INFN:

Istituto Nazionale di Fisica Nucleare

INFN, perchè?

dal nostro sito WEB

- " INFN : istituito 8 agosto 1951 da gruppi delle Università di Roma, Padova, Torino e Milano per 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.* "

- *Non è semplicemente una collaborazione fra 4 Università*

- La ricerca in fisica nucleare e poi delle particelle ha bisogno di STRUTTURE e risorse per realizzarle:
  - *Laboratori*
  - *Officine*
  - *Personale tecnico (e amministrativo)*

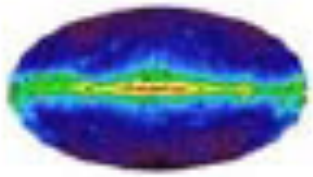
INFN, cos'è ?

- INFN, è l'istituto che promuove, coordina ed effettua la ricerca scientifica in fisica nucleare, subnucleare e astroparticellare, nonché lo sviluppo tecnologico necessario alle attività in tali settori

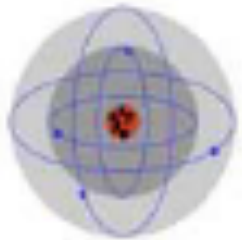
- Opera in stretta connessione con l'Università e nell'ambito della collaborazione e del confronto internazionali.

- Le attività di ricerca sono così raggruppate:

FISICA PARTICELLARE



FISICA ASTROPARTICELLARE



FISICA NUCLEARE

FISICA TEORICA

RICERCA TECNOLOGICA

L' INFN & LA FISICA CON GLI ACCELERATORI

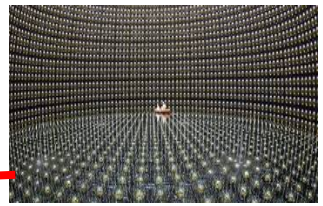
PARTICELLE & NUCLEI

ALICE @ LHC
CERN, Ginevra

ZEUS @ HERA
DESY, AMBURGO

Cavita' Superconduttive
LNL, Legnaro

KLOE @ DAFNE
LNF, FRASCATI

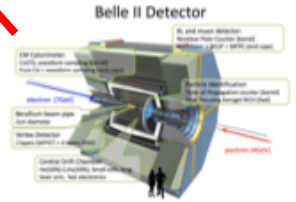


superKamiokande
@ TOKAI, Giappone

BABAR
SLAC, California

CDF @ Tevatron
FERMILAB, Chicago

LABORATORI NAZIONALI DELL' *INFN*

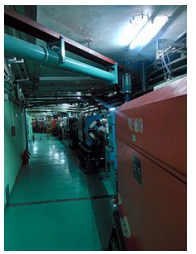


BELLE II @ KEK,
Giappone

AIACE @ Jefferson LAB
Virginia

Ciclotrone Superconduttore
LNS, Catania

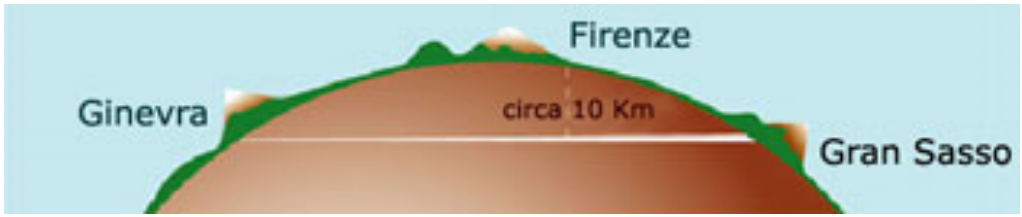
BESS III,
Pechino

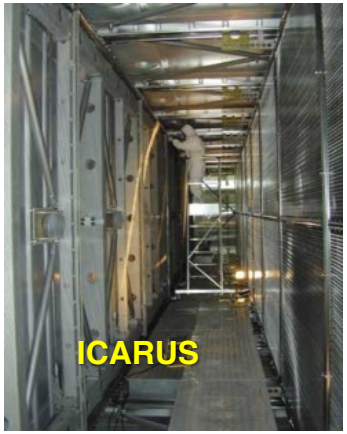


L' INFN & LA FISICA SENZA ACCELERATORI 1/2

ASTROPARTICELLE, NEUTRINI & EVENTI RARI

- **Neutrini ν da**
  - **Sorgenti astrofisiche**: laboratori nelle profondità marine KM3NET (Sicilia)
  - **Sole e supernovae** : esperimenti BOREX, LVD @ LNGS
  - **Acceleratori** : esperimenti ICARUS @ LNGS, JUNO @ Japan



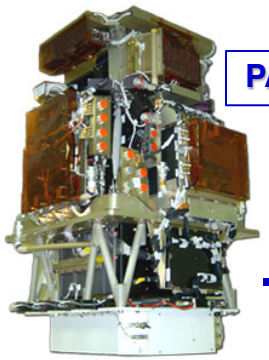


- **Ricerca di segnali di materia oscura**
  - Al Gran Sasso, grazie al silenzio della montagna: DAMA, CRESST, DARKSIDE, XENON

L' INFN & LA FISICA SENZA ACCELERATORI 2/2

ASTROPARTICELLE, NEUTRINI & EVENTI RARI

- **Segnali dal cosmo**
  - Raggi gamma di altissima energia
    - MAGIC, CTA
  - Raggi gamma di alta energia
    - AGILE, Fermi
- **Onde gravitazionali prodotte da masse accelerate:**
  - VIRGO, in Toscana (interferometri ottici)
  - LISA-PF
- **Spettrometri volanti per studiare la composizione dei raggi cosmici**
  - PAMELA-GAPS
  - AMS02

