FIFTY YEARS OF THE IMFP AND HEP IN SPAIN (1973-2023)

L INTERNATIONAL WINTER MEETING ON FUNDAMENTAL PHYSICS

SANTANDER, OCTOBER 2-6, 2023

MANUEL AGUILAR

CIEMAT, REAL ACADEMIA DE CIENCIAS, FUNDACIÓN RAMÓN ARECES

2023
CELEBRATE SEVERAL ANNIVERSARIES

. 50 years of the IWMFP (1973)
. 40 years of the return of Spain to CERN (1983)

. 50 years of the discovery of neutral currents at CERN (1973)
. 40 years of the discovery of the Z and $W^{\pm}$ bosons at CERN (1983)

DISCLAIMER

. TO SUMMARIZE HIGH ENERGY PHYSICS IN SPAIN DURING THE LAST FIFTY YEARS IS A TOO MUCH AMBITIOUS ENDEAVOUR

. REVIEW THE LESS KNOWN PERIOD OF TIME (1962-1983):
THE CONSTRUCTION OF THE HEP EXPERIMENTAL COMMUNITY

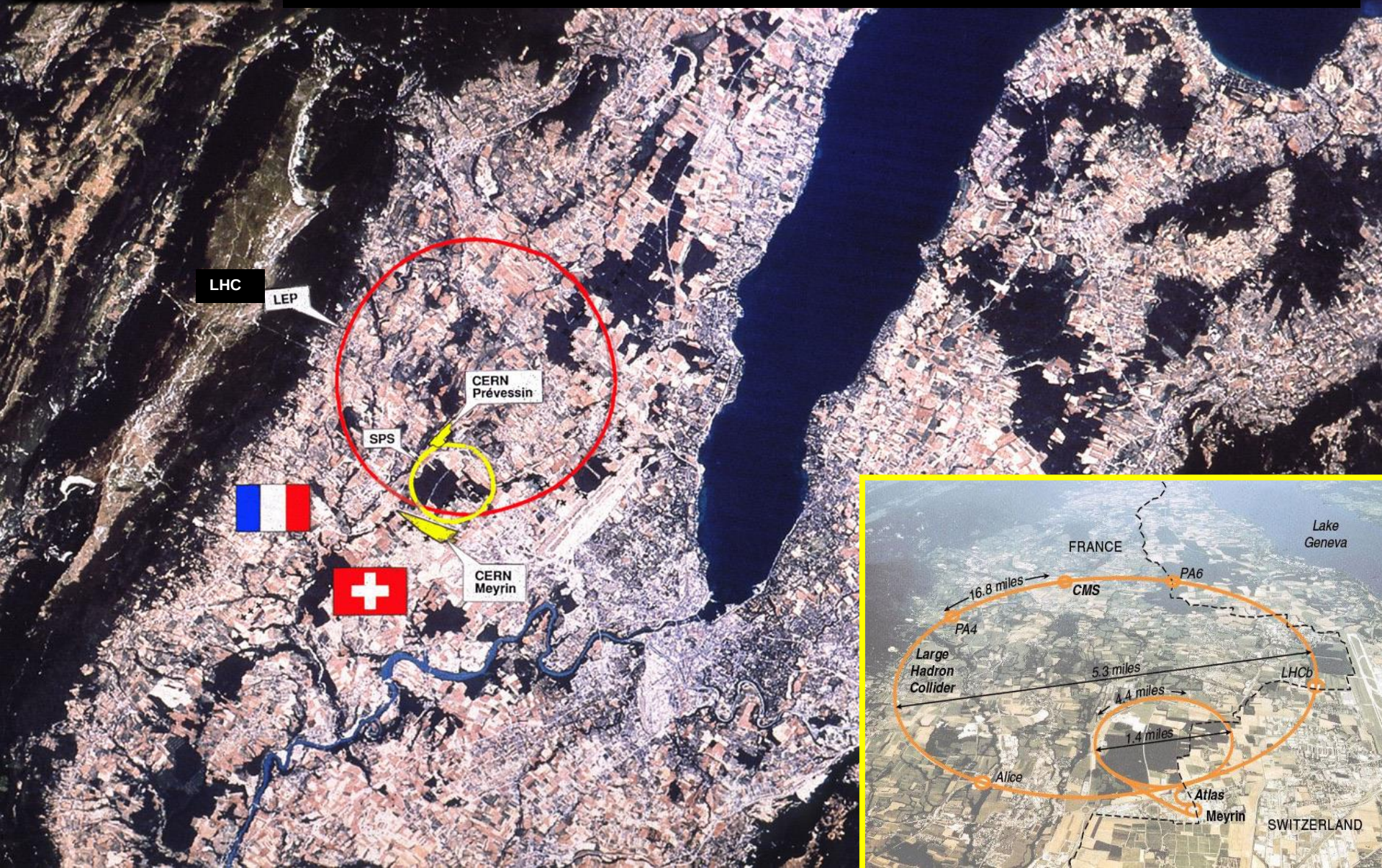
APOLOGIES

OVERVIEW SIMPLIFIED, INCOMPLETE, BIAS

CERN, 50 Aniversario, Manuel Aguilar / Revista Española de Física , Volumen 18, Número 4, 2004
Prestigious Discoveries at CERN, Roger Cashmore, Luciano Maiani, Jean-Pierre Revol, Springer, 2003
Luigi Di Lella / CERNCOURIER, January/February 2023, Sanje Fenkart / CERNCOURIER, July/August 2023

HIGH ENERGY PHYSICS IN SPAIN
INEVITABLY ASSOCIATED TO CERN

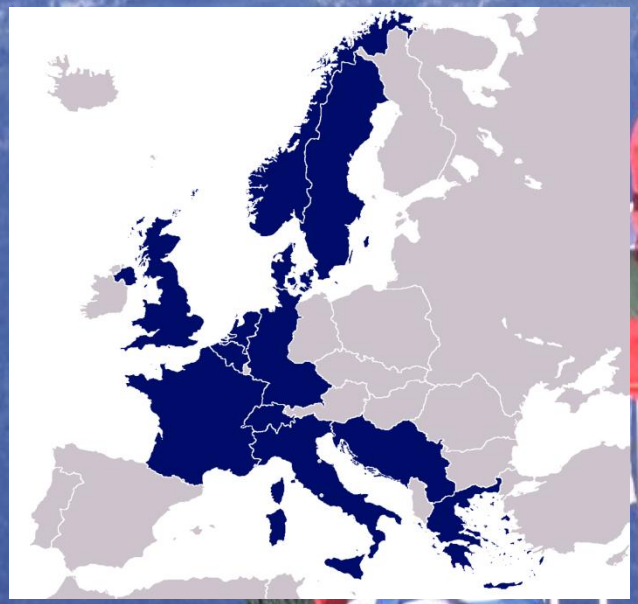
CERN (1954–2023)



CERN (1954-2023)

CERN

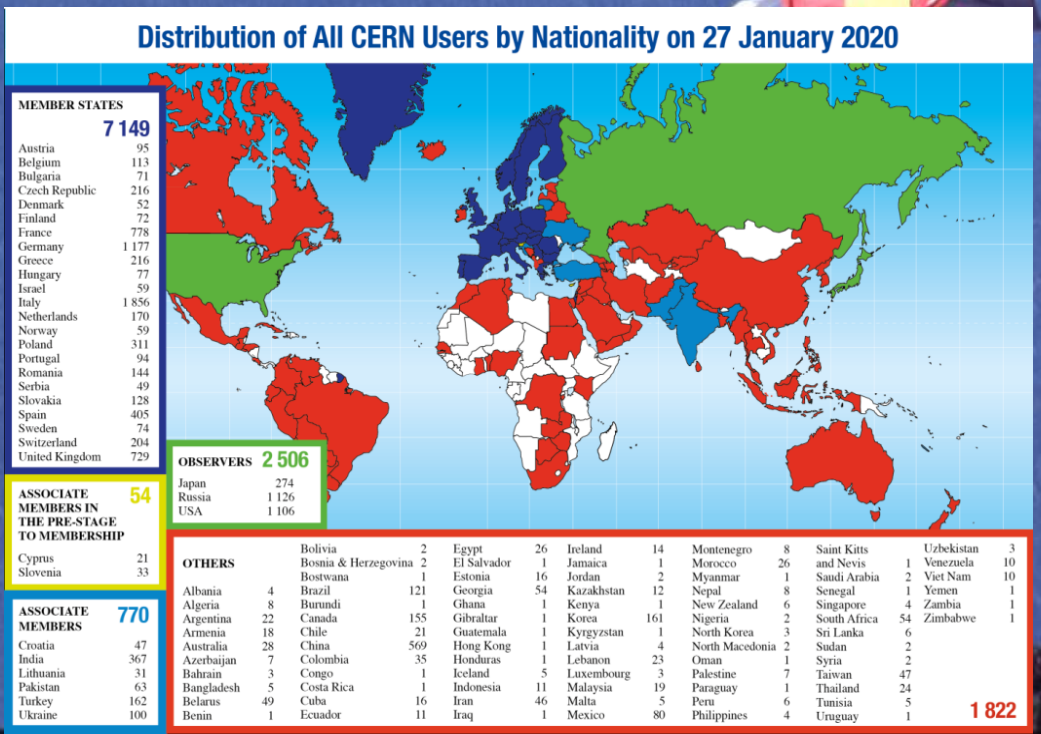
The CERN convention was signed in 1953 by the 12 founding states Belgium, Denmark, France, the Federal Republic of Germany, Greece, Italy, the Netherlands, Norway, Sweden, Switzerland, the United Kingdom and Yugoslavia, and entered into force on 29 September 1954.

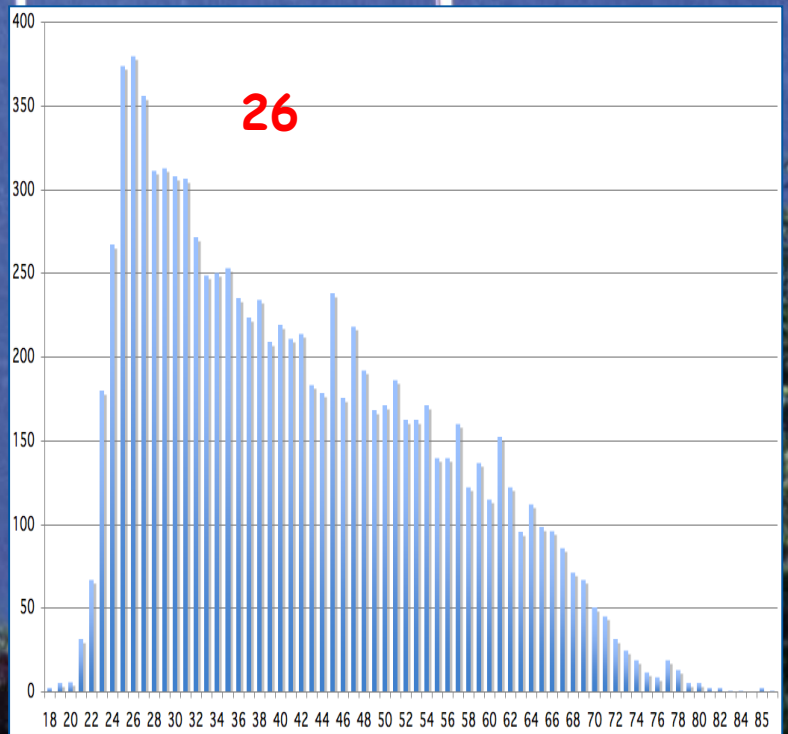


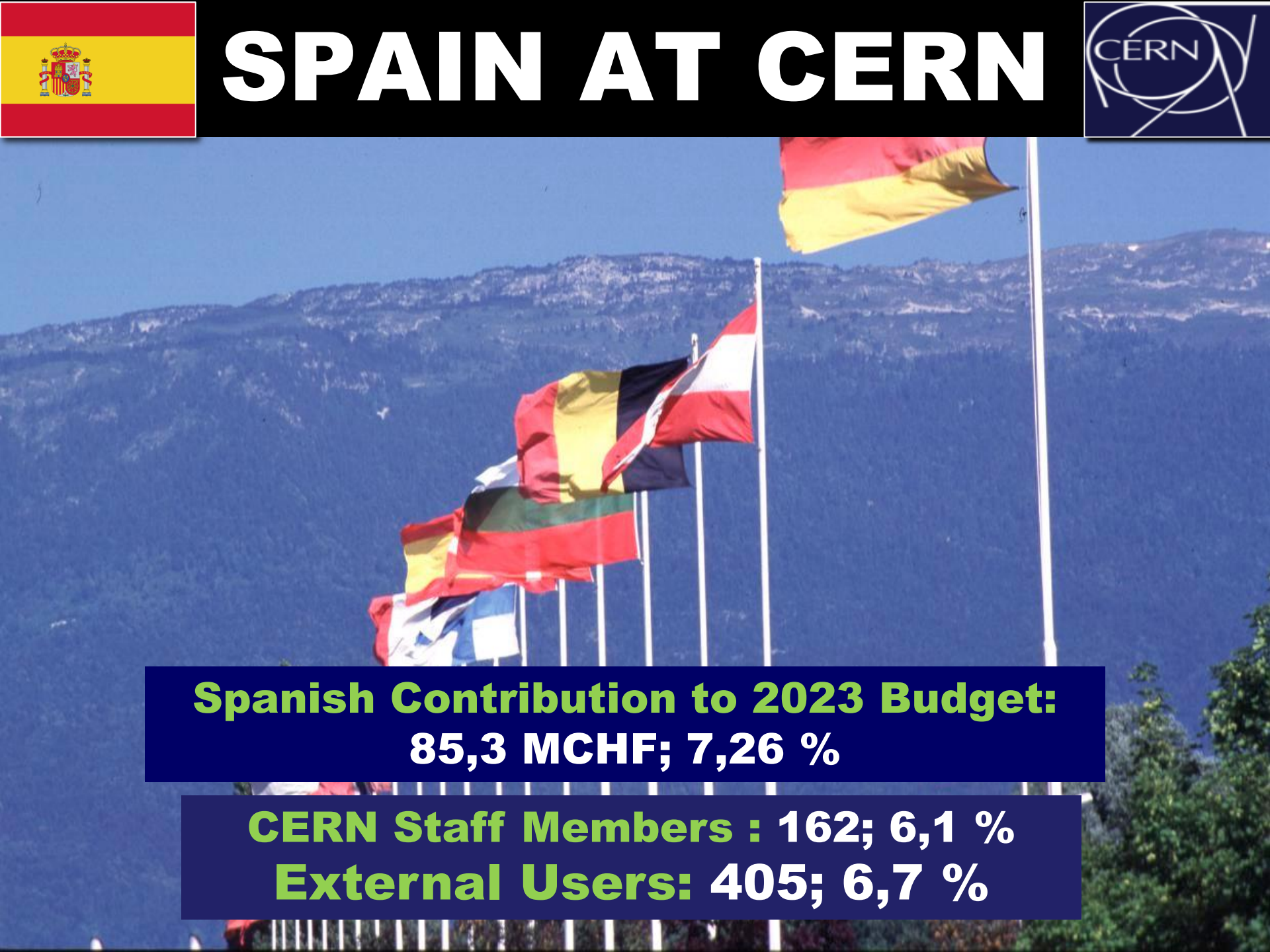
23 Member States
9 Associated Member States
3 In the process of being Member States
9 Countries / Organizations & Observers

CERN

- **2.658 Staff (31.12.2022)**
- **900 Fellows, 377 Aprendices, Others 597 + 542**
- **13.376 External Users, 16.934 Total Users**
- **Budget (2023): 1.395 MCHF**
- **Member States Contributions (2023): 1.175 MCHF**






SPAIN AT CERN
CERN
Spanish Contribution to 2023 Budget:
85,3 MCHF; 7,26 %
CERN Staff Members : 162; 6,1 %
External Users: 405; 6,7 %

SPAIN & CERN

MEMBER STATE : 1962–1968; 1983–

I. Disposiciones generales

MINISTERIO DE ASUNTOS EXTERIORES

CONVENIO para la creación de una Organización Europea de Investigación Nuclear.

Los Estados partes en el presente Convenio,

Considerando el Acuerdo sobre la creación de un Consejo de representantes de Estados europeos para el estudio de los planes de un laboratorio internacional y sobre la organización de otras formas de cooperación en investigación nuclear, Acuerdo abierto a la firma, en Ginebra, el 15 de febrero de 1952;

Considerando el Acuerdo suplementario que prorroga dicho Acuerdo, firmado en París el 30 de junio de 1953;

Deseosos, conforme a la Sección 2 del artículo III del Acuerdo del 15 de febrero de 1952, de concluir un Convenio para la constitución de una Organización Europea de Investigación Nuclear, que comprenderá la fundación de un Laboratorio Internacional destinado a desarrollar un programa convenido de investigaciones de carácter puramente científico y fundamental sobre partículas de alta energía,

Convienen en lo que sigue:

ARTÍCULO I

Creación de la Organización

1. Por el presente Convenio se crea una Organización Europea de Investigación Nuclear (más abajo denominada «la Organización»).

2. El domicilio de la Organización radicará en Ginebra.

ARTÍCULO II

Fines

1. La Organización procurará la colaboración entre Estados europeos para las investigaciones nucleares de carácter puramente científico y fundamental, así como para otras investigaciones relacionadas esencialmente con aquéllas. La Organización se abstendrá de toda actividad con fines militares y los resultados de sus trabajos experimentales y teóricos serán publicados o se harán accesibles por algún otro medio.

2. Por lo que respecta a la colaboración prevista en el párrafo 1 del presente artículo, la Organización se limitará a las actividades enumeradas en los párrafos siguientes: 3, 4 y 5.

3. El programa básico de la Organización comprenderá:

a) La construcción de un Laboratorio internacional (en adelante denominado «el Laboratorio») para investigaciones sobre partículas de alta energía, incluidos los trabajos en el campo de los rayos cósmicos. Este Laboratorio comprenderá:

(i) un sincrotón de protones para energía que exceda de diez mil millones de electrones-voltios (10^{10} eV);

(ii) un sincro-ciclotón capaz para acelerar protones hasta unos seiscientos millones de electrones-voltios (6×10^{8} eV);

(iii) el aparato auxiliar necesario para efectuar programas de investigaciones mediante las máquinas a que se hace referencia en (i) y (ii);

(iv) los edificios necesarios para albergar el equipo mencionado en (i), (ii) y (iii), así como para la administración de la Organización y el cumplimiento de sus otras funciones.

b) El funcionamiento del Laboratorio más arriba especificado.

c) La Organización y el fomento de la cooperación internacional en el campo de la investigación nuclear, incluida la colaboración fuera del Laboratorio. Esta cooperación puede comprender en particular:

(i) estudios teóricos en el campo de la física nuclear;

(ii) el fomento de contactos entre investigadores, el intercambio de éstos, la difusión de informaciones y de las medidas que permitan a los investigadores profundizar en sus conocimientos y completar su formación profesional;

(iii) la colaboración con los institutos nacionales de investigación y su asesoramiento;

(iv) investigaciones en el campo de los rayos cósmicos.

4. Los programas suplementarios deberán ser sometidos al Consejo a que se alude en el siguiente artículo IV y aprobados por el por mayoría de los dos tercios de todos los Estados miembros de la Organización.

5. Dentro de su programa básico y de los programas suplementarios de actividades el Laboratorio colaborará en todo lo posible con los Laboratorios e institutos existentes en el territorio de los Estados miembros. En la medida compatible con los fines de la Organización el Laboratorio habrá de procurar evitar todo doble empleo con las investigaciones que se lleven a cabo en dichos Laboratorios o institutos.

ARTÍCULO III

Condiciones de adhesión

1. Los Estados partes en el Acuerdo de 15 de febrero de 1952, mencionado en el preámbulo del presente Convenio, así como los Estados que han contribuido en metálico o en especie al Consejo creado por dicho Acuerdo y han tomado parte efectiva en sus trabajos, tendrán derecho a llegar a ser miembros de la Organización, convirtiéndose en partes del presente Convenio conforme a lo dispuesto en los artículos XV, XVI y XVII.

2. (a) La admisión de otros Estados en la Organización la decidirá el Consejo mencionado en el artículo IV mediante acuerdo unánime de los Estados miembros.

ARTÍCULO XX

Registro

Entrado en vigor el presente Convenio, el Director general de la Organización de las Naciones Unidas para la Educación, la Ciencia y la Cultura mandará que se registre en la Secretaría General de las Naciones Unidas, conforme al artículo 102 de la Carta de las Naciones Unidas.

En fe de lo cual, los infrascritos representantes, debidamente autorizados a dicho efecto por sus Gobiernos respectivos, firman el presente Convenio.

Dado en París a 1 de julio de 1955, en inglés y francés, textos ambos igualmente fehacientes, en un ejemplar único que se depositará en los archivos de la Organización de las Naciones Unidas para la Educación, la Ciencia y la Cultura. El Director general de esta Organización extenderá una copia certificada conforme a los Estados signatarios o adheridos, así como a los Estados miembros que hayan tomado parte en la Conferencia para la organización de los estudios relativos a la creación de un Laboratorio Europeo de Investigaciones Nucleares.

El Convenio que antecede, de conformidad con su artículo XIX, entró en vigor el 29 de septiembre de 1954.

El Instrumento de adhesión de España al presente Convenio fué depositado en la Organización de las Naciones Unidas para la Educación, la Ciencia y la Cultura el 6 de junio del año actual, y surte efectos a partir de la indicada fecha.

Lo que se hace público para conocimiento general, insertándose a continuación relación de los Estados que lo han ratificado o se han adherido.

RATIFICACIONES

Reino Unido, 30 diciembre 1953; Suiza, 12 febrero 1954; Dinamarca, 5 abril 1954; Países Bajos, 15 junio 1954; Grecia, 7 julio 1954; Suecia, 15 julio 1954; Bélgica, 19 julio 1954; Francia, 29 septiembre 1954; República Federal Alemana, 29 septiembre 1954; Noruega, 4 octubre 1954; Yugoslavia, 9 febrero 1955, e Italia, 24 febrero 1955.

ADHESIONES

Austria, 10 de noviembre de 1959.

Madrid, 16 de agosto de 1962. — El Subsecretario, Pedro Cortina.

JEFATURA DEL ESTADO

3146 *INSTRUMENTO de adhesión de 3 de noviembre de 1983 de España al Convenio para la creación de una Organización Europea de Investigación Nuclear (CERN), hecho en París el 1 de julio de 1953 (publicado en el «Boletín Oficial del Estado» de 10 de septiembre de 1962).*

JUAN CARLOS I,

REY DE ESPAÑA

Concedida por las Cortes Generales la autorización prevista en el artículo 94.1 de la Constitución y, por consiguiente, cumplidos los requisitos exigidos por la legislación española, extiendo el presente Instrumento de Adhesión de España al Convenio para la creación de una Organización Europea de Investigación Nuclear, hecho en París el 1 de julio de 1953, para que, mediante su depósito y de conformidad con lo dispuesto en su artículo XVII, España pase a ser Parte de dicho Convenio.

En fe de lo cual firmo el presente Instrumento, debidamente sellado y refrendado por el infrascrito Ministro de Asuntos Exteriores.

Dado en Madrid a 3 de noviembre de 1983.

JUAN CARLOS R.

El Ministro de Asuntos Exteriores
FERNANDO MORAN LOPEZ

ESTADOS PARTE

Alemania, República Federal de (*)	29- 9-1954	R/
Austria	10-11-1959	Ad/
Bélgica	19- 7-1954	R/
Dinamarca	5- 4-1954	R/
España	15-11-1983	Ad/
Francia	29- 9-1954	R/
Grecia	7- 7-1964	R/
Italia	24- 2-1955	R/
Noruega	4-10-1954	R/
Países Bajos	15- 6-1954	R/
Reino Unido	30-12-1953	R/
Suecia	15- 7-1954	R/
Suiza	12- 2-1954	R/

(*) Con extensión al Land de Berlín.
R/ = Ratificación.
Ad/ = Adhesión.

El presente Convenio entró en vigor de forma general el 29 de septiembre de 1954.

España pasó a ser parte de este Convenio en fecha 6 de junio de 1962, habiéndose retirado del mismo en 31 de diciembre de 1968.

Posteriormente, España ha depositado un nuevo Instrumento de Adhesión a este Convenio con fecha 15 de noviembre de 1983. Como consecuencia de ello, el Convenio ha entrado de nuevo en vigor para España en esa misma fecha.

Lo que se hace público para conocimiento general.
Madrid, 30 de enero de 1984.—El Secretario general técnico del Ministerio de Asuntos Exteriores, Fernando Perpiñá Robert Peyra.

BOE.-Núm. 217, 10 septiembre 1962, 12889
Instrument of accession signed on August 10, 1962

BOE.-Núm. 32, 7 febrero 1984, 3099
Instrument of accession signed on November 3, 1983

ESPAÑA & CERN

MEMBER STATE: 1962–1968

December 1960
CERN Council decided to admit Spain as CERN's 14th Member State

6 June 1962
Entry into force of Spain's Membership at CERN
CERN Budget : ~ 70 MCHF; Spain's contribution: ~3 MCHF (4,21 %)

December 1963
Council accepts to reduce Spain's contribution by the following percentages:
1964 : 50 % , 1965 : 35 % , 1966 : 20 %

December 1966
Council decided to reduce Spain's contribution for 1967 by 20 %

December 1967
Council decided to maintain Spain's contribution for 1968 at the level decided for 1967

Summer 1968
Spain asks the Council to reduce its contribution by 50 % for the next 5 years, and subsidiarily announces its withdrawal from CERN at the end of 1968

31 December 1968
Withdrawal of Spain from CERN Membership becomes effective

ESPAÑA & CERN

MEMBER STATE: 1983–

February 1982
Application for Membership by Spain

June 1982
Council Resolution *readmitting* Spain as Member of CERN, with a 6 year transitional scheme of reduced contributions, (contribution reduced to 30% to 83 % of the normal contribution)

January 1983
Spain's membership becomes effective

1992-1993
Delay in payments of the contributions. Major conflict

May 1994
Request by Spain to reduce the Spanish contribution to CERN over 5 years from 1994 to 1998, equivalent on an average reduction of 23 %, to be reimbursed during the years 1996-1999

June 1994
Council Resolution accepting this request and the proposed scheme

2011-2012
Delay in payments of the contributions. Major conflict

November 2012
CERN Director General R. D. Heuer: Spain owns to CERN 137 MCHF (110 M€)

OBVIOUS CONCLUSION: SPAIN IS NOT THE MOST RELIABLE PARTNER

THE SIXTIES

THE BEGINNING

IN THE EARLY SIXTIES

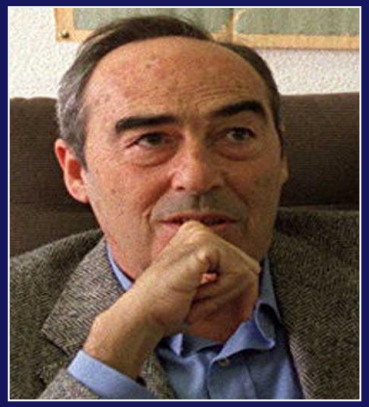
SPAIN WAS A COUNTRY WITH

- NO TRADITION IN MODERN PHYSICS
- LOW LEVEL TEACHING OF MODERN PHYSICS AT THE UNIVERSITIES
- NO EXPERIMENTAL FACILITIES
- RATHER FRAGILE INDUSTRIAL AND TECHNOLOGICAL INFRASTRUCTURES

THE SIXTIES

A. GALINDO
1934-

P. PASCUAL
(1934-2006)



F.J. YNDURÁIN
(1940-2008)

JOSÉ BERNABÉU
1945-

THE FOUNDATIONS OF THEORETICAL PHYSICS

SIXTY YEARS LATER, THEORETICAL PHYSICS IN SPAIN HAS BECOME A LARGE, PRESTIGIOUS AND WELL RECOGNIZED COMMUNITY AT THE INTERNATIONAL LEVEL

WELL ESTABLISHED GROUPS IN BARCELONA, GRANADA, MADRID, SANTIAGO DE COMPOSTELA, VALENCIA, ZARAGOZA, SANTANDER .... OUTSTANDING RESEARCH IN FRONTIER FIELDS

THE SIXTIES

1962: SPAIN BECAME CERN MEMBER STATE

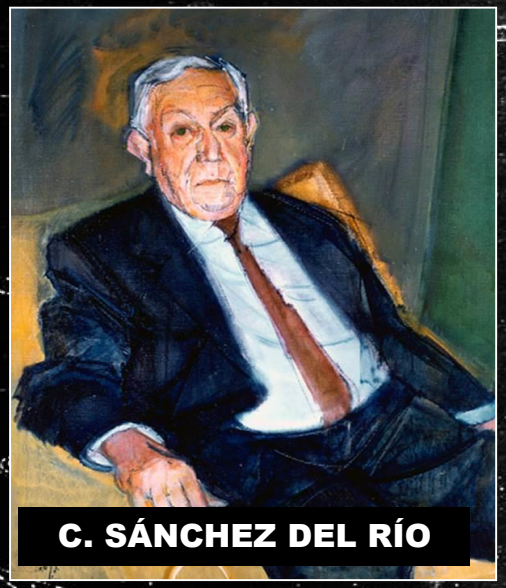
FAIRLY MODEST ACTIVITIES IN EXPERIMENTAL HIGH ENERGY PHYSICS

AT THE JUNTA DE ENERGIA NUCLEAR (1962):
SCANNING OF PICTURES FROM CERN BUBBLE CHAMBERS
(Bruno Escoubés, Salomé de Unamuno)

AT THE UNIVERSITY OF VALENCIA (1952):
ANALYSIS OF EMULSION PLATES
(Joaquín Catalá, Fernando Senent, José Aguilar, José Casanova)

J.M. OTERO DE NAVASCUES
WERNER HEISENBERG

JEN & CIEMAT, MARID (1951)



C. SÁNCHEZ DEL RÍO

SANTANDER, CANTABRIA UNIVERSITY
VALENCIA UNIVERSITY, IFIC
1970's

IODV (1940's)

J. CATALÁ

E. VILLAR, A. FERRER, J. CATALÁ, A. RUIZ ...

THE SIXTIES

October 1965

JEN organized a 2 year post graduate course to train young students from several Universities (Madrid, Barcelona, Zaragoza) in theoretical and experimental HEP

Teachers:

Alberto Galindo, Ángel Morales, Rafael Nuñez Lagos, Salomé de Unamuno, Bruno Escoubés, Ramón Ortiz de Fornaguera

Attendees:

Universidad Complutense: Manuel Aguilar, Juan Antonio Rubio, Álvaro de Rújula, Antonio Ferrando, José Luis Sánchez Gómez, Ramón Fdez. Álvarez Estrada

Univeridad de Barcelona: Benjamín Carreras, Luis Oliver

Universidad de Zaragoza: Miguel Ángel Goñi, Lorenzo Abellanas

1966

Antonio Lloret, from the French École Polytechnique, was hired to organize at JEN an experimental HEP group and to start a collaboration with CERN. In particular to train young students. Several of the participants in the JEN HEP Course profited from this initiative.

