CMS/CDF CIEMAT-UAM project

(CIEMAT sub-project: FPA2008-05696-C02-01)
(UAM sub-project: FPA2008-05696-C02-02)

J. Alcaraz (CIEMAT - Madrid)

Presentation to the 2008 Spanish Particle Physics Panel

27 May 2008

Ciemat
Centro de Investigaciones Energéticas, Medioambientales y Tecnológicas

UAM
UNIVERSIDAD AUTONOMA DE MADRID

Outline

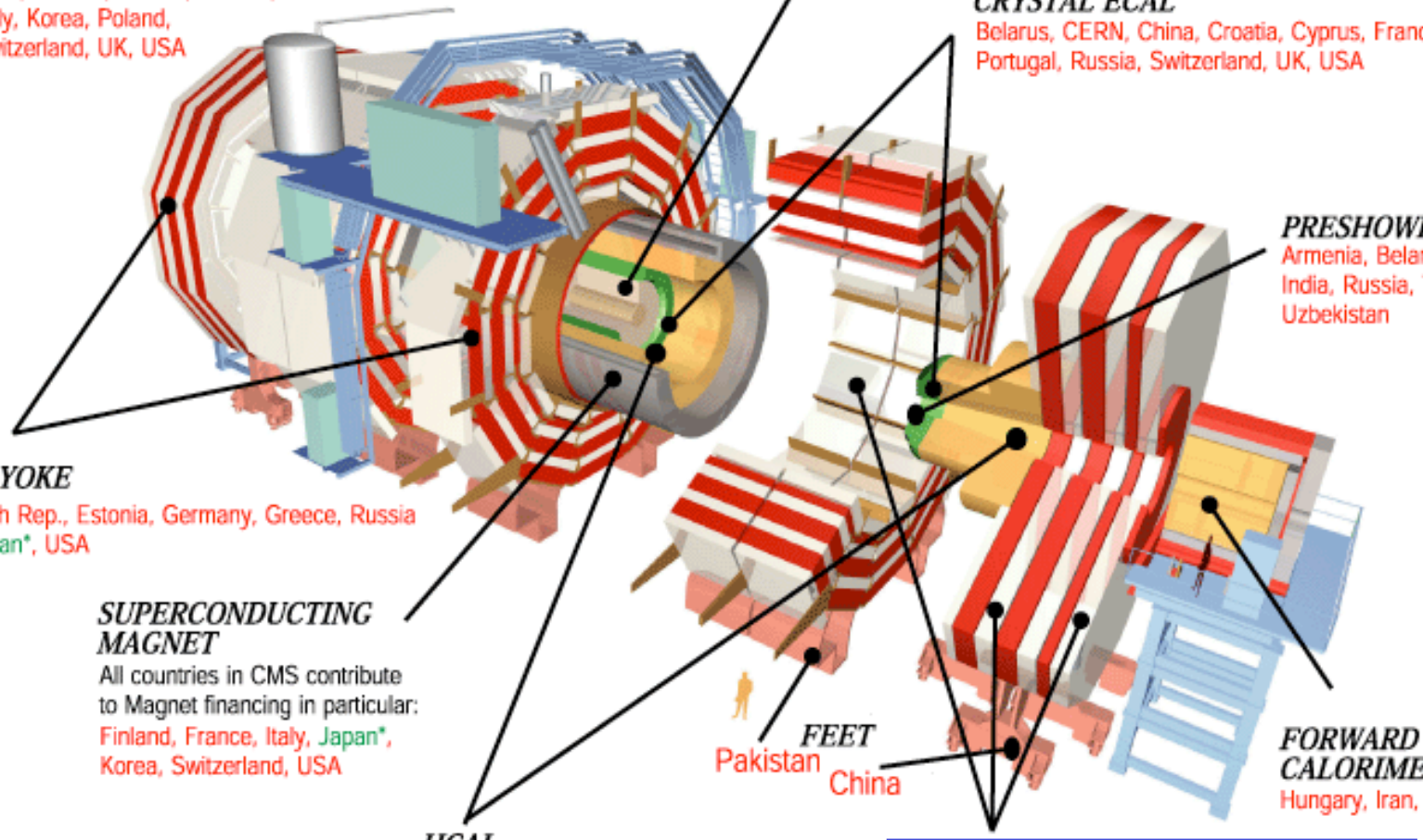
- Record of past and current CIEMAT/UAM activities in CMS and CDF:
  - DT chambers and electronics, alignment (CIEMAT), trigger (UAM)
  - Commissioning and tests
  - Offline/analysis activities
  - CIEMAT participation in CDF and recent results
  - Computing
  - SLHC plans
- Request:
  - Personnel
  - Budget

Ciemat
Centro de Investigaciones Energéticas, Medioambientales y Tecnológicas

The CMS detector at the LHC

UAM UNIVERSIDAD AUTONOMA DE MADRID

31 Nations, 150 Institutions, 1870 Scientists



TRIGGER & DATA ACQUISITION
Austria, CERN, Finland, France, Greece, Hungary, Italy, Korea, Poland, Portugal, Switzerland, UK, USA

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

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

PRESHOWER
Armenia, Belarus, CERN, Greece, India, Russia, Taiwan (PC), Uzbekistan

RETURN YOKE
Barrel: Czech Rep., 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

FEET
Pakistan
China

FORWARD CALORIMETER
Hungary, Iran, Russia, Turkey, USA

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

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

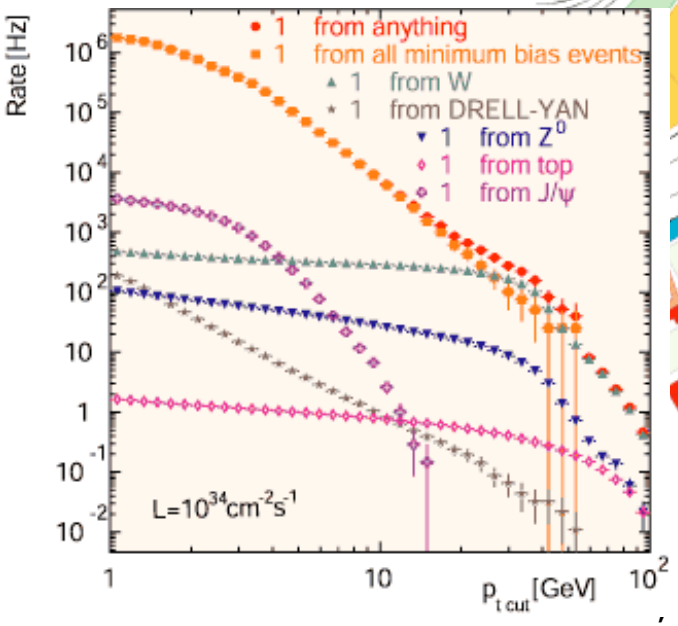
Total weight	**:**	**12500 T**
Overall diameter	**:**	**15.0 m**
Overall length	**:**	**21.5 m**
Magnetic field	**:**	**4 Tesla**

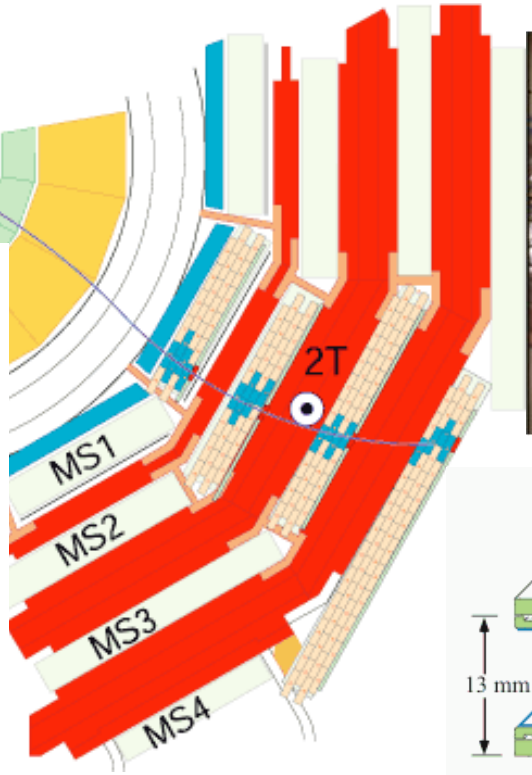
* Only through industrial contracts

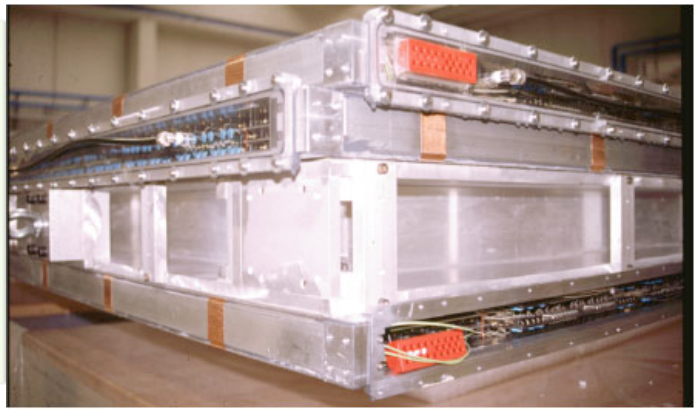
CMS Barrel Muon Chambers

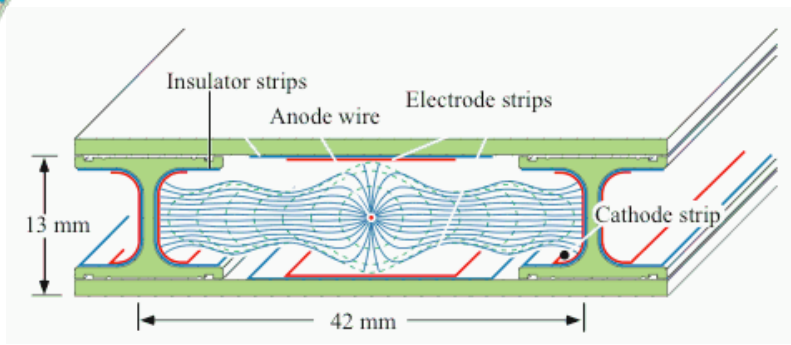
- The CMS muon system (barrel and also endcap) is optimized for:
  - Robust, efficient and redundant muon triggering system (chambers+RPCs)
  - Efficient muon identification and reconstruction ($|\eta|<2.4$, redundant coverage)
  - Precise measurement (< 10%) for TeV momenta (good alignment + level arm)

Intrinsic position resolution per chamber ~ 100 microns









CIEMAT responsibilities in CMS

Construction, Installation, Commissioning of the muon detector (coordinator: M. Cerrada)

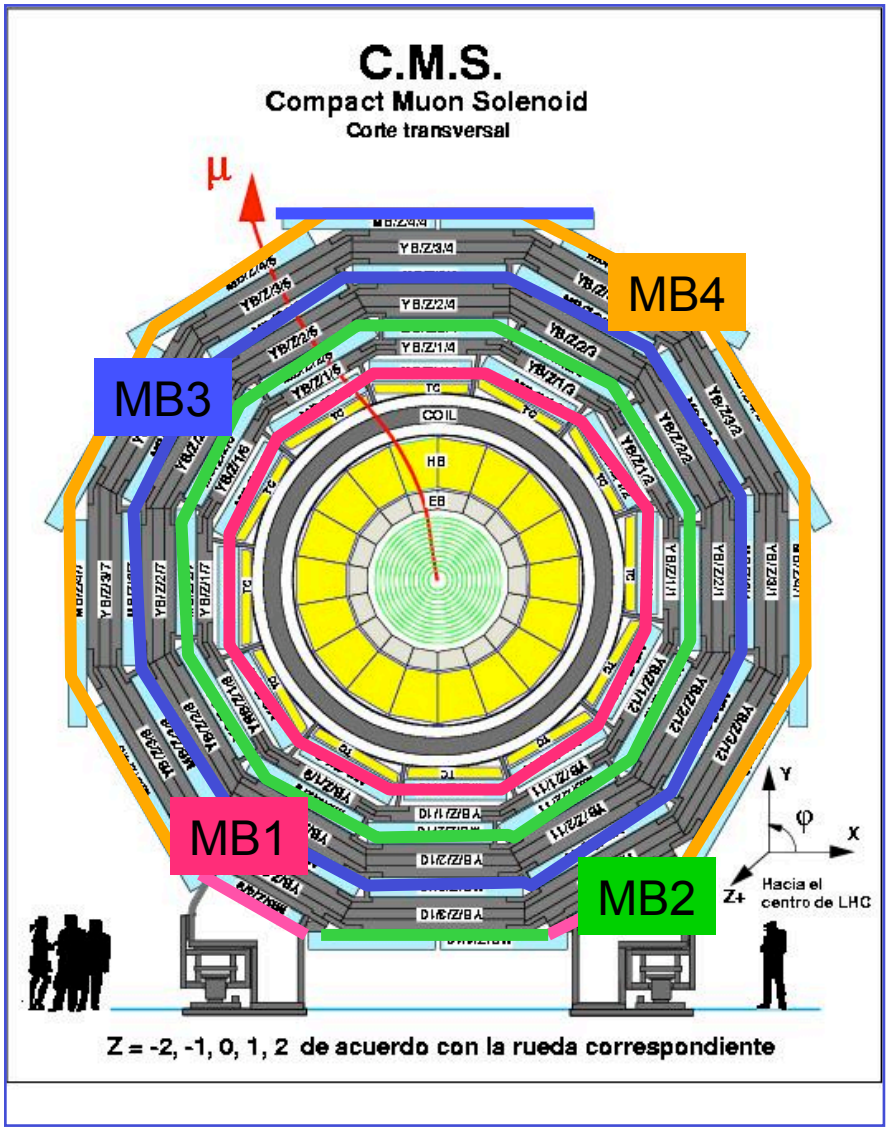
- Drift tube barrel muon chambers (L. Romero et al)
- Electronics for data acquisition (C. Willmott et al)
- Alignment system (A. Ferrando et al)

