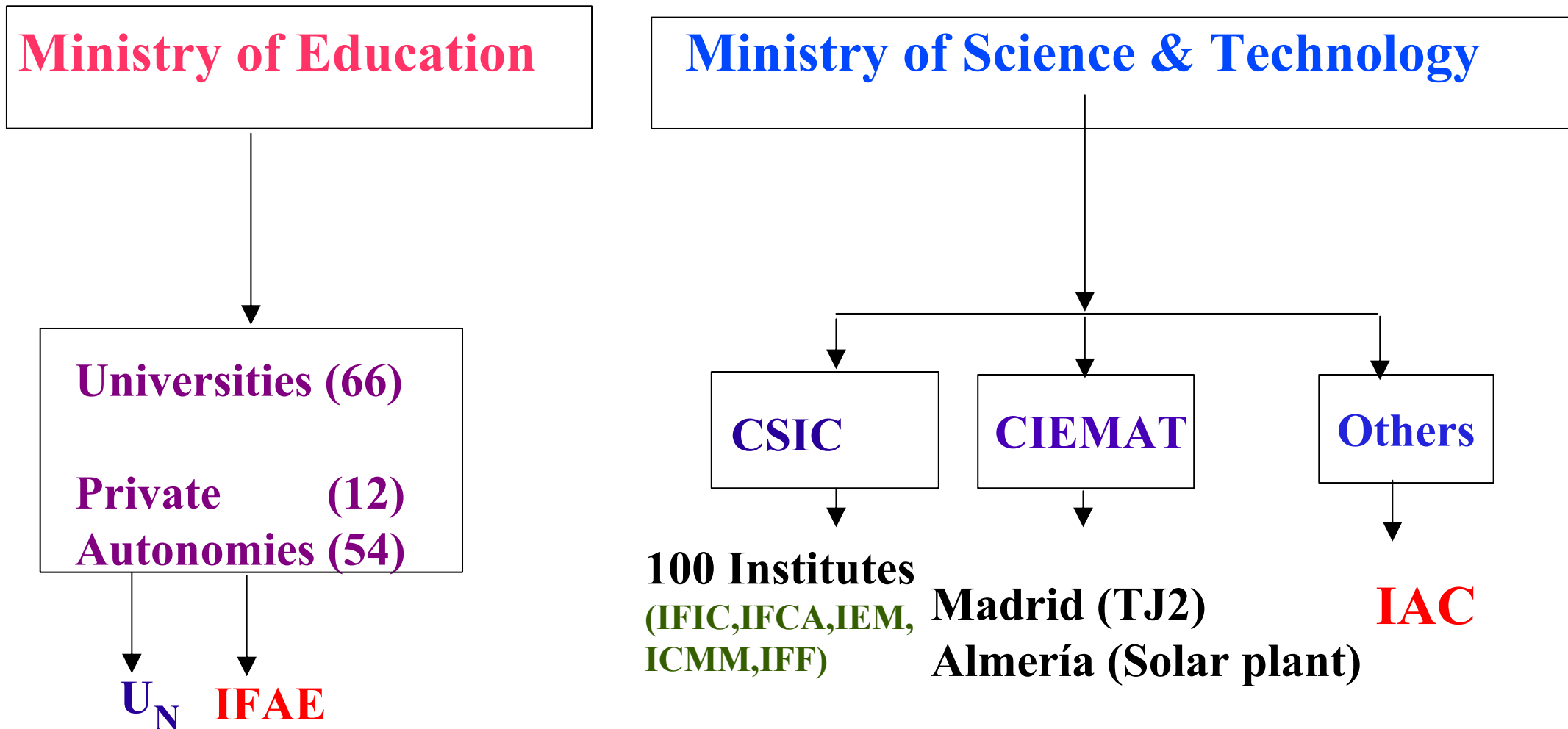


Present and recent past of HEP in Spain

Antonio Ferrer (IFIC -- Valencia University; CSIC)

Past Chairman of *Particle Physics & Large
Accelerators National Program*

Research Institutions in Spain



National Research Plan

(Ministry of Science and Technology)

23 National Programs: 3 year **Projects(+Spec. Actions)**

Basic research: Astronomy & Astrophysics
Particle Physics
Physics ...

Others on Biotechnology, Materials, Chemistry, Agriculture,...

Priorities of the National Program

1. Elementary Particle Physics (CERN).

Quarks & Leptons, Astroparticle, Neutrino,
Hadrons, Theory

2. Astroparticle Physics & Cosmology.

3. Experimental Nuclear Physics (N-TOF, ISOLDE, GSI).

4. GRID technologies.

5. Detector and Accelerator technologies.

Human resources

Personnel by status

	(1999)	(2002)		
Experimental	(200)	(270)	Staff	42%
			Fellows	29%
			Contracts	17% (4% RyC)
			Technical	12%
Theoretical	(190)	(220)	Staff	41%
			Fellows	36%
			Contracts	22% (12% RyC)
PhD's (exp) outside Spain:			24	(11% of total exp.)
			11	got Ramón y Cajal contract

HEP Geographical (Spain)



HEP Programme -Projects (2003)

1. Theory	15	(5+5+5)
2. LHC	12	(5+5+3)
3. HERA	2	
4. ASTROPARTICLES	12	(6+5+1)
5. ISOLDE & ions	7	(3+2+2)
6. Neutronics	6	(6+0)
7. Sync. Rad.	4	

Special Actions ... 26 (2 LHC, 7 GRID, 1 ASTRO,...)

HEP Programme (Spain)

1.	Theory	7	%
2.	LHC (ATLAS, CMS, LHC-b)	46	%
3.	GRID (ATLAS, CMS, LHC-b)	8.6	%
4.	HERA (Zeus)	0.7	%
5.	PS+ISOLDE (Dirac, +Legnaro, Ganil)	4.0	%
6.	Astroparticle (Auger, Canfranc, Magic, Antares, AMS)	21	%
7.	Neutronics... N-Tof, Ions, Spallation	4.0	%
8.	Tecnologías	1.5	%

HEP Groups & projects

2. Experimental

CIEMAT (Madrid)		CMS	AMS	ICARUS	N-TOF
IFAE (Barcelona)		ATLAS	MAGIC	CDF(FNAL)	K2K
UAB (Barcelona)			MAGIC		
IFIC (Valencia) hep		ATLAS	ANTARES	HARP	K2K
UB (Barcelona)		LHC-b	HERA-b		
ICMB (Barcelona)		ATLAS			
IFIC (Valencia) nuc		GSI	ISOLDE-LEGNARO	HADES	N-TOF
UAM (Madrid)		ATLAS	ZEUS (DESY)		
UCM (Madrid)		MAGIC	HEGRA	AUGER	
UAH (Madrid)				AUGER	
IFCA (Santander)		CMS	CDF (FNAL)		
IFAE (Santiago)		LHC-b	AUGER DIRAC	HADES	N-TOF
IFPFN (Zaragoza)		CAST	LSC (Canfranc)		
IEM (CSIC, Madrid) nuc			ISOLDE-LEGNARO-GANIL		ILL
UPC (Barcelona)					N-TOF
Huelva-Sevilla	nuc	ISOLDE			N-TOF
UGR		ICARUS			

LEP

1985-2000

1. ALEPH

(19 PhD)

IFAE- Barcelona

Luminosity Monitor (BCAL, BCAL++) &
FALCON

2. DELPHI

(28 PhD)

IFIC- Valencia

IFCA - Santander

UCM - Madrid

TOF (100%) & FEMC (20%)

3. L3

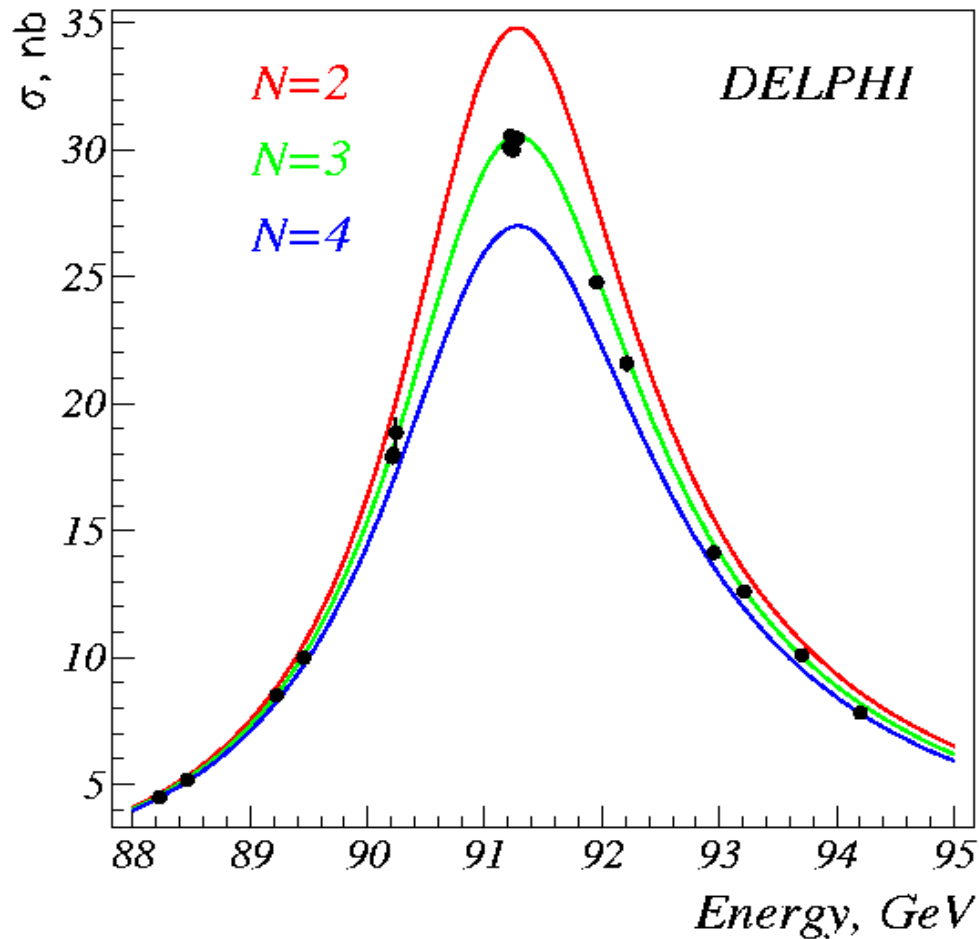
CIEMAT

(17 PhD)

Muon Chambers (100% Z, 2/3 P)

64 Ph D, about 1000 papers

The Z^0 boson



The three most important results:

- 3 neutrino families.
- top mass prediction.
- Limits on Higgs mass.

