Activities in Particle Physics at IFIC (Universitat de València – CSIC)

Juan A. Fuster Verdú

RECFA Meeting at Barcelona, March 29-30, 2003

IFIC means Institut de Física Corpuscular

The Institut belongs to two Main Parent Institutions

Offices and adminstration

Laboratories

UVEG
Universitat de València
- **FAMN**
- **Theoretical Physics**

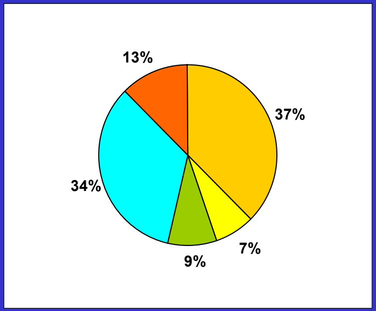
CSIC
Consejo Superior de Investigaciones Científicas
(The Spanish Research Council)

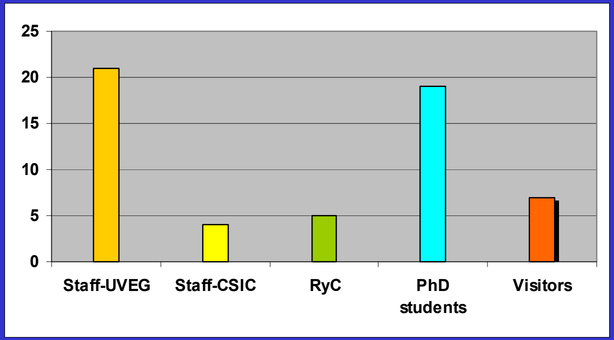
It is structured in:
- **Research Departments:** Theory and Experiment
- **General Services Support:** Adminstration, Computing, Electronics, Mechanics and Maintenance.

IFIC, The Institute

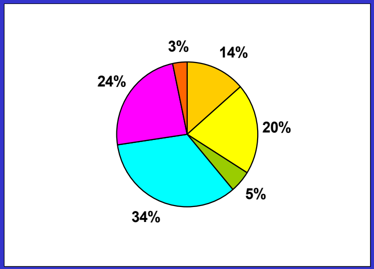
- Personnel
- Research Summary
- Infraestructure

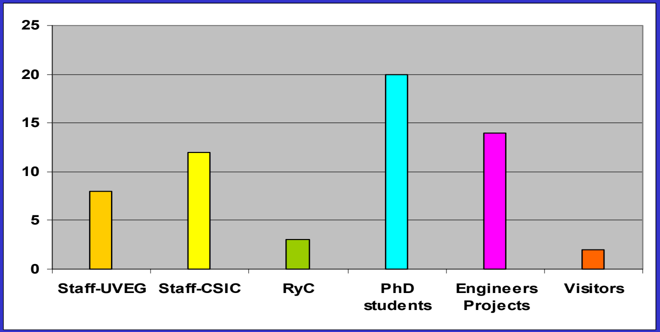
Personnel



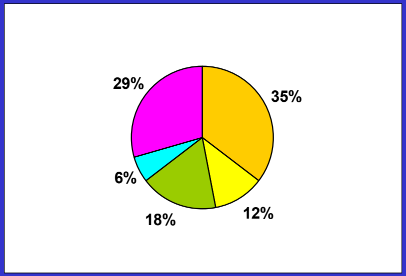


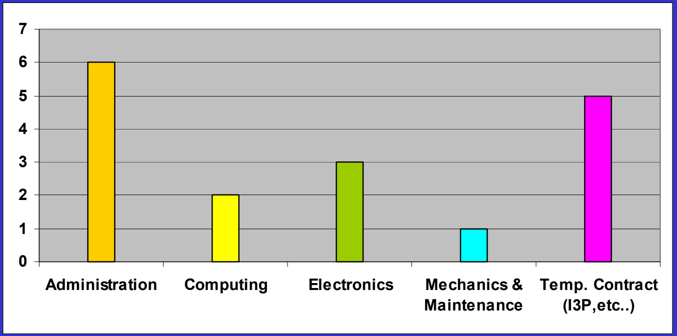
Theoretical Department
56 members





Experimental Department
59 members

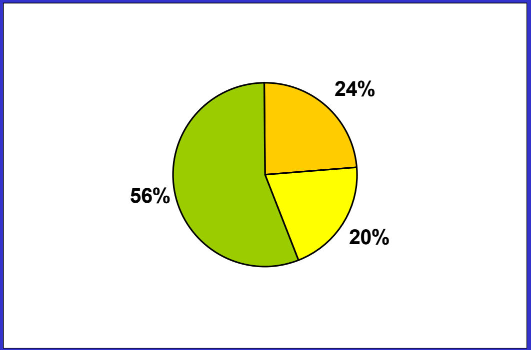


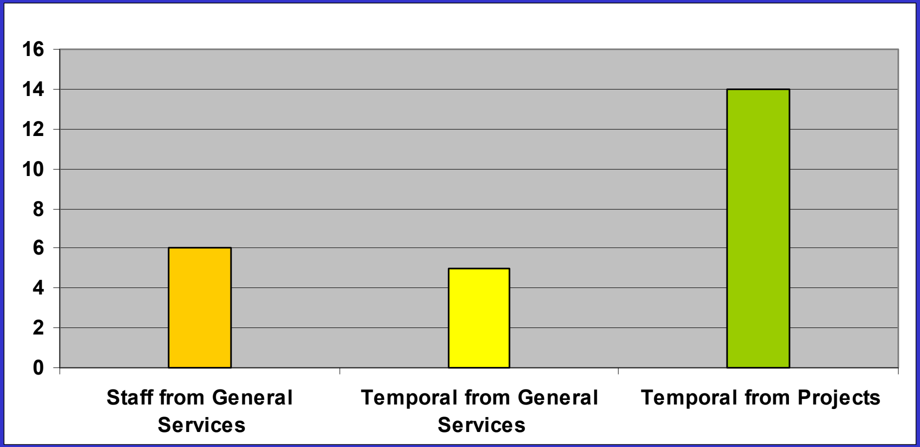


General Services Support
17 members

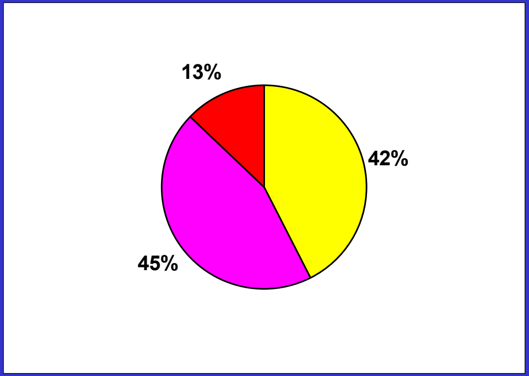
Personnel

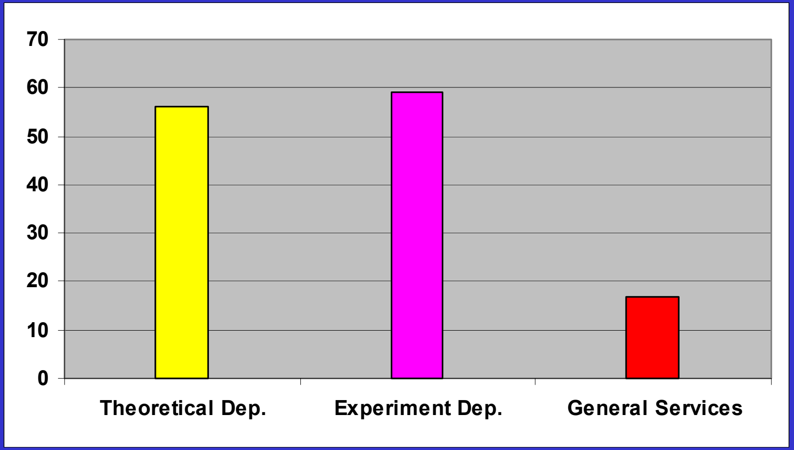
Summary for Technical Support
25 members





Summary for total Personnel at IFIC
132 members





Research (2000-2001)

	2000	2001
International Publications	185	139
Theses	10	11
New PhD students	9	12
Projects PN	10	19
Projects PGC	12	5
Projects GVA	12	8
Projects UE	7	8
International Cooperations	15	13

PN: Programa Nacional; PGC:Programa General del Conocimiento; GVA: Generalitat Valenciana; EU: Unión Europea

Total budget managed by IFIC during 2001:

CSIC 432,9 Mpts (2.6 Meuros)

UVEG 199,8 Mpts (1,2 Meuros)

Infraestructure: Labs

- Potential surface available in the lab building is 3000 m^2 . Only 2/3 have been built at present.
- It contains:
  - Offices for people: physicists, engineers, technicians
  - Computing Center: 100 m^2
  - Electronics lab for general services: 120 m^2
  - Hall for mechanics workshop and material storage: 300 m^2
  - Services: 75 m^2
  - Clean room: 80 m^2
  - Labs for projects: LHC, Antares, Nuclear, Medical Applications,R&D, etc..

Infraestructure for the Computer Center

Provides computing services to the IFIC experiments, research scientists and personnel

In numbers:

- **+450 registered entities in the domain ific.uv.es**
- **+150 desktop PC's running Linux/Windows**
- **11 departmental printers**

Central Services:

- **Main Web and Mail Server**
- **Software repository**
- **Printing services**
- **Software and Hardware maintenance**
- **Backup service**

Infraestructure for the computer center

Computing room:

- ➢40 KW air-cooling system
- ➢ 30 KVA UPS (30 min)

Network:

- ➢ Gigabit Ethernet backbone
- ➢ 100 Mbps to computers

AFS:

- ➢ Cell ific.uv.es
- ➢ 200 GBytes of RAID 5 disks

Farms:

- ➢ GOG: 134 pc's Athlon 1.2GHz
- ➢ NPQCD: 5 pc's Dual Xeon 2GHz
- ➢ BEE: 5 pc's Athlon 1.2 Ghz
- ➢ GCHIRAL: 5 pc's Athlon 1.5 Ghz

Infraestructure: Electronics and Mechanics

Mechanics:
- ➢Design of pieces
- ➢Crane 10 Tn

Electronics:
- ➢Card design and fabrication
- ➢Multilayer (8) PCB production facility
- ➢Component assembly
- ➢Programming of PLDs

Infraestructure: Clean Room

- **Clean room with 20 m^2 class 1000 and 55 m^2 class 10.000. Temperature controled within 0.5 ^{0}C and humidity controled within 5% (always below 50%)**
- **Assembling and gluing robot systems with 1-2 μm precision**
- **Metrology system with 0.5 μm precision for module QA**
- **Setup to perform electrical characterization Si detectors**
- **Bonders: 8090 K&S and 1470 K&S**
- **Pull tester**
- **Enviromental chamber**
- **Infrared camera**
- **Module electronic readout systems**
- **Laser and source systems for module QA**

Research Activities

- Theory Department
- Experimental Department

Theory Department Research I

Effective Field Theory

- **EQFT grounds**
- **Chiral perturbation theory**
- **Heavy quark effective theory**
- **Dynamical symmetry breaking**
- **Effective theories and new physics**
- **QFT at finite temperatures**

QCD

- **QCD jets**
- **Tau decays and QCD**
- **Heavy quark masses**
- **Lattice QCD**
- **Quark masses in the lattice**
- **QCD sum rules**

Weak interactions

- **Flavour Dynamics**
- **B-quark physics**
- **CP violation**
- **Electroweak Radiative Corrections**
- **Neutrino Physics**
  - **Neutrino Phenomenology**
  - **Neutrino Mass Models**

Beyond the SM

- **Supersymmetry**
- **String theory**
- **Dual models**
- **Lepton number violation and massive neutrinos**
- **Extra dimensions (b-physics, neutrino masses, GUT in extra dimensions, effect in colliders)**

Theory Department Research II

Astroparticle Physics

- Neutrinos in astrophysics and cosmology
- Compact objects in astrophysics
  - Supernovae
  - Neutron Stars
- Baryogenesis
- Dark matter

Mathematical Physics

- Qyantum gravity
- Symmetries and quantization
  - Gauge theories and anomalies
  - Deformation of symmetries
- Dynamical systems
  - Sympletic integrators
  - Non linear systems
  - Evolution of quantum and classical systems

Hadronic Physics
Many Body Theory

- Hypernuclei
- Nuclear Drell Yan
- Interactions of photons, electrons and neutrinos in nuclei
- Static properties and variation density
- Spectrum of exotics
- Parton distributions
- Bosonization
- Effective theories for nucleons
- Nucleon dynamics
- Nuclear matter
- Quantum liquids

