The ALICE experiment

Dariusz Miśkowiec
GSI Darmstadt

(heavily based on a presentation by Christoph Blume)

Hades Summer School, Riezlern, September 2007

Outline

- ***Heavy ion physics at LHC***
- ***ALICE detector setup***
- ***Physics topics and performance***
- ***Running plans***

Sources of information

- ***1995 ALICE Technical Proposal***

  CERN-LHCC 95-71

- ***Physics Performance Report, Volume I***

  J.Phys.G 30(2004)1517-1763

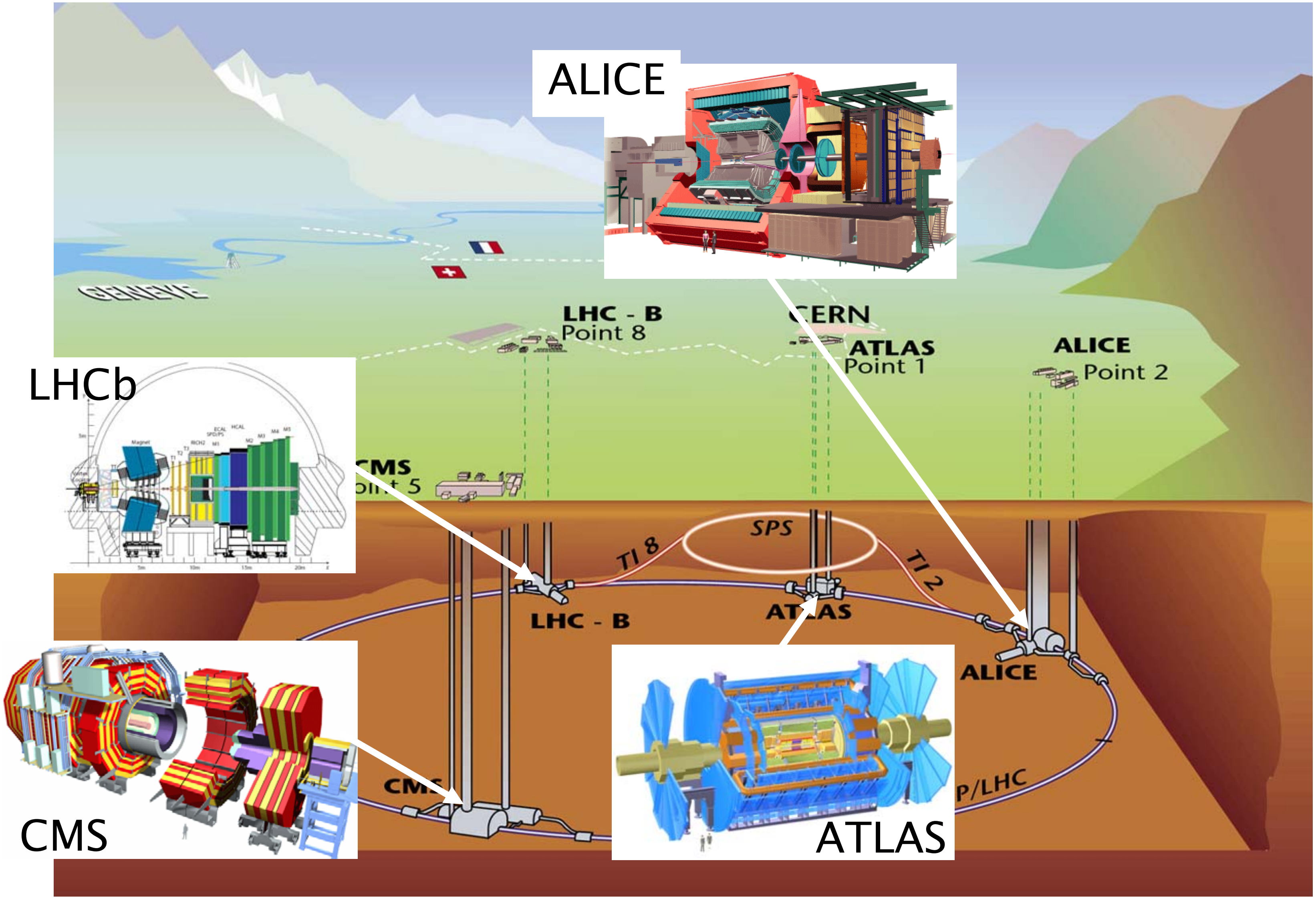
  physics topics, LHC conditions, detector summary, computing