Plus

- Many, many high precision measurements

HERA

ZEUS

UAM - Madrid

U + Scint. Calorimeter

Light Guides + PMs + Electronics

RO Electronics of HES

HERA-b

UB - Barcelona

Spanish contributions to the LHC

ATLAS	IFIC-Valencia	TiCal	315 submodules (50% of EB) 1500 PMs ROD
	IFIC-Valencia	STC	200 módulos de silicio (+IMB)
	Barcelona IFAE		315 submódulos
		TiCal	65 módulos (1 Extended Barrel)
	Madrid UAM		Forward LAr Calorímetro
CMS	CIEMAT		MB2 Chambers Electronics
	IFCA Santander		Alignment
	Madrid UAM		Trigger, Electronics
LHCb	USC		Si Tracker
	UB-URL		RICH (PM, Electronics)

Spanish contributions to the LHC

ATLAS		Core	Fund	
-----		-----	-----	
SCT	(IFIC)	1.2		
TiCal	(IFAE)	1.2		
TiCal	(IFIC)	0.9		
LAr	(UAM)	2.4		
-----		---	---	
Total		5.7	4.1	9.8 MCHF (2.0%)

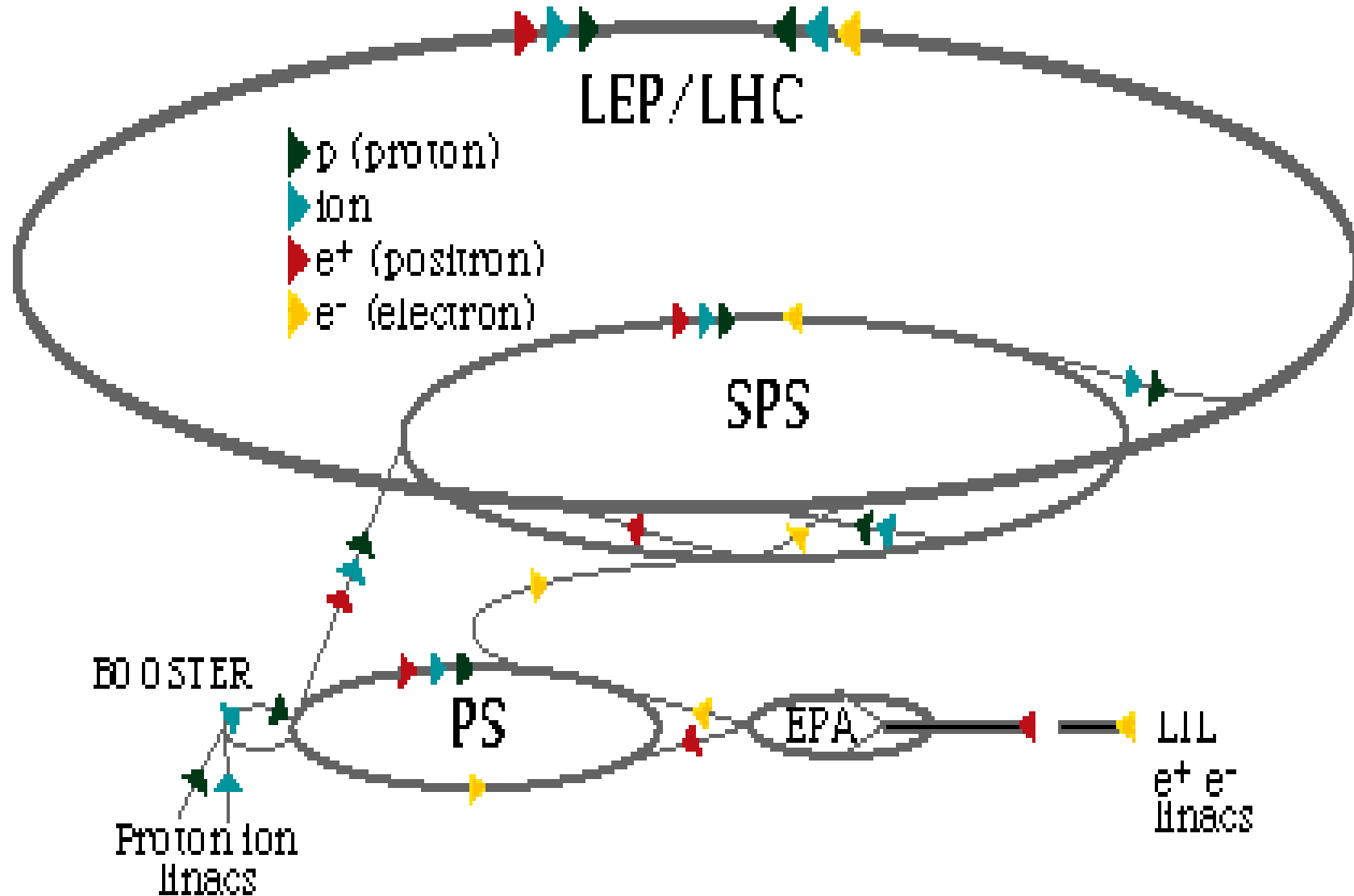
CMS		Core	Fund	
-----		-----	-----	
Mu	(CIEMAT)	3.5		
Align	(IFCA)	0.7		
-----		---	---	
Total		4.2	1.8	6.0 MCHF (1.3%)

LHCb		Core	Fund	
-----		-----	-----	
Calo	(UB)	0.63		
SiT	(USC)	0.80		
-----		---	---	
Total		1.43	0.57	2.0 MCHF (2.7%)

El colisionador LHC del CERN



El complejo de aceleradores del CERN



The LHC Challenge

" p + p 14 TeV s = 100 mb

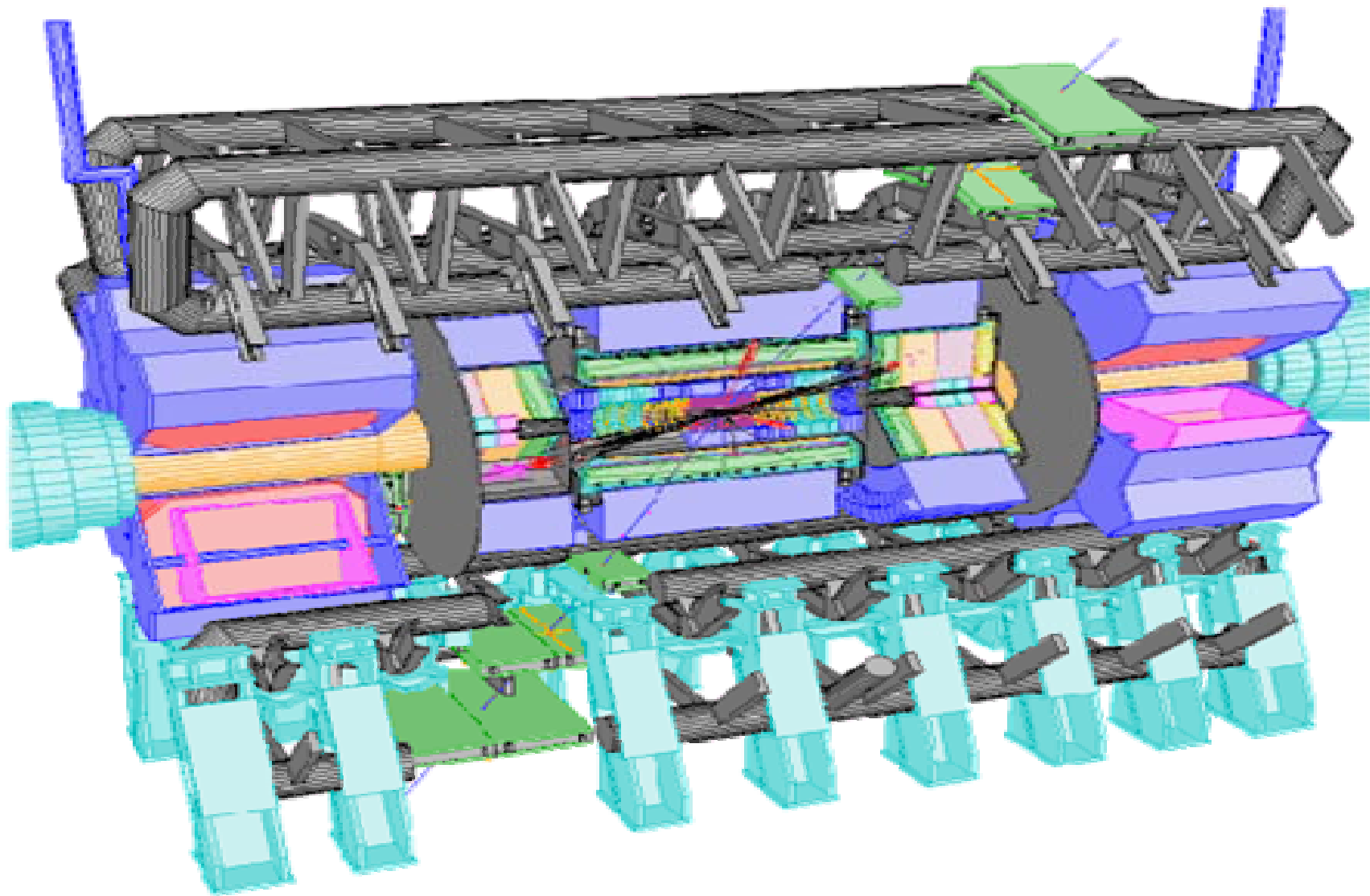
" L = 10^{34} cm⁻² s⁻¹ 10^9 collisions/s

