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**INFN:**

**Istituto**

**Nazionale di**

**Fisica**

**Nucleare**



# INFN, perchè?

*dal nostro sito WEB*

- “ L'INFN venne istituito l'8 agosto 1951 da gruppi delle **Università di Roma, Padova, Torino e Milano** al fine di proseguire e sviluppare la tradizione scientifica iniziata negli anni '30 con *le ricerche teoriche e sperimentali di fisica nucleare di Enrico Fermi e della sua scuola.*”
  
- *Perche' non semplicemente una collaborazione fra 4 grandi Università?*
  
- La ricerca in fisica nucleare e (successivamente) delle particelle ha bisogno di **STRUTTURE** e di risorse per realizzarle:
  - *Laboratori*
  - *Officine*
  - *Personale tecnico (e amministrativo)*

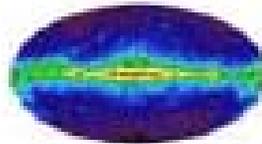
# INFN, cos'è ?

*dal nostro sito WEB*

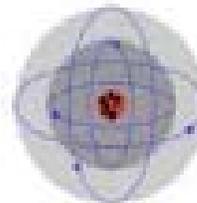
- “ L'INFN, Istituto Nazionale di Fisica Nucleare, è l'istituto che promuove, coordina ed effettua la ricerca scientifica nel campo della **fisica subnucleare, nucleare e astroparticellare**, nonché lo **sviluppo tecnologico necessario alle attività in tali settori**. Opera in stretta connessione con l'Università e nell'ambito della collaborazione e del confronto internazionale. ”
- Le attività di ricerca sono così raggruppate:



FISICA  
PARTICELLARE



FISICA  
ASTROPARTICELLARE



FISICA  
NUCLEARE



FISICA  
TEORICA



RICERCA  
TECNOLOGICA

# L' INFN & LA FISICA CON GLI ACCELERATORI

**PARTICELLE & NUCLEI**



**ALICE @ LHC**  
CERN, Ginevra



**BABAR**  
SLAC, California



**CDF @ Tevatron**  
FERMILAB, Chicago



**ZEUS @ HERA**  
DESY, AMBURGO



**Cavita' Superconduttive**  
LNL, Legnaro



**KLOE @ DAFNE**  
LNF, FRASCATI



**AICE @ Jefferson LAB**  
Virginia



**Ciclotrone Superconduttore**  
LNS, Catania

# L' INFN & LA FISICA SENZA ACCELERATORI 1/2

ASTROPARTICELLE, NEUTRINI  
& EVENTI RARI

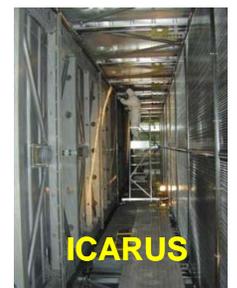
## ■ Neutrini ( $\nu$ ) da

- **Cosmo**: laboratori nelle profondita' marine, NEMO (Sicilia)
- **Sole** : esperimenti GALLEX, GNO, BOREXINO al LNGS
- **Acceleratori** : esperimenti OPERA, ICARUS al LNGS



## ■ Ricerca di segnali di materia oscura

- Al Gran Sasso, grazie al silenzio della montagna: DAMA, CRESST, HDMS



# L' INFN & LA FISICA SENZA ACCELERATORI 2/2

ASTROPARTICELLE, NEUTRINI  
& EVENTI RARI

- **Segnali dal cosmo**
  - I raggi gamma di alta energia- **ARGO (Tibet)**



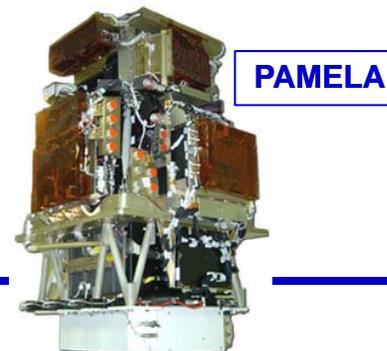
- **Onde gravitazionali prodotte da masse accelerate:**

- **VIRGO**, in Toscana (interferometri ottici)
- barre ultracriogeniche Nautilus (Frascati) e Auriga (Legnaro) (barre risonanti)



