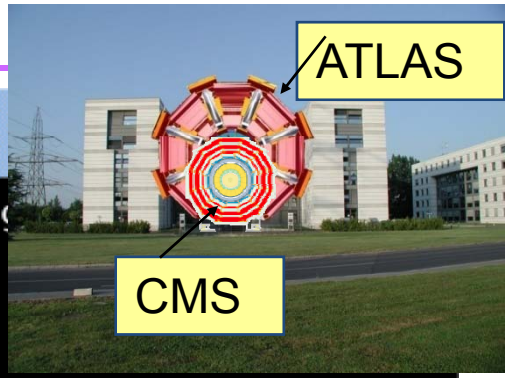
CMS in Greece

(CMS Preshower-Trigger/DAQ-Castor, Physics)

N. Manthos, University of Ioannina, Greece

TWEPP 2008, Naxos, Greece

CMS geometry and collaboration - GR financial contribution



CMS Collaboration

38 Countries, 183 Institutes, 3000 scientists and engineers (includin

TRIGGER, DATA ACQUISITION & OFFLINE COMPUTING
Austria, Brazil, CERN, Finland, France, Greece, Hungary, Ireland, Italy, Korea, Lithuania, New Zealand, Poland, Portugal, Switzerland, UK, USA

TRACKER
Austria, Belgium, CERN, Finland, France, Germany, Italy, Japan*, Mexico, New Zealand, Switzerland, UK, USA

CRYSTAL ECAL
Belarus, CERN, China, Croatia, Cyprus, France, Italy, Japan*, Portugal, Russia, Serbia, Switzerland, UK, USA

PRESHOWER
Armenia, CERN, Greece, India, Russia, Taiwan

RETURN YOKE
Barrel: Estonia, Germany, Greece, Russia
Endcap: Japan*, USA

SUPERCONDUCTING MAGNET
All countries in CMS contribute to Magnet financing in particular: Finland, France, Italy, Japan*, Korea, Switzerland, USA

CASTOR

FEET
Pakistan
China

FORWARD CALORIMETER
Hungary, Iran, Russia, Turkey, USA

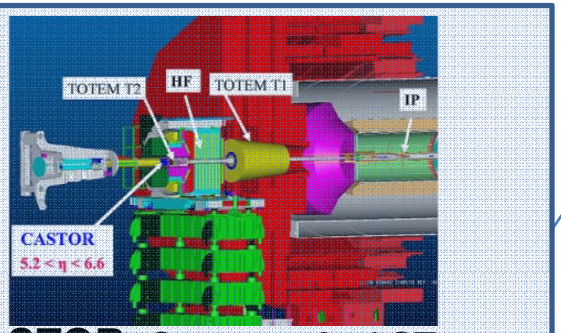
HCAL
Barrel: Bulgaria, India, Spain*, USA
Endcap: Belarus, Bulgaria, Georgia, Russia, Ukraine, Uzbekistan
HO: India

MUON CHAMBERS
Barrel: Austria, Bulgaria, CERN, China, Germany, Hungary, Italy, Spain.
Endcap: Belarus, Bulgaria, China, Colombia, Korea, Pakistan, Russia, USA

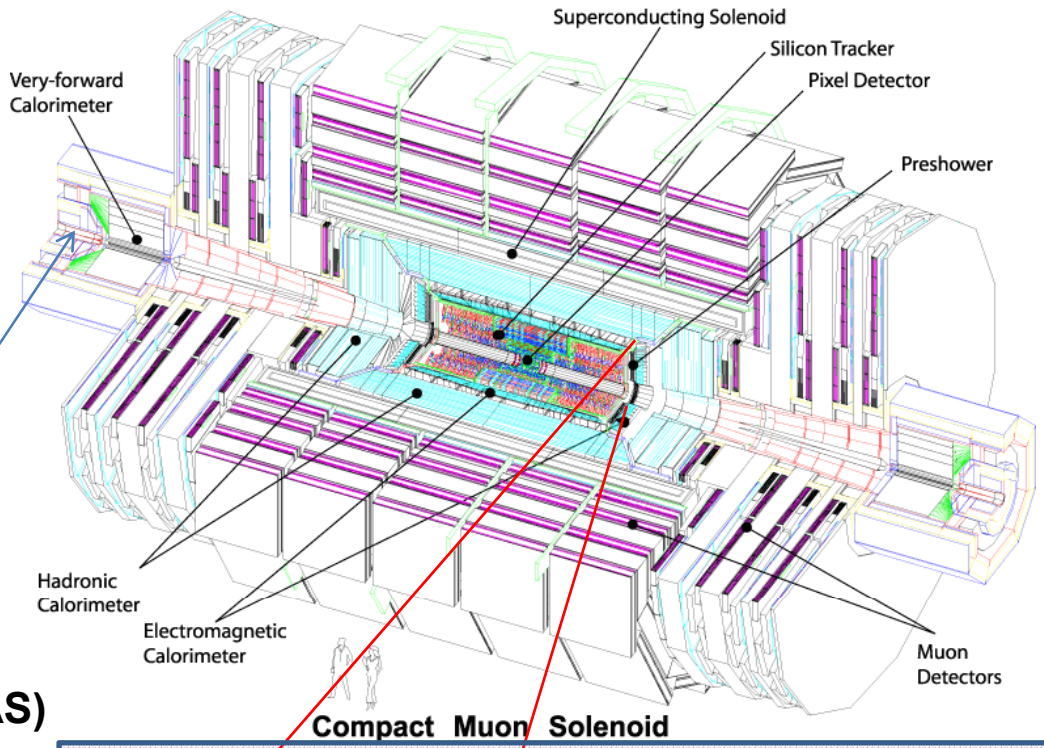
* Only through industrial contracts

Total weight	: 12500 T
Overall diameter	: 15.0 m
Overall length	: 21.5 m
Magnetic field	: 4 Tesla