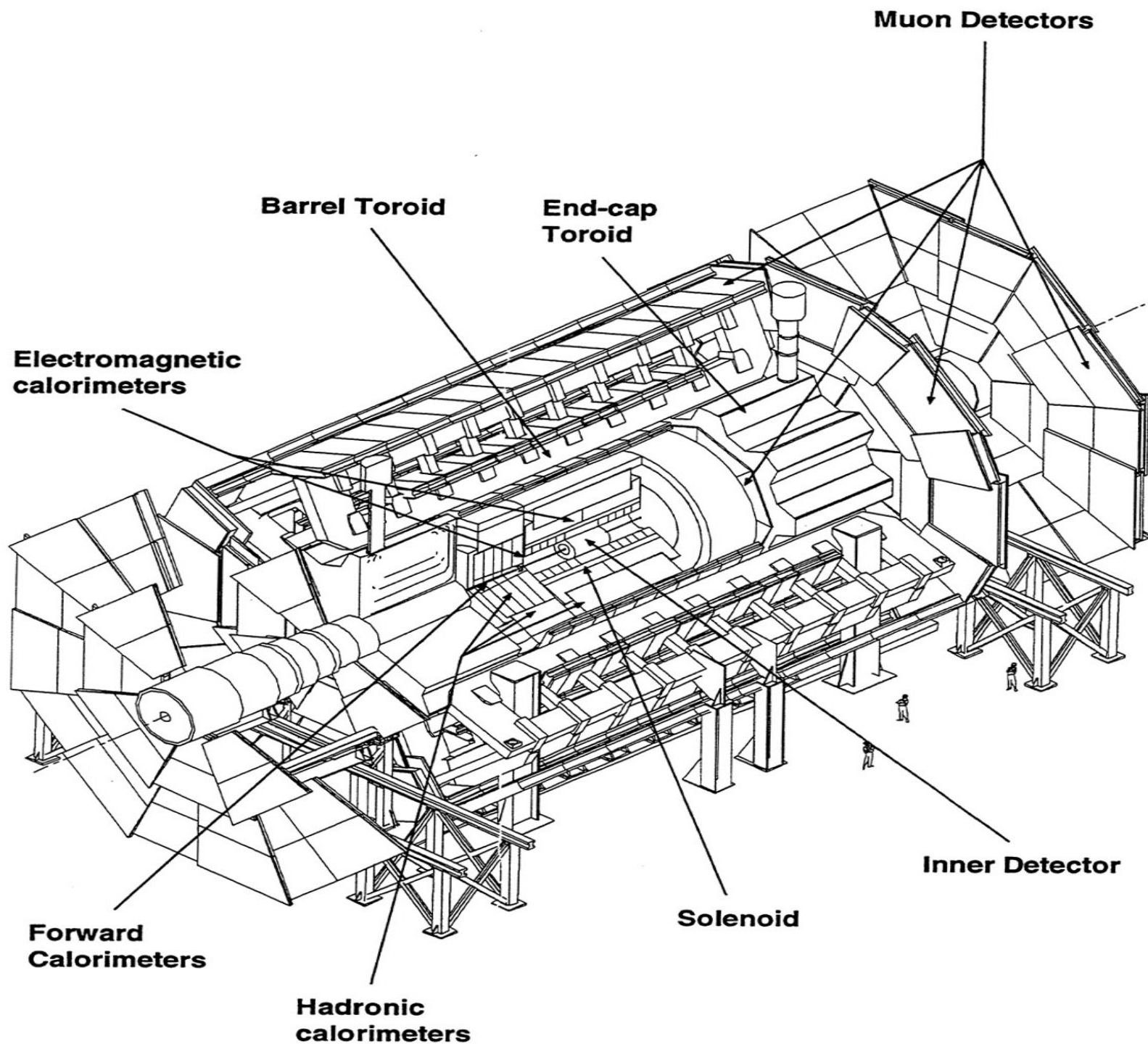
" ~ 100 events registered/s 100 Mbytes/s

" 10^7 events/year 1 Pbyte/year

Completely new computing challenge: the GRID

El espectrómetro ATLAS



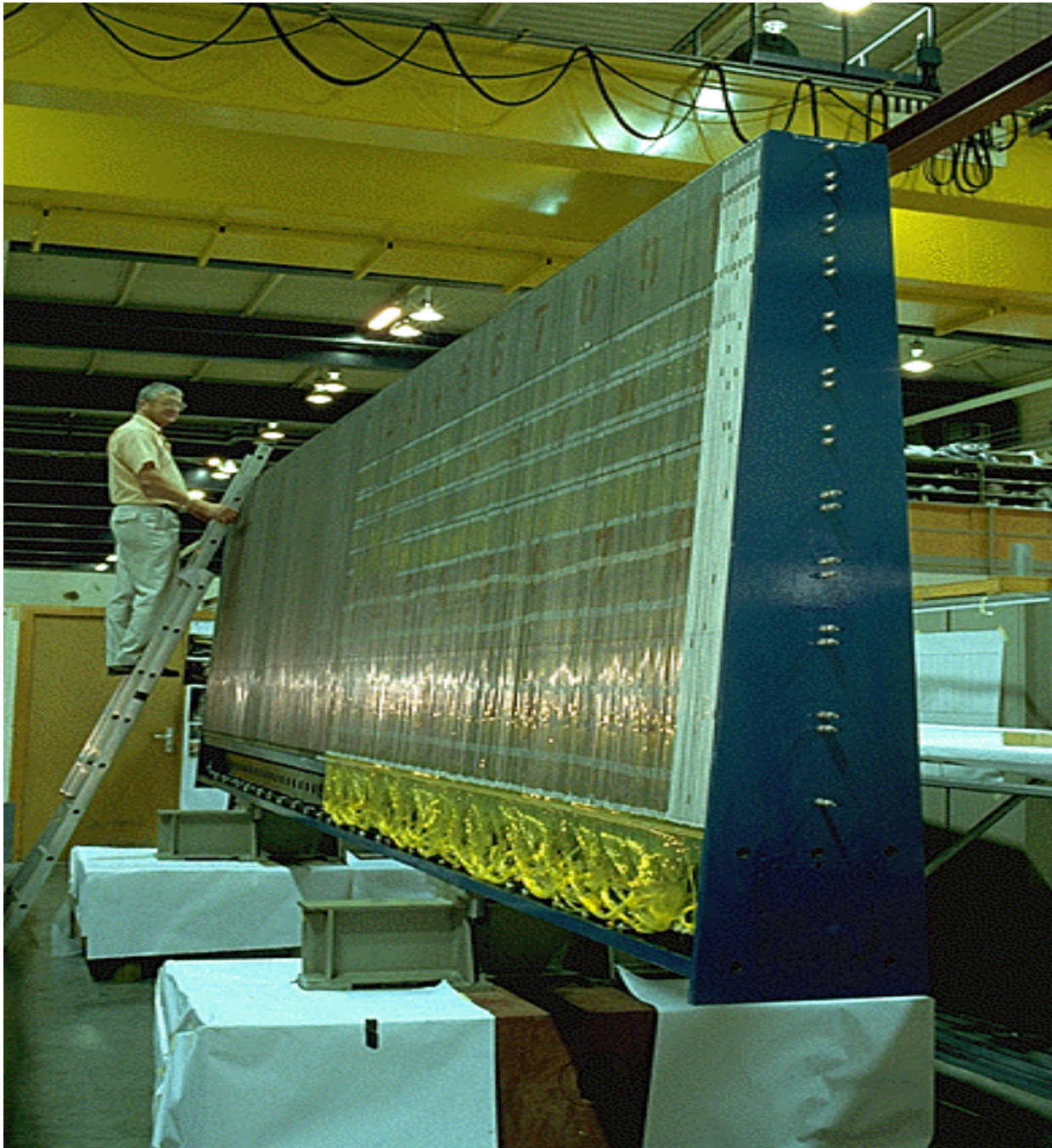


ATLAS-1: The ATLAS Detector for LHC

Submódulo del Calorímetro *TileCal*



Módulo del Calorímetro *TileCal*

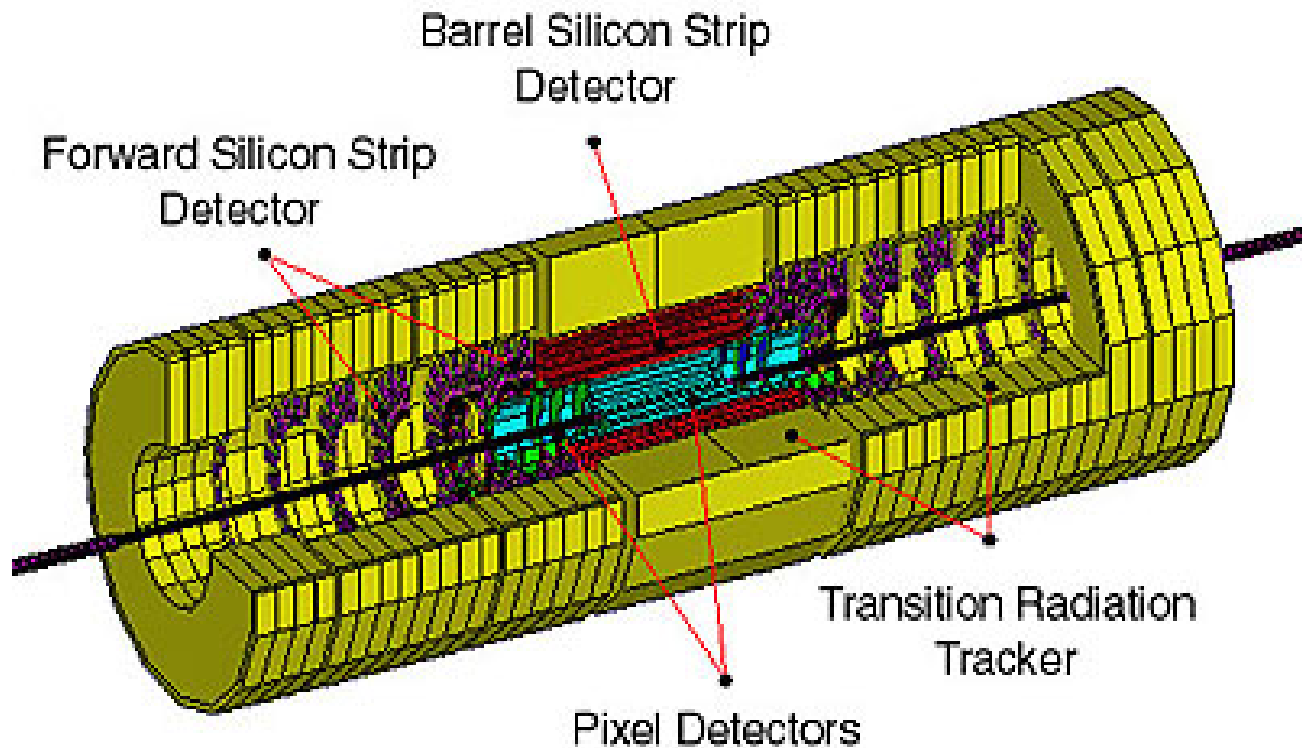


España construye 1 EB
= 64 módulos
640 Toneladas

50% submódulos en
Valencia (IFIC)
50% submódulos en
Barcelona (IFAE)

Extended Barrel montado
e instrumentado en IFAE

SCT (Inner Tracker)



