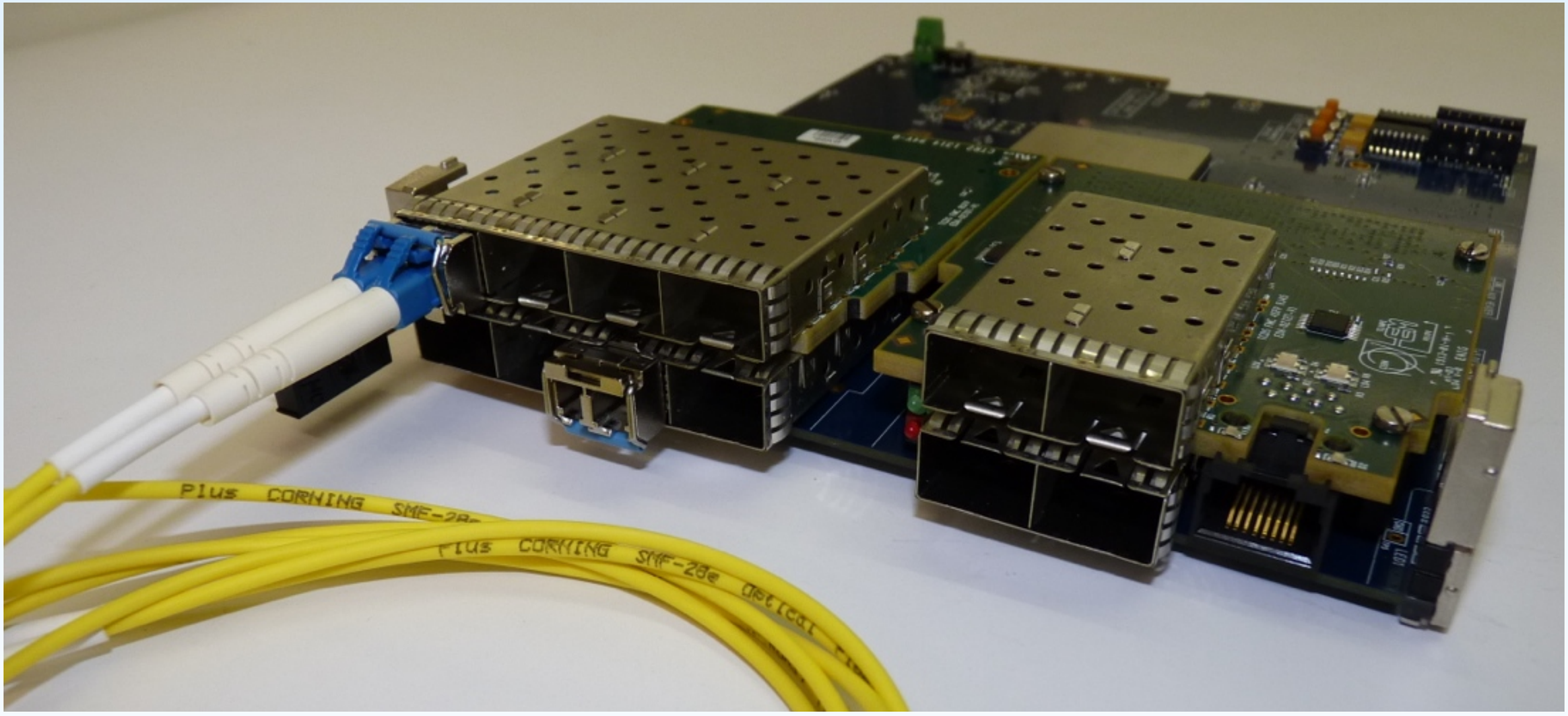
- Based on common hardware developments
  - AMC13 (Boston Uni) become CPM module
  - FC7 becomes LPM and PI module
- Also developed a crate-based TTC spy & TTS generator to receive generated data packets

Hardware Implementation (LPM)