A MAJOR UNEXPECTED BLOW DECEMBER 1968

SPAIN DROP OUT FROM CERN

Antonio Lloret, Salomé de Unamuno, Bruno Escoubés left JEN. Some of the doctoral students at CERN decided to stay there or move to other Laboratories.

Few people (mostly doctoral students) remained at JEN analysing data from CERN bubble chambers (Antonio Ferrando, Miguel Tomás). They were joined by Rafael Llosá and Pedro Ladrón de Guevara from Valencia.

The support from the CERN group led by Lucien Montanet was of paramount importance for the survival of the JEN Team.

THE RETURN TO CERN TOOK 15 YEARS

A MAJOR UNEXPECTED BLOW DECEMBER 1968

CONTROVERSIAL DECISION AT THE TIME THAT SOME INICIATIVES WERE IMPLEMENTED TO IMPROVE THE SCIENTIFIC AND TECHNOLOGICAL RETURNS FROM CERN MEMBERSHIP

LOOKING FOR AN EXPLANATION

CERN LABORATORY II: SPAIN SUBMITTED ITS CANDIDACY TO HOST THE SPS IN EL ESCORIAL, BUT IT WAS NOT ON THE SHORT LIST OF CANDIDATES

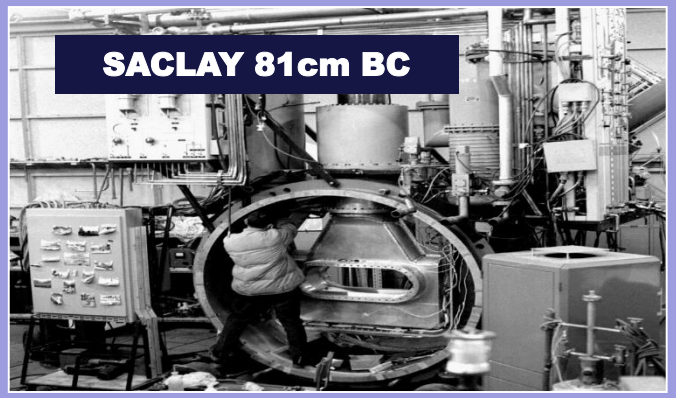
MAJOR UPSET, PROBABLY A RISKY *ALIBI* ....

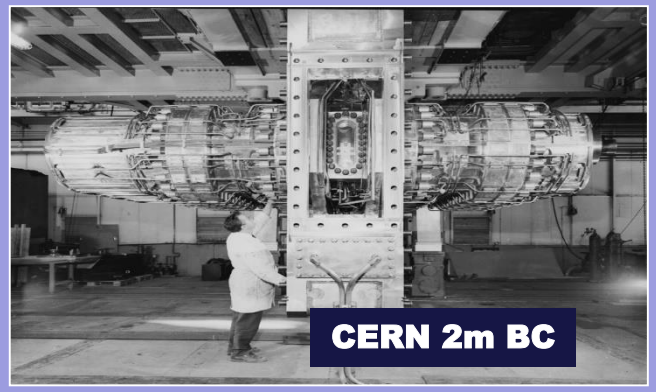
THE SEVENTIES

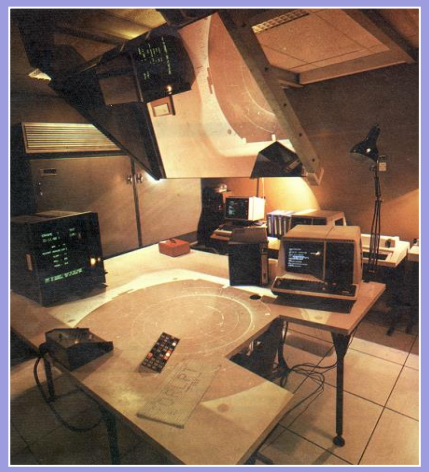
BUBBLE CHAMBER PHYSICS

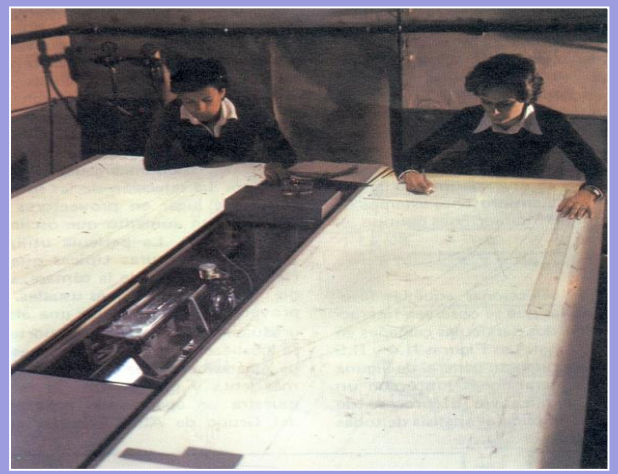
1971 – 1972

Juan Antonio Rubio (in 1971) and **Manuel Aguilar** (in 1972) came back to JEN from CERN and BNL. **Fernando Barreiro**, **Marcos Cerrada** and **Enrique Fernández** joined in 1971 the HEP Group as doctoral students. JEN management decided to allocate new resources. CERN strengthens its support.

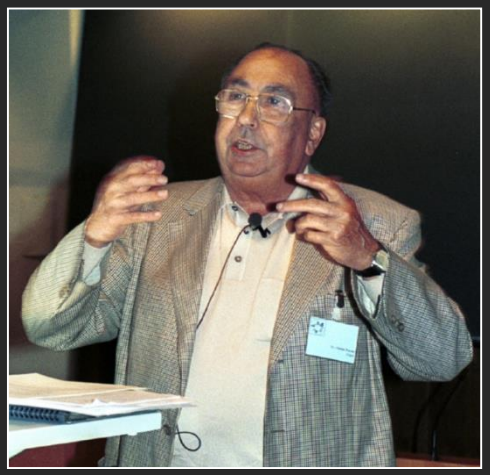








BUBBLE CHAMBER PHYSICS



CH. PEYROU

R. ARMENTEROS
L. MONTANET

EXPERIMENTS (HADRON SPECTROSCOPY, REACTION DYNAMICS)
proton-antiproton annihilations, $K^- p$ and $\pi^- p$ interactions

EXPERIMENT PROPOSED AND APPROVED IN 1973 BY THE TRACK CHAMBER COMMITTEE
"Study of Hypercharge Exchange Reactions and Resonance Properties in $\pi^- p$ interactions at 3,95 GeV/c in the 2m CERN Bubble Chamber"

IWMFP

"INTERNATIONAL WINTER MEETING ON FUNDAMENTAL PHYSICS"

It was in the course of a visit of Lucien Montanet to JEN, during the Xmas 1971-1972 break, that he suggested to organize a Winter Meeting similar to the very successful Rencontres de Moriond. The goal was to invite prestigious foreign physicists to lecture to a young audience on some of the most fashionable ongoing topics.

Juan Antonio Rubio, Paco Ynduráin and Manuel Aguilar easily convinced of the goodness of his suggestion.

The first edition of the IWMFP took place in Formigal (Spanish Pyrenees) on 5-10 February 1973; 36 participants, 28 talks.
The suject was:
"Hadron Interactions: Theory, Phenomenology, Experiment"

IWMFP

"INTERNATIONAL WINTER MEETING ON FUNDAMENTAL PHYSICS"

FORMIGAL 1973

FORMIGAL 1997

Pedro Ladrón de Guevar, Eduardo de Rafael,
Paco Ynduráin, Enrique Fernández, Manuel Aguilar


CANDANCHU 1977


SANTANDER 1990


LA TOJA 1998


SOTO CANGAS 2003


SANTIAGO 2007


EL PAULAR 1978


SANT FELIU 1991


SANLÚCAR 2000


ALICANTE 2004


BENASQUE 2009


SANTILLANA 1984


JACA 1993


SITGES 2001


BENASQUE 2005


CANFRANC 2011


SANT FELIU 1986


COMILLAS 1995


JACA 2002


EL ESCORIAL 2006


PEÑISCOLA 1988


FOMIGAL 1997


LA PALMA 2010

WINTER MEETING & LIST

I.	1973, Formigal, (JEN-UAM)
II.	1974, Formigal, (JEN-UAM)
III.	1975, Sierra Nevada, (JEN-UAM)
IV.	1976, Baqueira Beret, (JEN)
V.	1977, Candanchu, (JEN)
VI.	1978, El Paular, (JEN-UAM)
VII.	1979, Segovia, (JEN-UAM)
VIII.	1980, Ronda, (JEN)
IX.	1981, Sigüenza, (JEN)
X.	1982, La Masella, (JEN-UAB)
XI.	1983, Toledo, (JEN)
XII.	1984, Santillana del Mar, (JEN-IFCA)
XIII.	1985, Cuenca, (JEN)
XIV.	1986, Sant Feliu de Guixols, (IFAE)
XV.	1987, Sevilla, (UAM)
XVI.	1988, Peñiscola, (IFIC)
XVII.	1989, Lekeitio, (CIEMAT-UPV)
XVIII.	1990, Santander, (IFCA)
XIX.	1991, Sant Feliu de Guixols, (IFAE)
XX.	1992, La Palma, (CIEMAT-UCM)
XXI.	1993, Jaca, (UZAR)
XXII.	1994, Manzanares el Real, (UAM)
XXIII.	1995, Comillas, (IFCA)
XXIV.	1996, Gandía, (IFIC)
XXV.	1997, Formigal (IFAE-CIEMAT-UZAR)

XXVI.	1998, La Toja, (USC)
XXVII.	1999, Sierra Nevada, (UGR)
XXVIII.	2000, Sanlúcar de Barrameda, (CIEMAT)
XXIX.	2001, Sitges, (UCM)
XXX.	2002, Jaca, (UZAR)
XXXI.	2003, Soto de Cangas, (UO)
XXXII.	2004, Alicante, (IFIC)
XXXIII.	2005, Benasque, (IFAE-UB)
XXXIV.	2006, El Escorial, (UAM)
XXXV.	2007, Santiago de Compostela, (USC)
XXXVI.	2008, Baeza, (UGR)
XXXVII.	2009, Benasque, (CIEMAT)
XXXVIII.	2010, La Palma, (UCM)
XXXIX.	2011, Canfranc, (UZAR)
XL.	2012, Benasque, (IFIC)
XLI.	2013, Santander, (IFCA)
XLII.	2014, Benasque, (UAB, UB, IFAE)
XLIII:	2015, Benasque, (USC, UZAR, CIEMAT)
XLIV.	2016, Madrid, (UAM)
XLV.	2017, Granada, (UGR)
XLVI.	2018, Salamanca, (CIEMAT)
XLVII.	2019, Aranjuez, (UCM)
XLVIII.	2021, Benasque, (UZAR)
XLIX.	2022, Benasque, (IFIC)
L.	2023, Santander, (IFCA)

Prestigious speakers: J. Steinberger, G. Charpak, M. Veltman, J. Cronin, C. Rubbia, S. Ting, B. Barish, …

Today we are celebrating its 50th Anniversary

LONG LIFE TO THE WINTER MEETING

MEETING IN SIGÜENZA - 1981
ATTENDED BY CHARLES PEYROU AND CARLOS SÁNCHEZ DEL RIO

FIRST IDEAS TO WORK UP A ROAD MAP TO RETURN TO CERN

UNDENIABLE, BY SHEER DETERMINATION, JUAN ANTONIO RUBIO (1944-2010) KEPT THE PROJECT OF RETURN TO CERN ALIVE, ENDING SUCCESSFULLY IN 1983

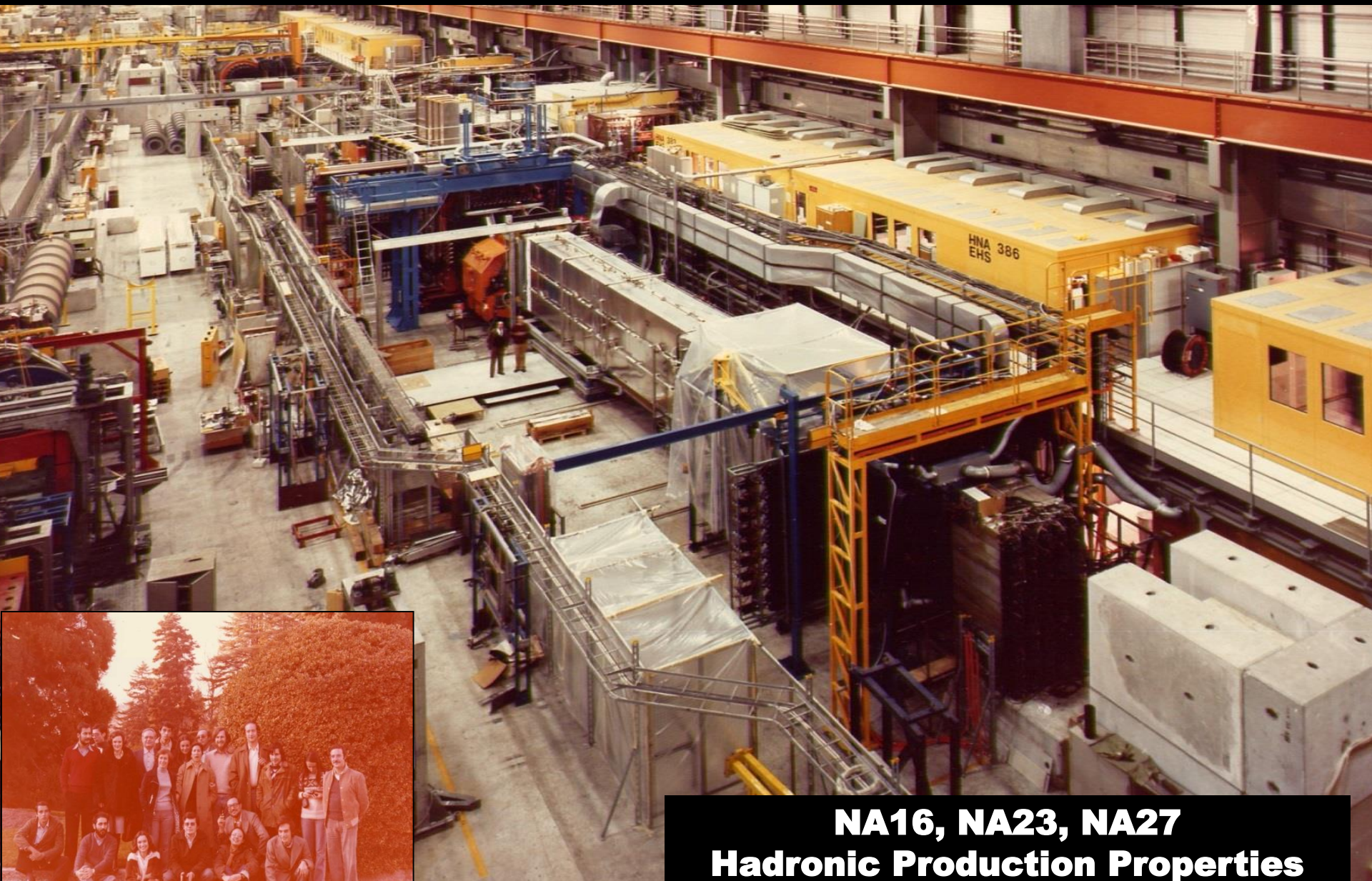
EVERYBODY AGREE

THE EIGHTIES

THE WAY TOWARDS PARTIAL CONSOLIDATION AND GROWTH

THE EUROPEAN HYBRID SPECTROMETER AT CERN

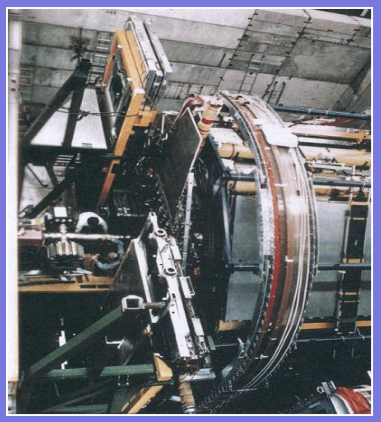
A Facility to Study Multi-Hadron Events Produced in High Energy Interactions (1979-1989)



NA16, NA23, NA27
Hadronic Production Properties

S.C.C.TING (1981)

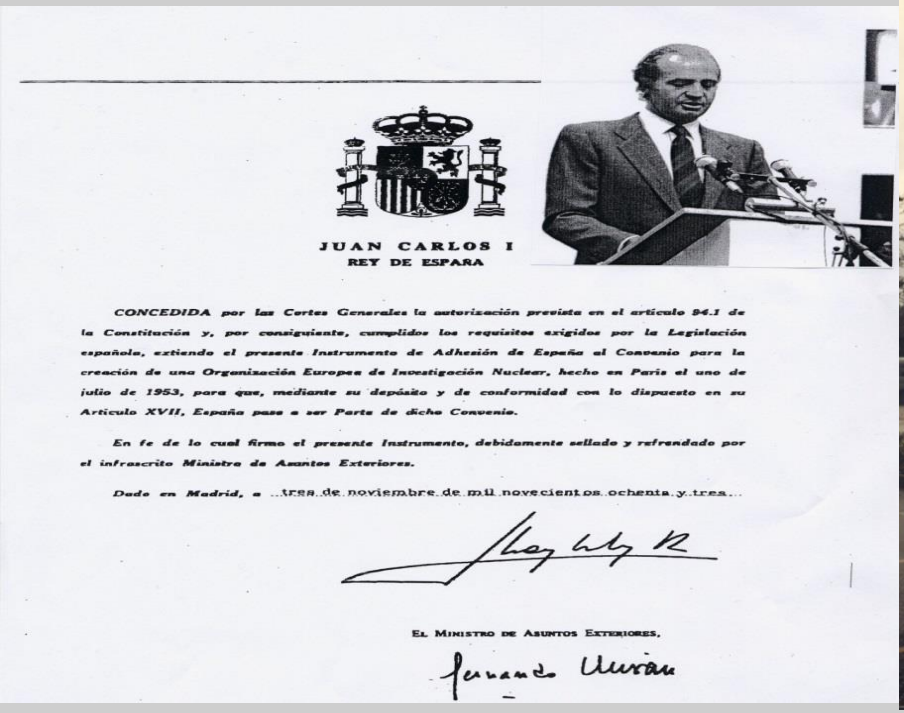
José Salicio, Bernardo Adeva, Carlos Mañá, Javier Berdugo
Later on: Manel Martínez, Lluis Garrido



INVITATION TO JOIN MARKJ (PETRA) AND L3 (LEP)

Later on: Juan Fuster (CELLO)

SPAIN BACK AT CERN (1983)



JUAN CARLOS I
REY DE ESPAÑA

CONCEDIDA por las Cortes Generales la autorización prevista en el artículo 94.1 de la Constitución y, por consiguiente, cumplidos los requisitos exigidos por la Legislación española, extiendo el presente Instrumento de Adhesión de España al Convenio para la creación de una Organización Europea de Investigación Nuclear, hecho en París el uno de julio de 1953, para que, mediante su depósito y de conformidad con lo dispuesto en su Artículo XVII, España pase a ser Parte de dicho Convenio.

En fe de lo cual firmo el presente Instrumento, debidamente sellado y refrendado por el infrascrito Ministro de Asuntos Exteriores.

Dado en Madrid, a ...tres de noviembre de mil novecientos ochenta y tres...

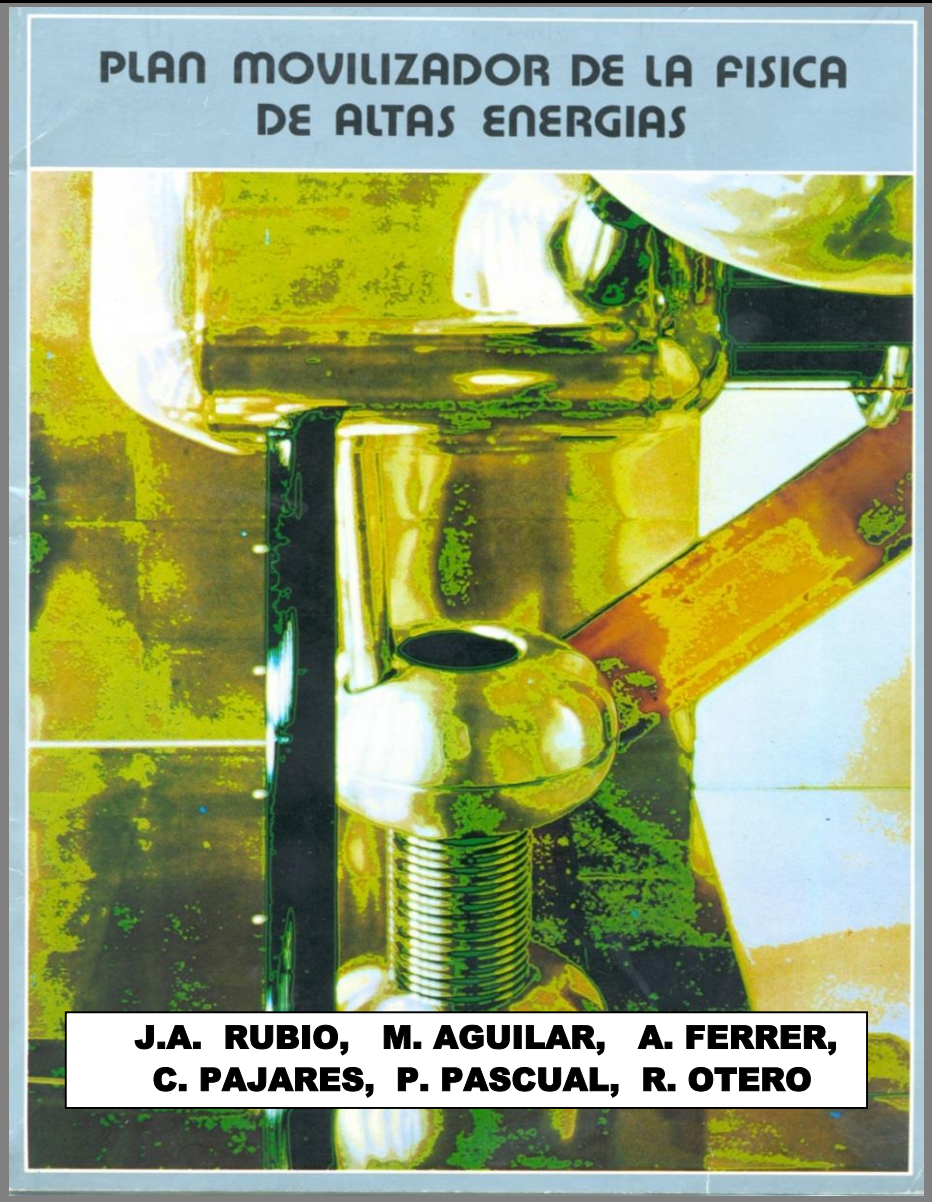
EL MINISTRO DE ASUNTOS EXTERIORES,

Fernando Morán

1984: CERN 30th ANNIVERSARY

2004: CERN 50th ANNIVERSARY

STEERING PLAN FOR HEP (1984)



STEERING PLAN FOR HEP (1984-1987)

JEN-CIEMAT
U. VALENCIA (IFIC)
U. SANTANDER (IFCA)

U.A. BARCELONA (IFAE)
U.A. MADRID
U. SANTIAGO DE COMPOSTELA

U. ZARAGOZA
CSIC MADRID

U. BARCELONA
U. GRANADA
U. OVIEDO

- PROTOTYPE FOR THE NATIONAL R&D PLAN (1986)
- IMPLEMENTED A NOVEL REVIEW PROCESS BY EXTERNAL REFEREES
- SET-UP OF THE FIRST RESEARCH COMPUTER NETWORK (FAENET)

CREATION OF THREE CHAIRS AT THE

. UNIVERSITY AUTONOMOUS OF BARCELONA: ENRIQUE FERNÁNDEZ
. UNIVERSITY AUTONOMOUS OF MADRID: FERNANDO BARREIRO
. UNIVERSITY OF VALENCIA: ANTONIO FERRER

NATIONAL PROGRAM OF HIGH ENERGY PHYSICS (1988-2023)

MANAGERS

José Bernabéu, Enrique Fernández, Manuel Aguilar, Antonio Ferrer, Domenec Espriu, Juan Fuster, Francisco del Aguila, Mario Martínez, María José García Borge, Pilar Hernández

ALTHOUGH THE PROGRAM HAS BEEN EFFICIENTLY MANAGED AND THE OVERALL COMMITMENTS HAVE BEEN SATISFIED, THE COMMUNITY EXPRESSED IN SEVERAL OCCASIONS THE ADVANTAGE OF HAVING A SPECIFIC INSTITUTE FOR HEP AND VARIOUS PROPOSALS WERE PUT FORWARD FOLLOWING THE FRENCH (IN2P3) AND ITALIAN (INFN) MODELS.

Jaca (1977)

Barcelona (1989)

Toledo (1993)

NATIONAL PROGRAM OF HIGH ENERGY PHYSICS (1988-2023)

ON MARCH 10, 1994, THE MINISTRY OF EDUCATION AND SCIENCE PROPOSED TO CERN A SOLUTION TO PAY CERN THE ACCUMULATED DEBT IN 1994 DUE TO THE DELAY IN THE 1992 AND 1993 PAYMENTS.