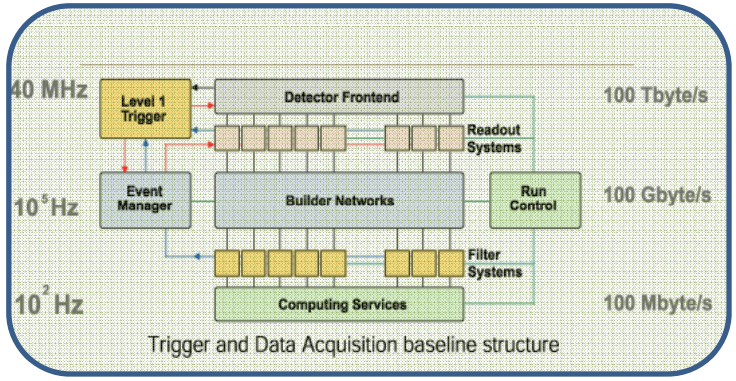
CMS – Greek contribution

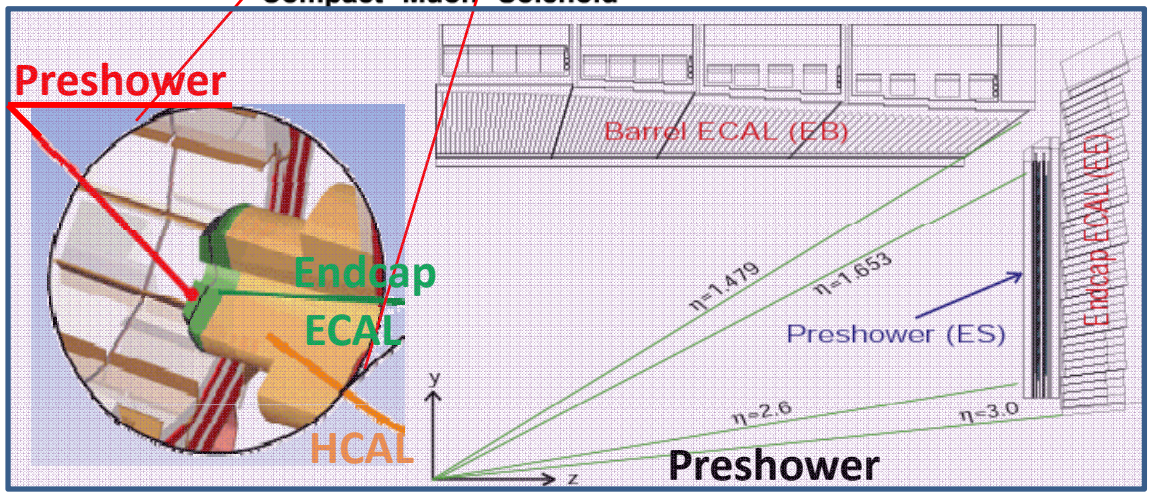


CASTOR: Centauro **A**nd **ST**range **O**bject **R**esearch, 5.2<η<5.6 , 14.37 m from the interaction point



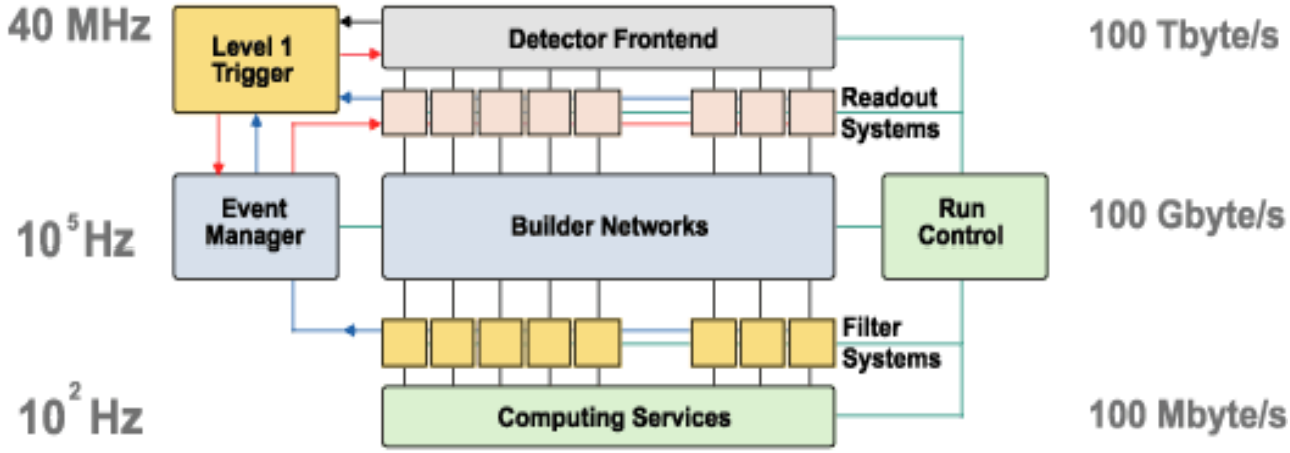
CMS Trigger/DAQ System (TriDAS)