- ***Physics Performance Report, Volume II***

  J.Phys.G 32(2006)1295-2040

  combined detector performance, event reconstruction

LHC experiments



physics questions at LHC

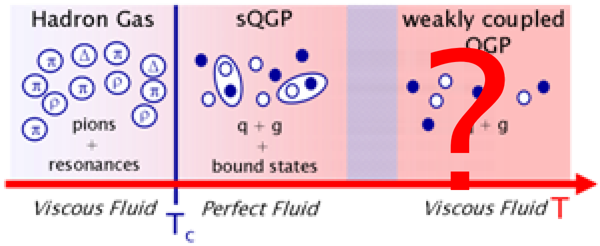
***ATLAS, CMS, LHCb*:**
electroweak symmetry breaking
origin of mass of quarks and gauge bosons
supersymmetric particles
CP violation

***ALICE*:**
chiral symmetry breaking
origin of mass of hadrons
deconfinement
hadronization

***ALL*:**
understanding high energy nuclear interactions
(input needed for cosmic ray studies)

ALICE programme

mission:
create quark-gluon matter
study its properties quantitatively
be prepared for unexpected = be versatile



methods:
spectra and correlations of various particles

e.g. heavy quarks (open beauty, upsilon-states)
jets in heavy ion environment
weakly interacting probes (Z^0, $W^\pm$)

special at LHC:
higher energy density
larger system
more heavy quarks and jets
weak probes W/Z available
access to lower x

	SPS	RHIC	LHC
$\sqrt{s_{NN}}$ (GeV)	17	200	5500
dN_{ch}/dy	~450	~850	1500-4000
ε(GeV/fm^3)	3	5	15-60
τ_{QGP} (fm/c)	≤ 2	2-4	≥ 10

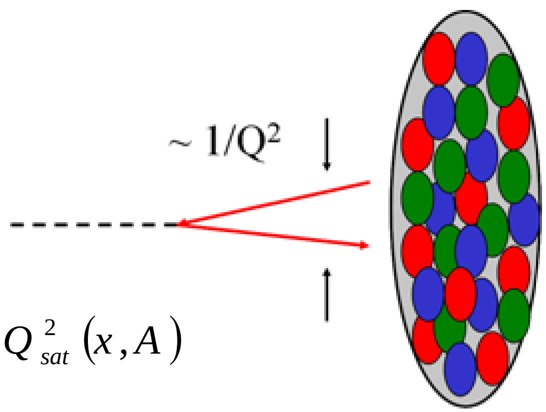
Kinematic Range at LHC

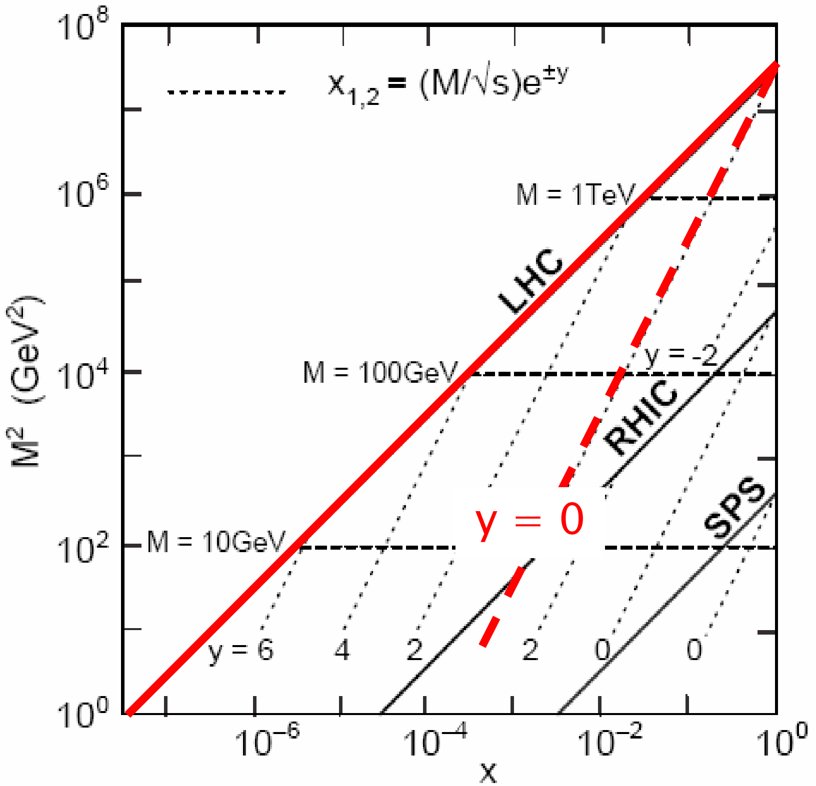
Physics at smaller x

- Bulk physics: $10^{-4} < x < 10^{-3}$
- Forward regions: $x \approx 10^{-5}$

Different initial state?