IFIC - Valencia
CNM-Barcelona

2 Forward Wheels

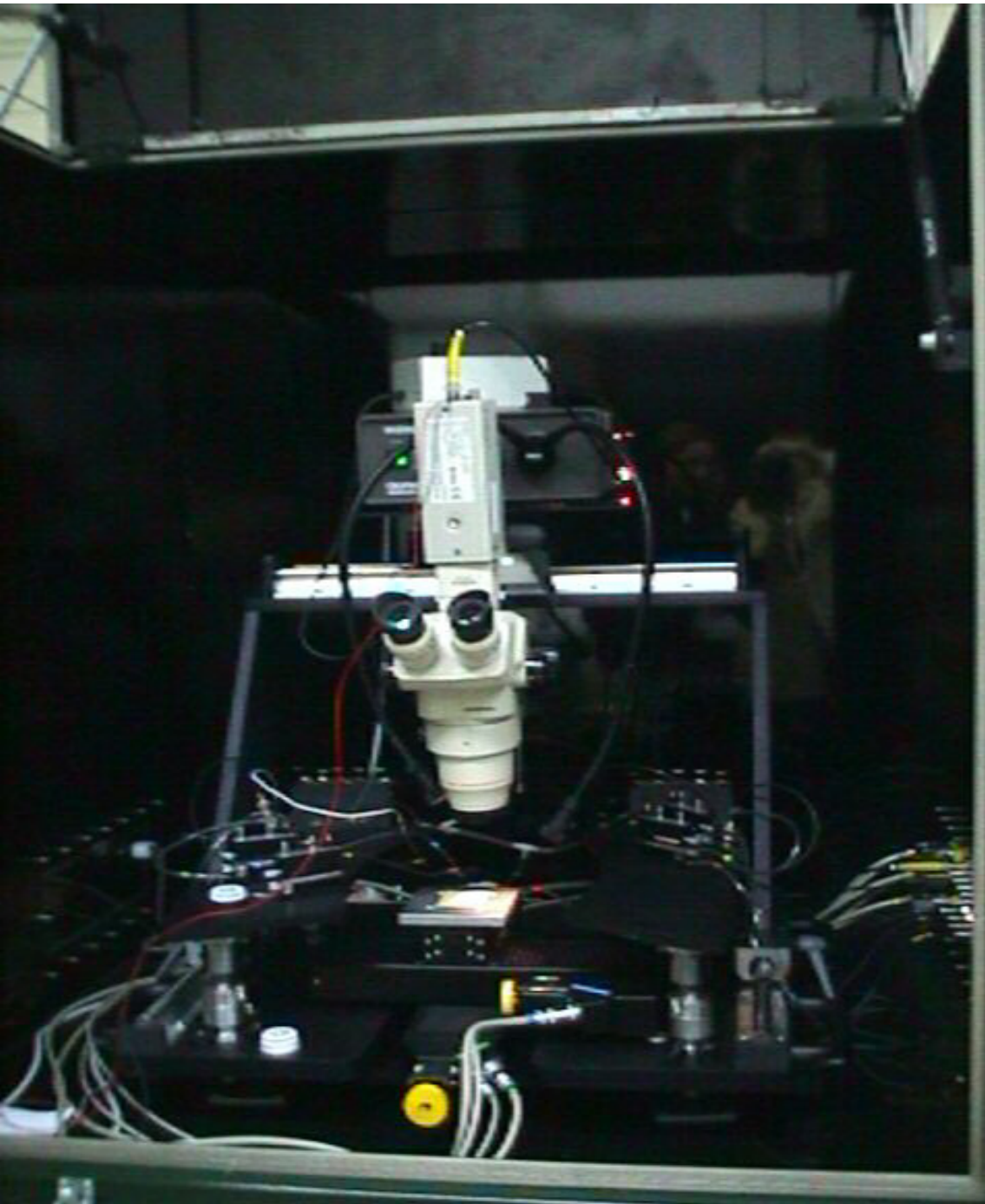
200 modules

Test, Bond, Mount

Inner Tracker



IFIC SCT Lab

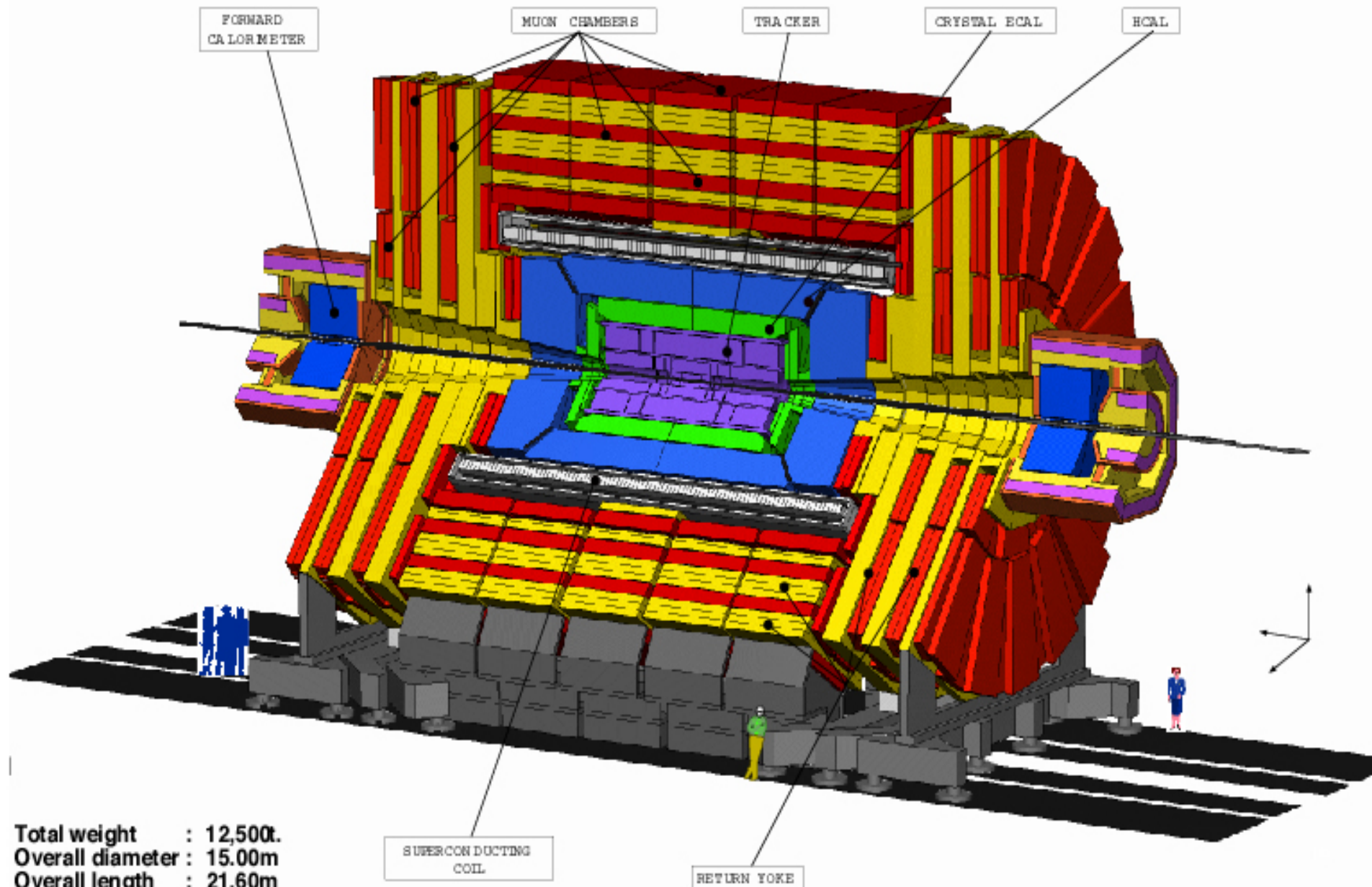


IFIC, clean room (SCT)



CMS

A Compact Solenoidal Detector for LHC



Total weight : 12,500t.
Overall diameter : 15.00m
Overall length : 21.60m
Magnetic field : 4 Tesla

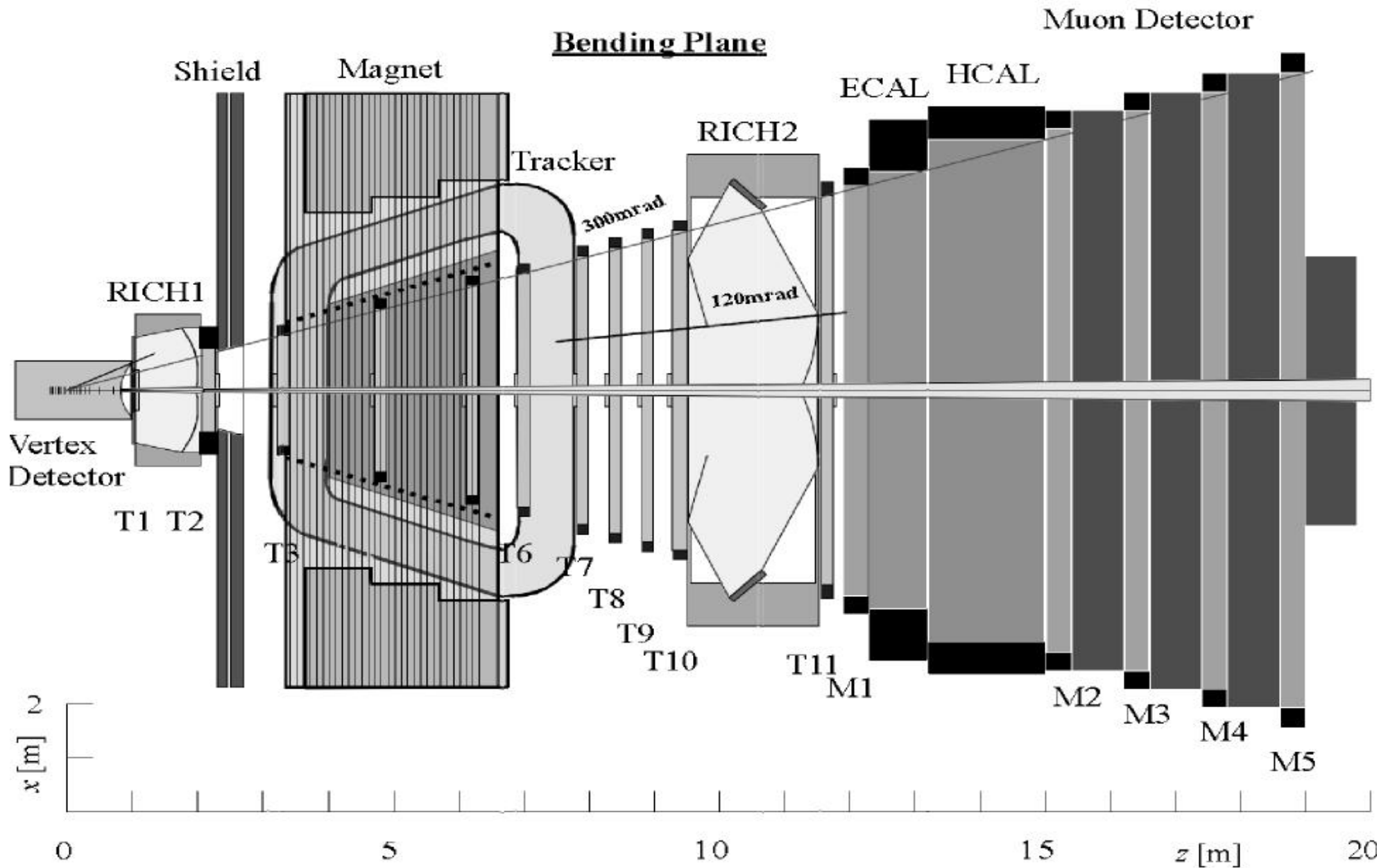
Construcción de cámaras de muones en el CIEMAT



First MB2 Chamber Assembled at CIEMAT



El espectrómetro LHCb



Astropartículas+neutrinos

1. Experimentos en el LSC CANFRANC +
CAST UZ
2. ANTARES IFIC
3. AMS CIEMAT
4. MAGIC IFAE - UAB - UCM
5. AUGER USC-UCM-UAH
6. K2K IFAE+IFIC (HARP)
7. ICARUS UGR - CIEMAT