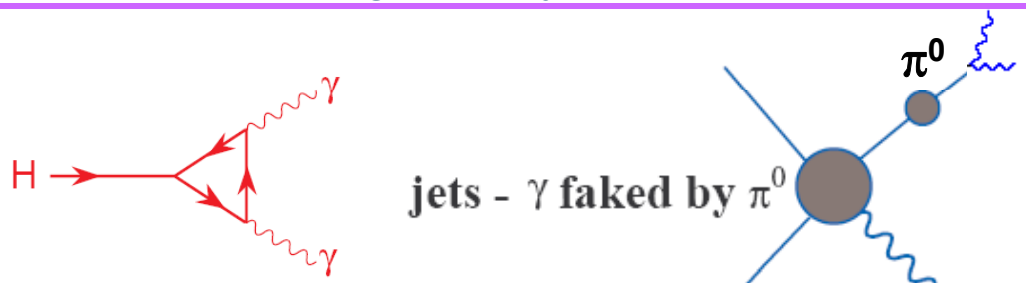
Level 1 Trigger:
Muon and ECAL data, latency 3.6 μs
High Level Triggers (on line filter farm): 100 Hz. 10^6 SI95 CPUs : 1500 dual quad-core PCs @2.6 GHz (2009, now 50%)

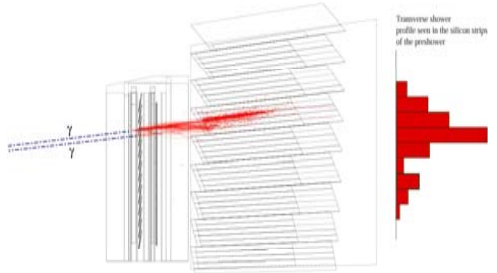
Data Acquisition Main Parameters	
Collision rate	40 MHz
Level-1 Maximum trigger rate	100 kHz
Average event size	1 Mbyte
No. of electronics boards	10000
No. of readout crates	250
No. of In-Out units (200-5000 byte/event)	1000
Event builder (1000 port switch) bandwidth	1 Terabit/s
Event filter computing power	5 10^6 MIPS
Data production	Tbyte/day



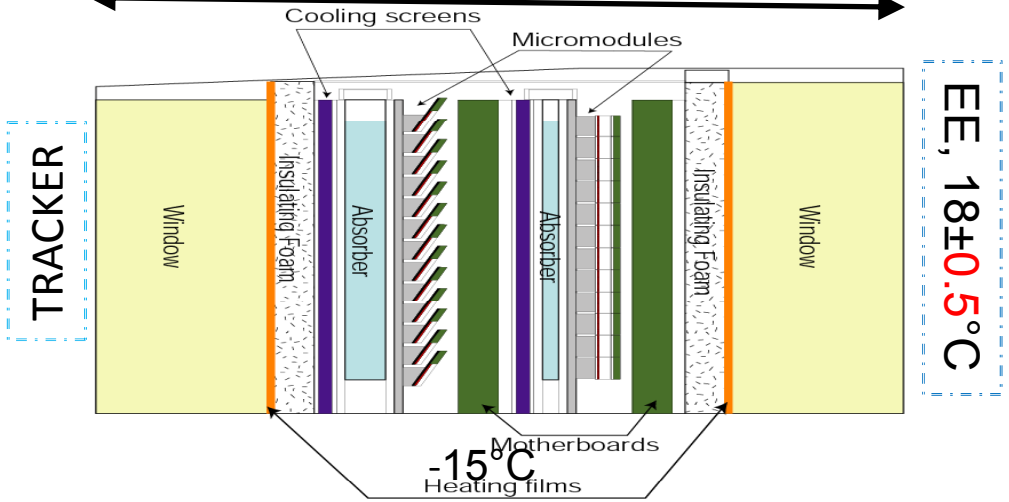
Trigger and Data Acquisition baseline structure

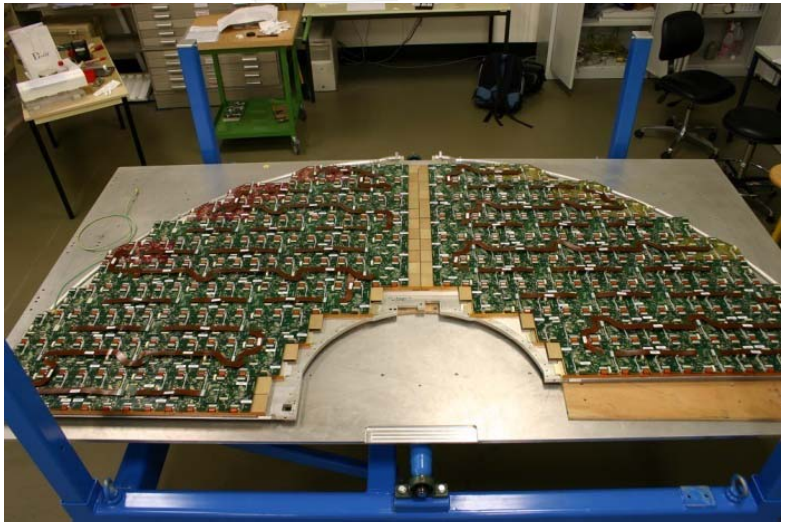
CMS Preshower geometry

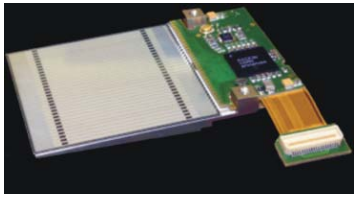




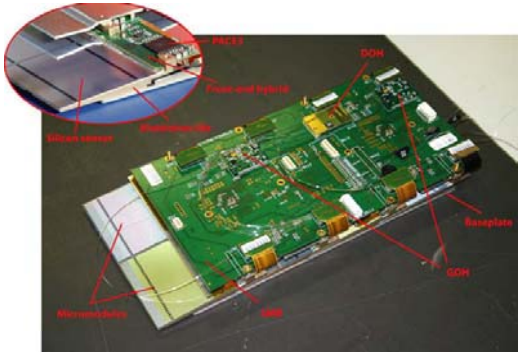
Preshower (20cm)