Theory: MCyT Projects

FPA2002-00612 **Interacciones fundamentales y sus implicaciones experimentales**

FPA2001-3031 **Partículas elementales: física de color y sabor**

BFM2002-00568 **Estudios perturbativos y no perturbativos del modelo estándar y sus extensiones**

BFM2002-00345 **Neutrinos en astrofísica y cosmología**

BFM2000-1326 **Física nuclear y de hadrones a energías intermedias**

BFM2001--3563-C02-01 **Modelos hadrónicos, interacciones fundamentales y física nuclear**

BFM2001-0262 **Dinámica de sistemas complejos. Hadrones, núcleos, átomos**

BFM2002-04031-C02-01 **Aspectos cuánticos de agujeros negros**

BFM2002-03681 **Geometría, grupos, teorías de campos y supersimetría**

Experimental Department Research

High Energy Physics

- LEP-Delphi
- LHC-ATLAS:
  - TiCal
  - SCT
  - GRID
- Neutrino Oscillations
- Antares
- BaBar
- Accelerator Physics
- Detector R&D

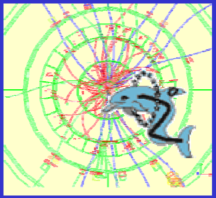
Nuclear Physics

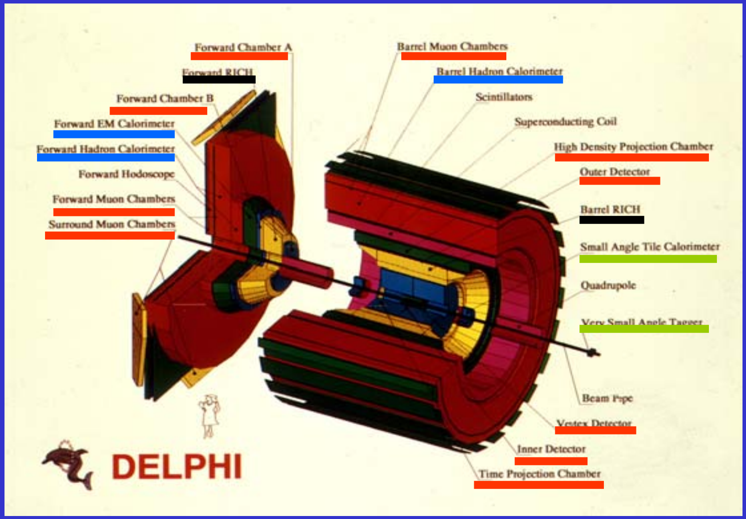
- γ–Spectroscopy
- nTOF
- Hades, TAPS
- Integral

Medical Applications

- Nuclear Medicine
- CIMA

Delphi-Data Analysis

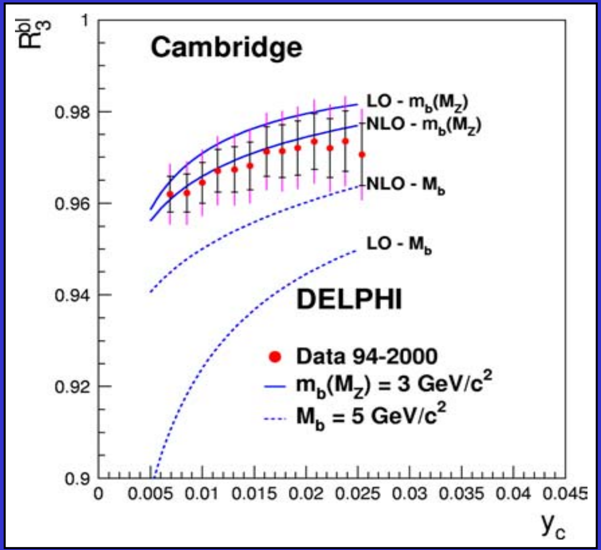


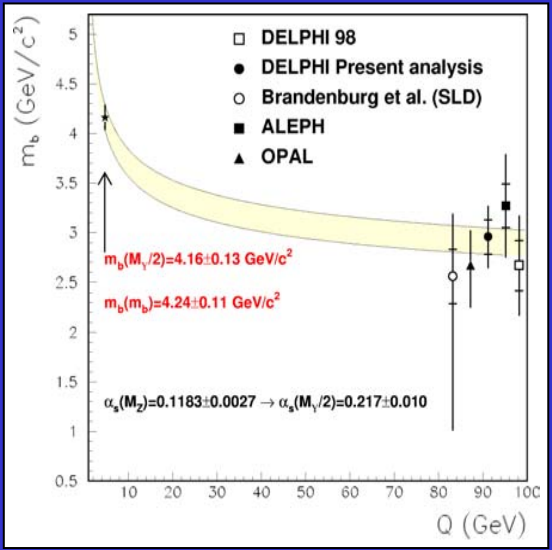


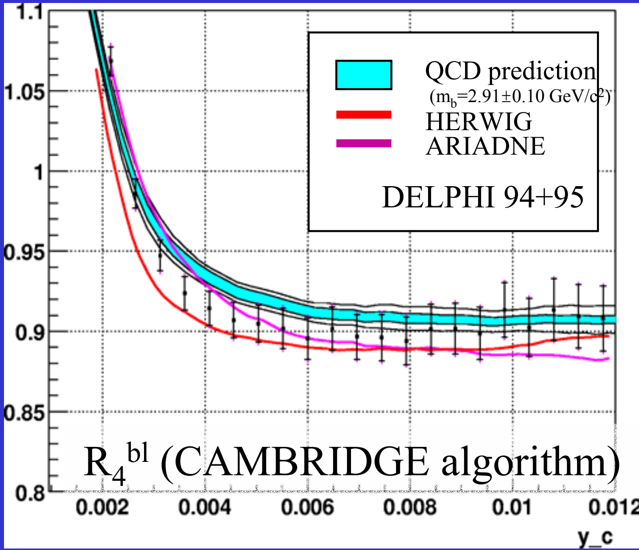
Present work in Delphi involves Data analyses of on-going theses

QCD:

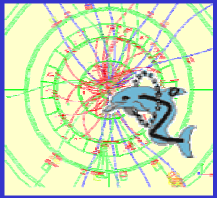
- **Study of generators for b/B production**
- **Multijet production for flavour tagged jets**
- **Flavour independence, m_b@M_Z determinations**







Delphi-Data Analysis



B-Physics:

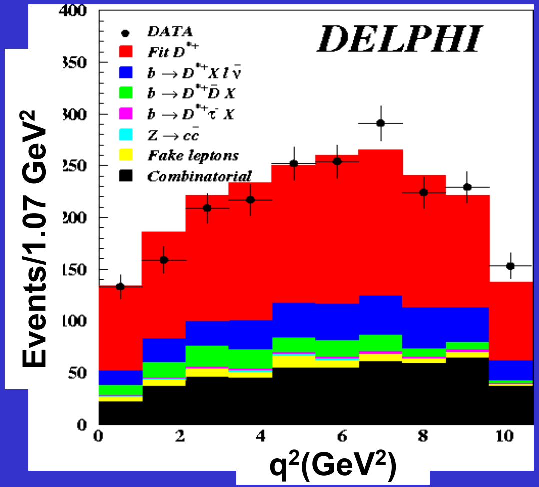
- Semileptonic branching ratios
- V_{cb} measurements

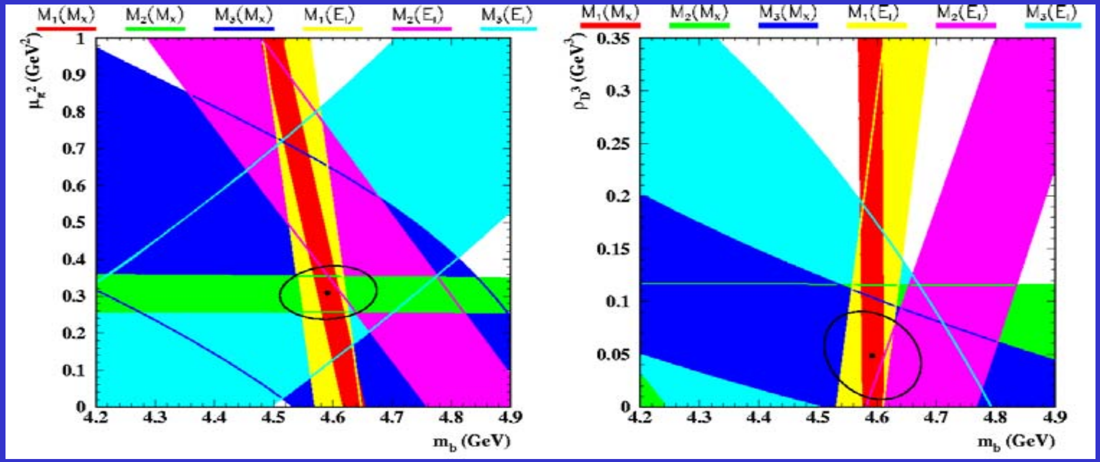
Exclusive B reconstruction

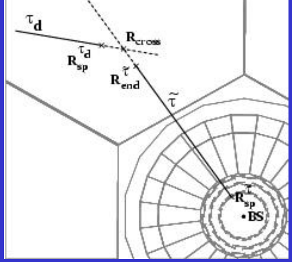
Inclusive B reconstruction

$$|V_{cb}|=0.0418 \pm 0.0020 \pm 0.0023 \pm 0.0017_{F(1)}$$
$$\rho^2 = 1.32 \pm 0.15 \pm 0.33$$
$$BR(\overline{B}^0 \to D^{*+}\ell^-\overline{\nu}_\ell) = (5.54 \pm 0.20 \pm 0.41)\%$$
$$BR(b \to D^{*+}X\ell^-\overline{\nu}_\ell) = (0.64 \pm 0.08 \pm 0.09)\%$$

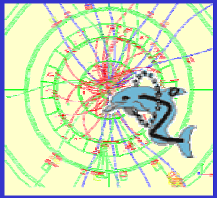
$$|V_{cb}| = 41.9 \times (1 \pm 0.016_{expt} \pm 0.015_{fit.} \pm 0.010_{theo.}) \times 10^{-3}$$







Delphi-Data Analysis



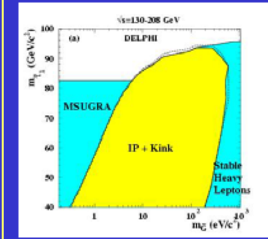
Searches:

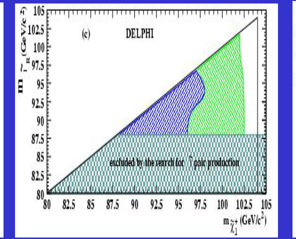
➢ **Search for kinks and displaced vertices**

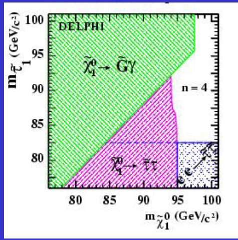
GMSB

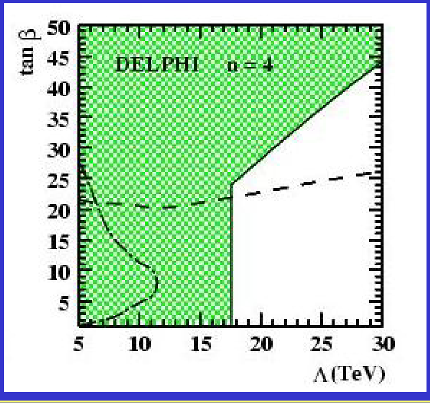
Gravitinos LSP and Slepton or Neutralinos NLSP all other sparticles can decay chain decay to the NLSP.

Sleptons **Charginos** **Neutralinos**





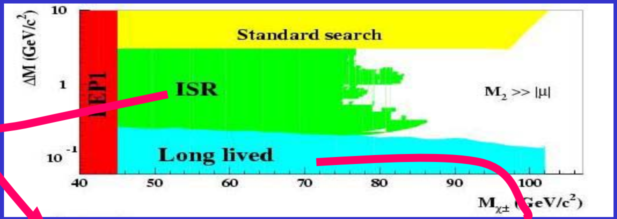


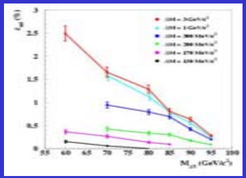


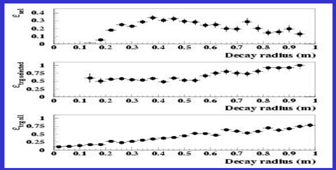
Limit to the scale of su-persimmetry breaking

MSUGRA

Charginos nearly mass-degenerated with the LSP (neutralino) .