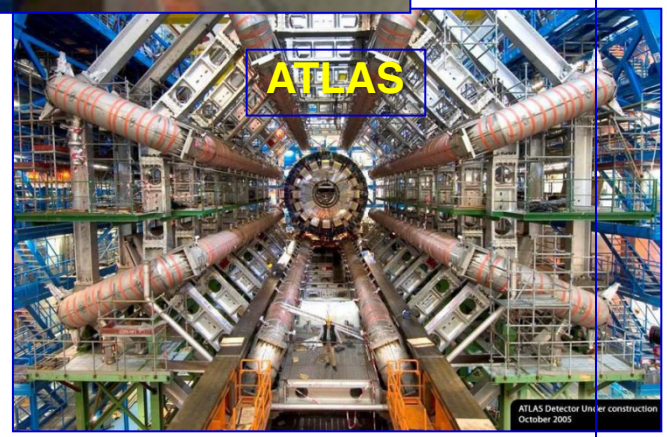


INFN – SVILUPPO TECNOLOGICO

I 3 PILASTRI TECNOLOGICI PER LA SPERIMENTAZIONE

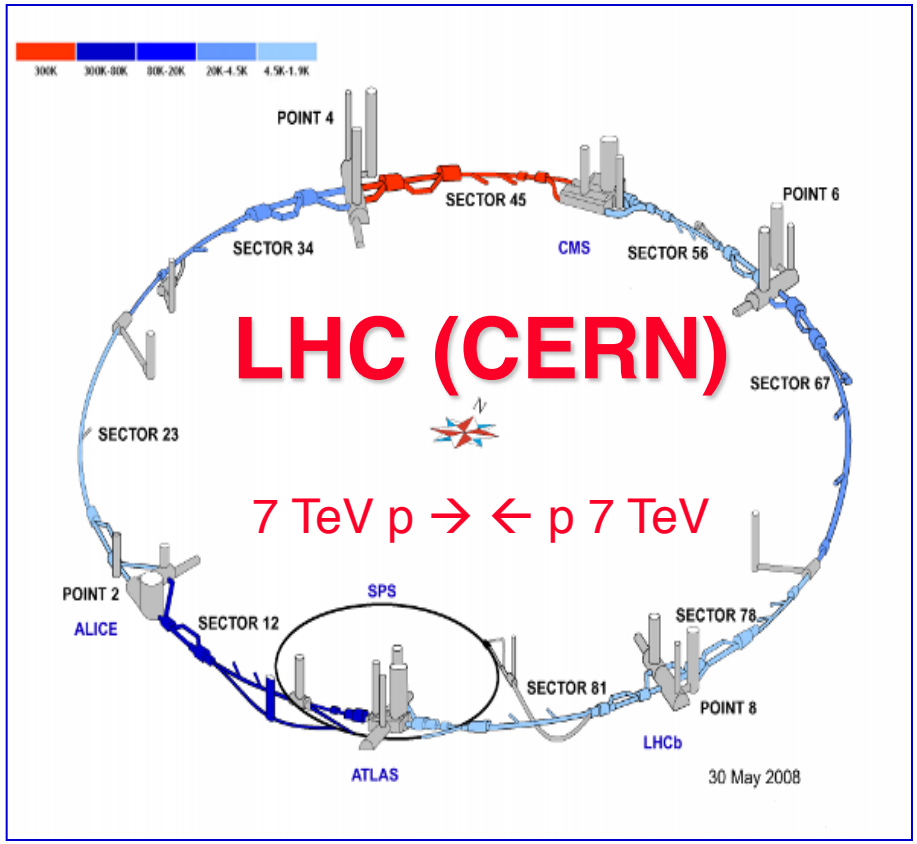
- ACCELERATORI DI PARTICELLE

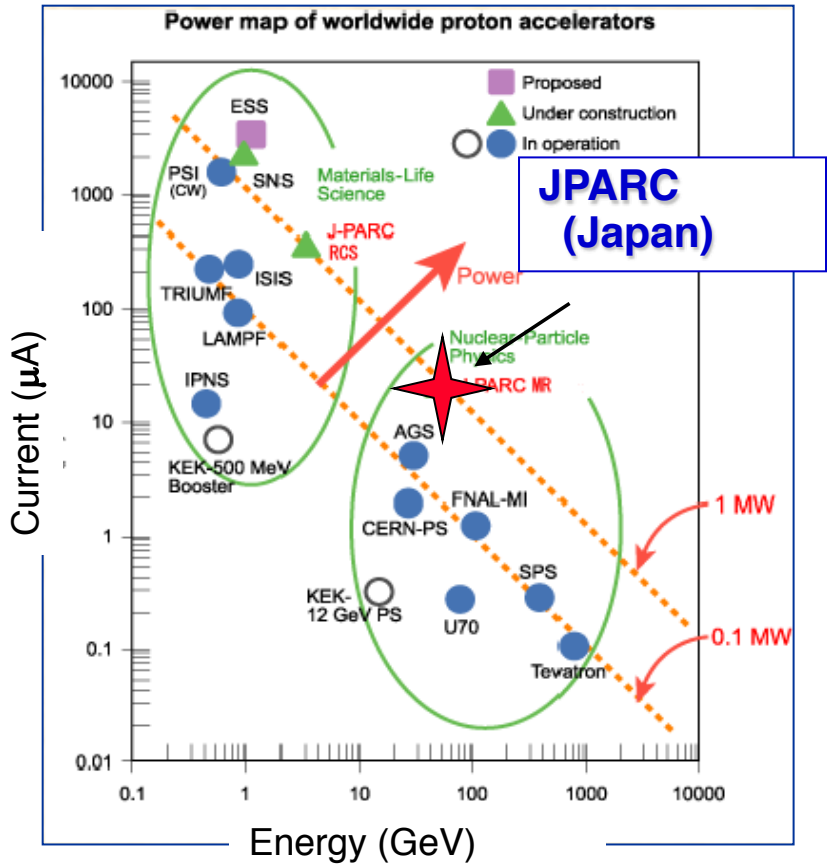
- RIVELATORI DI PARTICELLE



- CALCOLO

particle accelerators with increasing energy and intensity





JPARC (Japan)

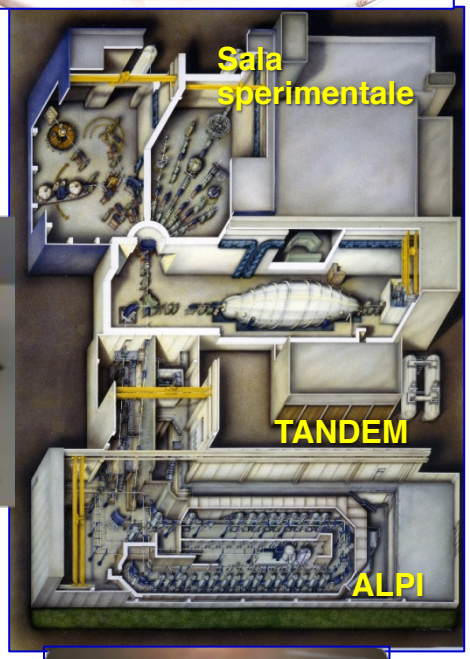
Reached 6.5 + 6.5 = 13 TeV Collision energy in june 2015

OPERATION STARTED: 4TH QUARTER 2008

MACCHINE ACCELERATRICI

Presso i laboratori nazionali

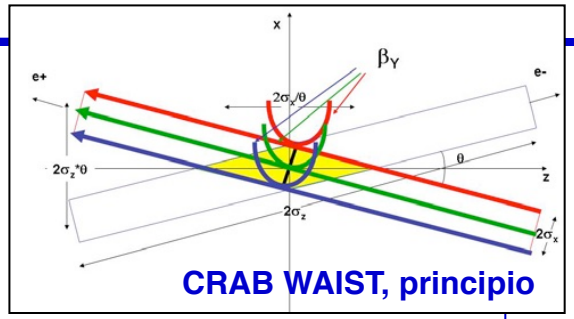
- LNF (Frascati)
  - DAFNE (collisionatore elettrone-positrone)
  - SPARC (FEL) – il secondo in operazione in Europa
    - Collaborazione con Fermi (Sincrotrone TS)
- LNL (Legnaro, PD)
  - 3 acceleratori elettrostatici di ioni: CN, AN2000, Tandem
  - ALPI – linac superconduttore
  - Inaugurato il 3 dicembre 2016 : SPES
    - studio ioni esotici
    - radionuclidi per il medicale
- LNS (Catania)
  - Tandem
  - Ciclotrone superconduttore
    - Anche terapia oncologica
  - EXCYT – fasci radioattivi



MACCHINE ACCELERATRICI

SVILUPPI (esempi)

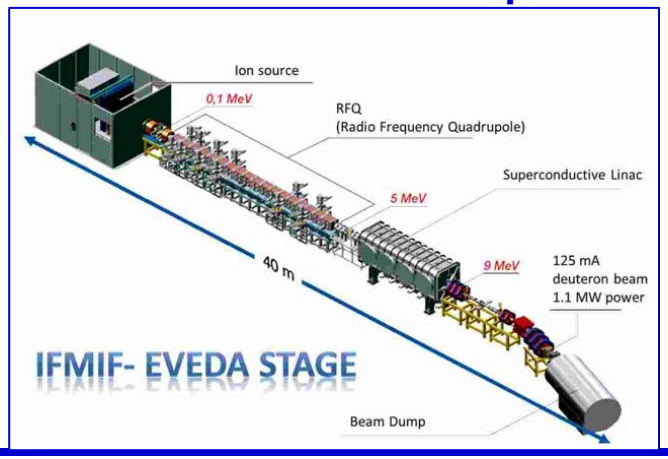
- **LNF (Frascati)**
  - **Crab waist collision per aumentare la luminosità nei collisionatori elettroni/positrioni**
    - **Invenzione italiana che sarà usata in Giappone (Belle 2)**