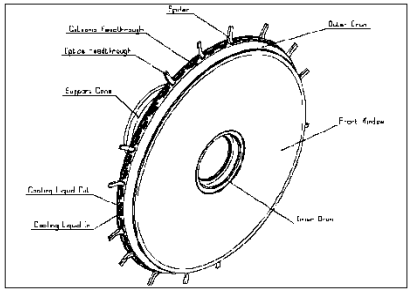




Preshower μmodule (total 4288)



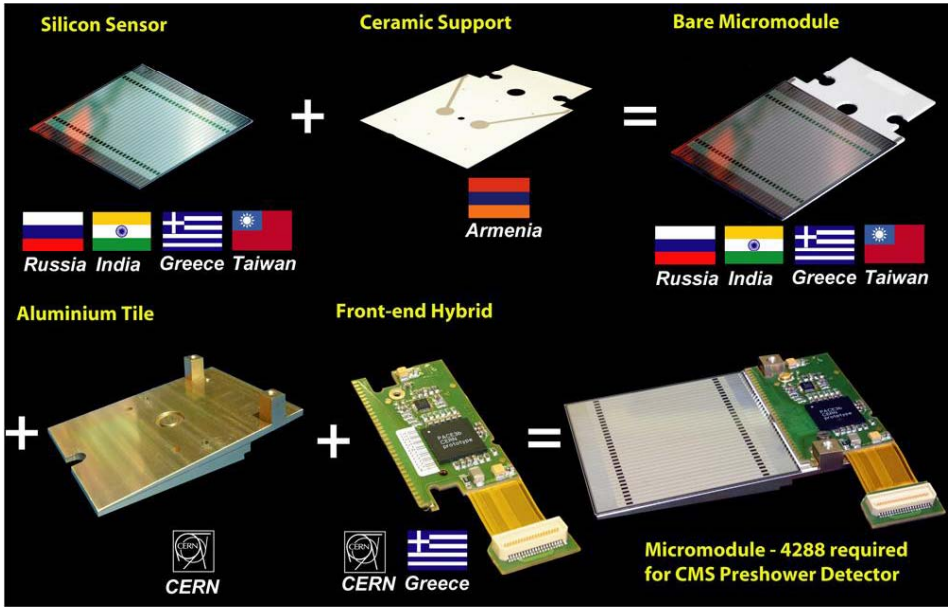
Type-1 ladder



It will be inserted in CMS during the LHC winter shutdown.

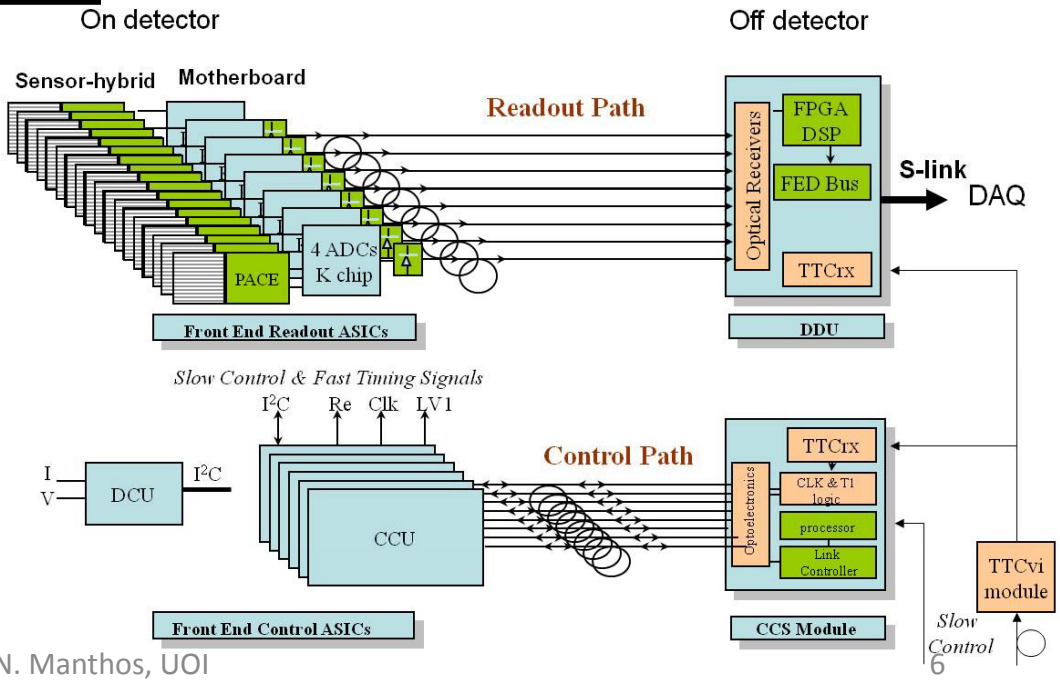
"ESIAB" has been inserted in CMS mainly to facilitate integration in to the full CMS DAQ, on line monitoring and control systems.