Preparation for data taking and análysis

- GRID infrastructure (N. Colino et al)
- Software and analysis (J. Alcaraz et al)

DT chamber production

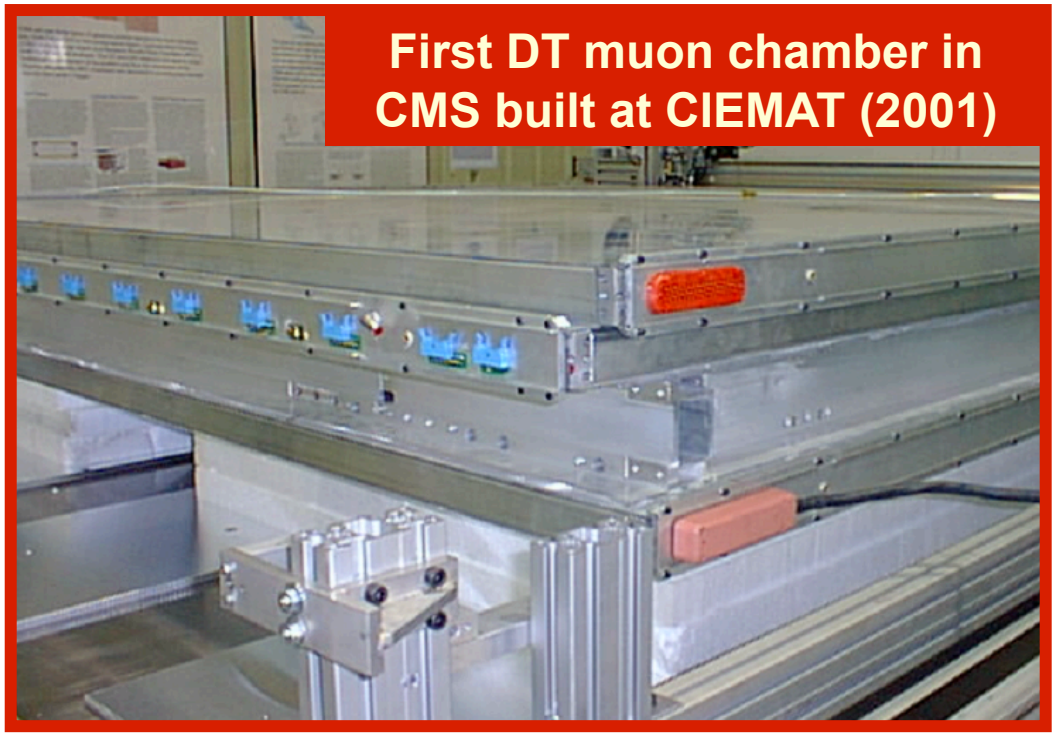
RWTH-Aachen (DE)	60MB1 + 10MB4
CIEMAT (S)	60MB2 + 10MB4
INFN-Legnaro (I)	60MB3 + 10MB4
INFN-Torino (I)	40 MB4



Ciemat
Centro de Investigaciones Energéticas, Medioambientales y Tecnológicas

DT chambers

UAM UNIVERSIDAD AUTONOMA DE MADRID



Production finalized in 2006

L. Romero et al.

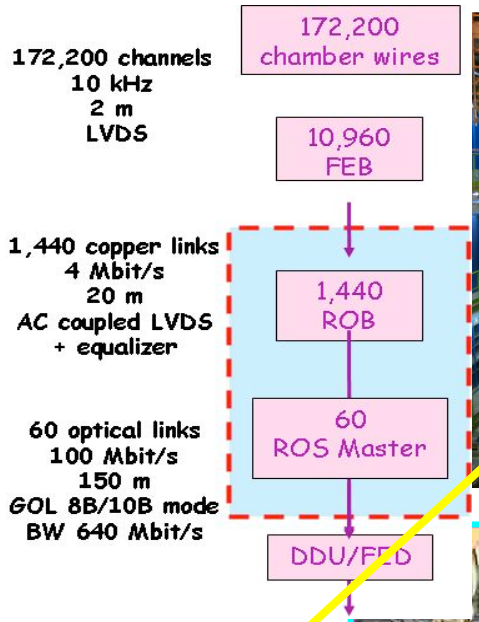
CERN: reception, tests, installation (all DT chambers)

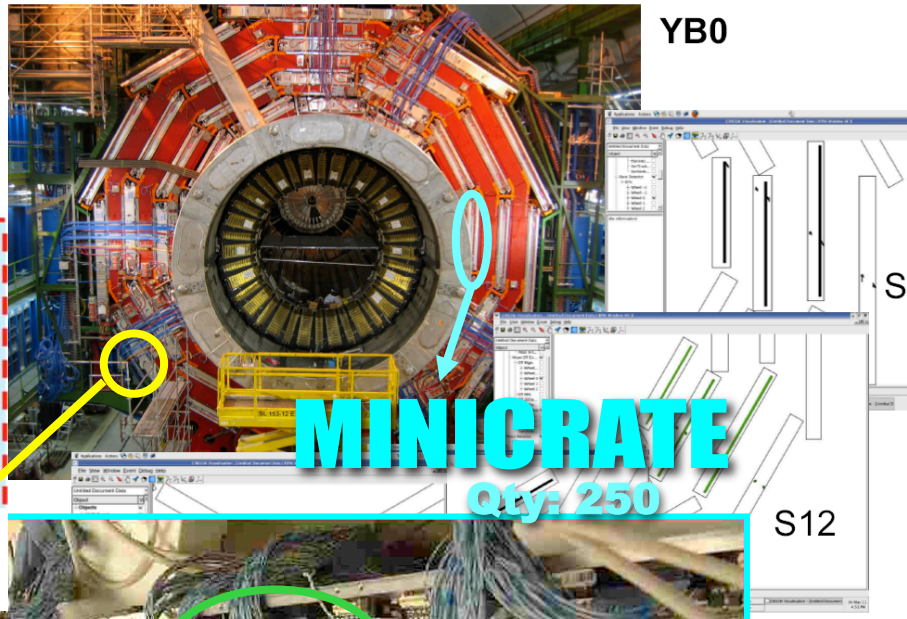
J. Puerta et al.

DT read-out electronics

Design and fabrication of a large fraction of the read-out system of the muon barrel detector:

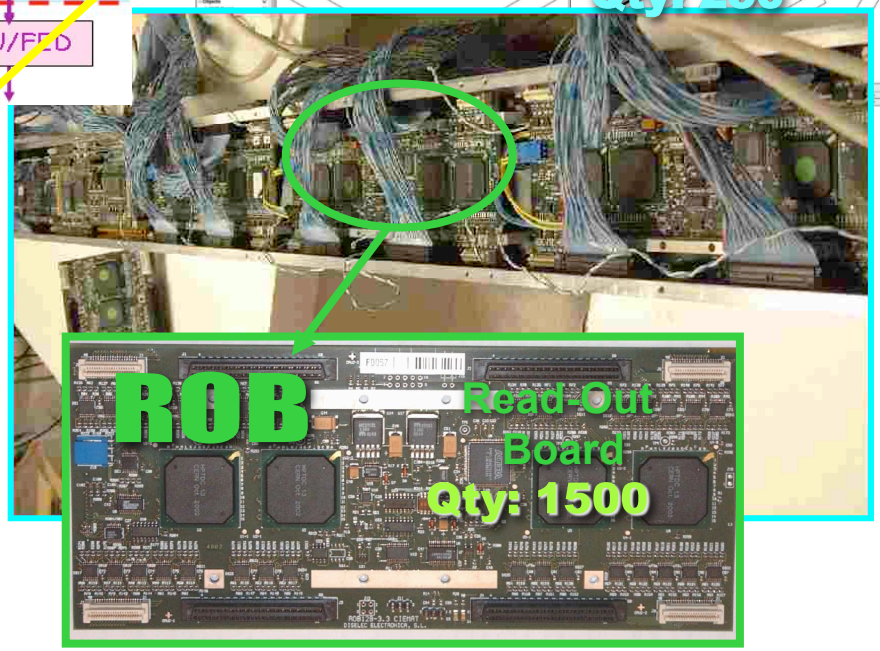
- ❑ **Minicrates**
- ❑ **ROB (Read-Out Boards)**
- ❑ **ROS (Read-Out Server)**





DT electronics activities are coordinated by CIEMAT

C. Willmott
C. Fernández

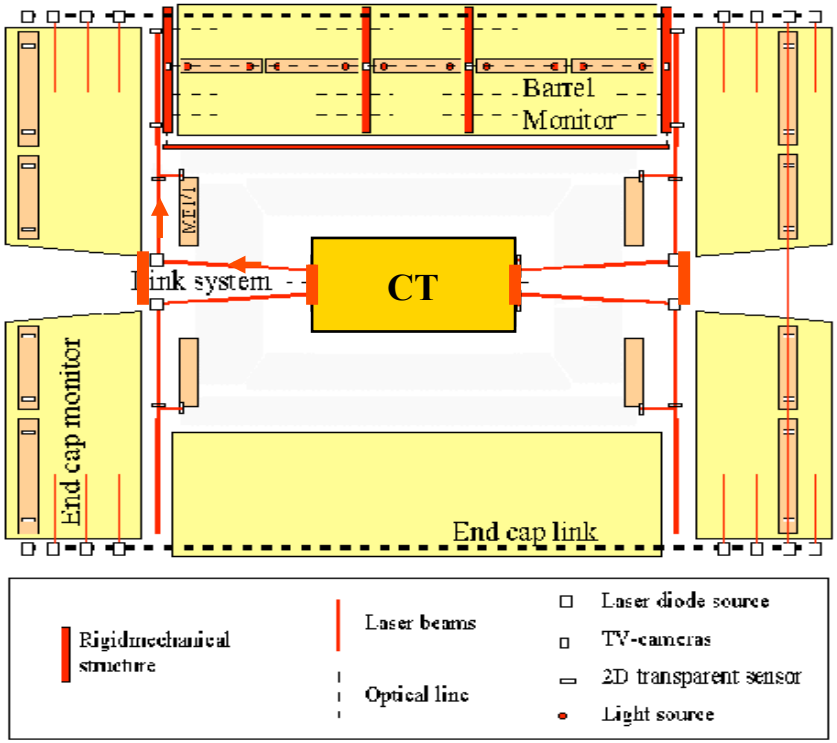


Electronics installed and tested
Necessary interventions have taken place

"Link" alignment system

Main objective:

- Opto-mechanical system designed to monitor the relative position between the muon chambers and the central tracker (CT)
- Expected precision: 100-250 μm.



Joint responsibility of CIEMAT and Universidad de Santander (ICFA):

- System design
- Mechanical design and fabrication of components
- Irradiation tests
- Electronics, DAQ (strong CIEMAT contribution)
- Sensor characterization and tests
- Calibration at CERN (ISR hall)
- Integration in CMS

Antonio Ferrando et al

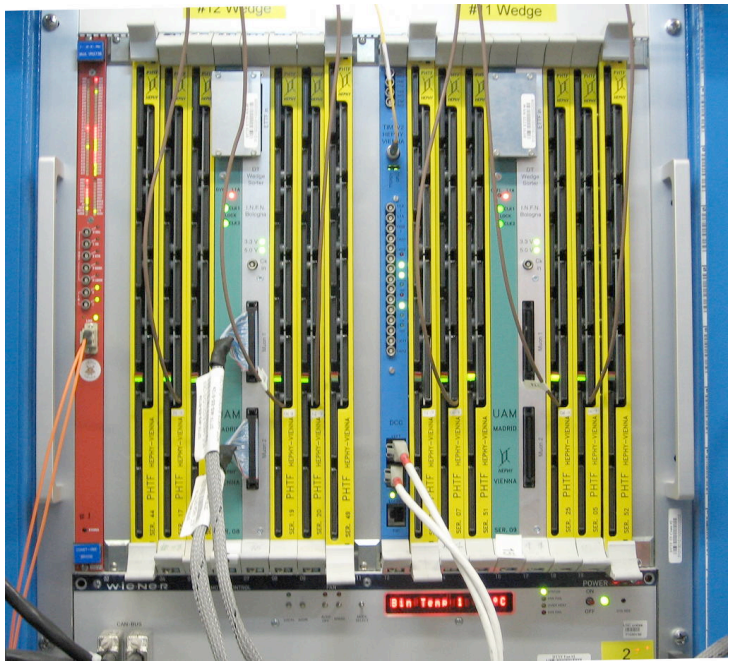
The full system is in place

More details in T. Rodrigo's presentation

UAM responsibilities in CMS

- ✓ **Core of current UAM Projects has been development of DT Track Finder (DTTF) trigger at CMS.**

- ✓ **DTTF activities carried out in close collaboration with High Energy Physics Group of Austrian Academy of Sciences (HEPHY)**



J. Fernández de Trocóniz et al.

- ✓ **Status:**
  1. **April 2006. Production and quality control of all DTTF boards completed.**
  2. **2007-08. Hardware installation and cabling at CMS cavern.**
  3. **2007-08. Final online and offline software development.**
  4. **2006-08. Trigger decision for DT Commissioning and Global Run activities.**

Commissioning / global runs

We have set-up the local system to run simultaneously the 5 wheels with the possibility of running also with other sub-systems (RPC, etc).