- **Spettrometri volanti per studiare la composizione dei raggi cosmici**

- **PAMELA**
- **AMS**



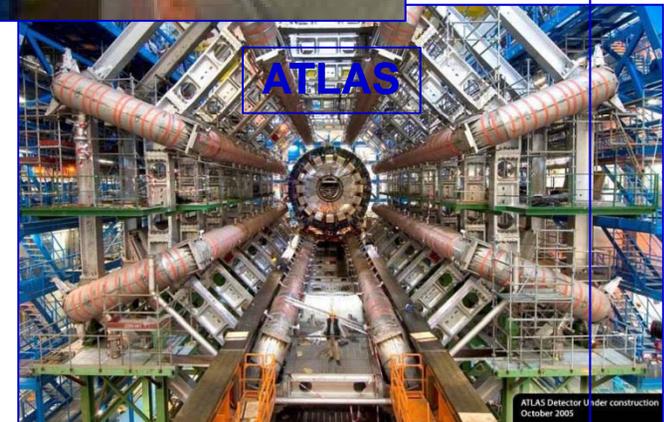
# INFN - SVILUPPO TECNOLOGICO

## I 3 PILASTRI TECNOLOGICI PER LA SPERIMENTAZIONE

- **ACCELERATORI DI PARTICELLE**



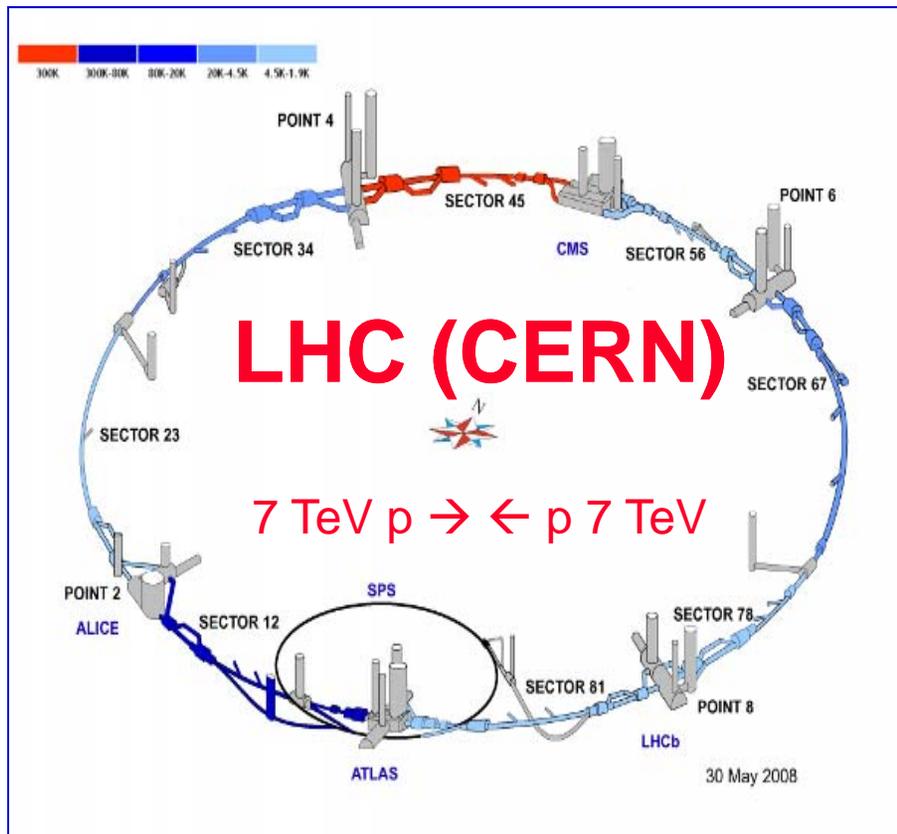
- **RIVELATORI DI PARTICELLE**



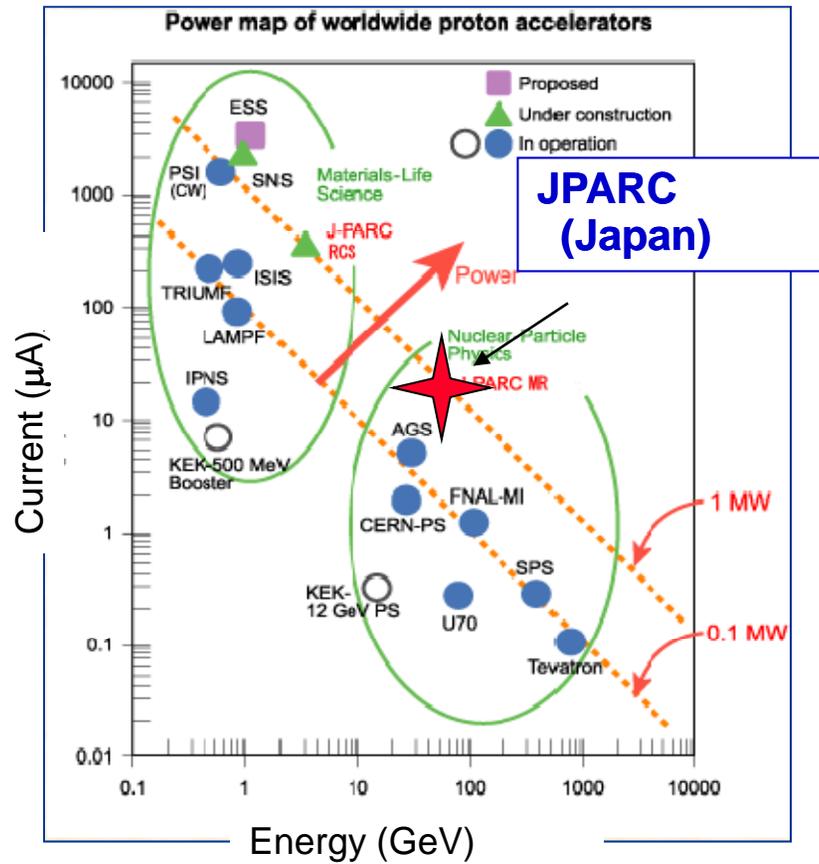
- **CALCOLO**



# particle accelerators with increasing energy and intensity



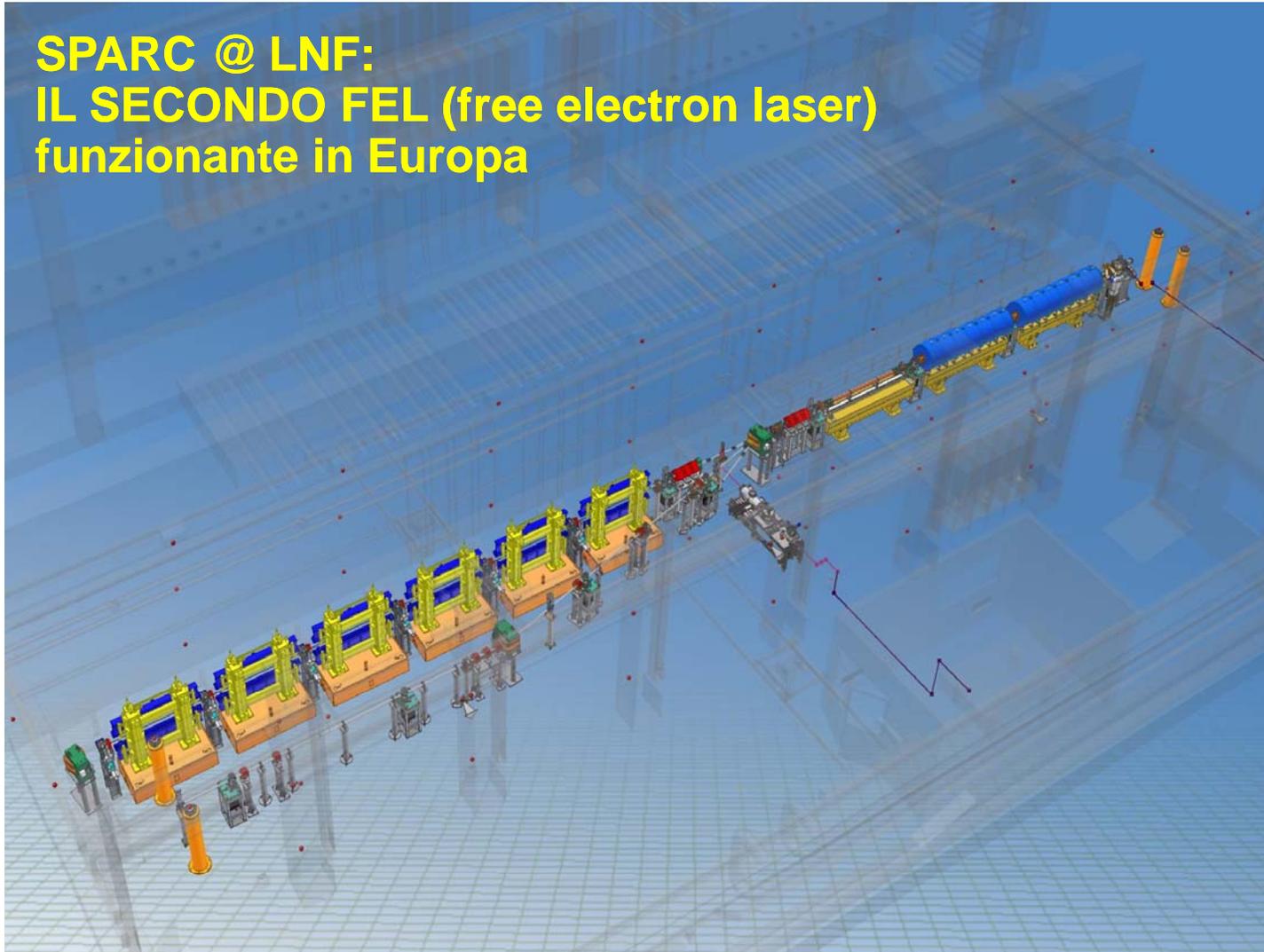
**OPERATION STARTING: 2<sup>ND</sup> HALF 2008**



**OPERATION STARTING: 4<sup>TH</sup> QUARTER 2008**

# TECNICHE ACCELERATICI: IL PIU' RECENTE SUCCESSO DELL' INFN

**SPARC @ LNF:  
IL SECONDO FEL (free electron laser)  
funzionante in Europa**



# IONIZING PARTICLE DETECTORS

- **WHICH RELEVANCE FOR THE PROGRESS OF PHYSICS?**
  - central while designing an experiment is designing an apparatus, namely a suitable collection of detectors, able to measure the interaction under study with the required performance:
    - resolution      efficiency      rate capability      sample purity
  - up to a large extent the experiment and its apparatus cannot be disentangled →  
no progress in physics possible w/o progress in the detector sector
  - detectors are invented, developed, designed and built by the physicists
  - the relevance of detector development is widely recognized
    - an example: NOBEL PRIZE (1993) awarded to George CHARPAK for “for his invention and development of particle detectors, in particular the multiwire proportional chamber”
    - but the list is longer