CMS Preshower



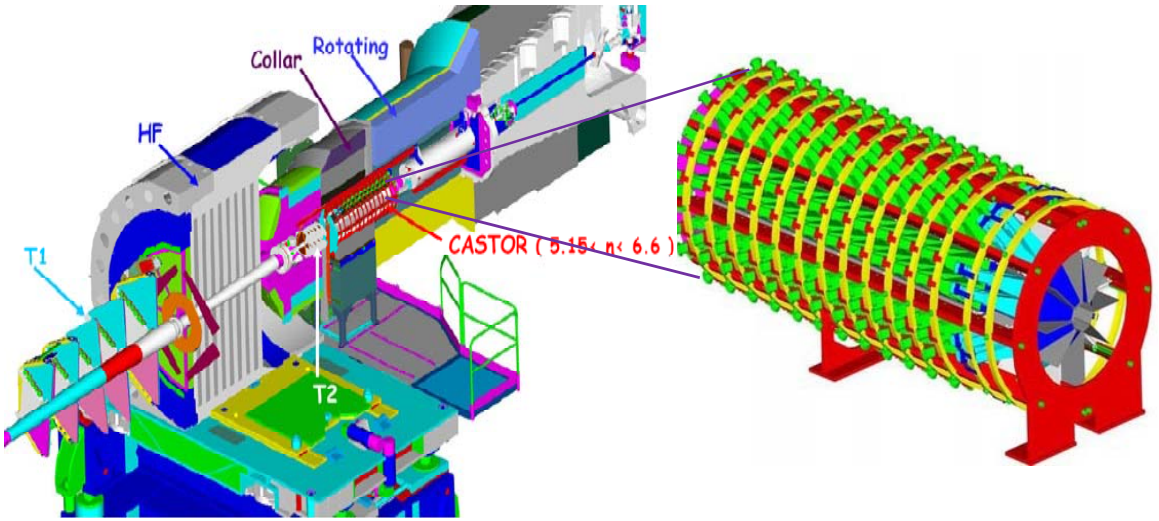
μmodule construction

Preshower electronics



CMS CASTOR

CASTOR: quartz / tungsten Cherenkov EM/HAD calorimeter, placed at the very forward rapidity region of the CMS experiment. It is azimuthally divided into 16 semi-octants and longitudinally into 14 sections, with full length of 10 λ_I.



CASTOR detector will investigate physics topics both in pp and HI collisions at the LHC:

- **Forward QCD studies** (diffractive, low–x, ...)
- Especially designed to study totally **unexplored cosmic ray phenomena**. (Centauros, Strangelets, disoriented chiral condensates-DCC's, ...)

Half of the CASTOR is installed in the CMS line for the LHC start up run

Participation of GREEK TEAMS in CMS

University of ATHENS ,

L. Gouskos, A. Kalogeropoulos, G. Karapostoli, P. Katsas, M. Lebeau, A. Panagiotou, Ch. Papadimitropoulos, K. Saganis, P. Sphicas.

NCSR 'Demokritos', Institute of Nuclear Physics,

M. Barone, G. Daskalakis, C. Filippidis, Th. Geralis, K. Karafasoulis, A. Kyriakis, D. Loukas, A. Markou, Ch. Markou, Ch. Mavrommatis, I. Papadakis, E. Petrakou, K. Theofilatos, A. Zachariadou.

University of Ioannina, HEP Lab,

I. Evangelou, P. Kokkas, N. Manthos, I. Papadopoulos, F. Triantis.

Official GR CMS financial contribution (CMS M&O U)

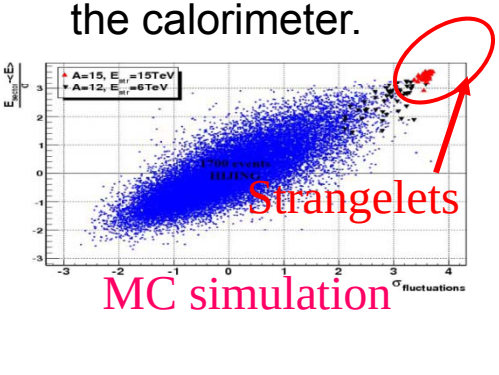
Trigger/DAQ:	7.2% (2060kCHF)
ECAL (Preshower)	1.1% (1360kCHF)
Magnet-offline&computing	1.2% (1580kCHF)
CASTOR	(240kCHF)
2008 : M&O A (17 PhD physicists)	1.5%

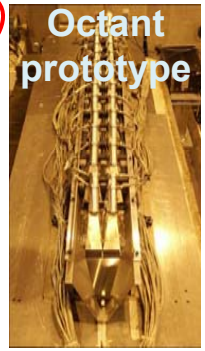
CMS and University of Athens

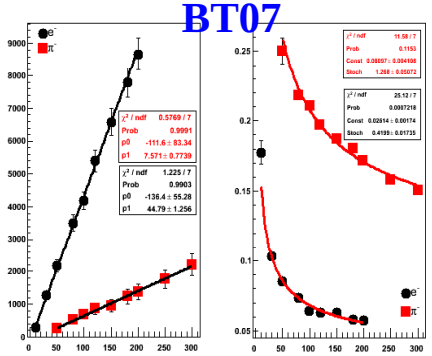
- CMS Management (Physics coordination).
- Participation in the TriDAS FRL and RU builder.
- Participation in the LCG (LHC Computer GRID).
- CASTOR Project management.
- Participation (+ X. Aslanoglou from University of Ioannina-NP lab) in the CMS CASTOR forward calorimeter.
- Participation in CMS Physics reconstruction and selection.
- Participation in SUSY Analysis.