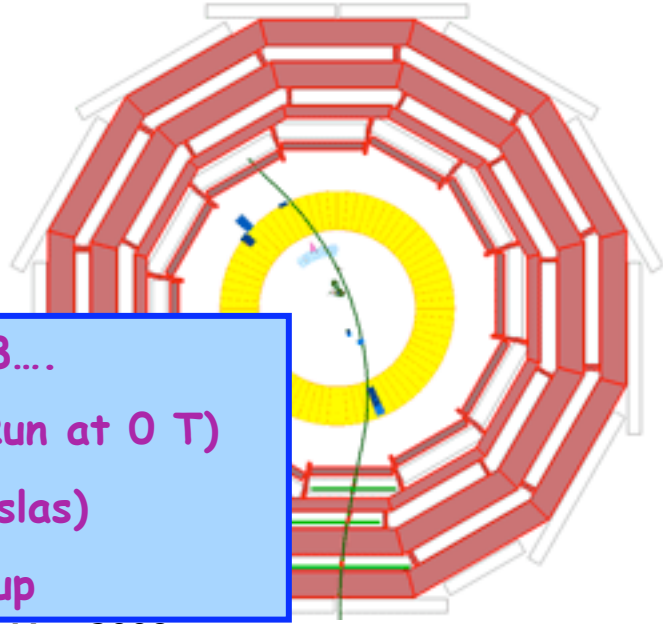
We have participated in different integration tests for joined data acquisition with the various CMS subsystems (ECAL, HCAL, RPC …) and with the Global DAQ and Global Trigger system. This includes the following Global Runs:

Global run May 2007
1 sector (trigger)
Global run June 2007
1 sector (trigger+read-out)
Global run July 2007
1 sector (trigger+read-out)
Global run August 2007
1 Sector synchronized with ECAL. DTTF readout.
Global run September 2007
4 sectors in 2 different wheels (trigger+read-out)
Global run November 2007 (GREN)
Full wheel 0 (trigger+read-out)
Global run March 2008 (GRUMM)
3 full wheels (trigger+read-out)
Global run May 2008 (CRUZET)
5 wheels (trigger+read-out)

Also, some other significant tests performed include:

-High L1A rate tests (91kHZ, limited by DAQ)

-Synchronization tests with the different trigger systems.



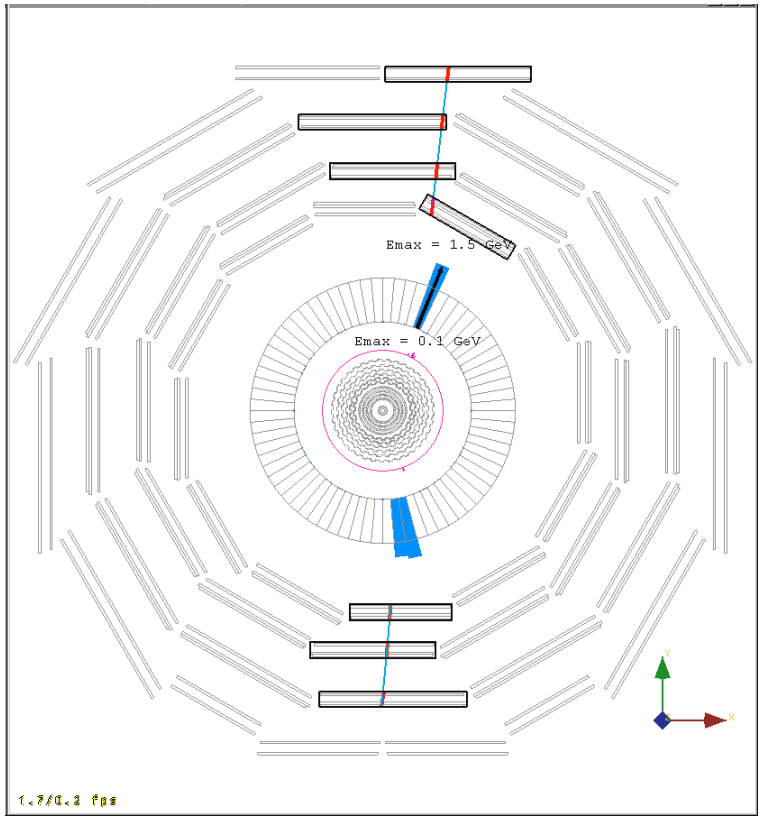
Next in 2008….

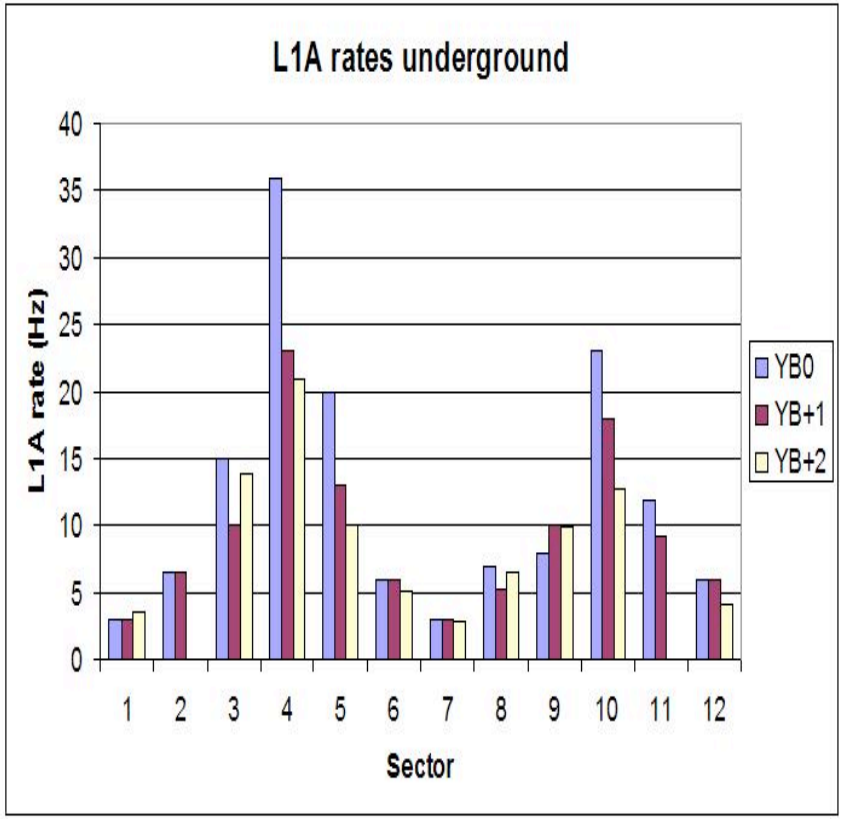
CRUZET II (Global Run at 0 T)

CRAFT (4 Teslas)

LHC Start up

Nice cosmic muons in CMS





The 5 barrel wheels in action

Very high cell efficiency (>90%, usually close to 100%)

Extremely high efficiency of the whole L1 DT trigger system

with DTTF providing final trigger decision

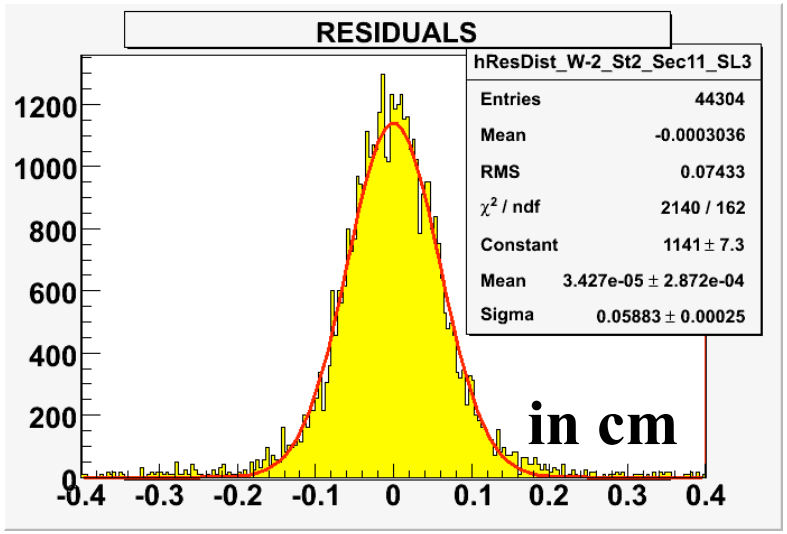
Muon Barrel DPG Coordination (M.C. Fouz)

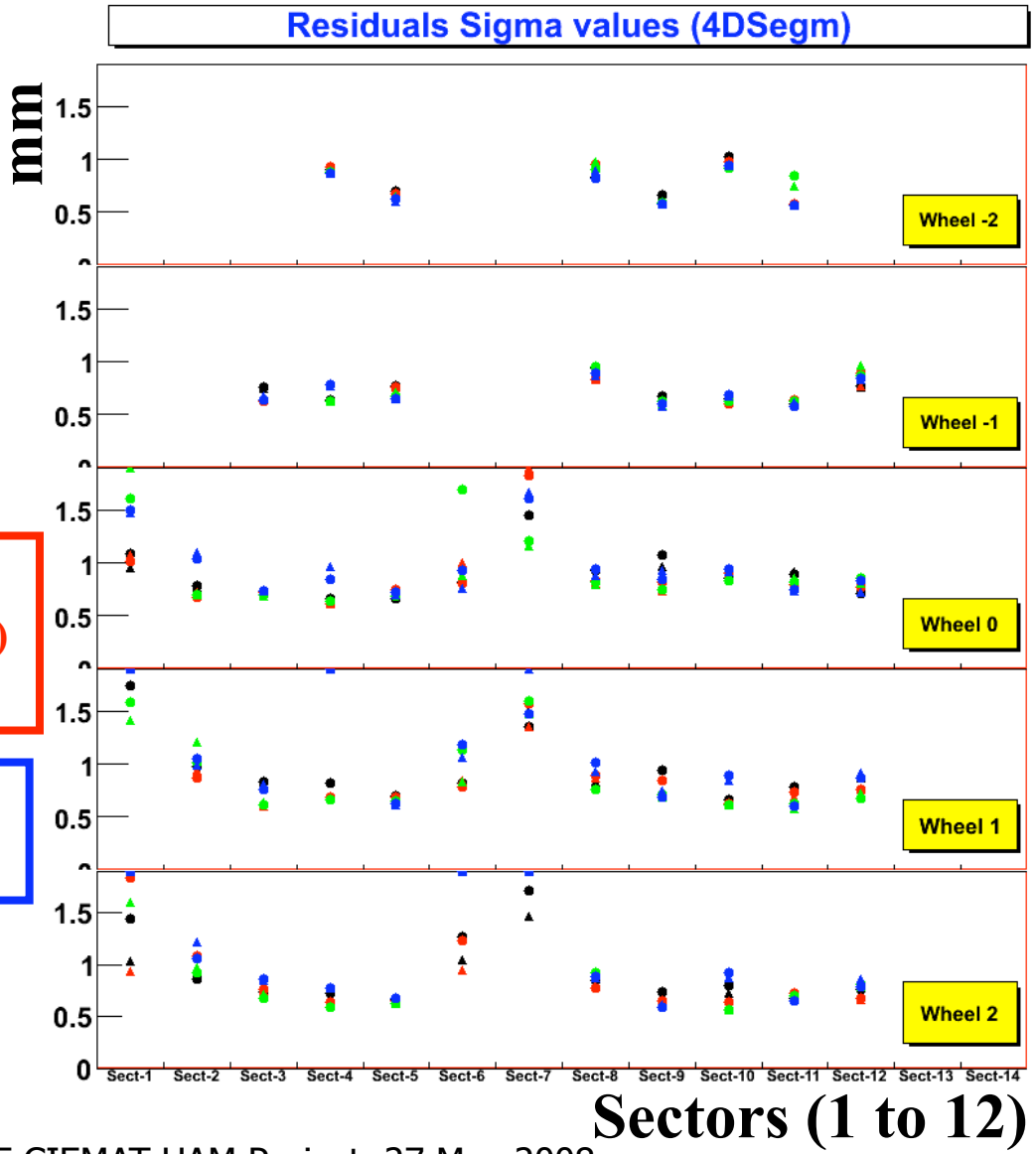
- The DT-DPG (Detector Performance Group) is responsible for establishing the performance of the DT sub-detector system

- The core of the DT-DPG activities is presently focused on the Cosmic Global Run data taken ➔ Preparation for pp collisions:
  - Data Quality Monitoring (DQM) software development
  - Development and test of calibration workflow methods & DB issues
  - Performance of the read-out electronics chain:
    - ROB, ROS, DDU ➔ Data Integrity plots information.
  - Detector performance studies
    - Digitized information: Cell occupancies, time spectra, noise studies
    - Segment reconstruction: Resolutions, single cell efficiency, track reconstruction efficiencies…
  - Local Trigger studies
    - Bunch crossing identification, assignment of muon trigger qualities
    - Cross checks between chamber and local trigger information (efficiencies)
  - Alignment studies

Intense offline data analysis activity to certify the chamber and trigger performance and to provide a fast feedback on possible problems.

