ALICE

A Large Ion Collider Experiment

Purpose: study the physics of strongly interacting matter at extreme energy densities

CERN LHC: Colliding Pb ions at E_{CM}=5.5 A TeV, p-p, light ions collisions

84 institutes. Italian institutes are from: Alessandria, Bari, Bologna, Cagliari, Catania, Legnaro, Padova, Roma, Salerno, Torino, Trieste

The experiment involves over 900 physicists, more than 140 from Italy

INFN responsible: E. Nappi (Bari)

Physics topics:

Estabilish and analyze the existence of QCD bulk matter and QGP

Observables accessible to ALICE:

Initial conditions: global event features → number of colliding nucleons

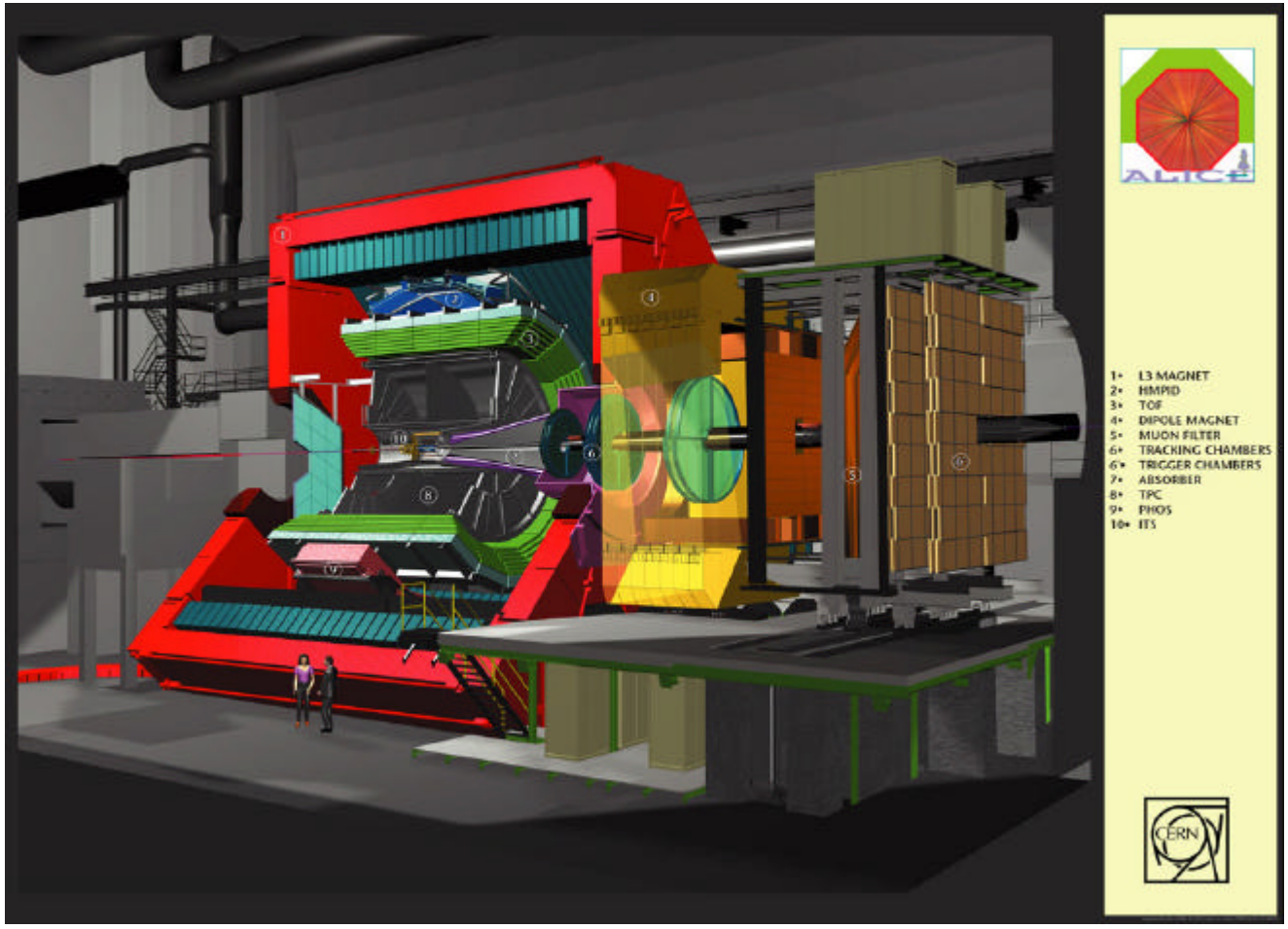
QGP: open charm production, prompt photons, high p_t hadrons, J/ψ, Y suppression