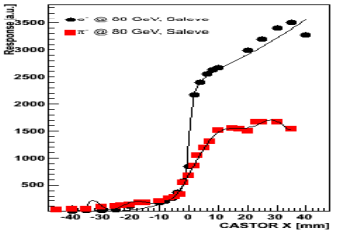
UoA participation in CASTOR

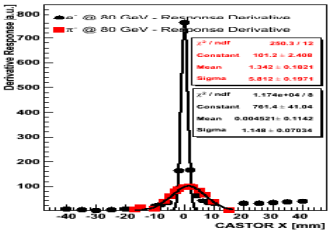
Four test beams (2003, 2004, 2007 & 2008), in addition to simulation studies, where held at the CERN SPS to test the performance and finalize the design of the calorimeter.





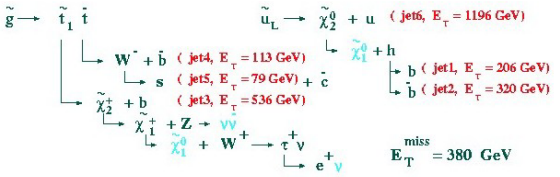


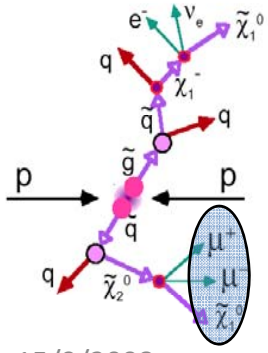


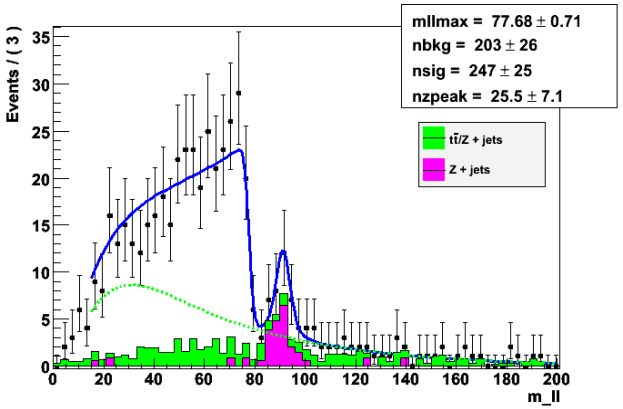


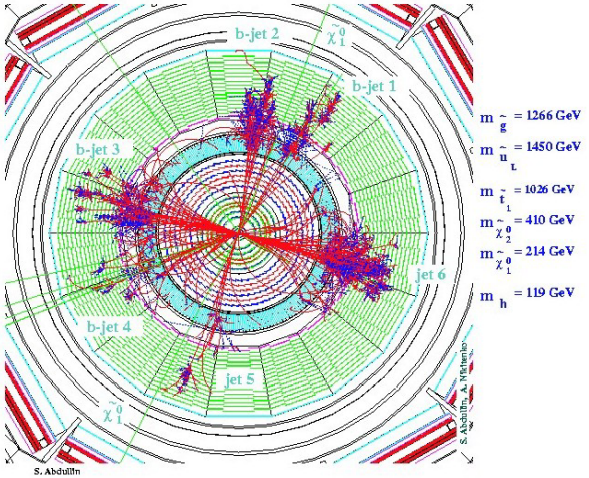
UoA participation in SUSY searches

Di-leptons + Jets + MET channel : Observation and measurement of $x_2 \rightarrow x_1$ ll (Karapostoli PhD thesis).









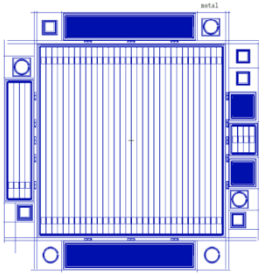
CMS and University of Athens- Publications

1. X. Aslanoglou et al, “First performance studies of a prototype for the CASTOR forward calorimeter at the CMS experiment”, CMS Note, AN-2006/142, Acta Physica Polonica Vol. 39(2008) 1429-1453
2. X. Aslanoglou et al, “Performance Studies of Prototype II for the CASTOR forward Calorimeter at the CMS experiment, 2004”, CMS Note, AN-2006/153, Eur. Phys. J. C 52, 495–506 (2007)
3. P. Katsas and A. D. Panagiotou, “Simulation of Energy Response Linearity, Resolution and e-/π Ratio for the CASTOR calorimeter at CMS”, CMS Note, AN-2006/147
4. X. Aslanoglou et al “Performance studies of the final prototype for the CASTOR forward calorimeter at the CMS experiment” CMS Note 2008/022
5. A. D. Panagiotou, P. Katsas, “Search for Strange Quark Matter with the CMS/CASTOR detector at the LHC” Nuclear Physics **A10674** (2006)