- AMC motherboard
  - Proof of concept with GLIB
  - Final system with FC7
- Mezzanines
  - 8x SFP on Std. i/o to PI
  - 2x SFP on SerDes plus Lemo for Clk & external Trig

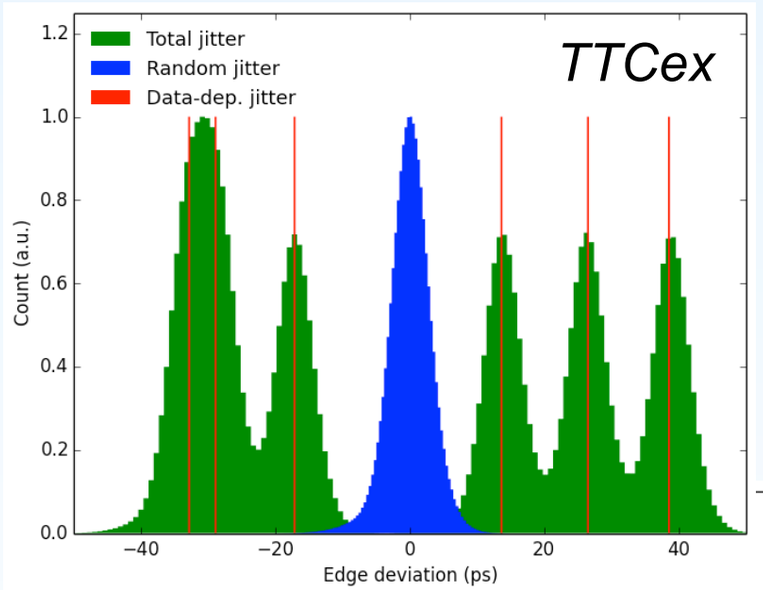
Hardware Implementation (PI)

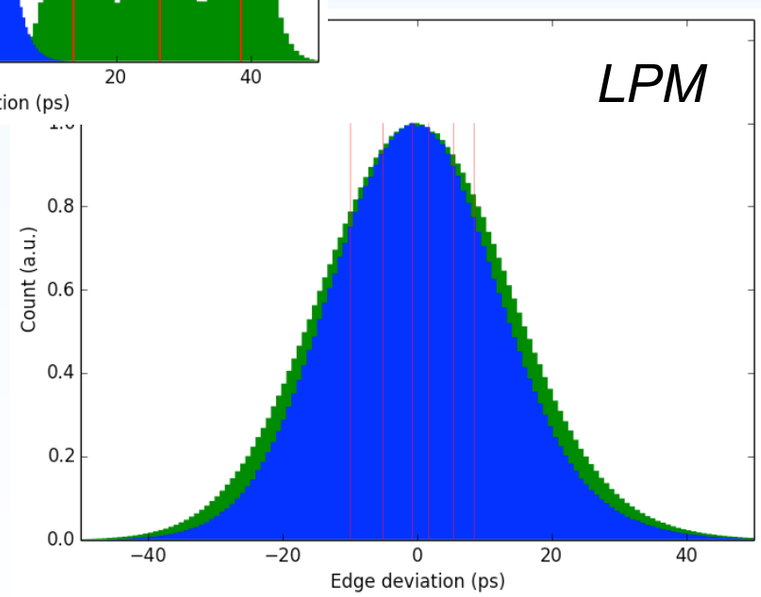


- AMC motherboard
  - Proof of concept with GLIB
  - Final system with FC7
- Mezzanines
  - 8x SFP on Std. i/o
  - 4x SFP on Std. i/o plus RJ45 for legacy TTS

Timing Performance

- Jitter measured on the 160 MHz clock reconstructed from an idle TTC A+B-channel signal.
- Measured using an Agilent DSO9254A oscilloscope and EZJIT Plus analysis software.





