Overview of the IFCA Activities

Delphi (LEP)
CDF (Tevatron)
CMS (LHC)
GRID

A. Ruiz-Jimeno
Instituto de Física de Cantabria (CSIC - Univ. de Cantabria)
RECFA-meeting

Permanent

CARLOS FERNANDEZ
Technician CSIC

JESUS MARCO
Researcher CSIC

CELSO MARTINEZ
Tenure CSIC

FRANCISCO MATORRAS
Lecturer Univ. Cantabria

TERESA RODRIGO
Full Professor U. Cantabria.

ALBERTO RUIZ
Full Professor U.Cantabria

JAVIER CUEVAS
Lecturer U. Oviedo

Contracts, PostDoc

ENRIQUE CALVO
Engineer Contract

JAVIER FERNANDEZ
P.D.

GERVASIO GOMEZ
P.D. Contract

ISIDRO GONZALEZ
P.D. Contract

JOSE MARIA LOPEZ
Assoc. Contract U.O.

IVAN VILA
P.D. Contract

ROCIO VILAR
P.D. Fellow

Students

ALICIA CALDERON
FPI Fellow

DANIEL CANO
Contract

AMPARO LOPEZ
FPI Fellow

RAFAEL MARCO
Contract

JONATAN PIEDRA
FPU Fellow

DAVID RODRIGUEZ
Contract

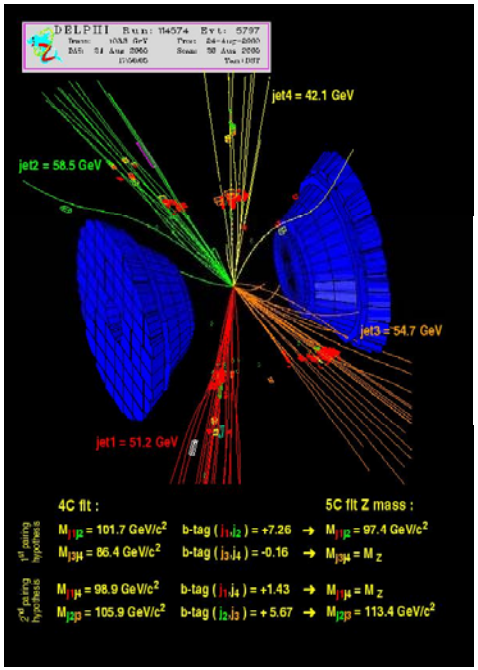
Personnel / Task & Responsabilities

Name	Task/Responsability	% of involvement
E. Calvo (Engineer)	CMS: Engineering & Integration	100%
	Installation & Commissioning	
J. Cuevas (Physicist)	CMS: Simul/Reconst. Software	50%
Univ. of Oviedo	CDF: Software & Data Analysis (Higgs)	
C. F. Figueroa (Physicist)	CMS: Laboratory Infraestructure	50%
	Safety & Control	
G. Gomez (Physicist)	CDF: TOF Operation & Maintenance	100%
	Data Analysis (Top Physics)	
J. Marco (Physicist)	CMS: Software development & DataBase	50%
	CDF: Software & Data Analysis (Higgs)	
C. Martinez (Physicist)	CMS: Simul/Reconst. Software	50%
F. Matorras (Physicist)	CMS: Simul/Reconst. Software	50%
	Alignment Instrumentation	
T. Rodrigo (Physicist)	CMS: Alignment Instrumentation	100%
	CDF: Data Analysis (Top Physics)	
A. Ruiz (Physicist)	CDF: Data Analysis (B Physics)	100%
	Group Leader	
I. Vila (Physicist)	CMS: DAQ & Laser System	100%
	CDF: TOF Maintenance & Analiysis (B Phys.)	
R. Vilar (Physicist)	CDF: TOF Operation & Maintenance	100%
	Data Analysis (Top Physics)	
	Students (Today: 1 in CDF & 2 in CMS)	

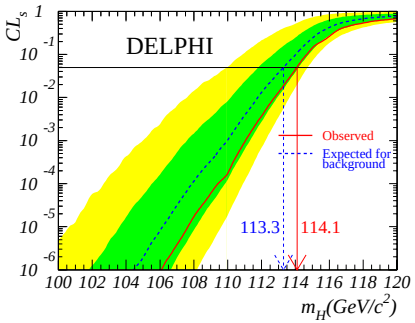
DELPHI Activities. Higgs search

J.Cuevas, J. Fernandez, J. Marco, R. Marco, C.Martinez

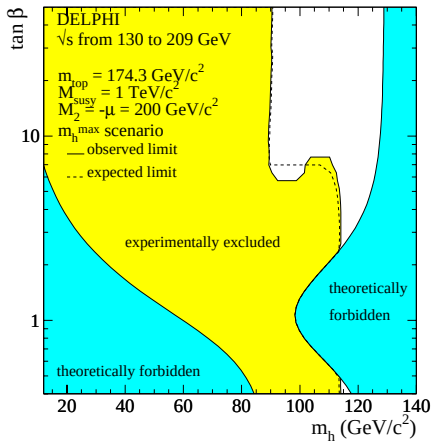
Search for Higgs bosons at LEP with the DELPHI detector



A candidate in the 4 jet channel: analsysis based on: b-tagging, pairing and mass reconstruction

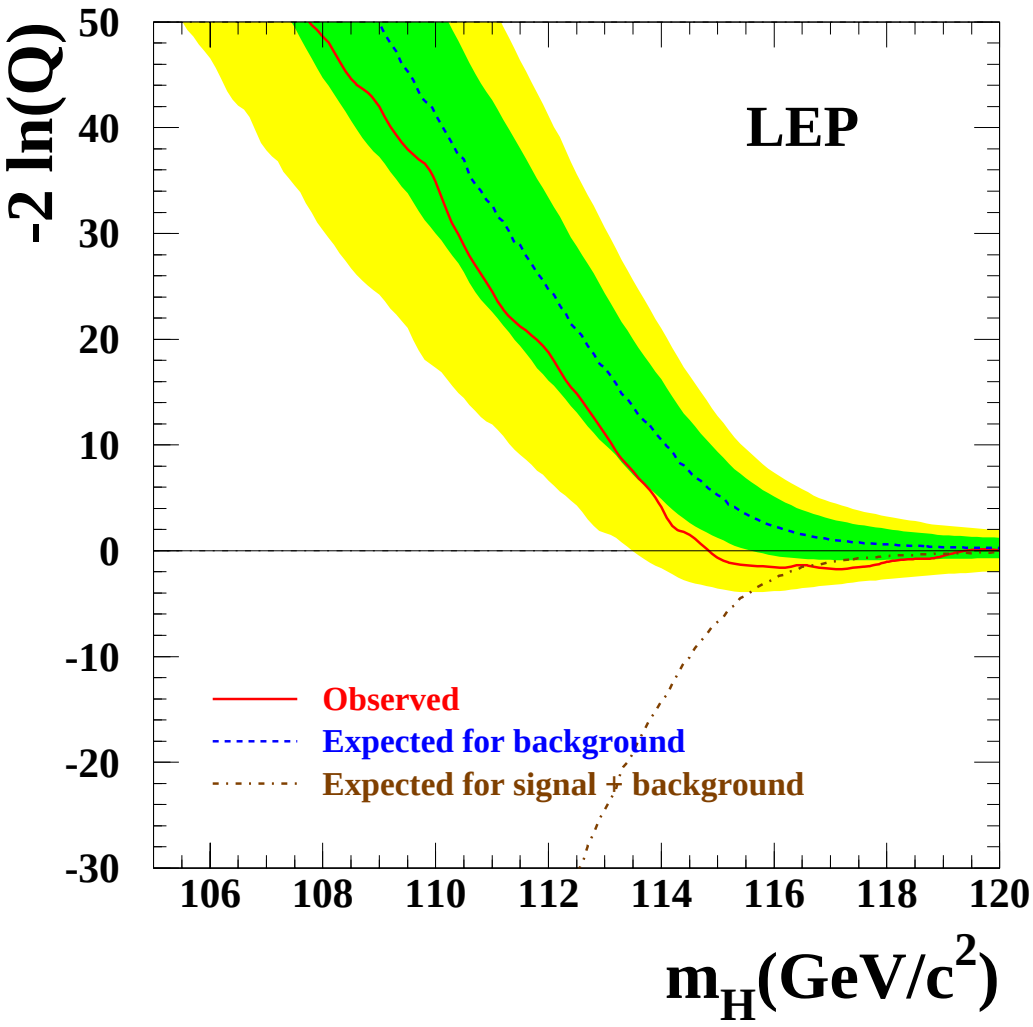


DELPHI: No evidence for any SM Higgs signal, limit set to $m_H > 114.1$ GeV/c²



DELPHI MSSM Higgs bosons: excluded regions at 95% CL by the searches in the hZ and hA channels

Signal compatibility



-2 ln Q negative (s+b slightly preferred) from 115 onwards

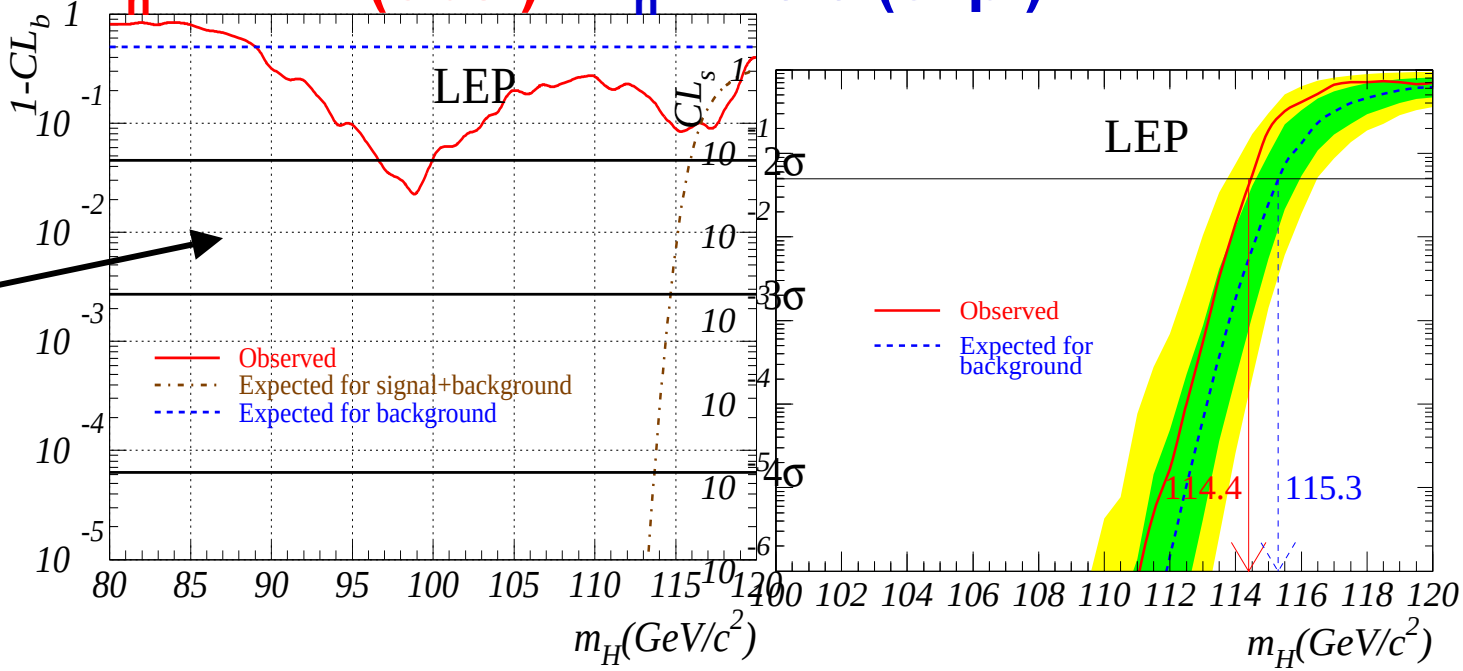
Broad minimum distribution for values above the kinematical limit

Exclusion limits:

- Confidence levels $CL_b(m_h)$ & $CL_s(m_h)$ as function of m_h

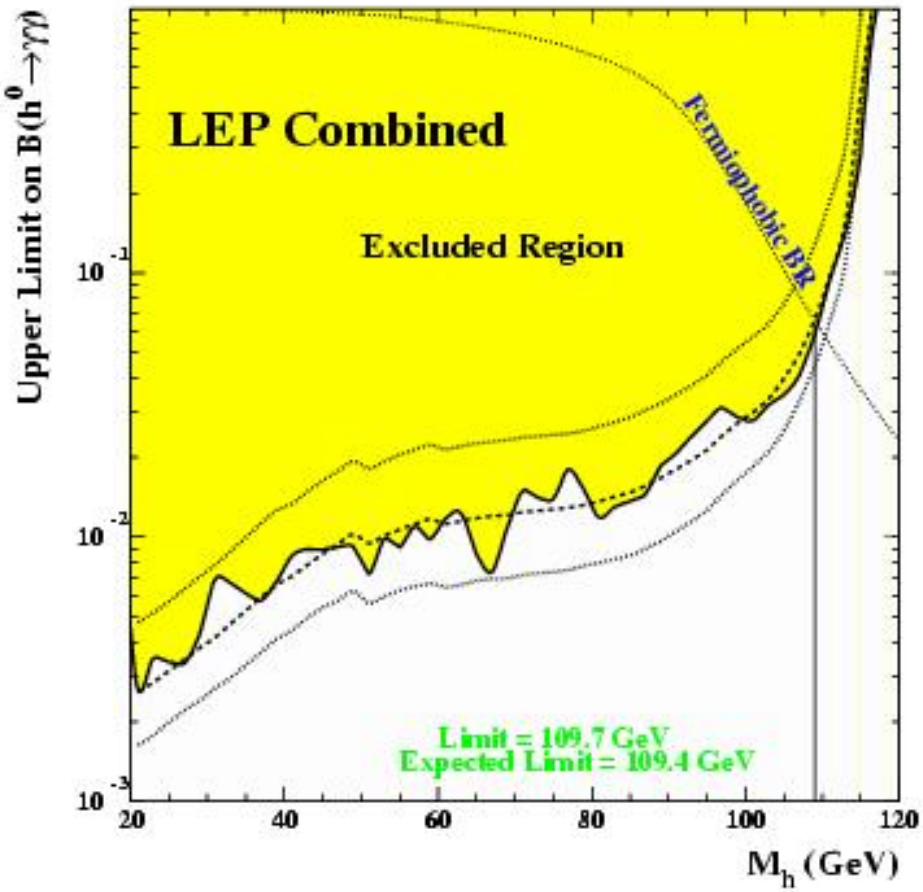
m_h>114.4 (obs.) m_h>115.3 (exp.)

Not compatible with a SM Higgs of 98 GeV/c².
Not completely understood



From 12 to 80 GeV/c², a cross-section 20 times less than the SM one is excluded

Fermiophobic Higgs



In 2HDM (type I) model, H decays dominantly into $\gamma\gamma$ and other bosons.