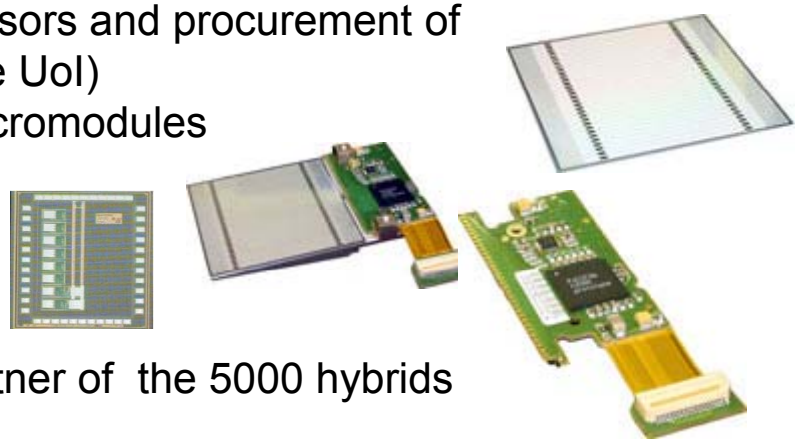
CMS and NCSR 'Demokritos', Institute of Nuclear Physics (INP)

CMS preshower and INP

Si Detectors Development & Electronics :



1. Conception: Simulation programs for capacitance calculations
2. Design: Design of various sensor configurations
3. Prototyping : Five years joint effort with the Institute of Microelectronics for the fabrication and characterization of sensor prototypes
4. Final Detectors : Fabrication at Demokritos of 50 sensors and procurement of additional 1000 from Hamamatsu (50% share with the UoI)
5. Construction and full characterization of 600 bare micromodules
6. Final assembly of 1000 micromodules (wire bonding)



7. VLSI prototypes for Silicon sensor Readout

8. Supervision of the fabrication by Greek industrial partner of the 5000 hybrids needed for the entire Preshower detector
9. Participation to the Preshower beam tests and data analysis

CMS TriDAS and INP

Construction of 22 IOP cards

(NCSR "Demokritos", Univ. of Athens, Ioannina, Hourdakis company)

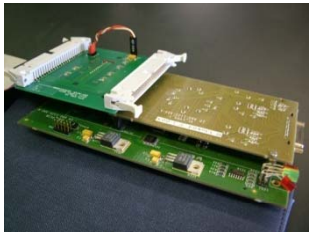
To prove the feasibility of the Readout system

IOP : 10 pcb layers PCI cards, construction, test, configuration

CPU:PowerPC, 3 PCI buses, intelligent I/O, Real Time System download (VxWorks).

CMS and NCSR 'Demokritos', Institute of Nuclear Physics (INP)

The Global Trigger Processor Emulator (GTPe) : 5 GTPes



- designed, built, mounted and tested
- The firmware of the 400kGates FPGA based on mixed VHDL and Handel-C.
- GTPe is used in the central TriDAS and the pre-series tests

CMS GRID at INP

A GRID cluster with ~100 CPUs and ~25 Tb storage capacity is in operation at the INP for the LHC experiments. Aim to considerably increase its power.
Used by the INP members as well as by the three LHC experiments with Greek participation.

CMS physics at INP

- **Analysis of ECAL test-beam data**,
- **Development of π^0 rejection algorithms for converted and unconverted photons**
- **Four Physics Analyses, included in the CMS Physics-TDR V. II :** FCNC decays of Top quarks, SUSY search at LM4, MSSM Higgs search, Little Higgs search
- **Three Physics Analyses for the early data taking :**
  - **Methods for Measurement of electron efficiency from data**
  - **Cross section measurement of W and Z in the electron channel**
  - **Measurement of Zγ (ISR) production and TGC measurement**

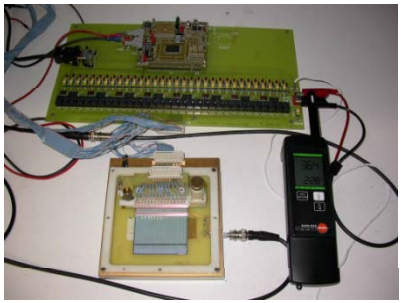
CMS and NCSR 'Demokritos', Institute of Nuclear Physics - Publications

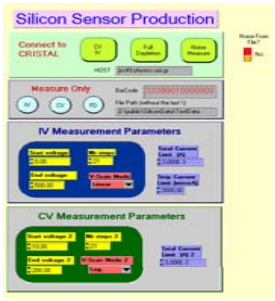
Publications

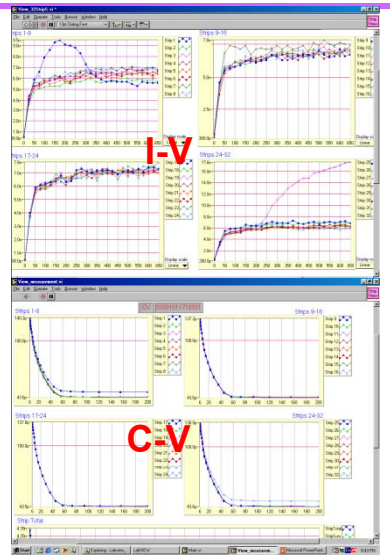
1. P. Adzic, et al., '' Reconstruction of the signal amplitude of the CMS electromagnetic calorimeter'', Eur Phys J C 46(2006) 23
2. P. Adzic, et al., '' Results of the first performance tests of the CMS electromagnetic calorimeter'', Eur Phys J C 44, s02, 1 (2006)
3. Ph . *Bloch, et al*., "Silicon sensors for the CMS preshower detector" Nucl. Instr. and Meth., A479(2002)265-277
4. T. Geralis et al. "The Global Trigger Processor Emulator for the CMS experiment", 2005 IEEE Trans. on Nucl. Sci., Vol 52, 1679
5. G. Anagnostou and G. Daskalakis, "Search for the MSSM A->Zh decay with Z->l+l-, h->b bbar", J. Phys. G: Nucl Part. Phys. 24 (2007) N251-N268
6. G.L Bayatian et al. "CMS technical design report, V. II : Physics Performance" J. Phys. G34:995-1597, 2007
7. P. Adzic et al., "Energy resolution of the Barrel of the CMS electromagnetic calorimeter", JINST 2:P0404,2007
8. CMS Collaboration, "Measuring Electron Efficiencies at CMS with Early Data", CMS PAS EGM-07-001
9. CMS Collaboration, "Towards a Measurement of the Inclusive W->ev and Z->ee Cross Sections in pp Collisions at sqrt(S)=14 TeV", CMS PAS EWK-08-005
10. L. Benucci, A. Kyriakis, "CMS sensitivity to top Flavour Changing Neutral Currents", Nuc. Phys. B (Proc. Suppl.) 177,258, 2008