- Saturation of gluons
- Color Glass Condensate





Detector Requirements

Robust tracking performance

Needs to digest highest multiplicities (O(10^5) tracks !)

Need to cover low p_t region (~100 MeV/c)

Soft physics important for event characterization

But the high p_t region as well (>100 GeV/c)

Hard probes transmit information about early phase

Good PID capabilities over large p_t–range essential

Many effects are flavour dependent

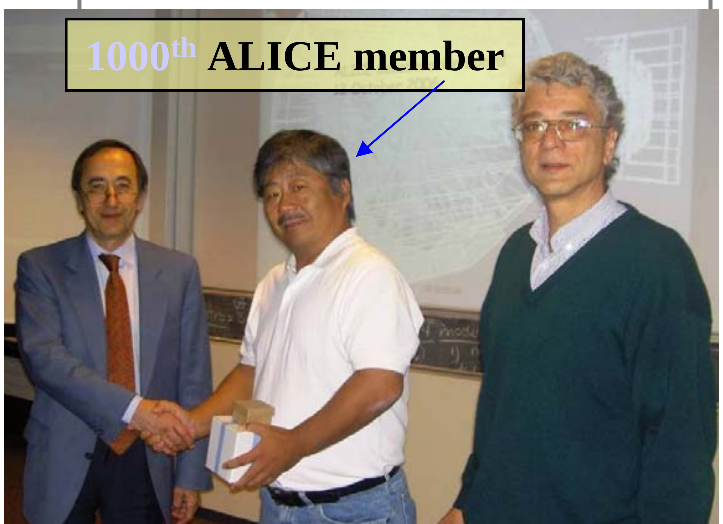
Sensitivity to rare probes

Heavy flavour, quarkonia, photons, ...

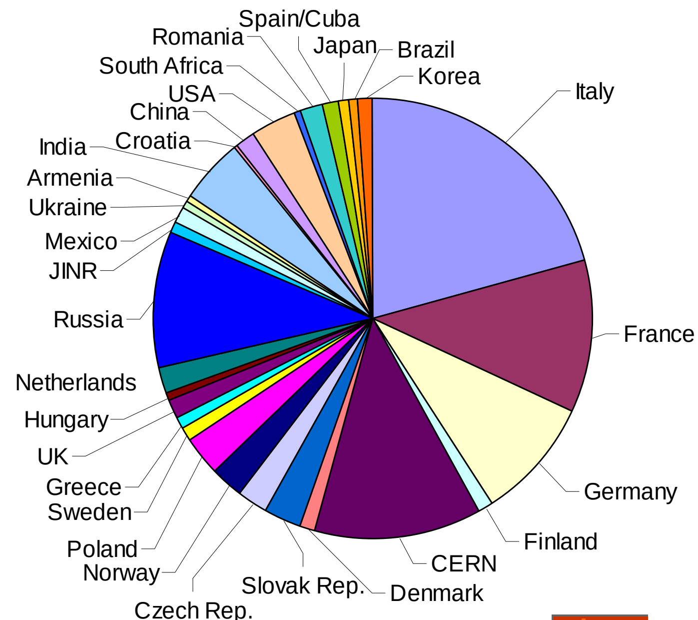
The Alice Collaboration

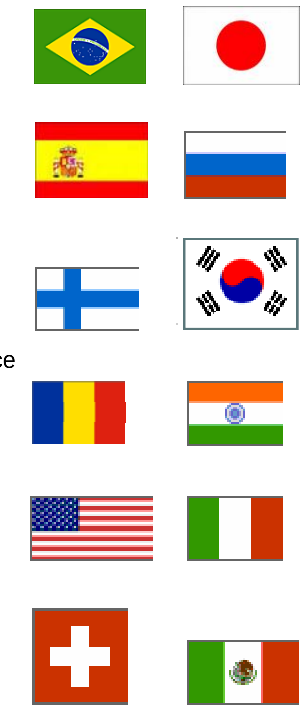
Some numbers:

Members: ca. 1000



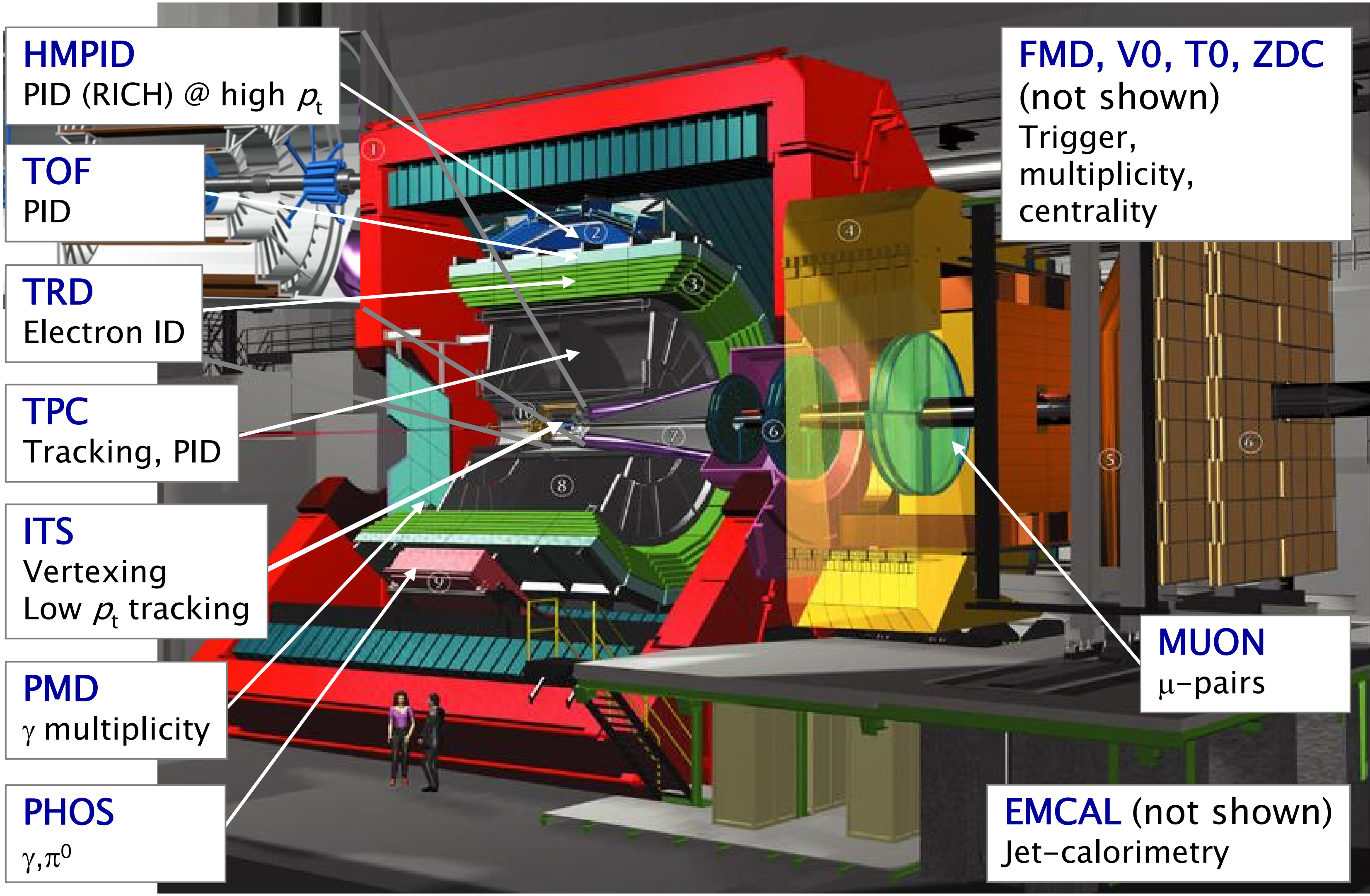
Universität Heidelberg
FZK Karlsruhe
FH Köln
Universität Münster
FH Worms