CRAB WAIST, principio

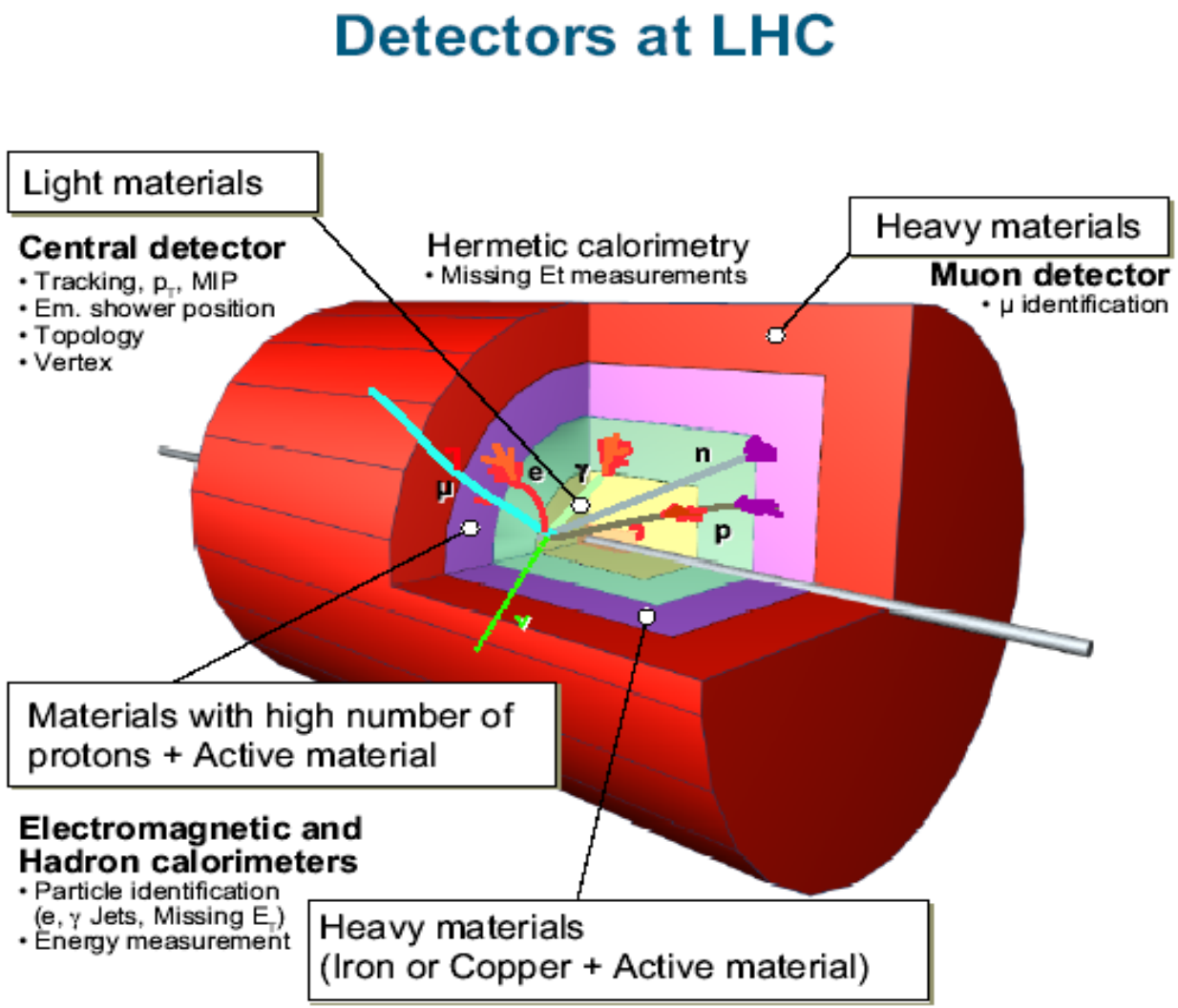
- **LNL (Legnaro, PD)**
  - **RFQ (Radio Frequency Quadrupole): 10 m, protoni 5 MeV con potenza 200 kW (record mondiale)**
  - **Iniettore Pb per LHC (CERN)**
  - **IFMIF (dimostratore di iniettore per ITER)**