CMS Notes 14, Conference Reports 2.
PhD Theses : 2 completed , 3 in progress.

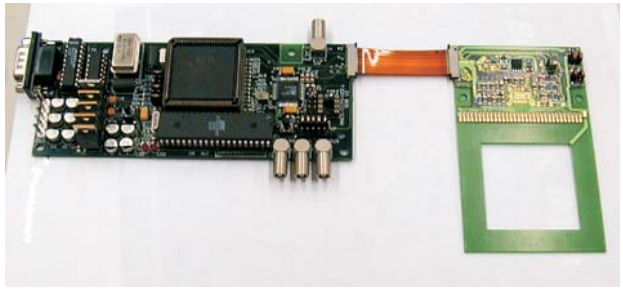
CMS Preshower and UOI-HEP Lab participation



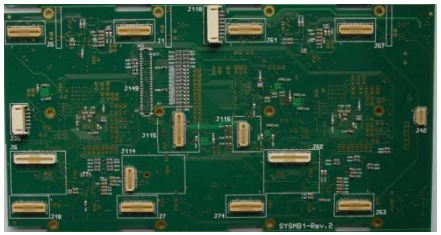




- Purchase and characterization (I-V, C-V, full depletion voltage) of 587 Preshower sensors out of ~ 4500.
- Participation in
  - the development of sensor FE and readout electronics,
  - the sensor-FE noise measurements,
  - the design and evaluation of the external noise in the Kapton cable,



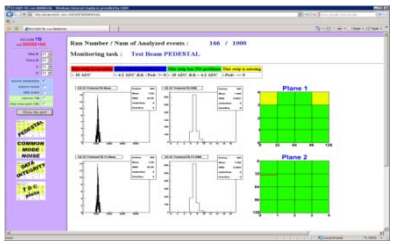
  - the development of the on detector electronics.

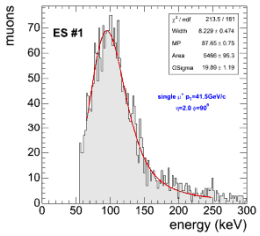


CMS Preshower and UOI-HEP Lab participation

- Participation in
  - the development of the off detector electronics, mainly in the firmware of the digital data filter,

  - the development of the Preshower control and DAQ software(XDAQ).
- Participation in the production testing and quality assurance of
  - the PACE3 FE chips (~7000),
  - the PACE3 hybrids (~2000),
  - the Preshower micromodules (~1000),
  - the Preshower token ring kaptons (~ 400).
- Participation in the development of the Preshower Data Quality Monitoring (DQM) system.





- Participation in Preshower simulations and Preshower calibration.
- Participation in the Preshower Beam tests, and test-beam data analysis.
- Preparation for Physics analysis
  - CMS GRID site GR-07-UOI-HEPLAB: 14 nodes, upgrade to 24 nodes in the near future,
  - Participation in the “SUSY-All hadronic searches” CMS analysis group.
- Future participation in SLHC.

CMS Preshower and UOI, HEP Lab participation- Publications

Publication

1. G. Antchev et al, A VME-based readout system for the CMS preshower sub-detector, IEEE TNS 54:623, 2007.
2. P. Adzic et al, Energy resolution of the barrel of the CMS electromagnetic calorimeter, JINST 2:P04004,2007
3. D.Barney et al, Implementation of on-line data reduction algorithms in the CMS endcap preshower data concentrator cards, JINST 2:P03001,2007
4. N. Manthos et al, An efficient hardware design for rejecting common mode in a group of adjacent channels of silicon microstrip sensors used in high energy physics experiments IEEE TNS 53:1045,2006
5. P. Adzic et al, Results of the first performance tests of the CMS electromagnetic calorimeter Eur.Phys.J.C44S1:1,2006
6. D. Barney et al, Detection of muons at 150-GeV/c with a CMS preshower prototype NIMmA564:126,2006
7. I. Evangelou, CMS preshower in-situ absolute calibration with physics events. NIM A572:624,2007
8. I. Evangelou et al, Noise measurements on Si sensors, NIM A493:25,2002.

Notes etc.

11 notes and Internal notes, 8 conference talks.
PhD Theses : 3 completed , 1 in progress.

Summary and conclusions

The contribution of the three Greek teams in the construction phase of CMS has been substantial, especially in electronics, instrumentation and in physics.

We look forward to a similarly substantial contribution also in the operation phase of CMS and in particular in data analysis.