- Spain will pay CERN the accumulated debt in 1994
- CERN will grant Spain a 30 percent temporary reduction in its contribution for five years, starting in 1994
- Spain will improve its scientific and tecnological infrastructures in HEP

ON SEPTEMBER 6, 1994, THE GENERAL SECRETARY OF THE Plan Nacional de I+D, COMISIÓN INTERMINISTERIAL DE CIENCIA Y TECNOLOGÍA, CHAIRED A MEETING TO DISCUSS IN DEPTH THE POSSIBLE CREATION OF AN INSTITUTO NACIONAL DE FÍSICA DE ALTAS ENERGÍAS, FOLLOWING NEW RULES PUBLISHED ON DECEMBER 15, 1993 in BOE núm. 299 (29705 *Orden de 24 de noviembre de 1993 sobre Institutos y Centros con Patronato del Consejo Superior de Investigaciones Científicas*).

The team composed by Bernardo Adeva, Manuel Aguilar, José Bernabéu, Enrique Fernández, Mariano Quirós, Pedro Pascual was instructed to produce a document for the creation of the

Centro Español de Física de Altas Energías

Several versions of the document were circulated during 1995, the last one on January 6, 1996.

NATIONAL PROGRAM OF HIGH ENERGY PHYSICS (1988-2023)

The starting budget of the new Institute was 100 Mpts, approximately 25% of budget of the ongoing National Program. The management of the new Institute was going to be located at the premises of CSIC in Madrid.

CONVENIO PARA LA CONSTITUCIÓN DEL PATRONATO DEL CENTRO ESPAÑOL DE FÍSICA DE ALTAS ENERGÍAS, DE CONFORMIDAD CON LA ORDEN DE 24 DE NOVIEMBRE DE 1993 SOBRE INSTITUTOS Y CENTROS CON PATRONATO DEL CONSEJO SUPERIOR DE INVESTIGACIONES CIENTÍFICAS

En Madrid, a 26 de junio de 1995

NATIONAL PROGRAM OF HIGH ENERGY PHYSICS (1988-2023)

Ministerio de Educación y Ciencia
El Secretario de Estado de Universidades e Investigación

Madrid, 10th March 1994

Dear Minister,

In relation to our participation in CERN, of which Spain has been member since 1983, the Government has asked us to discuss with the CERN Management and Council a possible solution to the problems related to our contribution to CERN. We would take this opportunity to present to you our viewpoints and our proposed solution and, at the same time, to ask for your understanding and support in order to arrive to a working solution which is satisfactory to all parties involved.

When Spain joined CERN in 1983, we did so because we were, and continue to be, convinced that international cooperation was the best way to decrease the gap that existed in Science and Technology between Spain and the most advanced european countries. Since 1983, new investments have been directed at developing our R & D system and, in the field of High Energy Physics (HEP), substantial growth has taken place over the last decade through the HEP National Programme.

Notwithstanding our recent efforts , we have to recognize that, because of our unfavorable starting position, the field of HEP in Spain is still well below the average of the European Community. Even if we were to increase our growth rate in HEP, it would be very difficult to close the current gap, at least on the short term. The above explains in part the difficulties that Spain has had in recent years in increasing the scientific and industrial returns from CERN. At present, we have the lowest returns relative to our contribution. As you may be aware, Spain is contributing around 7.4 percent of the CERN budget, an effort which is well above the weight of the spanish HEP programmes in Europe. Hopefully, future developments of our science and technology in this field will decrease such an unbalance.

Ministerio de Educación y Ciencia
El Secretario de Estado de Universidades e Investigación

The present economic crisis in Europe has dramatically affected Spain. To an inflation rate of about 5% and a public deficit that has almost doubled over the last two years, we have to add an unemployement rate of 23% of the working force, and an urgent need to complete basic infrastructures. All of this is happening in a country in which the per-capita income is about 70% of the average of the CERN countries. Although R & D is a priority for our government, the urgent need to provide solutions to some of the more relevant economic problems cannot be overemphasized. In addition, the spanish contribution to CERN in 1994 amounts to 69 MSF, the fifth largest among the 17 member countries. As a result of the devaluation of the spanish peseta against the swiss franc, such an amount represents a 35 percent increase in pesetas over our 1991 contribution. An important fact adding to our present difficulties in meeting our dues.

All these circunstances make it impossible for Spain to afford the normal contribution to CERN for the next few years and have been equally responsible for the delay in the 1992 and 1993 payments. We are convinced that our problems are temporary and that it is possible to find within the CERN Convention a solution which is satisfactory for both CERN and Spain.

We propose to CERN the following solution:

- Spain will pay CERN the accumulated debt in 1994.
- CERN will grant Spain a 30 percent temporary reduction in its contribution for five years, starting in 1994.
- Spain will improve its scientific and technological infrastructure in HEP.

If an agreement is reached, we intend to pay all the debt (1992 and 1993 full contributions) as early as possible in 1994. Please note that we are willing to pay the full 1993 contribution even though we repeatedly requested a reduction in our contributions at all of 1993 CERN's meetings. Specific details on the payment will be provided at the 17 March Council meeting.

Last December, at a meeting in Madrid with the President and Director General of CERN to discuss the temporary reduction, Spain's final proposal was a 30 percent reduction for five years while the Presidente of CERN offered up to a 25 percent reduction. Spain insists on a 30 percent reduction, although it could be applied on a sliding scale if it suits better CERN's budgetary plans.

Ministerio de Educación y Ciencia
El Secretario de Estado de Universidades e Investigación

Finally, Spain will be committed to improve the scientific and technological infrastructure in HEP with the objective of approaching the average European Standards by the end of the century. At the same time, it is expected that the new purchasing rules of CERN will permit more equitable returns to Spain.

The economic crisis has, evidently, affected other member countries and even the CERN organization. We understood and supported the exceptional treatment that Germany received from CERN which resulted in a significant, although temporary, reduction in its contribution. Furthermore, the CERN Council has granted reductions to Greece and Portugal, actions which Spain viewed positively and supported at the time. When Spain joined CERN in 1983, a six-year transition period was granted during which our contribution was less than the theoretical one. Subsequently, it has been shown that such a period was too short and a ten-year period of adjustment has become nearly the rule and is being granted to new member countries.

We believe that our proposal represents a very significant effort on our part, taking into account the present situation. We hope that you will realize our position and that your Delegation will show an understanding of our problems and a willingness to solve them in such a way that Spain would not be forced to take an irrevocable decision in view of the magnitude of the problem.

Sincerely yours,

E. Fereres
Secretary of State
Universities and Research
Ministry of Education and Science

J.J. Moltó
Secretary of State
Industry
Ministry of Industry and Energy

J.L. Dicenta
Secretary of State
International Cooperation
Ministry of Foreign Affairs

NATIONAL PROGRAM OF HIGH ENERGY PHYSICS (1988-2023)

Un comité de expertos evaluará las grandes instalaciones científicas

Nace el Instituto de Física de Altas Energías, adscrito al CSIC

MARIMAR JIMÉNEZ, **Madrid**

Un comité de expertos asesorará al Gobierno sobre las grandes instalaciones científicas; el Plan Nacional de Investigación y Desarrollo absorbe el Fondo de Investigaciones Sanitarias (FIS); se crea el esperado Instituto de Física de Altas Energías, y también una instalación española en el sincrotrón de Grenoble. Los responsables de la ciencia española quieren aprovechar el "buen momento presupuestario" para dinamizar la actividad científica, aletargada durante los últimos cuatro años, y "no dejar escapar ningún tren de la investigación".

La Comisión Interministerial de Ciencia y Tecnología (CICYT) ha aprobado la creación de un comité asesor de grandes instalaciones científicas en España, explicó ayer Emilio Octavio de Toledo, secretario de Estado de Universidades e Investigación. "En ciencia", dijo, "cada vez hay una dependencia más acentuada del equipamiento científico adecuado. Pero las instalaciones son tan costosas, que hacen aconsejable que la Administración cuente con el máximo asesoramiento posible para tomar sus decisiones".

Este órgano consultivo asesorará sobre si es conveniente o no crear algunas de estas grandes instalaciones, como el telescopio de ocho metros previsto para Canarias; si deben ampliarse otras, como la red Iris, el Centro Nacional de Biotecnología, o el centro de supercomputación de Barcelona, y hará los estudios de viabilidad en el caso de la participación de España en organismos internacionales de investigación como la ESA o el CERN. El próximo mes se conocerá su presupuesto y las 10 personas que lo formen, "científicos de reconocido prestigio o responsables de instituciones de especial relieve tanto del sector público como privado", señaló Octavio.

Altas energías

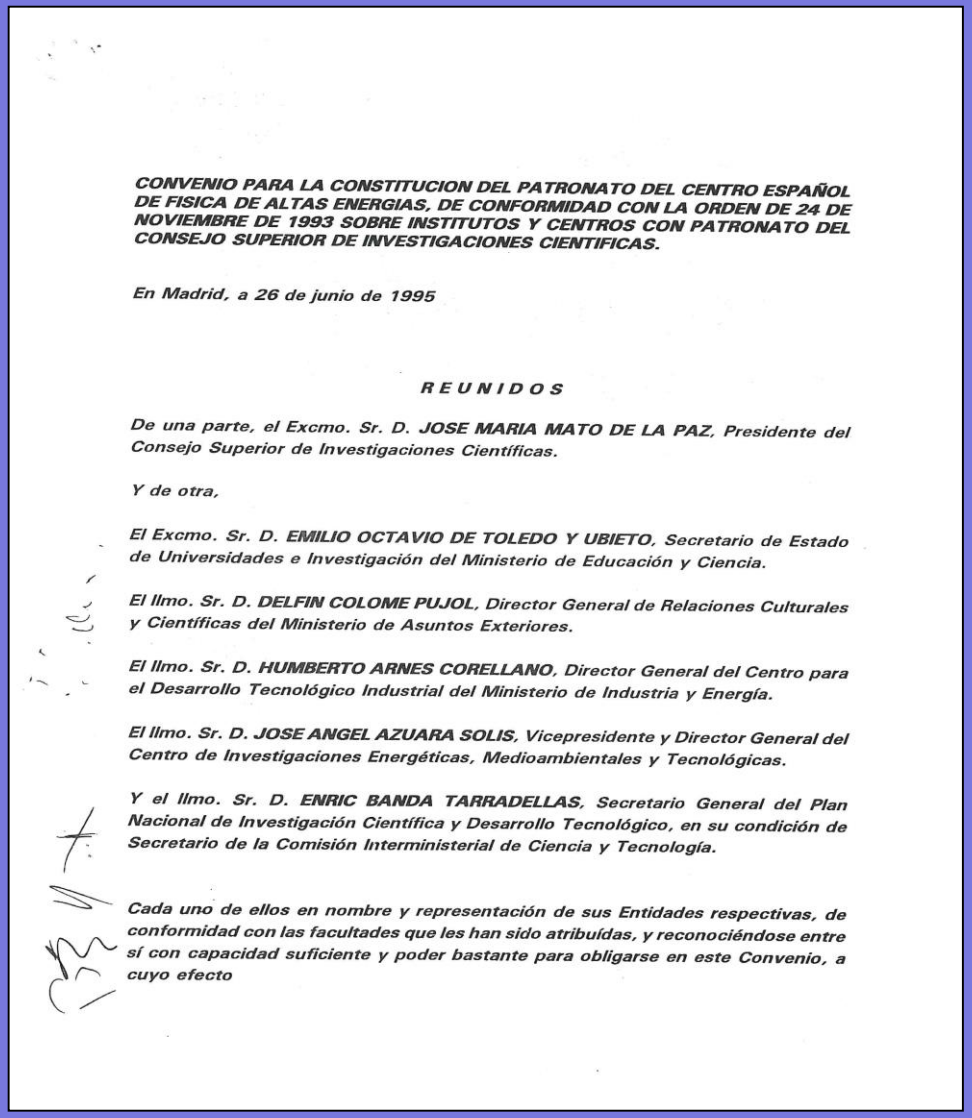
Asimismo, se ha decidido la creación de un Centro Español de Físicas de Altas Energías, que será operativo en el primer trimestre de 1995 y que es el resultado de las negociaciones con el CERN, donde España se comprometió a mejorar su infraestructura científica y tecnológica en este campo. Enric Banda, secretario general del Plan Nacional de I+D, recordó que el problema de los retornos del CERN "no es un problema de cuotas sino de formación de personal. La principal meta del nuevo instituto es que los técnicos e ingenieros que están en el CERN regresen a España", dijo.

Este centró dependerá del CSIC y será dirigido por Enrique Fernández; tendrá patronato, y un presupuesto inicial de 100 millones de pesetas. "No concebimos un instituto que suponga comprar un solar y levantar unas paredes, sino que relacione y aproveche lo que ya existe", añadió Octavio. "Transferiremos la gestión del Programa Nacional de Físicas de Altas Energías al CSIC, con un presupuesto de 400 millones de pesetas".

La CICYT ha aprobado igualmente la construcción de una línea española de rayos X en el Laboratorio Europeo de Radiación Sincrotrón en Grenoble (ESRF), inaugurado el pasado 30 de septiembre, donde la participación científica española es ya superior a la económica. La nueva línea, además de cubrir las demandas de la ciencia y la tecnología española para los próximos años, permitirá formar técnicos. La inversión será de 700 millones de pesetas. Y un 25% de tiempo de uso se ofrecerá a otros países.

Finalmente, la CICYT ha acordado integrar en el Plan Nacional de I + D el Fondo de Investigaciones Sanitarias (FIS) que actualmente depende del Ministerio de Sanidad y fomentar la coordinación en investigación con las comunidades autónomas.

NATIONAL PROGRAM OF HIGH ENERGY PHYSICS (1988-2023)



CONVENIO PARA LA CONSTITUCION DEL PATRONATO DEL CENTRO ESPAÑOL DE FISICA DE ALTAS ENERGIAS, DE CONFORMIDAD CON LA ORDEN DE 24 DE NOVIEMBRE DE 1993 SOBRE INSTITUTOS Y CENTROS CON PATRONATO DEL CONSEJO SUPERIOR DE INVESTIGACIONES CIENTIFICAS.

En Madrid, a 26 de junio de 1995

REUNIDOS

De una parte, el Excmo. Sr. D. **JOSE MARIA MATO DE LA PAZ**, *Presidente del Consejo Superior de Investigaciones Científicas.*

Y de otra,

El Excmo. Sr. D. **EMILIO OCTAVIO DE TOLEDO Y UBIETO**, *Secretario de Estado de Universidades e Investigación del Ministerio de Educación y Ciencia.*

El Ilmo. Sr. D. **DELFIN COLOME PUJOL**, *Director General de Relaciones Culturales y Científicas del Ministerio de Asuntos Exteriores.*

El Ilmo. Sr. D. **HUMBERTO ARNES CORELLANO**, *Director General del Centro para el Desarrollo Tecnológico Industrial del Ministerio de Industria y Energía.*

El Ilmo. Sr. D. **JOSE ANGEL AZUARA SOLIS**, *Vicepresidente y Director General del Centro de Investigaciones Energéticas, Medioambientales y Tecnológicas.*

Y el Ilmo. Sr. D. **ENRIC BANDA TARRADELLAS**, *Secretario General del Plan Nacional de Investigación Científica y Desarrollo Tecnológico, en su condición de Secretario de la Comisión Interministerial de Ciencia y Tecnología.*

Cada uno de ellos en nombre y representación de sus Entidades respectivas, de conformidad con las facultades que les han sido atribuídas, y reconociéndose entre sí con capacidad suficiente y poder bastante para obligarse en este Convenio, a cuyo efecto

NATIONAL PROGRAM OF HIGH ENERGY PHYSICS (1988-2023)

ON 14 APRIL 1896 THE V LEGISLATURE ENDED, A NEW GOVERNMENT WAS IN PLACE AND THE NEW ADMINISTRATION DID NOT CONSIDER A PRIORITY TO CREATE THE

Centro Español de Física de Altas Energías

COORDINATION EFFORTS TOWARDS THE CREATION OF A NATIONAL CENTRE

CPAN / CENTRO NACIONAL DE FÍSICA DE PARTÍCULAS, ASTROPARTÍCULAS Y NUCLEAR

(DOMENEC ESPRIU, ANTONIO PICH, MARCOS CERRADA)

Programa CONSOLIDER-Ingenio 2010 (2005)

(400 researchers, 26 groups)

XV CPAN DAYS (2023)

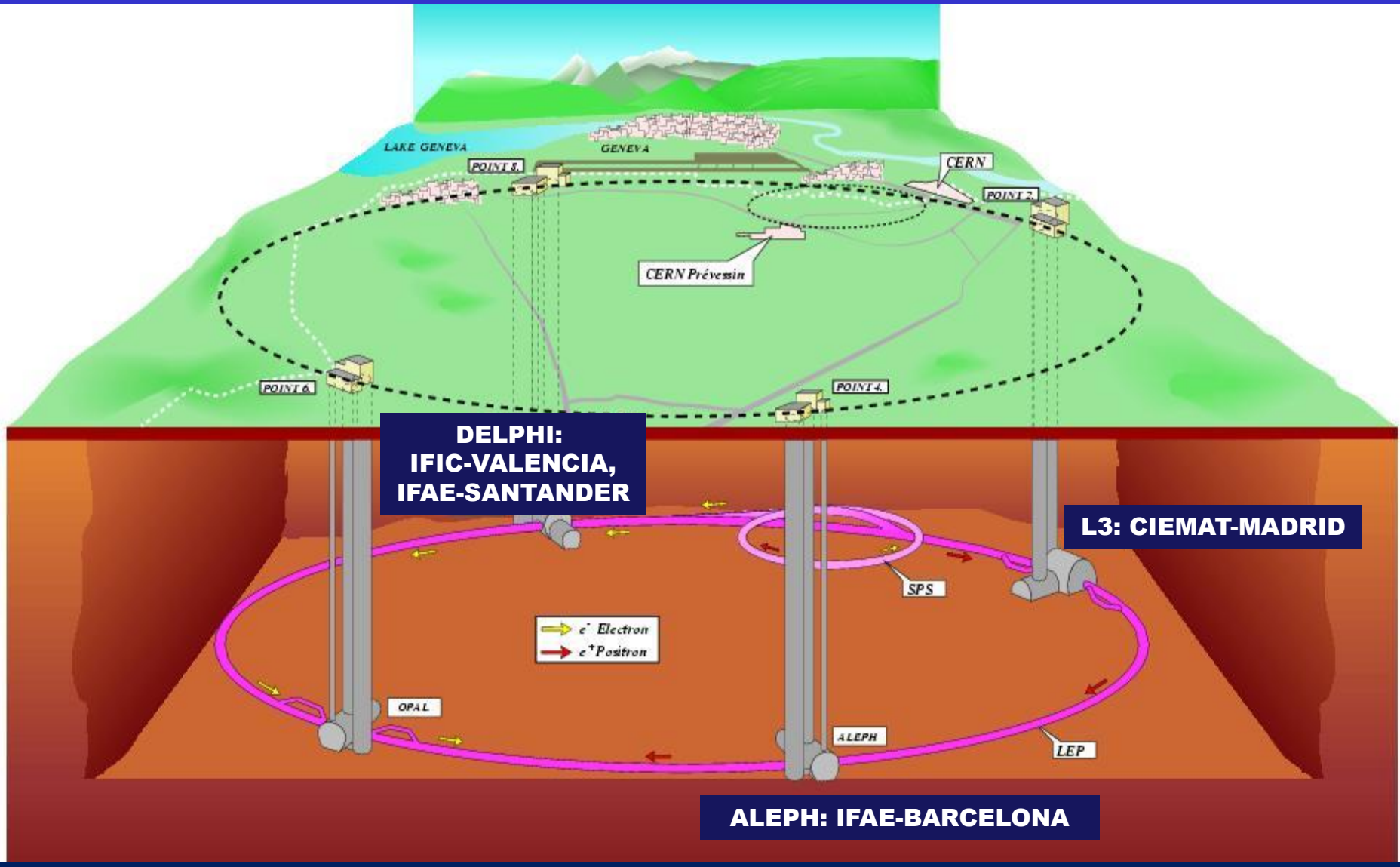
(MARÍA JOSÉ COSTA, CARLOS SALGADO)

HIGH ENERGY PARTICLE PHYSICS DIVISION AT THE ROYAL SPANISH PHYSICS SOCIETY

Santiago (1995)
Gran Canaria (1997)
Valencia (1999)
Sevilla (2001)
Madrid (2003)
Orense (2005)
Granada (2007)

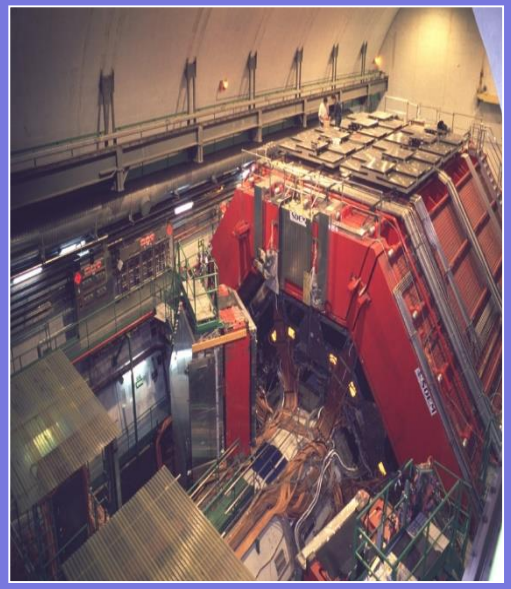
Ciudad Real (2009)
Santander (2011)
Valencia (2013)
Gijón (2015)
Santiago (2017)
Zaragoza (2019)
Murcia (2022)

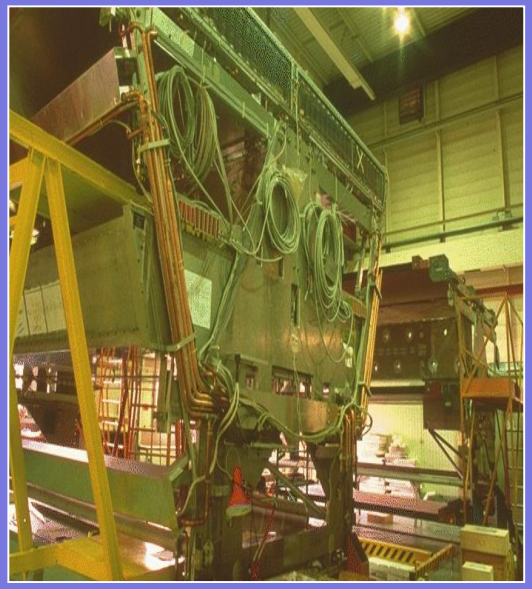
THE LARGEST UNDERTAKING IN THE MID 80s



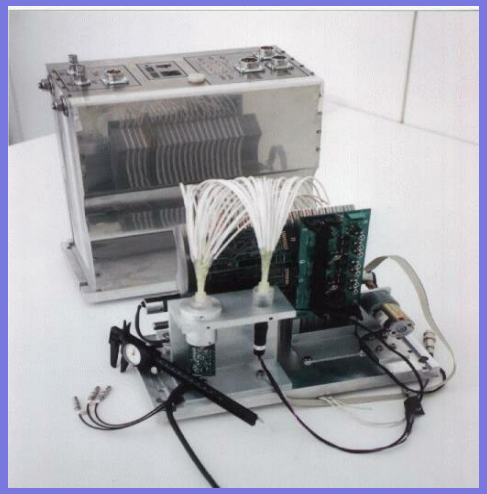
PARTICIPATION IN THE CONSTRUCTION OF ALEPH, DELPHI, L3

L3-MUON SPECTROMETER
CIEMAT (1983-1989)



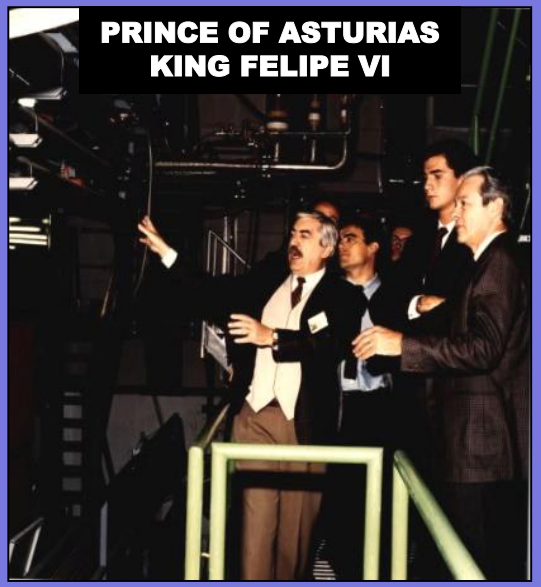


ALEPH LUMI. MONITOR & FALCON

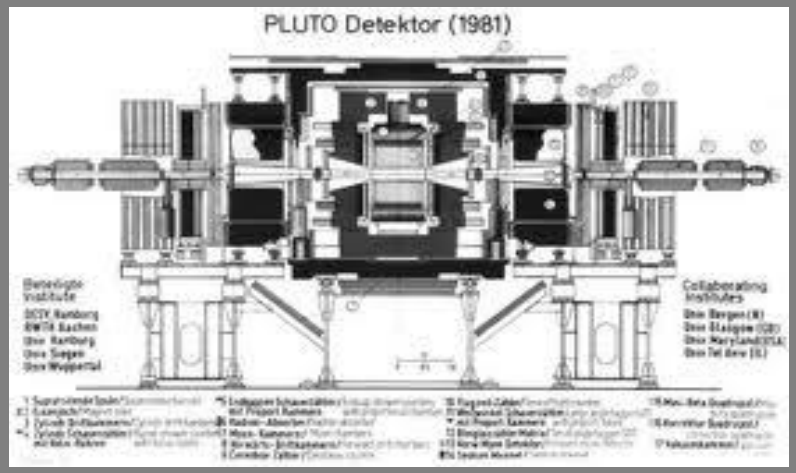


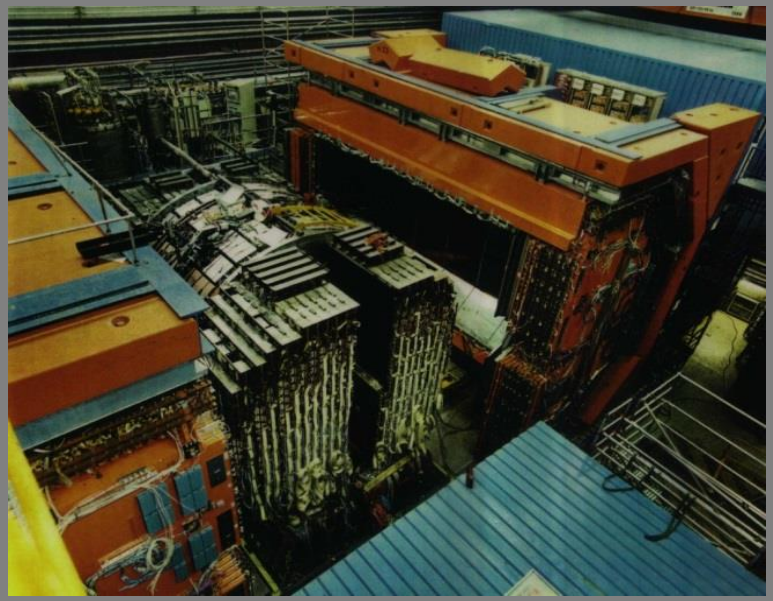
DELPHI FEM & TOF

PRINCE OF ASTURIAS KING FELIPE VI



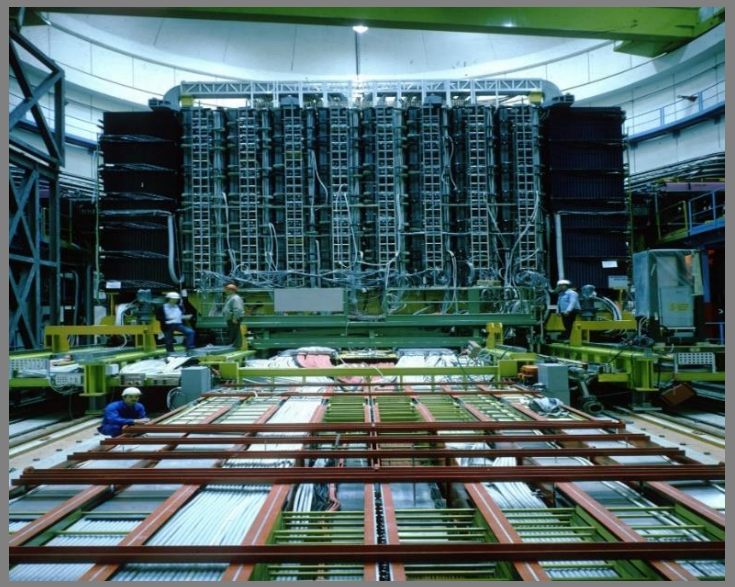
PARTICIPATION IN PLUTO-TASSO-ZEUS (PETRA-HERA) (1984)
F. BARREIRO (UAM)