THE CANFRANC UNDERGROUND LABORATORY

PHYSICS RESEARCH PROGRAM STATUS, RESULTS AND PROSPECTS



**Laboratory of Nuclear and High Energy Physics
University of Zaragoza**

LSG LABORATORIO SUBTERRÁNEO DE CANFRANC

CANFRANC UNDERGROUND ASTROPARTICLE LABORATORY

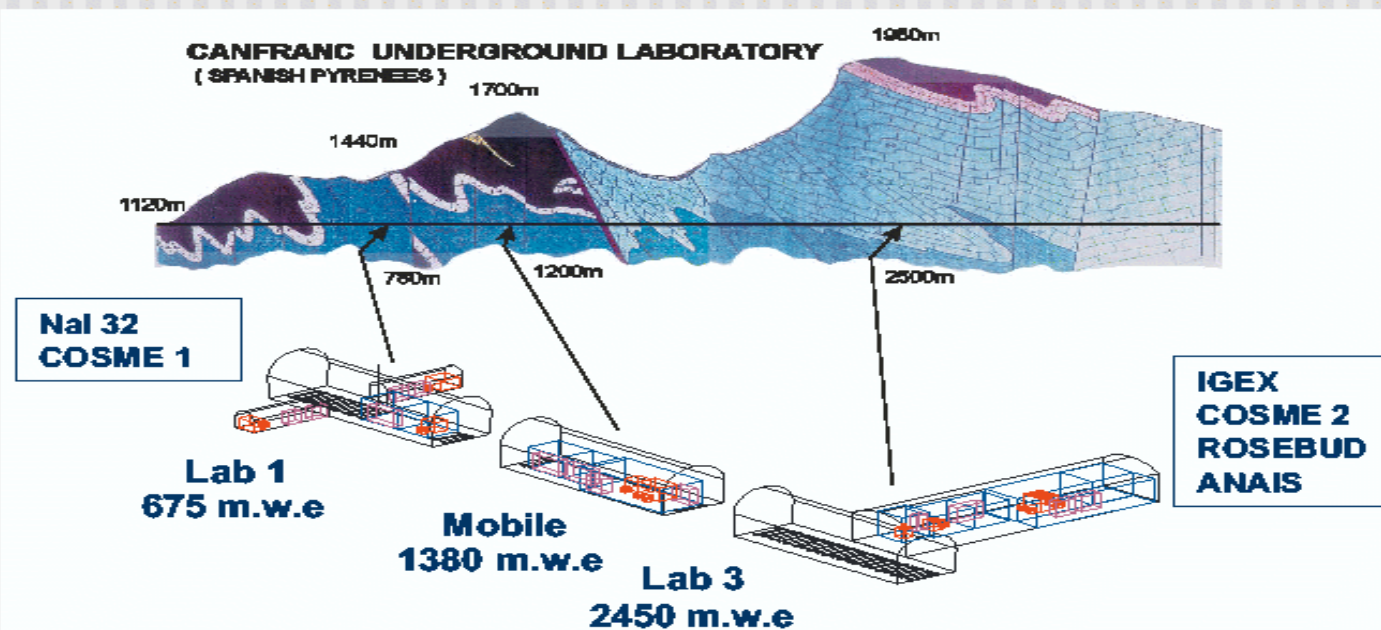
SPAIN



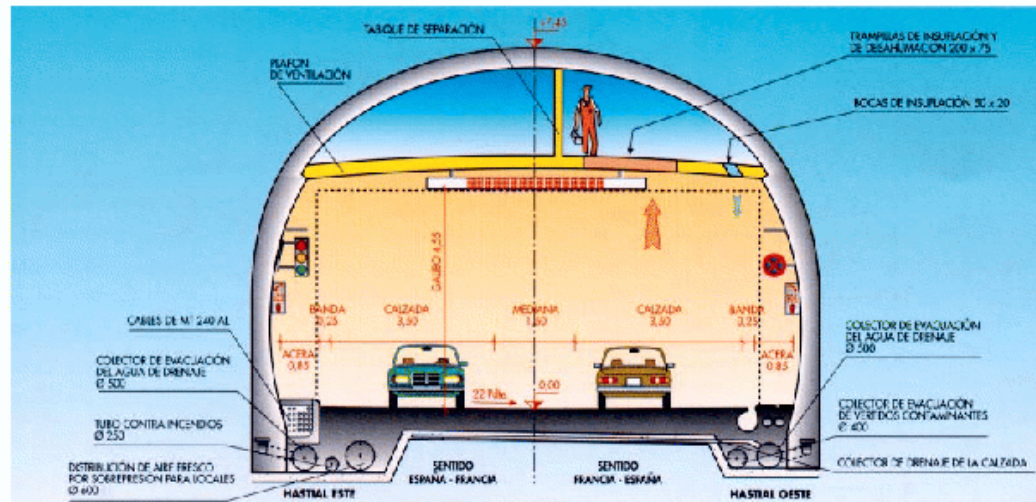
Spanish Pyrenees



Railway tunnel (not in use)