DT chamber performance





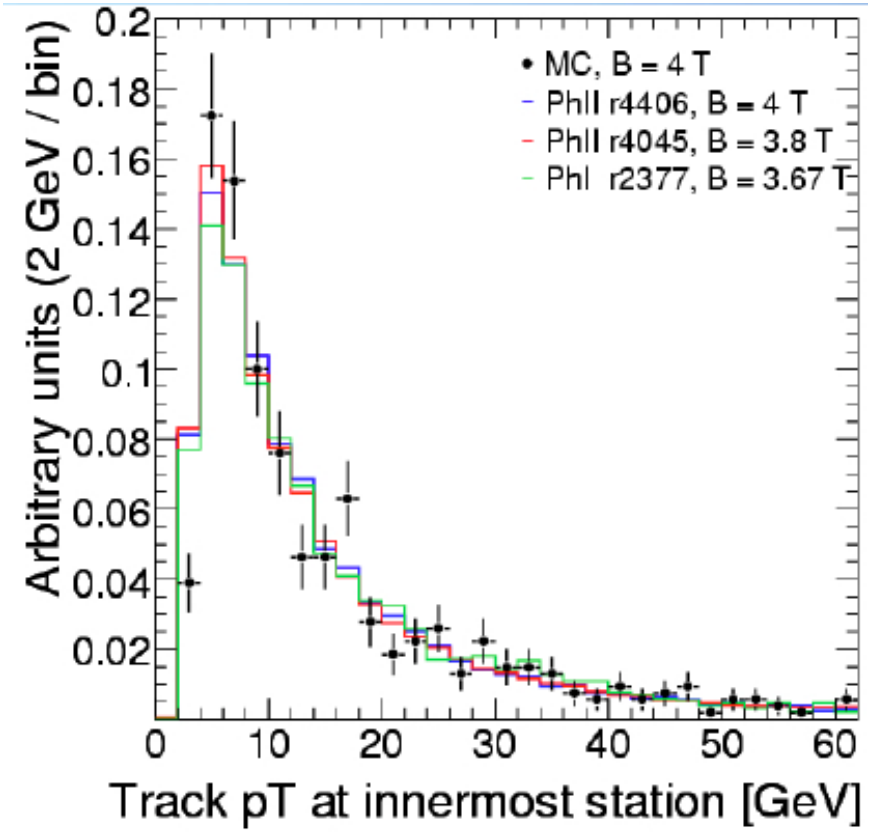
Cosmics are asynchronous ➔
Time uncertanties ±12.5ns (bunch crossing) dominates the resolution (~600 microns)

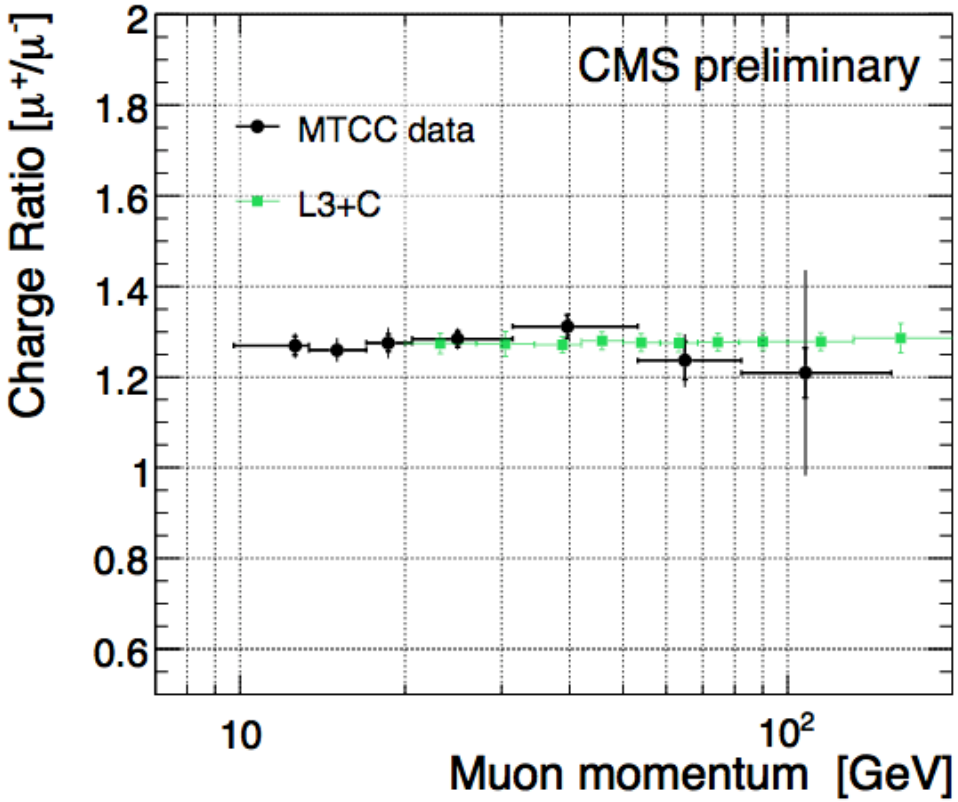
Non-trivial test of T0 corrections:
- **Different sectors are involved**

Horizontal sectors (1,7) ➔ Large incident angles ➔ worse resolution (this will not happen at LHC)

Analysis activities: Cosmic Charge Ratio

P. García-Abia, M. Aldaya, CMS Note 2008-016





A non-trivial test of alignment: constants and implementation

First 'physics measurement' with a LHC detector!

J. Alcaraz, CMS/CDF CIEMAT-UAM Project, 27 May 2008

HLT studies

Available on the CMS information server

CMS AN 2007/009

CMS Analysis Note

The content of this note is intended for CMS internal use and distribution only

October 19, 2007

CMS High Level Trigger

D. Acosta[29], N. E. Adam[32], J. Alcaraz Maestre[16], N. Amapane[14], L. Apanasevich[30], A. Aurisano[35], A. Avetisyan[5], S. Baffioni[5], R. Bainbridge[24], S. Bansal[6], P. Bargassa[34], C. Battilana[10], R. Bellan[14], U. [illegible][5], [illegible][12], T. Bose[25], V. Brigljevic[3], J. Brooke[22], M. Chen[29], L. Christofek[25], B. Dahmes[31], S. Dasu[36], E. Delmeire[17], A. Everett[33], M. Felcini[8], T. M. Frueboes[15], D. Futyan[24], S. Gennai[13], V. Ghete[1], A. Ghezzi[18], D. Giordano[9], S. Goy Lopez[18], S. Greder[24], M. W. Grünewald[8], L. Gray[29], M. F. Hansen[22], G. Heath[22], M. Huhtinen[18], A. Kalinowksi[15], M. Konecki[15], D. Kotlinski[19], V. Krutelyov[27], G. Landsberg[25], D. Lange[31], S. Lehti[4], G. D. Lentdecker[2], J. Leonard[36], C. Leonidopoulos[18], C. Liu[33], B. Mangano[26], K. Mazumdar[7], I. Mikulec[1], M. U. Mozer[2], M. Narain[25], N. Neumeister[33], C.N. Nguyen[35], D. Nguyen[25], A. Nikitenko[24], P. Paganini[5], E. Perez[18], K. Petridis[24], M. Pieri[26], A.N. Saf[illegible][28], S. Sarkar[12], V. Smith[36], T. Speer[21], P. Sphicas[18], W. Sun[28], A. Tapper[24], I.R. Tomalin[23], J.F. de Trocóniz[17], P. Trüb[20], A. Tumanov[34], M. Vander Donckt[18], S. Vanini[11], M. Vazquez Acosta[18], M. Weinberger[35], J. S. Werner[32], L. Wilke[21], M. Wingham[24], G. Wrochna[15], and P. Zotto[11]

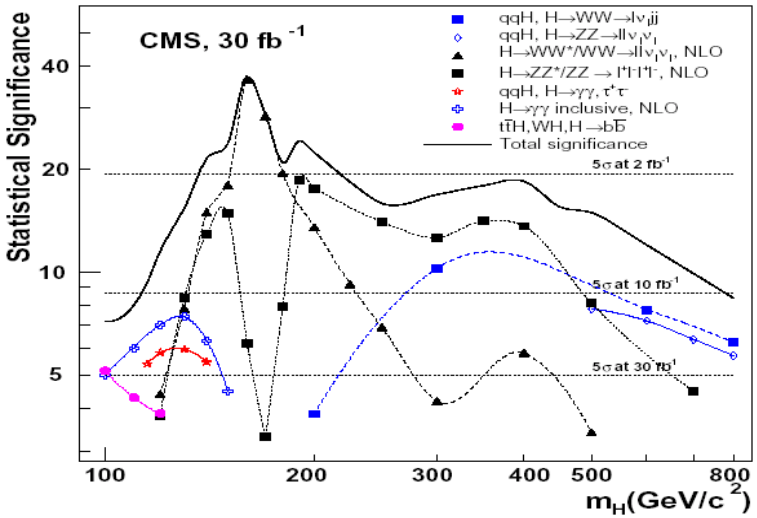
- Reference report concerning the implementation and performance of the High Level Trigger System of CMS
- Processing time / event ~ 40 ms. Event rate considered ~ 150 Hz (factor of 3 safety)
- Muon section editor: J. Alcaraz

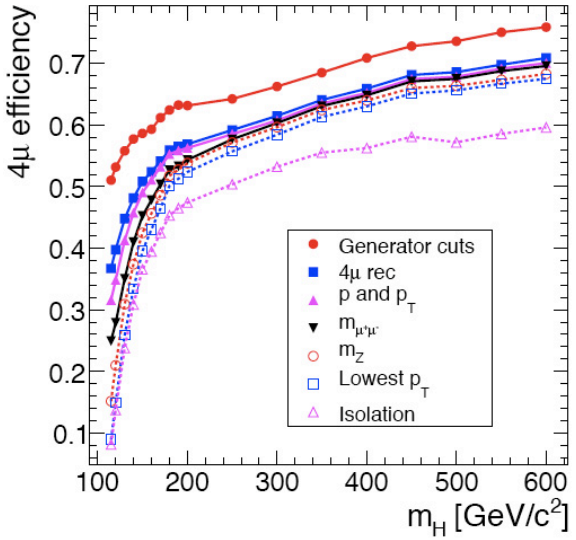
Past analysis activities: TDR

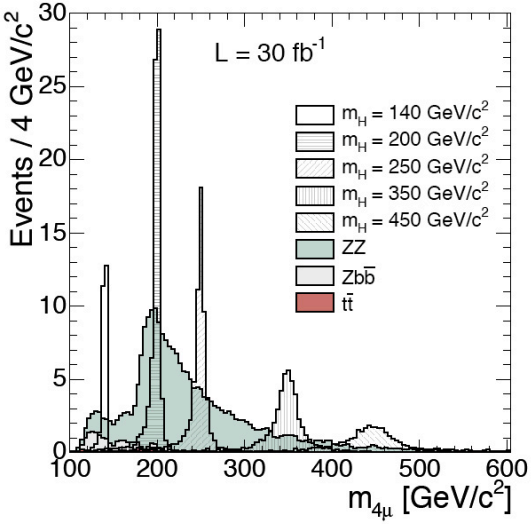
(M. Aldaya, P. Arce, J. Caballero, B. De La Cruz, P. Garcia, J.M. Hernandez, M.I. Josa)

- Full $H \rightarrow ZZ^{(*)} \rightarrow 4\mu$ analysis description

CMS Note 2006-106, CMS Note 2006-107







(J. Alcaraz)

- W/Z studies in the muon channels CMS Note 2006-068

EW/Drell-Yan studies

(J. Alcaraz,, M. Cepeda, B. De La Cruz, M.I. Josa et al.)