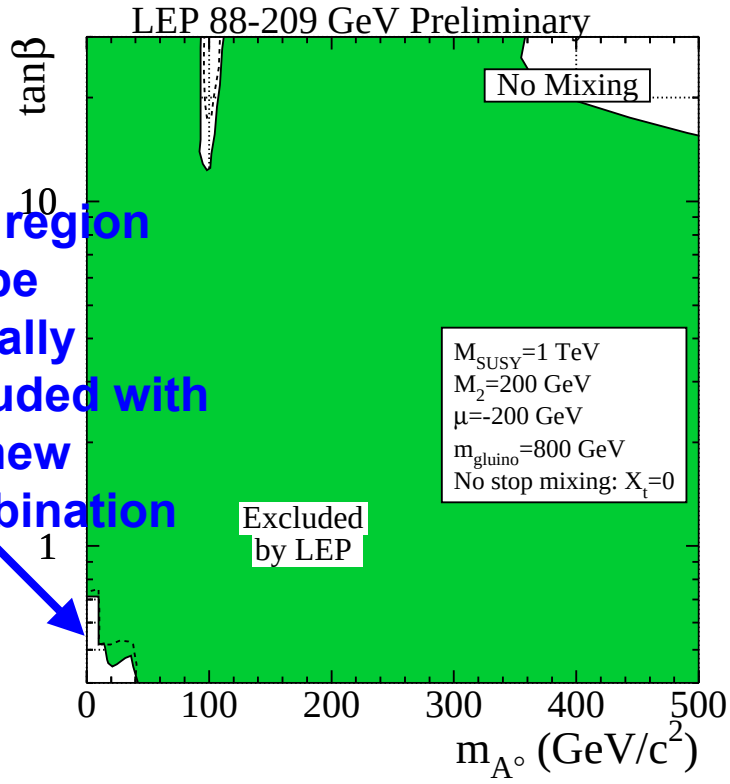
All 4 experiments searched for the $\gamma\gamma$ final state

A 115 GeV/c^2 fermiophobic Higgs has a BR($H\rightarrow\gamma\gamma$) < 0.04

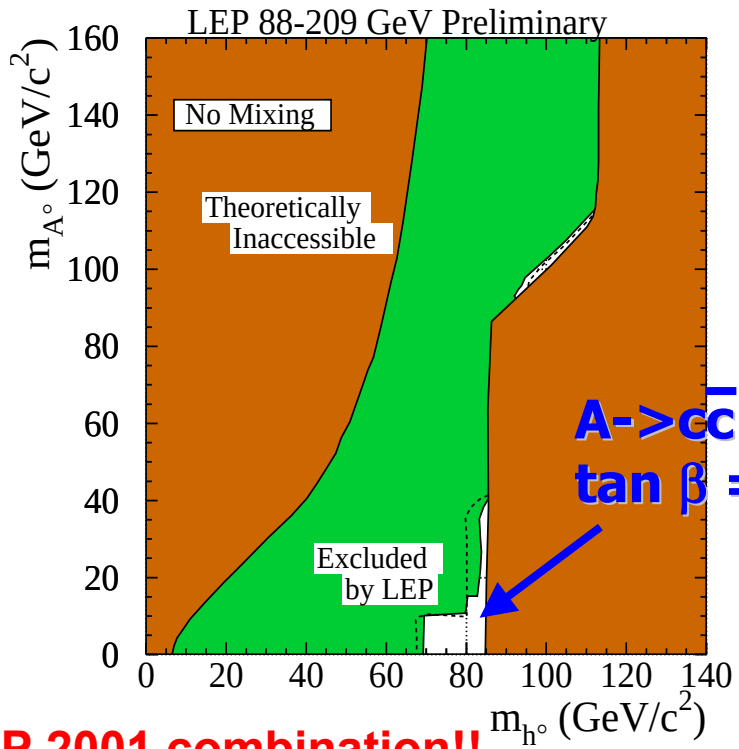
Obs. Limit 109.7 GeV

Exp. Limit 109.4 GeV

No mixing scenario



This region will be partially excluded with the new combination



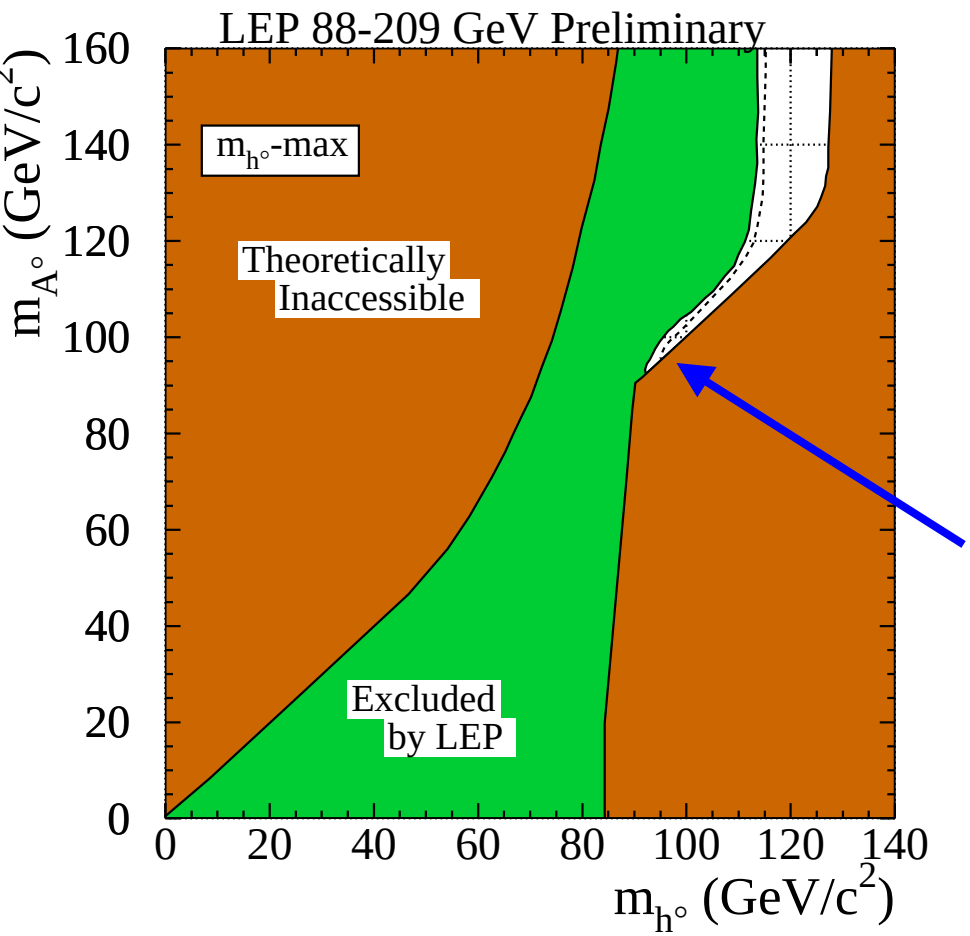
A->$c\bar{c}$ pred. tan β = 0.44

LEP 2001 combination!!

In this scenario, maximum m_h is ~ 115 GeV/c^2

The region m_h~m_A is beyond the hA kinematical reach

m_h^{max} scenario



LEP 2001 combination

Without radiative corrections, MSSM would have been widely excluded

The hZ and hA kinematical walls are visible

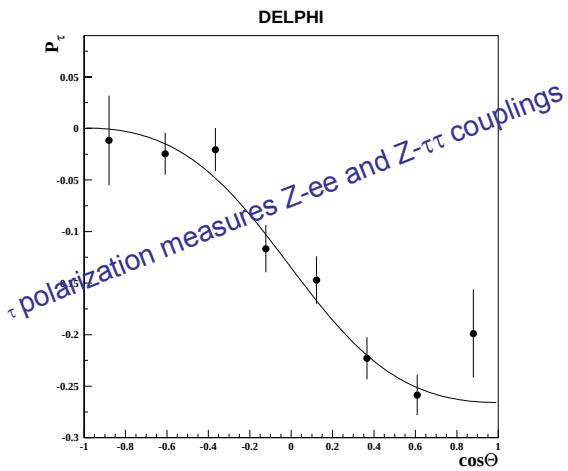
m_h >91.0 (exp. 94.6) GeV/c^2

m_A >91.9 (exp. 95.0) GeV/c^2

DELPHI Activities

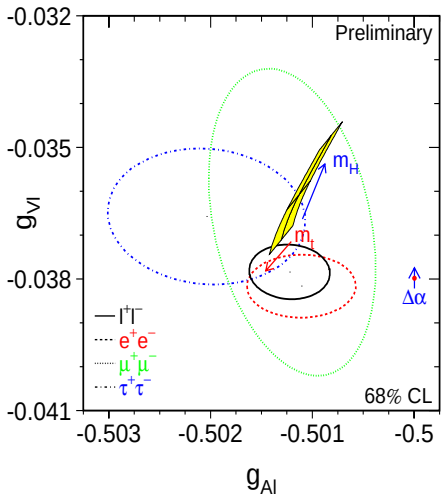
G.Gomez-Ceballos, J.M.Lopez, F.Matorras, A. Ruiz

τ physics at DELPHI was also a probe of new physics

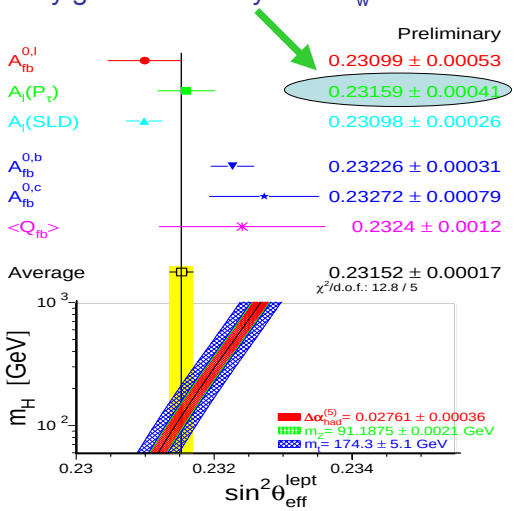


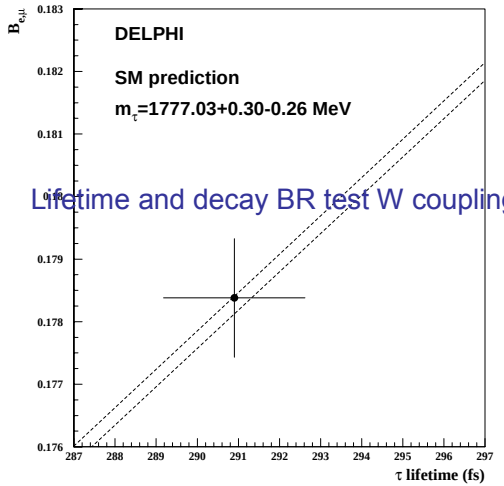
τ polarization measures Z-ee and Z-ττ couplings

axial and vector leptonic coupling to the Z



very good sensitivity to $\sin\theta_w$



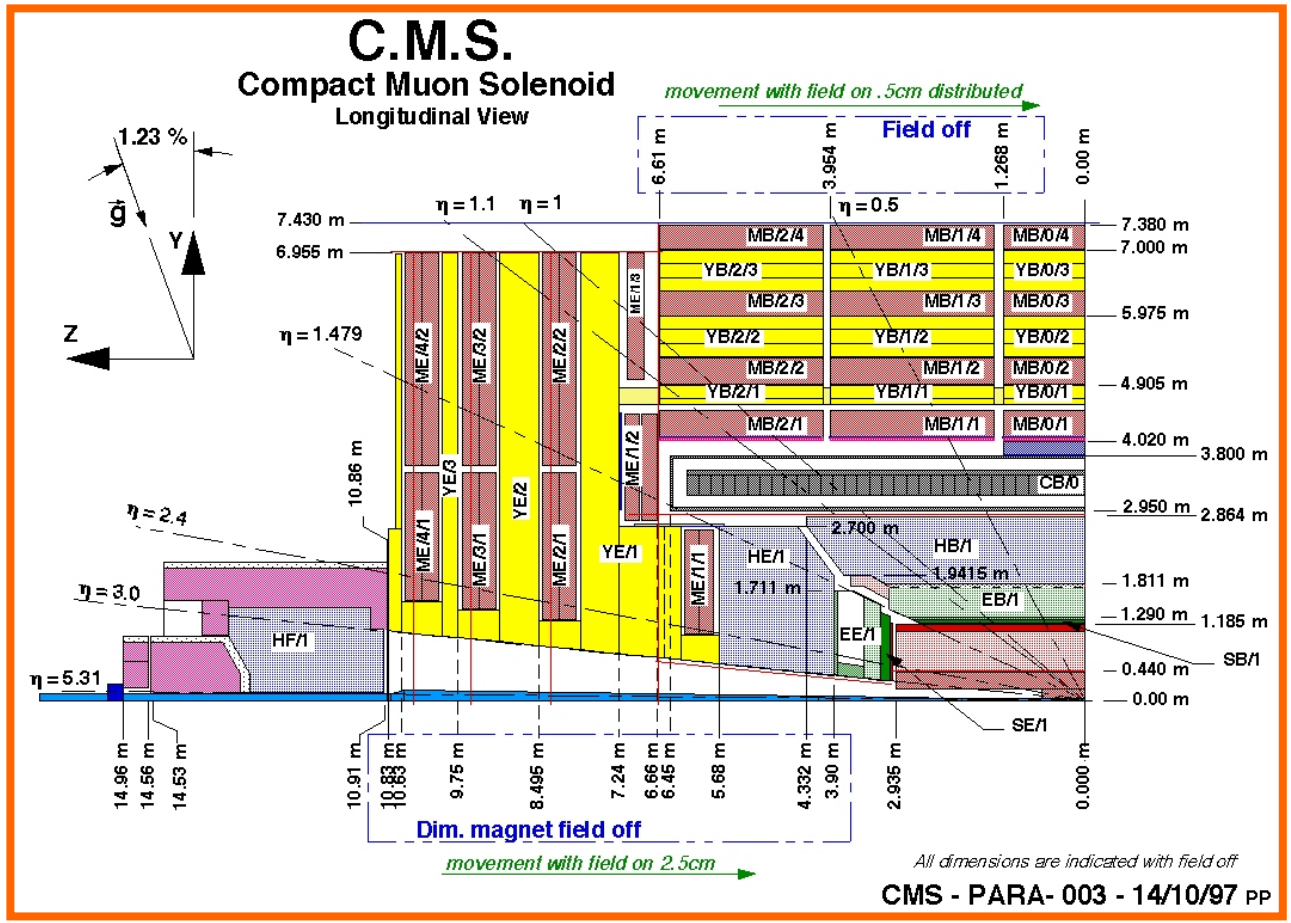


Lifetime and decay BR test W couplings

Antecedents & associated projects

- CDF experiment (Collider Detector at Fermilab): Since Feb. 1999
  - CDFII Detector upgrade (μ scintillation counters, TOF detector)
  - Physics analysis: B physics, and High P_t physics (Top, Higgs)
- CMS experiment (Compact Muon Solenoid): Since mid 1994
  - Detector construction (μ alignment system)
  - Software development (detector specific: simul/reconstruction packages)