Phase transition: strangeness production, multiplicity fluctuations, particle interferometry

Hadronic matter: particle ratios, p_t distributions, resonance line-shape, interferometry

ALICE: experimental layout

ITS: layers of Si pixel, Si drift and Si strip detectors
TPC: main tracking system
TOF: multigap RPC
PHOS: high granularity E.M. Calorimeter
HMPID: RICH detector for high momentum PID
Muon arm: 5 tracking stations + trigger chambers
ZDC: forward calorimeters
PMD: photon muliplicity detector



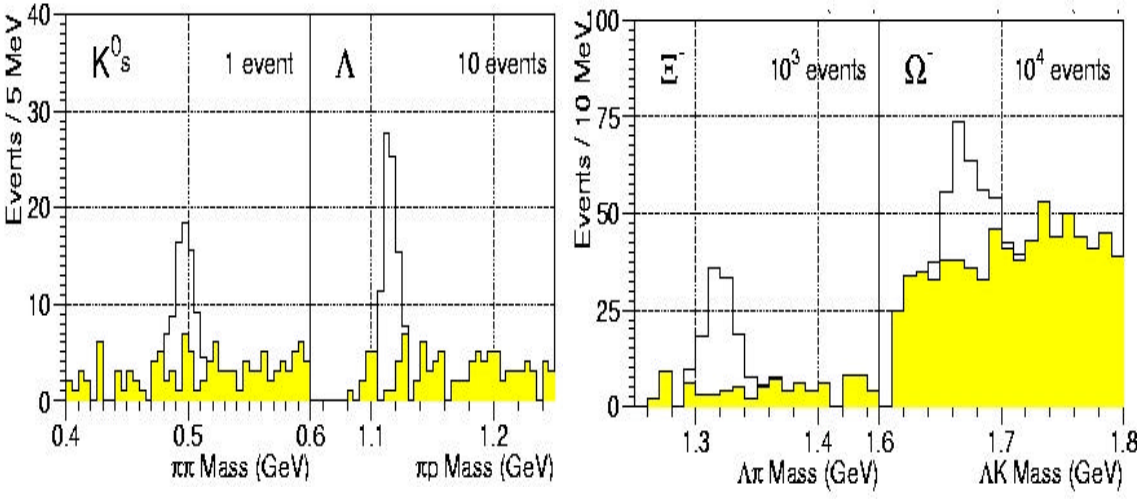
Central part covers $|\eta|<0.9$
Muon arm: 2-9^0 (2.5<η<4)
ZDCs located at ~115m from the IP
PMD: 1.8<η<2.6

HMPID: Bari
ITS: Alessandria, Bari, Bologna, Catania, LNL,Torino, Padova, Roma, Salerno
MU: Alessandria, Cagliari, Torino
TOF: Bologna, Salerno
ZDC:Alessandria, Cagliari, Torino

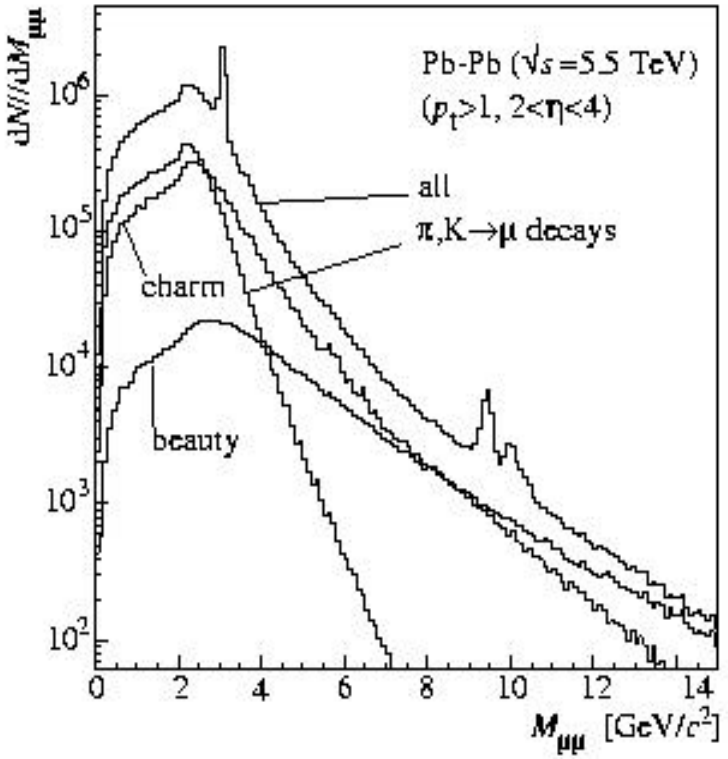
LHC planned to be operative in 2004. ALICE taking Pb-Pb data in 2005.