Available on the CMS information server **CMS PAS 2007/002**

CMS Physics Analysis Summary

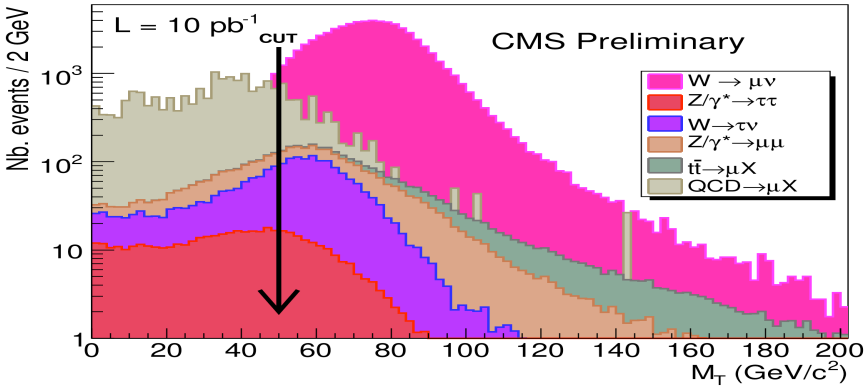
2008/01/30

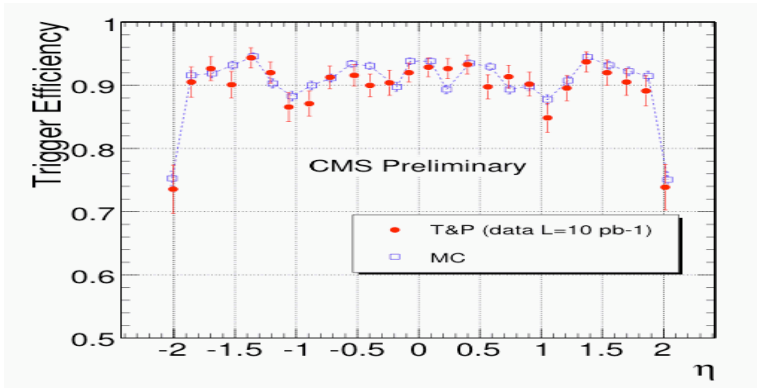
Towards a measurement of the inclusive $W \to \mu\nu$ and $Z \to \mu^+\mu^-$ cross sections in pp collisions at $\sqrt{s} = 14\,\text{TeV}$

The CMS Collaboration

Abstract

We discuss and develop methods for the measurement of the cross sections $pp \to W + X \to \mu\nu + X$ and $pp \to Z + X \to \mu^+\mu^- + X$ with the CMS detector at the LHC, at a center-of-mass energy of 14 TeV. We assume an integrated luminosity of 10 pb^{-1}. It is shown that many of the trigger, isolation, reconstruction and selection efficiencies, as well as the dominant background contributions can be extracted from dedicated studies on data. Uncertainties related to the theoretical description of these processes are also discussed.





- Startup-oriented analysis of W/Z->muons. Special focus on determination of efficiencies, backgrounds and systematic uncertainties using real data. (Editor: J. Alcaraz)

Electroweak Physics coordination: J. Alcaraz

- Electro-weak activities cover the study of all processes related with "direct" boson production:
  - W/Z->leptons (e/μ/τ), W/Z + jets, Drell-Yan processes.
  - Multiple weak-boson production, triple gauge couplings.
  - Parton distribution functions related with the processes above.
  - Studies of validity associated Monte Carlos (re-summation, NLO, …).
  - Methods to determine efficiencies and backgrounds using W and Z samples.
- To be noted that:
  - One of the responsibilities of this group is to provide some of the first LHC physics results (with integrated luminosities ~ 1 pb^{-1} to 10 pb^{-1})
  - Many efficiency/background studies are based on the analysis of W/Z samples: this implies coordinated efforts with other calibration/physics groups.
  - Many activities are in the frontier between electroweak studies and new physics searches:
    - In CMS, the main priority for the Standard Model groups is not to perform precision physics studies, but to understand in detail all processes that are relevant to searches. For instance: di-boson for Higgs, W/Z -> leptons + jets/MET for SUSY, Drell-Yan for high-mass exotic searches, …)

Offline/analysis plans (CIEMAT/UAM)

In the short/medium term, our contribution will be focused on:

a) Participation in muon-related activities:

- Global run studies: understanding of the detector, calibration, muon reconstruction.
- Trigger studies (CIEMAT+UAM): DTTF, L1, HLT

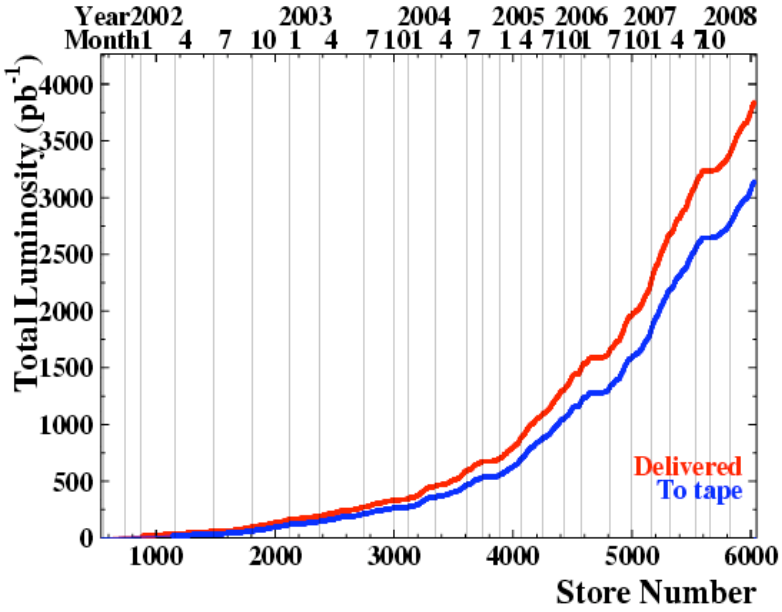
b) Electroweak physics:

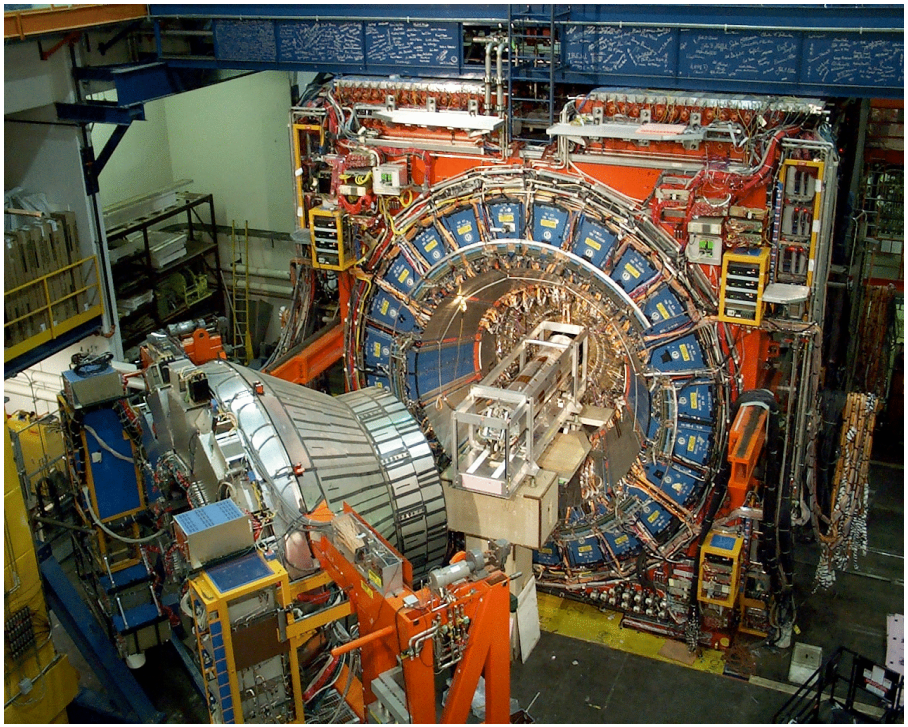
- Concentrating on inclusive W and Z production studies when new data will arrive (cross sections, efficiencies, backgrounds, systematics, PDFs)
- Studies at the frontier between Electroweak and new physics searches (W/Z +jets, Drell-Yan at high invariant masses)

c) New physics studies:

- Continuation of the Higgs studies that we started at the time of the CMS TDR (luminosities above or around 100 pb^{-1} are necessary)

CIEMAT participation at Tevatron



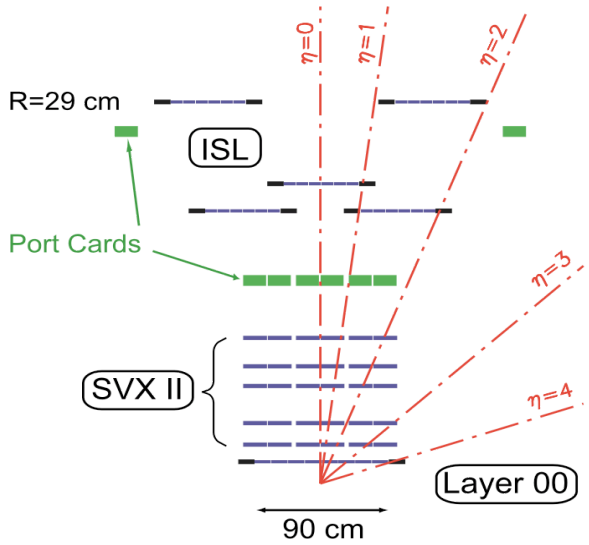


- Present hadron collider with the maximum center-of-mass energy, √s=1.96 TeV. Operation approved until Sept 2009 (extendable to 2010).

- Expected integrated luminosity (by 2009) ~6-7 fb^{-1}, 3.2 fb^{-1} already collected by CDF

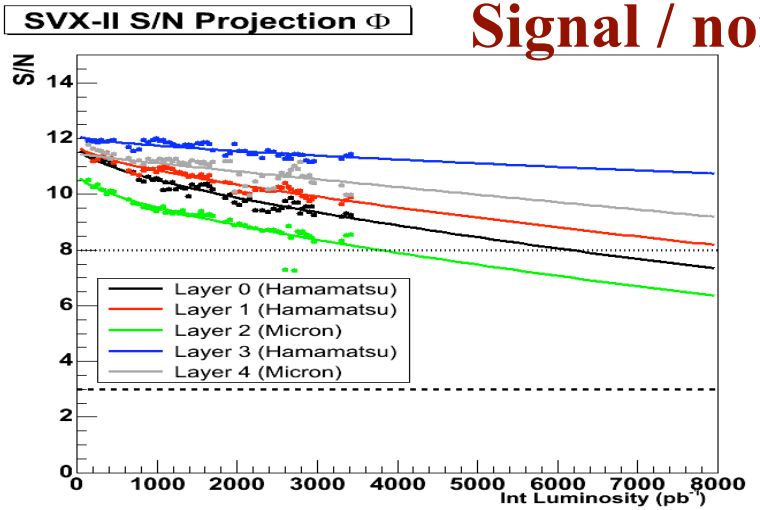
- To optimally exploit the characteristics of the Run II, CDF has upgraded many of its subcomponents, Design, construction, commissioning and maintenances are major tasks. An exampe is the silicon detector.

CDF Silicon Detector



3 subsystems : L00 , SVXII , ISL

Signal / noise



No significant degradation in S/N expected until the end of Run II

Main CIEMAT commitment in CDF

- Initially designed to operate during the first 2-3 fb^{-1} of RunII. Now it must be operated up to 6-8 fb^{-1} : maintenance is a challenge
  - ✓ 1 FTE CIEMAT: agreed contribution to the operation of the Silicon detector.
  - ✓ J.P. Fernández is responsible of ISL alignment, O. González is responsible of the monitoring, I. Redondo was sub-project leader in 2007.
  - ✓ CIEMAT contributes 4 persons out of 9 in total in shifts.