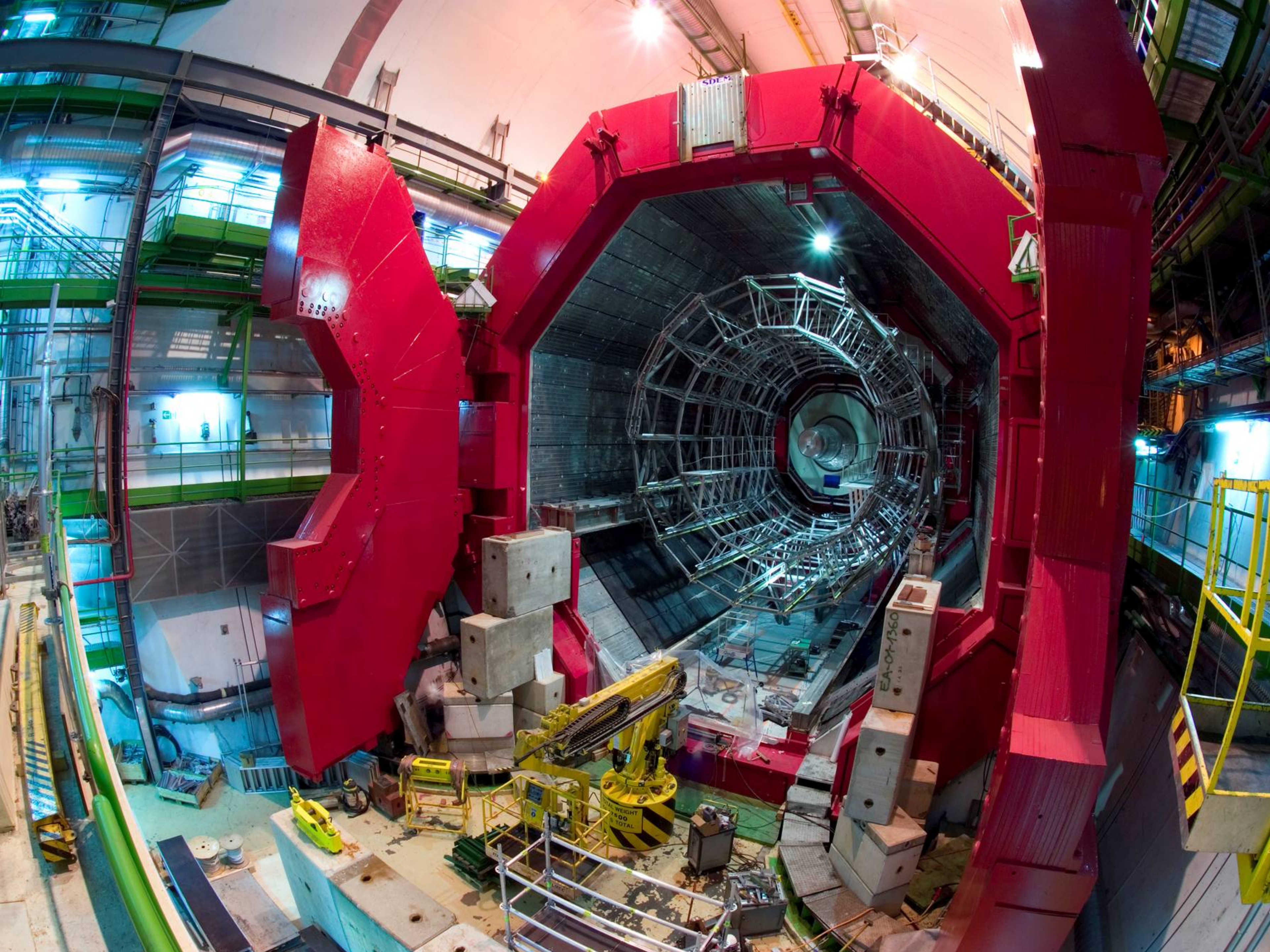




Alice Detector

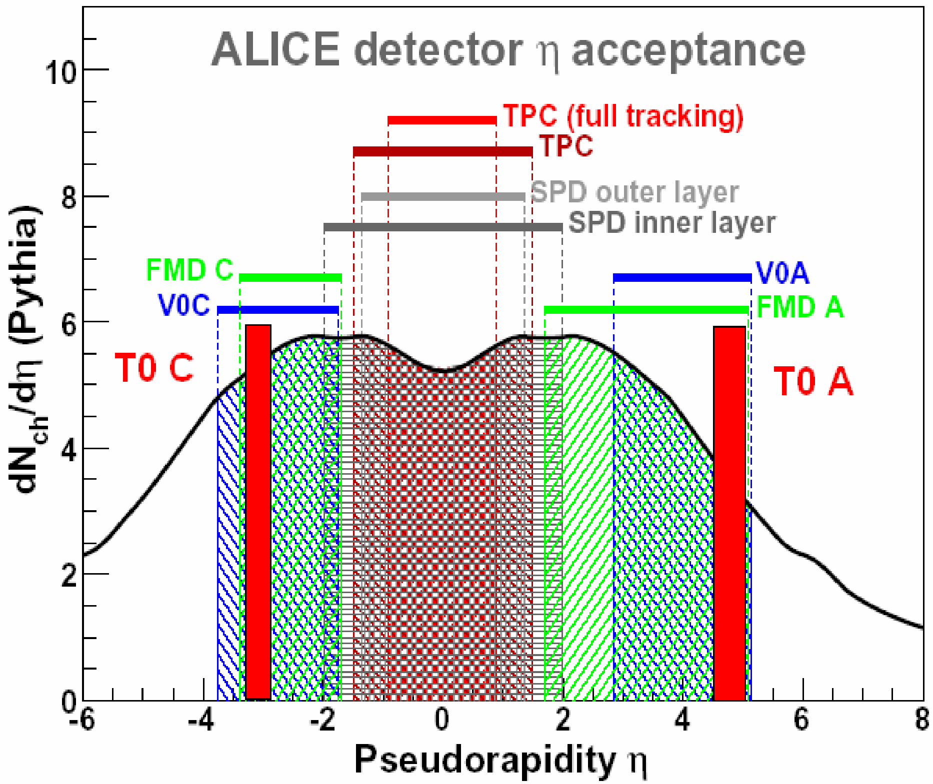
height: 16 m   ***length 26 m***   ***weight: 10,000 tons***   ***price: 10 € / kg***




EA-04-1360

Acceptance for Charged Hadrons

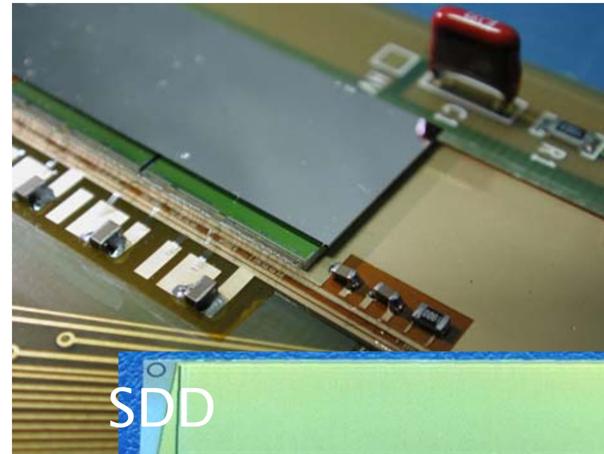
- **central barrel** $-0.9 < \eta < 0.9$
  - ITS,TPC,TRD,TOF 2 π tracking, PID
  - HMPID single arm RICH
  - PHOS single arm EM cal