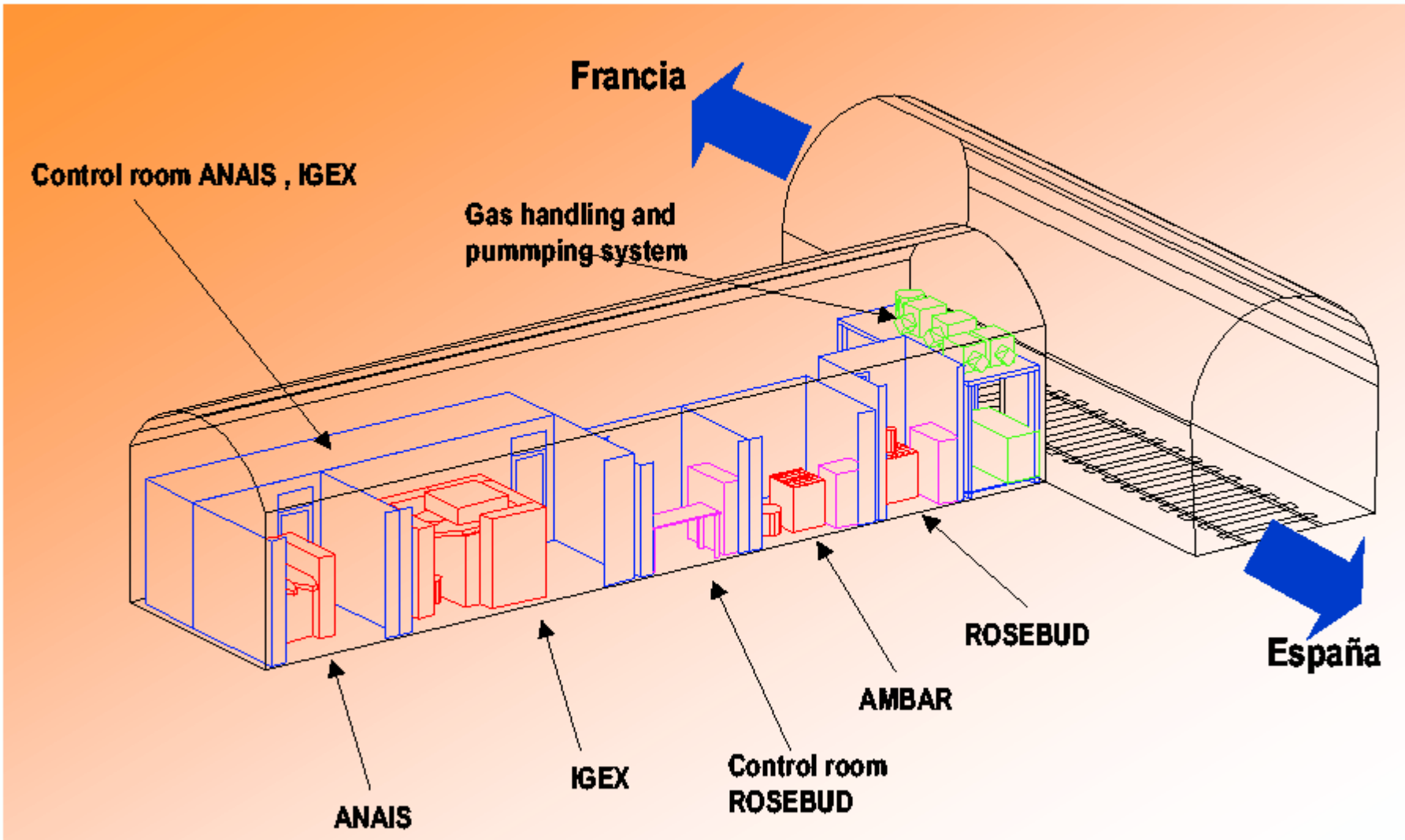
TUNEL DE SOMPORT



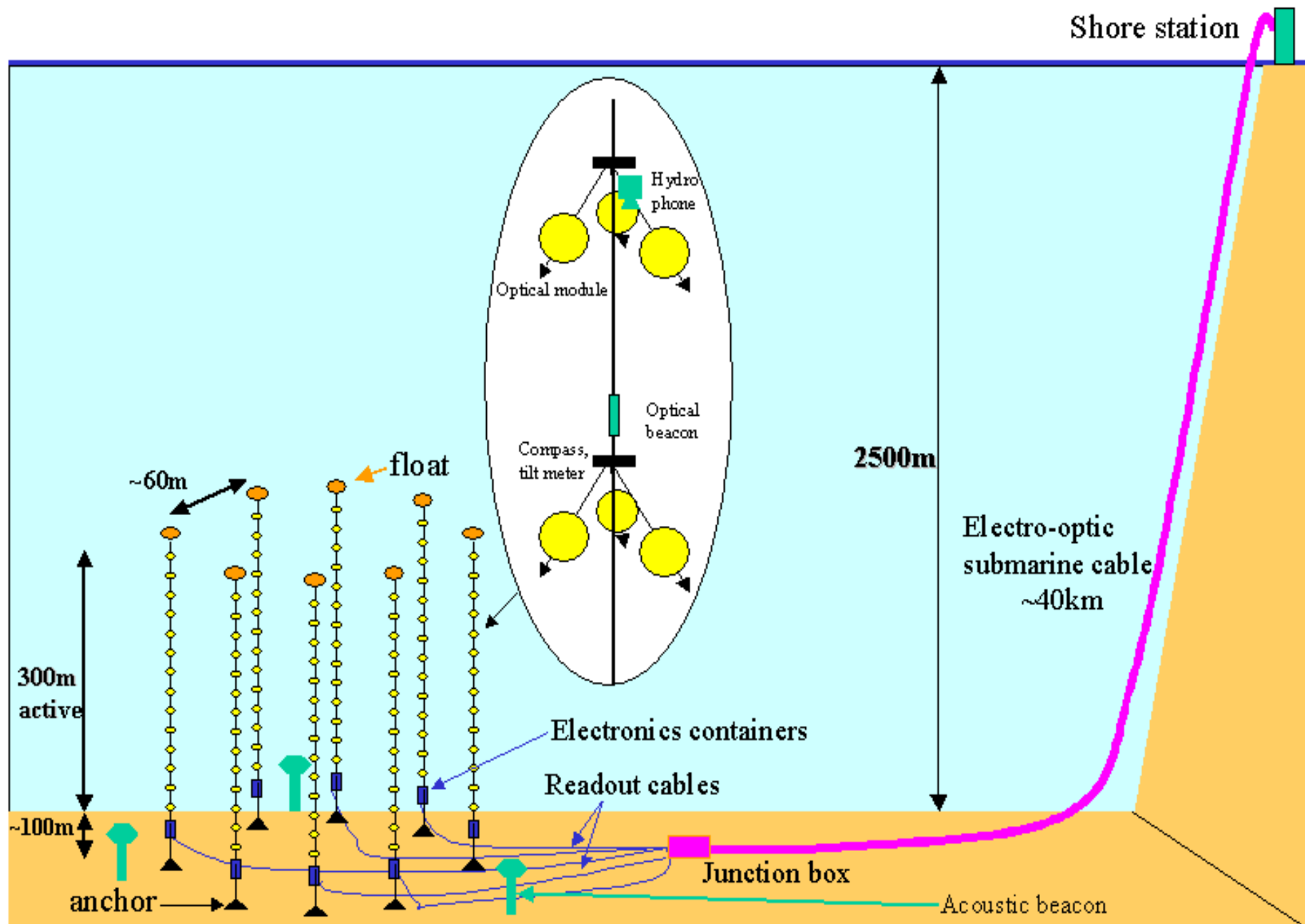
Tunnel section



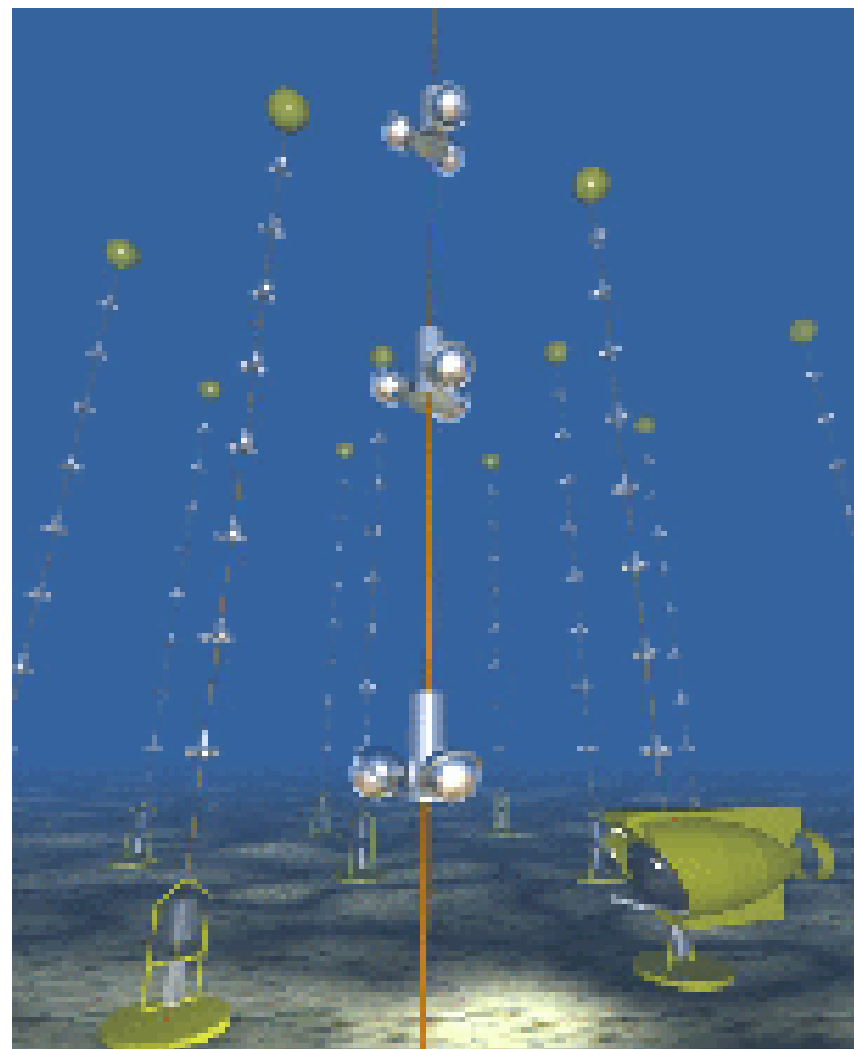
Canfranc Underground Laboratory



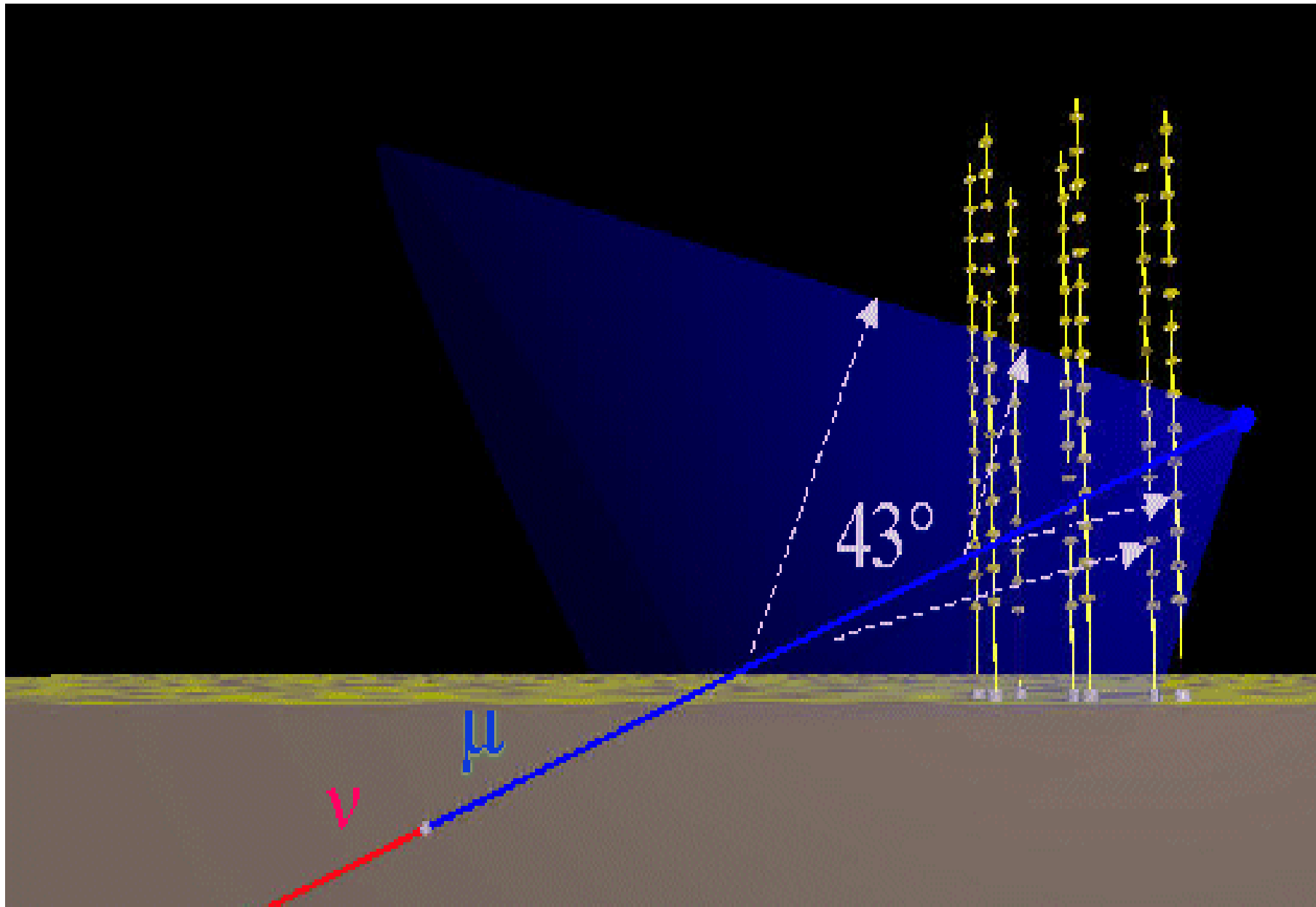
ANTARES 0.1km² Detector



ANTARES



ANTARES (Detection of μ)



ANTARES



HEGRA & MAGIC

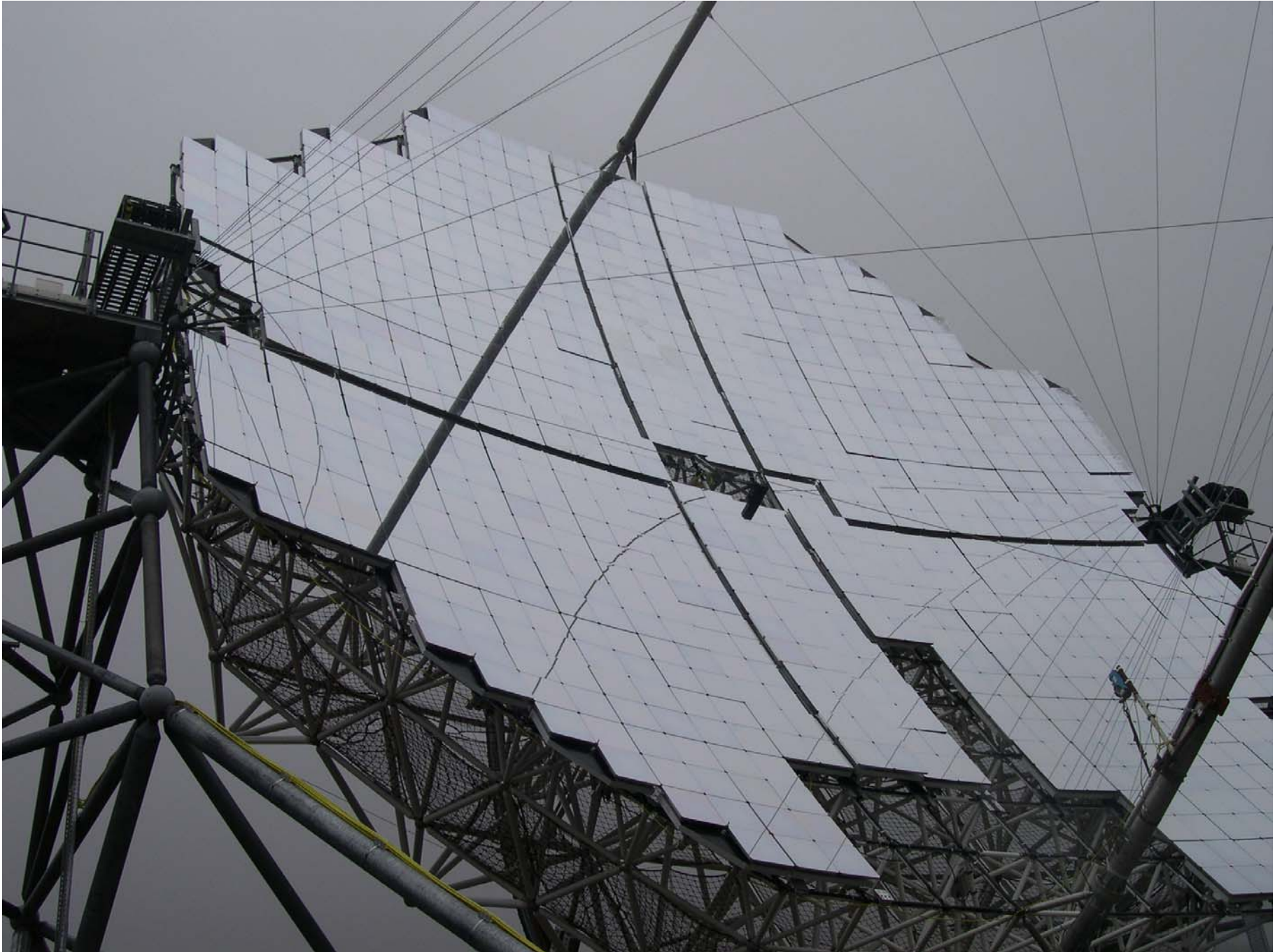
(El Roque de los Muchachos)