1927: C.T.R. Wilson, Cloud Chamber  
1939: E. O. Lawrence, Cyclotron & Discoveries  
1948: P.M.S. Blacket, Cloud Chamber & Discoveries  
1950: C. Powell, Photographic Method & Discoveries  
1954: Walter Bothe, Coincidence Method & Discoveries  
1960: Donald Glaser, Bubble Chamber  
1968: Luis Alvarez, Bubble Chamber & Discoveries  
1992: Georges Charpak, Multi Wire Proportional Chamber

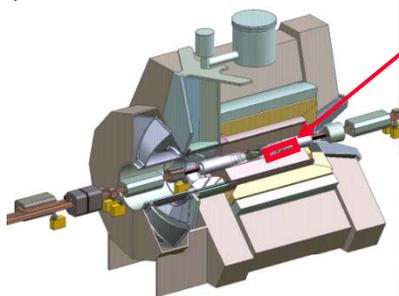
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RIVELATORI, ESEMPI:  
tutte realizzazioni di  
INFN - TRIESTE

# SOLID STATE TRACKERS & TRIESTE



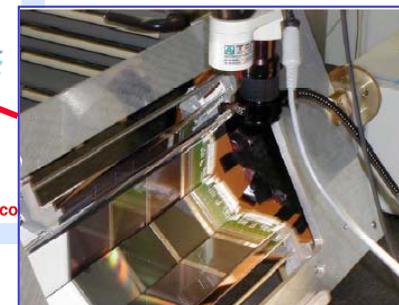
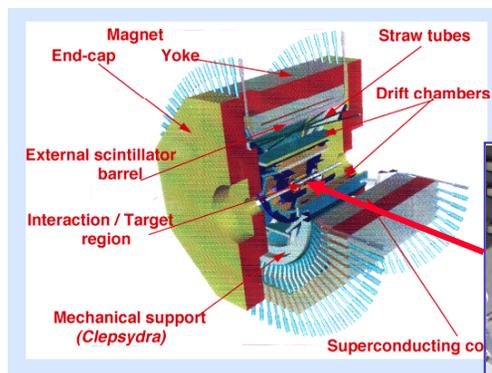
## BABAR @ SLAC B-factory



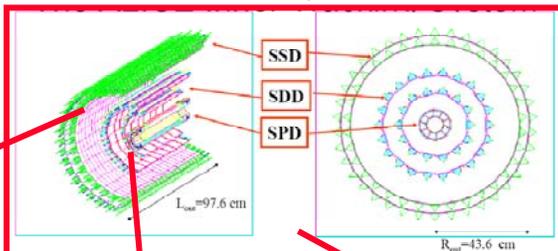
**Silicon Vertex Tracker**  
5 layers (double-sided Si sensors)  
vertexing + tracking (+ dE/dx)



## FINUDA @ Frascati $\Phi$ -factory



## ALICE @ CERN LHC: strips, Si drift detectors



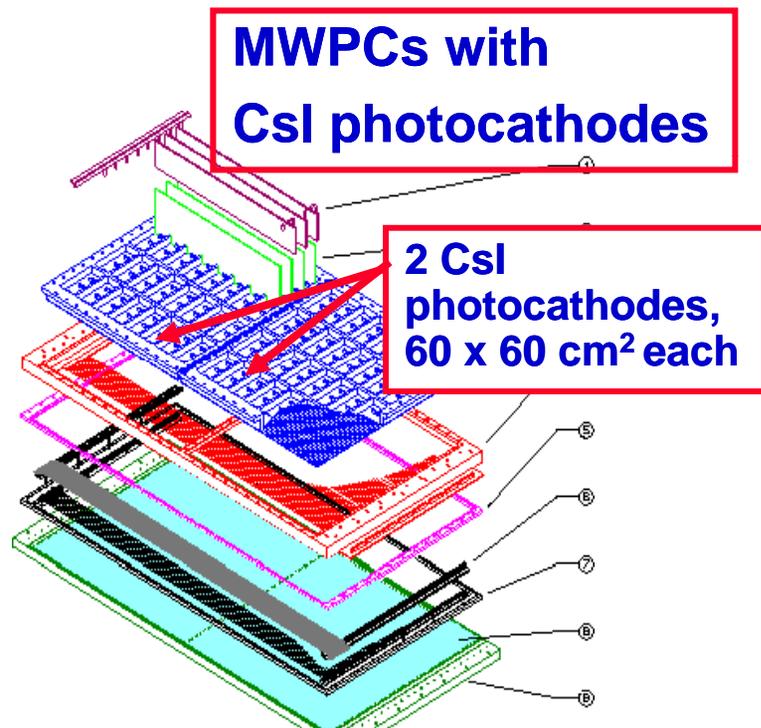
## AGILE, space-born exp. for $\gamma$ astronomy





## THE PRESENT

MWPCs with CsI photocathodes  
for COMPASS RICH-1



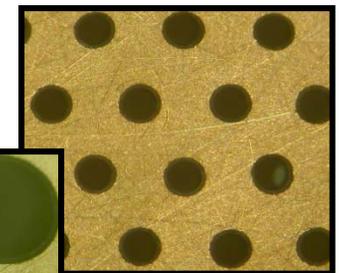
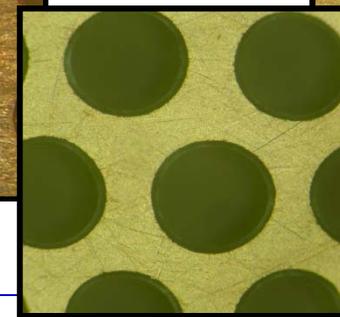
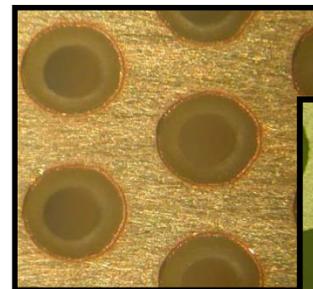
**8 chambers, 5.5 m<sup>2</sup> in total; the largest CsI MWPC system in operation so far**