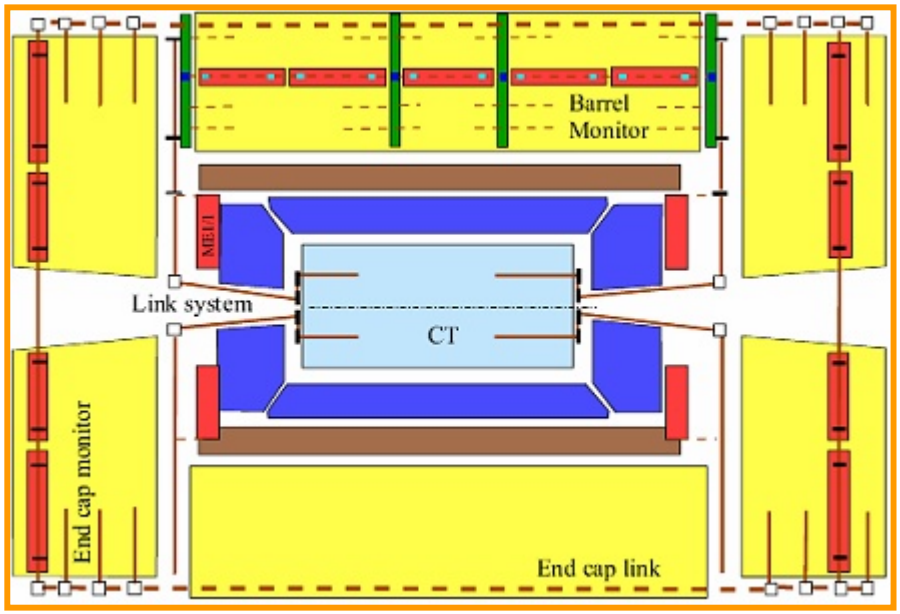
Compact Muon Solenoid (CMS)

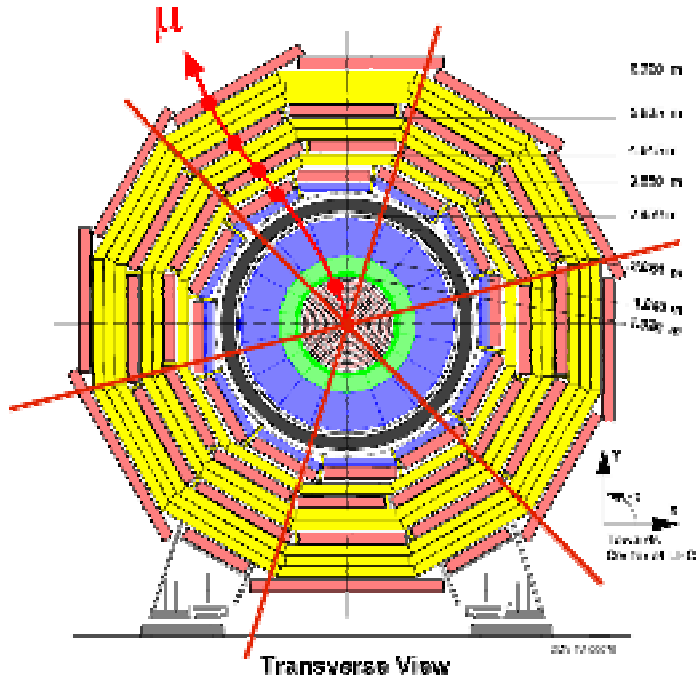


1040 High precision Muon chambers rest on return iron yoke
-Expected cm movement when magnet on/off
-T changes, humidity (sub-millimetre range)

} Detectors position changes are monitorised for further online/offline corrections

The CMS Alignment System





Task of the align. system

- Measure the relative position of the μ-chambers, and wrt to the TK detectors

- Monitor the stability of Tracker & Muon detectors

Building blocks: 4 subsystems

- Internal tracker align.
- Internal muon : barrel and endcap
- The link tracker ⇔ muons
  (3 alignment planes)

IFCA, CIEMAT

System Specifications:

Optimal Muon trigger & Precise momentum measurement

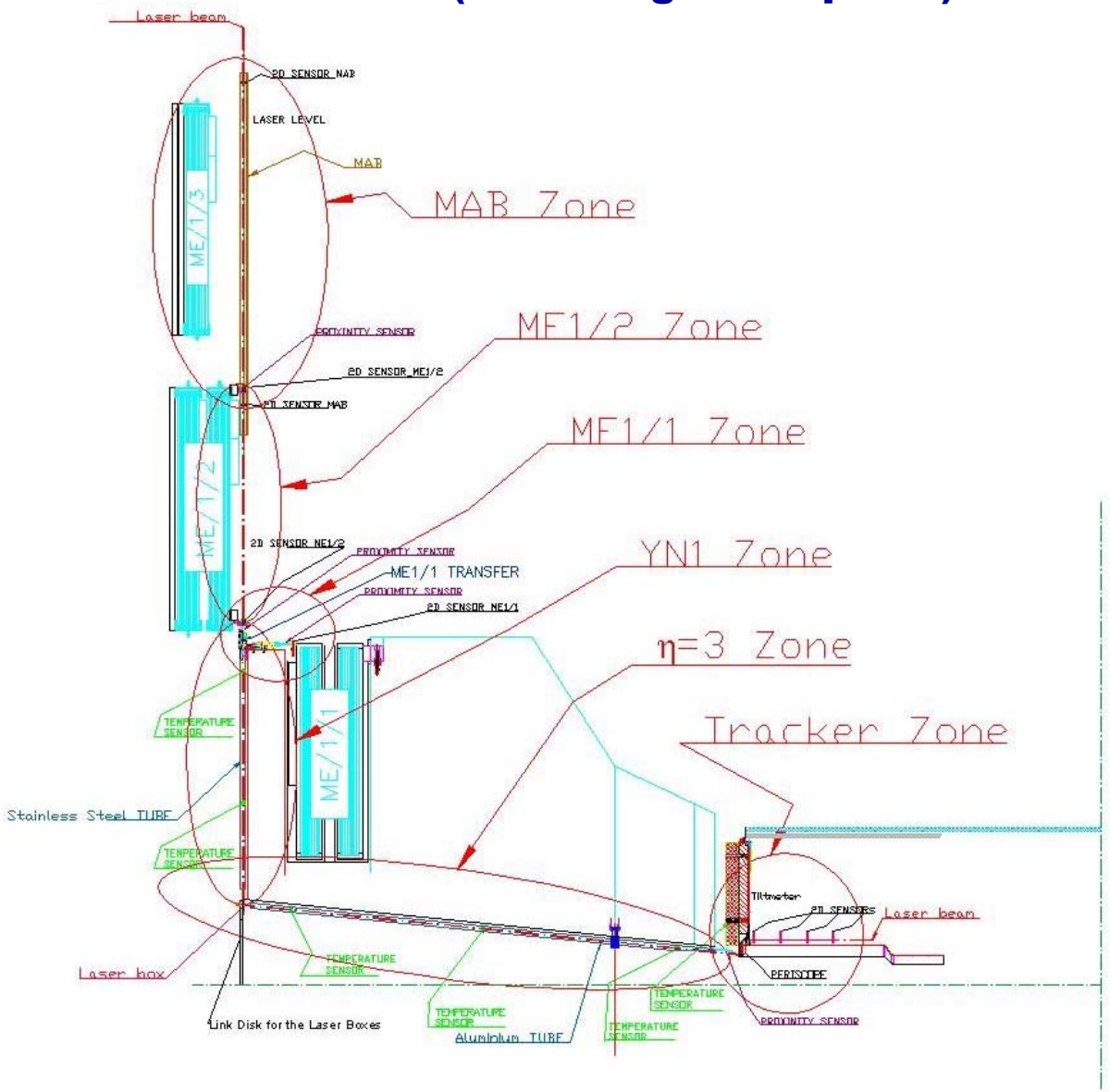
1) **Trigger rates (L1,L2)** (Required pt resolution at each trigger Level)
   - few mm for L1 & L2
   - effect on L2: track quality & pt resolution degrades, with almost no change in efficiency

2) **Track matching/ reconstruction** (From Higgs, Z, Z´ processes. Looking at drop in efficiency, fake tracks, track quality)
   - 0.3 to 0.5 mm for high momentum muons
   - few mm for low momentum muons

It determines the design parameters

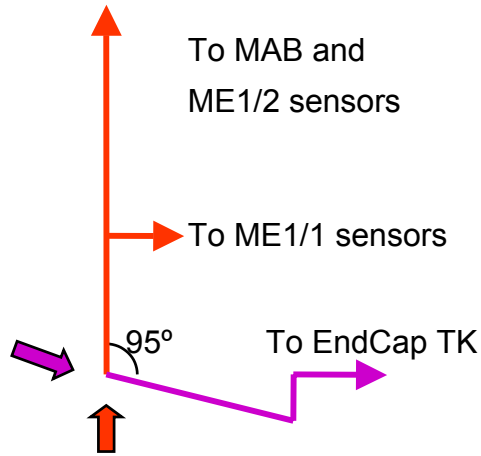
3) **Momentum measurement**
   - rϕ coordinate: Barrel: 150 (350) μm MB1 (MB4)
     Endcap: 150 μm ME1 layer
   - r & z coordinates: at the mm level
   - In r, and because CSCs detector geometry, 0.43 (0.86) mm for 20(10)-degree chambers

Link System Layout
(1/4 of alignment plane)



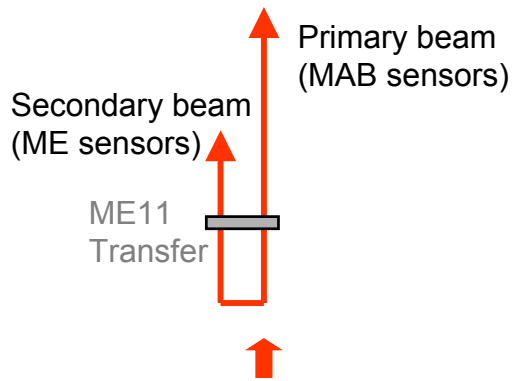
Light path

R-Z Plane



LB: Two Laser diodos -o.f.-
670 nm and 1064 nm

R-ϕ Plane



System Parts Status (1)

- CIEMAT
- IFCA

Laser System

- **Laser modules**
- **Optical fibers & collimating optics**

Sensors: type & technology

- **Photo-sensors**
- **Inclinometers (angular meas.)**
- **Proximity distance sensors**
- **Temperature sensors**
- **Tracker Si-sensors**

Optics for light path definition

- **Splitters & Mirrors**
- **Penta and Rhomboidal prims**
- **Periscopes**

Front-End Electronics

- **Photo-sensors (LEBs)**
- **Analog sensors / Laser control (ELMBs)**

R&D with prototypes

- **Performance and characterization tests ⇒ sensors specs.**
  (mainly at Santander Laboratory)
- **Associated electronics: working parameters, cable length vs noise, etc.**
  (Madrid & Santander)
- **Radiation hardness tests**
  (Radiation facilities: Ciemat, Atomki, Lovaina)
- **B field sensitibity**
  (at Santander Laboratory up to 2T)

System Parts Status(2)

Mechanics
- **Sensors mounts / Transfer plates**
- **Laser handling**
- **Long distance meas. / Light path protection**

System Design & Integration
- **Muon & Tracker zones**
- **Inner detector part**

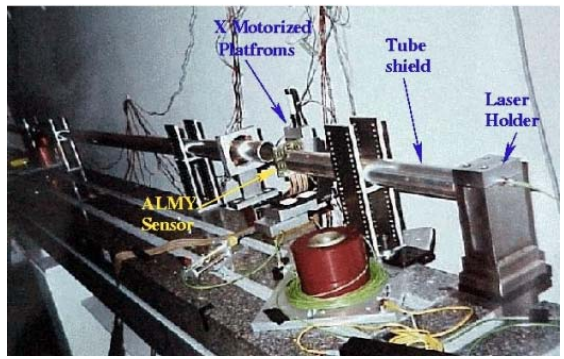
Data Acquisition
- **DAQ network & software**
- **DCS Integration**

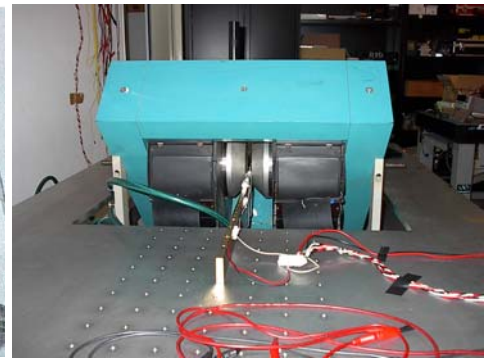
Software package (⟹) and Data Bases
- **Simulation / reconstruction**
- **Data validation**

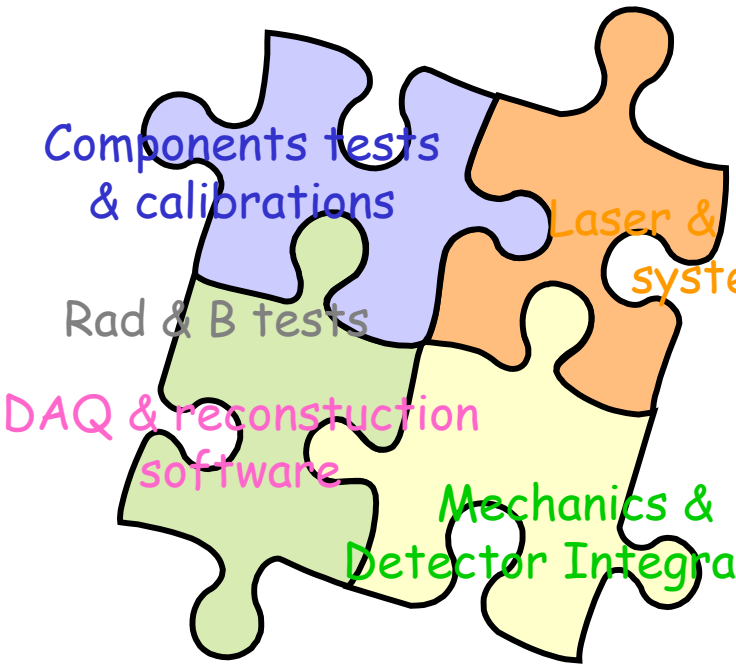
System Engineering

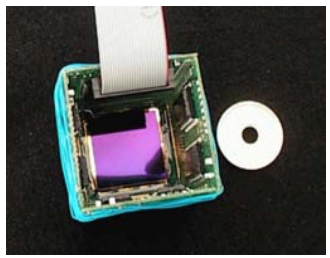
- **Material Selection**
- **FEA calculations**
- **Prototyping**
- **Production drawings**
- **Integration parameters**
  ⇒ **Link parameters book**
- **Installation procedure**

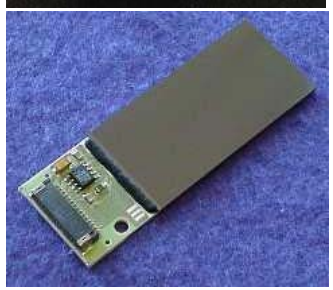
At Santander: Design, Tests & Construction of an Optical Alignment System