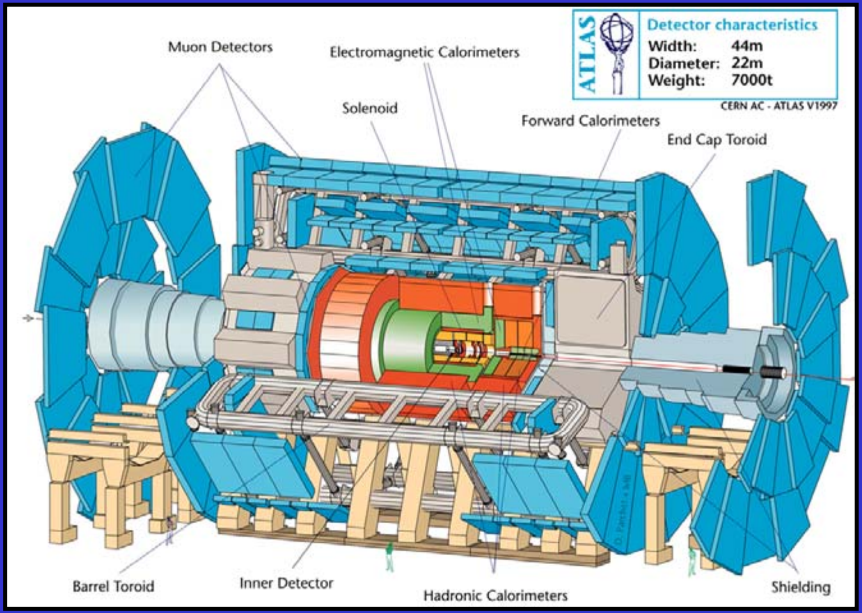




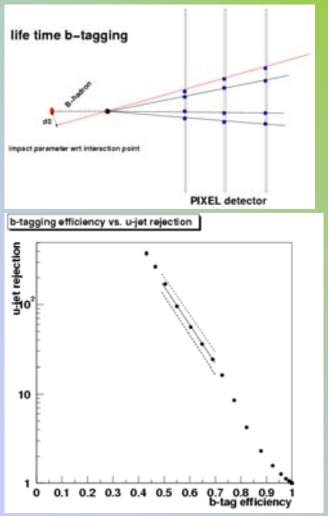
Trigger with the ISR photon

Reconstruction of se-condary vertives with low momentum tracks

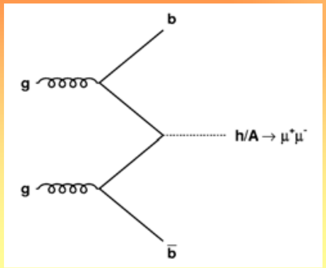
ATLAS-Simulation Studies

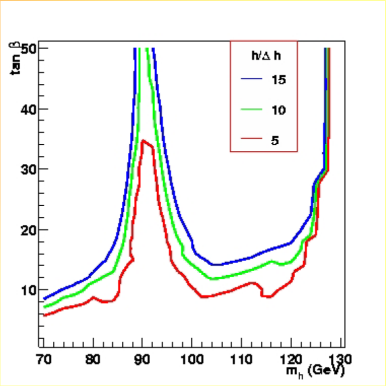


B-tagging techniques

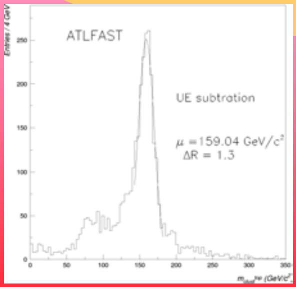


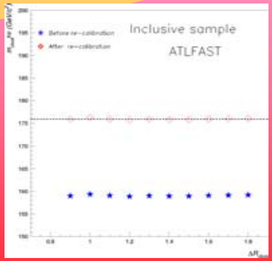
Higgs in MSSM





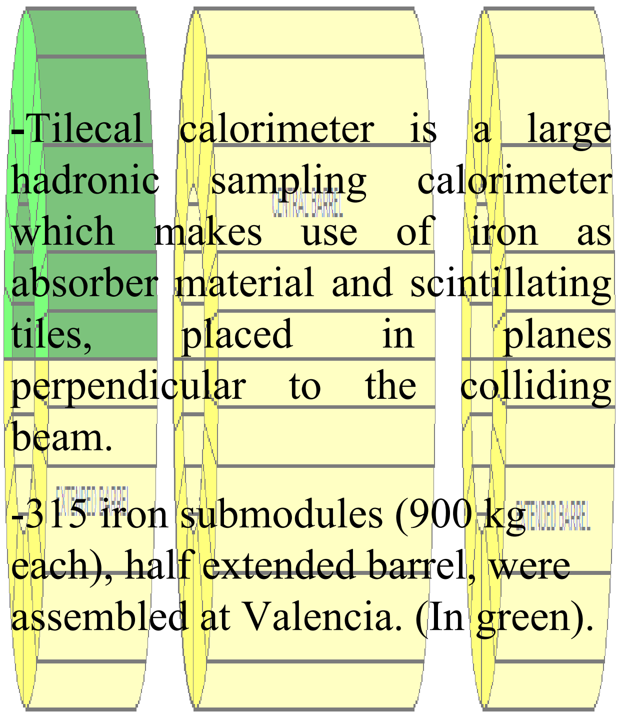
Top production studies





ATLAS-TiCal

Submodules Construction



-Tilecal calorimeter is a large hadronic sampling calorimeter which makes use of iron as absorber material and scintillating tiles, placed in planes perpendicular to the colliding beam.

-315 iron submodules (900 kg each), half extended barrel, were assembled at Valencia. (In green).

Photomultipliers Testbench

-1750 (17%) of the Tilecal photomultipliers are tested in Valencia laboratory in a test bench labview based environment. Having the responsibility of the acceptation/rejection decision for the final ATLAS assembly.

-Two LEDs (continuous and pulsed) simulate as close as possible Tilecal light conditions.

-16 photomultipliers (1%) were rejected

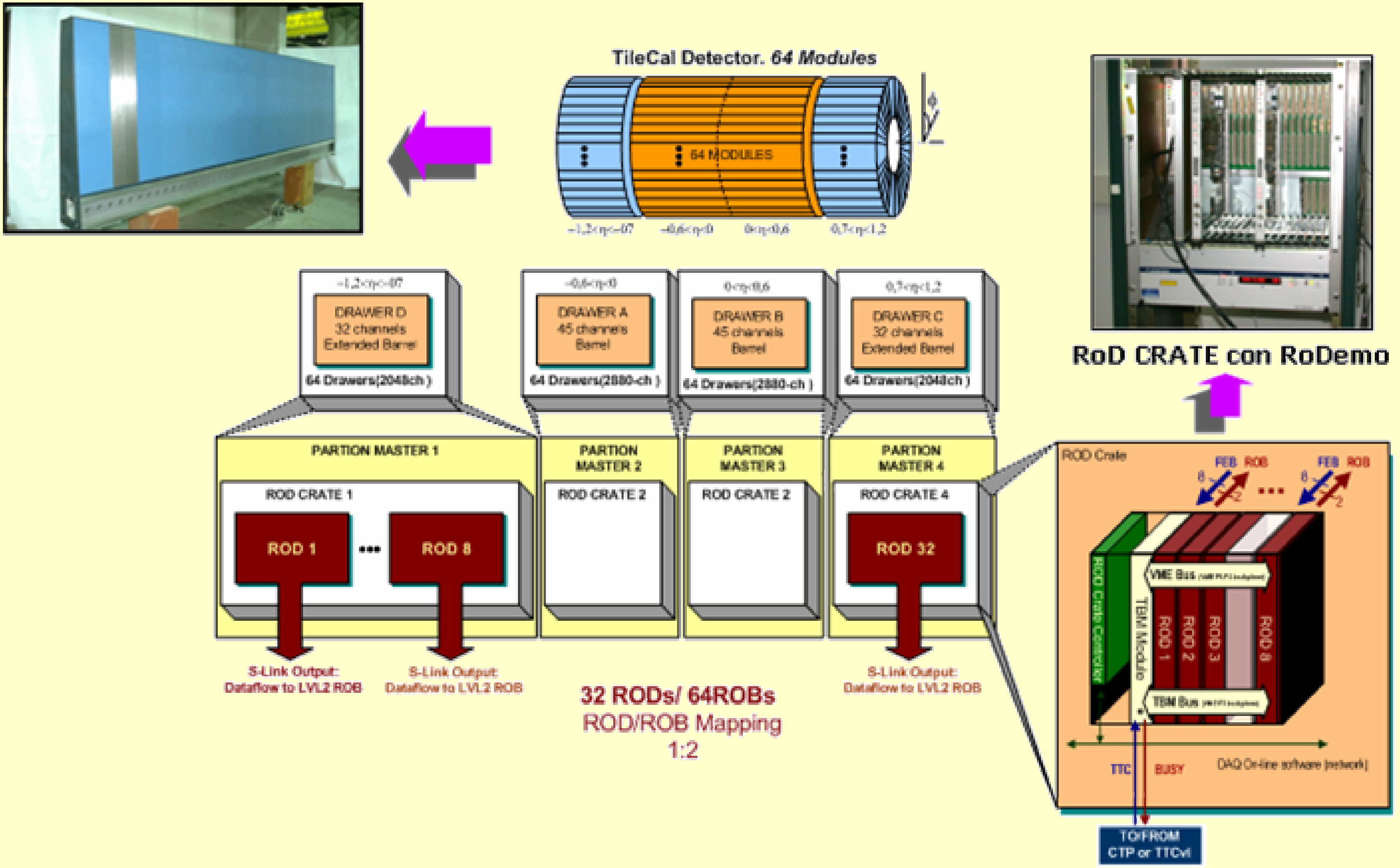
Read Out Driver (ROD)

-The 32 RODs calculate energy, time and quality information of the more than 10.000 channels of the calorimeter at level 1 rate (100KHz) providing an output rate of 2.5 Gb/s via a S-link protocol.

-High Tech electronics (DSPs and FPGAs) will be implemented in the cards

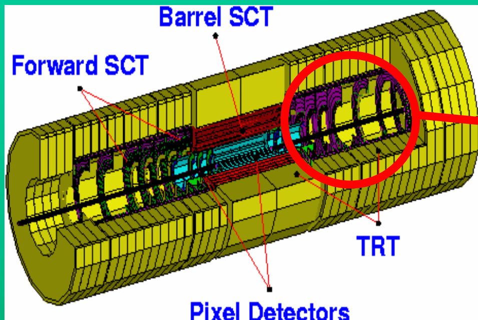
-Optimal Filtering Algorithm will be programmed inside DSPs to reconstruct energy and time while minimizing noise

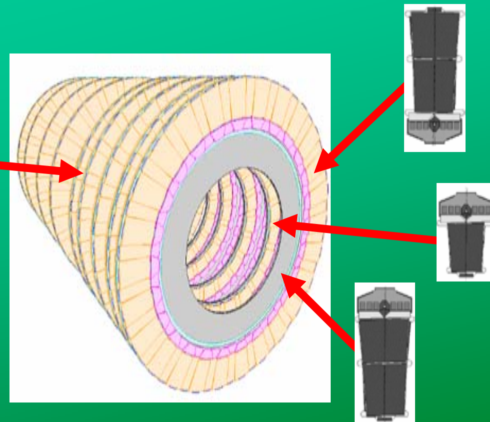
ATLAS-TiCal


TileCal Detector. 64 Modules
64 MODULES
RoD CRATE con RoDemo
DRAWER D
32 channels
Extended Barrel
64 Drawers(2048ch)
DRAWER A
45 channels
Barrel
64 Drawers(2880-ch)
DRAWER B
45 channels
Barrel
64 Drawers(2880-ch)
DRAWER C
32 channels
Extended Barrel
64 Drawers(2048ch)
PARTION MASTER 1
ROD CRATE 1
ROD 1
ROD 8
PARTION MASTER 2
ROD CRATE 2
PARTION MASTER 3
ROD CRATE 2
PARTION MASTER 4
ROD CRATE 4
ROD 32
S-Link Output:
Dataflow to LVL2 ROB
S-Link Output:
Dataflow to LVL2 ROB
S-Link Output:
Dataflow to LVL2 ROB
32 RODs/ 64ROBs
ROD/ROB Mapping
1:2
ROD Crate
FEB ROB
FEB ROB
ROD Crate Controller
TBM Module
VME Bus
ROD 1
ROD 2
ROD 3
ROD 8
TBM Bus
TTC
BUSY
DAQ On-line software (network)
TO/FROM
CTP or TTCvi

ATLAS-SCT

Coordinated project: IFIC-València and CNM-Barcelona

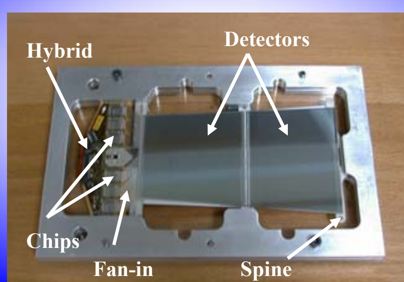


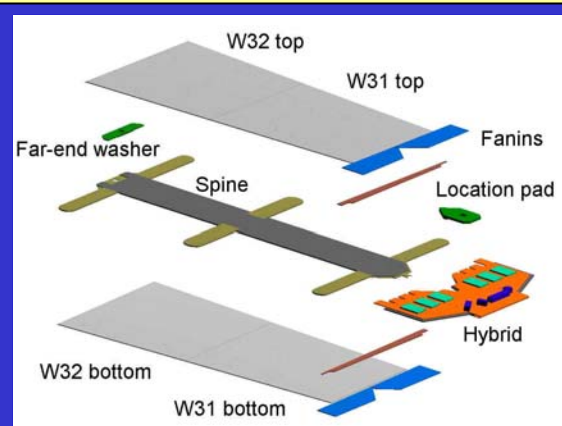


The Inner Detector is a sub-detector of the ATLAS experiment. It will provide a very precise tracking and vertex determination. The Semiconductor Tracker is a part of the tracking system based upon silicon microstrip detector technology.
The SCT will be composed by a Barrel and Forward sectors. Four different types of modules are employed in the SCT (1 for the Barrel sector and 3 for the Forward).