## TOWARDS THE FUTURE

R&D: THGEM (Thick GEM) based photon detectors for future applications in COMPASS

### Thick GEM-like e-multipliers

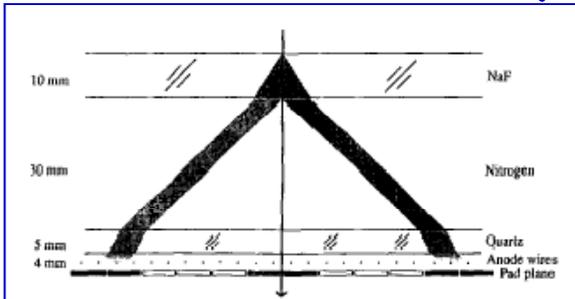
- manufactured by standard PCB
- **drilling** and **Cu etching**
- Coupled to a **reflective** photocathode



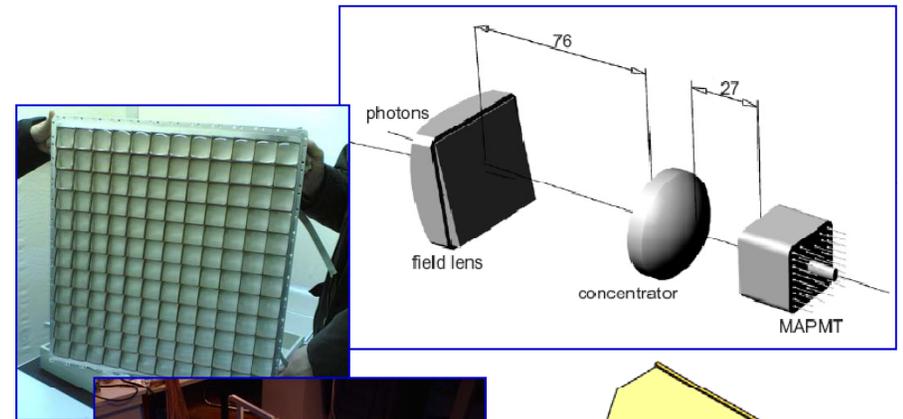
# RICHes AND TRIESTE



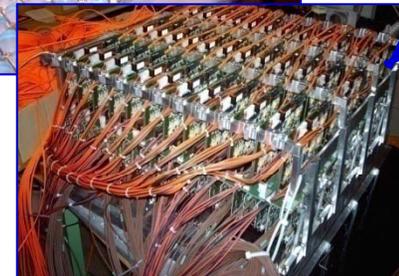
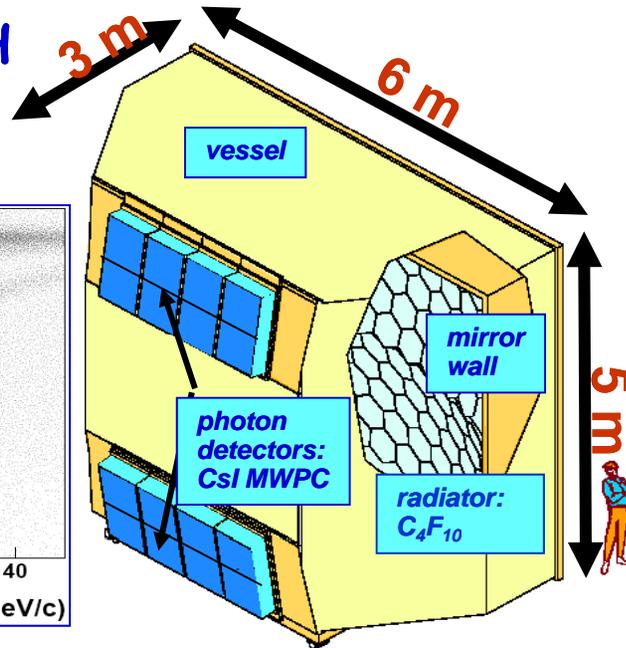
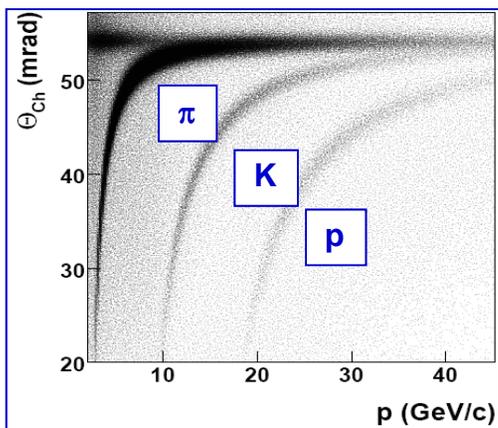
## CAPRICE RICH - the first flying RICH