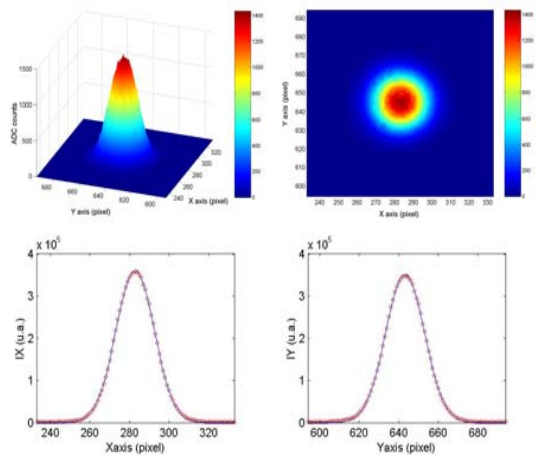












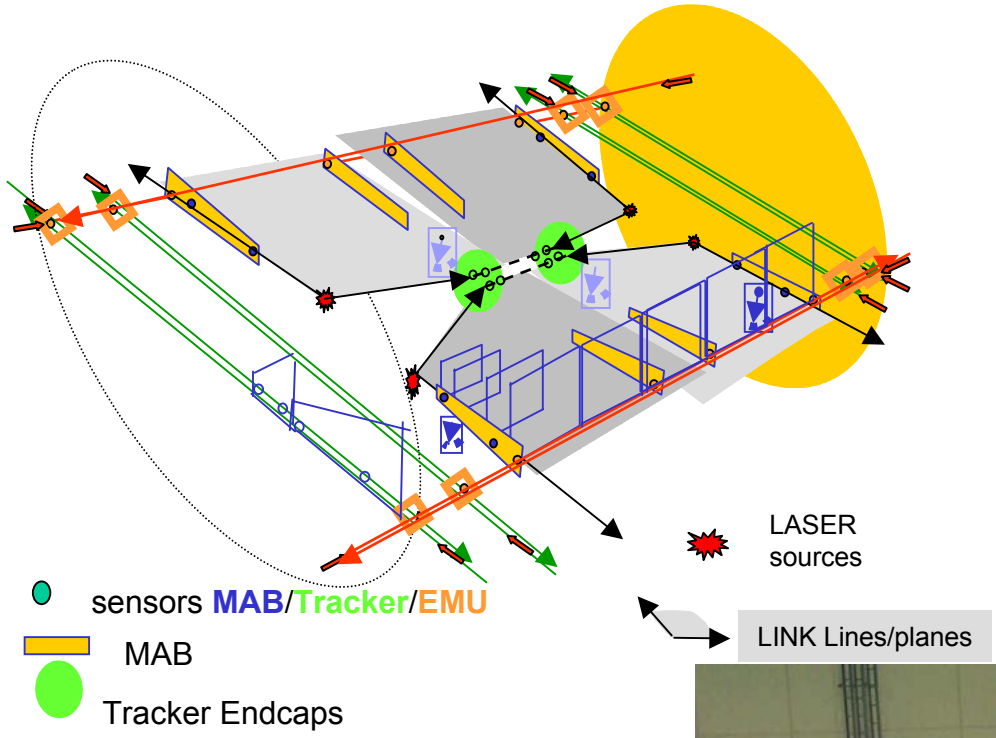
Global Test

- Layout of a relevant part of the system

- Principle test: Check (static) performance at real scale & interfaces among the subsystems

- Prototypes of hardware, DAQ and reconstruction software (COCOA)

- Construction of the Test Stand from early 2000. Data taking periods during summer ´00

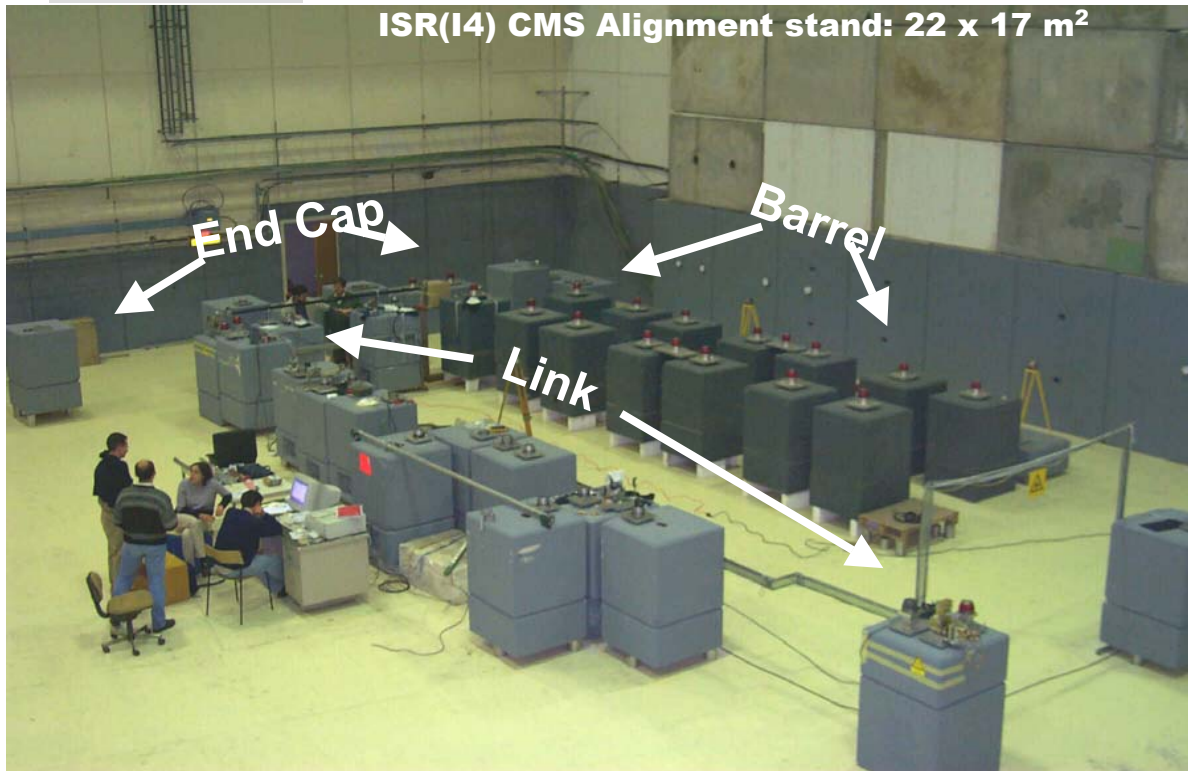


- Lab: Network of survey points.

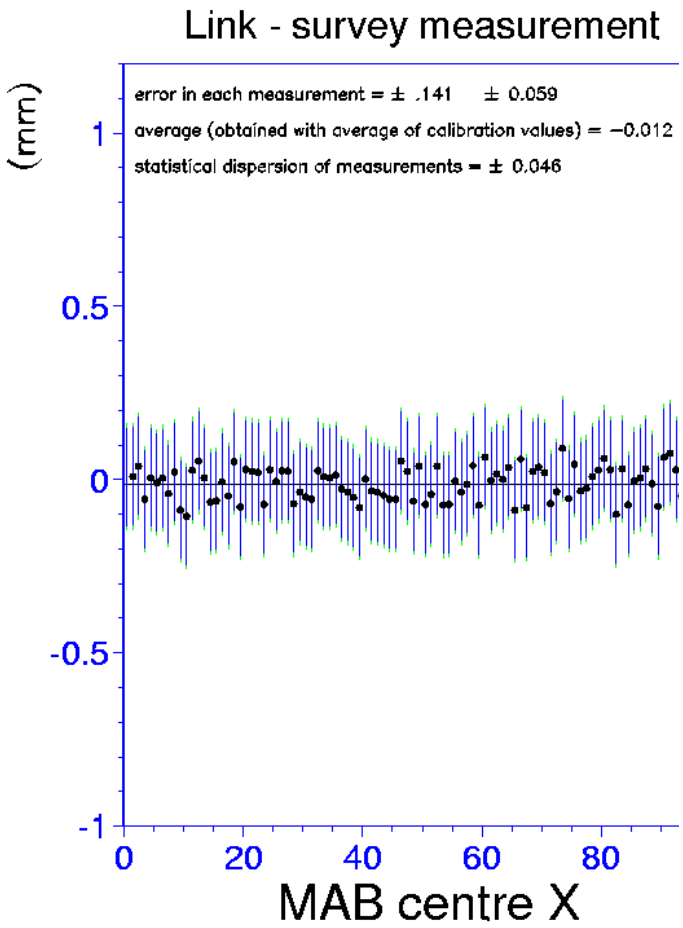
- 3D position of measurement points known within 50 μm (local) and 100 μm (global), by using standard survey and photogrammetry techniques.

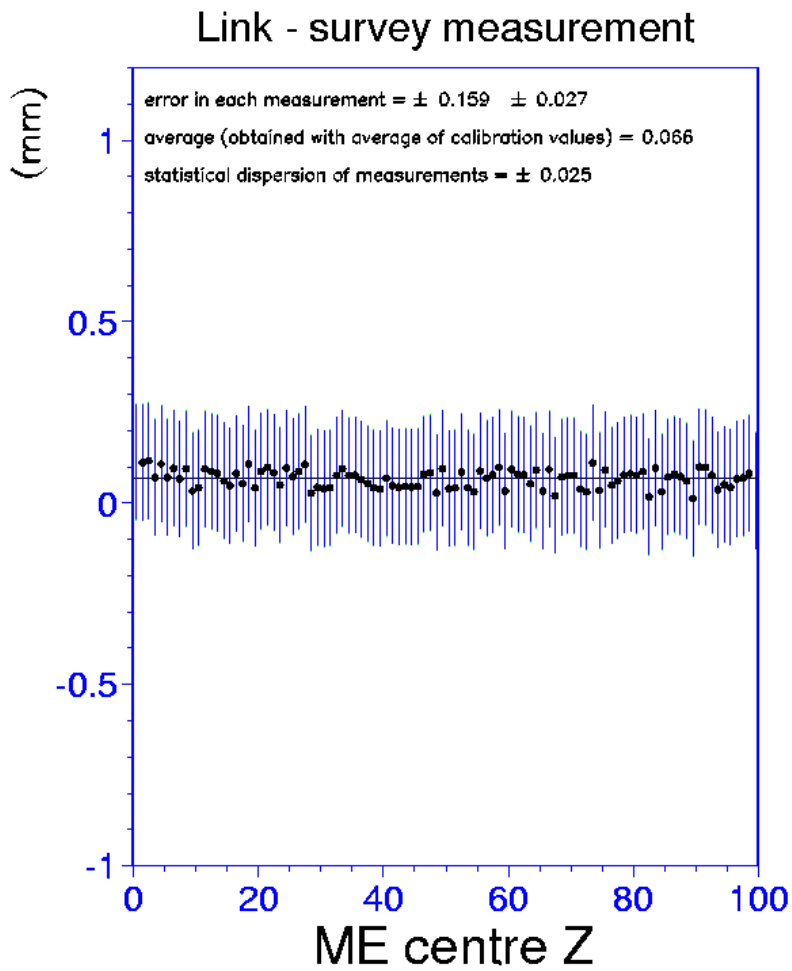
- Stability of the layout within 100 μm. Thermal stability of the experimental area < 1ºC.

- Test: Compare system measurements against survey information.



Test Results





PRODUCTION READINESS

Engineering Design Review - Feb. 2002

Work Program & Schedule

- Procurement & Fabrication
- Assembly, Test & Calibration

} Task list & Schedule Breakdown

- Installation in the detector (end 2004)

- First commissioning of the system: May 2005 (L1 CMS Milestone)

software, analysis & computing

current effort oriented towards three basic and interconnected objectives:

- **CMS data challenge 04**
- **CMS physics TDR**
- **CMS computing TDR**

contribute to:

- **hardware and software for production**
- **physics analysis and tools**
- **dedicated tools for alignment**