El Roque de los Muchachos (MAGIC)



Magic, the inauguration day



El Proyecto AUGER

Propósito: Detectar y descubrir el origen de los rayos cósmicos con $E > 10^{19}$ eV

2 despliegues (uno por hemisferio; coste 50 M\$)

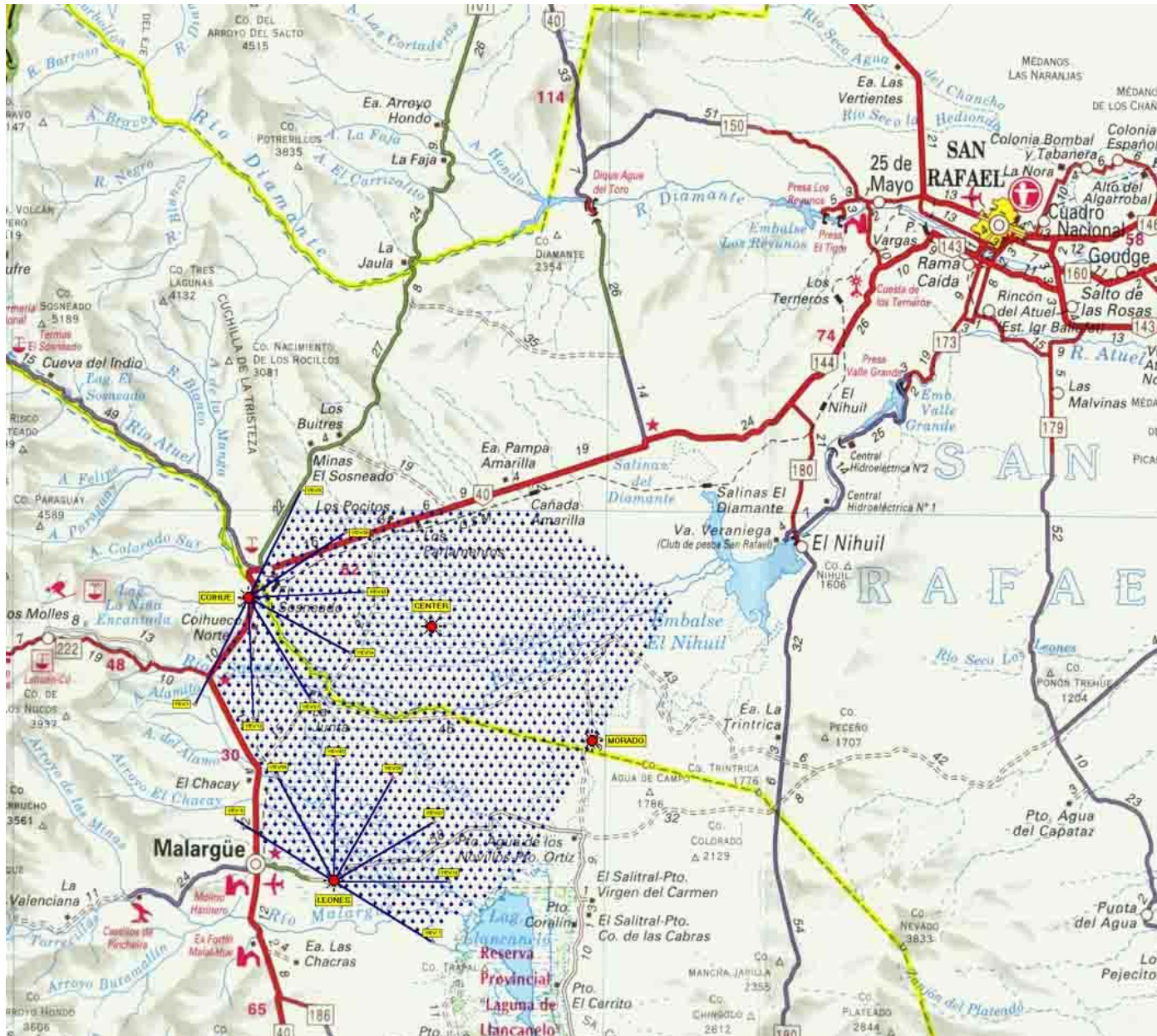
En cada hemisferio:

1600 detectores (de superficie) y 30 telescopios de fluorescencia desplegados en 3000 km^2

Sur: Provincia de Mendoza, Argentina

Norte:

Observatorio Auger en el Sur



El Proyecto AUGER

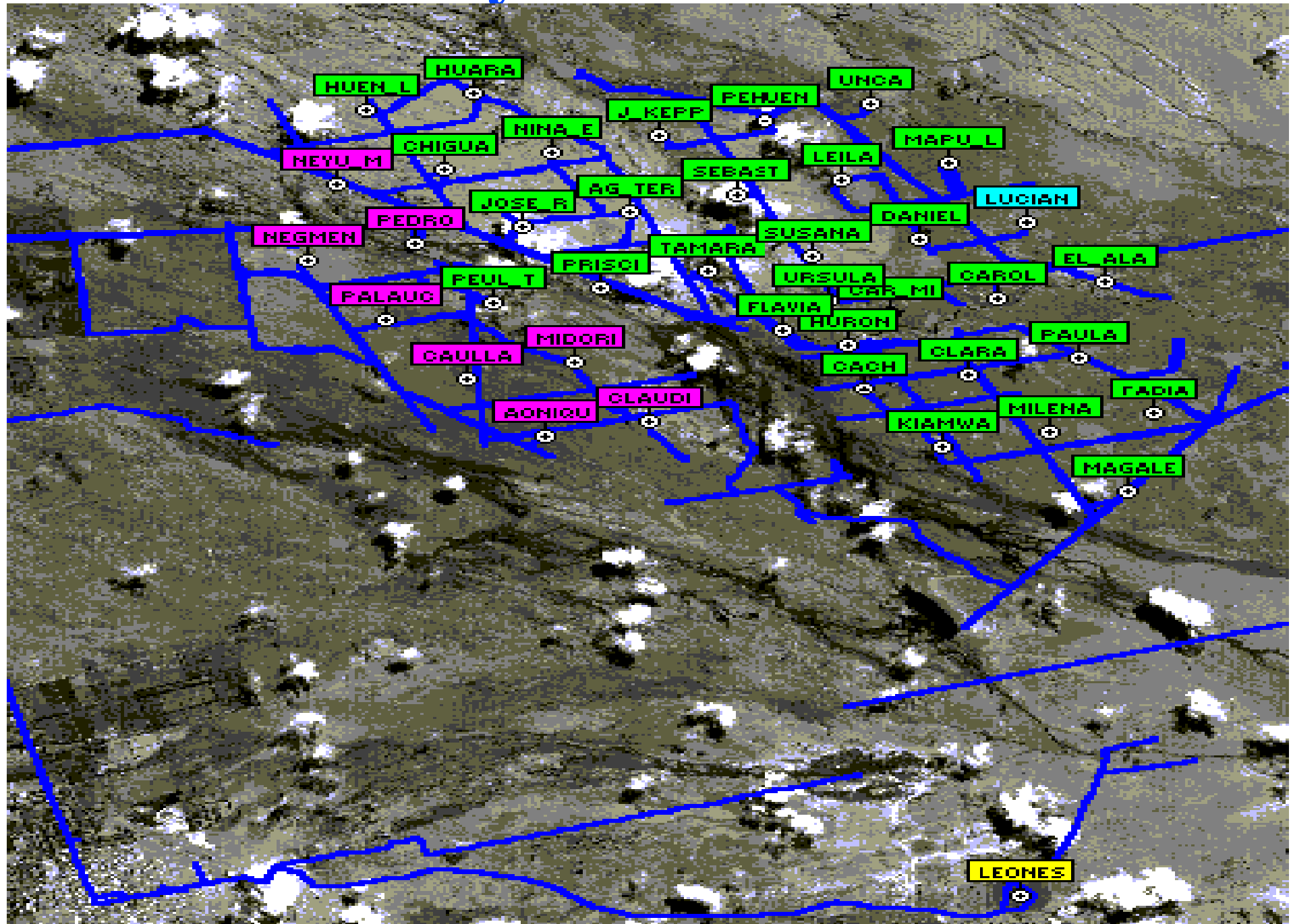


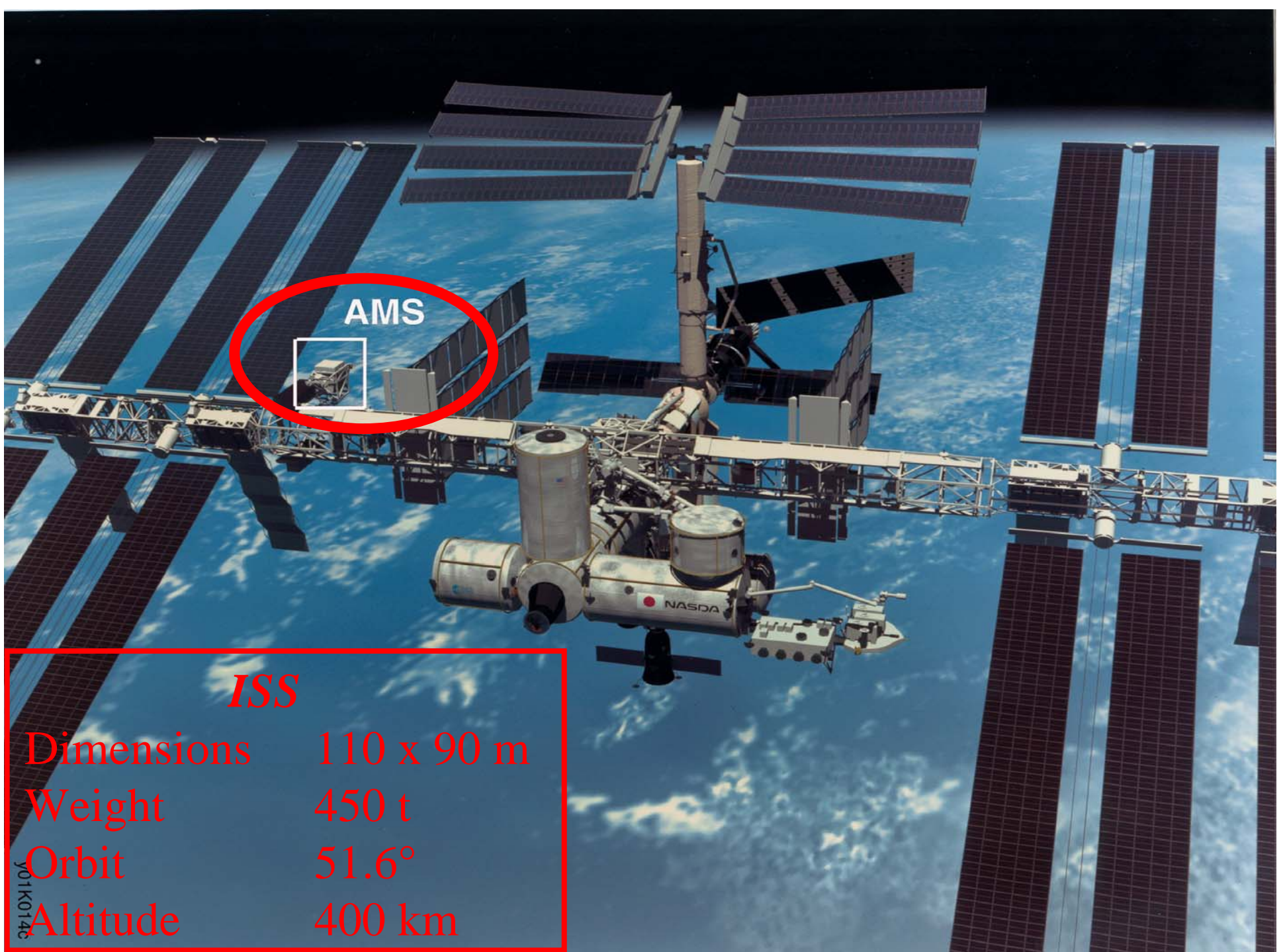
**Contribución
española:**

Paneles solares
(1000)
de los detectores
de superficie
(Cerenkov)

Simulación de
cascadas

El Proyecto AUGER





AMS

ISS

Dimensions 110 x 90 m

Weight 450 t

Orbit 51.6°

Altitude 400 km

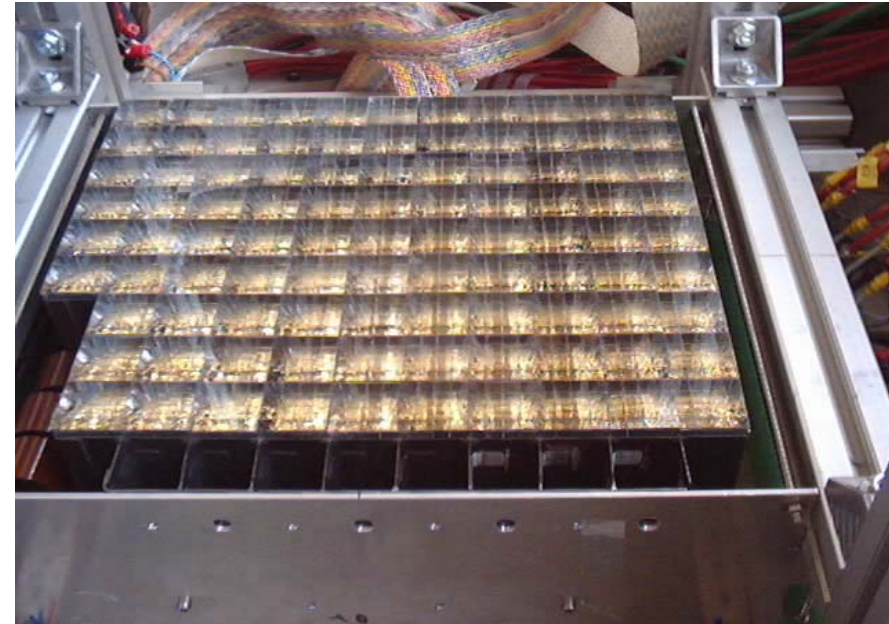
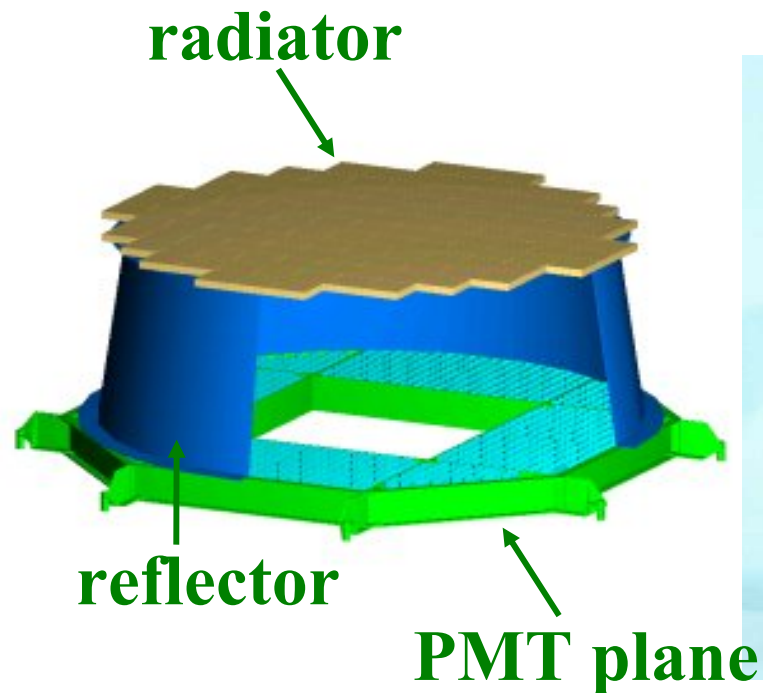
yo1k014c

AMS-02 Ring Imaging Cerenkov Counter

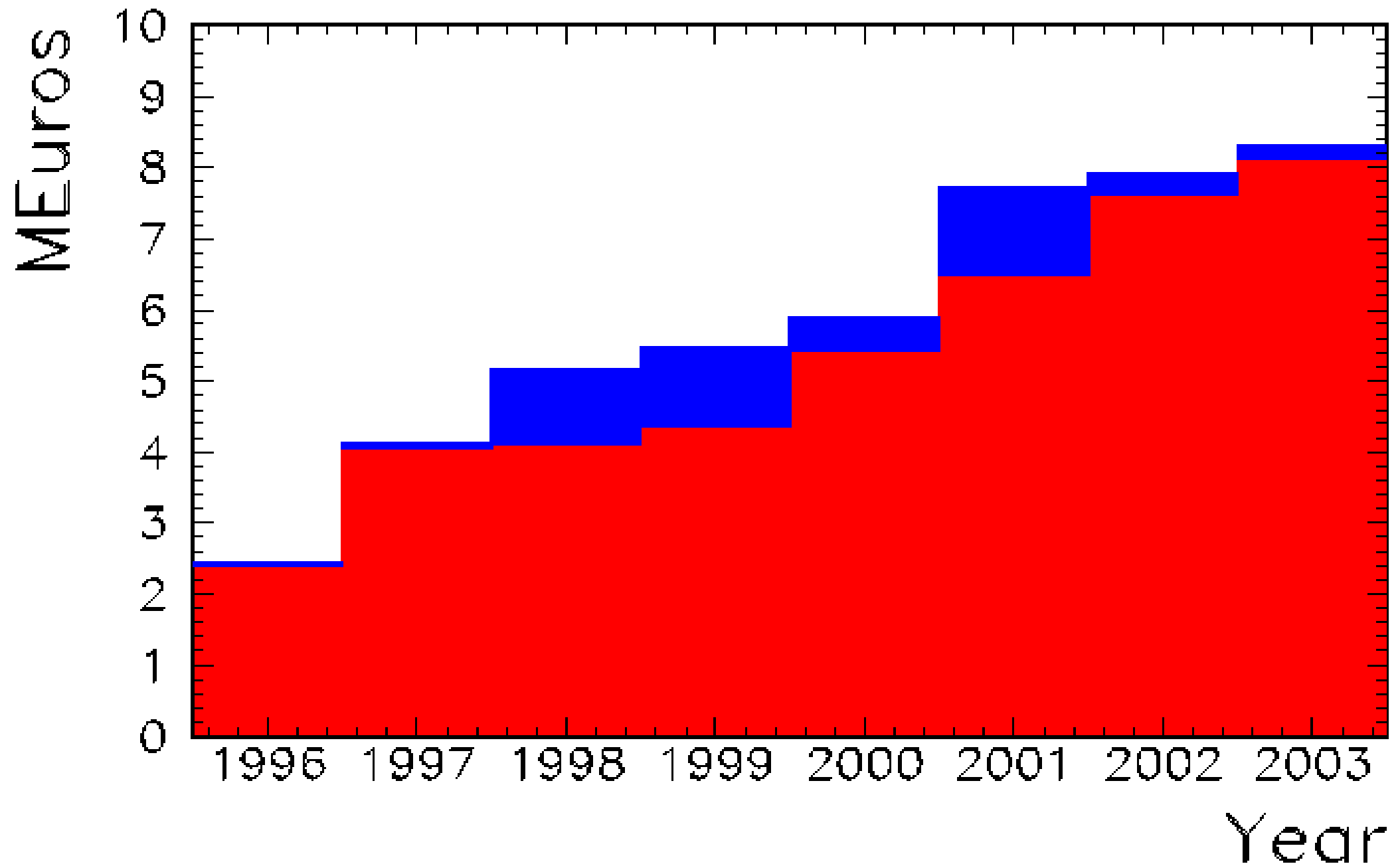
3 cm silica aerogel ($n=1.05$) radiator

680 multianode (4x4) PMTs

$\sigma(\beta)/\beta = 0.1\% @ \beta = 1$ (protons)



HEP National Funding



Spain HEP & CERN

Spain's CERN budget	7.0%	Staff:	85	(3.3%)	
Excellent Fellows candidates:			29	(13.4%);	low EP high TH
Paid Associates			22	(7.5%)	
Students			25	(15.8%)	

Unpaid Associates			181	(3%)	

Reasonable industrial return (since 1998, about 80%).

Special contributions:

CNGS	4	MCHF
LHCG	0.7	MCHF
	+5 men-year during phase 1	

Future Perspectives

(How to improve scientific & technological returns)

1. Large number of PhD's in foreign countries

“Ramón y Cajal” Program

NEED to strengthen LHC participation (Technicians)

PROPOSE "creation" of INFP to improve coordination

2. Computing for LHC (Data GRID).

3. Accelerator technologies R&D

Neutrino beam to Gran Sasso

TESLA Linear Collider + XFEL