Alice has been designed as a dedicated heavy-ion experiment, to study the quark-gluon plasma in a systematic way. Some observables are needed to characterize the global features of the state created during the collision, yielding information about the initial conditions and the space-time evolution. Signals specific as a QGP signature are also needed: open charm production (probing the parton kinematics in the early stage) prompt photons (revealing the thermal radiation from the plasma) high pt hadrons (sensitive to the energy loss of partons in the plasma) charmonia and bottomonia suppression (probing deconfinement). The strangeness production is sensitive to the large s-quark density expected from chiral symmetry restoration.

One of the most important signatures probing deconfinement is the J/Ψ and Υ suppression, that can be detected via the decay of the resonances in muons.

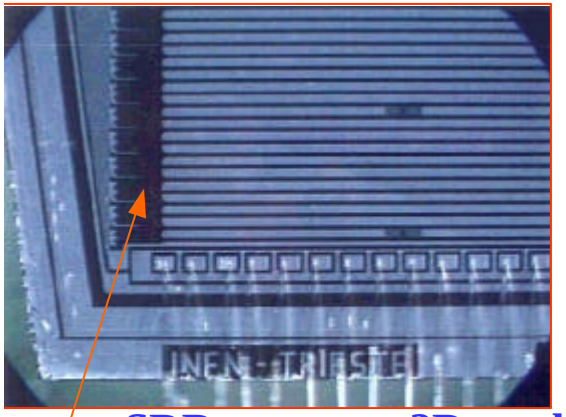


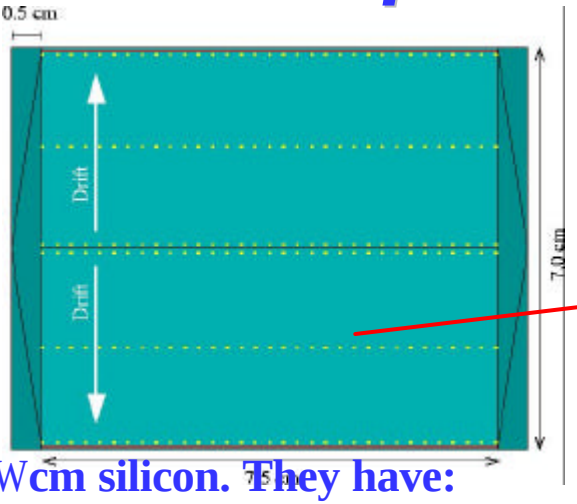
Strange particle production expected in 1, 10, 10^3 and 10^4 central Pb-Pb collisions respectively