ISOLDE (1985)

M.J. GARCÍA BORGE, CSIC-MADRID.
LATER JOINED BY IFIC, VALENCIA



1986: CIEMAT JOINS UA1 (1986)
A. Ferrando, T. Rodrigo, ...
C. Albajar (UAM)

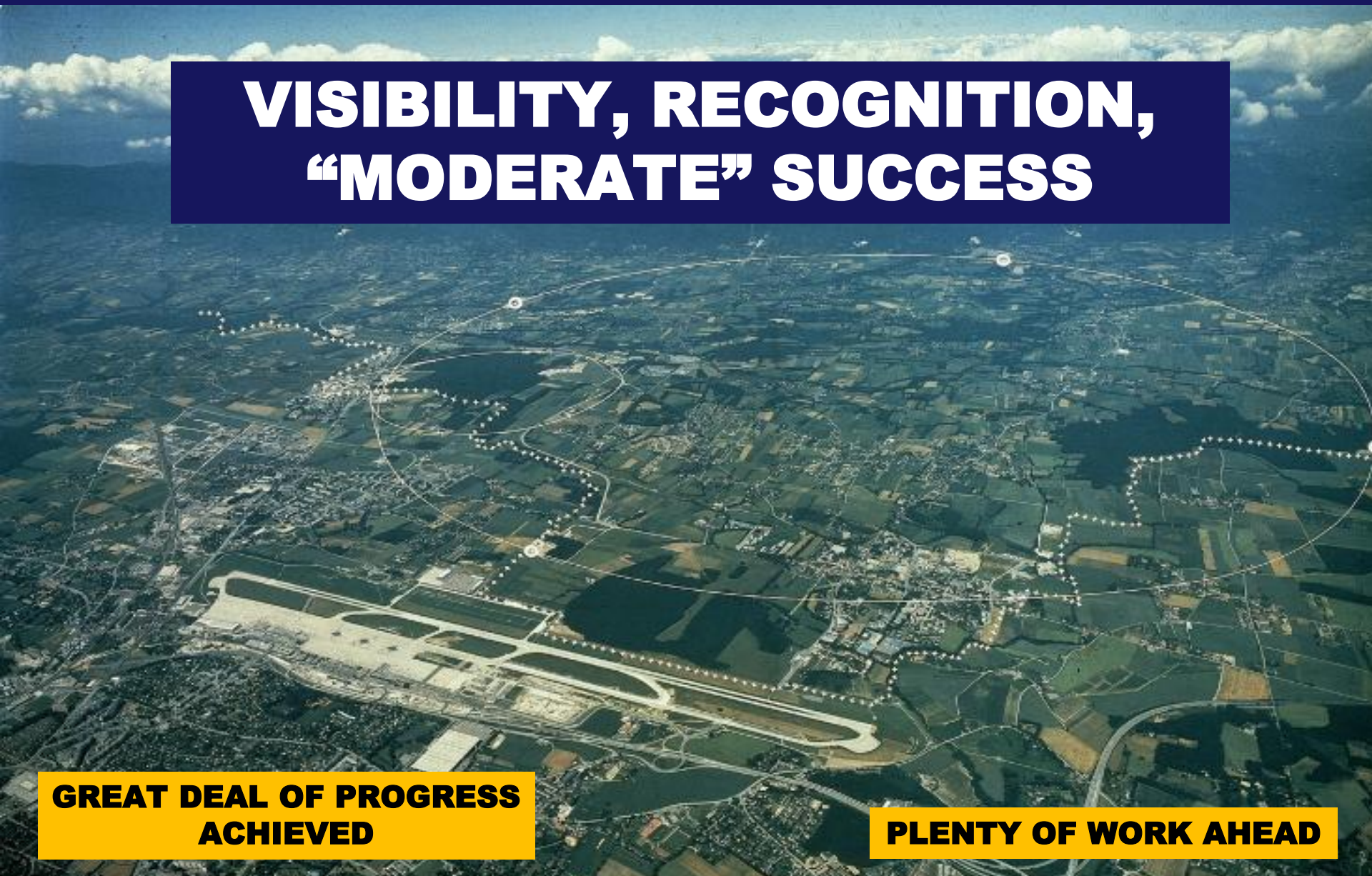
CANFRANC UNDERGROUND LABORATORY (1985)

JULIO & ANGEL MORALES
U. ZARAGOZA

HEGRA
(High Energy Gamma Ray Astronomy) experiment AT IAC (1987)

VICTORIA FONSECA, UCM

THE LAST 35 YEARS

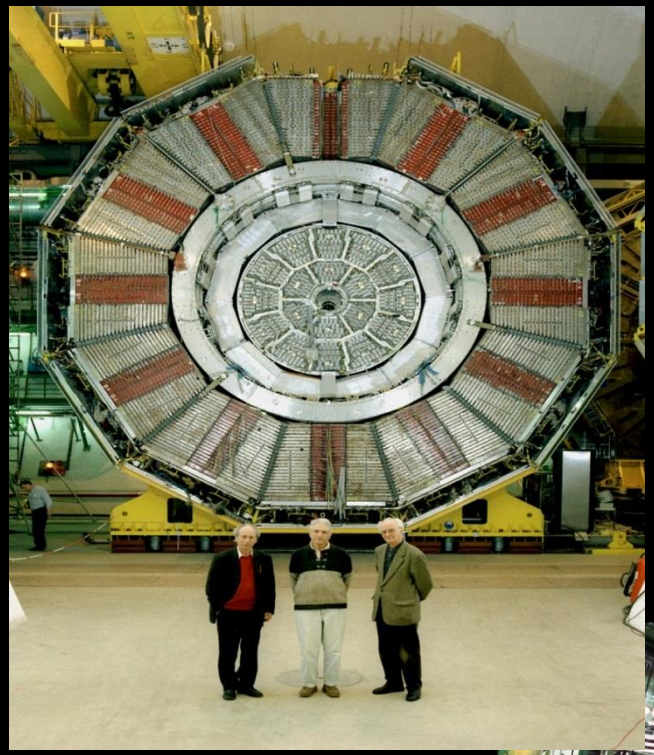


VISIBILITY, RECOGNITION, "MODERATE" SUCCESS

GREAT DEAL OF PROGRESS ACHIEVED

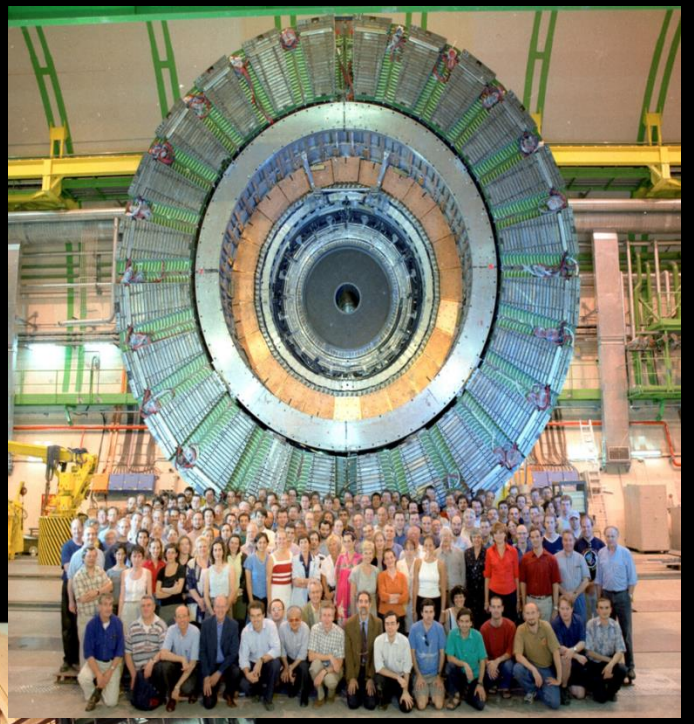
PLENTY OF WORK AHEAD

SCIENTIFIC EXPLOITATION OF LEP DATA



ALEPH: IFAE-BARCELONA

L3: CIEMAT-MADRID



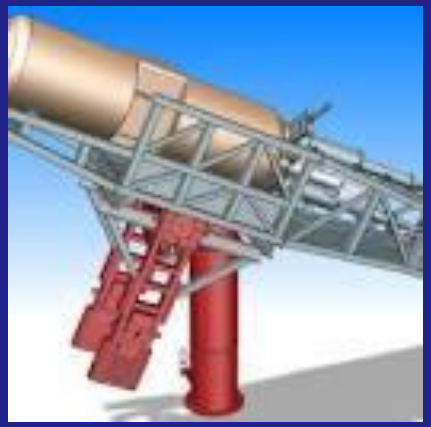
DELPHI:
IFIC-VALENCIA,
IFCA-SANTANDER

SMC (Spin Muon Collaboration)-NA47 @ CERN (1995) U. Santiago de Compostela

CAST @ (CERN Axion Solar Telescope) (2000) U. Zaragoza

IAXO (International Axion Observatory) (2012) U. Zaragoza

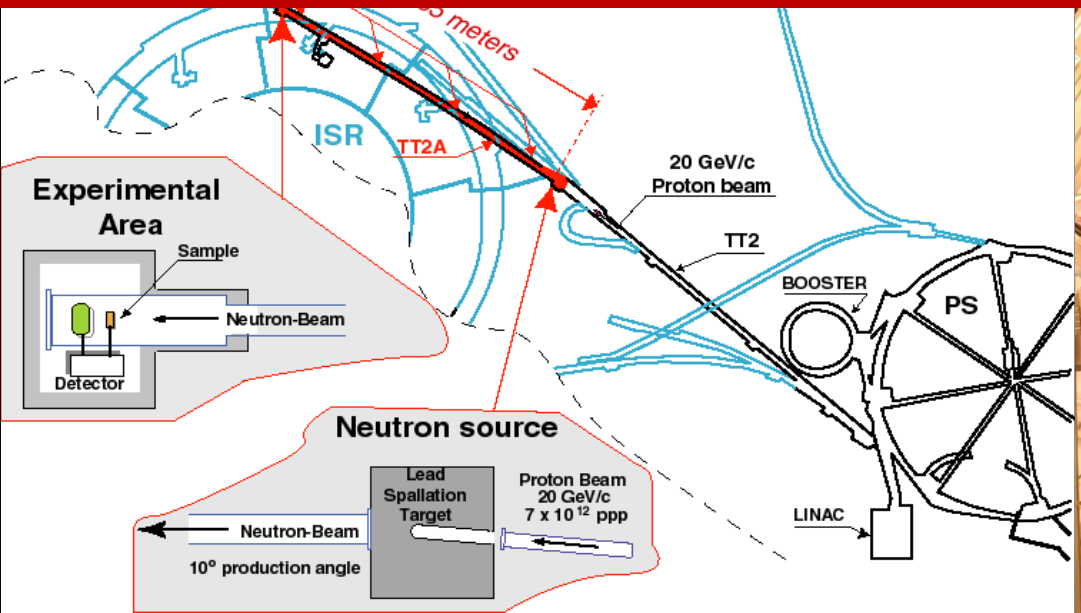
PS212-DIRAC @ CERN (1996)
Lifetime Measurement of
π+ π- atom lifetime of 1fs
U. Santiago de Compostela

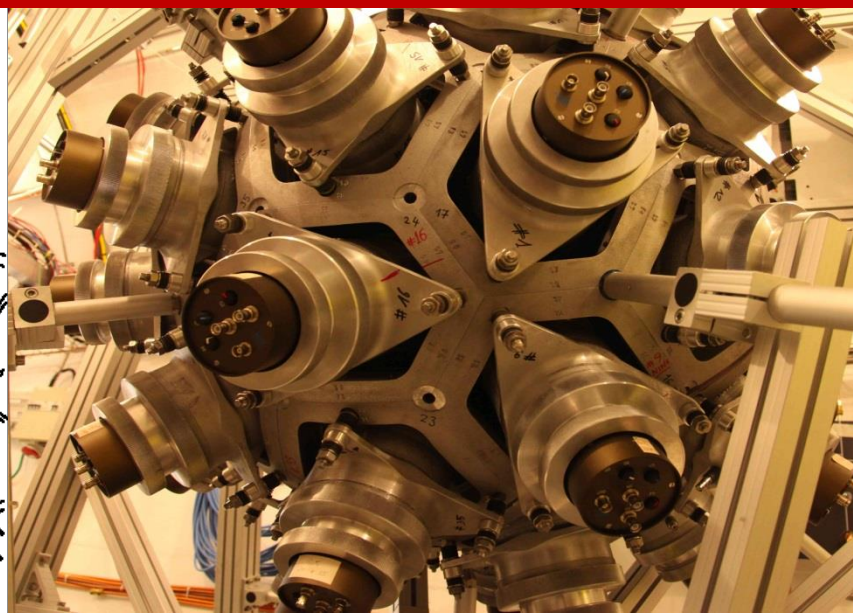


Baby IAXO proposal to DESY approved in 2019 U. Zaragoza

HERA-B @ DESY (1996)
U. Barcelona

nTOF @ CERN (1994)
CIEMAT, IFIC, UPC, UPM, U. Sevilla, U. de Santiago de Compostela



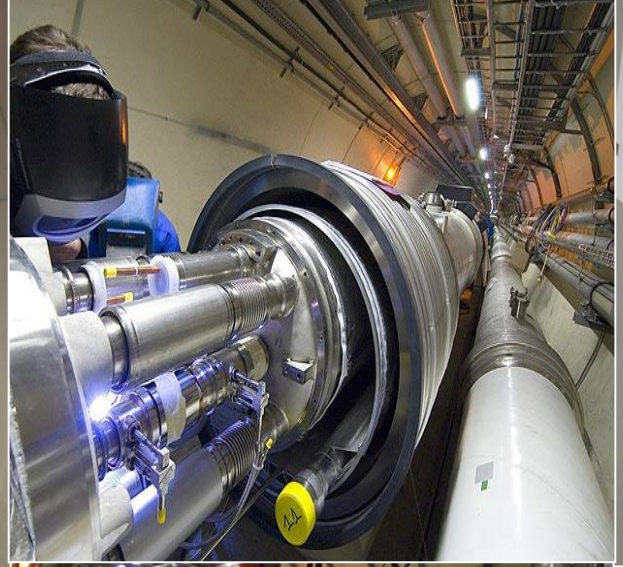


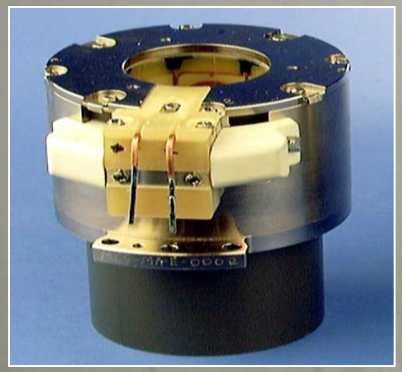
IFCA-SANTANDER JOINS CDF (1999)

IFAE, CIEMAT JOINED LATER (2003, 2005)

IFIC JOINS BaBar AT SLAC B FACTORY (2004)

HIGH PRIORITY: PARTICIPATION IN THE LHC PROJECT

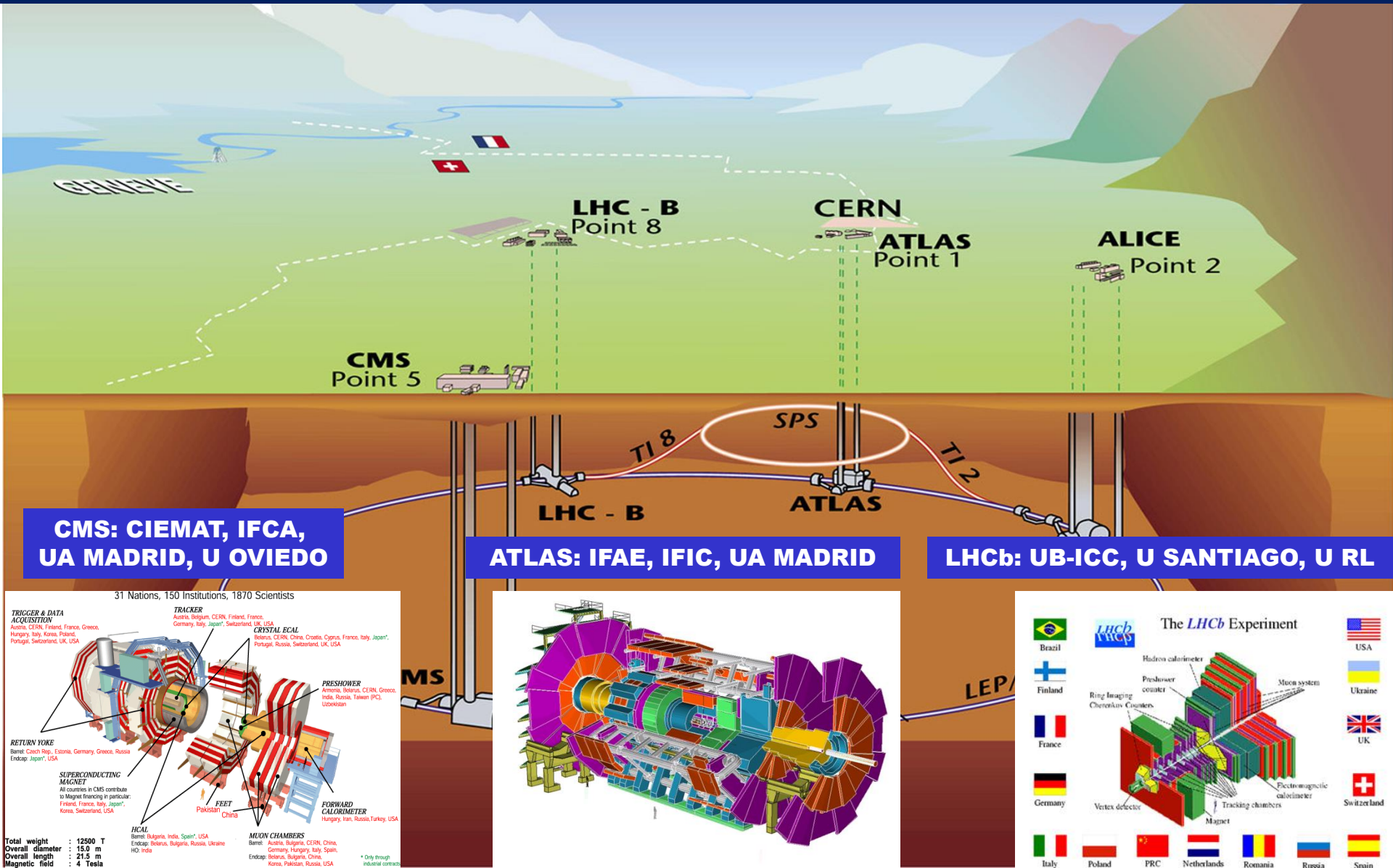




1/3 of the dipole cryostats
30% of the cryoline components
P5 civil engineering
2000 small SC magnets