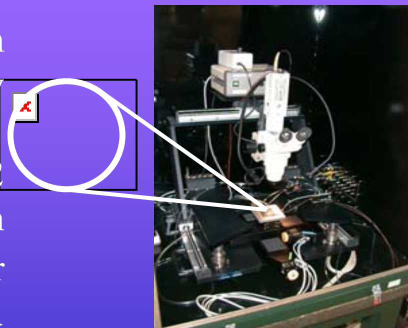
IFIC SCT group is involved in the Atlas Forward Silicon Tracker construction. 220 modules with 4 detectors each and its corresponding read out electronics have to be assembled and tested. All the different procedures in the Forwad modules assembly and tests are performed in a (class 10.000 and 1.000) 80 m^2 cleanroom with continous temperature and humidity control.

Forward outer module

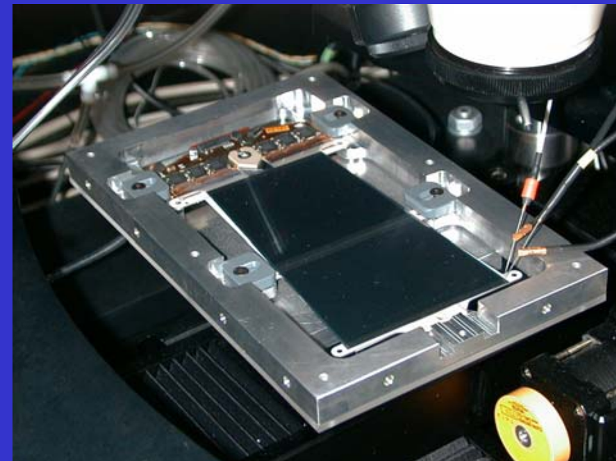


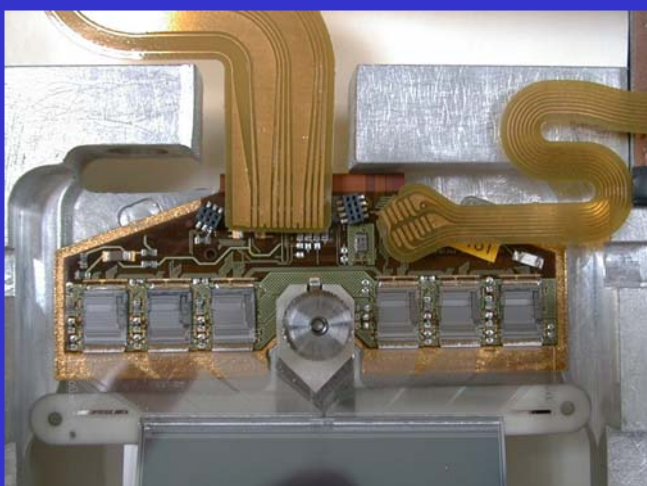


Wafers Characterization



A total of 880 silicon wafers have been fully characterized.
This is equivalent to 3.2 m^2 of microstrip silicon detectors. For each wafer the leakage current and depletion voltage have been measured and compared with the SCT specifications. More exhaustive tests are perfomed on a subset of detectors.



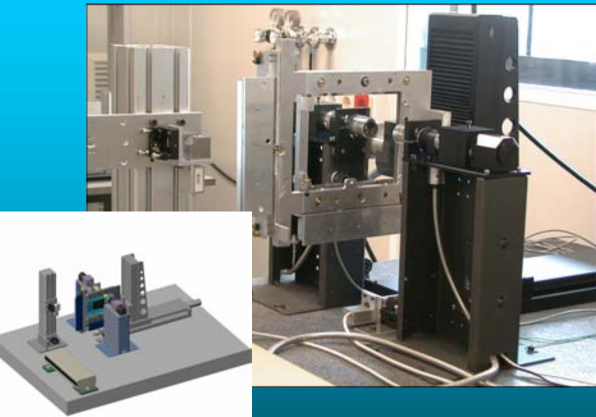


Assembly System

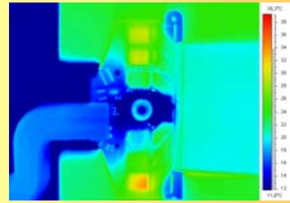
All the components need to be assembled together with high precision, being the alignment tolerances of few microns.

ATLAS-SCT

Metrology System



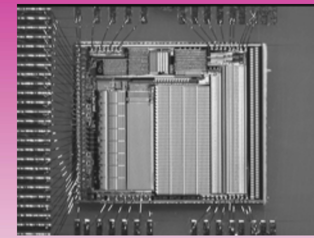
n automatic measurement system has een developed in order to verify the orrect assembly of SCT modules. This evice has a resolution of 0.2 μm.



• Infrared thermal imaging can reveal hidden systematic problems like bonding failures or hybrid hot points.

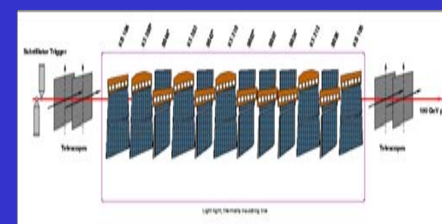
Quality Assurance

Bonding

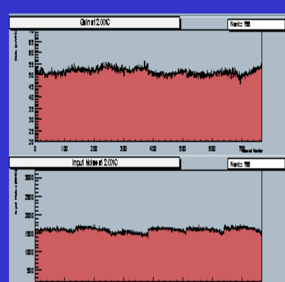


Each strip on the detector is ultrasonically stitched to its corresponding amplifier on a readout chip with an aluminum wire of 17-24 μm of diameter.

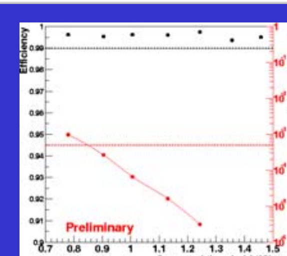
A full assembled module must pass several quality assurance (QA) tests. The aim of the QA procedures is to ensure that each SCT forward module fulfills all required specifications



• The behaviour of the chips in Gain and Noise is one of the most important results of the electrical characterization.



• The modules need to be tested under beam to probe its particle detection capability. Beam tests are performed at CERN and KEK regularly for this purpose.



ATLAS-GRID

Participation in EU projects: Grid Testbeds of DataGrid/CrossGrid

Participation in LHC experiments: ATLAS

Initial development and exploitation of a Grid infrastructure in Valencia.

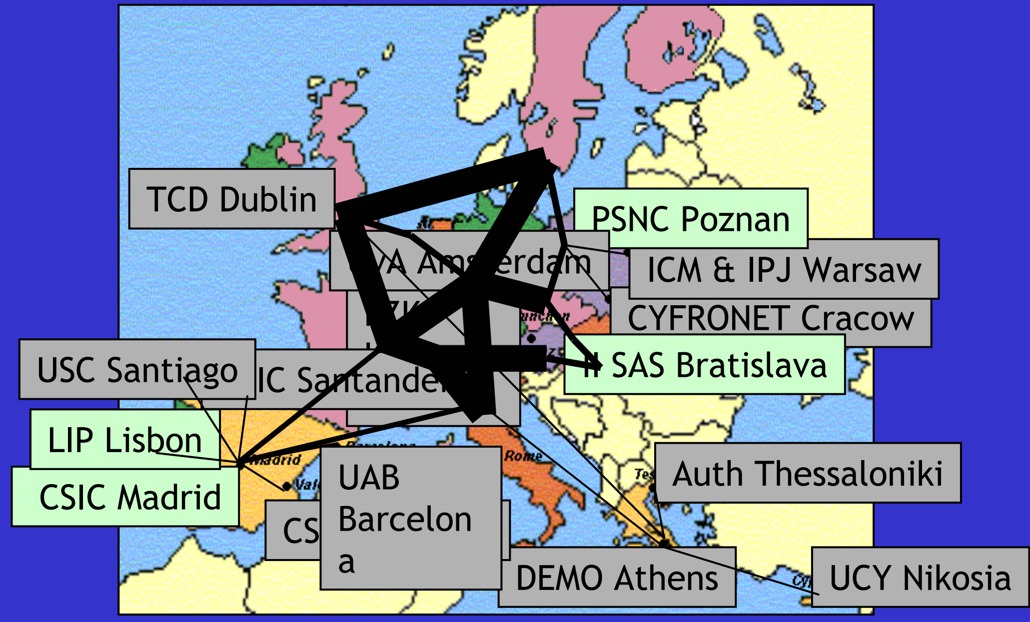
Provide support and infrastructure for:

- **Development of Grid applications;**
- **Test and validation of Grid applications.**

Physics analysis for preparation for Grid Computing.

CrossGrid WP4 – International Testbed Organisation

- **Objectives:**
  - **Testing and validation for**
    - **Applications**
    - **Programming environment**
    - **New services & tools**
  - **Emphasis on collaboration with DATAGRID**
    - **extension to DataTAG**
  - **Extension of GRID across Europe**



ATLAS-GRID

- **Infrastructure for Grid activities from CSIC-Universitat de València:**
  - **Grupo de Ordenadores para el Grid (GoG)**
  - **192 CPU’s**
    - **Chassis: 2U (Rack Mountable)**
    - **CPU: AMD K7 Athlon @ 1.2 and 1.4 GHz**
    - **Memory: 1Gbytes, PC133**
    - **HD: 40 Gbytes, ATA 100 @ 7200 rpm**
    - **NIC: 100 Mbps full duplex.PXE 2.1, WOL**
    - **9 Racks 19”**

ATLAS-GRID

- Data Challenge 1 runs from April 2002 to first half of 2003
- It was divided in two phases, DC1/1 and DC1/2
- Major goal is to provide simulated data to the High Level Trigger (HLT) community that has to prepare its own Technical Design Report (TDR) by mid 2003

DC1 phase 1 (DC1/1) in 2002

In April-August 2002:

Set the infrastructure and the production tools

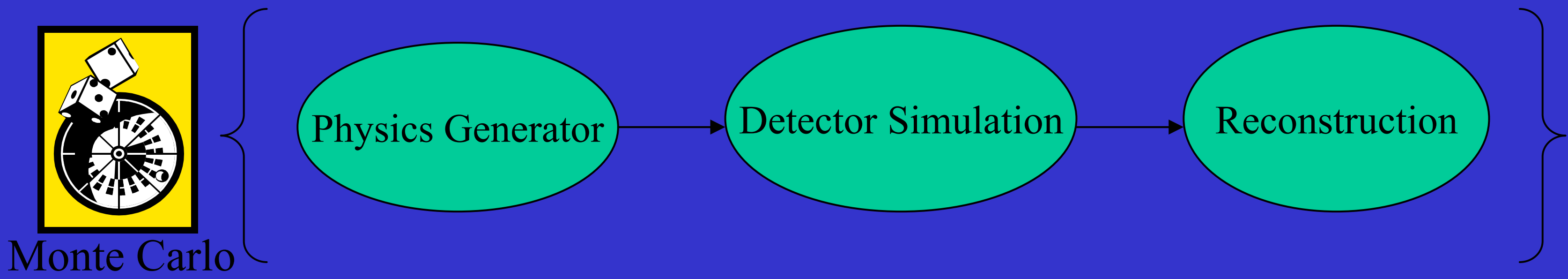
A major simulation production was performed