## COMPASS RICH-1 upgrade upgrade designed in TS the first *fast* RICH



## COMPASS RICH-1 - counter designed in TS the largest RICH in operation



# RICH - THE STATUS OF THE ART



## High tech solutions

### Mirror wall

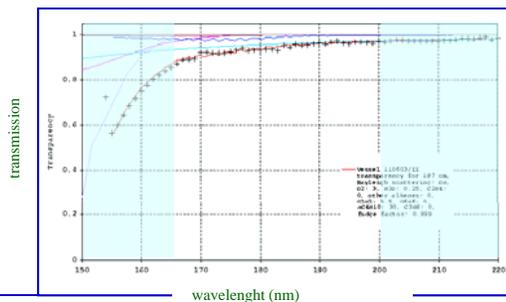
Large surface (21 m<sup>2</sup>) covered with 116 mirrors.  
Radius of curvature: 6.6 m  
VUV reflecting



MIRROR WALL MECHANICS:  
the elements of the modular structure



Very good radiator transparency:  
at left, transmission through 1.87 m, corresponding to:  
H<sub>2</sub>O: ~1 ppm,  
O<sub>2</sub>: ~3 ppm



## Performance

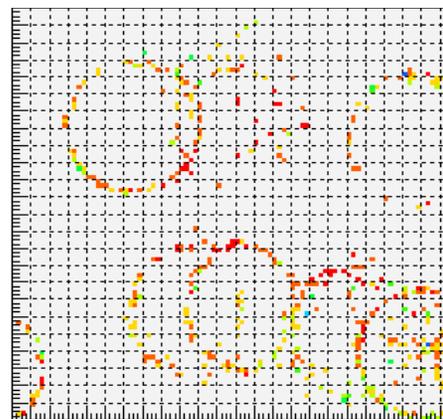
Before and after the RICH-1 Upgrade

Ring resolution: 0.6 mrad → 0.3 mrad

Num. photons per ring at saturation

14 → 56

Reconstructed hadron mass spectrum

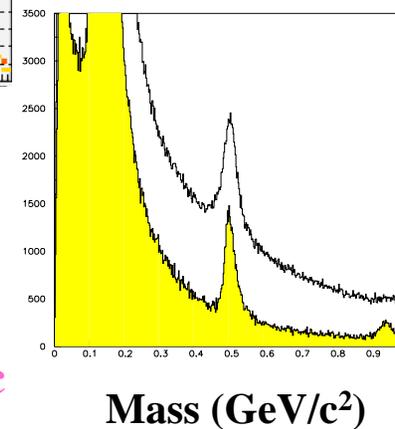


K id efficiency

60% → 95%

2σ π-K separation at

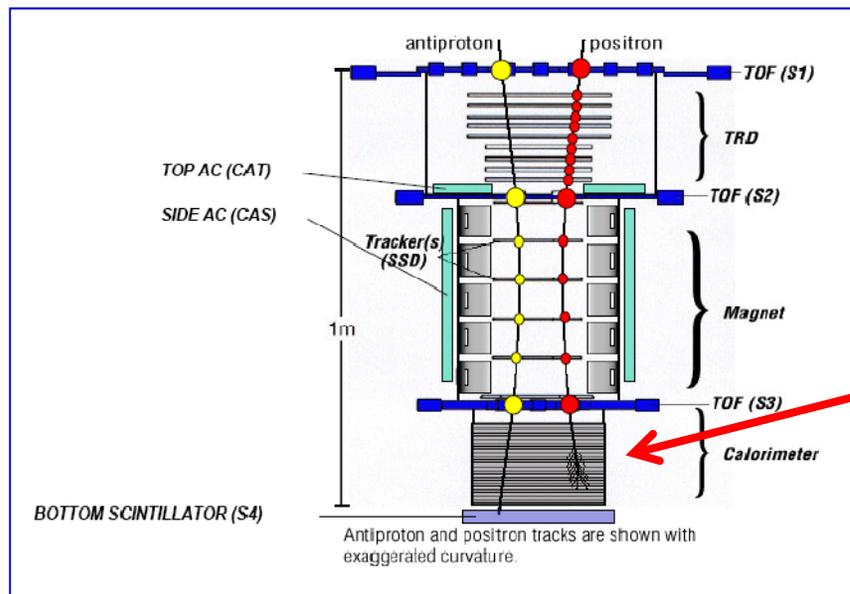
43 GeV/c → 55 GeV/c



# ELECTROMAGNETIC CALORIMETERS

## SAMPLING

- Si - Cosmic ray composition in a space-born experiment  
Si-W calorimeter for PAMELA