CONTRIBUTIONS TO THE CONSTRUCTION OF THE LHC

PARTICIPATION IN THE CONSTRUCTION OF ATLAS, CMS, LHCb

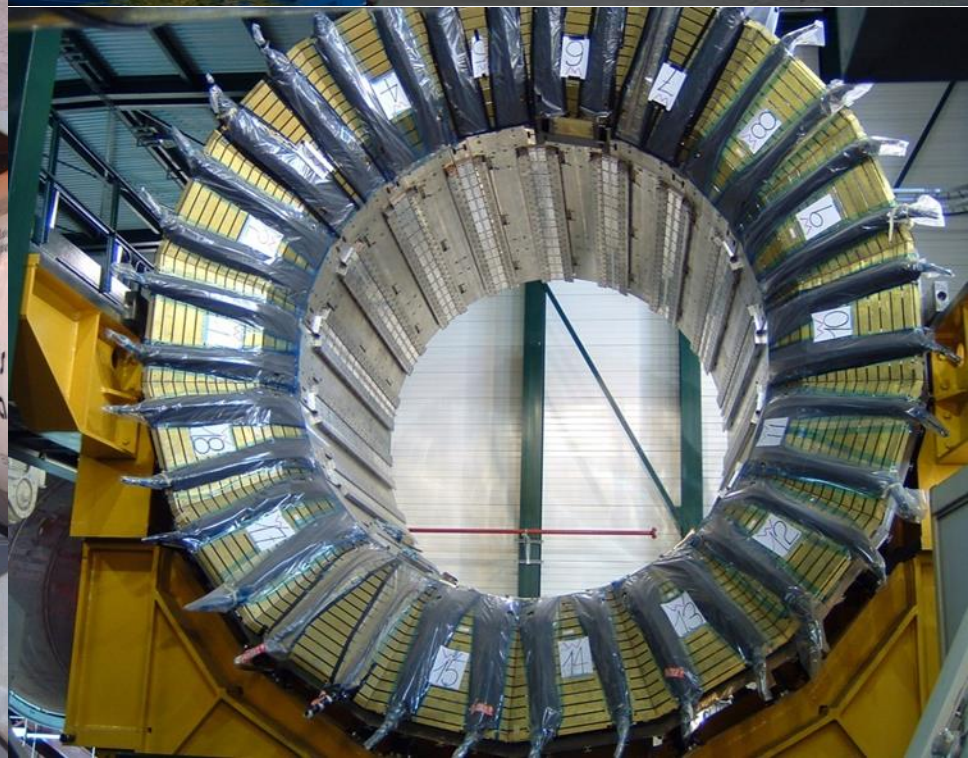


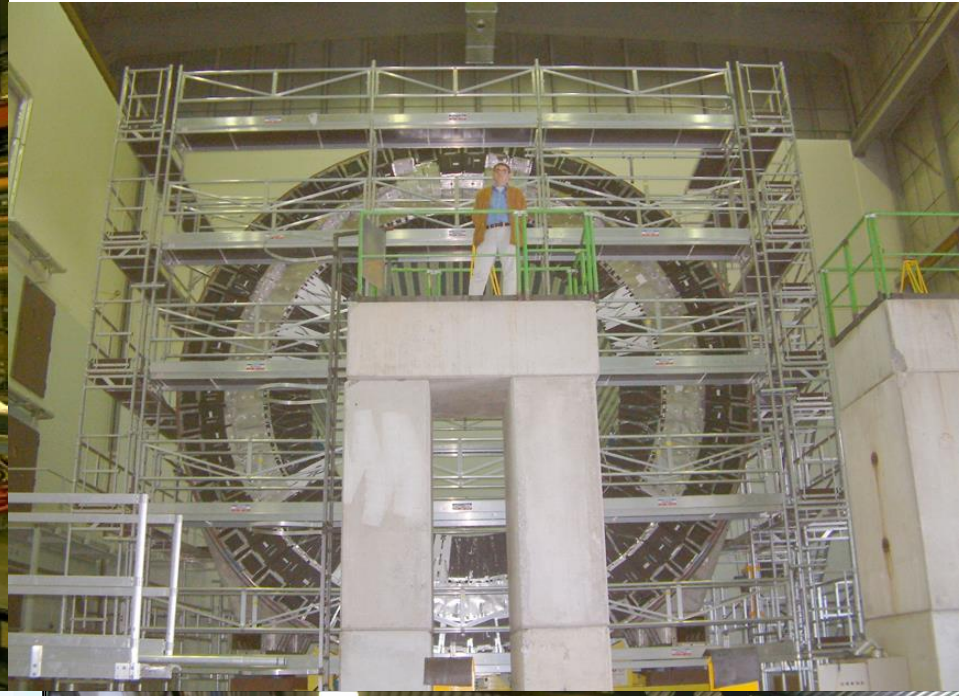
CMS: CIEMAT, IFCA, UA MADRID, U OVIEDO

ATLAS: IFAE, IFIC, UA MADRID

LHCb: UB-ICC, U SANTIAGO, U RL

CRYOSTATS ATLAS SC TOROIDS, CMS HCAL FCM-ASTURIAS

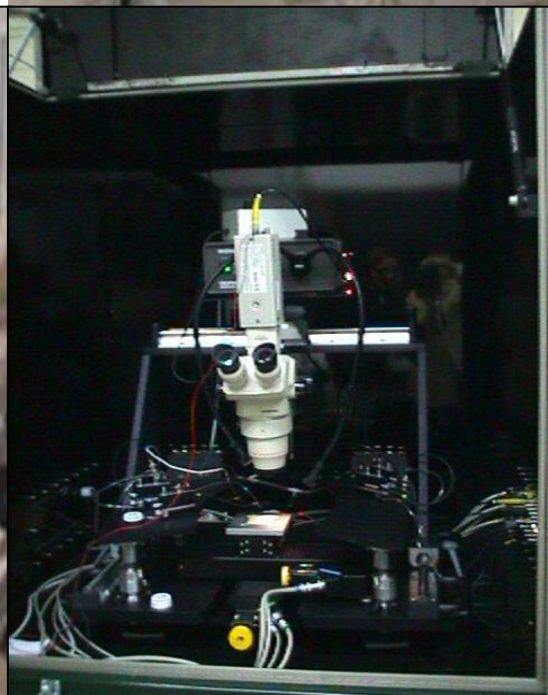




ATLAS TILE CALORIMETER

IFAE-BARCELONA & IFIC-VALENCIA

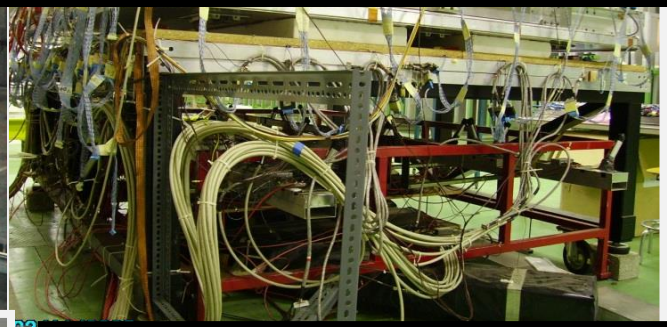
IFIC-VALENCIA

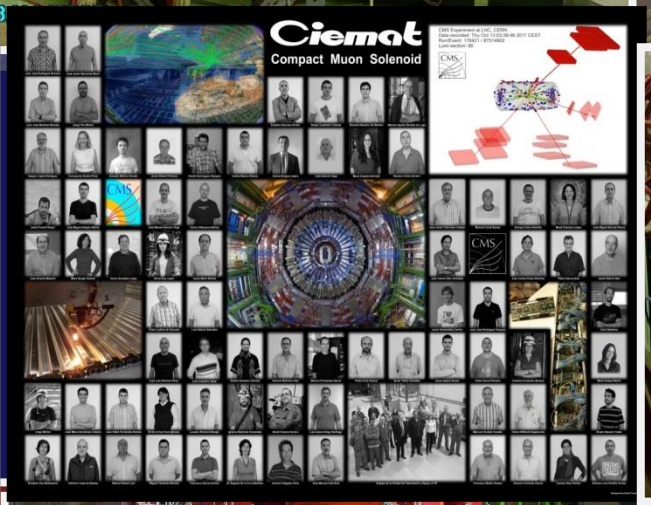


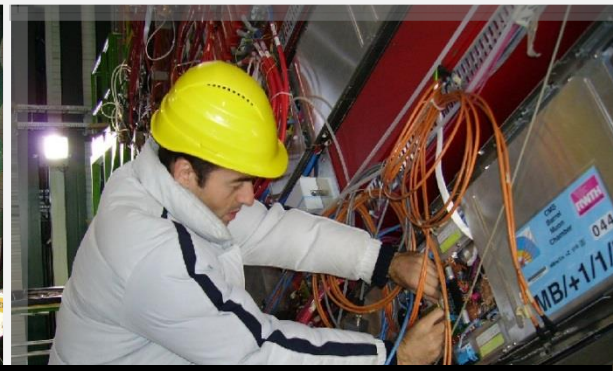
U.A. MADRID

ATLAS Electromagnetic Calorimeter
ACCORDION STRUCTURE

CIEMAT-MADRID

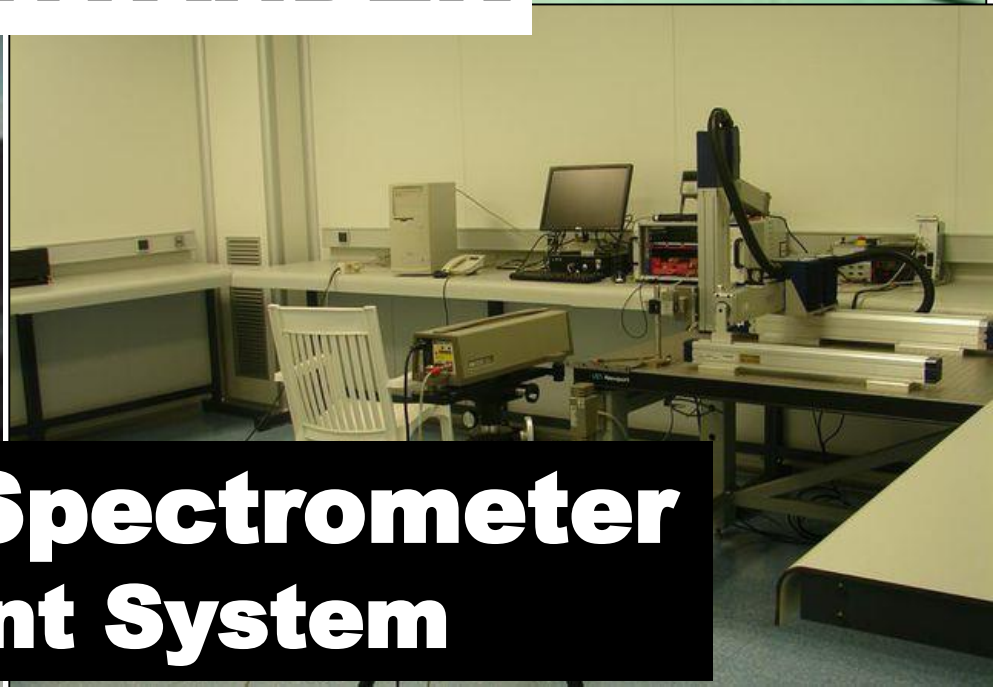




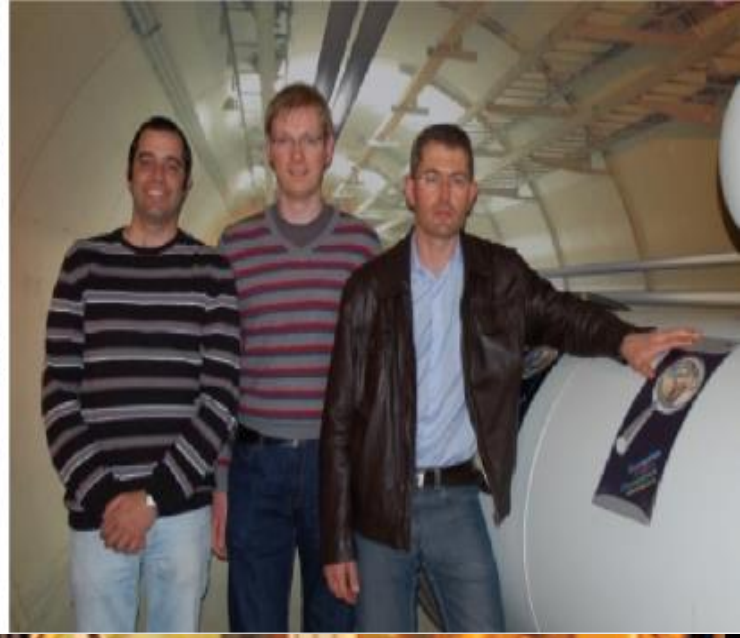


CMS Central Muon Spectrometer

IFCA-SANTANDER



CMS Muon Spectrometer
Alignment System



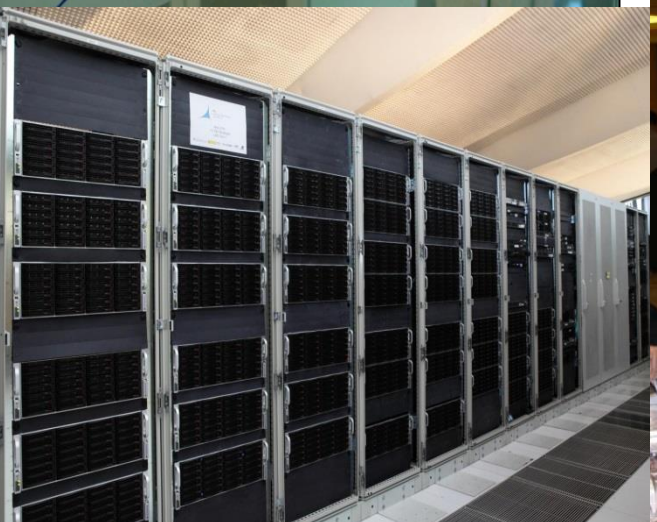
U. SANTIAGO DE COMPOSTELA

LHCb INNER TRACKER

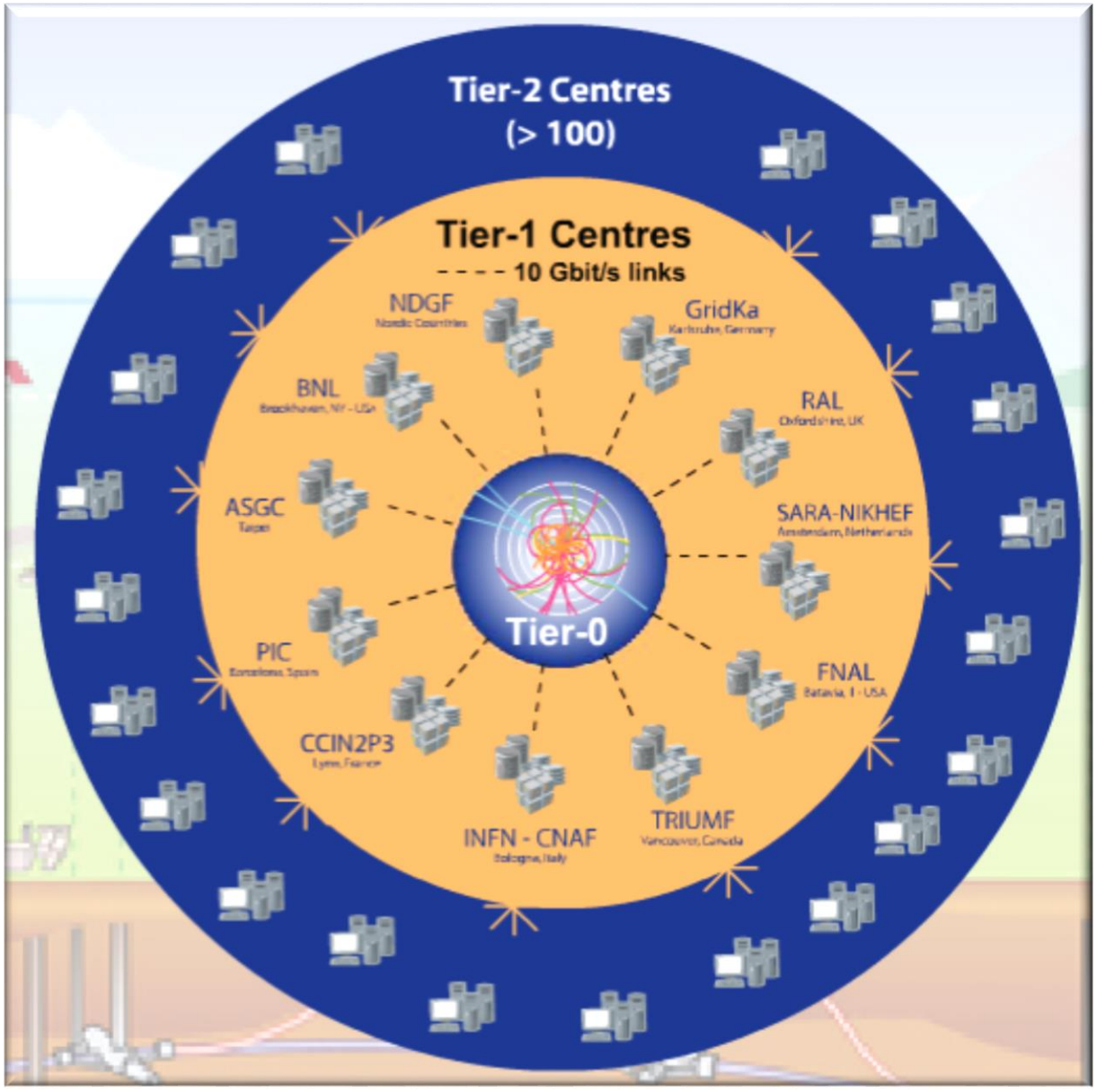
U. BARCELONA

LHCb INNER TRACKER

PIC
PUERTO DE INFORMACIÓN CIENTÍFICA
LHC TIER 1
CIEMAT – GENERALITAT DE CATALUNYA
CONSORTIUM (2003)



The Worldwide LHC Computing Grid (WLCG)

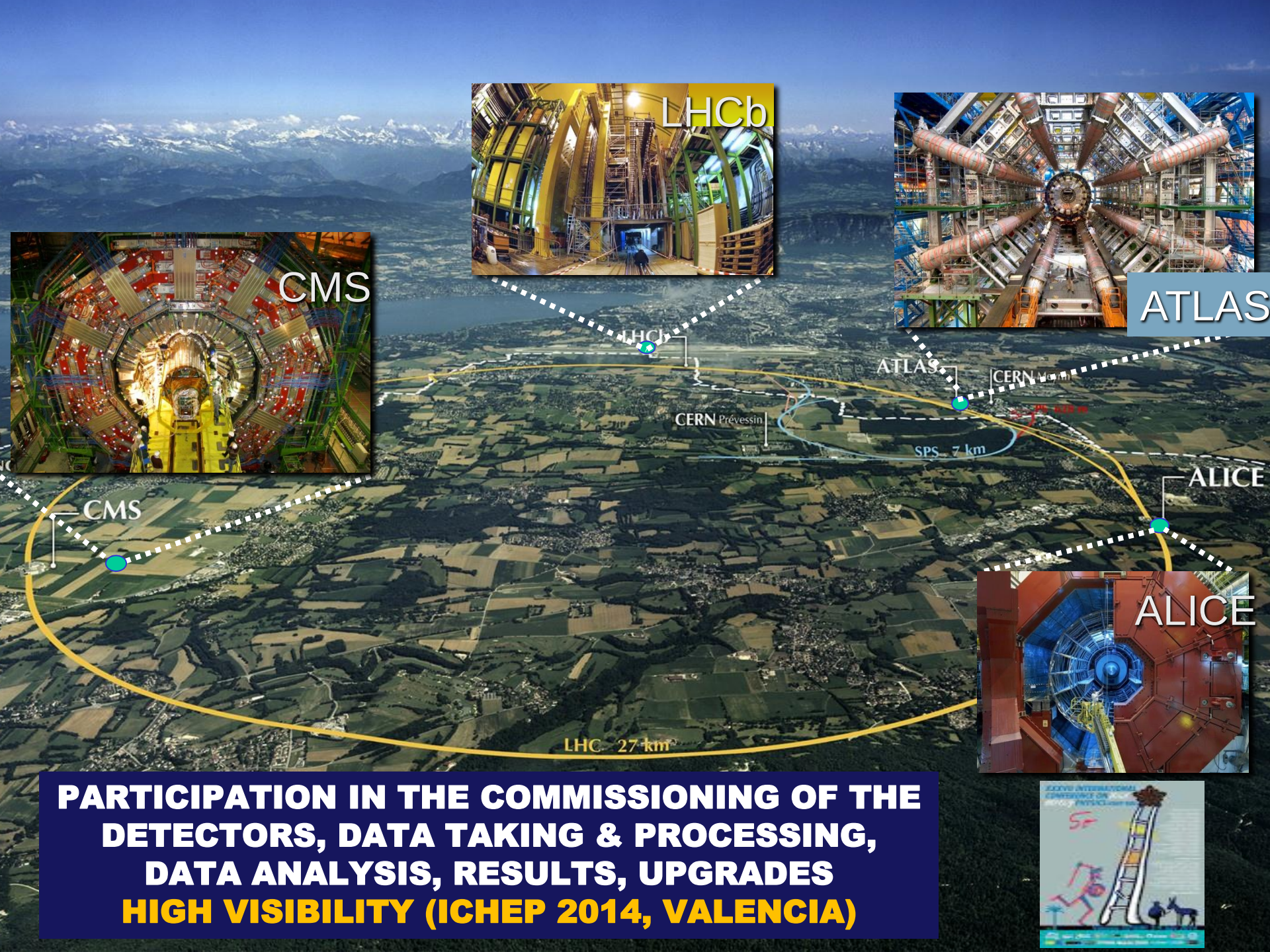


WLCG
Worldwide LHC Computing Grid

Tier-0 (CERN):
- Data recording
- Initial data Reconstruction
- Data distribution

Tier-1 (12 centres):
- Permanent storage
- Re-processing
- Analysis
- Simulation

Tier-2 (68 federations of >100 centres):
- Simulation
- End-user analysis



PARTICIPATION IN THE COMMISSIONING OF THE DETECTORS, DATA TAKING & PROCESSING, DATA ANALYSIS, RESULTS, UPGRADES

HIGH VISIBILITY (ICHEP 2014, VALENCIA)

COLLATERAL EFFECTS
THE SAGA OF THE TAU CHARM FACTORY

EUROPEAN LABORATORY FOR PARTICLE PHYSICS

CERN/AC/90-07

A TAU-CHARM FACTORY LABORATORY IN SPAIN combined with a SYNCHROTRON LIGHT SOURCE (A conceptual study)

Y. Baconnier, J.-L. Baldy, J.-P. Delahaye, R. Dobinson, A. De Rújula, F. Ferger, A. Hofmann, J.M. Jowett, J. Kirkby, P. Lefèvre, D. Möhl, G. Plass, L. Robertson, J. A. Rubio, T.M. Taylor and E.J.N. Wilson
CERN, Geneva, Switzerland

F. Dupont and J. le Duff
LAL, Orsay, France

C. Willmott
CIEMAT, Madrid, Spain

Abstract

A conceptual design for a τ-charm factory and its associated laboratory is given. It includes the physics interest, a description of the scope and layout of the new laboratory in Spain, the τ-charm factory collider and detector, the injector system and a synchrotron light source, together with estimates of the time-scale and necessary resources.

Geneva, Switzerland

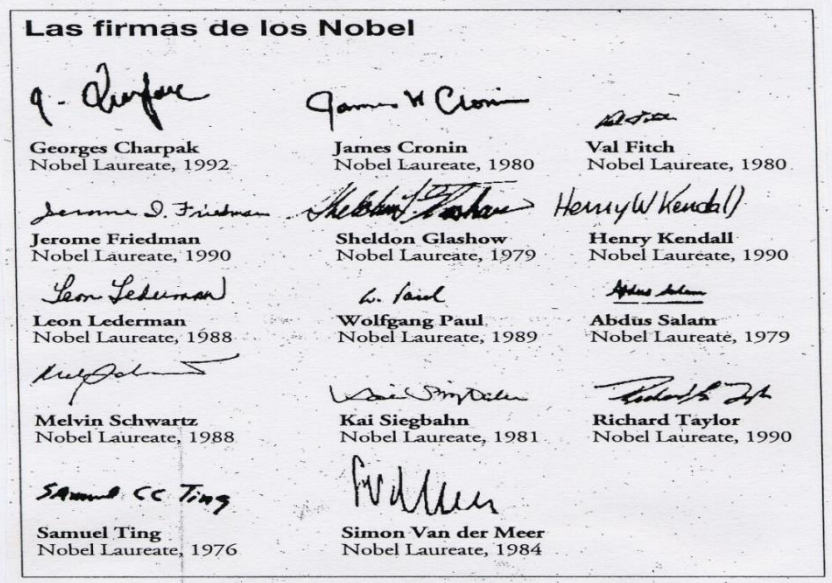
20 November 1990

EL PAÍS, domingo 14 de febrero de 1993

Es un laboratorio esencial, según los físicos

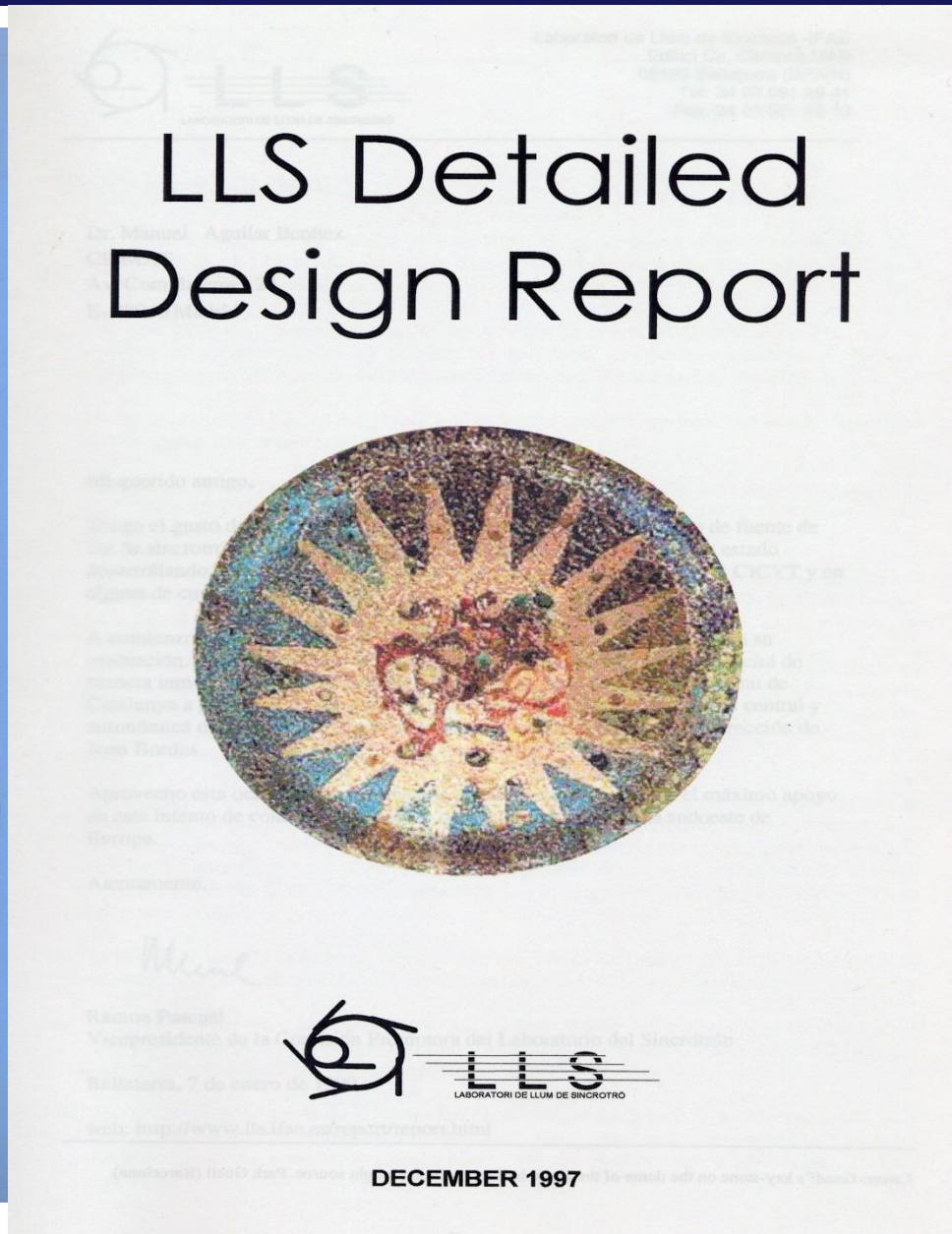
14 premios Nobel piden a Felipe González que apoye la 'fábrica de taus'

Las firmas de los Nobel



Firmas de los 14 físicos en la carta dirigida a Felipe González.

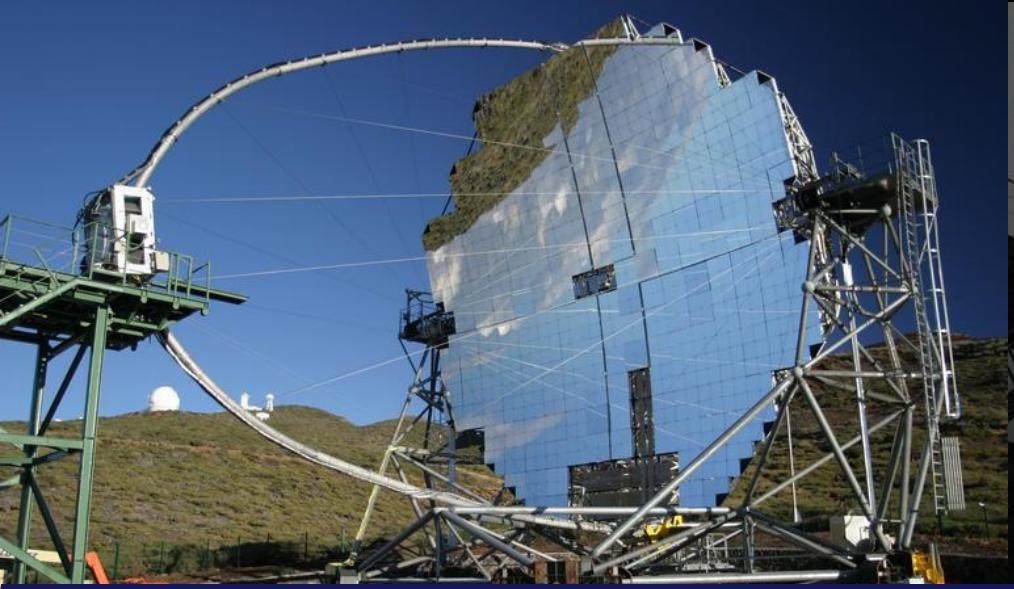
THE SAGA OF THE TAU CHARM FACTORY



RAMÓN PASCUAL

ALBA SYNCHROTRON BARCELONA (2003-2010)

COSMIC RAY PHYSICS

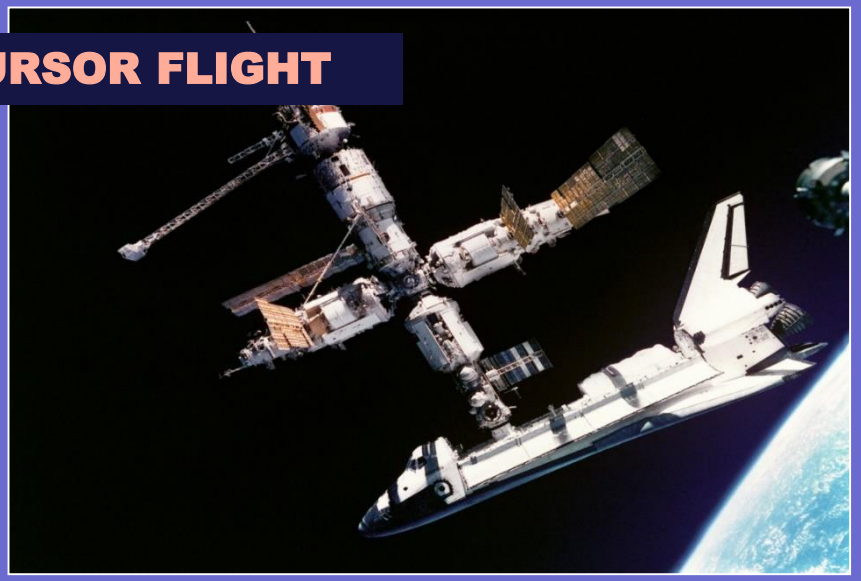


MAGIC (1997)

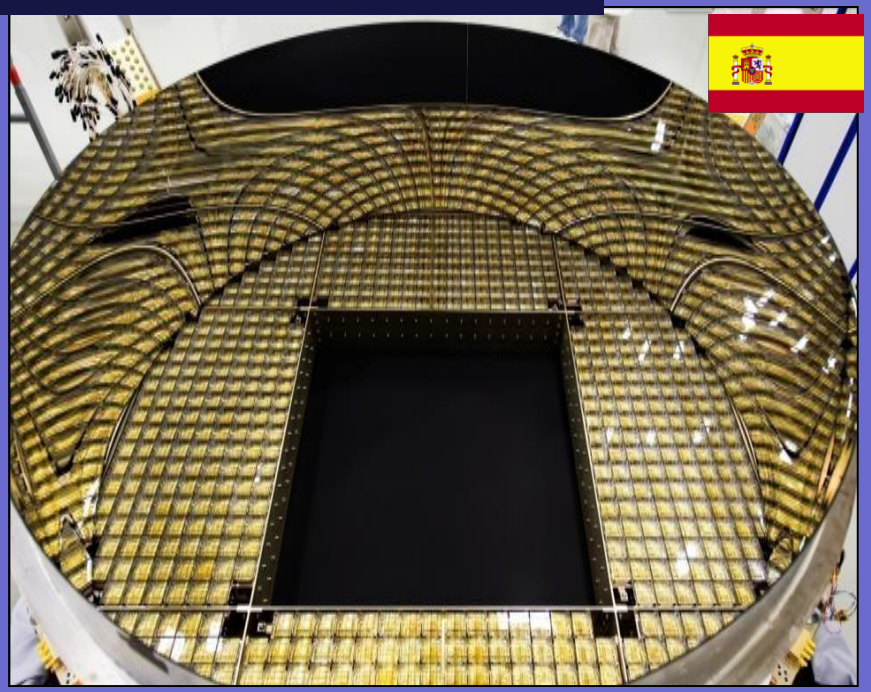
IFAE, U.C. MADRID, U.A. BARCELONA, CIEMAT, ...