LNL, RFQ

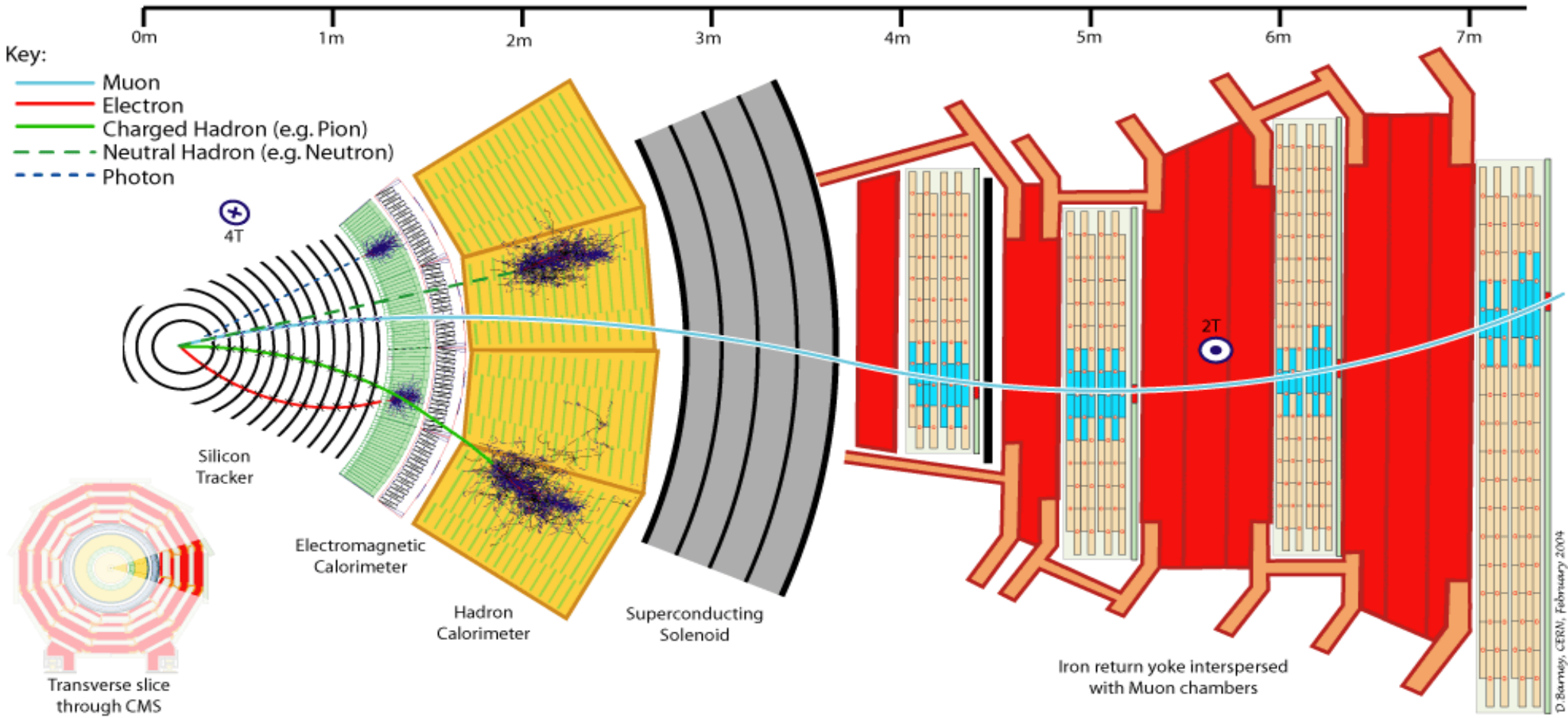


RIVELATORI

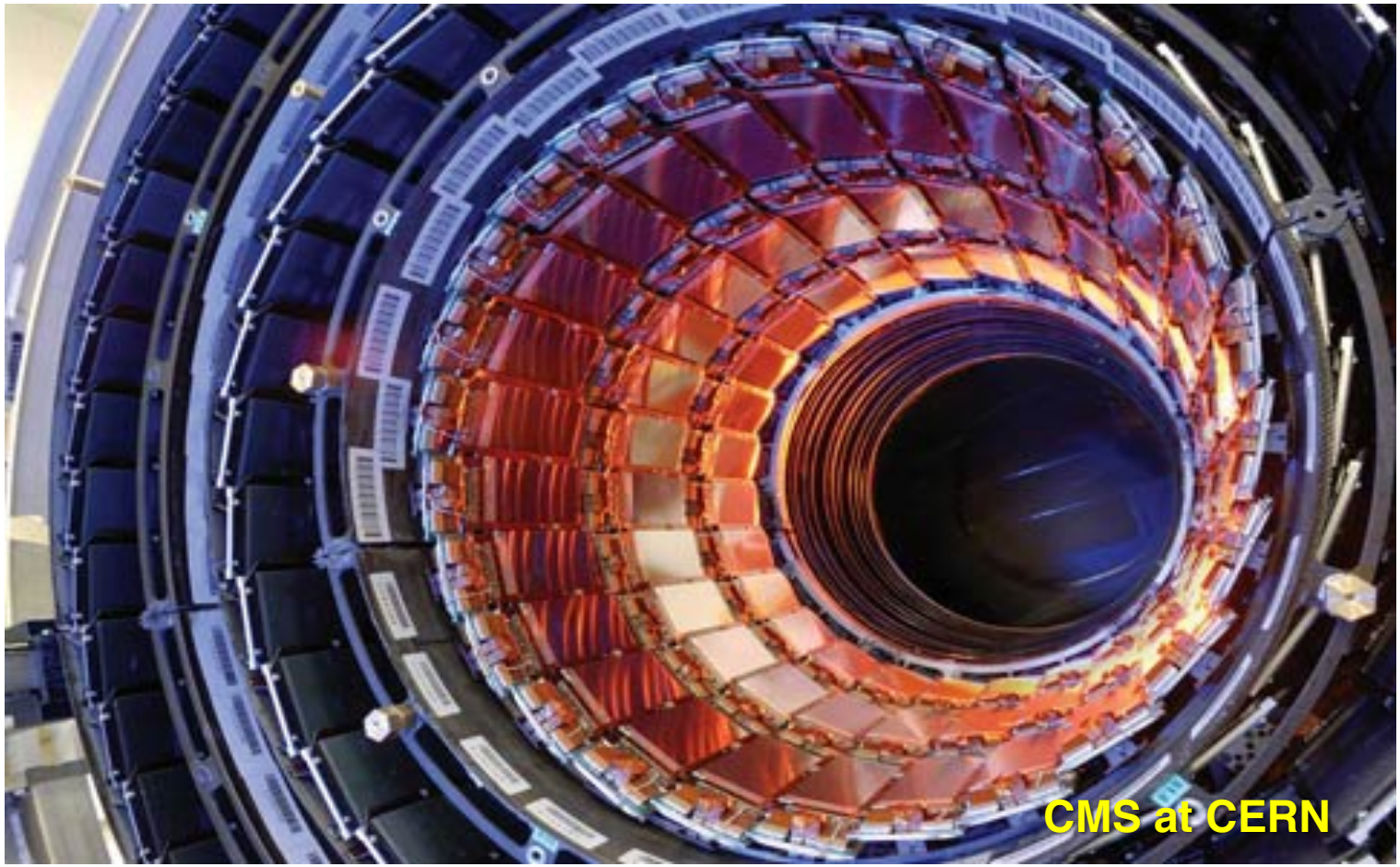
Un tipico rivelatore



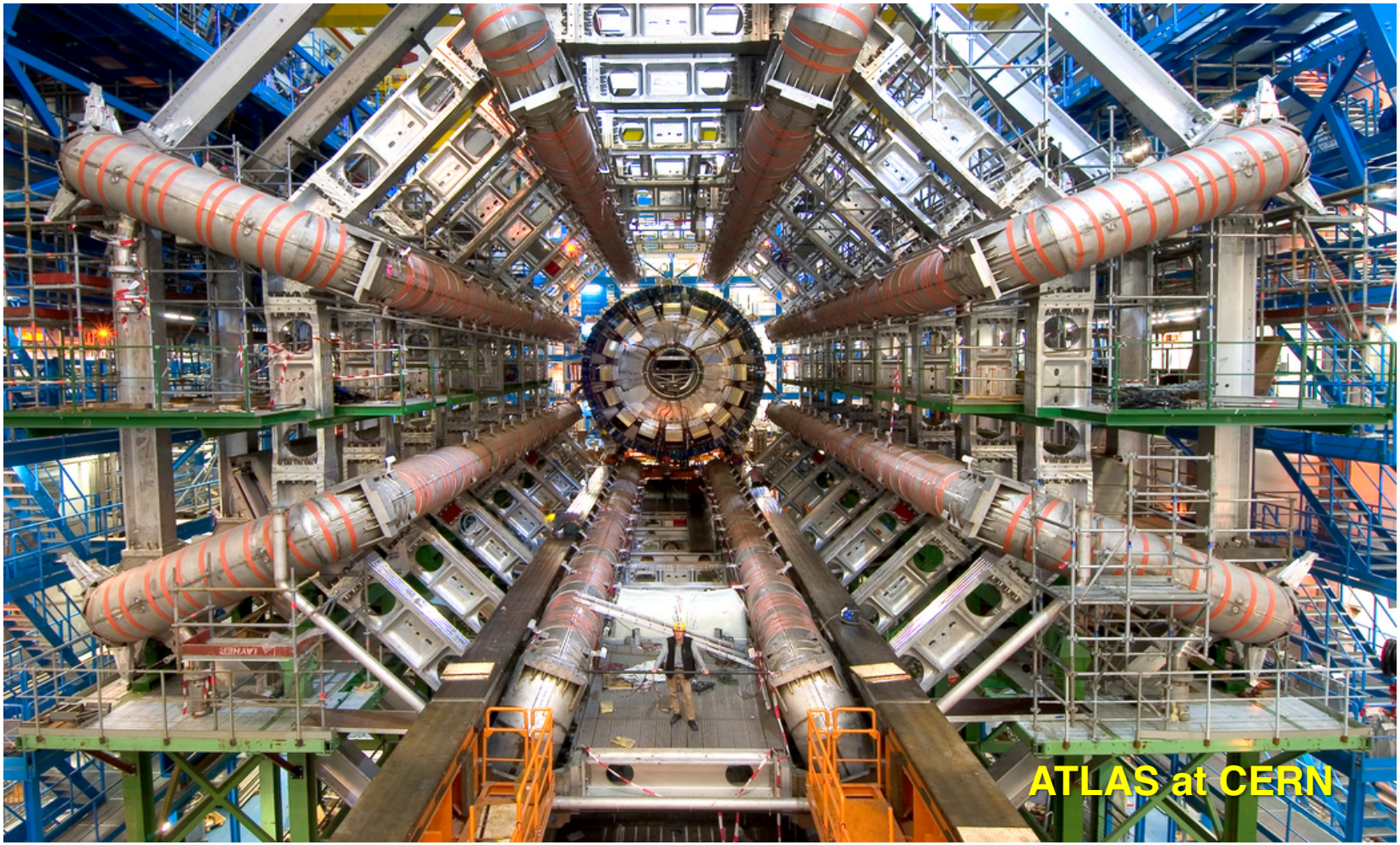
Indentificazione di particelle



Tracciatori



Campi Magnetici



Calorimetri

RIVELATORI:

Realizzazioni

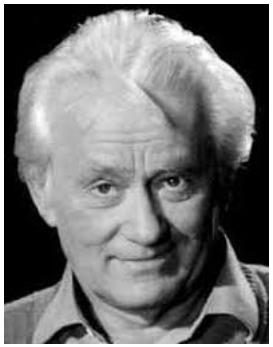
@INFN - TRIESTE

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

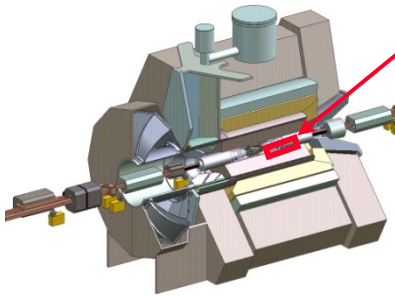
      "his invention and development of particle detectors, in particular the MultiWire Proportional Chamber (MWPC)"
    - but the list is longer



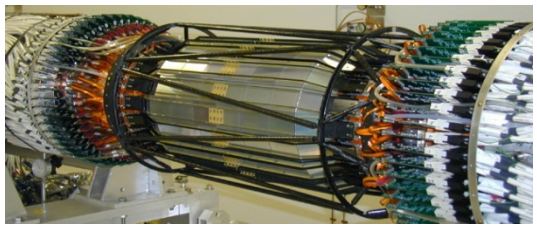
1927: C.T.R. Wilson, Cloud Chamber
1939: E. O. Lawrence, Cyclotron & Discoveries
1948: P.M.S. Blacket, Cloud Chamber & Disccoveries
1950: C. Powell, Photographic Method & Discoveries
1954: Walter Bothe, Coincidence Method & Discoveries
1960: Donald Glaser, Bubble Chamber
1968: Luis Alvarez, Bubble Chamber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

Solid State Trackers @Trieste

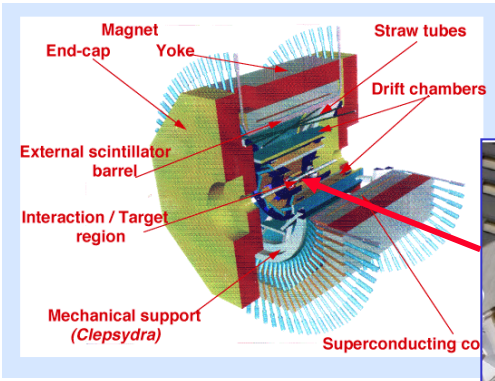
BABAR @ SLAC

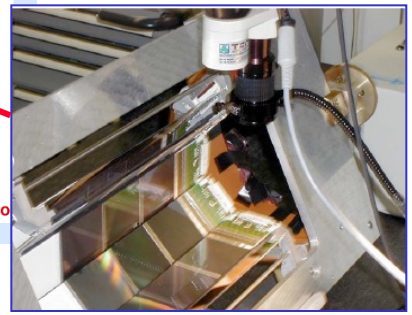


Silicon Vertex Tracker
5 layers (double-sided Si sensors)
vertexing + tracking (+ dE/dx)

