DAQ for CASTOR calorimeter of the CMS experiment

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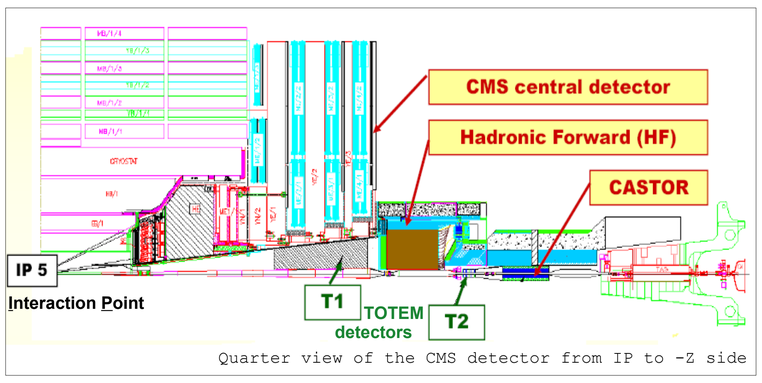
CMS forward region:



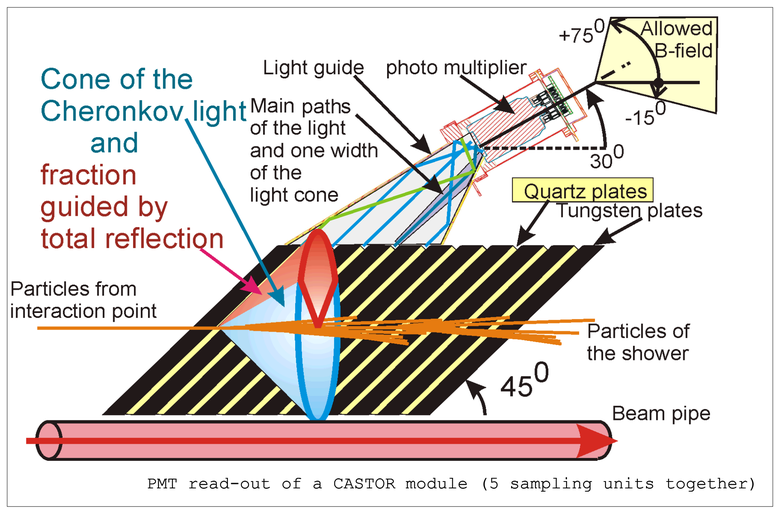
Quarter view of the CMS detector from IP to -Z side

CASTOR (Centauro And Strange Object Research):

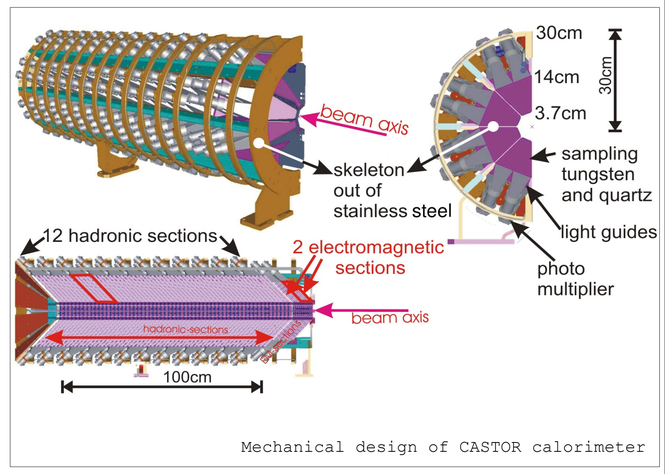
- Forward calorimeter for low-x parton dynamics, minimum bias event structure, diffraction, cosmic ray related physics in low-luminosity proton-proton and heavy-ion collisions
- Design challenges: restricted space available, high radiation level (≤ 20 kGy in 2009/10), operation in magnetic field (≤ 0.16 T)

CASTOR design:

- Forward ($5.2 < \eta < 6.6$) Čerenkov quartz-tungsten sampling calorimeter - compact, radiation hard and fast
- CASTOR consists of **16 azimuthal sectors** (semi-octants) mechanically organized in two half calorimeters;
- Each sector is divided longitudinally in electromagnetic (EM) and hadronic (HAD) modules: **2xEM+12xHAD**
  - → 2 x EM = $0.77\ \lambda_I = 20\ X_0$
  - → 12 x HAD = $12 \times 0.77\ \lambda_I$
  - → total depth = $13 \times 0.77\ \lambda_I \approx 10\lambda_I$
- 5 sampling units (quartz+W) per each module



PMT read-out of a CASTOR module (5 sampling units together)

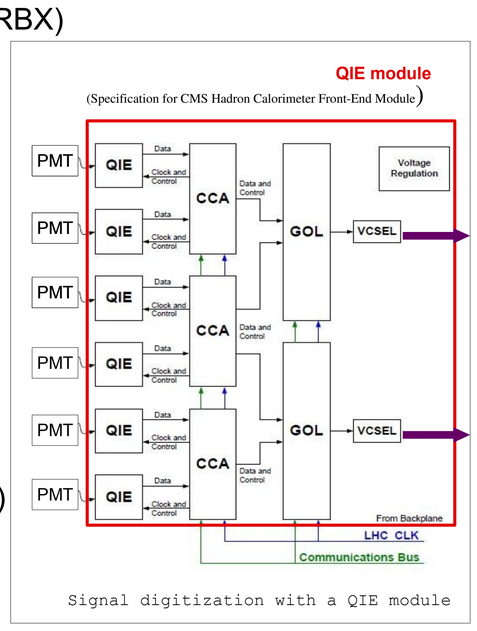


Mechanical design of CASTOR calorimeter

- Each module is read-out individually:
  → 16 x (2+12) = **224 read-out channels**
- Fine-mesh photomultipliers for read-out: present solution should tolerate magnetic filed ≤ 0.5 T and withstand radiation corresponding to ~ 800 pb^{-1}

Signal Digitization:

- based on HCAL Forward (HF) Readout BoX (RBX)
- signal from PMT is digitized with a **QIE chip**
  - → fast (40 MHz) nonlinear FlashADCs
  - → 32 bins (5 bit) with different weights and 4 ranges
  - → **dynamic range of 10,000** from 2.6 fC/bin 26pC/bin
- one QIE module for 6 read-out channels



Signal digitization with a QIE module

Per a QIE module:

→ 3 CCA chips (Channel Control ASIC)
- data composition and synchronization
- clock to QIE chips
- control of QIE chips

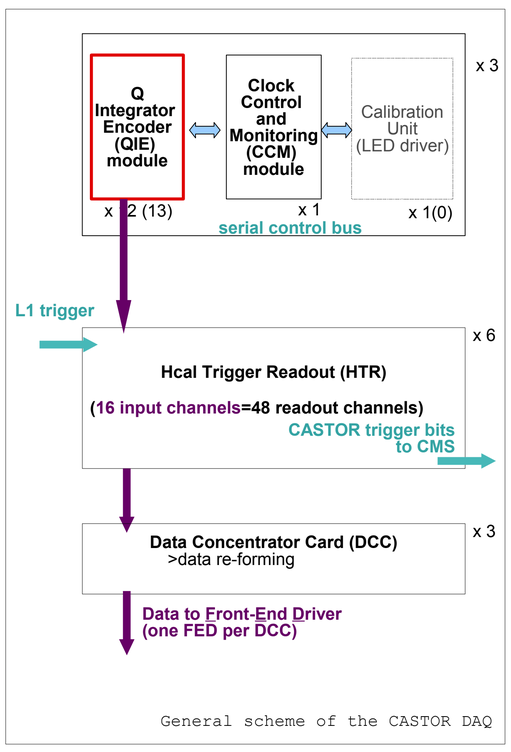
→ 2 GOL (Gigabit Optical Link)
- data flow transformation from parallel to serial