	Random Jitter (ps)	*Total Jitter (ps)*
TTCci	*26*	*753*
TTCex	*3*	*120*
LPM	*11*	*180*

Demonstration System in EIC (904)

- Deploy demo system for integration tests with sub-systems
  - µTCA crate
  - CPM
  - LPM
  - PI
- Ensure that hardware signals can be used to drive sub-systems in CMS Electronics Integration Centre
- Ensure that sub-system software integration can start early

Demonstration System in EIC (904)

- Deploy demo system for integration tests with sub-systems
  - μTCA crate
  - CPM
  - LPM
  - PI

Installed and operational
Integrating with CMS sub-systems

- Ensure that hardware signals can be used to drive sub-systems in CMS Electronics Integration Centre
- Ensure that sub-system software integration can start early

Demonstration System in USC55

- Deploy demo system for integration tests with sub-systems
  - 2x µTCA crate
  - 2x CPM
  - Nx LPM
  - Mx PI
- Ensure that hardware signals can be used to drive sub-systems in USC55
  - Fibres and FMM cables can be patched in to existing partitions
- Ensure that software integration can start early
  - Run Control
  - Subdetectors
  - DCS for system monitoring

Demonstration System in USC55

- Deploy demo system for integration tests with sub-systems
  - 2x µTCA crate
  - 2x CPM
  - Nx LPM
  - Mx PI

Parts expected for installation beginning of April '14

- Ensure that hardware signals can be used to drive sub-systems in USC55
  - Fibres and FMM cables can be patched in to existing partitions
- Ensure that software integration can start early
  - Run Control
  - Subdetectors
  - DCS for system monitoring

Installation in CMS

- Must remove existing TTC system to install new TCDS
  - Sub-systems cannot run if they need a TTC input during that time
  - Go-ahead given by Installation Readiness Review
- Estimate 3 wks total to
  - Remove legacy TTC system
  - Install new TCDS system inc. fibre plant
  - Verify H/W and S/W installation
- Staged installation and commissioning April - Aug 2014
  - one TTC partition per detector at a time
- Changeover Aug 2014
  - ahead of cosmic runs in Q4-14

Summary

- CMS will deploy a new Trigger Control and Distribution System during LS1
  - Make available sufficient output partitions to meet sub-system requests
- Hardware for full system on order
  - Delivery expected end April 2014
- Demonstration systems being deployed
  - CMS Electronics Integration Centre (b.904) up and running
  - Larger system planned to be deployed in USC55 early April
- User integration underway
  - Installation Readiness Review in July with sign-off from all sub-systems
- Final installation in August 2014 in USC55

Extra Slides

Feature summary

Feature	CMS Note 2002/033	present TCS	present LTC	LPM	CPM
Number of partitions	32	32	6	8	96
Number of partition groups	8	8	1	1	2
Number of DAQ EVM interfaces	1	1	1	1	2
LHC clock input	●	●	●	●	●
LHC orbit input	●	●	●	●	●
BST input	●	●	●		●
Number of B-Gos	10	16	16	32	32
Number of TTS States	7	7	7	16	16
B-Go and TTS sequence definition	FW	FW	SW	SW	SW
Active BX mask	●	●	●	●	●
Resonant Trigger Cancellation				●	●
External Front-end Emulator	●	●	●		
Internal Front-end Emulator				●	●
LumiDAQ sync signals				●	●
Counters active between Start & Stop					
Orbits	●	●	●	●	●
BXs with L1A inhibited	●	●		●	●
BXs with L1A inhibited L1A True	●	●		●	●
BXs with L1A inhibited L1A False	●	●		●	●
Active BXs with L1A inhibited	●	●		●	●
Active BXs with L1A inhibited L1A True	●	●		●	●
Active BXs with L1A inhibited L1A False	●	●		●	●
Active BXs with L1A inhibited, per condition	●	●		●	●
Physics Triggers	●	●	●	●	●
Physics Triggers distributed	●	●	●	●	●
Calibration or Test Triggers distributed	●	●	●	●	●
All Triggers distributed	●	●	●	●	●