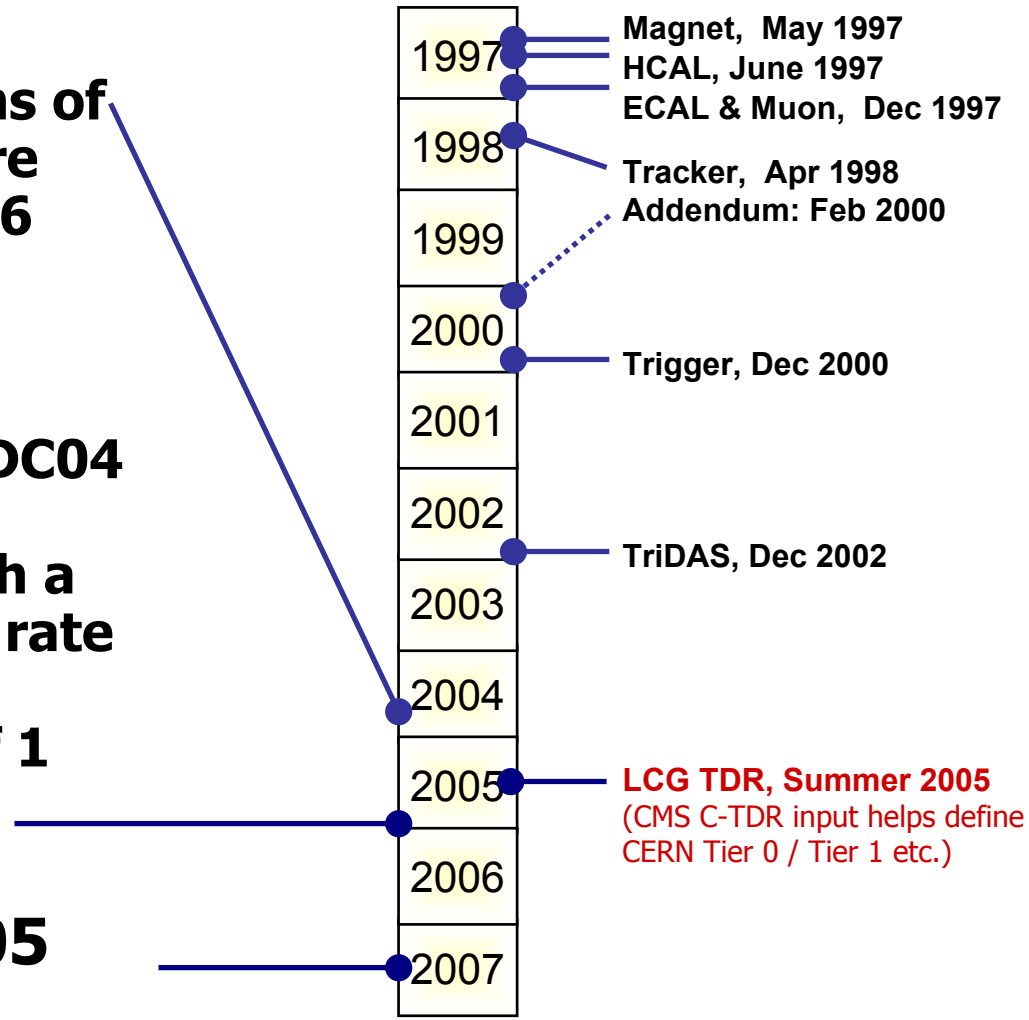
Computing TDR

Computing TDR, Oct 2004

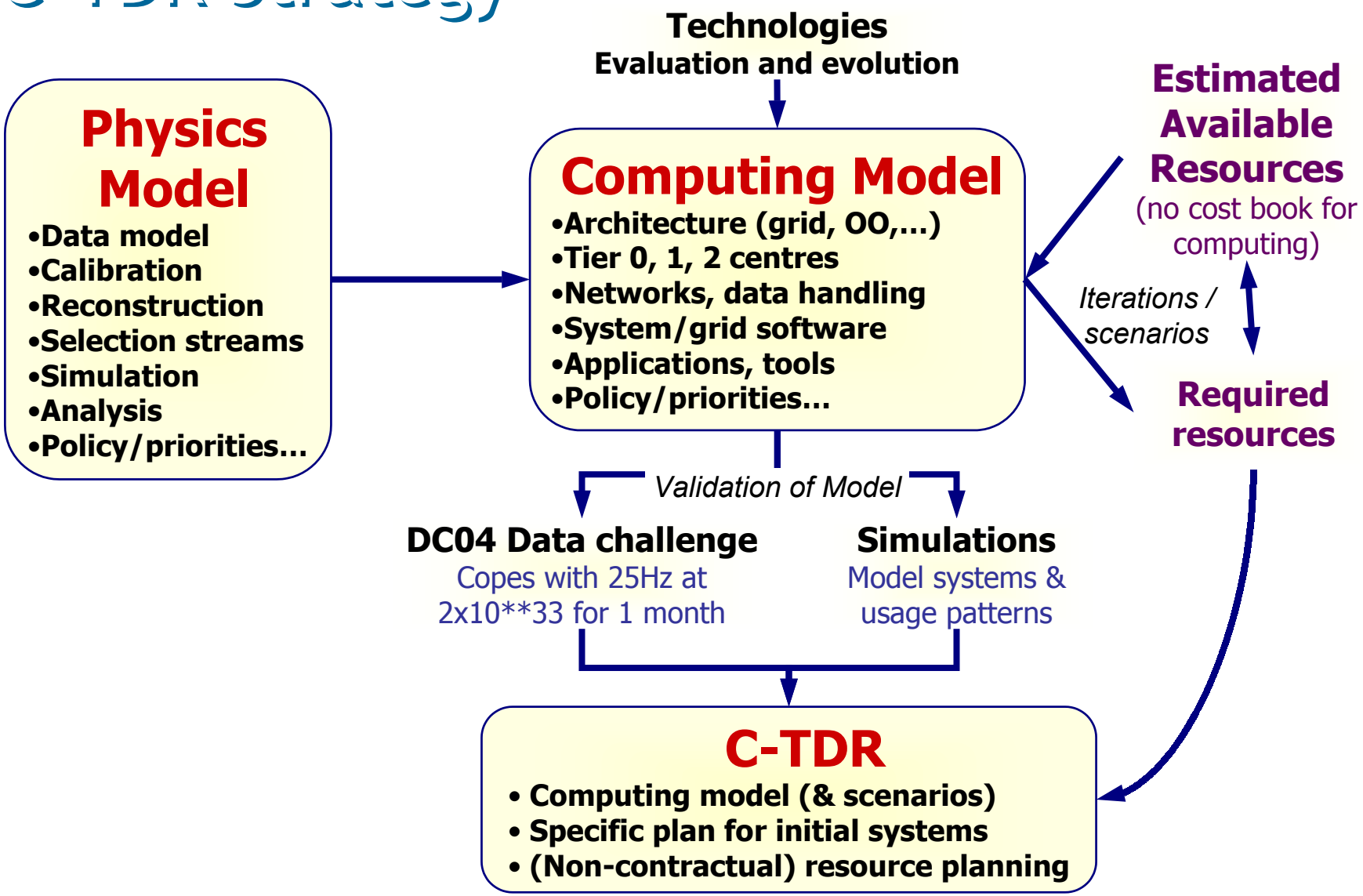
- **Technical specifications of the computing and core software systems DC06 Data Challenge and subsequent real data taking.**
- **includes results from DC04 Data Challenge which successfully copes with a sustained data-taking rate equivalent to 25Hz at 2x1033 for a period of 1 month**

Physics TDR, Dec 2005

CMS Physics, Summer 2007



C-TDR Strategy



Physics TDR: outline

Two volumes

- **Volume I: detector response, physics objects, calibrations, parameterization**
- **Volume II: high-level analyses, e.g Higgs, SUSY, extra dims, etc.**

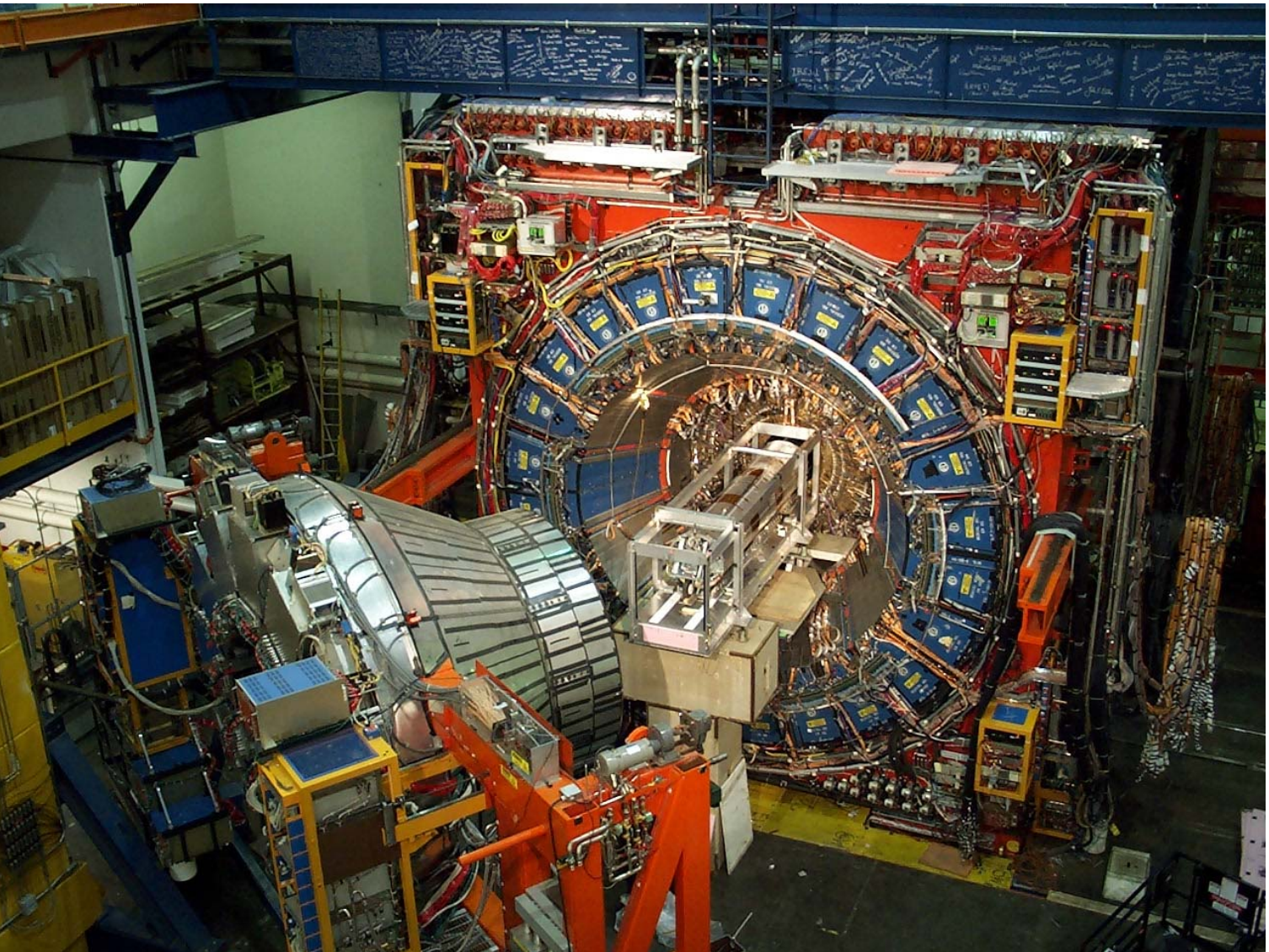
Part I: (small) number of full analyses

demonstrate how we will do physics

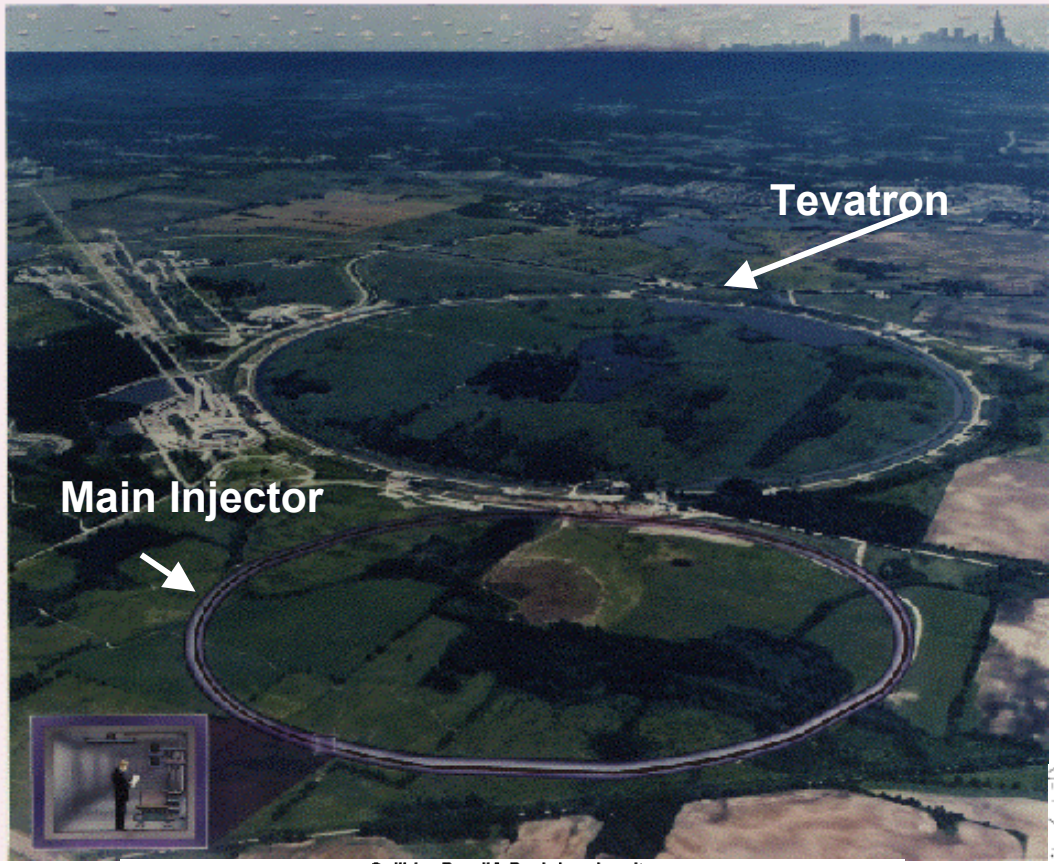
Part II: general physics topics (will be done with full simulation or detector parameterization)

demonstrate what physics we can do

Collider Detector at Fermilab



12 countries
58 institutions
607 physicist
(104 students)



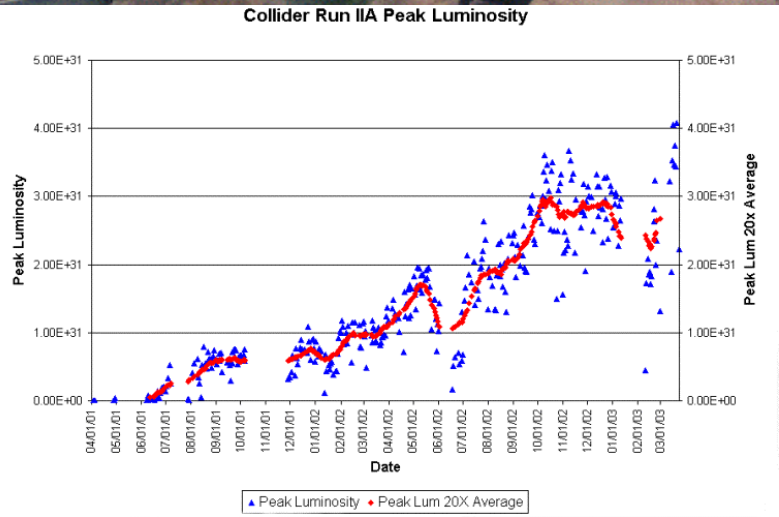
Tevatron (Fermilab)