Tools:

PYTHIA as event generator

ATLSIM for full simulation of the ATLAS detector response

ATRECON for the event reconstruction



ATLAS-GRID

Samples Produced DC1

In total

- 50×10^6 events generated
- 10×10^6 events, after filtering simulated with GEANT3
- 31×10^6 single particles simulated

At IFIC

- 2.2×10^6 events processed
- 400k events, after filtering simulated with GEANT3

CPU /Data Volume DC1

In total

- Up to 3200 processors (5000 PIII/500 MHz equivalent)
- To simulate one di-jet event: 620 s
- Total CPU: 1722K hours
- 100 TB

At IFIC

- Up to 100 processors (Athlon/1.2 & 1.4 GHz)
- To simulate one di-jet event: 200 s
- Total CPU: 30K hours
- 2.5 TB

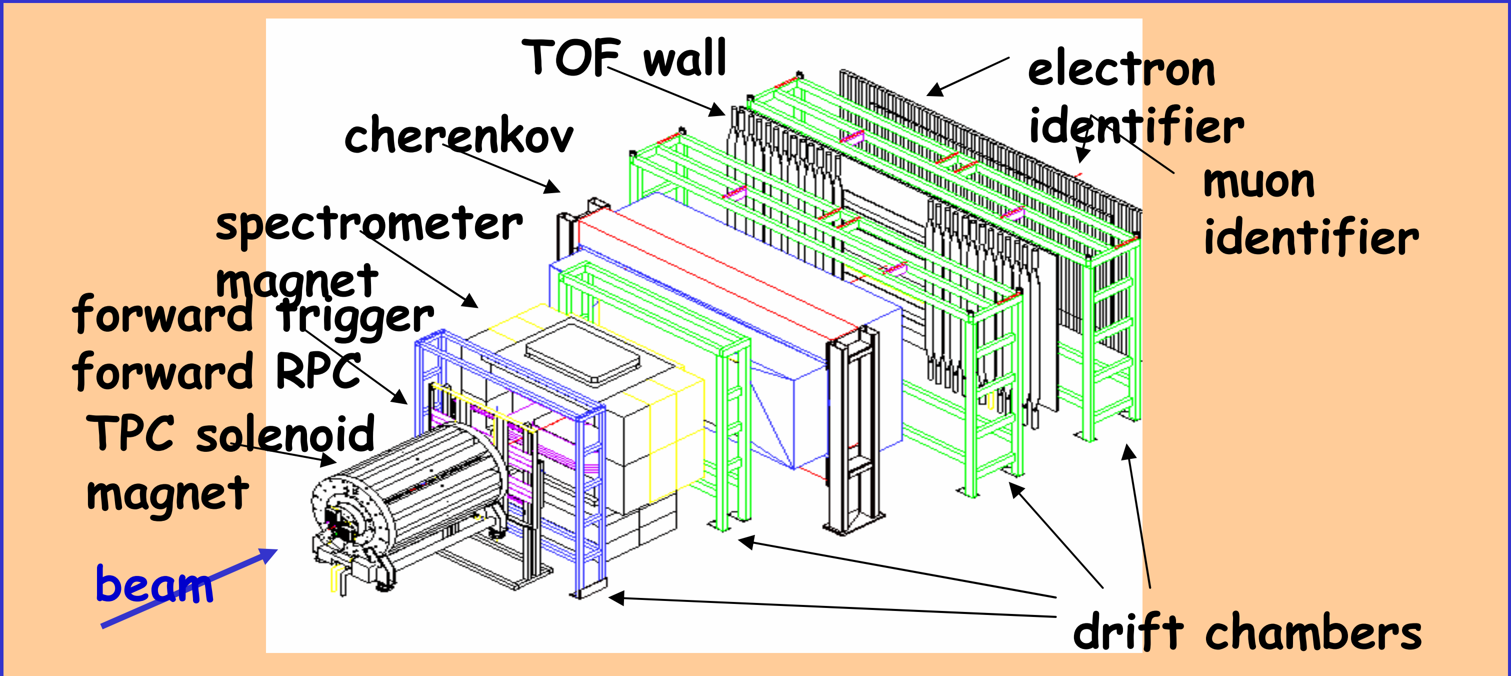
Neutrino Oscillations-Harp

Precision measurement of hadronic production cross sections in a selection of targets and energies relevant for various fields of neutrinos physics:

- **Atmospheric neutrino flux**
- **Precision measurement of K2K and Mini Boone targets**
- **Neutrino Factory design studies**

Contribution:

- **Built and commission the laser calibration system of the TPC**



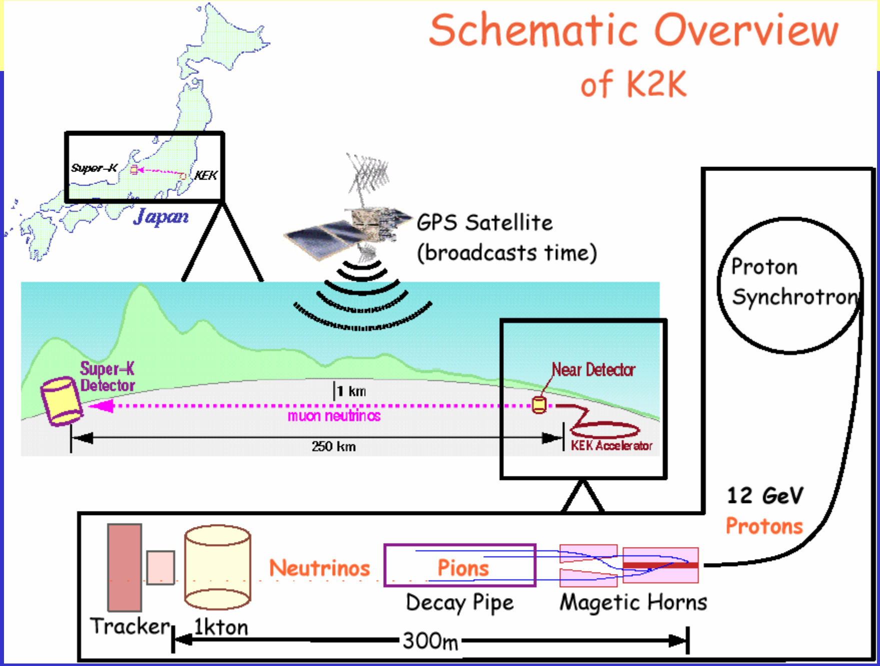
Neutrino Oscillations-K2K

KEK to SuperKamiokande:

- **Confirm the evidence of oscillations observed by Super-Kamiokande**
- **Measure the disappearance of muonic neutrinos in a beam that is produced in KEK and detected in Super-Kamiokande**

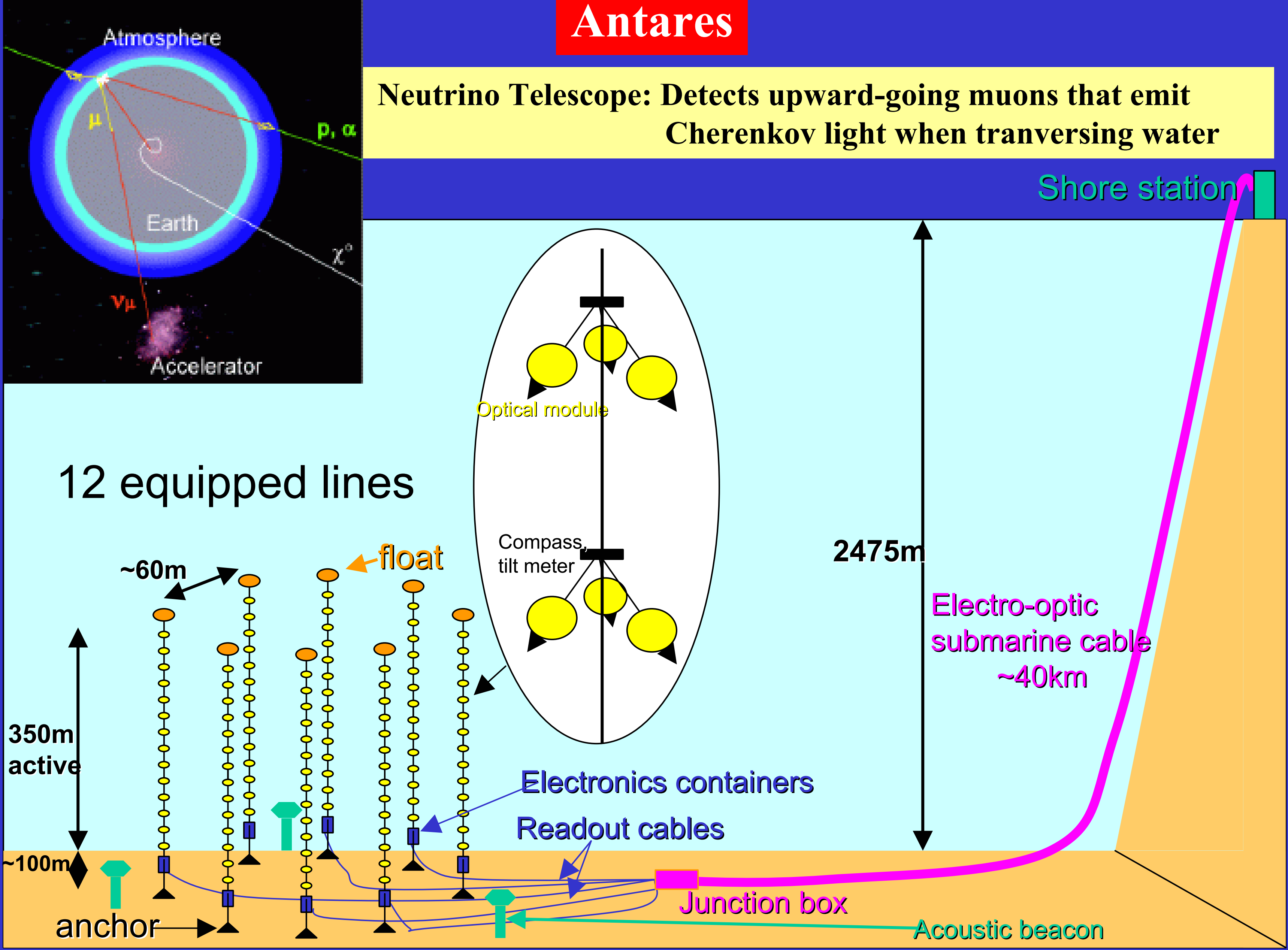
Two major contributions:

- **Extrapolation of the neutrino flux measured in the near detector to the far detector (from Harp data)**
- **Contribution to the reconstruction of the new SciBar detector (in collaboration with IFAE)**



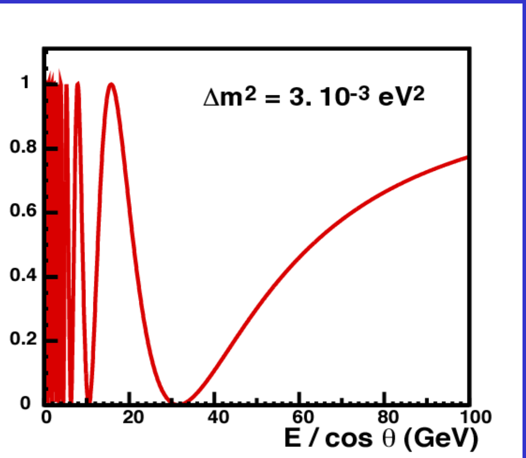
Antares

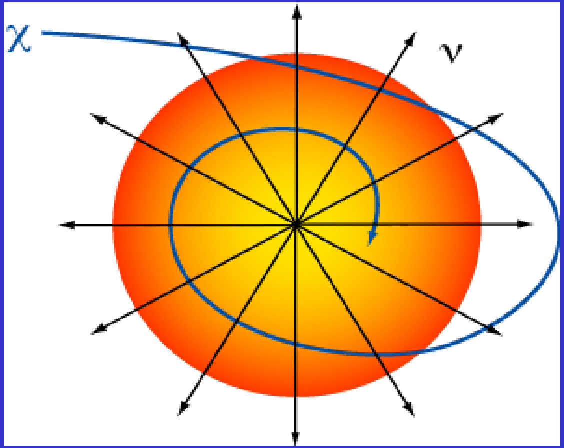
Neutrino Telescope: Detects upward-going muons that emit Cherenkov light when tranversing water

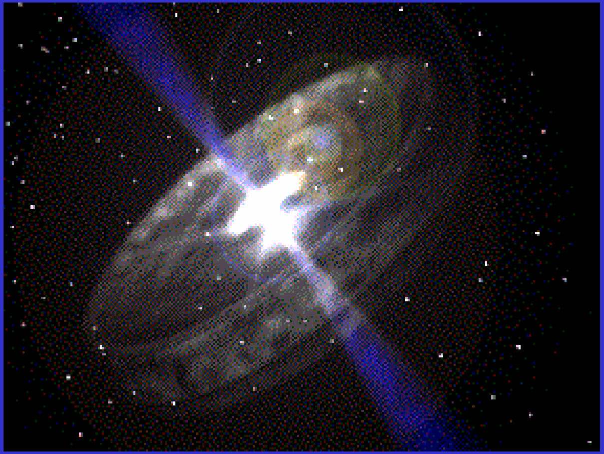


Antares

Main goals as function of the neutrino energy







Low Energy
10 GeV < E_ν < 100 GeV

ν-Oscillations

Intermediate Energy
10 GeV < E_ν < 1 TeV

Search for Neutralinos

High Energy
E_ν > 1 TeV

Search for Sources

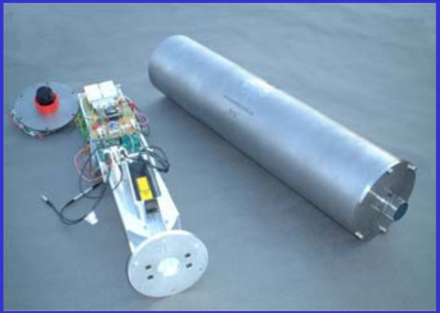
Antares

- IFIC hardware activities concentrate in time calibration devices (pulsed light sources):
  - Laser Beacons (full responsibility)
  - LED Beacons (with Universities of Sheffield and Leeds)
- IFIC analysis and software activites:
  - Track reconstruction algorithms
  - Energy reconstruction and energy spectra
  - Search for point-like astrophysical sources

Correct timing is essential in ANTARES. Pulsed light sources are one of the calibration methods.