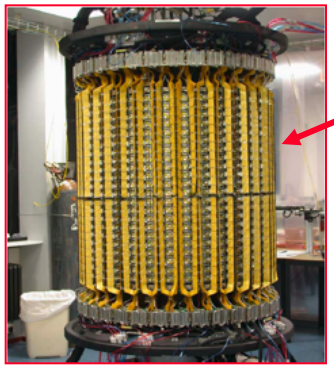


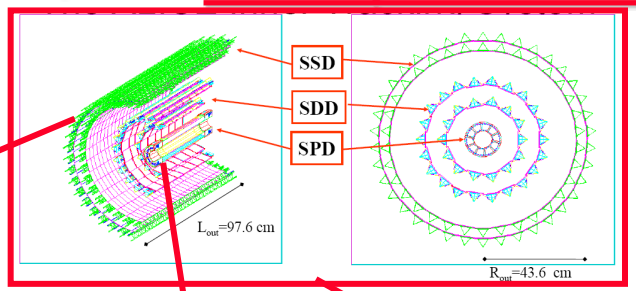
FINUDA @ Frascati Φ-factory

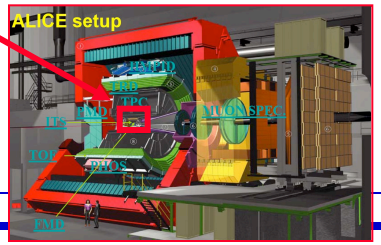




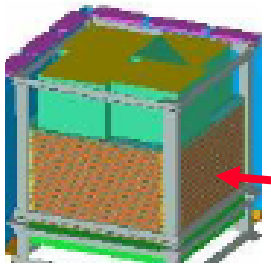
ALICE @CERN LHC: Si strip/drift detectors