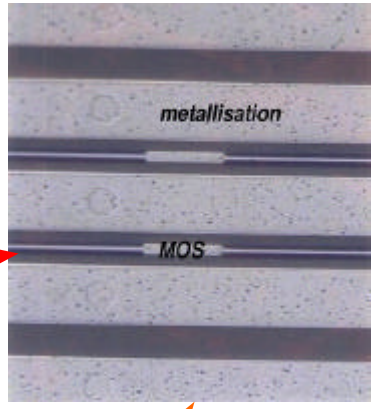


Dimuon mass spectrum simulated in central Pb-Pb collisions at the LHC energies

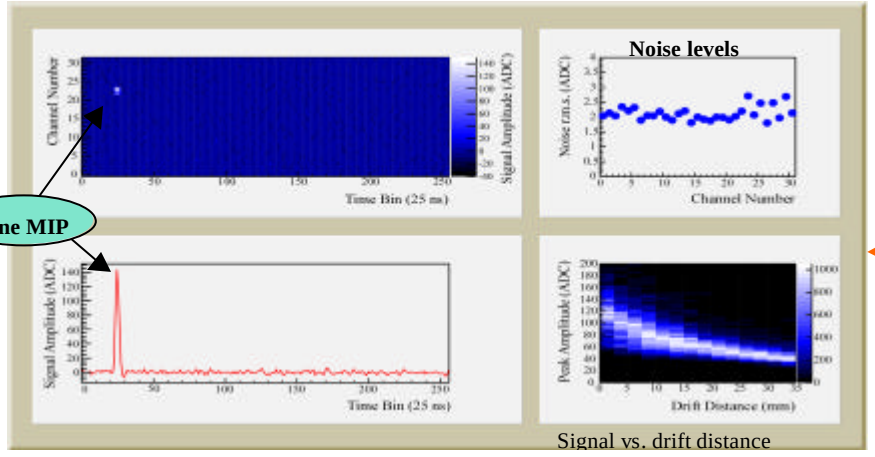
The Silicon Drift Detectors



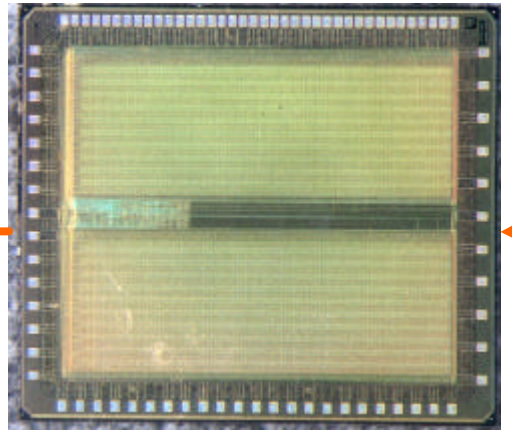


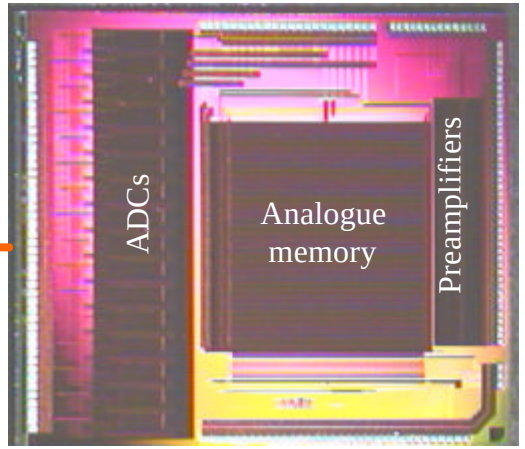


- **SDDs are true 2D readout detectors built on NTD 3kWcm silicon. They have:**
  - $7.02 \times 7.53 cm^2$ divided in two drift regions served by 2 x 256 readout anodes
  - built-in voltage dividers
  - 2 x 3 rows of MOS charge injectors for drift velocity monitoring
- **ALICE has 260 SDDs that equip the 2 middle layers of the Inner Tracking System**
  - they are read out by 40 Ms/s analogue memory followed by 4 Ms/s 10-bit linearADC
  - derandomizing multi-event buffers are included on the front-end hybrid
- **SDDs + rad-tol FEE feature ~30 mm resolution on both axes in beam test data**