Laser Beacon: placed at the bottom of the string. A Nd-YAG laser emits 523 nm light pulses (FWHM < 0.7 ns).

LED Beacon: placed every 4 storeys in the string. Several LEDs emit 470 nm light pulses (FWHM < 2 ns).



Babar: Asymmetric B-factory at SLAC

Physics analysis activities:

CP Violation measurements with charmonium events and Mixing studies with fully reconstructed hadronic decays

Precision measurements of sin2β and decay width difference $\Delta\Gamma$

Precision measurement of mixing frequency $\Delta\mu$

Detailed studies of Quantum Mechanics of the BB System at the Υ(4S): simultaneous and precision test of all discrete symmetries, as a probe for New Physics

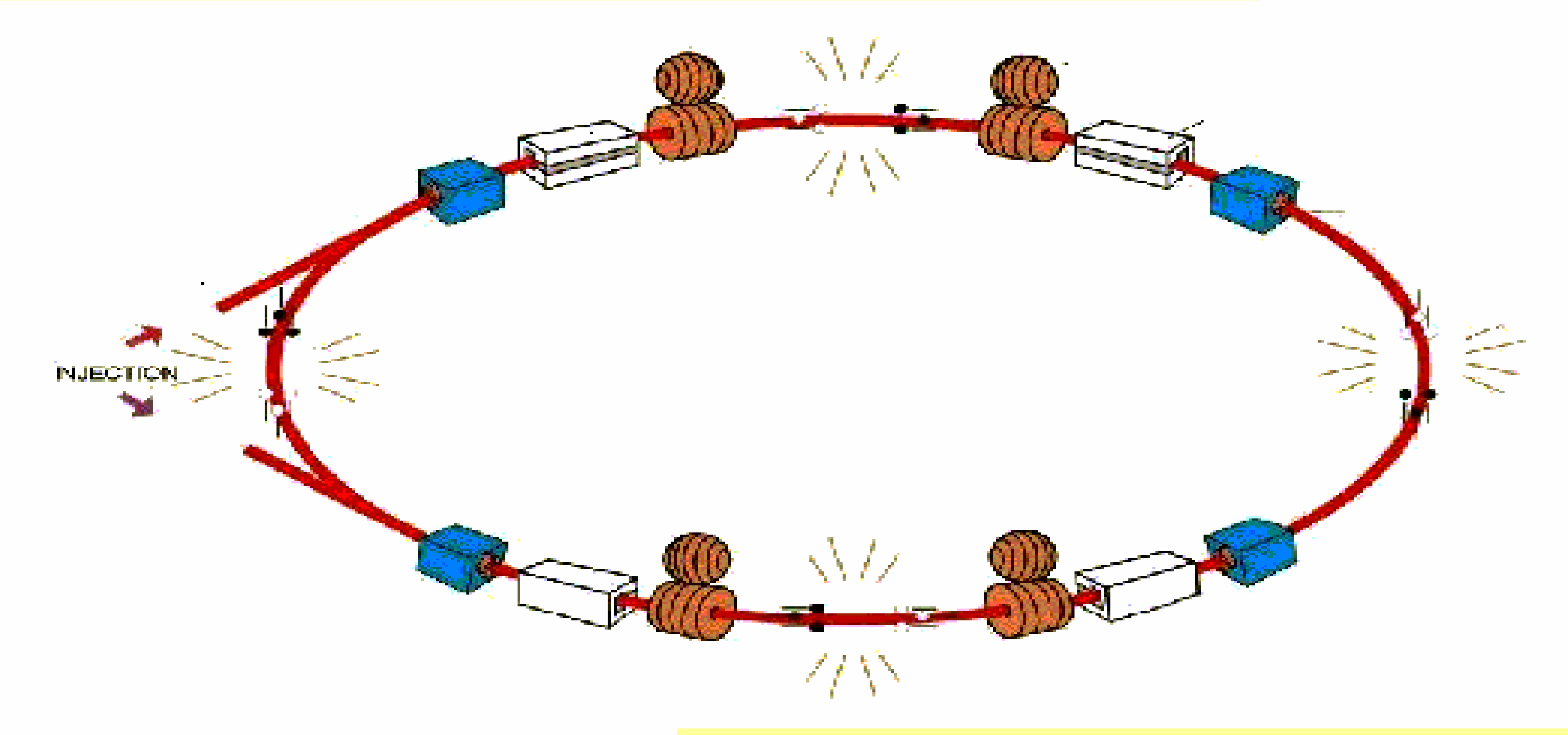
Current responsabilities

- **BaBar/PEP-II Long Term Planning Task Force. Evaluation of the physics impact of increased PEP-II luminosity and possible BaBar dectector upgrades.**
- **Coordination of Vertexing Software and Data Quality**

Starting new projects

- **Evaluating possibilities to use the IFIC computing resources for official BaBar Monte Carlo production**
- **Feasibility studies to measure γ (the 3rd CKM weak angle) via the decay** $B \rightarrow D^0 K \pi^0$

High-Energy / High-Intensity Proton Accelerators



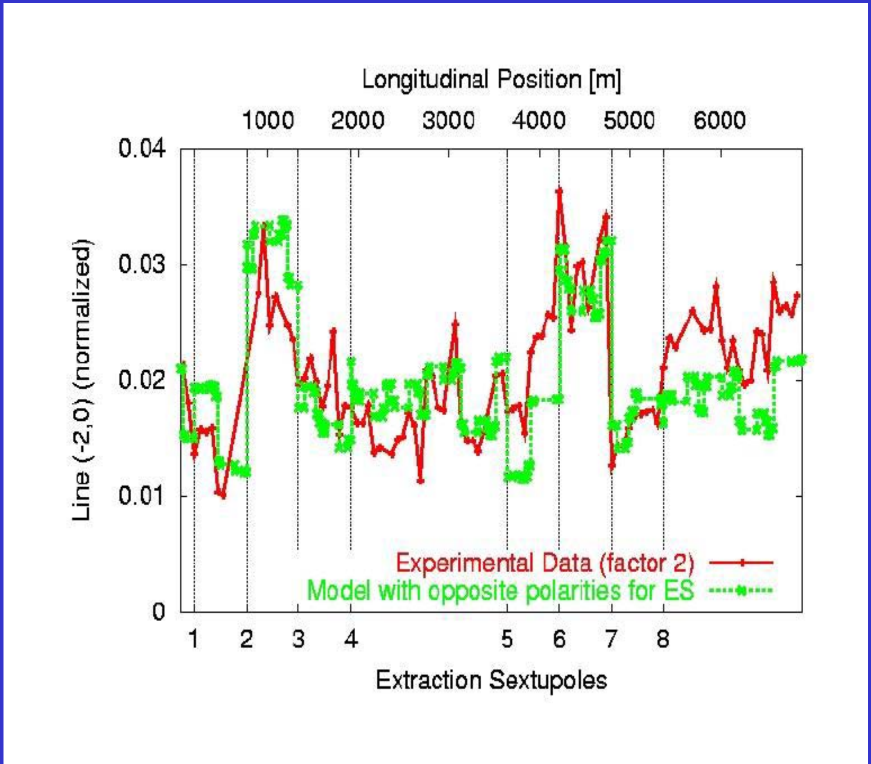
Electron Accelerators and Colliders

Accelerator Physics

High-Energy / High Intensity Proton Accelerators

Beam Dynamics expertise

Optics design, modelling of machine imperfections, study of non-linear resonance driving terms, localisation of sources of non-linearity, and analysis of beam measurement data also with Normal Form techniques.



Accelerator Physics

Electron Accelerators and Colliders

Beam Dynamics Expertise

Design optics, non-linear correction systems and dynamic aperture studies for electron colliders and linear colliders.

Interest

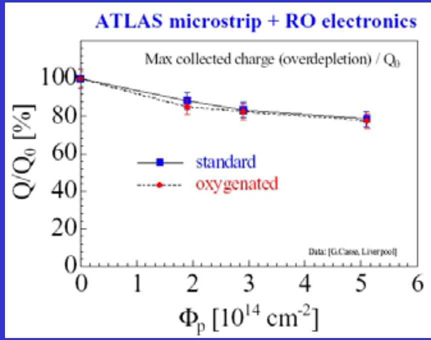
Participating in the design and testing of existing facilities of novel optical designs for Beam Delivery Systems of future linear colliders such as compact final focus and non-linear collimation.

Detector R&D

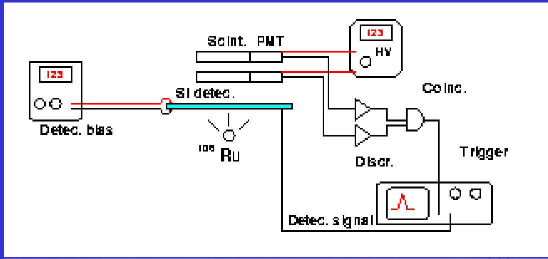
RD50: development of radiation hard silicon sensors

- Silicon sensors used in LHC will be exposed to high radiation doses
- After 10 years of of LHC operation integrated dose will be approx: $3\cdot10^{14}$ protons/cm^2
- Radiation degrades sensor properties: increased leakage current, depletion voltage and noise, and induces charge trapping.
- Set up at IFIC. Keep samples cooled (-20^{0}C). DAQ & trigger system in a freezer.