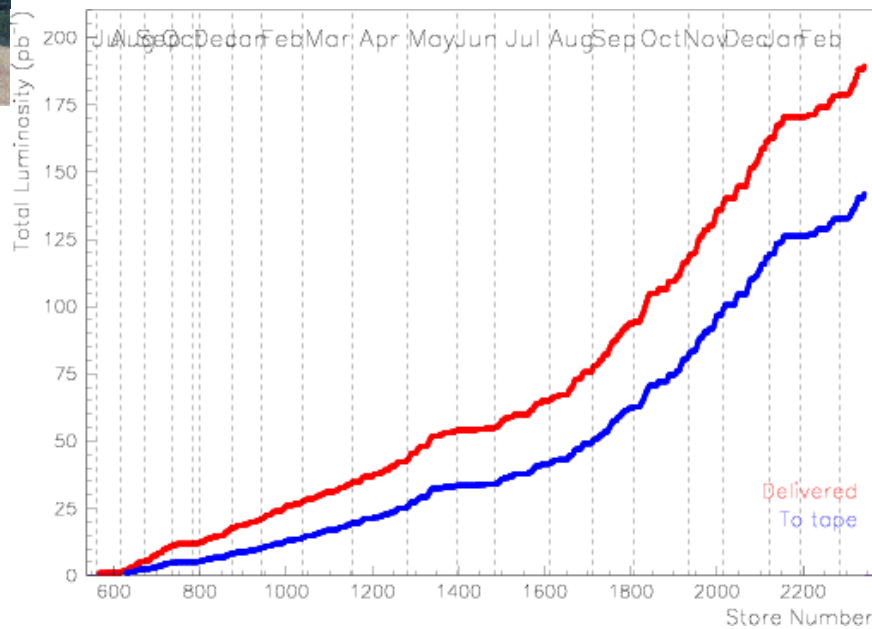
Protón-Antiproton machine

$\sqrt{s}$ = 2.0 TeV

$\mathcal{L}_{inst}$ up to 2(5)x10^{32} cm^{-2} s^{-1}

Two collision points: CDF & D0





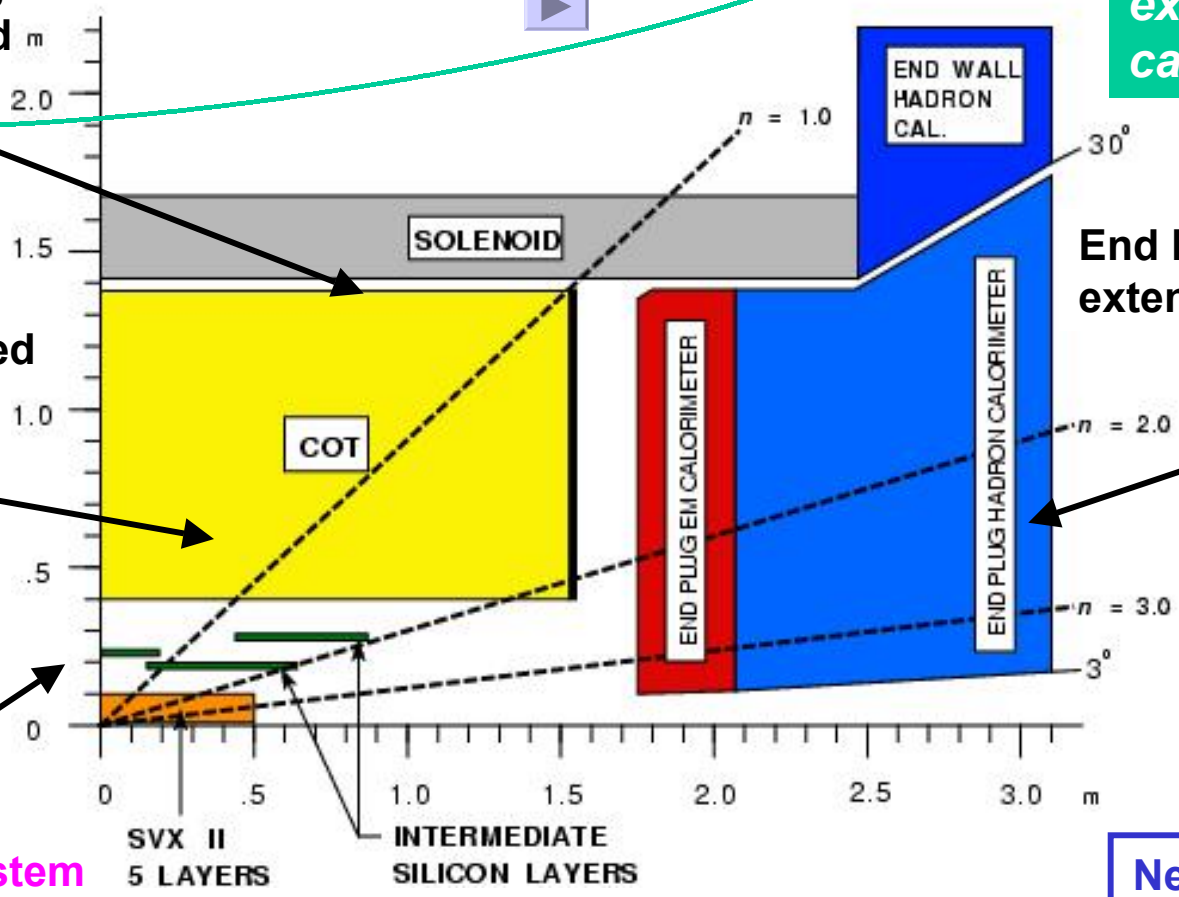
CDF upgrades for Run II

IFCA Contribution

Upgrades allow operation at high luminosity and extend physics capabilities

Muon System upgraded

Time-of-Flight (TOF) added



CTC replaced by COT

End Plug Calorimeters extended to larger η

Forward Calorimeter eliminated

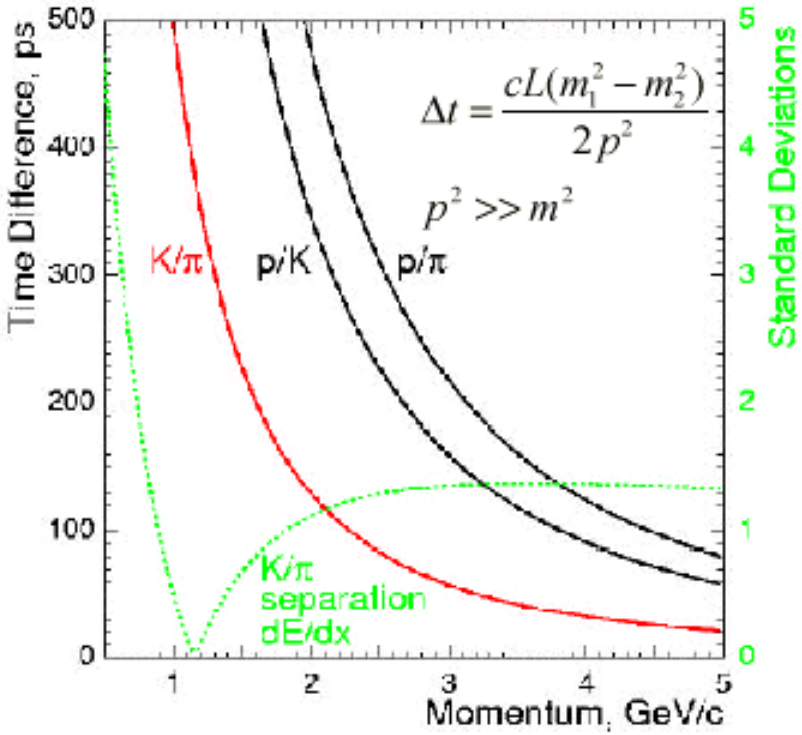
New Silicon Tracking System

New Electronics, Trigger, DAQ

Time of Flight detector (TOF)

For L= 140 cm ~ R_{tof}

Timing resolution σ_t= 100 ps

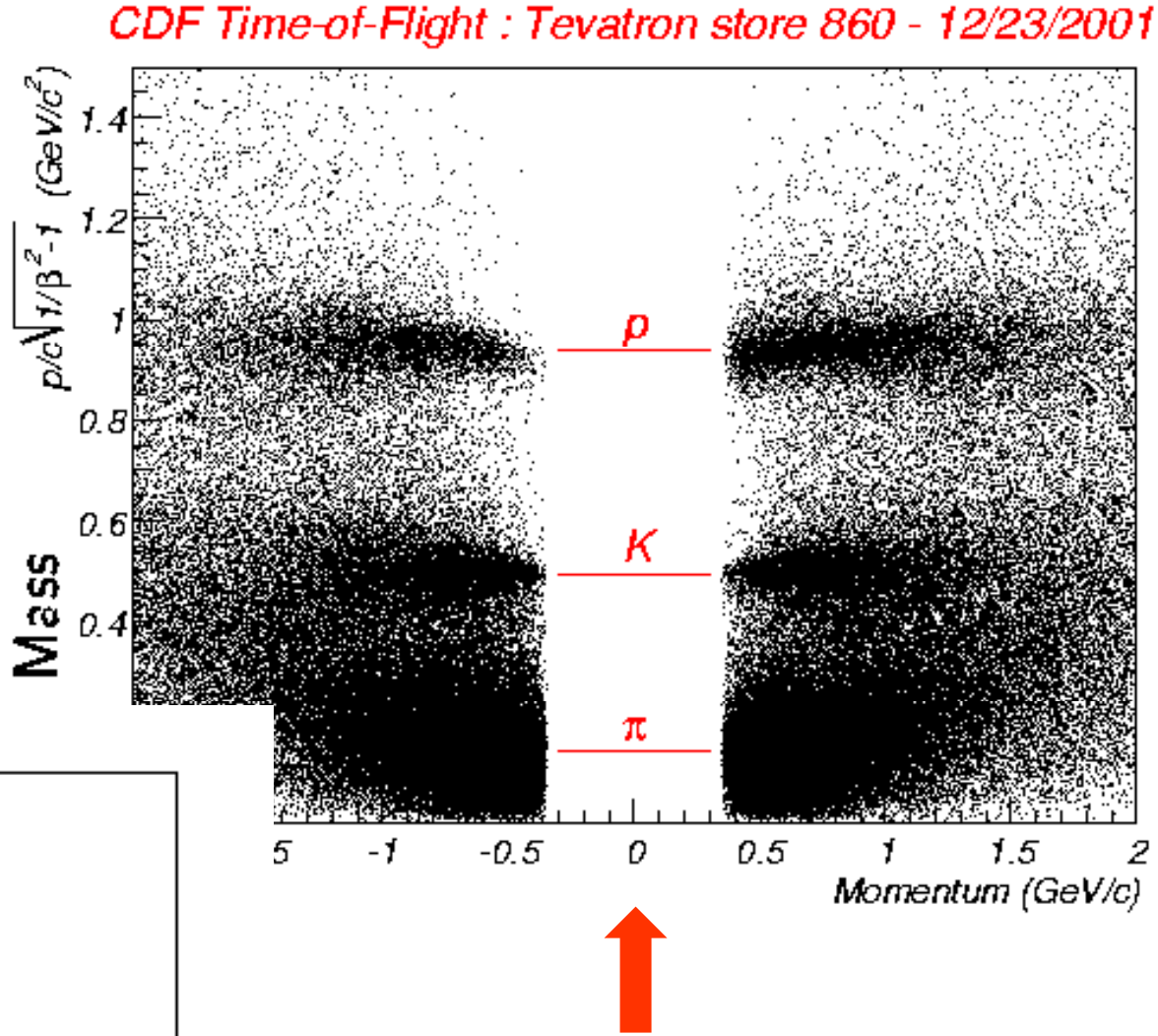


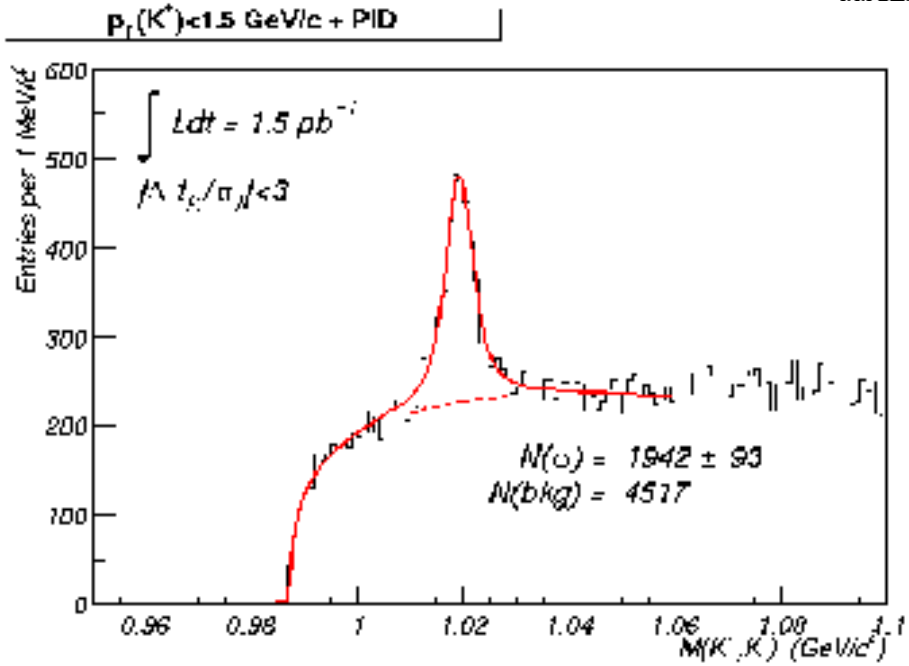
- 2σ K/π separation p<1.6 GeV/c
- 2σ K/p separation p< 2.7 GeV/c
- 2σ p/π separation p< 3.2 GeV/c
- 1.2σ K/p separation over all p

(It complements dE/dx measurements in the central tracker chamber)

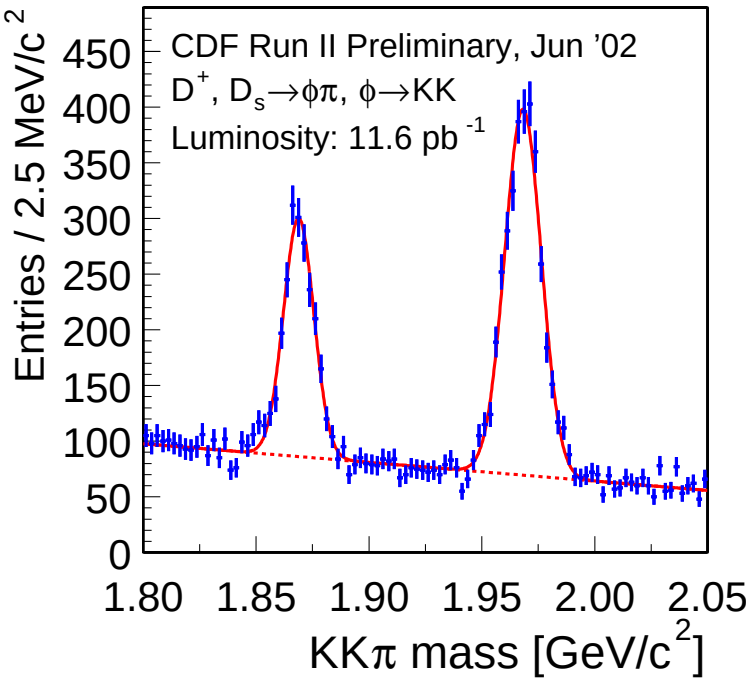
Enlarge CDF b-physics capabilities

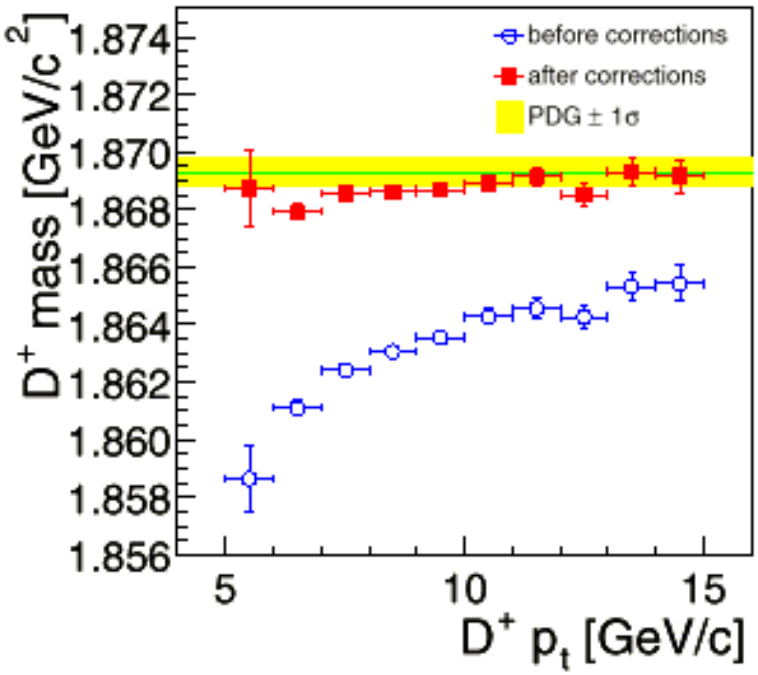
TOF initial performance ...





~ 110 ps resolution





Plans for first Run II physics results

- ***Progress reports in summer-fall 2002***
- ***First analysis results in winter 2003***
- ***New measurements from all physics topics in summer 2003***

Main goal for next years is to consolidate the data analysis lines:

- B physics: B mixing & CP violation

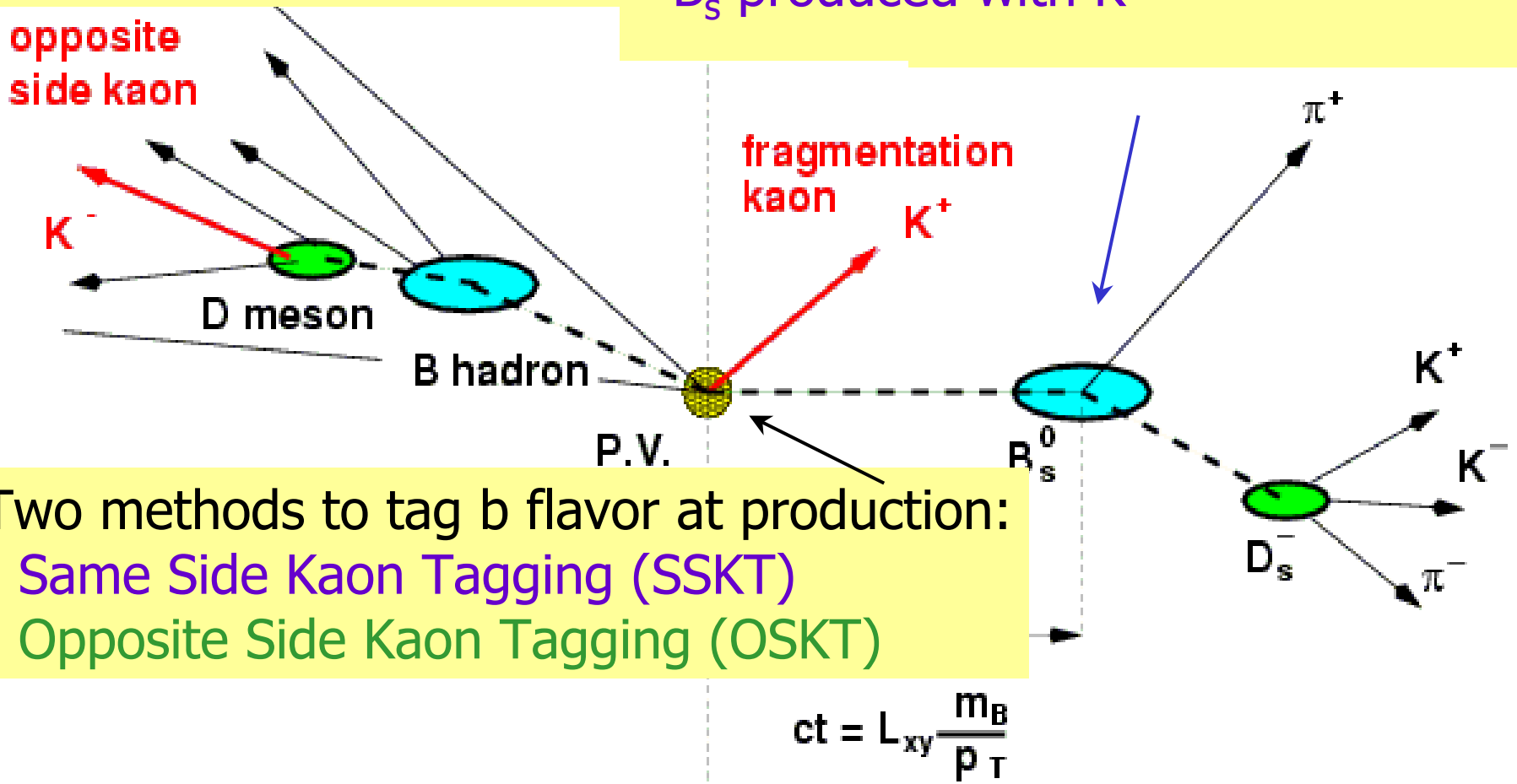
- Top physics: Top quark properties & Single and pair top production