MANEL MARTÍNEZ

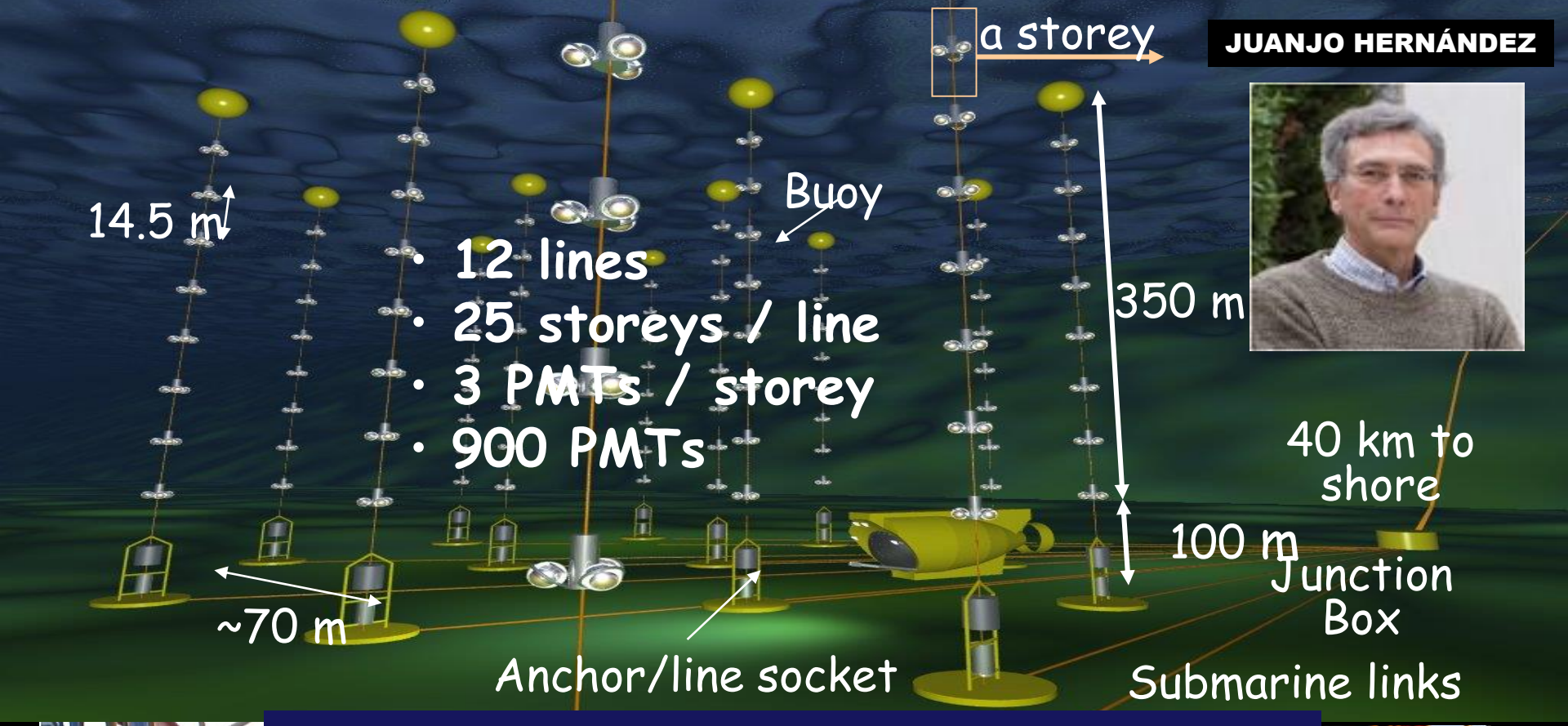
DISCOVERY PRECURSOR FLIGHT



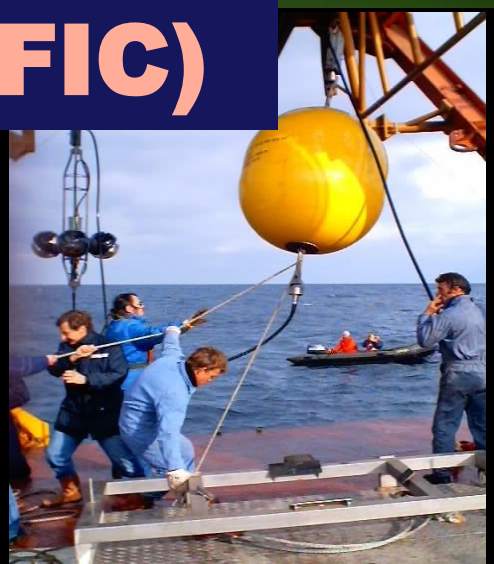
AMS (1997) CIEMAT, IAC



AMS (2011) ENDEAVOUR FLIGHT



1997: ANTARES (IFIC)



KM3NeT/ARCA (2012)

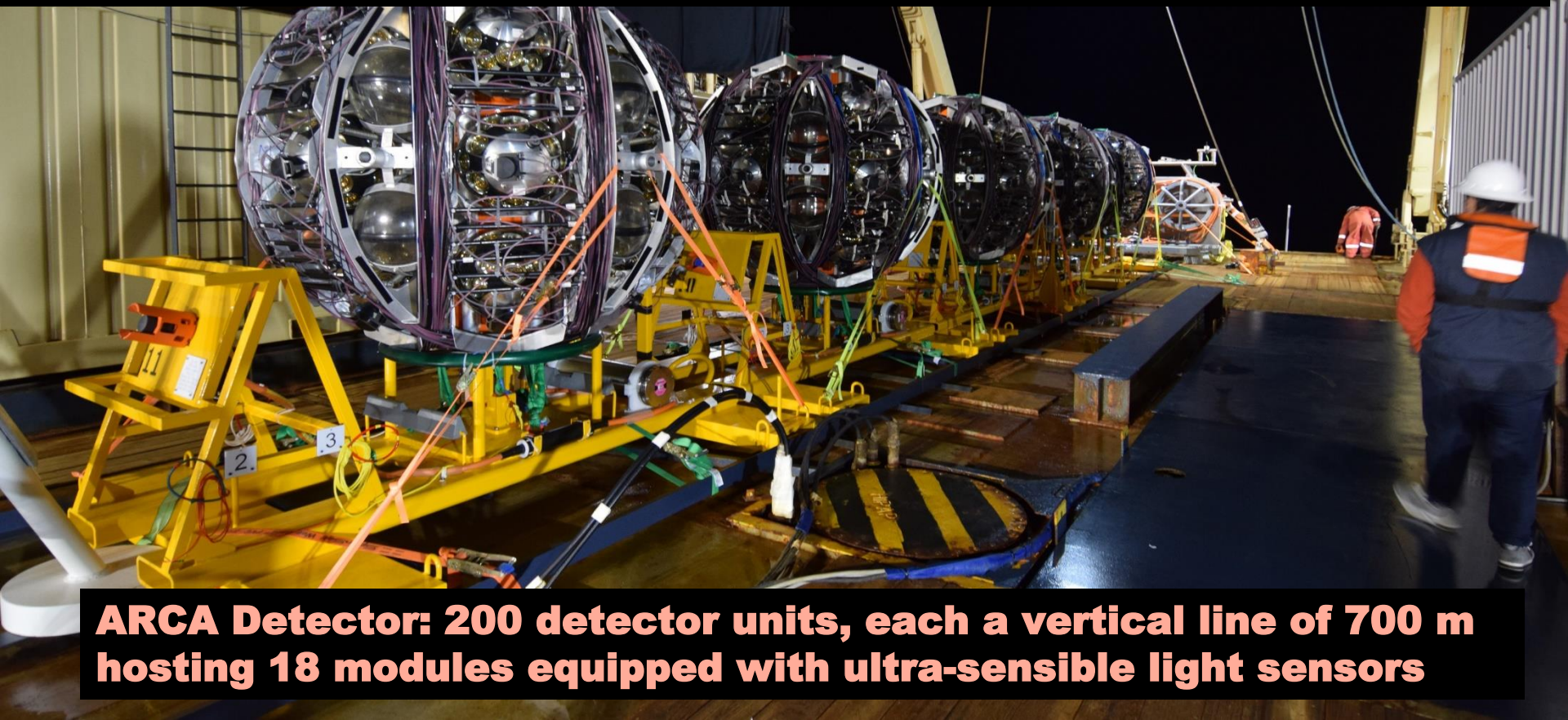
IFIC, U. GRANADA, U. P. VALENCIA, IEO, ICM-CSIC

KM3NeT-It (Sicily, Italy)

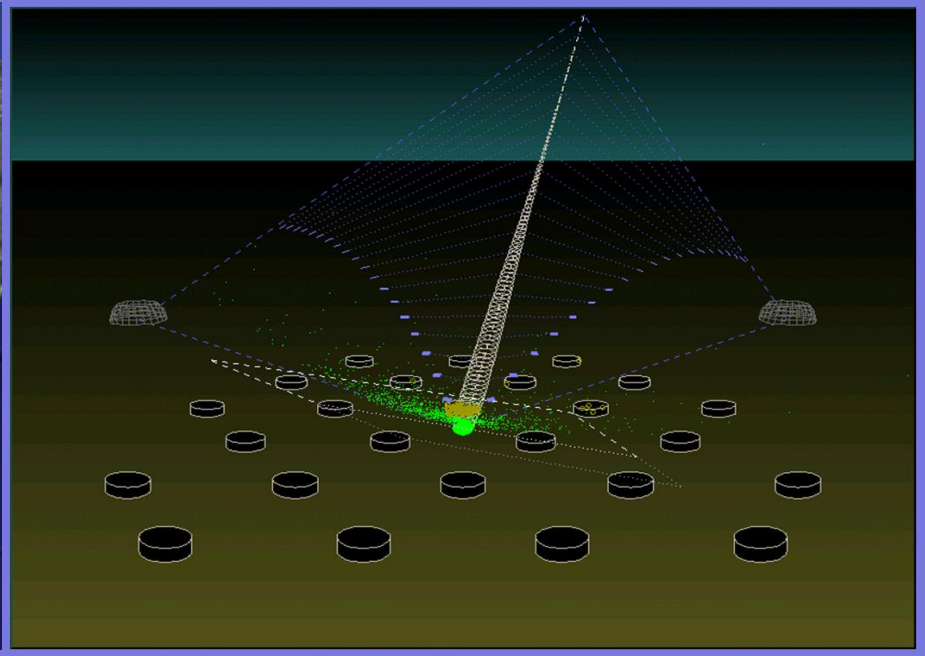
ARCA Detector (Astroparticle Research with Cosmics in the Abyss)

KM3NeT-Fr (Toulon, France)

ORCA Detector (Oscillation Research with Cosmics in Abyss)



ARCA Detector: 200 detector units, each a vertical line of 700 m hosting 18 modules equipped with ultra-sensible light sensors



AUGER (2001)

U. SANTIAGO, U.C. MADRID, U. GRANADA, ...

Cherenkov Telescope Array

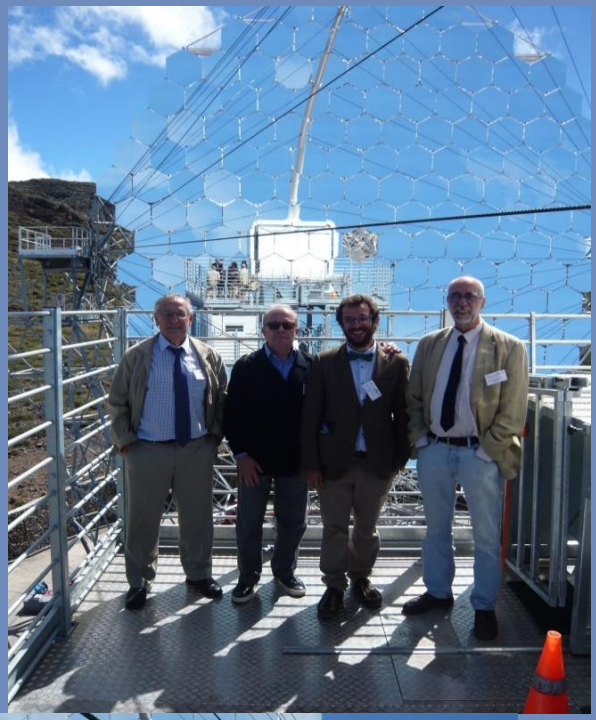
Instituto de Astrofísica de Canarias

Universidad Complutense de Madrid

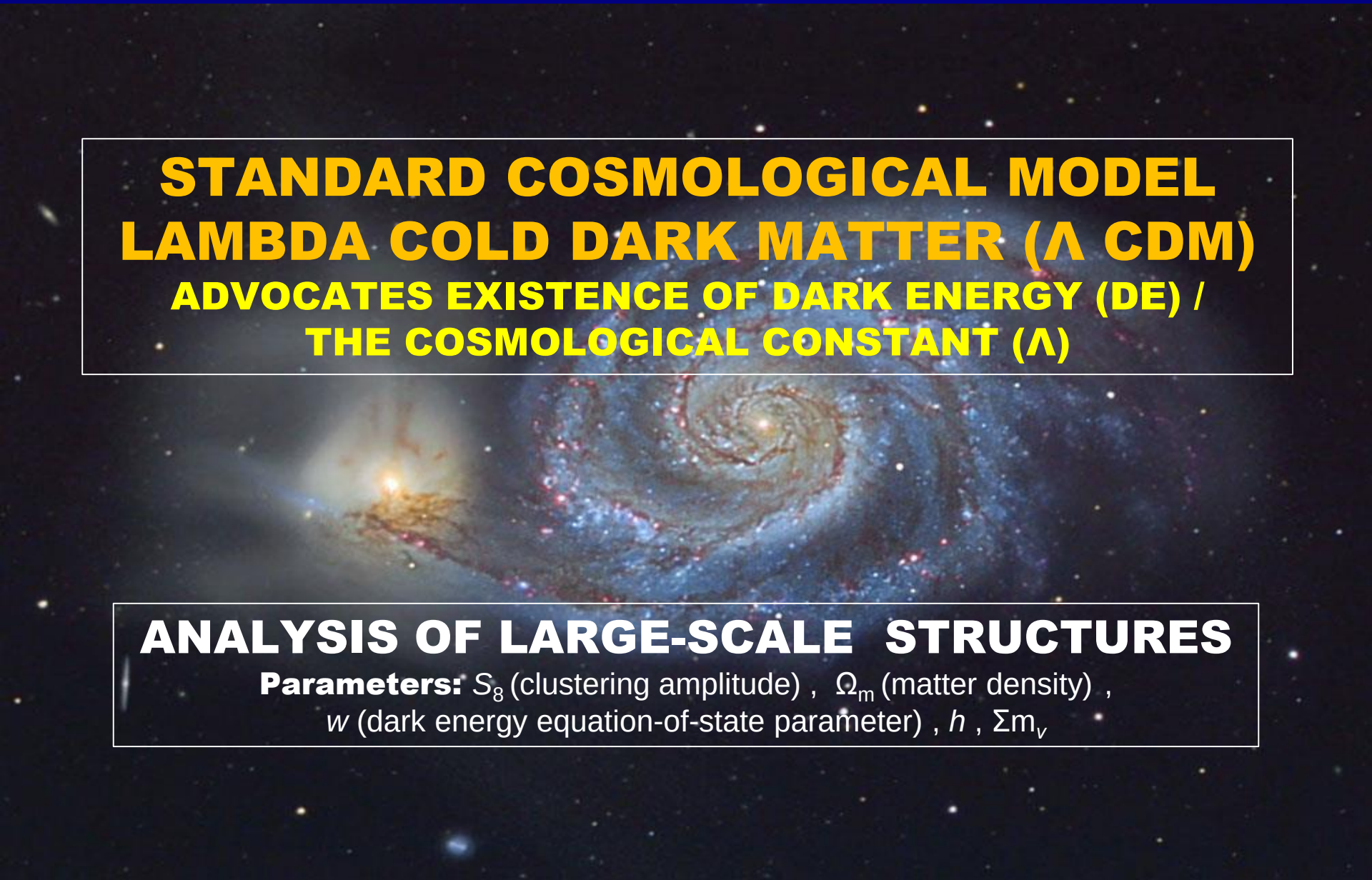
The CTAO's northern hemisphere array or CTAO-North is located on the island of La Palma in the Canary Islands (Spain) at the Instituto de Astrofisica de Canarias' (IAC's) Observatorio del Roque de los Muchachos in Villa de Garafia . At 2,200 metres in altitude and nestled on the slope below the rim of an extinct volcanic crater, the site currently hosts a prototype of one of the CTAO's Large-Sized Telescopes, the LST-1. In addition to the telescope array, the CTAO will have an operations building and calibration devices on site, as well as an office at sea level. The sum of these facilities is known as the "Northern Station."

The approved Alpha Configuration hosts four Large-Sized Telescopes to capture the low-energy gamma rays and nine Medium-Sized Telescopes to cover CTAO's core energy range. A prototype of an LST, the LST-1, was completed on site in October 2018 and is foreseen to become the CTAO's first telescope once it has completed its commissioning and is accepted by the CTAO.

CTA LST-1 INAUGURATION, 10/10/2018



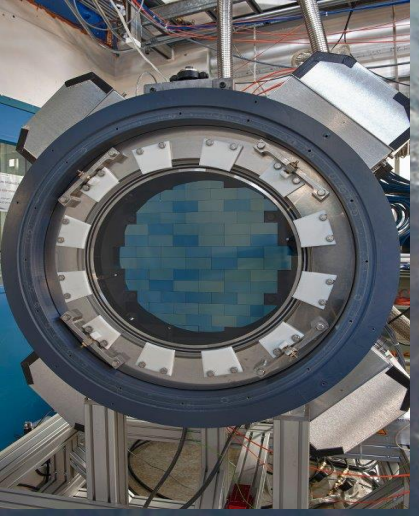
COSMOLOGY

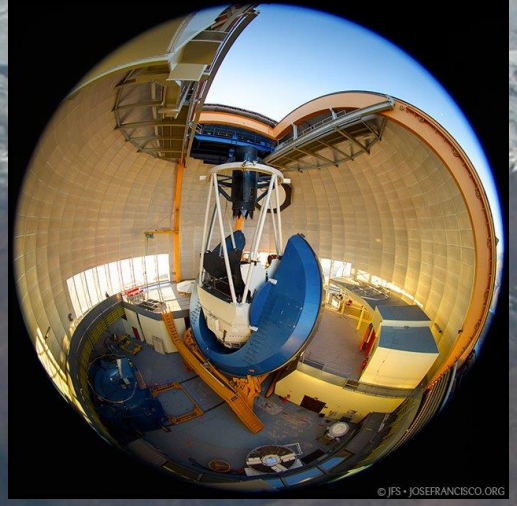


STANDARD COSMOLOGICAL MODEL
LAMBDA COLD DARK MATTER (Λ CDM)
ADVOCATES EXISTENCE OF DARK ENERGY (DE) / THE COSMOLOGICAL CONSTANT (Λ)

ANALYSIS OF LARGE-SCALE STRUCTURES

Parameters: S_8 (clustering amplitude) , Ω_m (matter density) , w (dark energy equation-of-state parameter) , h , Σm_ν

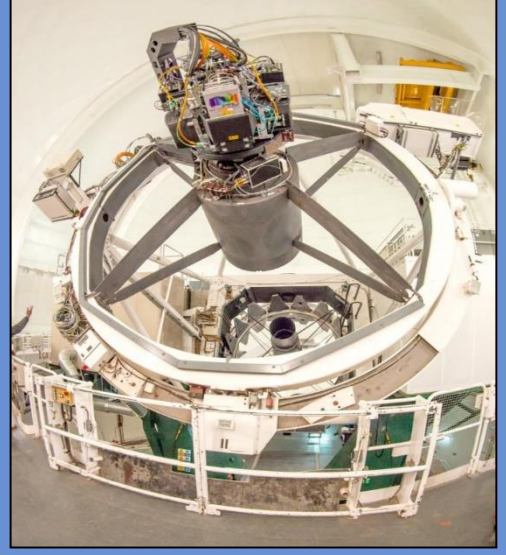


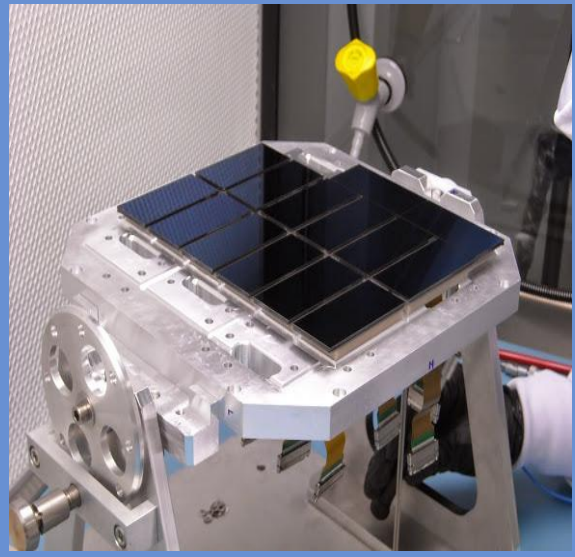


DARK ENERGY SURVEY

DES, CERRO TOLOLO, CHILE (2006)
IFAE, IEEC, CIEMAT, UAM, ...
Full 5000 deg^2 of imaging data; first 3 years.
Photometric LSS surveys

Constraints on the Hubble parameter, $h = 0.680^{+0.004}_{-0.003}$
Neutrino mass, $\Sigma m_\nu < 0.13$ eV (95% C.L.)





ROQUE DE LOS MUCHACHOS

PAU (2008)

IFAE, IEEC, CIEMAT, UAM, IAC, ...

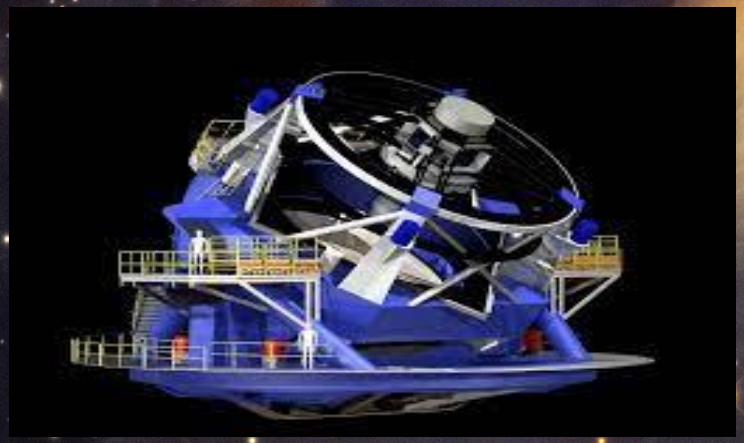
Clean and calibrated galaxy catalogs, precise photometric redshifts for the COSMOS field

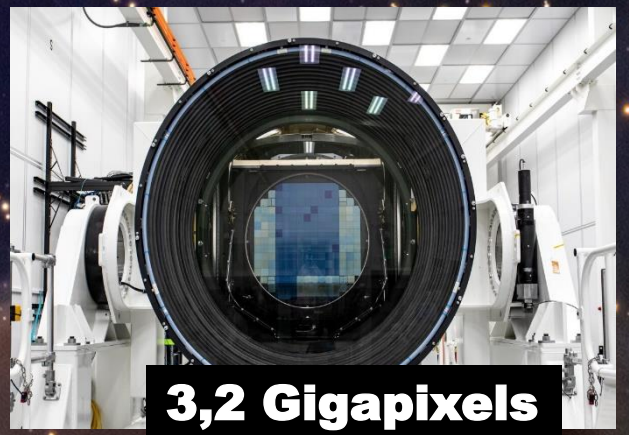
DESI, MAYALL, KITT PEAK, TUCSON

Full 14000 deg^2, 30 M galaxies and quasar spectroscopy survey

IFAE, IEEC, CIEMAT, UAM, IAC, ...

Baryon Acoustic Oscillations, Growth structure through redshift-space distortions (RSD), Expansion rate of the universe (unprecedented precision), Sum of neutrino masses (~ 20 meV uncertainty)



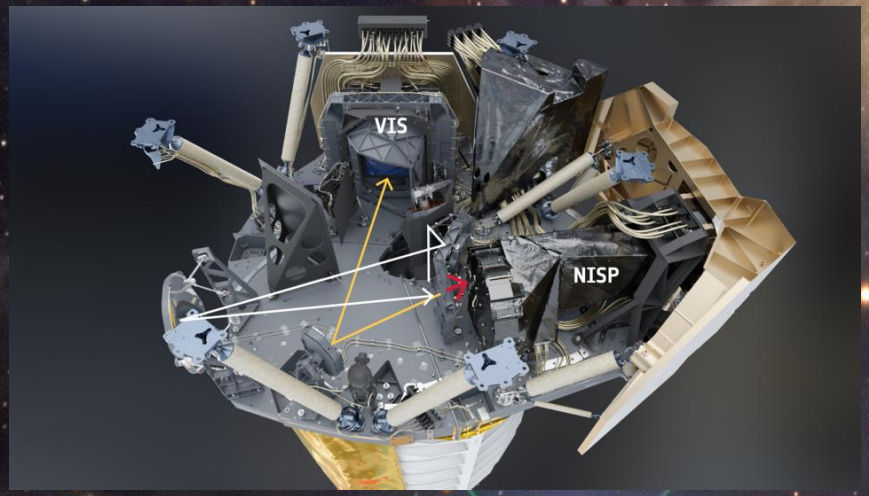


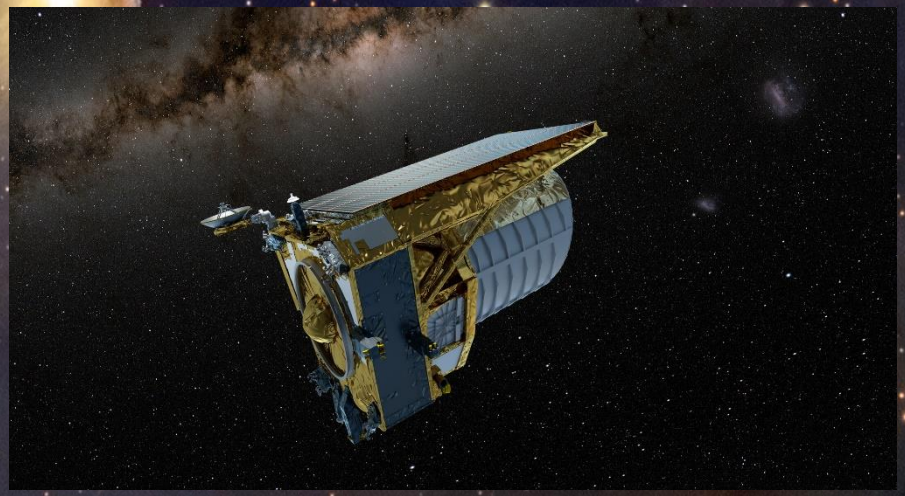
LSST (Large Synoptic Survey Telescope)

VERA RUBIN OBSERVATORY, CERRO PACHÓN, CHILE

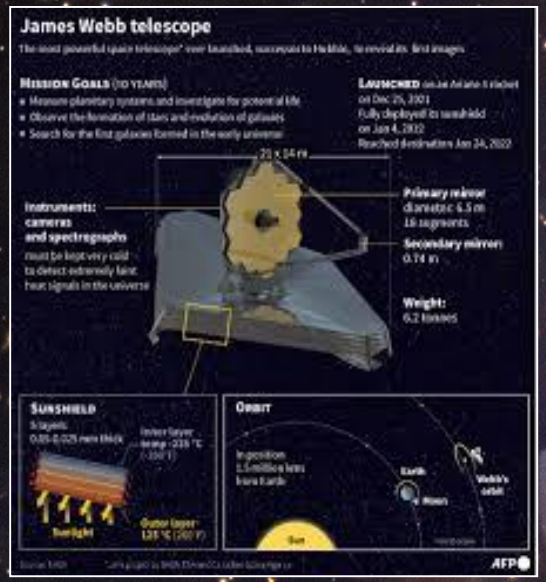
CIEMAT, IFAE, ICE-CSIC, IFT

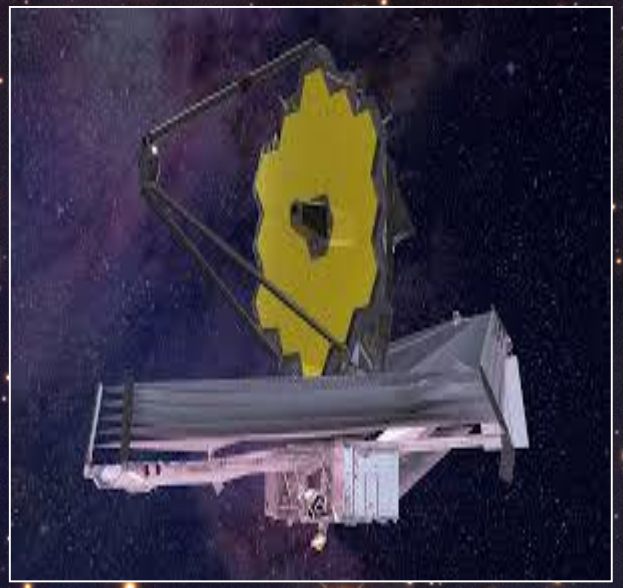
Probing dark energy and dark matter, Inventory of solar system, Exploring transient optical sky, Mapping the Milky Way

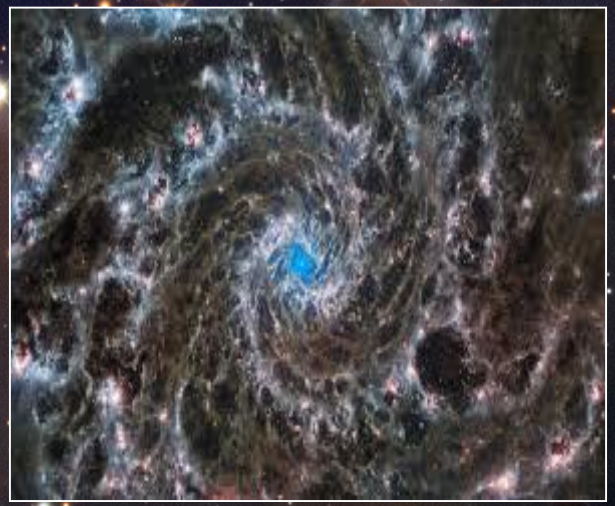




EUCLID SPACE TELESCOPE, L2







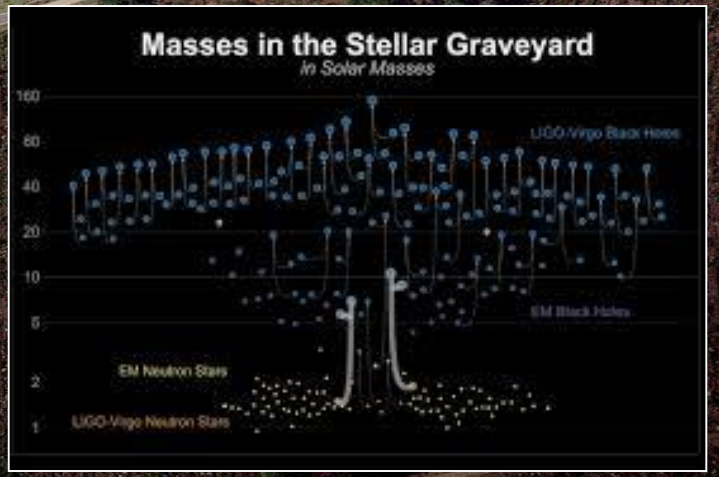
JAMES WEBB SPACE TELESCOPE, L2

LIGO-VIRGO / GRAVITATIONAL WAVES

ALICIA SINTES, UNIVERSIDAD ISLAS BALEARES (1997)

HANFORD (WASHINGTON) – LIVINGSTON (LUISIANA)

VIRGO (CASCINA)



PARTICIPATION OF SPANISH GROUPS SINCE 2020 (IFAE, CIEMAT, IEEC, ICCUB, IFT, ...)