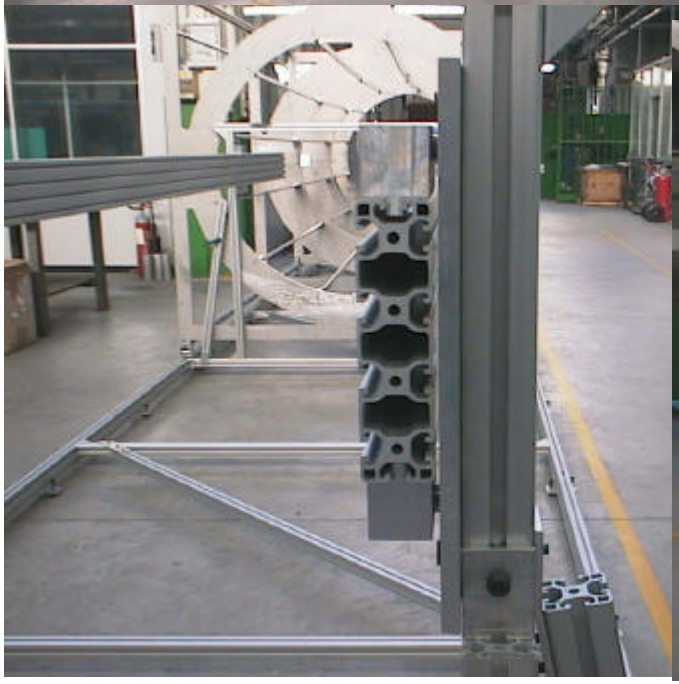


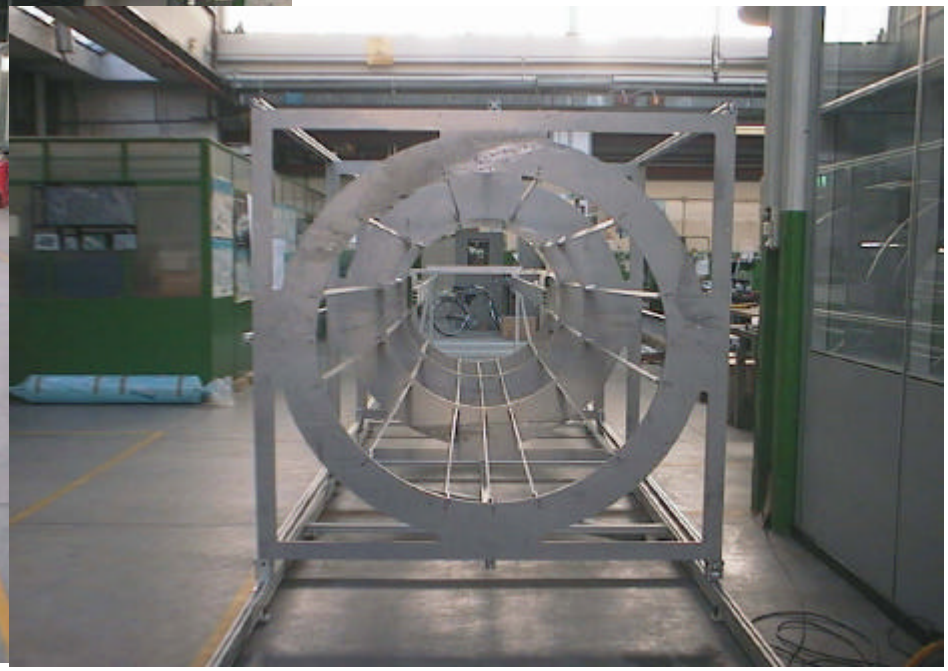
Signal vs. drift distance





ITS installation tests



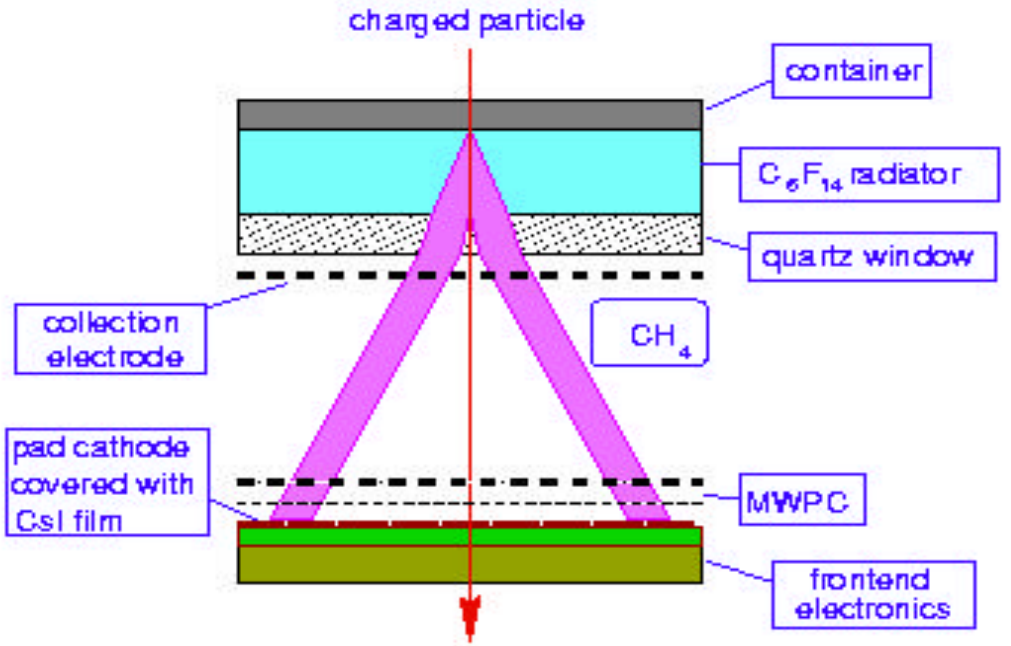


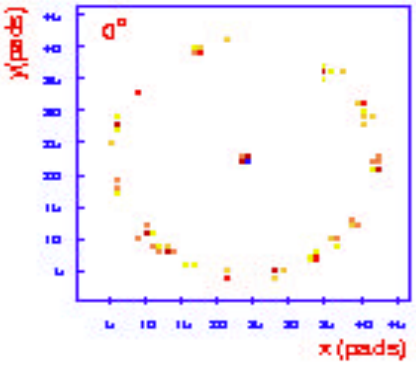
Full scale model to test rails, insertion and removal, and integration of ITS with FMD and beampipe