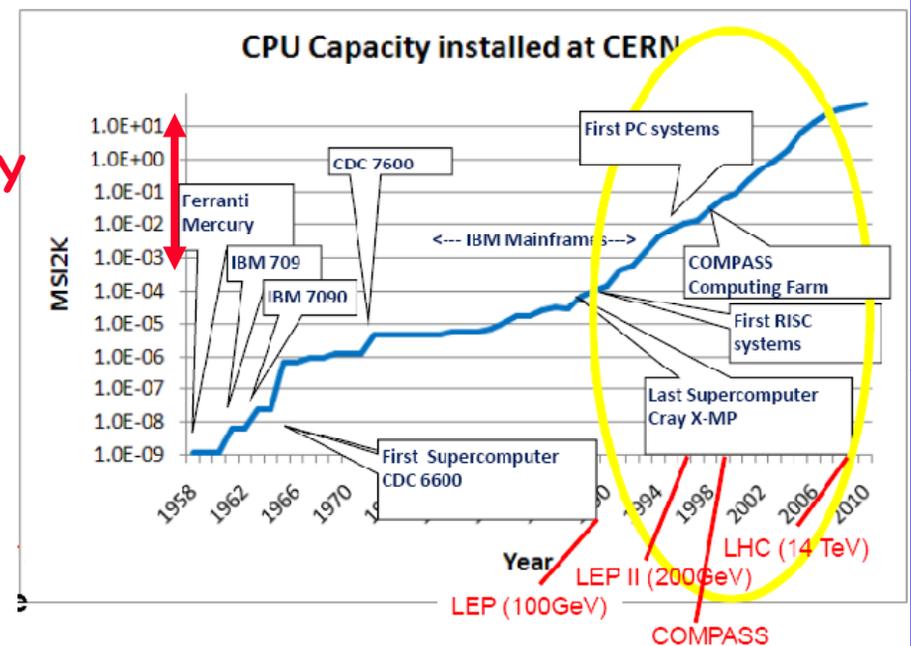


# computing power and techniques to digest information in the petabyte range

- about CPU capacity:  
@ CERN  
5 ORDERS OF MAGNITUDE IN 18 Y

- about amount of data:
  - COMPASS > 0.3 PB / year (running)
  - LHC experiments: 1.5 PB / year (expected)

- about techniques: **the GRID**
  - an infrastructure that provides seamless access to computing power and data storage capacity distributed over the globe





# Computer Farm



computer farm is a group of networked servers that are housed in one location. A computer farm streamlines internal processes by distributing the workload between the individual components of the farm and expedites computing processes by harnessing the power of multiple servers. The farms rely on load-balancing software that accomplishes such tasks as tracking demand for processing power from different machines, prioritizing the tasks and scheduling and rescheduling them depending on priority and demand that users put on the network. When one server in the farm fails, another can step in as a backup.

## Yesterday (2001): The Compass Trieste Farm

- "White box" dual single core 1 GHz processor PCs, 512 MB RAM  
(~ 0.8 kSI2k)

- PC disk servers (up to 1 TB/machine), few TB of total storage

First Computer Farm in Italy completely managed by *INFN*

## Today (2008): The *INFN Trieste Farm*

- "Rack-mount" dual quad-core >2 GHz processor PCs, 16 GB RAM  
(~ 9.6 kSI2k)

- General Parallel File System, >70 TB of total storage

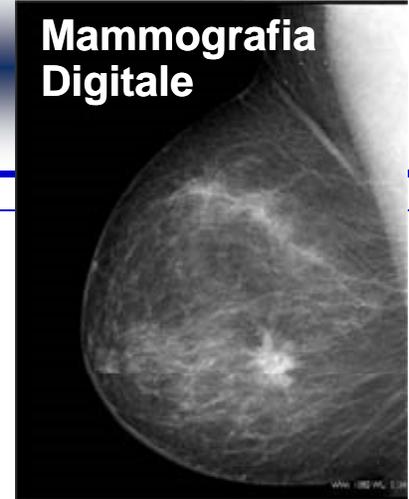
- Open to GRID activities

But GRID Tiers, it is one of the biggest *INFN farms installed nowadays*



9-11/4/2010

INFN



## Tecnologie e applicazioni interdisciplinari

### ■ Applicazioni mediche

- **Diagnostica** (mammografia digitale)
- **Progetto CALMA** : un sistema di acquisizione e di analisi di immagini mammografiche (supporto automatico allo screening)
- **Cura**
  - **Tumori dell'occhio a LNS**: fasci di protoni dal ciclotrone superconduttore
  - La costruzione del **CNAO** (Ministero Salute, INFN: co-direzione dell'alta tecnologia): fasci di protoni e ioni di Carbonio per trattamenti oncologici

### ■ **tecniche non distruttive per la salvaguardia dei beni culturali**

- **Datazione e analisi con tecniche**
  - **IBA** (Ion Beam Analysis) e
  - **AMS** (Accelerator Mass Spectrometry)
- **Datazione determinando la presenza di isotopi rari ( $^{14}\text{C}$ )**