LIGO-VIRGO / GRAVITATIONAL WAVES

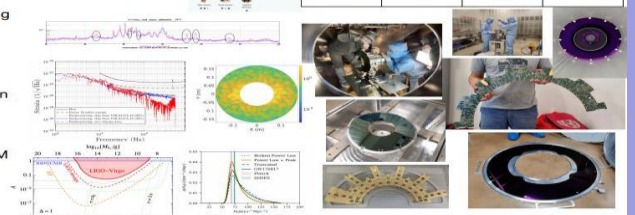
LARCE PARTICIPATION OF SPANISH GROUPS SINCE 2020 (IFAE, ICCUB, CIEMAT, IFT, ...)

IFAE

Joint Virgo in 2018 (10 authors)

- Commissioning & Noise Hunting
- Stray Light Simulations
  - SLC coordination
  - IMC, arms + cryotrap area
  - Parking position SRM design
- Instrumented Baffles
  - IMC instrumented baffle
  - Instrumented baffles for ETM
  - FDS filter cavity baffles
- Computing @ PIC (see slide)
- Physics analysis of LVK data
  - SGWB, CBC, CW, TGR, PBH
  - Deep Learning, etc..

Seniors	PostDocs	PhD students	Engineers Technician
5	4	3+1	~10



	IMC Baffle	FDS baffles	Baffles Phase II
In kind	120k€	20k€	~240k€

ICCUB- Barcelona

Joint Virgo in 2018 (9 authors)

- Data Analysis
- Computing and software engineering
- Hardware
  - Quadrant photodetectors for quantum noise reduction

Seniors	PostDocs	PhD students	Engineers Technician
5	4	3	3

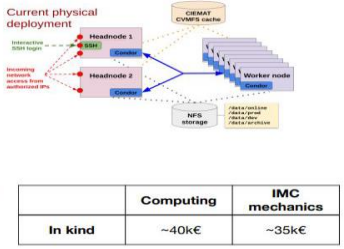
	QPD
In kind	~10k€

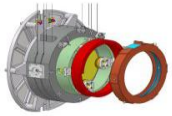
CIEMAT

Joint Virgo in July 2022 (will be 6 authors)

- Computing
  - Low latency cluster for O4 @ CIEMAT & PIC
- Physics analysis
- Hardware
  - Ring heater for IMC mirror

Seniors	PostDocs	PhD students	Engineers Technician
5		0+1	5





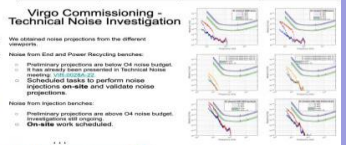
	Computing	IMC mechanics
In kind	~40k€	~35k€

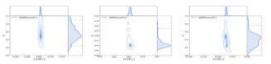
IFT-CSIC/UAM

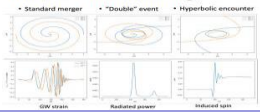
Joint Virgo in 2021 (5 authors)

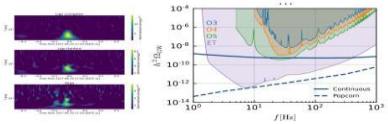
- Commissioning & Noise hunting
  - Scattered light noise from viewports
- Physics Analysis
  - pBHs, SGWB, CHEs
  - Deep Learning, etc..
- Theoretical Modeling

Seniors	PostDocs	PhD students	Engineers Technician
4	1	3	—







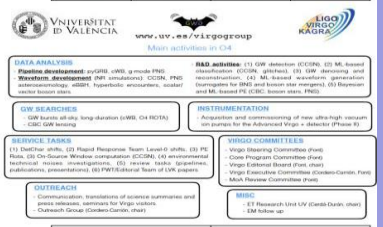


University of Valencia

Joint Virgo in 2016 (10 authors)

- Commissioning
- Data Analysis
- Waveform developments
- Outreach
- Hardware Contribution
  - ultra-high vacuum ion pumps for the AdV+

Seniors	PostDocs	PhD students	Engineers Technician
5	2	5	—



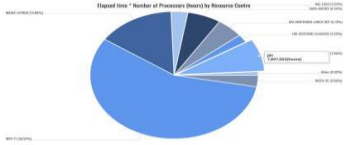
	UHV ion pumps
In kind	~200k€

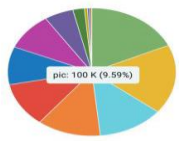
Computing

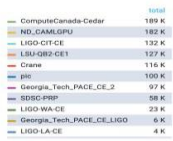
Notes on July 2019 - June 2023 performance

- Our LHC Tier1 Center (PIC) consistently provided opportunistic resources to LVK in a significant way
  - CPU: 7.9M CPUhrs. (2019 - 2023, 4y) 8% of total LVK
  - GPU: 95K CPUhrs (2021 - 2023, 3y) 10% LVK
  - Altogether this is about 40K€/year (Amazon Cloud)

	CPU 0.01€/h	GPU 0.6 €/h
Amazon Cloud Equivalent	~80k€	~57k€



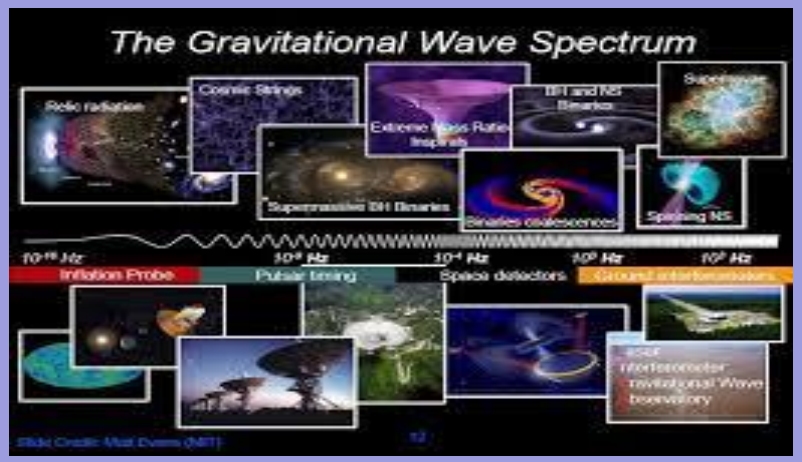


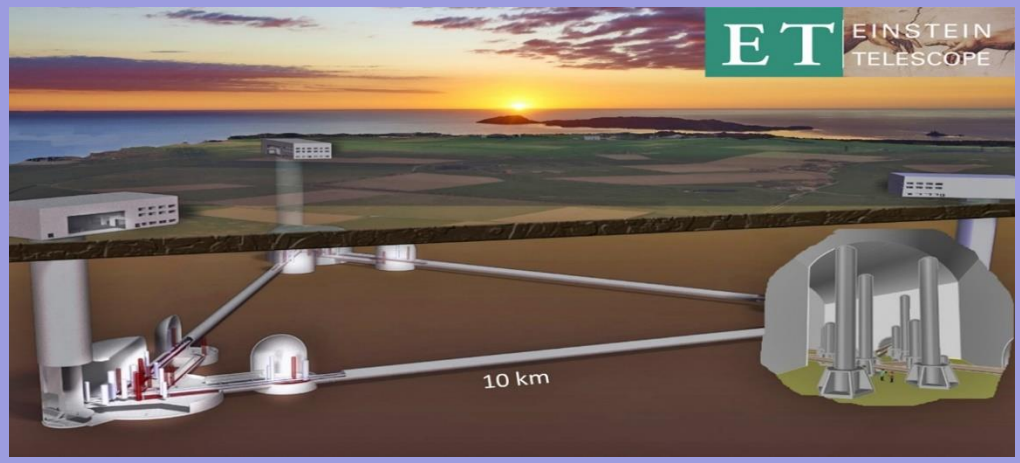


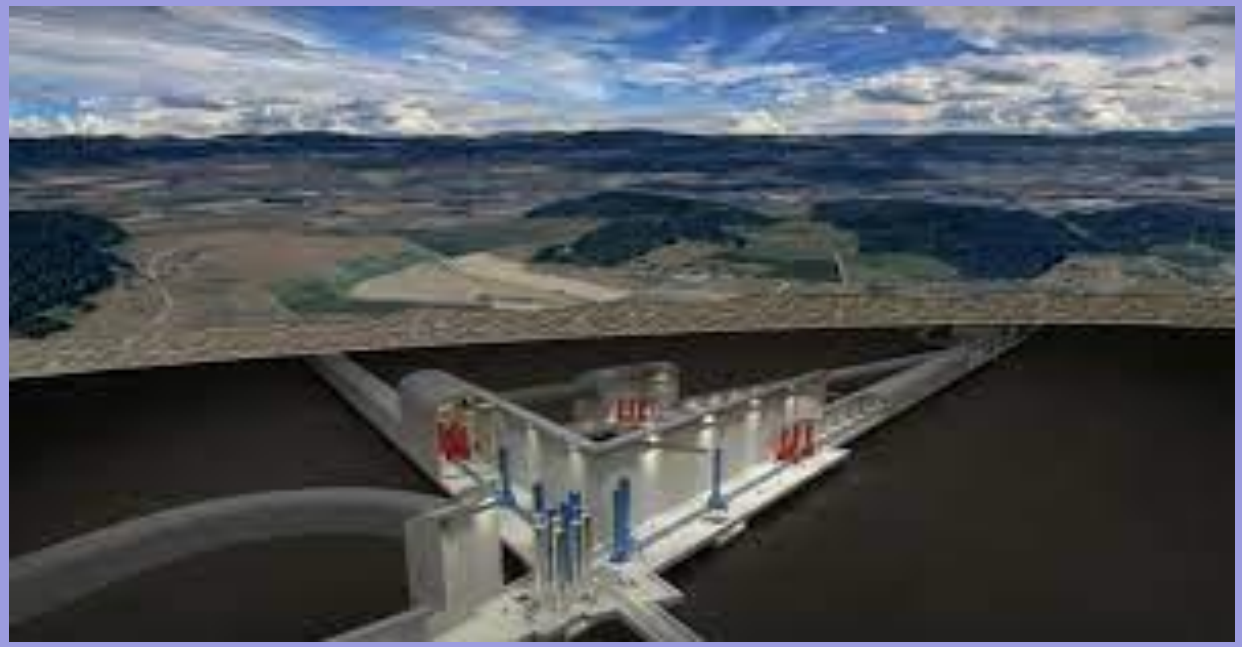
Mario Martínez-Pérez

The Einstein Telescope Project

GRAVITATIONAL WAVES EINSTEIN TELESCOPE







GRAVITATIONAL WAVES EINSTEIN TELESCOPE

CIEMAT-FP	CIEMAT	5
CSIC	CSIC IAA-CSIC ICE-CSIC & IEEC IEM-CSIC IFIC-CSIC & UV IFCA-CSIC & UC	30
ET - IFT Madrid	IFT-Madrid	7
ICCUB-Barcelona	ICCUB	21
Institut de Fisica d'Altes Energies	ICREA IFAE-Barcelona	21
IPARCOS-UCM	CENTRA IPARCOS-UCM AEI UCM	20
GRAVITY-UIB	GRAVITY-UIB	16
University of Valencia ET	UV	25
USAL-Fundamental Physics: Astrophysics and Cosmology	IUFFyM USAL	7

NEUTRINO PHYSICS

K2K - T2K, DOUBLE CHOOZ, NEXT-LSC, DUNE, HYPER-K

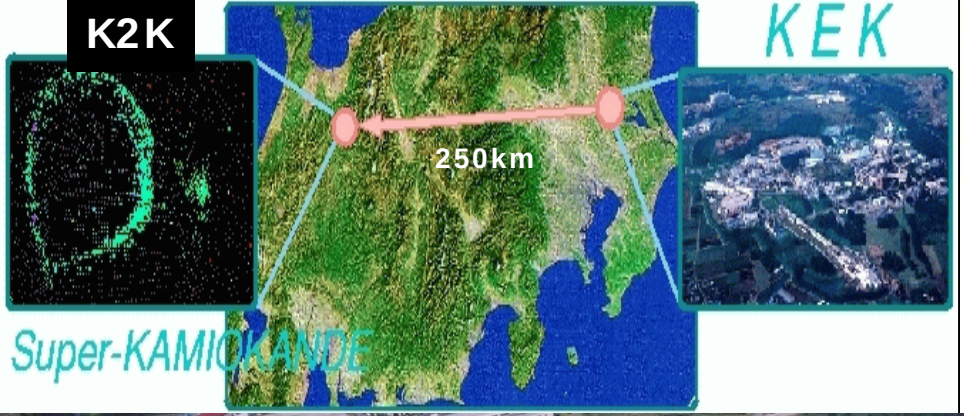
MASSES, MIXING ANGLES, CP VIOLATION

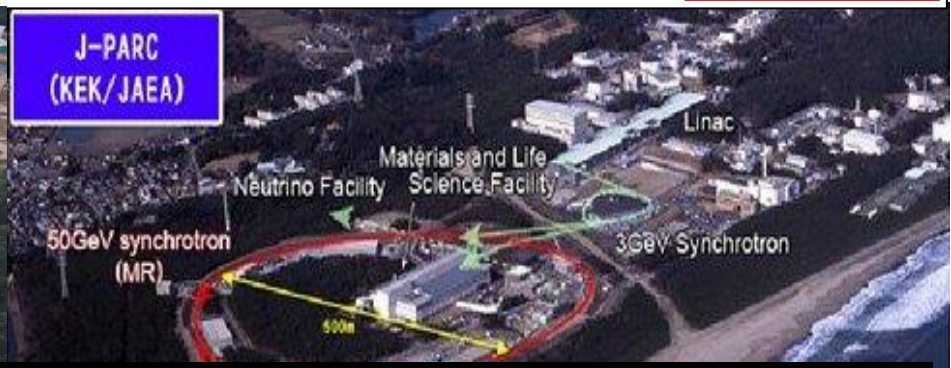
Pontecorvo-Maki-Nakagawa-Sakata Matrix

$$\begin{bmatrix} 1 & 0 & 0 \\ 0 & c_{23} & s_{23} \\ 0 & -s_{23} & c_{23} \end{bmatrix} \begin{bmatrix} c_{13} & 0 & s_{13}e^{-i\delta_{CP}} \\ 0 & 1 & 0 \\ -s_{13}e^{i\delta_{CP}} & 0 & c_{13} \end{bmatrix} \begin{bmatrix} c_{12} & s_{12} & 0 \\ -s_{12} & c_{12} & 0 \\ 0 & 0 & 1 \end{bmatrix}$$

$$= \begin{bmatrix} c_{12}c_{13} & s_{12}c_{13} & s_{13}e^{-i\delta_{CP}} \\ -s_{12}c_{23} - c_{12}s_{23}s_{13}e^{i\delta_{CP}} & c_{12}c_{23} - s_{12}s_{23}s_{13}e^{i\delta_{CP}} & s_{23}c_{13} \\ s_{12}s_{23} - c_{12}c_{23}s_{13}e^{i\delta_{CP}} & -c_{12}s_{23} - s_{12}c_{23}s_{13}e^{i\delta_{CP}} & c_{23}c_{13} \end{bmatrix}.$$

DIRAC vs MAJORANA, STERILE, ...

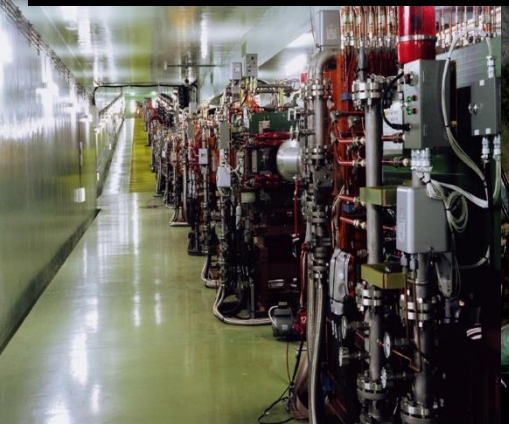




K2K (KEK-to-KAMIOKA) - T2K (TOKAI-to-KAMIOKA)

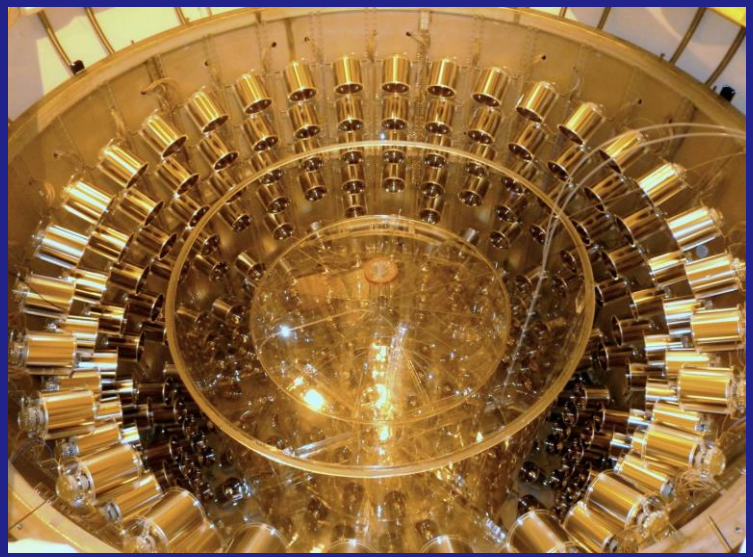
Long baseline Neutrino Oscillations Experiments

(2002) IFAE, IFIC



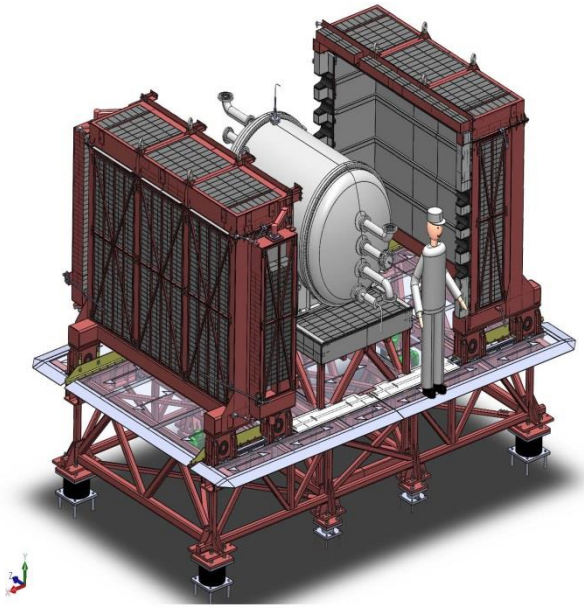
DOUBLE CHOOZ (2006) CIEMAT

First determination of the θ_{13} mixing angle



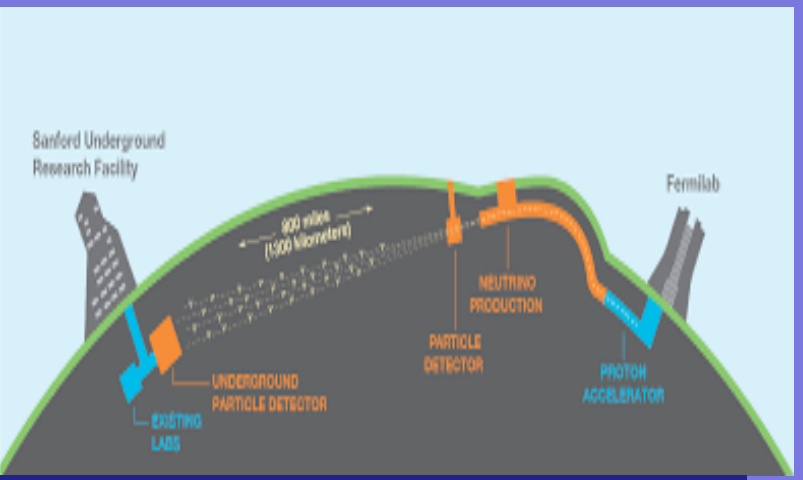
NEXT-LSC (2000)

IFIC, U. ZARAGOZA

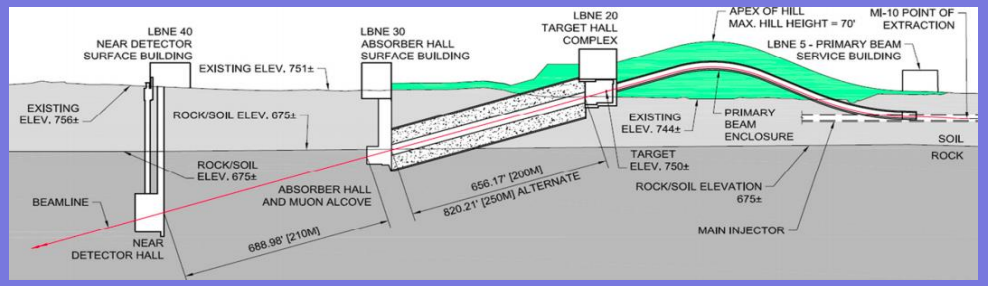


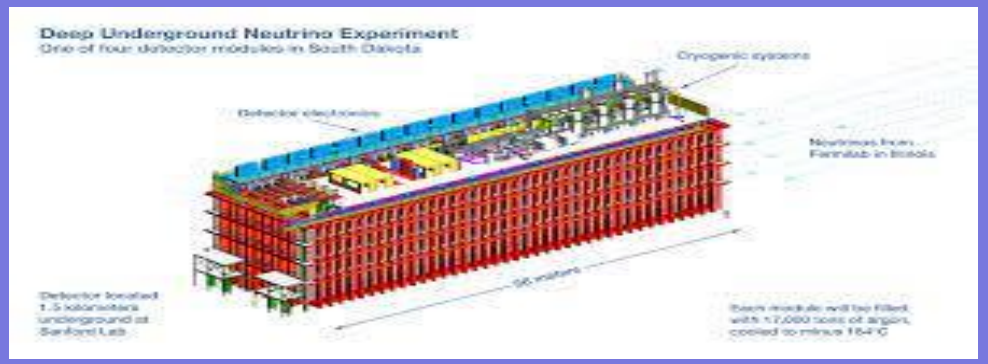
Neutrino Less Double Beta Decay

DUNE
Deep Underground Neutrino Experiment
CIEMAT, IFIC, U. GRANADA



40 kilotons of liquid Argon





DUNE
Deep Underground Neutrino Experiment

- **Investigation of neutrino oscillations to test CP violation in the lepton sector, which explores why the universe is made of matter.**

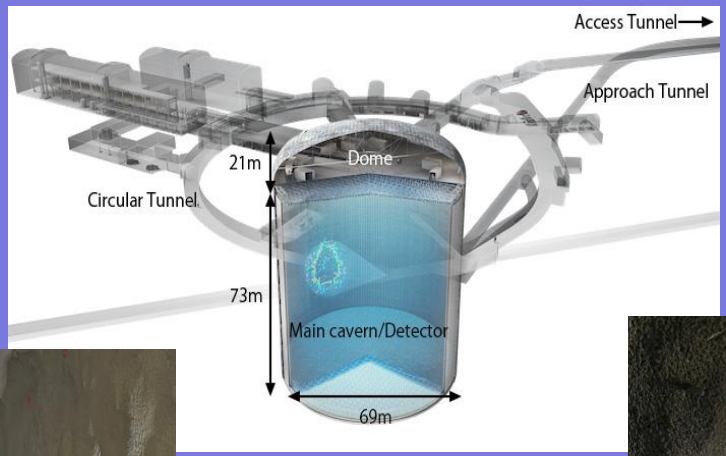
- **Determination of the ordering of the neutrino masses.**

- **Studies of supernovae and the formation of a neutron star or black hole, even though the detector is 1,490 meters (0.93 mi) deep underground with no direct view of the sky.**

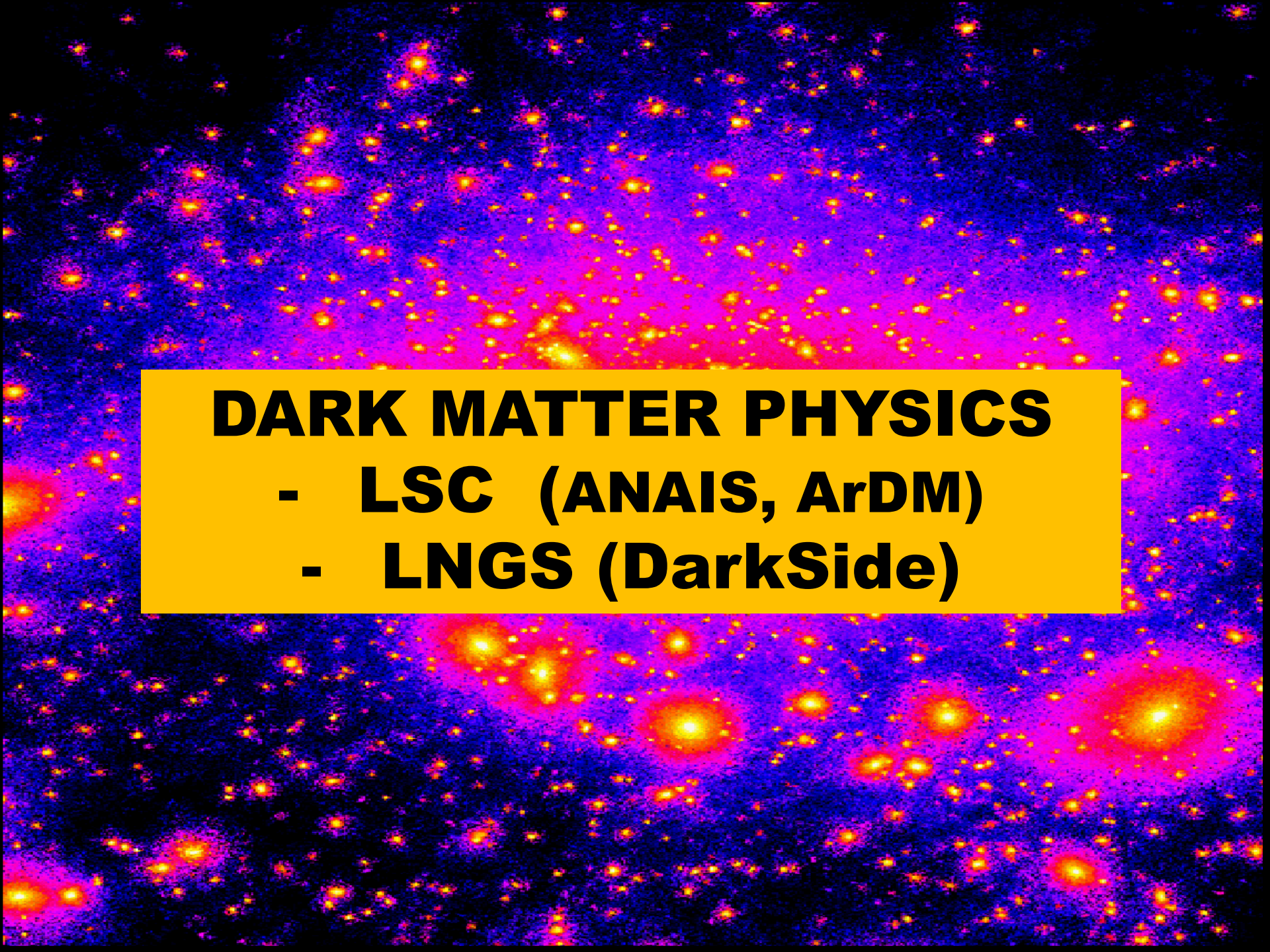
- **Search for proton decay, which has never been observed but is predicted by theories that unify the fundamental forces.**