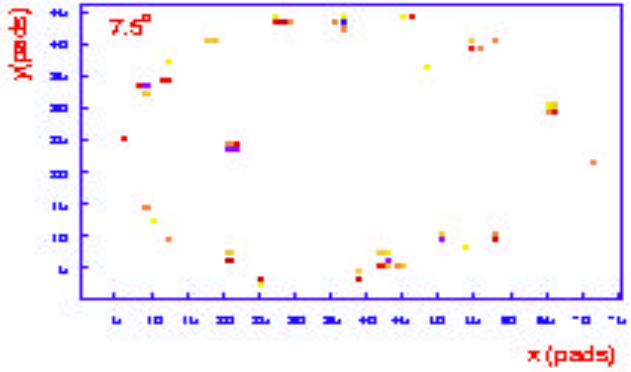
High Momentum Particle IDentification

- Operating principle: proximity focusing RICH detector
  - **photon converter:**
    A reflective layer of CsI
    (QE=23% @ 180 nm)
  - **radiator (15 mm):**
    C_6F_{14} n=1.295 @ 180 nm
  - **photon detector:**
    MWPC with CH_4 at atmospheric pressure (4 mm gap)

    analogue pad readout (~160 10^3 channels)
  - **PID range**
  - **1 < p < 3 GeV/c p K**
  - **2 < p < 5 GeV/c p**



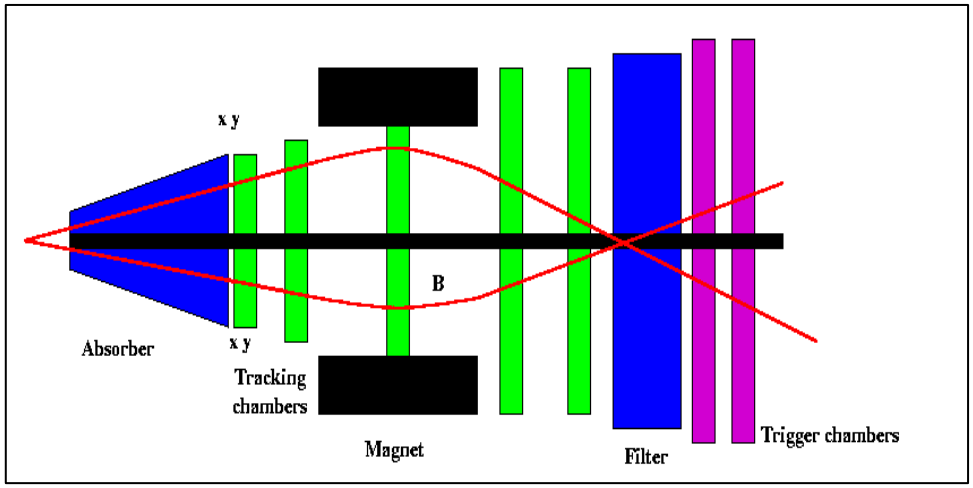




- Institutes involved:
  Bari-CERN-INR
- Project leader:
  E. Nappi (INFN-Bari)

The Muon Spectrometer for the ALICE experiment

Aim: Detection of Heavy Quarkonia through Their decay into Muons



The Apparatus

- **Dipole Magnet (0.7 T)**
- **3 Absorbers**
- **10 Tracking Chamber Planes (CSC + CPC)**
- **4 Trigger Chambers (RPC)**

Trigger Chambers

(Torino, Alessandria)

- Selection of high p_t $\mu^+\mu^-$ from J/Ψ e Υ with RPC
  (72 chambers of 70×270 cm^2 in 2 stations, total area of 150 m^2
- Rate capability: 3, 10 and 40 Hz/cm^2 for Pb-Pb, p-p and Ca-Ca
- Cluster size close to one (occupancy) and space resol. ≤1 cm (selection of high momentum - lightly bent muons from Υ decay)
- Time resolution: few ns
  (to strobe the signals in a 20 ns time window, given by LHC clock)

Tracking Chambers (5 stations) :

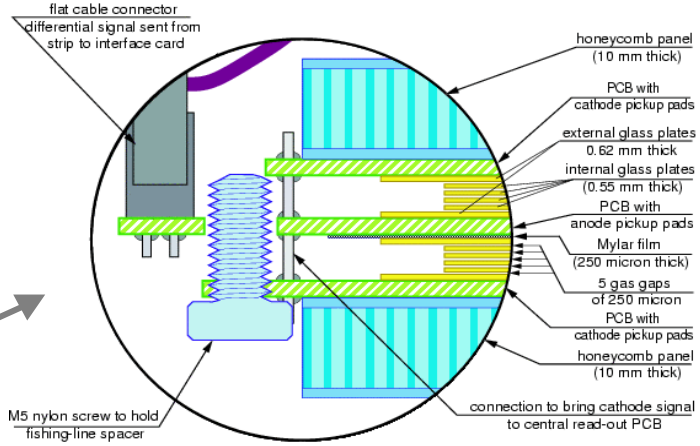
(Cagliari)