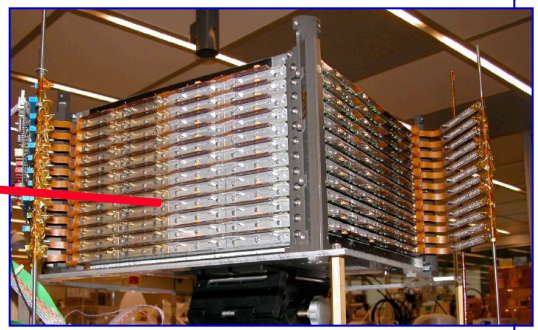




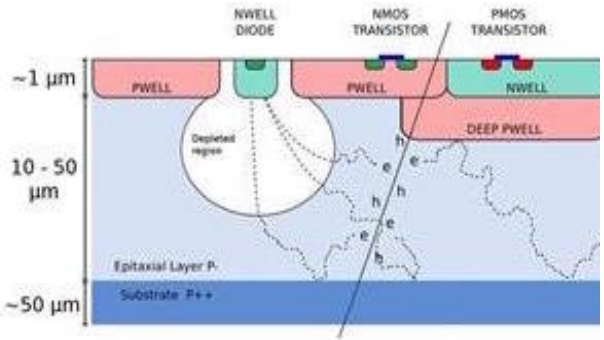


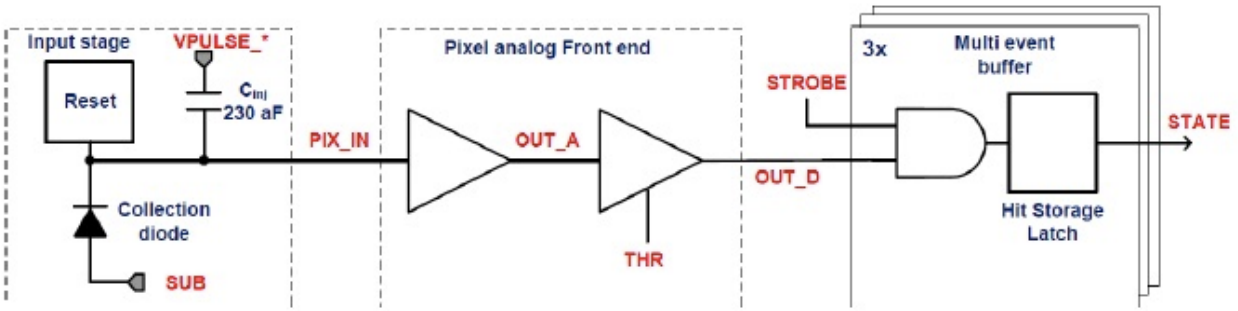
AGILE, space-born exp. for γ astronomy





Monolithic Active Pixel Sensors (MAPS) @Trieste

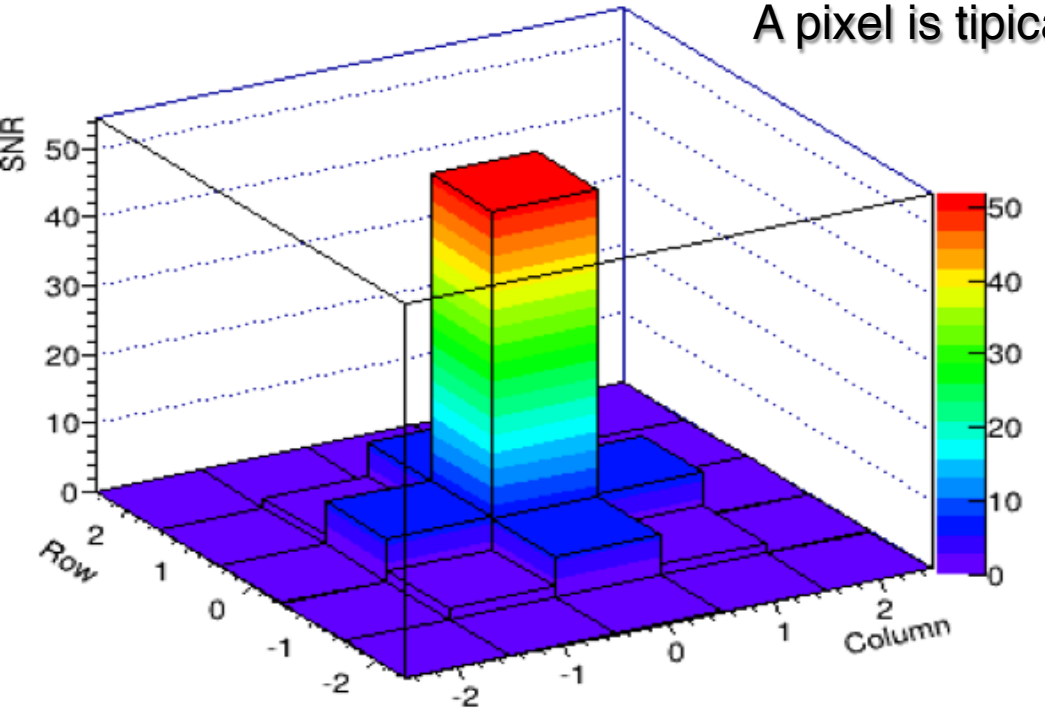


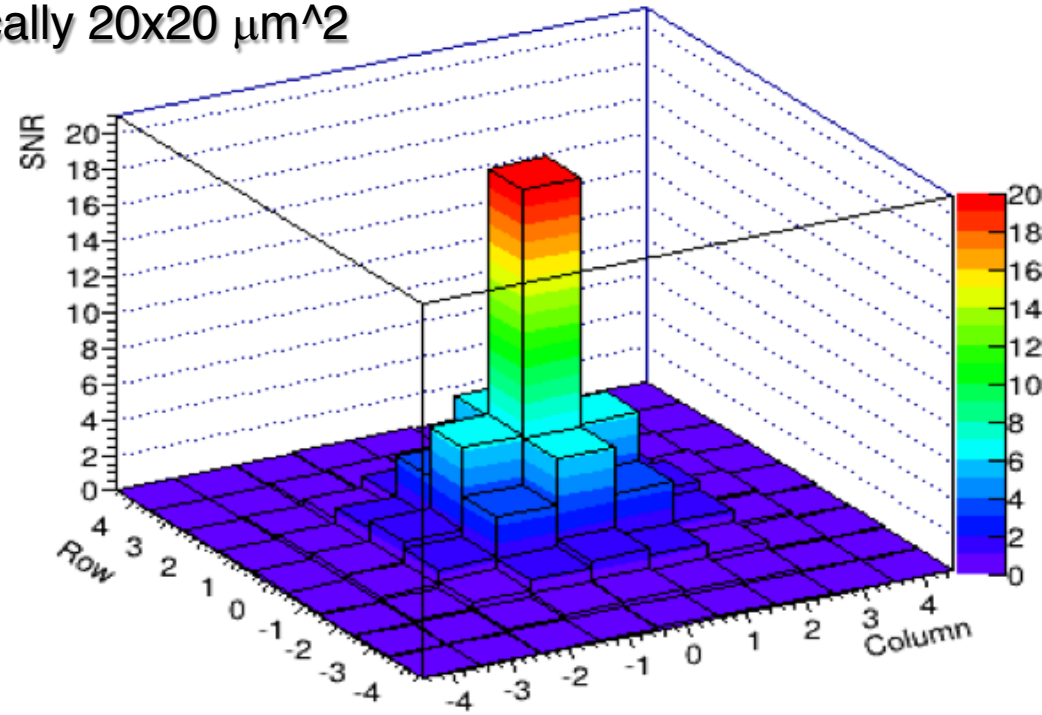


Average P4 cluster

Average P15 cluster

A pixel is tipically 20x20 µm^2



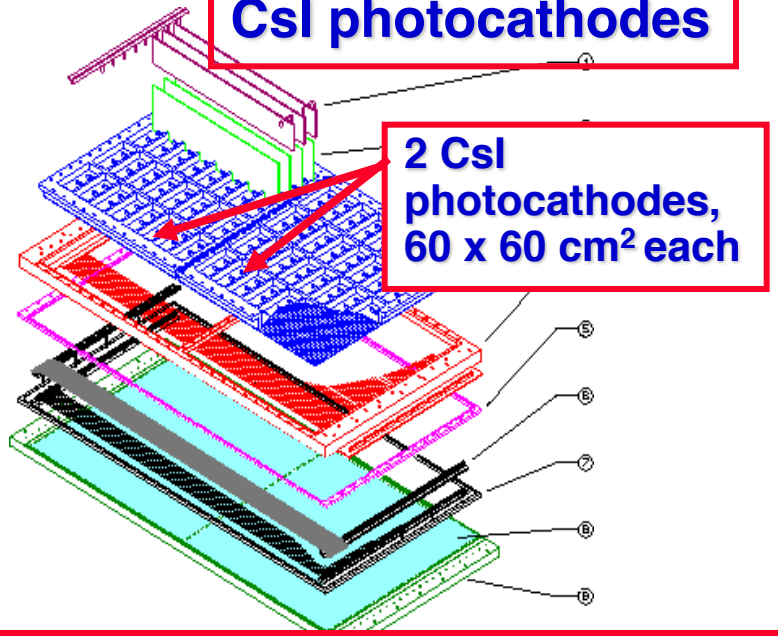


Single Photon Gaseous Detectors @Trieste

THE PRESENT

MWPCs with CsI photocathodes for COMPASS RICH-1

MWPCs with CsI photocathodes



2 CsI photocathodes, 60 x 60 cm^2 each

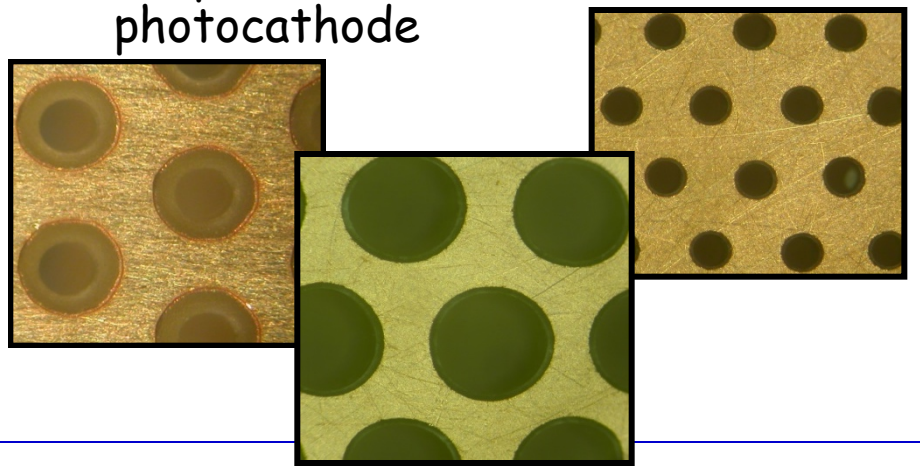
8 chambers, 5.5 m^2 in total; the largest CsI MWPC system in operation so far

TOWARDS THE FUTURE

R&D: THGEM (THick Gas Electron Multiplier) based photon detectors for future applications in COMPASS

Thick GEM-like e-multipliers

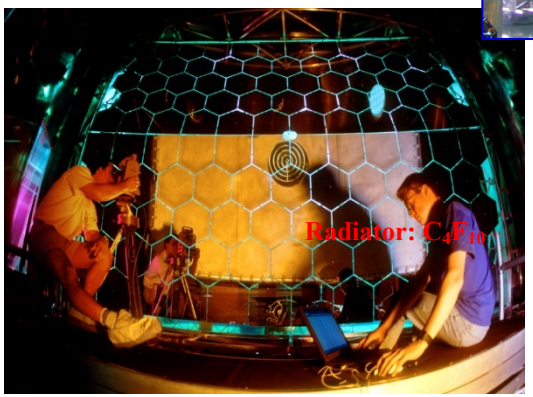
- manufactured by standard PCB
- **drilling** and **Cu etching**
- Coupled to a reflective photocathode



RICH @Trieste

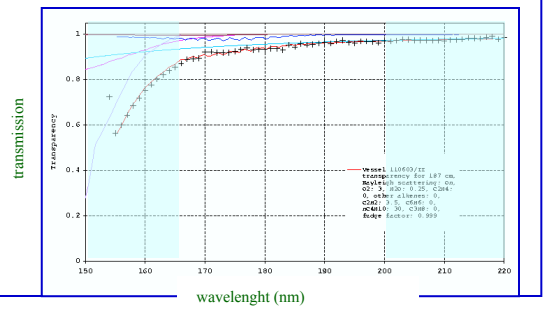
High tech solutions

Mirror wall
Large surface (21 m^2)
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_2O: ~1 ppm,
O_2: ~3 ppm