HYPER SUPERKAMIOKANDE

UAM / University Autonóma Madrid, IFT, UAM/CSIC



Water mass: 260.000 tons; Fiducial mass: 190.000 tons
~ 40.000 50 cm photomultipliers


DARK MATTER PHYSICS
- LSC (ANAIS, ArDM)
- LNGS (DarkSide)

ANAIS (1996) U. ZARAGOZA

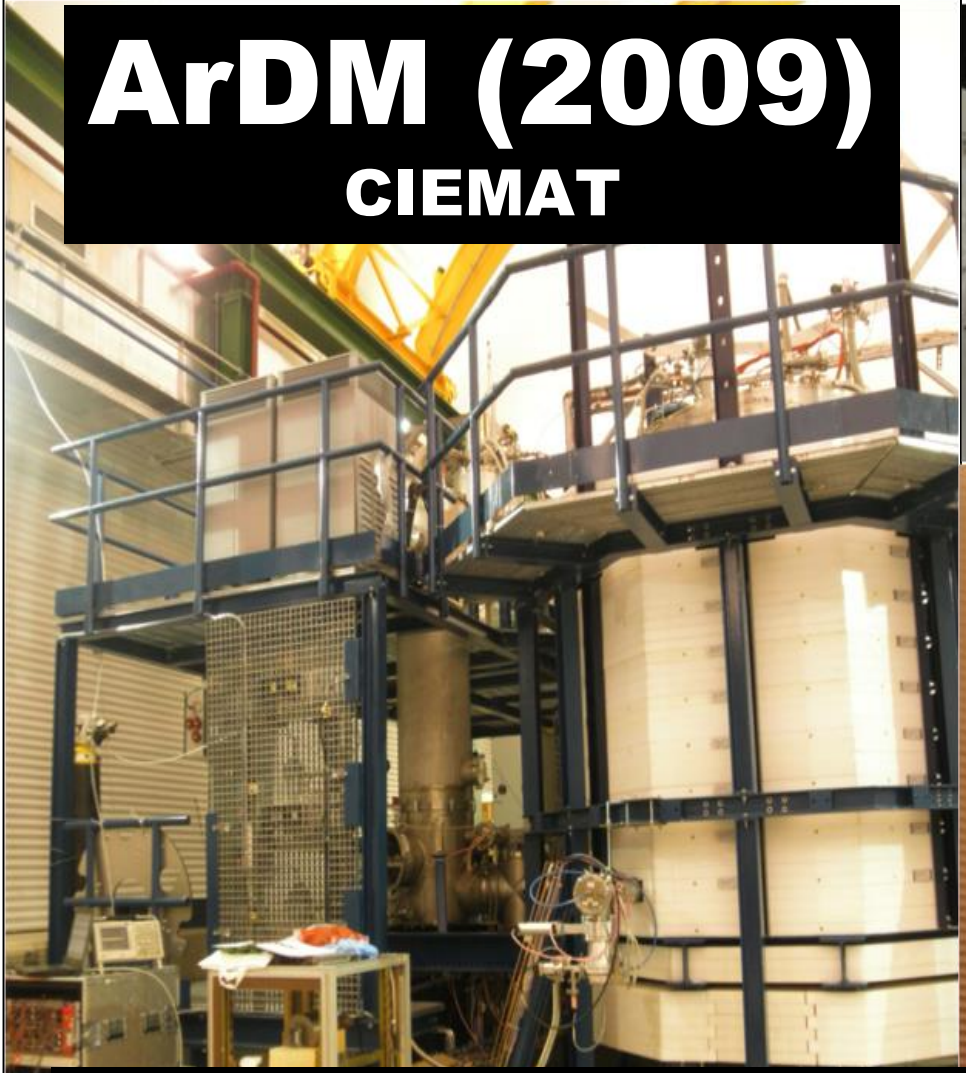
Annual Modulation of the expected interation rates in a target of sodium iodide (112,5 kg of NaI(TI)) crystals

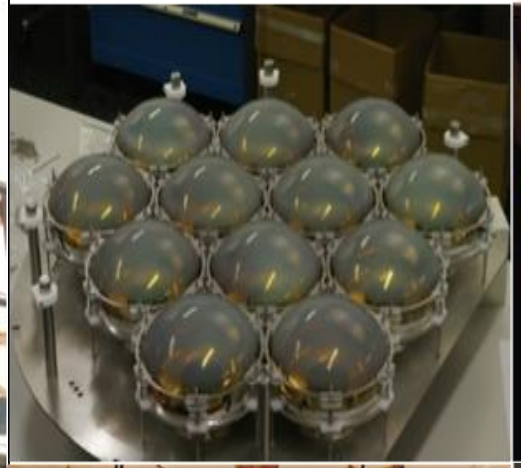
DAMA/LIBRA experiment at Gran Sasso Underground Laboratory has reported the presence of modulation in its data with a high statistical significance

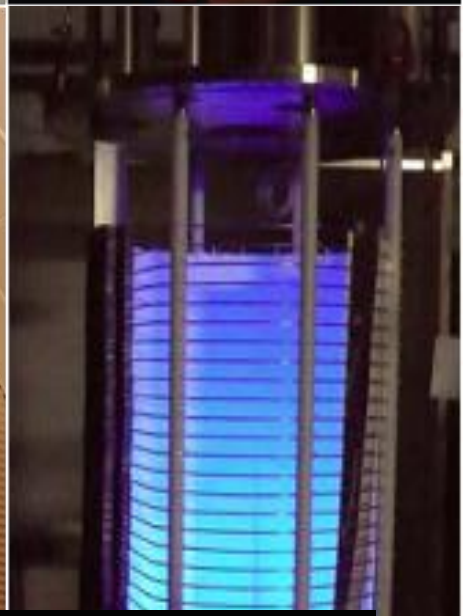
DAMA/LIBRA result is at reach , by ANAIS, with 3 sigmas of significance in 5 years of data

ANAIS preliminary data does not seem to confirm the DAMA/LIBRA results

ArDM (2009)
CIEMAT





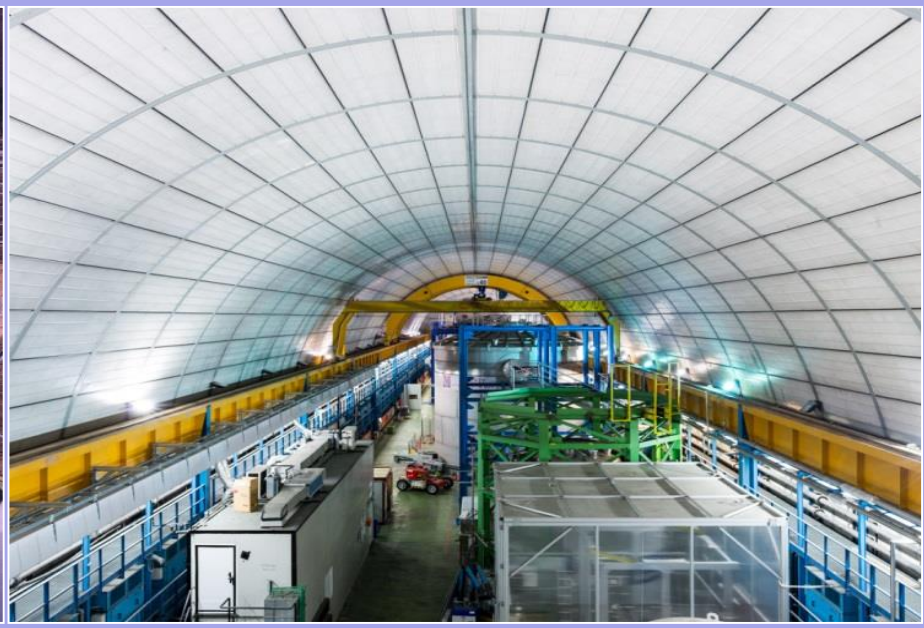


Global Argon Dark Matter Collaboration (GADMC)

Radiopure LAr target obtained from the low-radioactivity argon naturally depleted in ^{39}Ar

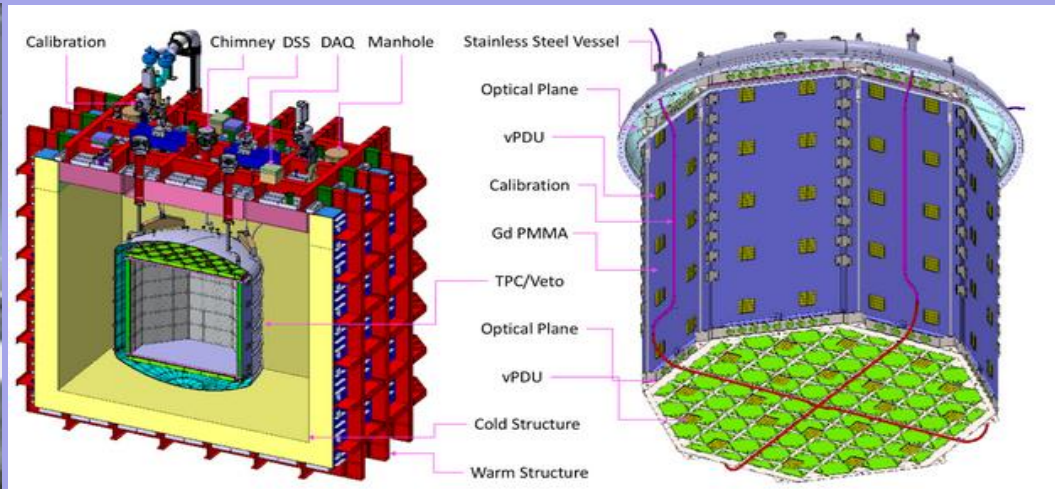
ArDM, DarkSide-50, DEAP-3600, MiniCLEAN, DarkSide-20k, ARGO

LABORATORI NAZIONALE DEL GRAN SASSO

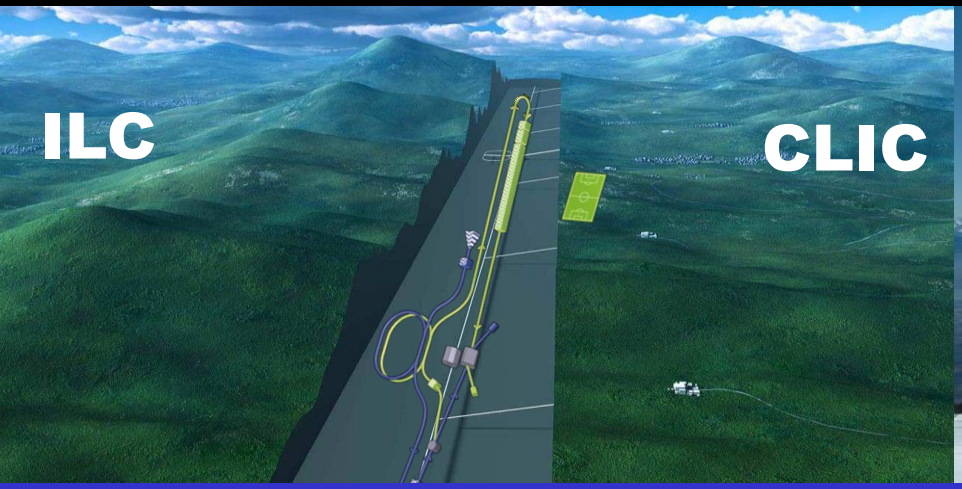


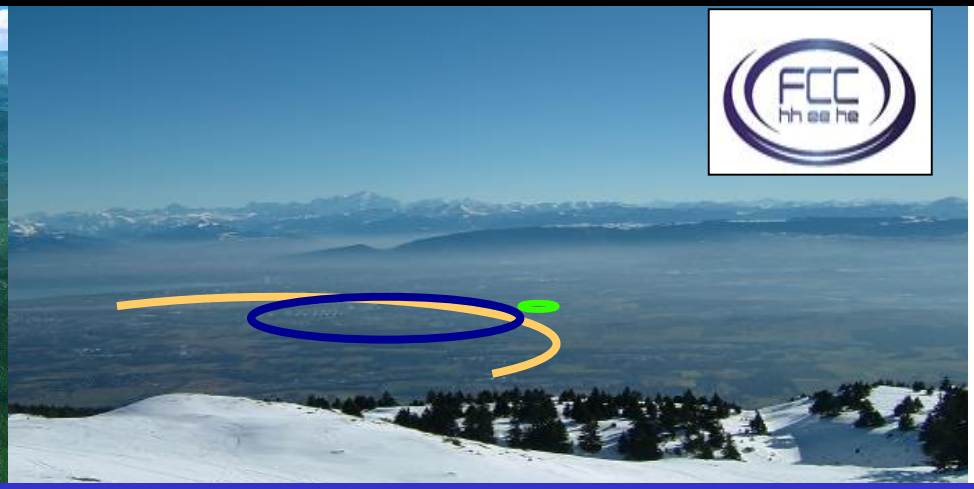
DarkSide-50

DarkSide-20k



R&D FUTURE DETECTORS&COLLIDERS





- DEPFET (IFIC, IFCA, UB, IMB-CNM, USC, ITA)
- CALICE (CIEMAT)

- ILC, ATF-ATF2 (IFIC, IFCA, UB, IMB-CNM, USC, ITA)
  - BEAM DYNAMICS, INSTRUMENTATION, BPM
  - MAGNET PACKAGE FOR ILC MAIN LINAC
- CTF3-CLIC, ILC (CIEMAT)
  - QUADRUPOLE MOVER, PETS, ORBIT CORRECTORS, KICKERS, SEPTA
  - MAGNET PACKAGE FOR ILC MAIN LINAC
- FCC (CIEMAT)
  - AMBITIOUS R&D MAGNET PROGRAM (HIGH FIELD MAGNETS)

WHERE WE STAND

“MODERATE” SUCCESS

- RELEVANT PARTICIPATION IN THE MOST IMPORTANT AREAS OF THE CERN EXPERIMENTAL PROGRAM AND IN OTHER INTERNATIONAL PROGRAMS (DESY, FERMILAB, SLAC, KEK, LNGS …)
- DIVERSIFICATION (COSMIC-RAYS, NEUTRINOS, COSMOLOGY, …)
- ATTRACT & COLLABORATE WITH MANY INDUSTRIAL COMPANIES
- TRAINING OF HUNDREDS OF SCIENTISTS, ENGINEERS, TECHNICIANS

THE KEY FOR "MODERATE" SUCCESS

RELEVANT INSTITUTIONAL INITIATIVES AT THE NATIONAL LEVEL

- 1984: HEP NATIONAL PROGRAM
- 2011: SEVERO OCHOA PROGRAM
- 2007: CONSOLIDER PROJECTS
- 2007: CPAN-CENTRE FOR PARTICLE, ASTROPARTICLE AND NUCLEAR PHYSICS (DOMENEC ESPRIU, ANTONIO PICH, MARCOS CERRADA)
- 2023: CPAN-CENTRE FOR PARTICLE, ASTROPARTICLE AND NUCLEAR PHYSICS (MARÍA JOSÉ COSTA, CARLOS SALGADO)

LARGEST CONCERN

VERY FEW NEW POSITIONS FOR RESEARCHERS WITH EXCELLENT SCIENTIFIC CAREERS

DANGER OF LOSING VERY HIGH QUALITY HUMAN RESOURCES

IRRETRIEVABLE LOSS OF OUR MOST PRECIOUS PATRIMONY

HUGE DAMAGE

PENDING ISSUES

- STRENGTHEN COORDINATION
- ENFORCE PRIORITIZATION
- IMPROVE MANAGEMENT
- FIGHT BUREAUCRACY

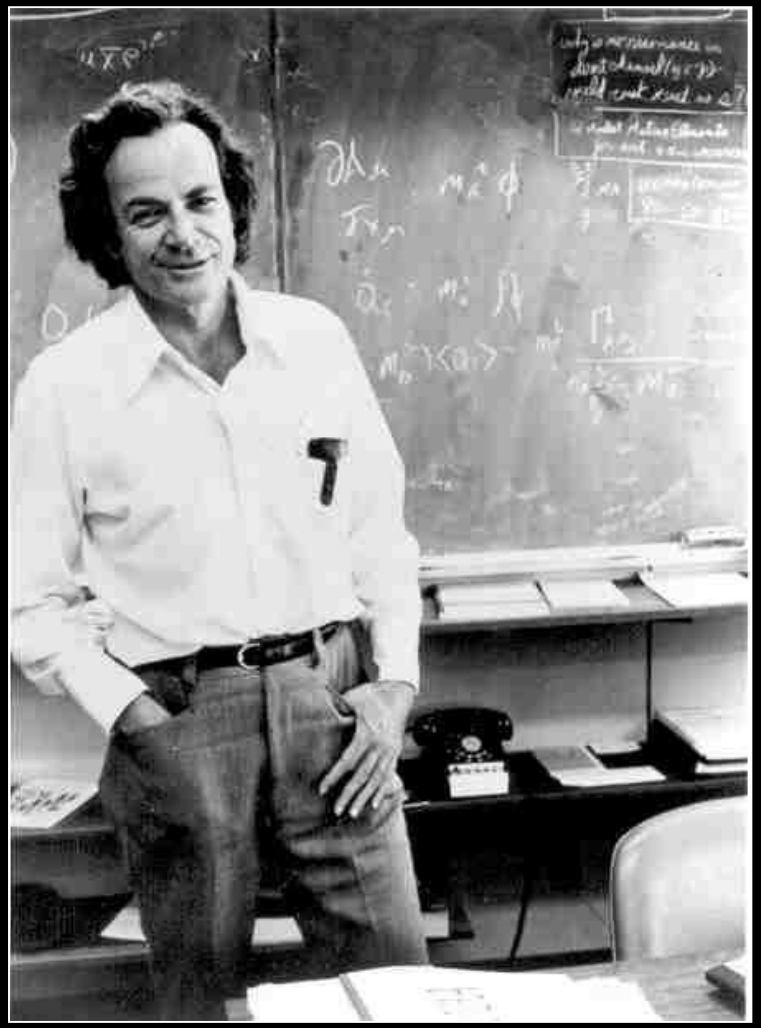
CPAN

MUST BE CONSOLIDATED

HEP 1973-2023

SUMMARY

THE AGE IN WHICH WE LIVE IS THE AGE IN WHICH WE ARE DISCOVERING THE FUNDAMENTAL LAWS OF NATURE, AND THAT DAY WILL NEVER COME AGAIN (1970's)



R.P. FEYNMAN

MAJOR DISCOVERIES / INVENTIONS 1973-2023

- 1973. DISCOVERY OF ASYMPTOTIC FREEDOM (Theory)
- 1973. DISCOVERY OF THE NECESSITY OF AT LEAST THREE FAMILIES (Theory)
- 1973. DISCOVERY OF WEAK NEUTRAL CURRENTS (CERN)
- 1974. DISCOVERY OF THE CHARM QUARK (BNL, STANFORD)
- 1975. DISCOVERY OF THE TAU LEPTON (STANFORD)
- 1977. DISCOVERY OF THE GLUONS (DESY)
- 1979. DISCOVERY OF THE BEAUTY QUARK (FERMILAB)
- 1983. DISCOVERY OF THE $W^{\pm}$ AND Z BOSONS (CERN)
- 1987. DISCOVERY OF COSMIC NEUTRINOS (HOMESTAKE, KAMIOKANDE)
- 1989. INVENTION OF WORLD WIDE WEB (WWW) (CERN)
- 1989. DETERMINATION OF THE NUMBER OF NEUTRINOS (CERN)
- 1994. DISCOVERY OF EW RADIATIVE CORRECTIONS (CERN)
- 1995. DISCOVERY OF THE TOP QUARK (FERMILAB)
- 1998. DISCOVERY OF NEUTRINO OSCILLATIONS (SUPERKAMIOKANDE, SNO)
- 2012. DISCOVERY OF THE HIGGS BOSON (CERN)

MAJOR DISCOVERIES / INVENTIONS 1973-2023

- 1992. DISCOVERY OF CMB ANISOTROPIES (COBE, WMAP, PLANCK)
- 1995. DISCOVERY OF FIRST EXOPLANET
- 2000. DISCOVERY OF THE ACCELERATED EXPANSION OF THE UNIVERSE
- 2000. LAMBDA COLD DARK MATTER MODEL (Theory)
- 2015. DISCOVERY OF GRAVITATIONAL WAVES (LIGO)
- 2018. DISCOVERY OF A SUPERMASSIVE B.H. AT THEE CENTER OF OUR GALAXY
- 2019. FIRST IMAGE OF A B.H. IN THE MESSIER 87 GALAXY (EH TELESCOPE)

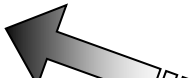
HEP 1973-2023

SUMMARY

THE TRIUMPH OF THE STANDARD MODEL

Selected NP since 1957

Standard Model



Politzer Wilczek Gross Salam Glashow Weinberg Veltman 't Hooft







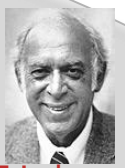




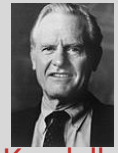








Reines Steinberger Schwartz Lederman Ting Rubbia van der Meer Fitch Cronin Friedman

Hofstadter Kendall









Perl Schwinger Feynman Richter Gell-Mann Alvarez Taylor Yang Lee

Englert Higgs







Davis Tomonaga Nambu Kobayashi Maskawa Kajita McDonald Koshiba

Technicolor

New (strong) interactions produce EWSB

Extensions of the SM gauge group :

Little Higgs / GUTs / ...

Supersymmetry

New particles at ≈ TeV scale. Light Higgs. Unification of forces. Higgs mass stabilized.

No new interactions.

Extra Dimensions

New dimensions introduced

$m_{Gravity} \approx m_{elw}$

Hierarchy problem solved

New particles at ≈ TeV scale

Successful for ever ??

DIFFICULTIES
CONCEPTUAL & OBSERVATION

- NATURALNESS, HIERARCHY, MASS ORIGIN, ...
- NEUTRINOS: MIXING, MASSES, ORDERING, NATURE (???)
- FLAVOUR: 3 GENERATIONS (???), MIXING
- BARYOGENESIS: MATTER – ANTIMATTER ASYMMETRY (???)
- DARK MATTER, DARK ENERGY

In a decade or two, we can hope to . . .

- Understand electroweak symmetry breaking
- Observe the Higgs boson
- Measure neutrino masses and mixings
- Establish Majorana neutrinos ($\beta\beta_{0\nu}$)
- Thoroughly explore CP violation in B decays
- Exploit rare decays (K, D, . . .)
- Observe neutron EDM, pursue electron EDM
- Use top as a tool
- Observe new phases of matter
- Understand hadron structure quantitatively
- Uncover the full implications of QCD
- Observe proton decay
- Understand the baryon excess
- Catalogue matter and energy of the universe
- Measure dark energy equation of state
- Search for new macroscopic forces
- Determine GUT symmetry
- Detect neutrinos from the universe
- Learn how to quantize gravity
- Learn why empty space is nearly weightless
- Test the inflation hypothesis
- Understand discrete symmetry violation
- Resolve the hierarchy problem
- Discover new gauge forces
- Directly detect dark-matter particles
- Explore extra spatial dimensions
- Understand the origin of large-scale structure
- Observe gravitational radiation
- Solve the strong CP problem
- Learn whether supersymmetry is TeV-scale
- Seek TeV-scale dynamical symmetry breaking
- Search for new strong dynamics
- Explain the highest-energy cosmic rays
- Formulate the problem of identity

. . . learn the right questions to ask . . .

. . . and rewrite the textbooks!

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. . . learn the right questions to ask . . .

. . . and rewrite the textbooks!

HEP 1973-2023

SUMMARY / PERSPECTIVES

PREDICTING IS VERY DIFFICULT, IN PARTICULAR ABOUT THE FUTURE,

Niels Bohr

IT IS ALREADY PRETTY HARD TO KNOW THE PAST; IT WILL BE UNBEARABLE TO KNOW THE FUTURE,

William Somerset Maughan

HEP 1973-2023

SUMMARY / PERSPECTIVES

EUROPEAN STRATEGY FOR PARTICLE PHYSICS UPGRADE

- JULY 2006, LISBOA
- MAY 2013, BRUSELAS
- JUNE 2020, CERN

HEP 1973-2023

EUROPEAN STRATEGY FOR PARTICLE PHYSICS UPGRADE

MAIN CONCLUSION

THE MOST PRECISE STUDY OF THE HIGGS PROPERTIES IS THE HIGHEST PRIORITY, BEING THE FCC, WHICH WILL NOT OPERATE BEFORE 2048, THE PREFERED INFRASTRUCTURE.

HEP 1973-2023

EUROPEAN STRATEGY FOR PARTICLE PHYSICS UPGRADE

NAIVE QUESTION

¿DO WE BELIEVE THAT, IN THE SECOND HALF OF THE XXI CENTURY, THE STUDY OF THE HIGGS PROPERTIES WILL REMAIN THE MOST RELEVANT SCIENTIFIC ISSUE IN THE HEP FIELD?

IF YES, WE HAVE A PROBLEM
IF NOT, WE HAVE A HARDER PROBLEM

CANDID APPRAISAL

- CERN MEMBERSHIP HAS BEEN A WONDERFUL OPPORTUNITY FOR SPANISH SCIENCE, NOT ONLY FOR PARTICLE PHYSICS. EDUCATION IN GENERAL, INDUSTRY AND INNOVATION HAVE ALSO GREATLY PROFITTED FROM IT.

- CERN HAS ALSO PROFITTED FROM HAVING SPAIN AMONG ITS MEMBER STATES, NOT ONLY FOR FINANCIAL REASONS. THE ADVENT OF A HIGHLY MOTIVATED, COMPETITIVE AND WELL TRAINED COMMUNITY IS AN IMPORTANT ASSET FOR THE FUTURE OF THE ORGANISATION.

FINAL REMARKS

- WE ARE GOING THROUGH DIFFICULT TIMES
- REFRAIN FROM DREAMING (.. WHEN THE NIGHT IS LONG ..)
- TRY HARDER
- MAINTAIN CREDIBILITY (PRIORITIES & SCHEDULES & COSTS & EXPENSES, etc.)
- EDUCATE SOCIETY ON THE TRUE VALUE OF BASIC RESEARCH

EVERYTHING SHOULD BE MADE AS SIMPLE AS POSSIBLE, BUT NOT SIMPLER

ALBERT EINSTEIN, 1955


THANKS