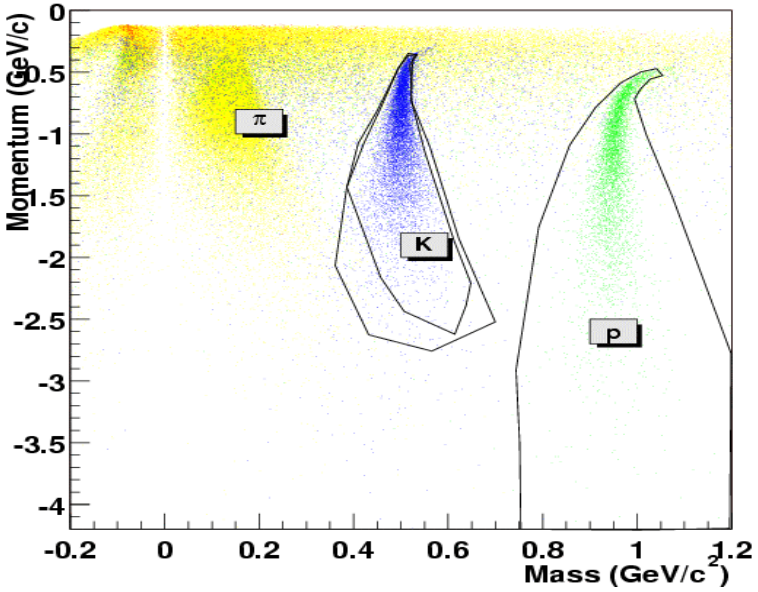
- Required Spatial Resolution ≤ 100 μm
- Read-out high granularity (occupancy)
- Station 3,4,5 (3-5 m diameter): modular structure (40×120 ÷240 cm^2)
- Cathode Planes: Double sided Printed Circuit Boards

TOF- Time of Flight System for ALICE Experiment

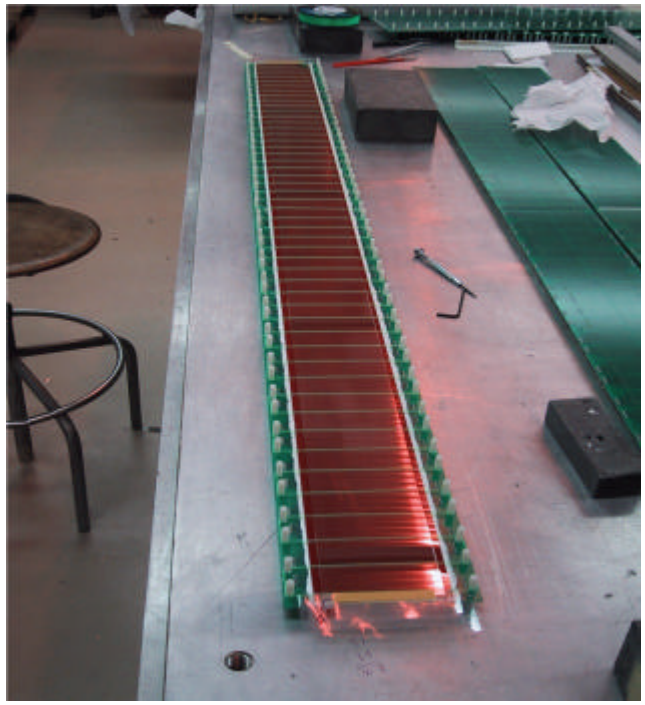
- *Aim:* determination of the time of flight for charged particle from about 0.5 GeV/c to about 2.5 GeV/c for Particle Identification.
- *Gaseous Detector:*

  to cover a large area.
- *Technology:* *Multigap RPC*
  - electric field is high and uniform over the whole sensitive gaseous volume of the detector;
  - no time jitter associated with the drift of the electrons to a region of high electric field.
- *Particle Identification:* π / K / p
  - Momentum from TPC vs reconstructed mass from time of flight





Performances: 10 gap double-stack MRPC strip design with intrinsic time resolution of **50 ps** and efficiency of about **99%**