→VCSEL (Vertical Cavity Surface Emitting Laser) 1.6 Gb/s laser (32 bit @ 40 Mhz) providing serial **data (3 read-out channels per a fiber)**

Read-Out:

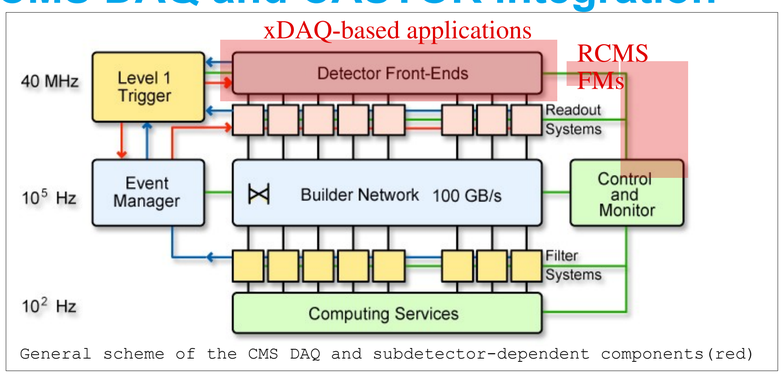
- 13 (12) QIE modules controlled with a one Clock Control and Monitoring Modul (CCM) - three crates providing 228 channels
- One calibration unit with 8 LEDs for PMT calibration/monitoring (1 common LED per two sectors)
- 6 Hcal Trigger Readout (HTR) boards 16 input channels = 48 readout channels per each HTR
  - data receiving
  - integrity check
  - data pre-formating
  - storing data during L1 latency
  - trigger decision (not yet)
- 3 Data Concentrator Cards (DCC)
  - data pre-formating

→ **3 data streams to the CMS Front-End Drivers (FED), one DCC to one FED**



General scheme of the CASTOR DAQ

CMS DAQ and CASTOR integration



General scheme of the CMS DAQ and subdetector-dependent components(red)

CMS DAQ software:

→ based on CERN developed „xDAQ“ framework (C++)
→ control via Run Control and Monitor System for CMS Experiment based on Tomcat/Ajax

CASTOR DAQ software:

→ on basis of HCAL DAQ
→ **fully integrated in CMS DAQ**

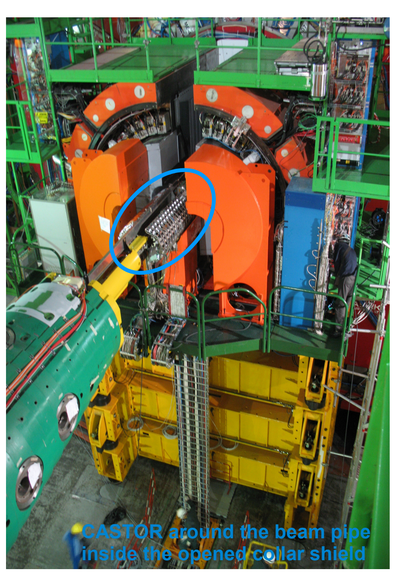
from CMS DAQ monitor

Data to Surface

Sub-System		State	FRL	FED	IN
TRG	I	Configured	4	4	3
CSC	I	Configured	9	9	9
DAQ	I	Configured	0	0	0
DQM	I	Configured	0	0	0
DT	I	Configured	10	10	10
ECAL	I	Configured	54	54	53
ES	I	Configured	40	40	40
HCAL	I	Configured	32	32	32
PIXEL	X	Out	40	40	0
RPC	I	Configured	3	3	3
SCAL	I	Configured	1	1	1
TRACKER	I	Halted	250	440	0
CASTOR	I	Configured	3	3	3
	X		0	0	0

CASTOR installation in CMS

- **CASTOR installed** on collar table of HF platform (-Z side) in June 2009
- CMS magnet tests at 3.8 T successful
- commissioned with LED (>90% of good channels)


CASTOR around the beam pipe inside the opened collar shield