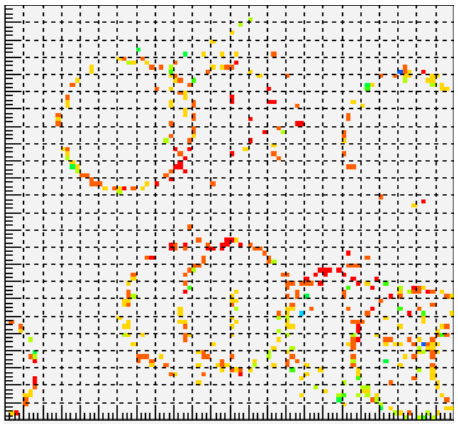


Performance

Before and **after** the RICH-1 Upgrade

Ring resolution: **0.6 mrad** → **0.3 mrad**

Num. photons per ring at saturation

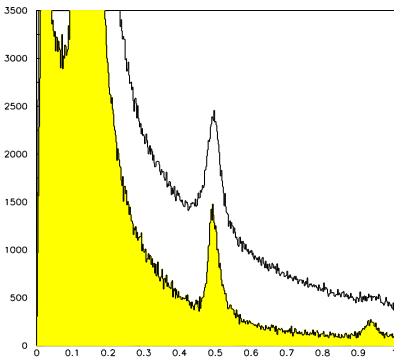


14 → **56**

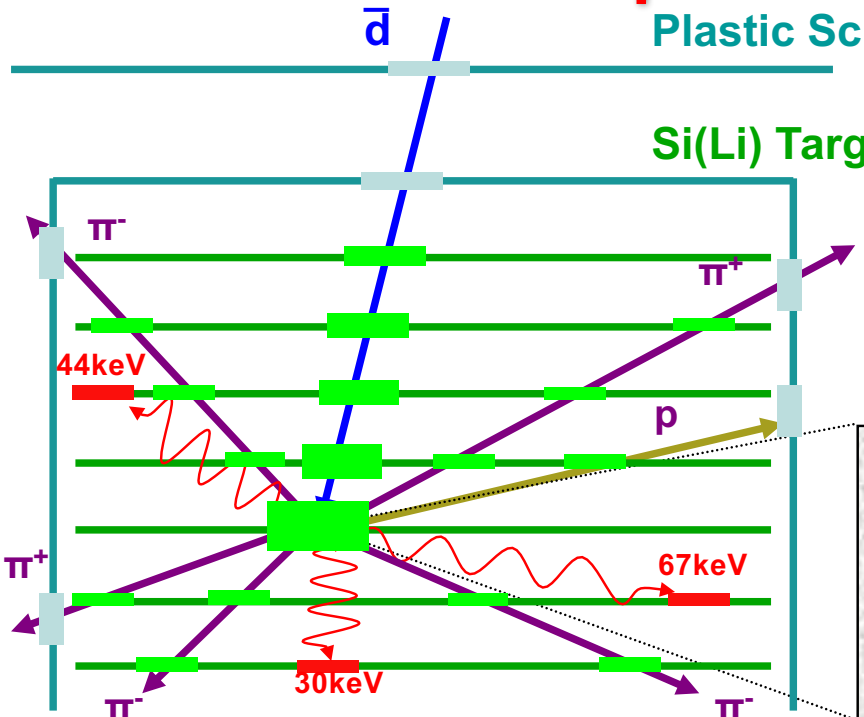
K id efficiency
60% → **95%**

2σ π-K separation at
43 GeV/c → **55 GeV/c**

Reconstructed hadron mass spectrum



GAPS detects atomic X-rays and annihilation products from exotic atoms

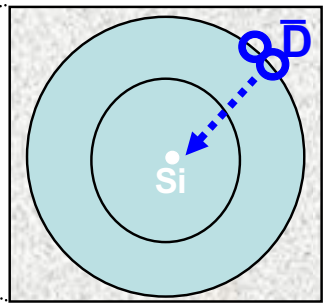


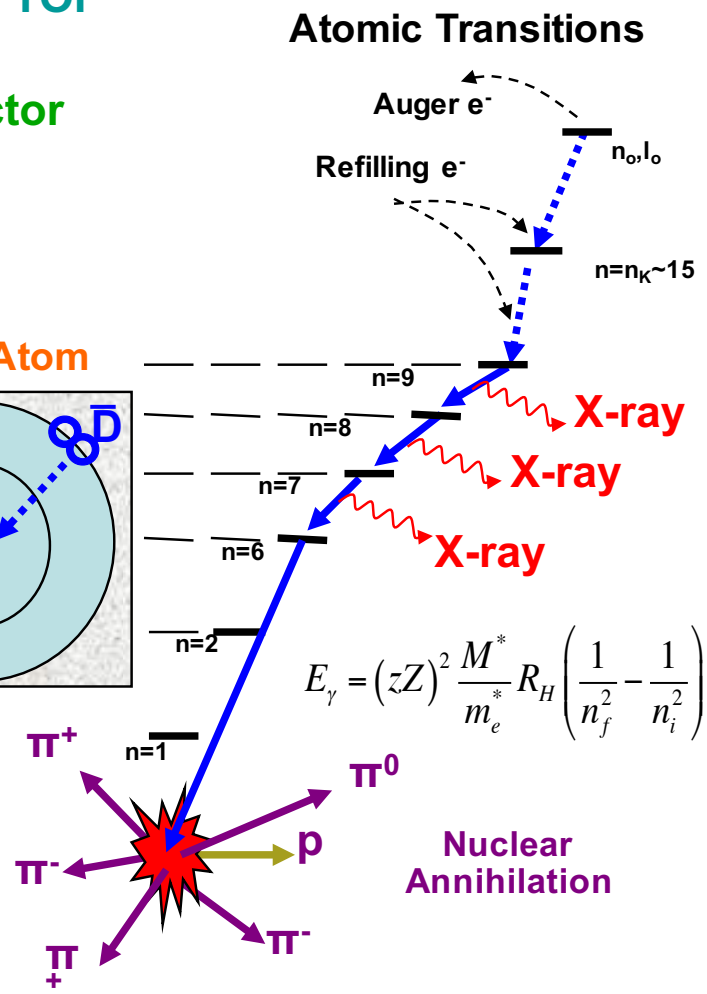
A time of flight (TOF) system tags candidate events and records velocity

The antiparticle slows down & stops in a target material, forming an excited exotic atom

Deexcitation X-rays provide signature

Annihilation products provide added background suppression



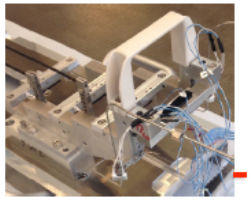


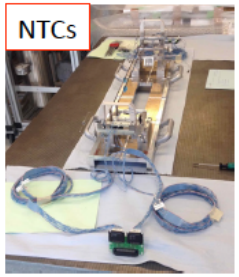
$$E_\gamma = (zZ)^2 \frac{M^*}{m_e^*} R_H \left(\frac{1}{n_f^2} - \frac{1}{n_i^2}\right)$$

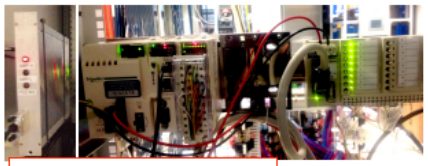
X-ray yields were measured at KEK in 2004 and 2005

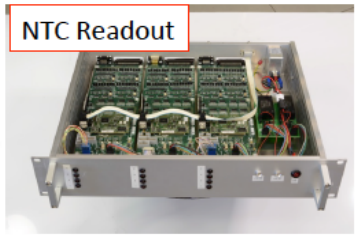
Belle2 @ Trieste

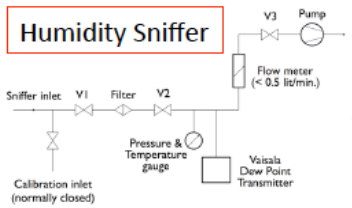
Monitoring commissioning at DESY







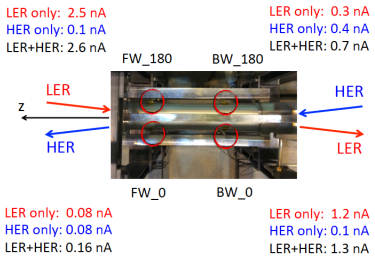




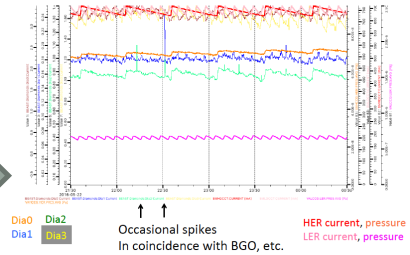
Sistema di monitoraggio ambientale (temperatura, umidità) sviluppato a Trieste

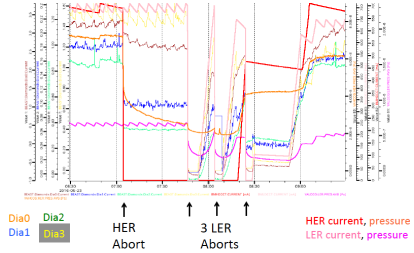
Diamond sensors in SuperKEKB Phase I

4 sensors
4.5 x 4.5 x 0.5 mm^3



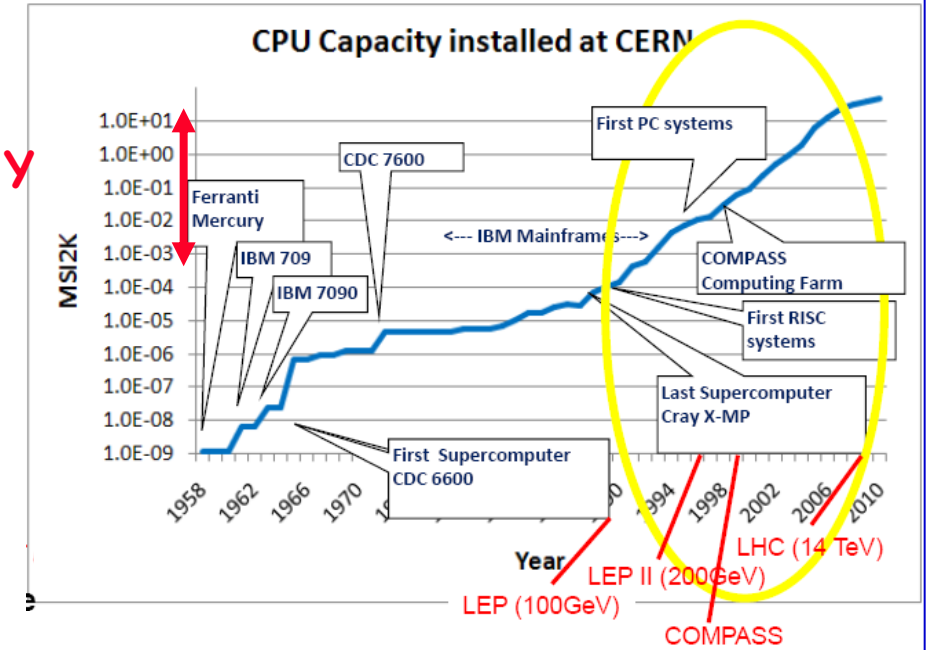
Sensori di radiazione sviluppati a Trieste
Test sui primi fasci a SuperKEKB





computing and techniques to digest information power in the petabyte range

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



- about amount of data:
  - LHC experiments: 35 PB / year
  - Google 97 PB/year
  - Facebook 180/year

- 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.