- *Detector summary:*
  - Rapidity acceptance range: **[-1,1]**
  - Number of strips:**1674**
  - Number of channel: **160000**
  - Area: **160 square meters**

ZDC Calorimeters for the ALICE experiment

Aim: determination of the impact parameter of the collision by measuring the energy carried by the spectator nucleons

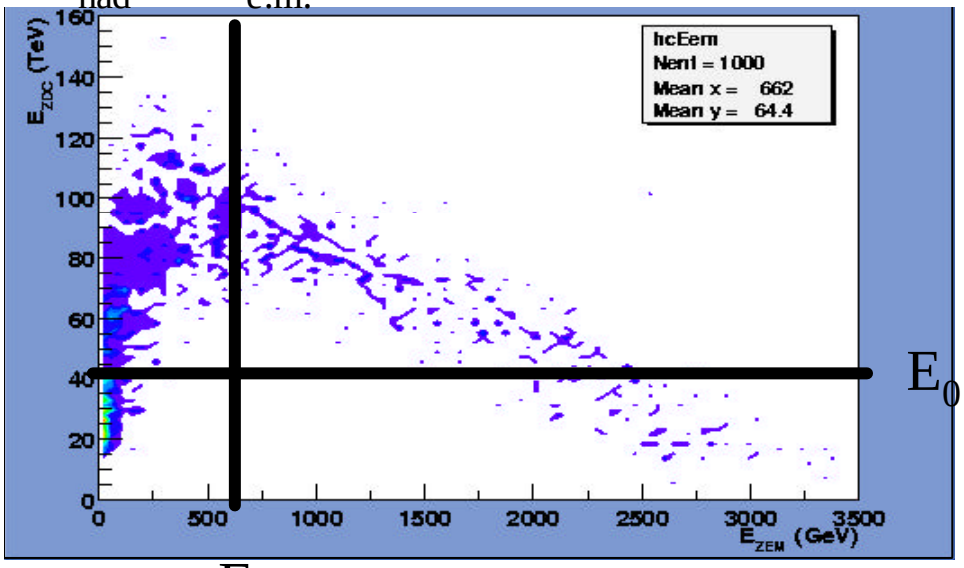
Where: hadronic calorimeters at ~ 116 m from IP
e.m. calorimeter at ~ 8 m from IP

*Central events selected with **both***:

-Energy in hadronic calorimeters $< E_0$

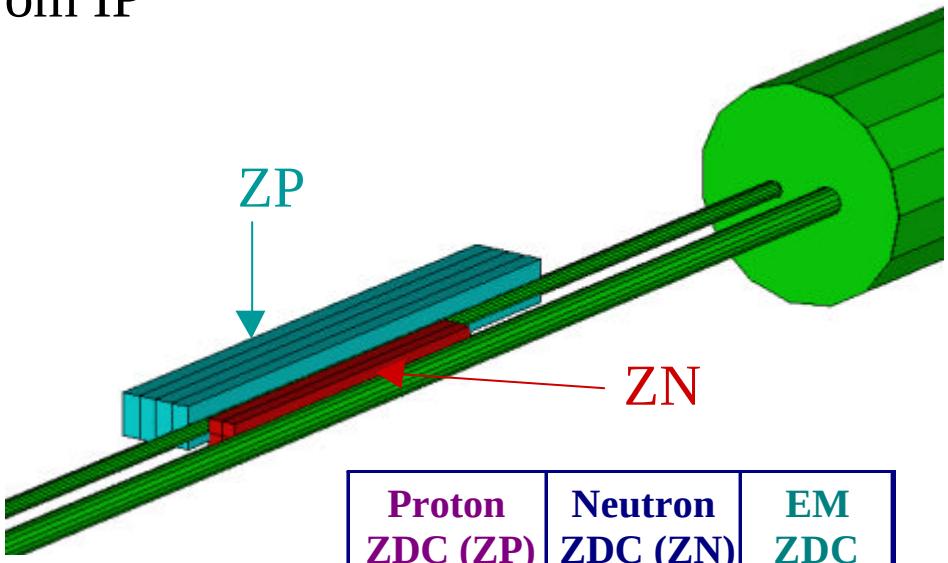
-Energy in e.m. calorimeter $> E_1$

E_{had} vs $E_{e.m.}$



E_0

E_1



	Proton ZDC (ZP)	Neutron ZDC (ZN)	EM ZDC
Dimensions (cm^3)	12x21x150	7x7x100	7x7x21
Absorber	brass	W-alloy	lead
Fibre angle wrt LHC axis	0^o	0^o	45^o
Fibre Æ (mm)	550	365	550