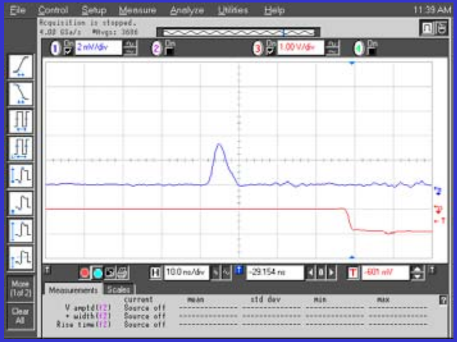
Charge collection efficiency



Set up: scheme and lab



Signal pulse



γ - Spectroscopy

Research

Beta decay studies with Total Absorption Techniques

Nuclear structure at extreme values of spin and isospin

Reactions with radioactive beams

Experiments at Large Scale Facilities mainly in Europe

ISOLDE (CERN), GSI (Germany), LNL (Legnaro Italy) Jyväskylä (Finland)

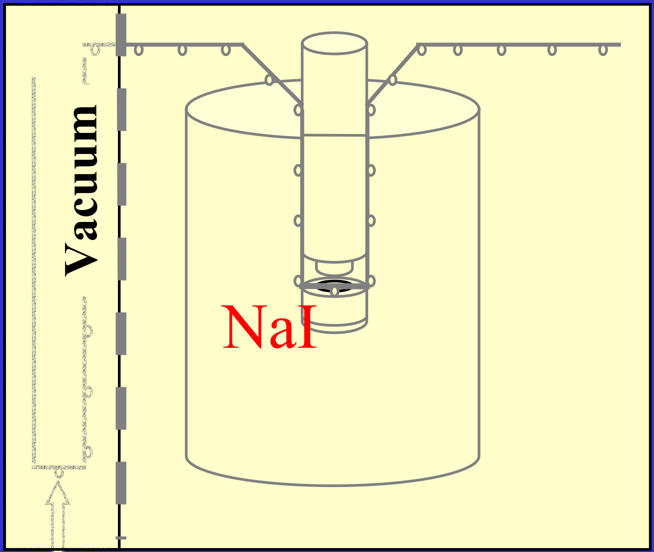
(spokespersons of the experiments are members of the group)

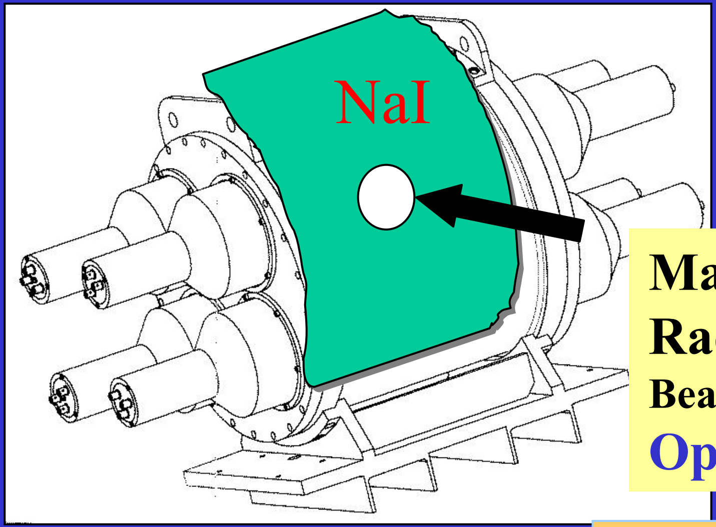
Example: Beta decay

γ - Spectroscopy

Lucrecia at ISOLDE

TAS at GSI



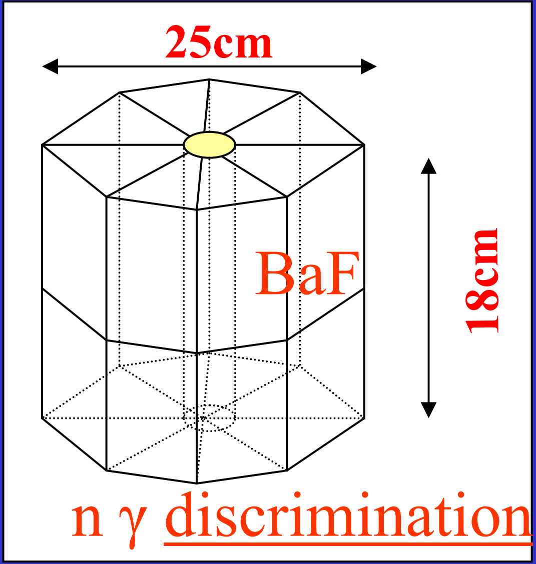


Mass sep.
Radioactive
Beam
Operating

(Madrid, Strasbourg, Surrey, Valencia)

Mass Separator beam
Operating

(Warsaw,
GSI,
St. Petersburg,
Valencia)



Under developmen
at IFIC

180 keuros

(Valencia, Surrey)

nTOF

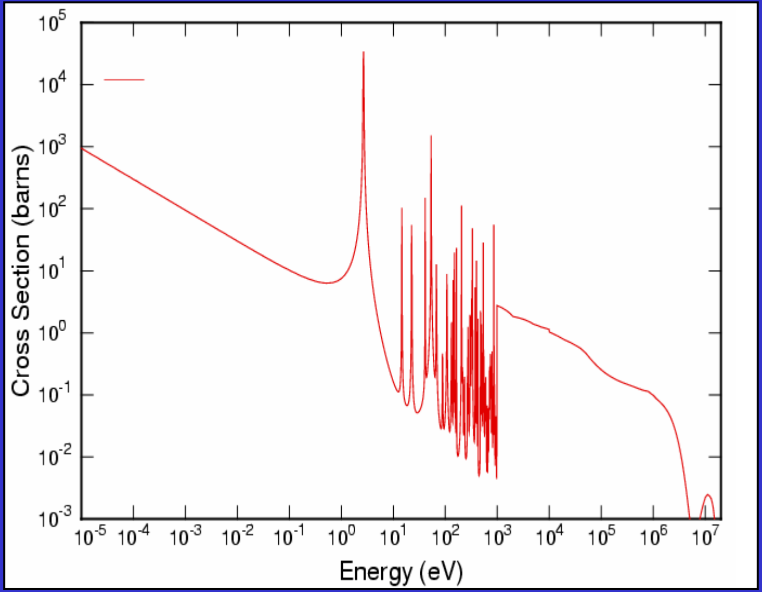
n_TOF Collaboration: +40 Institutes, 15 countries *, RTD contract 5FP (UE)

* Spain: CIEMAT, IFIC†,UPC,UPM,USC,USE; R&D project PNFPGA (CICYT)

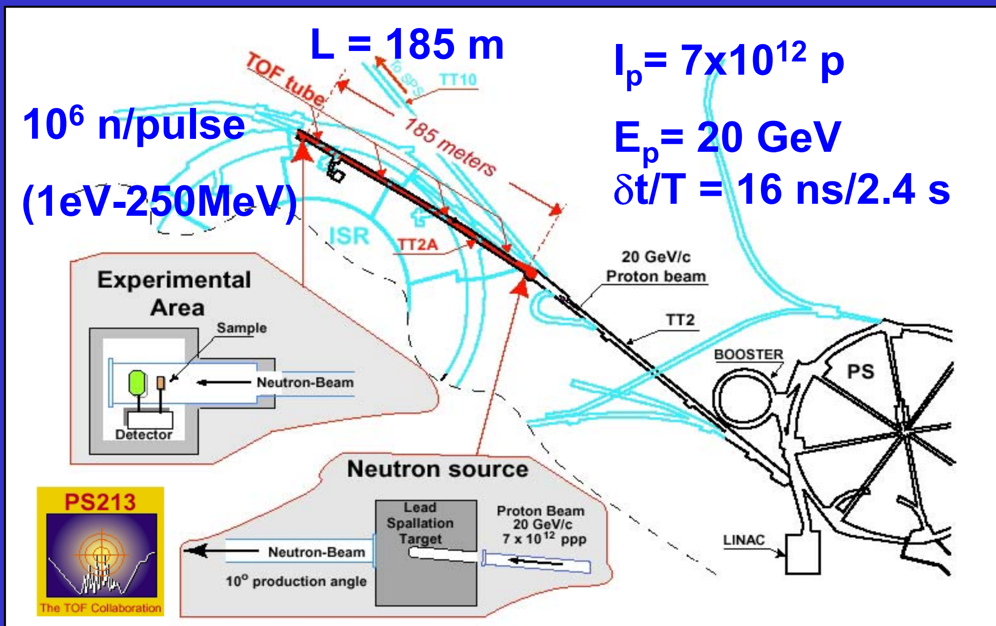
† IFIC: Gamma Spectroscopy Group

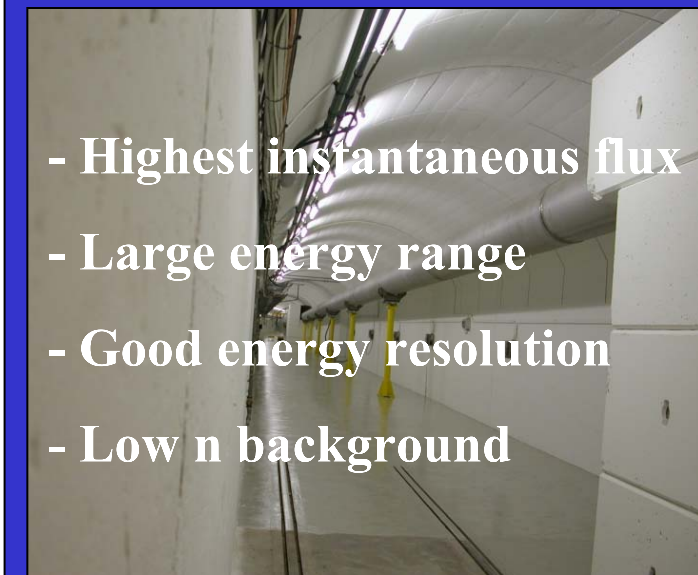
Objectives

Measurement of accurate neutron cross sections on key isotopes of interest in nuclear technology (ADS / waste transmutation), astrophysics and basic nuclear physics



Construction of the n_TOF facility @ CERN





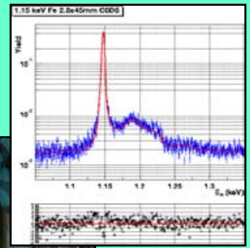
- Highest instantaneous flux
- Large energy range
- Good energy resolution
- Low n background

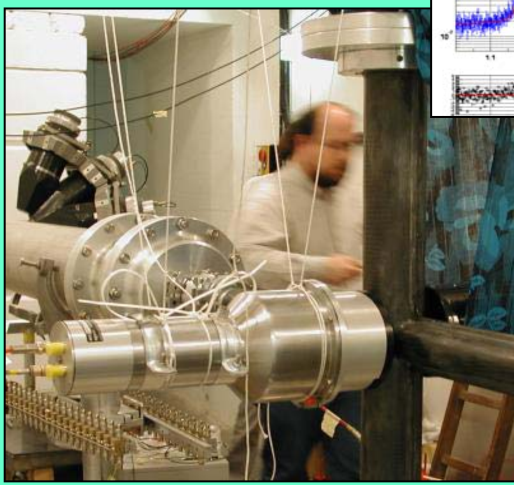
☞ Measurement of radioactive or rare samples

nTOF

IFIC is involved in capture (n,γ) measurements

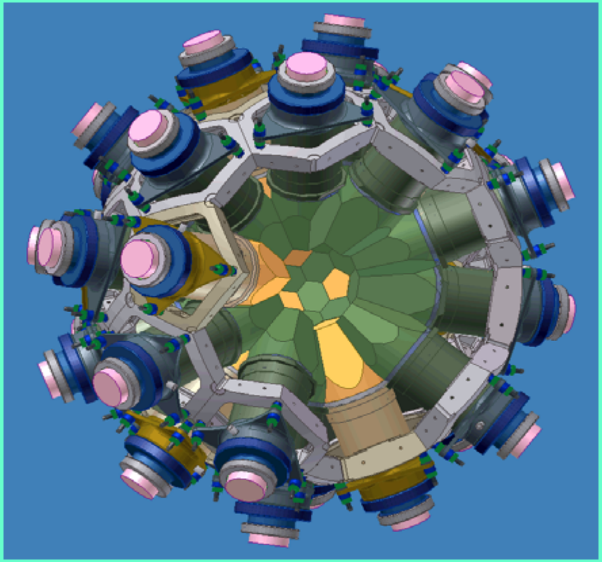
Improvement of Pulse Height Weighting Technique with C_6D_6 detectors