- Higgs bosons searches

B flavor tagging using TOF

OSKT: use TOF to find K in $\bar{B}$ hadrons produce more K through $b \Rightarrow c \Rightarrow s$

SSKT: use TOF to find K in p.v. tracks
- $\bar{B}_s$ produced with K^-
- B_s produced with K^+



Two methods to tag b flavor at production:
- Same Side Kaon Tagging (SSKT)
- Opposite Side Kaon Tagging (OSKT)

$$ct = L_{xy}\frac{m_B}{p_T}$$

Top quark measurements (Run I)

Top quark mass: **fundamental SM parameter**
needed to determine ttH coupling
important in radiative corrections (m_{Higgs})

$$M_{top} = 176.0 \pm 6.5 \text{ GeV}$$

Production cross section: **fundamental test of QCD**
discrepancies from QCD might imply non SM physi
(Current uncertainty is statistic dominated)

$$\sigma_{t\bar{t}}^{CDF} = 6.5 \pm 1.7 \pm 1.4 \, pb$$

Branching ratios:
B (t→(b)W): from ratio of double to single tagged event
B (t→b(W)): from ratio of dilepton to single lepton eve
(Process candidate is t->H^+b: the sensitivity is related to the mass and width of the H^+)

$$|V_{tb}| > 0.76 \text{ at } 95\% \text{ c.l.}$$

W helicity: **SM prediction for m_t =170 GeV/c^2**
since the top decays before hadronizing the helicity info is preserved (probing V-A V+A)

$$F_o = 70.6 \pm 1.6\%$$

Rare decays:
FCNC: BR(t->Zc) , BR(t->γc)
In Run II may become visible the CKM suppressed decays: BR(t->Ws)~0.1% , BR(t->Wd)~0.01%.

$$Br(t \to Zq) < 33\% \text{ at } 95\% \text{ c.l.}$$

$$Br(t \to \gamma q) < 3.2\% \text{ at } 95\% \text{ c.l.}$$

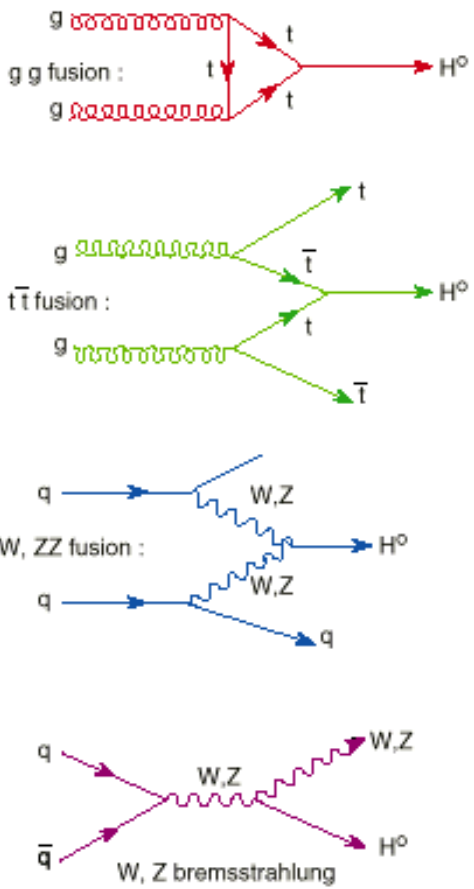
Single Top production:
From the 2 production modes

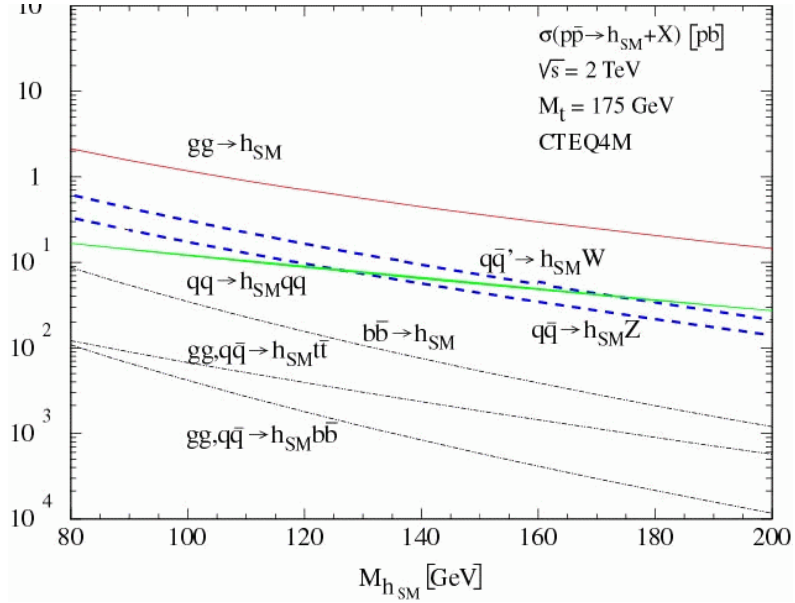
$$\sigma_{\text{single top}}^{\text{CDF}} < 15.4 \text{ pb at } 95\% \text{ c.l.}$$

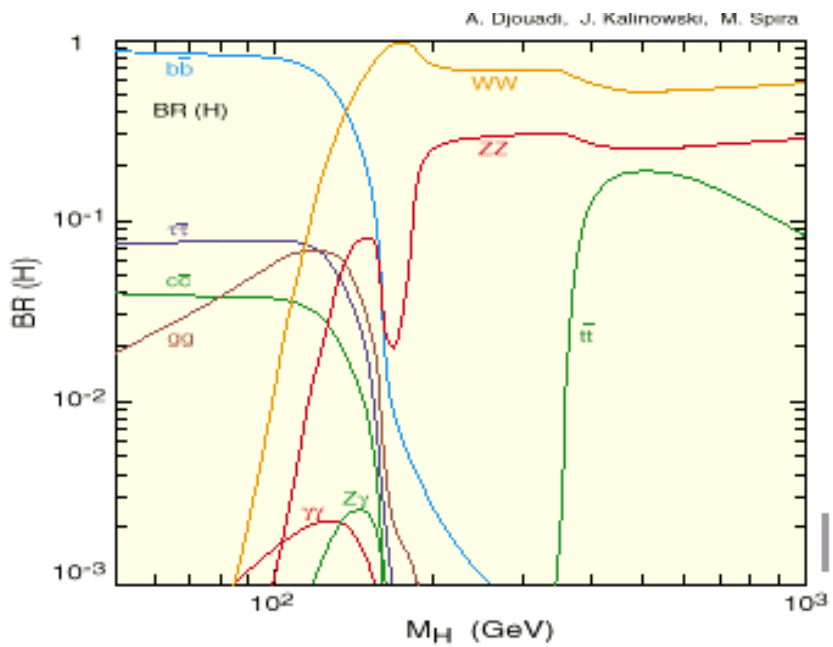
Experiment	Luminosity	Events
CDF Run I	100 pb^{-1}	~ 500
CDF Run II	2 fb^{-1}	~7000
CDF Run II	10 fb^{-1}	~ 70,000
LHC (x1)	10 fb^{-1}/year	~ 8M/year

Measurement	Precision
Top Mass	2-3 GeV/c^2
$\delta\sigma$(ttbar)	9%
$\delta\sigma$(ll)/σ(l+j)	12%
δB(t$\rightarrow$Wb)	2.8%
$\delta B(W_{longitudinal})$	5.5%
δV_{tb}	13%
B(t$\rightarrow c\gamma$)	$<2.8 \times 10^{-3}$
B(t$\rightarrow$Zc)	$<1.3 \times 10^{-2}$

SM Higgs production & decay

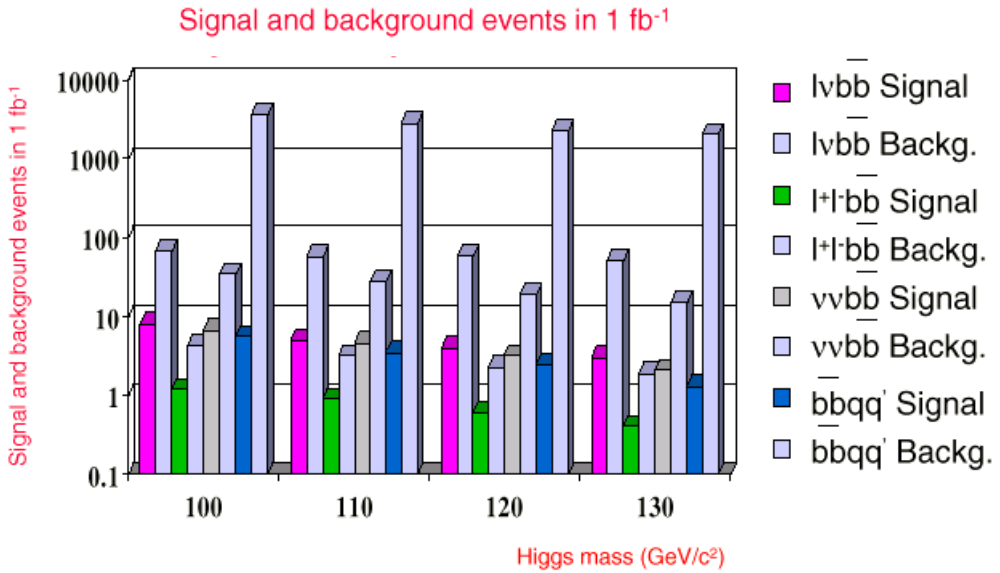


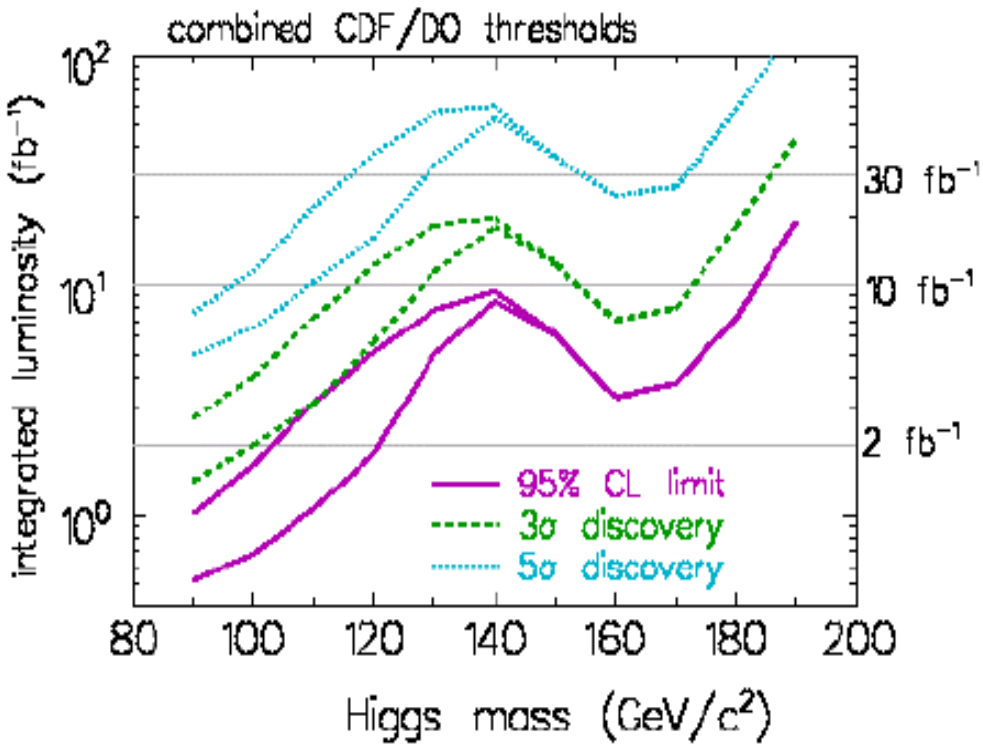




Prospects at the Tevatron

1) Via W/Z H production





Threshold	Run II (CDF + D0)
95% cl excl	< 190 10 fb^{-1}
3σ Evidence	< 180 20fb^{-1}
5σ Discovery	<120 30fb^{-1}

Applying the GRID framework in HEP computing

SANTANDER / OVIEDO HEP GROUP

Jesus Marco

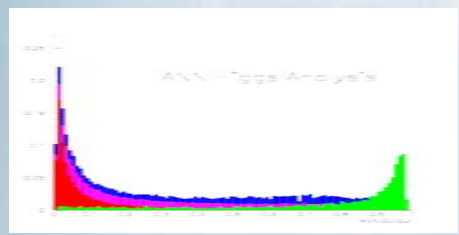
(marco@ifca.unican.es)

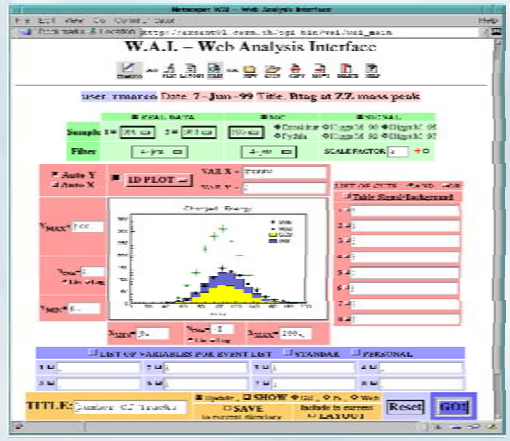
RECFA meeting

29 April 2003

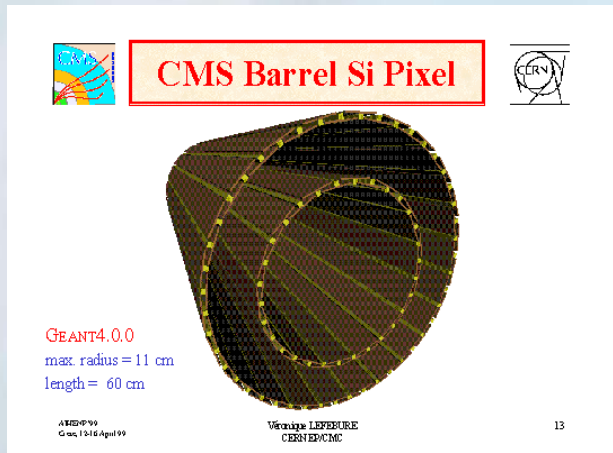
Our Computing Experience

- On-line and offline software at LEP (DELPHI):
  - Fast Simulation
  - Physics Analysis Software:
    - Hot-line Interactive Event Search (IES)
    - NN analysis (LEP200 Higgs 4jets)