Ciemat
Centro de Investigaciones Energéticas, Medioambientales y Tecnológicas

CIEMAT at CDF: CP violation

UAM UNIVERSIDAD AUTONOMA DE MADRID

J. P. Fernández

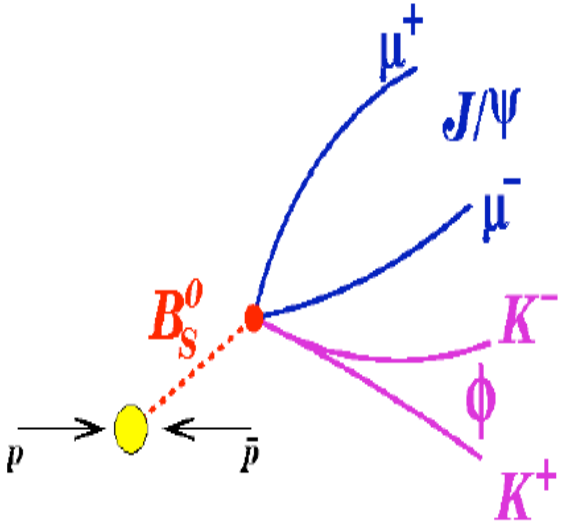
The CP asymmetry in $B^0_s \to J/\psi\,\phi$ is sensitive to the β_s phase

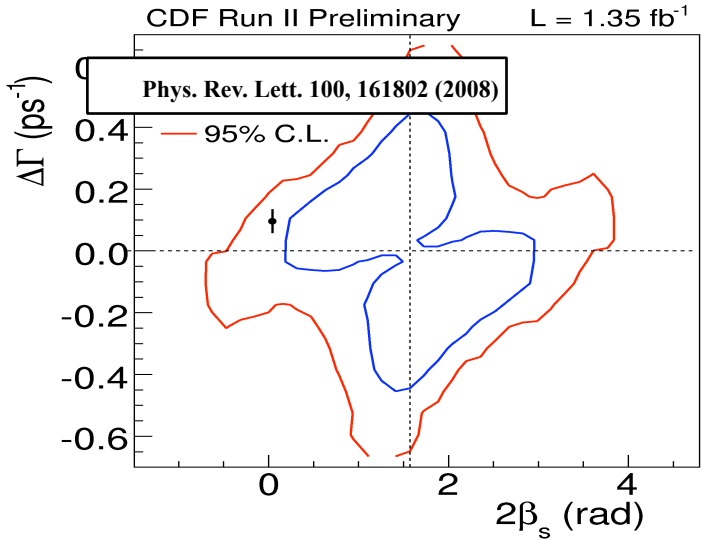
β_s is expected to be < 0.1 in the SM

Ingredients of the analysis: Flavour tagging of initial state + angular analysis of final state to disentangle the contributions from different CP-eigenstates

β_s: two minima are observed in the ($\Delta\Gamma$, β_s) contour plot of the measurement.

With 1.3 fb^{-1}: $2\beta_s \in [0.32, 2.82]$ at 68% CL PRL 100, 161802 (2008).

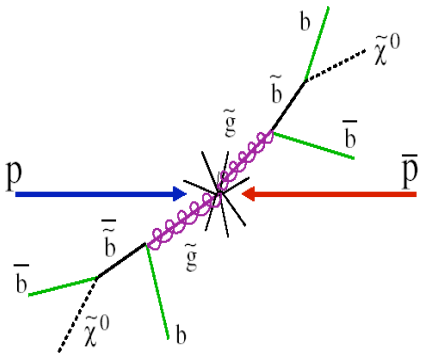


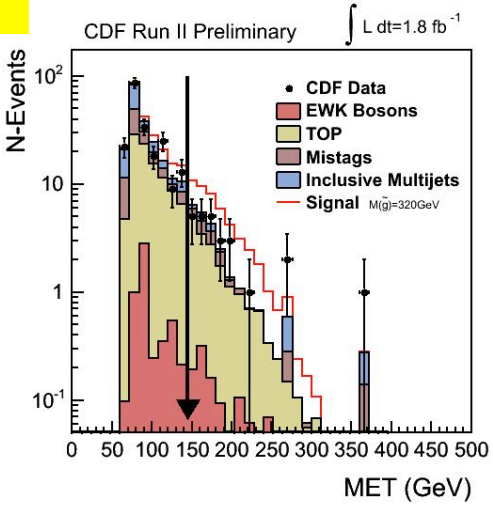


CIEMAT at CDF: searches

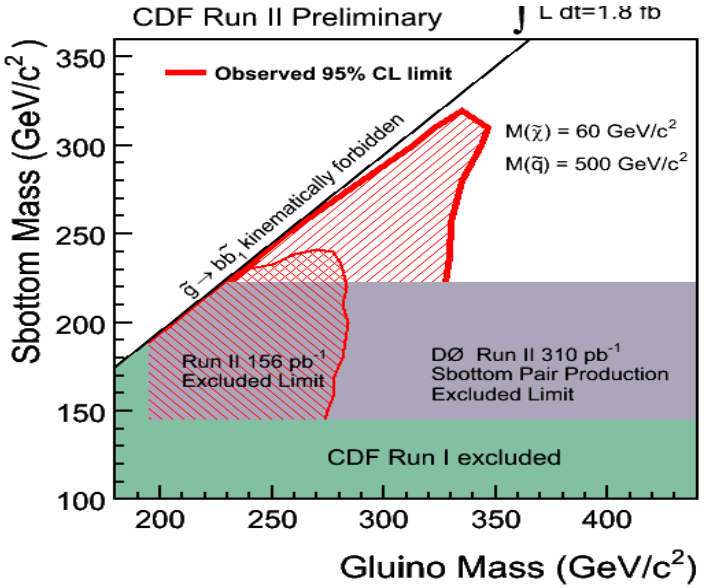
O. González, M. Vidal

- **O. González and one of our students are contributing to the CDF task force in charge of improving the calorimetric E_T resolution at the trigger.**

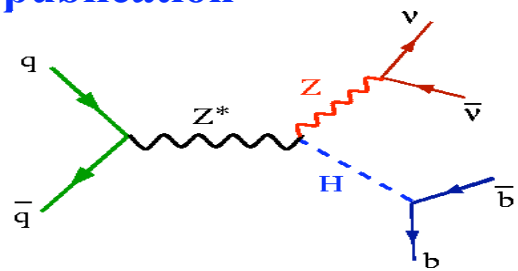




- **Best s-bottom limit from the search via gluino decay. Final state is 4 b-jets + missing E_T. Test of the SUSY region:** $m_t, m_{\tilde{\chi}^+} > m_{\tilde{b}} > m_{\tilde{\chi}^0}$



- **New analysis group: "Higgs Discovery Group". CIEMAT participates in the analysis of ZH →νν bbar. Final state is 2 b-jets + missing E_T. Results in the process of publication**



Ciemat
Centro de Investigaciones Energéticas, Medioambientales y Tecnológicas

GRID at the LHC

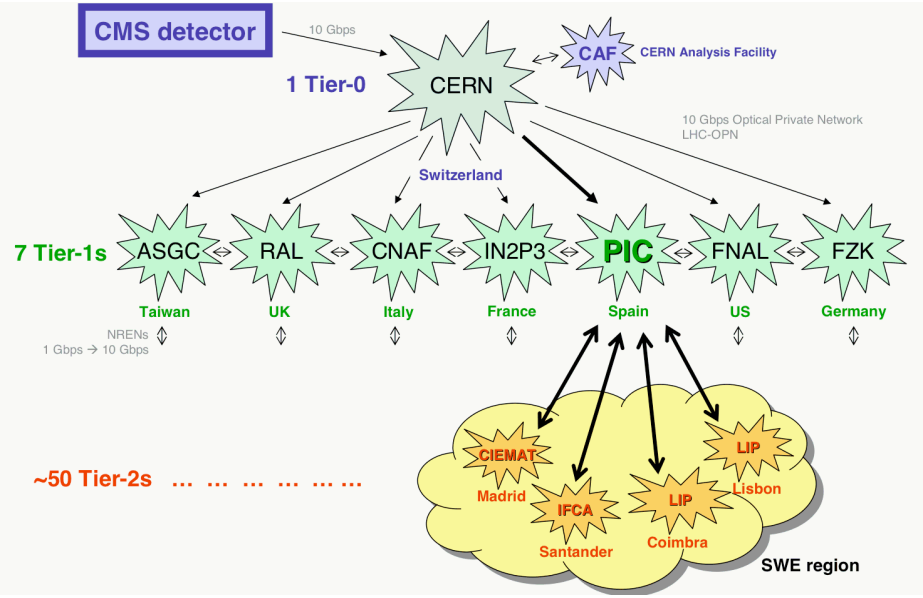
UAM UNIVERSIDAD AUTONOMA DE MADRID

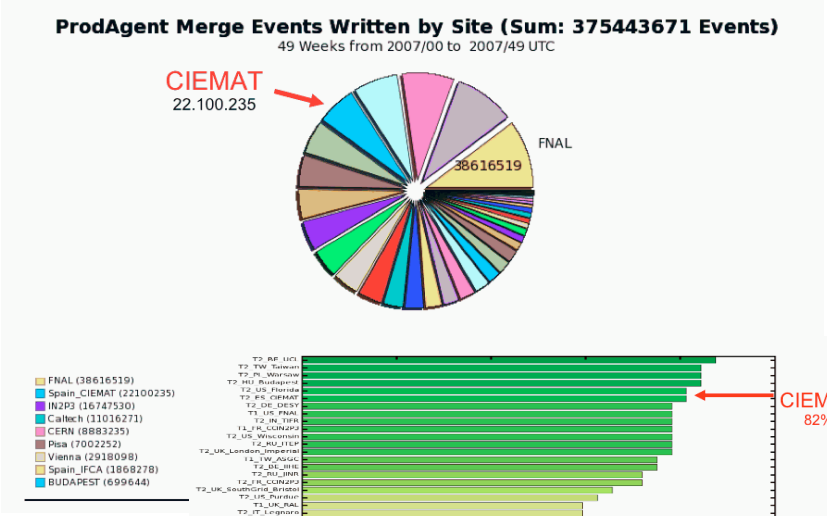
- Tier-0 (CERN):
  - Initial processing of data
  - Distribution to Tier-1 centers
  - Long-term storage of LHC data

- Tier-1 (for instance PIC in Spain):
  - Re-processing of data
  - High availability
  - Custodial/massive storage of data
  - Distribute data streams to Tier-2s
  - National/regional support

CIEMAT Tier-2. Performance

- Tier-2s (CIEMAT, for instance):
  - Production of Monte Carlo samples for Tier1s
  - Storage of regional/physics-analysis group related data
  - (Partial) coverage of user analysis needs



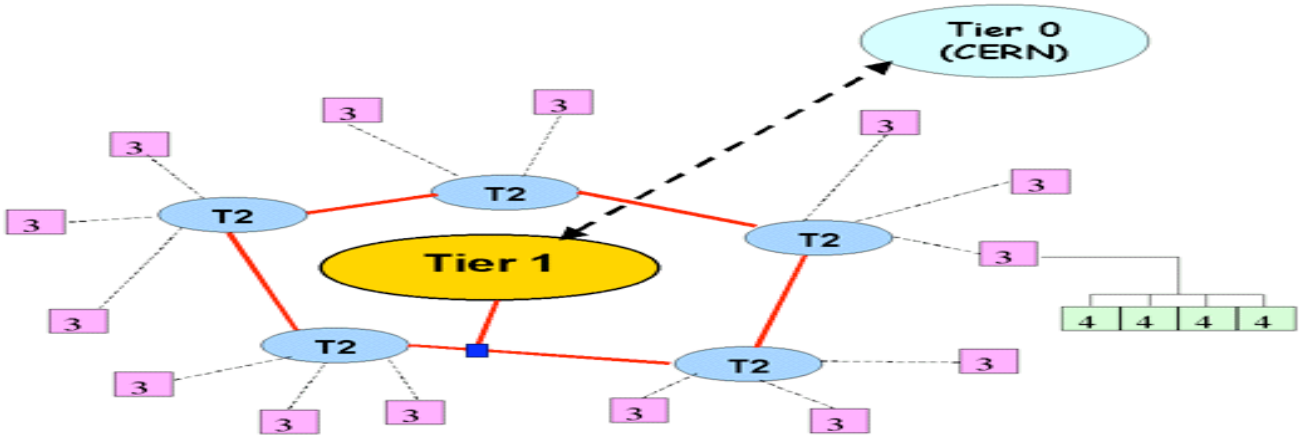


- **Most effective "Tier-2" center for Monte Carlo production in CMS (10%)**
- **One of the more reliable and available centers, also as a function of time**
- **CMS computing responsibilities related with integration, processing and data access**

Tier3 request

- Tier-3s (CIEMAT, UAM)
  - Storage of data relevant for user analysis:
    - Reduced/pre-selected CMS samples
    - User-dependent files for final analysis (Root files, for instance)
  - Agreement between CIEMAT and UAM to have a unique, common Tier-3 structure integrated in the Tier-2 CIEMAT center:
    - Easier for users (same logic and access to data as in the Tier-2)
    - Easier to maintain (more experts available on site)

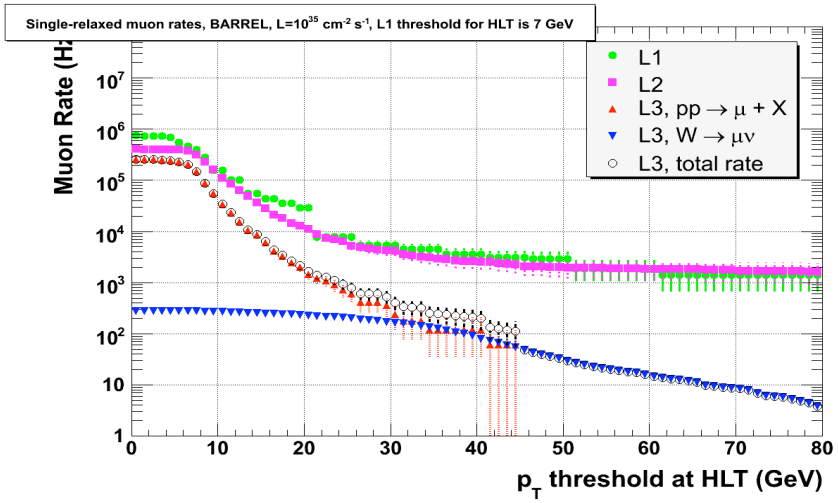
Specific Tier-3 request included in this project