✓ **Pb, Bi: ADS and stellar nucleosynthesis**

Construction of BaF_2 Total Absorption Calorimeter



✓ **Np, Pu, Am : long-lived waste transmutation**

Nuclear Reactions

Collisions at intermediate energies

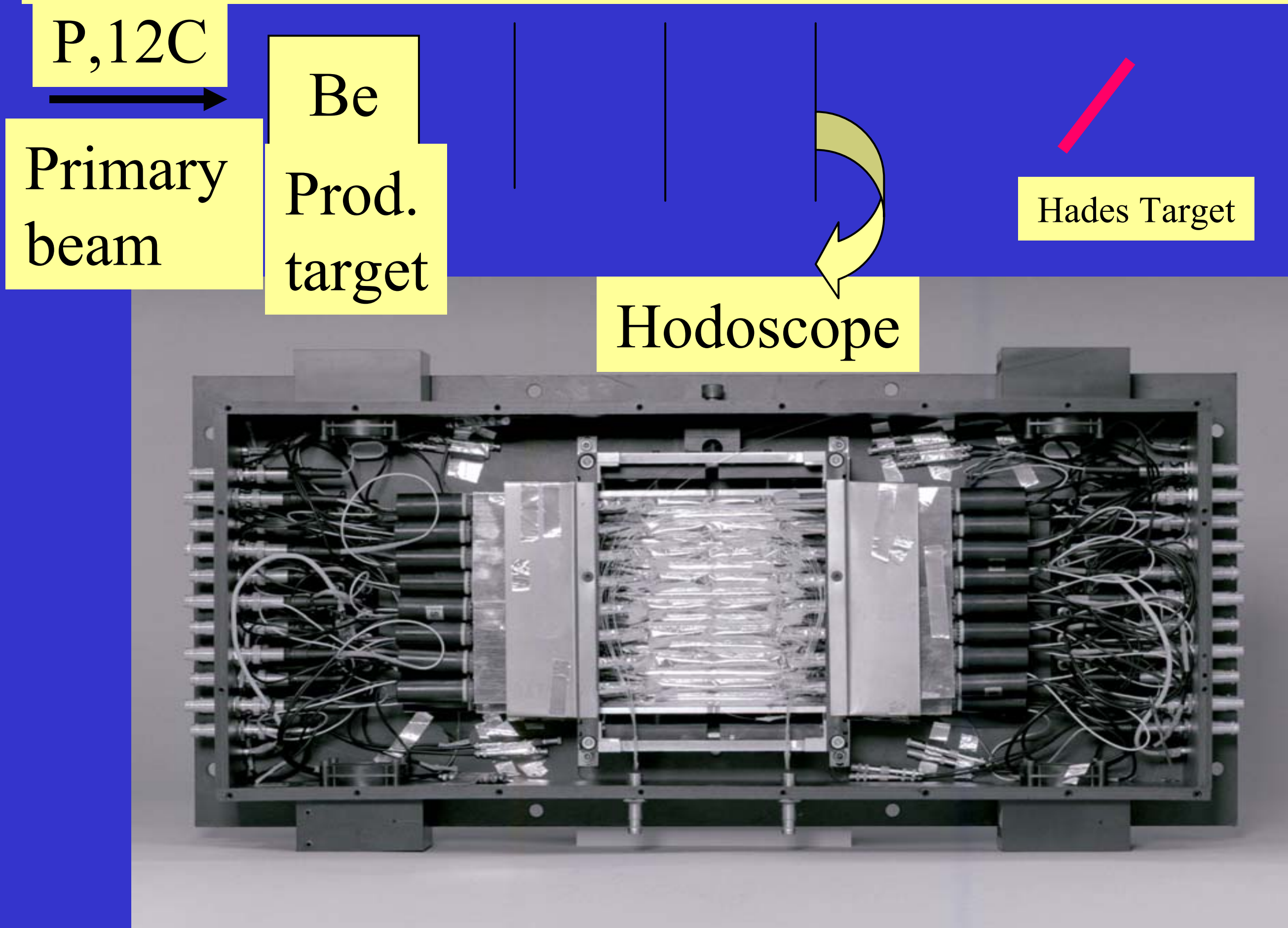
- **Accelerators: KVI Groningen, GANIL (50, 200MeV/u)**
- **TAPS Collaboration (384 BaF)**
- **Measurements of hard photon and subthreshold pion production in heavy ion collisions (i.e. Ar + Au 25 MeV/U, Π^o)**
- **Dynamics of heavy ion reactions**

Collisions at relativistic energiesAccelerator

- **SIS (Darmatadt GSI) (1GeV/u)**
- **Measurement of particle production at relativistic energies (TAPS Collaboration)**
- **Hadron Properties in Nuclear Matter (Hades Collaboration)**
- **Development of high energy pion beams (Hades Collaboration)**

Nuclear Reactions

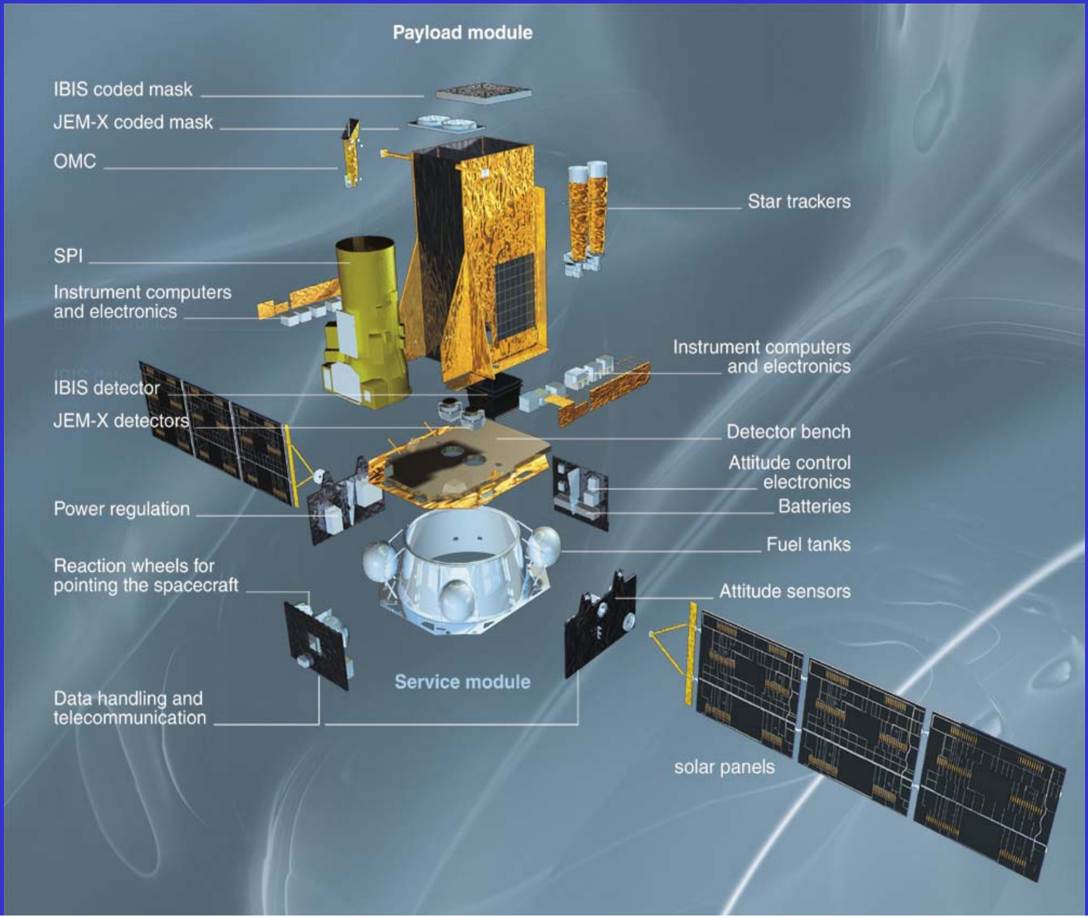
Development of high energy pion beams (Hades Collaboration)



Integral

Gamma-ray astronomy 15 keV - 10 MeV using high resolution spectroscopy and fine imaging. Concurrent monitoring in X-ray (3-35 keV) and optical (500-600 nm) bands. International collaboration ESA, Russia, NASA

Main scientific topics:
- **Compact objects**
- **Extragalatic astronomy**
- **Stellar nucleosynthesis**
- **Galactic structure**
- **The Galactic centre**
- **Particle processes and acceleration**
- **Identification of high energy sources.**
- **Targets of Opportunity (TOO).**



INTEGRAL
(**INTE**rnational **G**amma **R**ay **A**strophysics **L**aboratory).

INTEGRAL will monitor the galactic plane regularly to detect transient sources

Integral

Main activities

After INTEGRAL coded masks design, manufacturing and vibration-thermal test made by our group during past years, in 2002 we proceed to calibration of coded masks from the optical gamma-ray transmission point of view. After these on-ground calibrations the whole satellite was assembled and fully tested at ALENIA Space division facilities. INTEGRAL was successfully launched on October 17th 2002 from the Russian Baikonur launcher facilities on board a PROTON rocket.

After preliminary verification phase and in-orbit check and calibration procedures we actually are ready to analyse scientific data send by INTEGRAL. Until now, all the instruments are fully operative and scientific observing programme is developing as scheduled.

Flight Model of SPI coded Mask at U. Valencia clean room facilities during gamma ray transmission test.

Nuclear Medicine-Crystal Clear

- **Activities:**
  - **Development of gamma ray detectors for medical applications.**
  - **Members of Crystal Clear collaboration (CERN)**
  - **Organize 7th International Conference on Scintillating Crystals and Industrial Applications, Valencia 8-12, 2003 http://ific.uv.es/scint2003**
- **Technology Award, Chile 2002, from World Nuclear Medicine Association.**

Mini Gamma Camera (2000-2001)

- Useful for thyroid, kidney, etc..

- Connected to a laptop computer.

- High resolution: 2 mm

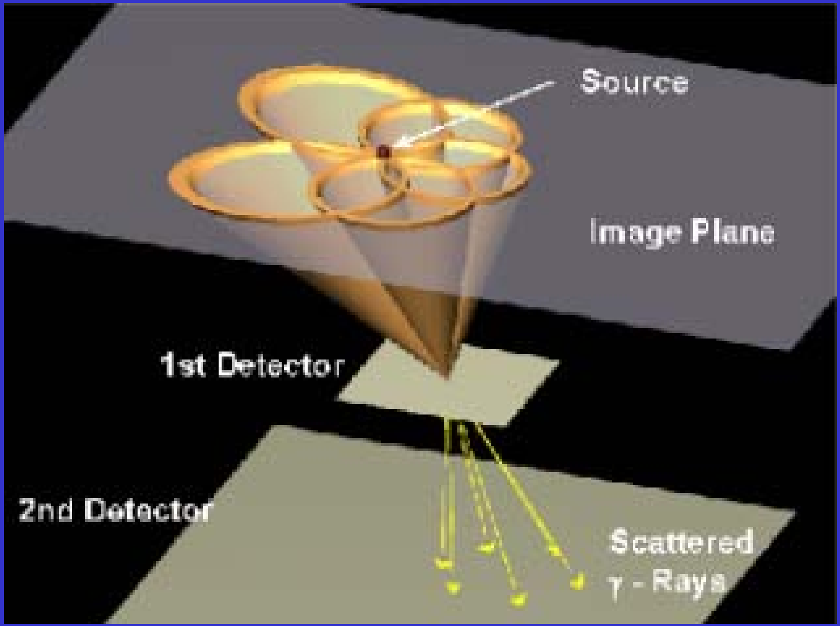
- High sensitivity.

European Patent Pending PCT number 200202220

Small Animal PET Camera (2002-2003)

CIMA: Compton Imaging for Medical Applications

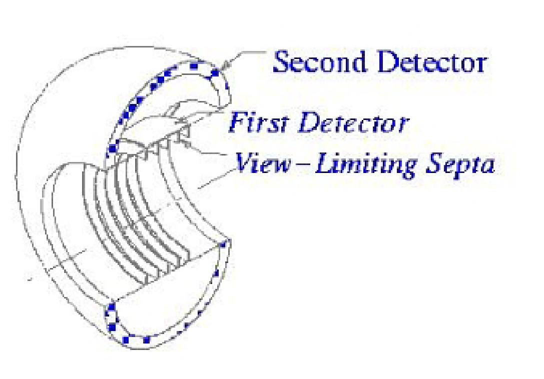
- Electronic collimation: mechanical collimators used in conventional Anger cameras are replaced by a first (silicon) detector.
- Photons coming from the object to be imaged compton-scatter in the silicon detector and are absorbed in the scintillator.
- Detector sensitivity and spatial resolution are not coupled. Sensitivity can be improved by orders of magnitude for a comparable resolution.
- Resolution improves with higher gamma-ray energies.
- Determining the impact points and the energy deposited in the first detector, it is possible to locate the source and reconstruct the image.

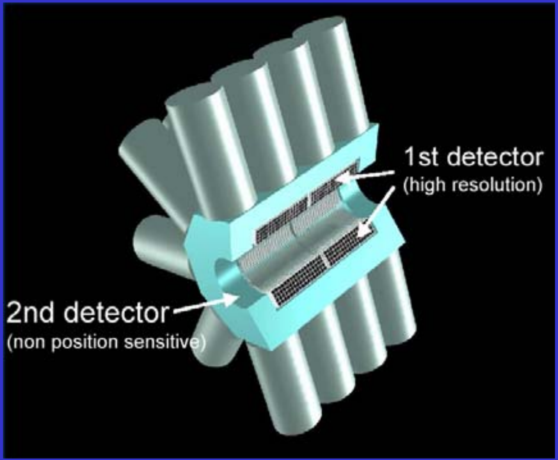


CIMA: Compton Imaging for Medical Applications

Ring Geometry Compton Camera

Simulations predict that this arrangement with 16 mm of silicon detectors would improve by more than 300 times the efficiency of conventional gamma cameras with the same resolution.





Very High Resolution small animal PET

Detects the two photons from positron annihilation. Its resolution (about 350 μm) approaches the physical limit, the range of positrons in the tissue.

Compton Prostate Probe

The combination of an intrarectal silicon probe, placed close to the prostate, and an external scintillator would improve resolution by a factor 4 and sensitivity by an order of magnitude.