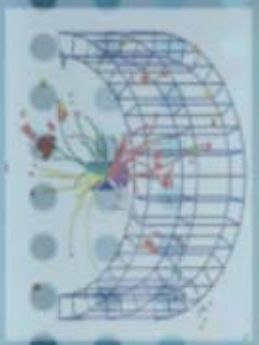




- OO software for CMS:
  - OSCAR framework (including Objectivity use)
  - Geant4 physics processes
  - Alignment
- O/R DBMS
  - Objective: alternative framework to ODMG (Objectivity)
  - IBM DMS: beta IDS9.3 + Object Translator
  - Also with Oracle 9i
    - D.Rodriguez at CERN IT: experience with NA48

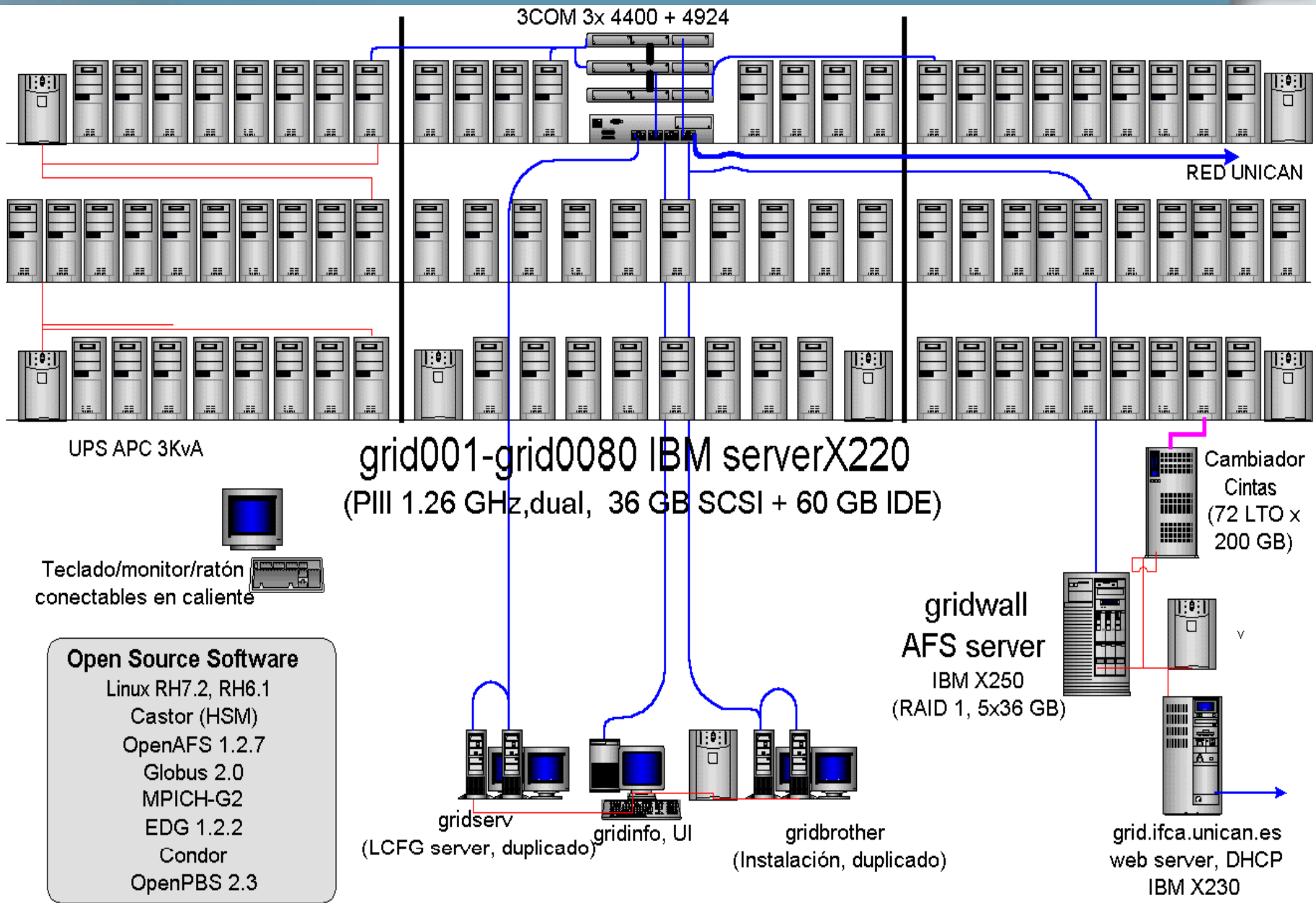


Resources

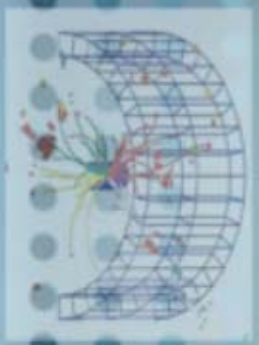


- Infrastructure:
  - Cluster ~200 CPU *(IBM servers ~50% available for HEP, 1.26 GHz, 640Mb-4GB RAM, 80 GB/server)* + 4-way processor server (AFS cell)
  - Storage:
    - 10 TB disk on-line
    - 60 TB IBM robot (LTO ultrascalable, up to Petabyte)
  - Gigabit local backbone
  - Improved network connection:
    - 622 Mbps Santander-Geant
    - 2.5 Gbps into-Geant and to USA
  - New building (September) with two computing rooms
  - Seed in Oviedo: cluster with 10 CPUs (link 622Mbps)
- Personnel (about 10 people):
  - 4 seniors with experience in HEP offline software
  - 2 Grid "experts" + support from computing architecture group + support from university for network
  - 2 DBMS "experts", funded by CSIC I3P program (tech. + post-doc)
  - 3 fellows (FPI equivalent) with good technical expertise
  - 3 graduating students in telecomm

Santander GRIDWALL



GRID activities



IFCA Santander present in EU-DataGRID

- Participation in testbed (WP6):
  - Certification Authority provider for SPAIN
  - Experience with Globus + EDG middleware

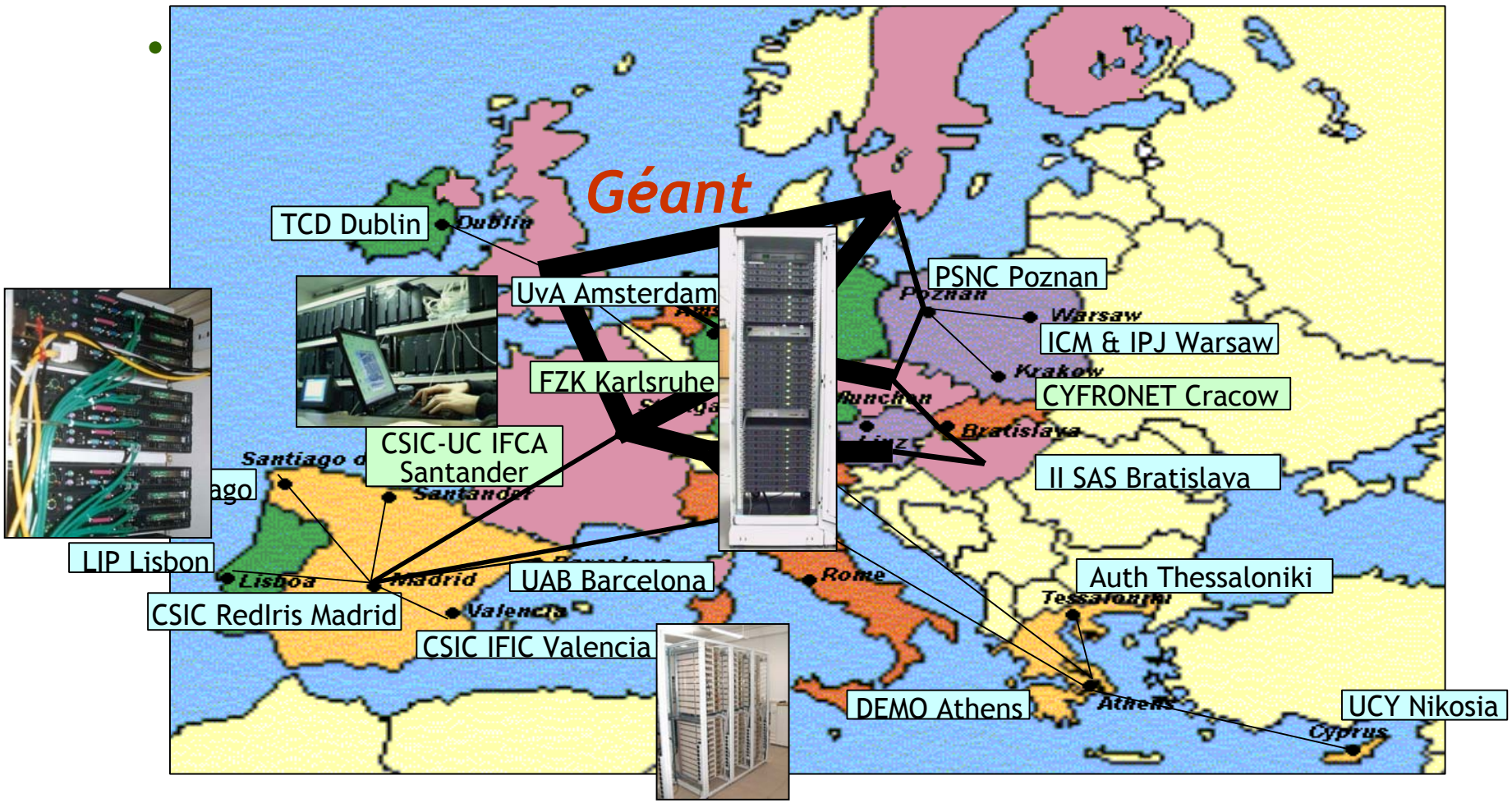
CSIC (IFCA, IFIC, RedIRIS) main partner in the CROSSGRID project

- Started 1st March 2002, driven by Poland+Spain+Germany
- Collaboration with DataGrid
- Use of distributed O/R DBMS
- Data-mining: distributed NN (via MPI)
- CSIC responsible for testbed (WP4) distributed over the Geant network across 11 european countries

The CrossGrid Testbed

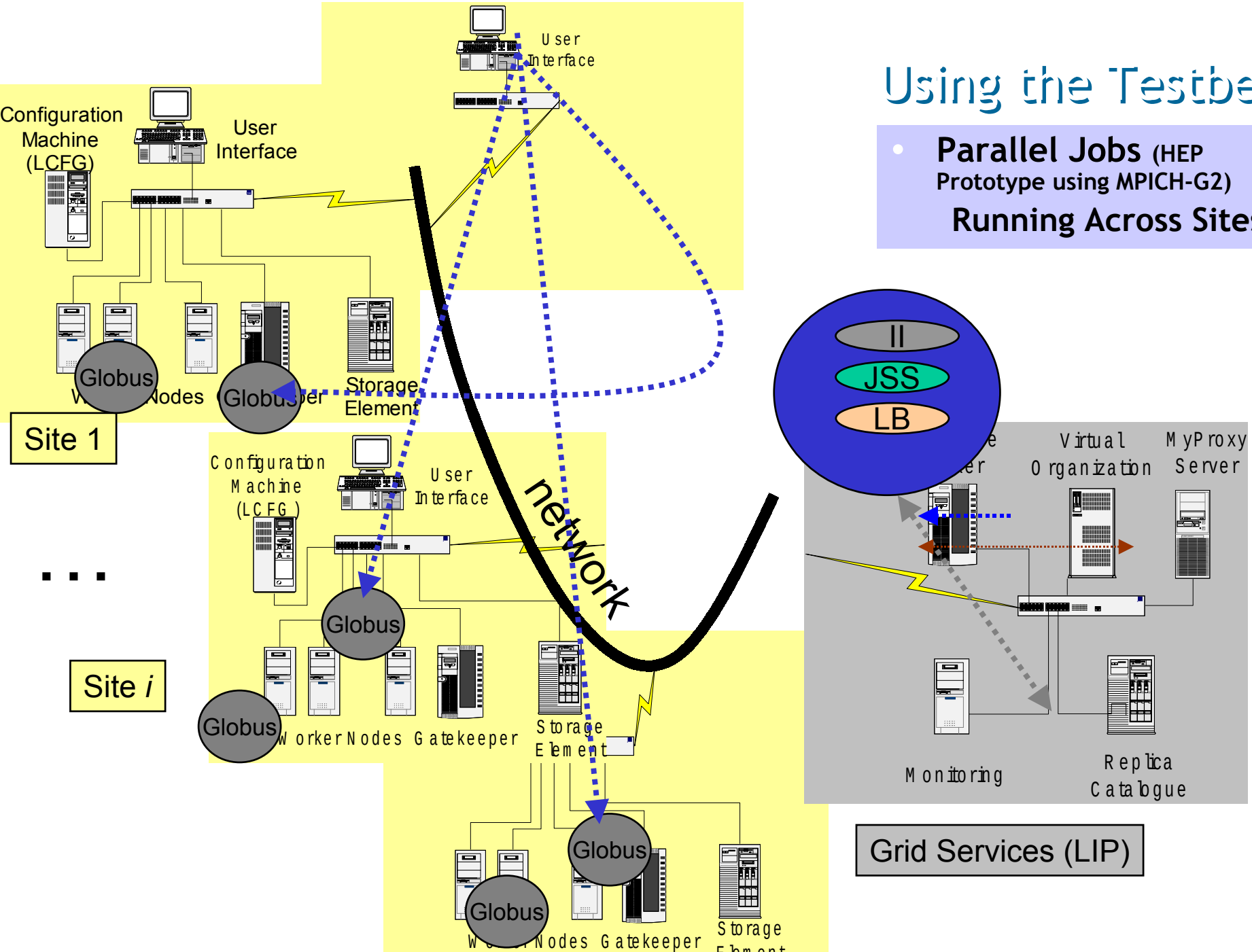
A collection of distributed computing resources

- 16 sites (small & large) in 9 countries, connected through *Géant* + NRN
-

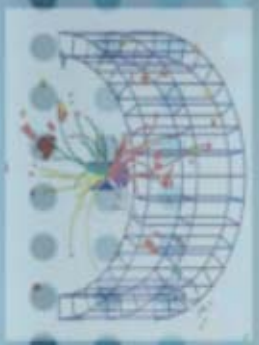


Using the Testbed

- **Parallel Jobs** (HEP Prototype using MPICH-G2)
  Running Across Sites



GRID activities



- IFCA CMS production center (participation in 2002 DC)
- LCG-ES: spanish LCG project (2002-2005)
  - IFCA participation:
    - MC farm for production (joint with IFIC)
    - Develop "data analysis station" able to digest Tb in distributed mode
    - Data management / persistency software
  - Use of IFCA Grid infrastructure
  - Profit from CrossGrid experience

Future:participation in EGEE

CSIC main promoter of IRIS-GRID (spanish Grid initiative)

Good local multidisciplinary contacts:

- Architecture Computing , Meteo, BioComputing, Astrophysics
- SME companies (CIC-SL, Mundivia, Semicrol)
- Hospital (HUMV)