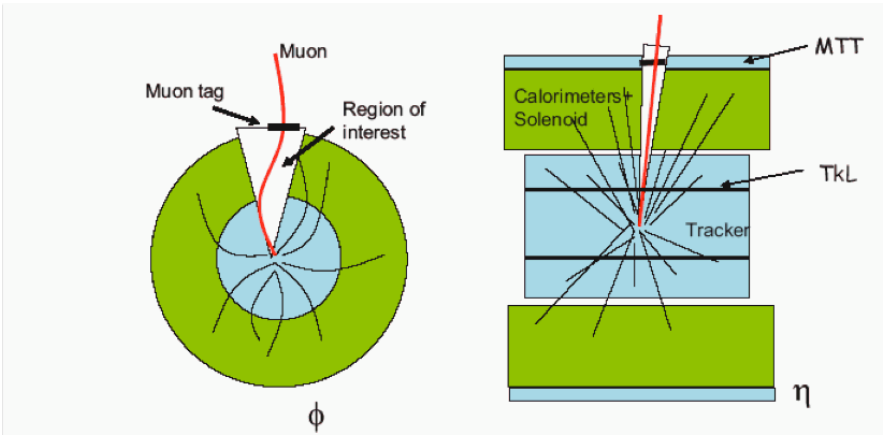


R+D activities for the SLHC

1. **DT read-out and control upgrade:**
   - **Read-Out Servers (ROS) and Device Dependent Units (DDU) will not be able to work properly with the expected increase in rate**

2. **Development of a combined Muon-Tracker Track Finder:**
   - **Natural extension of the DTTF activities already initiated by UAM**





More than 1 kHz in the barrel at L1 even at very high p_T

Improve resolution already at L1 by involving the central tracker in the game!

R+D at SLHC

- ✓ **First proposal for CMS DT upgrade (CMS-Upgrade-Doc 07.09), signed by CIEMAT and UAM (coordinated):**
  - ✓ **The document establishes the absolute necessity of front-end, trigger and read-out electronics upgrades, in which CIEMAT will certainly be involved.**
  - ✓ **Development of combined Muon-Tracker Track-Finder (Activity 4, Task 1). UAM-HEPHY document specifies replacement of Phi and ETa TF processors.**
- ✓ **Schedule (tentative):**
  1. **Complementary to CMS operation and physics exploitation.**
  2. **2010. Simulation. Decision about tracker integration mode.**
  3. **2011. Technology evaluation. Online software, prototyping.**

Ciemat
Centro de Investigaciones Energéticas, Medioambientales y Tecnológicas

UAM
UNIVERSIDAD AUTONOMA DE MADRID

CMS/CDF CIEMAT-UAM project

The request

Objectives of the CIEMAT/UAM project

1. **Maintenance, operation and optimization of the DT muon chambers, their associated read-out electronics and the Laser Alignment System during CMS data-taking at the LHC (CIEMAT)**
   - **DT Detector Performance group coordination by M. Cruz Fouz in 2008-2009**
   - **Close collaboration with UAM in past DT tests, test beams, cosmic data taking**
2. **Maintenance, operation and optimization of the DTTF trigger system during CMS data -taking at LHC (UAM)**
   - **Close collaboration with CIEMAT in past test beams/cosmic data taking**
3. **Participation in R+D efforts for the SLHC (CIEMAT+UAM)**
4. **Participation in analysis activities, and more specifically in activities related to event triggering, electroweak studies and new particle searches (CIEMAT+UAM)**
   - **Electroweak coordination by J. Alcaraz in 2008-2009**
   - **Past experience of UAM members in UA1 and CDF experiments**
5. **Deployment of a Tier-3 center (CIEMAT+UAM)**
6. **Continuation of CDF activities (CIEMAT)**
   - **A progressive migration of CDF members to CMS activities is envisaged.**
   - **Current experience in b-physics and new physics searches can be used to start new lines of research in CMS**

CIEMAT personnel

Ciemat
Centro de Investigaciones Energéticas, Medioambientales y Tecnológicas

UAM
UNIVERSIDAD AUTONOMA DE MADRID

People | **Activities** | **At CMS/CDF**

PARTICLE PHYSICS DIVISION OF CIEMAT

Dr. Juan ALCARAZ	General coordination, software/analysis	100%
María ALDAYA	Software/analysis	100%
Dr. Pedro ARCE	Software/analysis	50%
Constantino CALANCHA	Software/análisis in CDF	100%
Dr. Marcos CERRADA	Maintenance/operation/optimization DT chambers	50%
María Luisa CEPEDA	Software/analysis	100%
Dra. María CHAMIZO	Software/analysis and DT chambers	100%
Dr. Nicanor COLINO	Software/analysis	50%
Dra. Begoña de la Cruz	Software/analysis and DT chambers	100%
Dr. Juan Pablo FERNÁNDEZ	CDF, software/analysis	100%
Dr. Antonio FERRANDO	Alignment	100%
Dra. María Cruz FOUZ	DT chambers (until 2009)	50%
Dr. Pablo GARCÍA	Software/analysis	50%
Dr. Óscar GONZÁLEZ	CDF, software/analysis	100%
Dr. Jose María HERNÁNDEZ	Software/analysis	50%
Dra. Isabel JOSA	Software/analysis, DT chambers and readout	100%
Roberto MARTÍNEZ	Software/análisis in CDF	100%
Dr. Jesús PUERTA	Maintenance/operation/optimization DT chambers	50%
Dr. Ignacio REDONDO	CDF, software/analysis	100%
Miguel VIDAL	Software/análisis in CDF	100%

CIEMAT personnel

People	Activities	at CMS
CIEMAT ELECTRONICS/ENGINEERING AREA		
Cristina FERNÁNDEZ	Electronics/SLHC	50%
Antonio MOLINERO	Alignment	50%
Juan Carlos OLLER	Alignment/electronics	50%
Javier NAVARRETE	Alignment	50%
Dr. Carlos WILLMOTT	Electronics/SLHC	50%

Current UAM personnel

2002 Project		at CMS
Carmen Albajar	Senior physicist	100%
Jorge F. de Trocóniz	Senior physicist	100%
2006 Project		
José O. López	Software engineer (until December 2008)	100%
Alberto García	Physicist (until July 2008)	100%
Pedro Rodríguez	UAM Technical Engineer	33%

CIEMAT budget

Table 1

Summary of CIEMAT funding requested in kEuros

Concept	1st year	2 nd year	3rd year
Personnel	45	45	45
Computing equipment	30	25	20
Electronics spares	25	25	—
CDF experiment	50	50	20
CMS short stays at CERN	120	100	80
CMS Maintenance and Operation, cat. B	115	115	115
CMS Installation and Integration costs	150	—	—
CMS memorandum of Agreement for CMS maintenance and operation (longs stays at CERN)	96	96	96
TOTAL	631	456	376

- Personnel: 1 post-doc with DESY|Tevatron|LHC experience
- Computing equipment for Tier-3: 15 persons analyzing data are assumed; budget/person estimates agreed at the Spanish GRID level.
- Electronics: procurement for new ROB-ROS interfaces in 2009-2010
- CDF request just for stays in Fermilab (mostly students + 1 FTE senior). A progressive integration of CDF members in CMS is planned. Note: expenses correspond to the 2008-2010 period.
- CMS short stays at CERN: more frequent in the first years. More than realistic based on our previous experience.

CIEMAT budget

Table 1

Summary of CIEMAT funding requested in kEuros

Concept	1st year	2 nd year	3rd year
Personnel	45	45	45
Computing equipment	30	25	20
Electronics spares	25	25	—
CDF experiment	50	50	20
CMS short stays at CERN	120	100	80
CMS Maintenance and Operation, cat. B	115	115	115
CMS Installation and Integration costs	150	—	—
CMS memorandum of Agreement for CMS maintenance and operation (longs stays at CERN)	96	96	96
TOTAL	631	456	376

- Maintenance and Operation and extra costs of installation and integration: previously agreed Spanish contribution. The total costs are shared with IFCA, as also agreed
- MoA contribution: also an unavoidable commitment

- We have requested 3 Ph.D. students for the whole period of the project. CRITICAL FOR THE LHC STARTUP PERIOD!!
- Note that no specific budget request for detectors or SLHC developments had been made

Ciemat
Centro de Investigaciones Energéticas, Medioambientales y Tecnológicas

UAM budget

UAM UNIVERSIDAD AUTONOMA DE MADRID

Concept	2009	2010	2011
Electronics	1	1	1
Trigger M&O Cat. B	3	3	3
Computing equipment	14	7	7
Travel & Long stays at CERN	24	24	24
Personnel	54	64	32
Total	96 k€	99 k€	67 k€

✓ **Computing:** **Contribution to Tier-3 CIEMAT-UAM (20 k€); workstations (8 k€).**

✓ **Electronics + M&O + Travel:** **Maintenance, operation and upgrade (SLHC) of CMS DTTF Trigger.**

✓ **Travel:** **Collaboration with CMS physics analysis groups at CERN.**

UAM budget (personnel)

Electronics technical engineer for DTTF maintenance at CERN and UAM; SLHC R+D	24 months	84
FP2 Technician for Tier 3 installation and maintenance	36 months	66
Total		150 k€

✓ **In addition, it is extremely important to engage UAM Ph.D. students in LHC analyses: 2 FPI fellowships requested; 1 is minimum (in 2006-08, no fellowship was granted).**

Previous CIEMAT budget for CMS/CDF

- FPA 2005-01770 for CMS (november 2005 – november 2008)
  - Received: 790 KEuros (640 execution costs, 150 personnel)
  - Spent by today: EVERYTHING
  - Justified: only a small fraction of personnel (2 technicians) is left for justification in March 2009
- FPA 2006-26415-E Additional costs for CMS part 1: 150 kEuros
  - Everything spent and justified: cables, installtaion, low voltage power supplies, alignment sensors)
- FPA 2007-29113-E Additional costs for CMS part 2: 150 kEuros
  - 130 kEuros spent and justified already: completion of ROS electronics, installation and low-voltage power supplies
- FPA 2006-26411-E Special action for CDF expenses in 2007: 45 kEuros
  - Everything spent and justified

Previous UAM budget for CMS

- FPA 2002-02552 + FPA 2005-00780 for CMS muon trigger activities (2003–2008): 450 kEuros
  - Everything spent and justified

Backup slides

Ciemat
Centro de Investigaciones Energéticas, Medioambientales y Tecnológicas

Proyectos CICYT CIEMAT

UAM UNIVERSIDAD AUTONOMA DE MADRID

- AEN 91-1283-E: "Participación en RD5"
- AEN 92-0829: "Realización de los Experimentos L3 y WA94 en los aceleradores LEP y SPS del CERN. Investigación y desarrollo para el proyecto LHC"
- AEN 93-1069-E: "Prototipos de Módulos Calorimétricos para LHC"
- AEN 93-1012-E: "Diseño y desarrollo de un Sistema de Alineamiento de detectores"
- AEN 94-1264-E: "Calorimetría con PPC's para LHC"
- AEN 94-1263-E: "Desarrollo de un prototipo de Sistema de Alineamiento para CMS"
- AEN 95-1332-E: "Desarrollo y pruebas de prototipos para el Sistema de Alineamiento de CMS"
- AEN 95-1335-E: "Construcción y prueba de un calorímetro para CMS"
- AEN 95-1331-E: "Construcción de un prototipo de cámara de deriva para el detector de muones de CMS"
- AEN 95-2023-E: "Evaluación de una contribución al Sistema "FRONT END READ-OUT" del Experimento CMS"
- AEN 96-2051-E: "Calorimetría a pequeño ángulo para CMS"
- AEN 96-1646-C03-01: "Construcción de cámaras de deriva para el Detector Central de Muones del Experimento CMS"
- AEN 96-1646-C03-02: "Diseño y construcción del sistema de alineamiento que relaciona el Detector de Muones con el Detector de Trazas central en el Experimento CMS"
- AEN 96-1646-C03-03: "Diseño y fabricación de componentes electrónicos para los sistemas de adquisición de datos y "trigger" del Detector de Muones del Experimento CMS"
- AEN 97-1694: "Participación en la construcción del detector de muones de CMS"
- AEN 99-0312: "Participación en la construcción del detector de muones de CMS"
- FPA 2002-00829: "Participación en el experimento CMS del LHC"
- FPA 2005-01770: "Participación en el experimento CMS del LHC"

Desde 1999: 4,8 Meuros + 1,5 Meuros (Common Fund) + 0,4 Meuros (M+O)

CIEMAT offline/analysis activities in CMS

- Seniors:
  - **Juan Alcaraz**: HLT muon issues, W/Z->muons studies, CMS ElectroWeak (EW) Group coordinator (2008-2009).
  - Pedro Arce: DT muon simulation responsible, alignment, Higgs analysis.
  - Nicanor Colino: GRID and computing
  - Begona De La Cruz: DT muon validation responsible, Higgs analysis, HLT and EWK studies
  - M. Cruz Fouz: cosmic test activities, responsible of the analysis of commissioning data, ...
  - Pablo Garcia: Higgs analysis, CSA08 exercise coordination.
  - Chema Hernandez: GRID activities, Higgs analysis.
  - Isabel Josa: Validation, Higgs analysis., EWK sudies.
- Students:
  - Maria Aldaya: Ph.D. (June 2008): Higgs studies, muon reconstruction studies with cosmic data
  - Jose Caballero: Ph.D. on GRID activities (2008)
  - Maria Luisa Cepeda: Master work on muon calibration with J/Psis, electroweak studies with muons, search for high-energy muon pair resonances, ...
  - + 2 new students: starting now with their Master work: EW studies, muon chamber performance, ...