Few years ago (2001): The 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

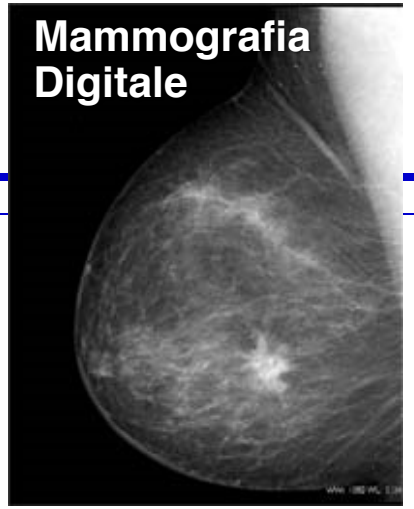
Yesterday (2015): The INFN Trieste Farm

-"Rack-mount" 83 nodes> TOTAL: 9293 HEP-SPEC06 = ~ 3200 kSI2k)

General Parallel File System, 309TB of total storage

- Open to GRID activities
- Progressing towards CLOUD operation

INFN & SOCIETA'



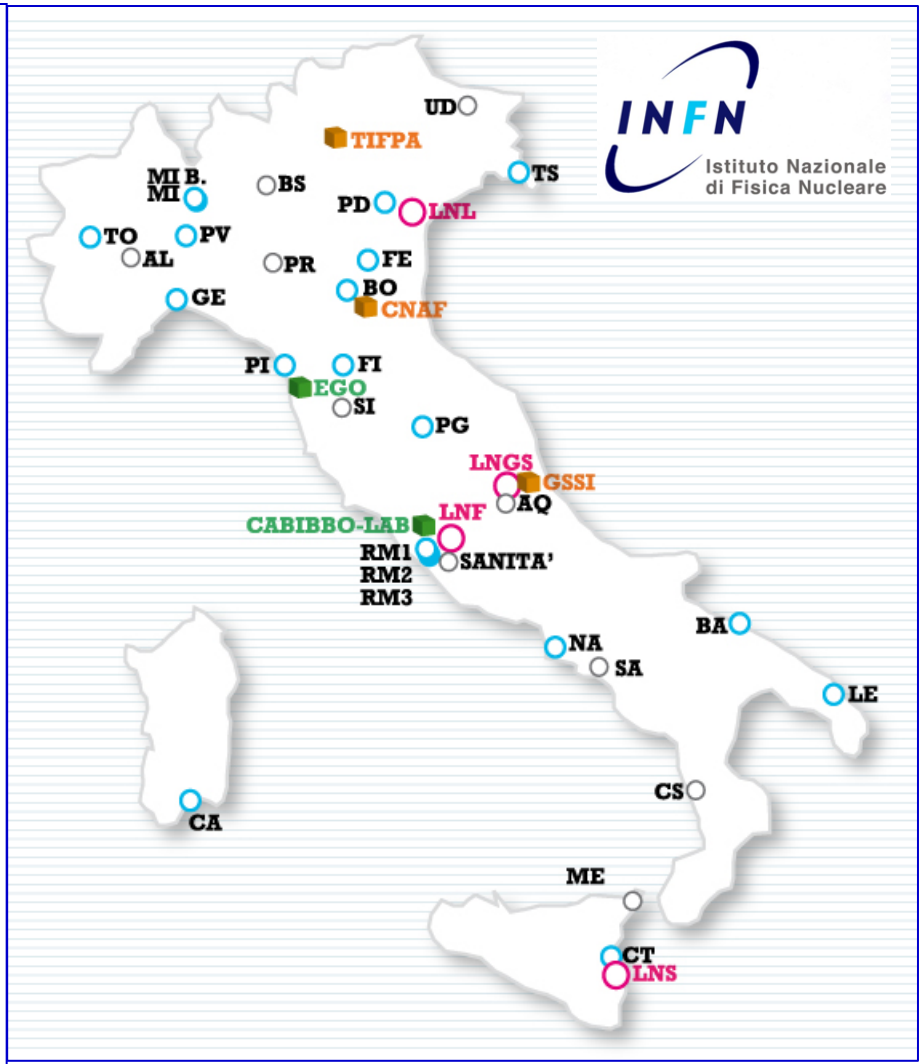
Tecnologie e applicazioni interdisciplinari

- 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}C)

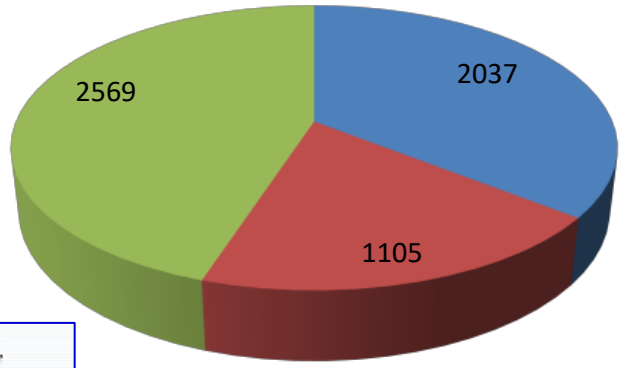
INFN - struttura

- 4 Laboratori Nazionali
  - LNL – Laboratori Nazionali di Legnaro
  - LNGS - Laboratori Nazionali del Gran Sasso → ERC Infrastructure
  - LNF - Laboratori Nazionali di Frascati
  - LNS - Laboratori Nazionali del SUD
- 2 Centri Tecnico-scinetifici
  - CNAF (Bo) – Calcolo
  - TIFPA (TN) – rivelatori e fisica medica
- 1 Centro di alta formazione
  - GSSI (GranSasso Scientific Institute) Ora diventato una Scuola di Dottorato.
- 20 "Sezioni" c/o 20 Università (fra cui Trieste)
- 11 "Gruppi Collegati", c/o Università (fra cui Udine, che è Gruppo collegato di Trieste)

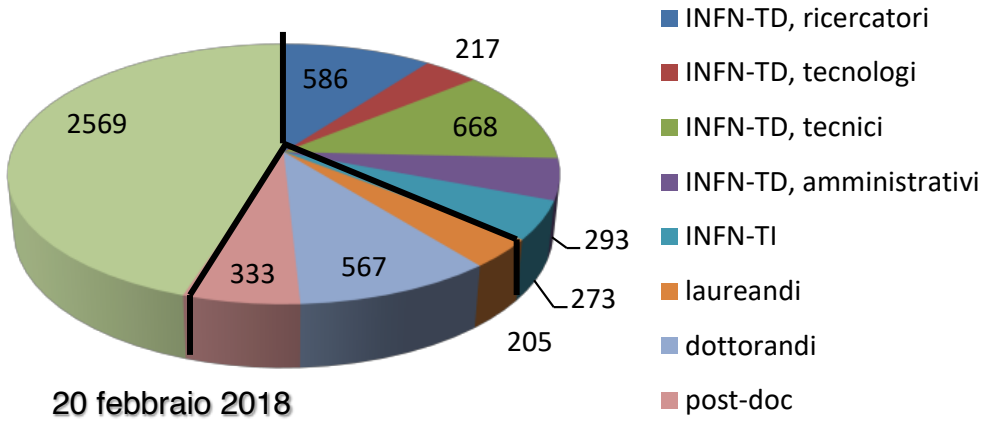


INFN - personale

personale INFN dipendente e associato: 5711 (dati 2012)



personale INFN dipendente e associato: 5711 (dati 2012)



20 febbraio 2018

Trieste 31/12/2016
278 persone
(50 dipendenti INFN)