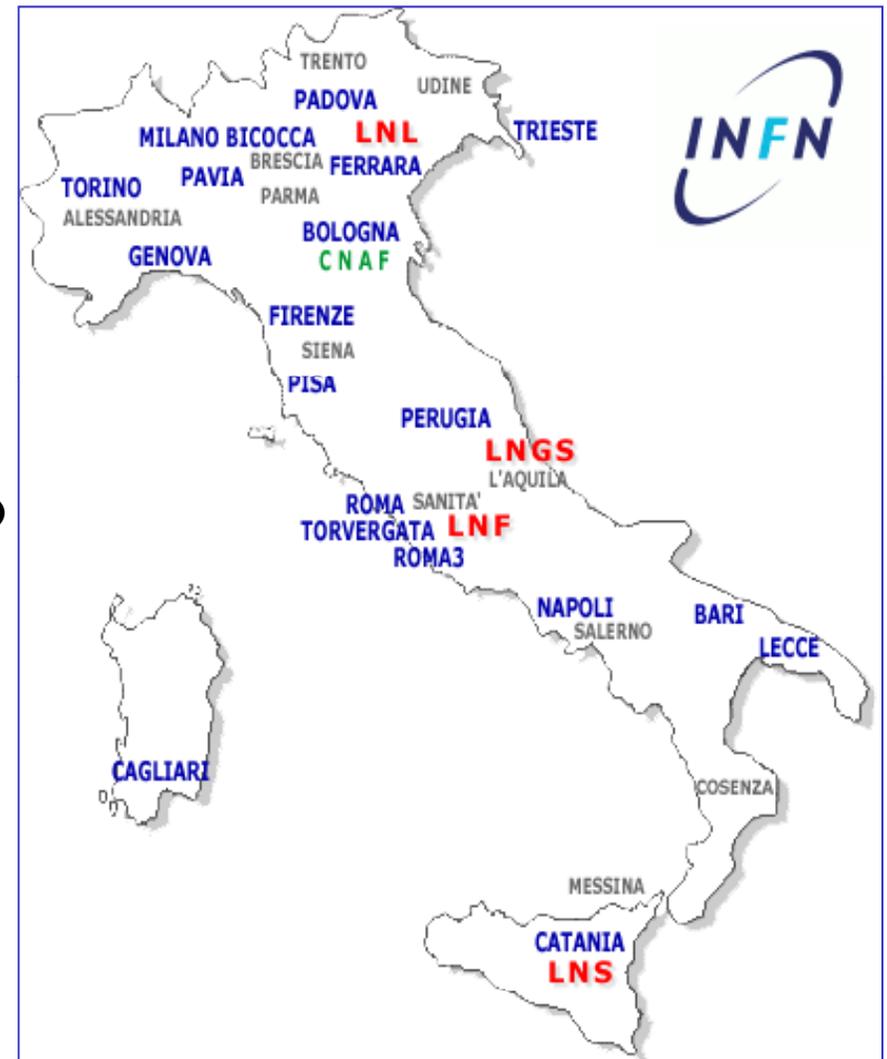


**... ECCETERA ...**

quanto abbiamo fugacemente visto assieme e' solo un campionario rappresentativo dell'attivita' INFN

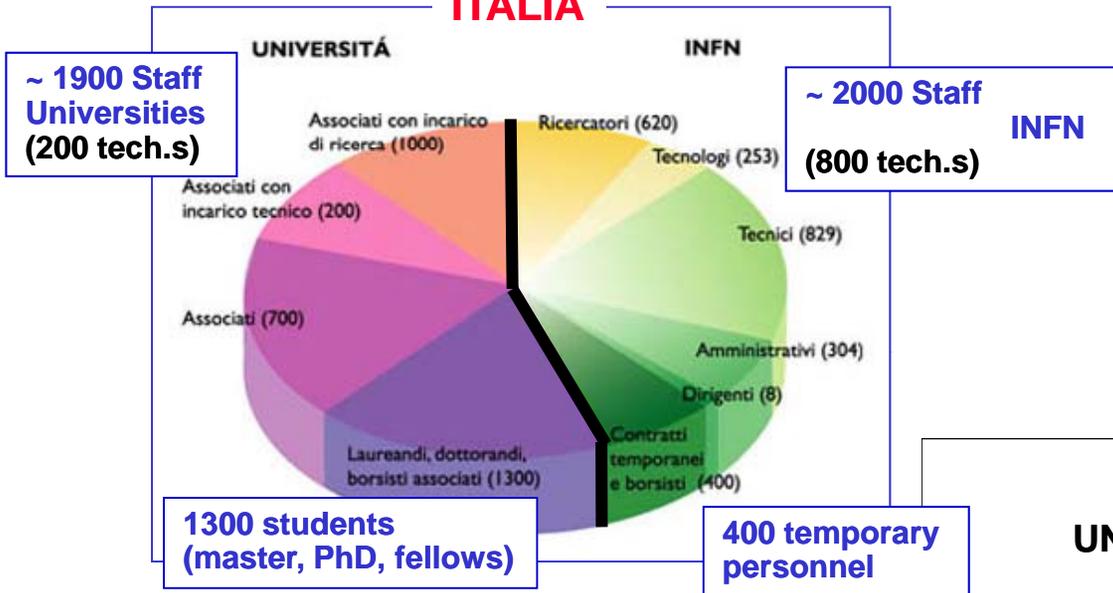
# INFN - struttura

- **4 Laboratori Nazionali**
  - **LNL** - Laboratori Nazionali di Legnaro
  - **LNGS** - Laboratori Nazionali del Gran Sasso
  - **LNF** - Laboratori Nazionali di Frascati
  - **LNS** - Laboratori Nazionali del SUD
- 20 "Sezioni" c/o 20 Università (fra cui **Trieste**)
- 11 "Gruppi Collegati", c/o Università (fra cui **Udine**, che è Gruppo collegato di Trieste)



# INFN - personale

## ITALIA



## TRIESTE