Ciemat
Centro de Investigaciones Energéticas, Medioambientales y Tecnológicas

Chronogram

UAM
UNIVERSIDAD AUTONOMA DE MADRID

Tasks	Centre	Persons	First Year (*)	Second Year (*)	Third Year (*)
DT Maintenance, Operation and Optimization	CIEMAT	M.C. Fouz, J. Puerta, M. Cerrada, B. De La Cruz, I. Josa, M. Aldaya, J. Alcaraz, …	x|x|x|x|x|x|x|x|x|x|x	x|x|x|x|x|x|x|x|x|x|x	x|x|x|x|x|x|x|x|x|x|x
Readout-electronics Maintenance, Operation and Optimizatior	CIEMAT	C. Willmott, C. Fernández, I. Josa	x|x|x|x|x|x|x|x|x|x|x	x|x|x|x|x|x	x|x|x|x|x|x
Alignment Maintenance, Operation and Optimization	CIEMAT	A. Ferrando, A. Molinero, J.J. Navarrete, J.C. Oller, P. Arce	x|x|x|x|x|x	x|x|x|x	x|x|x|x
Maintenance of the DTTF trigger electronics (ETTF) *Operation of DTTF trigger*	UAM	J.F. de Trocóniz P. Rodríguez Technician (eng.)	x|x|x|x|x|x|x|x|x|x|x	x|x|x|x|x|x	x|x|x|x
Reconstruction and simulation of DTTF data *Optimization of DTTF trigger performance*	UAM	J.F. de Trocóniz students	x|x|x|x|x|x|x|x|x|x|x	x|x|x|x|x|x	x|x|x|x
Muon offline activities: simulation, validation, reconstruction, High Level trigger	CIEMAT/UAM	B. De La Cruz, J. Alcaraz, P. Arce, J.F Trocóniz, …	x|x|x|x|x	x|x|x|x	x|x|x|x
CMS Analysis activities	CIEMAT/UAM	J. Alcaraz, P. García, B. De La Cruz, I. Josa, J.F. De Trocóniz, C. Albajar, N. Colino, J.M. Hernández, M.L. Cepeda, M. Aldaya, ...	x|x|x|x|x|x|x|x|x|x|x	x|x|x|x|x|x|x|x|x|x|x	x|x|x|x|x|x|x|x|x|x|x

Chronogram

Tasks	Centre	Persons	First Year (*)	Second Year (*)	Third Year (*)
Deployement of CIEMAT-UAM CMS Tier3	CIEMAT/UAM	N. Colino, J.F. Trocóniz, …	x|x|x|x|x|x|x|x|x|x|x	x|x|x|x|x	x|x|x|x
Computing activities CIEMAT	CIEMAT	J.M. Hernández, …	x|x|x|x|x|x|x|x|x|x|x	x|x|x|x|x	x|x|x|x
CDF activities	CIEMAT	J.P. Fernández, O. González, I. Redondo, students	x|x|x|x|x|x|x|x|x|x|x	x|x|x|x|x|x|x|x	x|x|x|x
SLHC activites: R+D for read-out electronics	CIEMAT	C. Willmott, C. Fernández	x|x	x|x|x|x	x|x|x|x
SLHC activities: R+D for muon trigger update	UAM	J.F. Trocóniz, P. Rogríguez (eng.)		x|x|x	x|x|x

Ciemat
Centro de Investigaciones Energéticas, Medioambientales y Tecnológicas

UAM UNIVERSIDAD AUTONOMA DE MADRID

UAM DTTF Responsibilities 2002-08

1. **Infrastructure:** Setup, in 2003, of UAM-CMS electronics lab in Madrid, used for prototype testing and online software development.
2. **Hardware:** Design, prototyping, and production of 17 9U VME ETa Track Finder Processor boards. Contribution to design, prototyping and production of 84 PHTF processors (with HEPHY).
3. **Online Software:** Responsibility for all DTTF software for design and quality control (up to 2006); configuration, operation, local DAQ, and monitoring (since 2006), integrated in CMS Trigger Supervisor.
4. **Offline Software:** Responsibility for all DTTF-related software in CMSSW platform: data unpacking and fast analysis; bit-level C++ emulator.
5. **DTTF Performance:** Responsible for DTTF trigger efficient operation (extrapolation and muon parameter assignment). Data analysis included beam-test (2004), MT/CC (2006), and Global Runs (2007-08).

Ciemat
Centro de Investigaciones Energéticas, Medioambientales y Tecnológicas

UAM UNIVERSIDAD AUTONOMA DE MADRID

UAM DTTF Responsibilities 2009-11

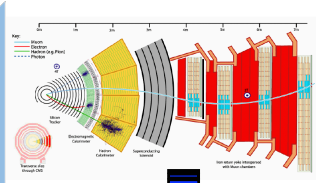
1. **Infrastructure and hardware:** Maintenance of UAM DTTF hardware contribution: UAM-CMS electronics lab; maintenance of ETTF boards and VME readout system at CERN.
2. **Online software:** DTTF trigger operation at CERN: 2009 development; 2010-11 maintenance.
3. **Offline software:** Appropriate reconstruction and high quality of (real and simulated) data.
4. **DTTF performance:** Trigger optimization in terms of efficiency, resolution and background rejection ➔ physics analysis.
5. **Involvement:** from ~100% in 2009 to ~50% in 2011 (including SLHC R+D).

Previous UAM Activities at CMS

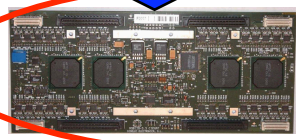
- ✓ **Involvement of UAM in CMS started in 1992 (CMS Letter of Intent CERN/LHCC 92-3; RD5; Technical Proposal, CERN/LHCC 94-38; Isolated Muon Trigger, CERN/LHCC 97-32, 00-38).**
- ✓ **Participation in CMS Muon Trigger activities since 2001 (FPA2000-3172E, FPA2002-02552, FPA2005-00780).**
- ✓ **Full list of notes since 2001 contains 83 items. In particular, 9 contributions to Conferences; 13 CMS notes; 14 papers.**
- ✓ **New Project is continuation of our previous CMS Project for the period 2009-11.**
- ✓ **Intense collaboration with CIEMAT-CMS group since 2001 (8 papers in common). Since now, formalized as coordinated project.**

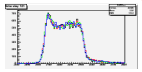
DT read-out electronics

Carlos Willmott (DT electronics responsible), Cristina Fernández



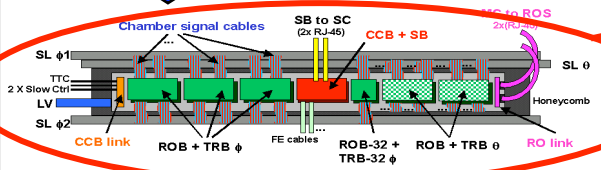
172200 channels





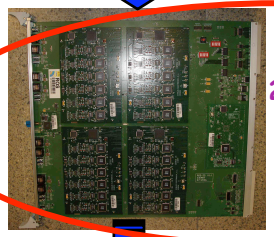
128 ch/ROB

250 Minicrates



30 m copper link

240 Mbps



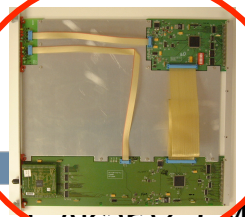
25 ch/ROS=> 1 sector

60 ROS

100 m optical link

800 Mbps

DDU



1500 ROB boards

- Timing digitalization of signals coming from the DT chambers.
- Design and testing at CIEMAT.

250 Minicrates

- Integrates first level of read-out, trigger and chamber control electronics.
- Design and fabrication (mechanics and cabling) at CIEMAT.
- Assembly and tests of read-out part at CIEMAT.

60 ROS boards

- Multiplexation of read-out data coming from one sector (25 ROBs).
- Design and testing at CIEMAT.

10 TIM boards + SC crates

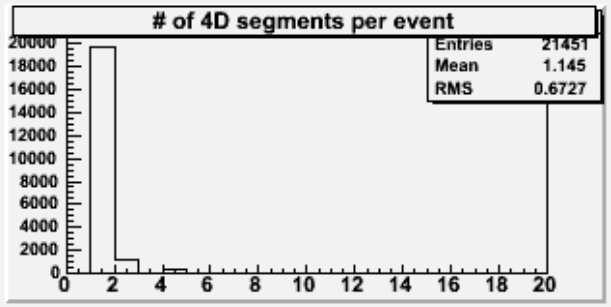
- Distribution of clock, L1A and synchronization signals in the SC crates.
- Design and testing at CIEMAT.

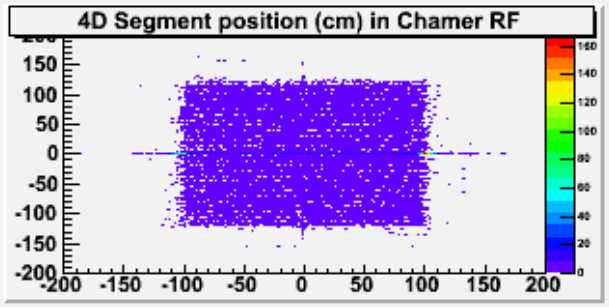
Ciemat
Centro de Investigaciones Energéticas, Medioambientales y Tecnológicas

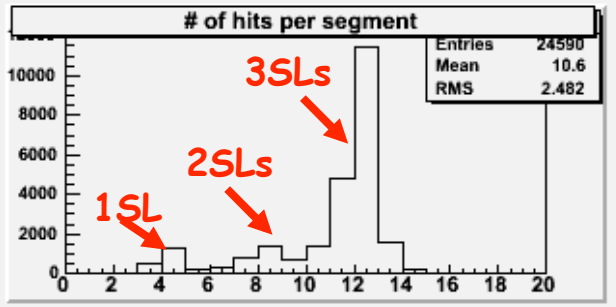
UAM
UNIVERSIDAD AUTONOMA DE MADRID

Chamber & Trigger Performance

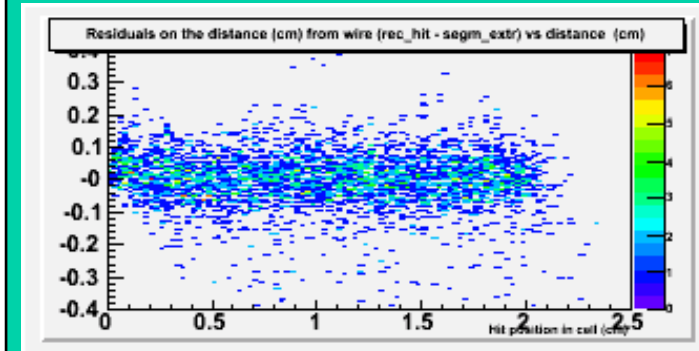
Local Segment Reconstruction

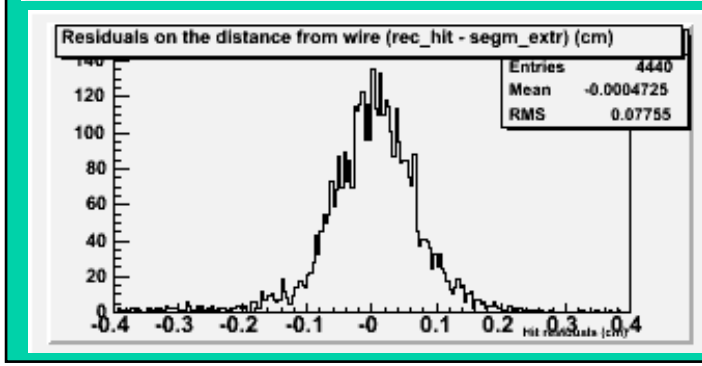






Residuals





Local Trigger efficiency