  - EMCAL jet calorimeter (proposed)
- **forward muon arm** $2.4 < \eta < 4$
  - absorber, 3 Tm dipole magnet
  - 10 tracking + 4 trigger chambers
- **multiplicity** $-5.4 < \eta < 3$
  - PMD including photon counting
- **trigger & timing**
  - FMD: silicon strip multiplicity det
  - T0: ring of quartz window PMT's
  - V0: ring of scintillator paddles
  - 6 Zero Degree Calorimeters

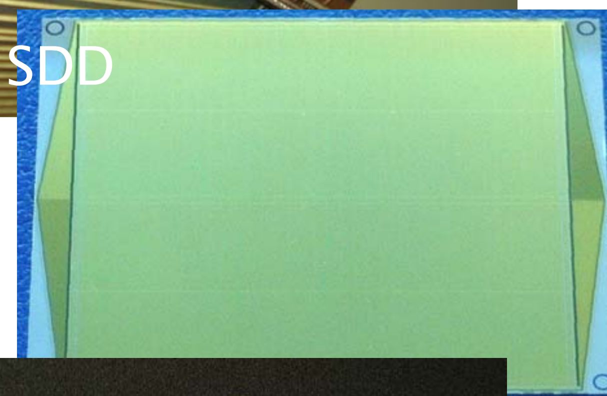


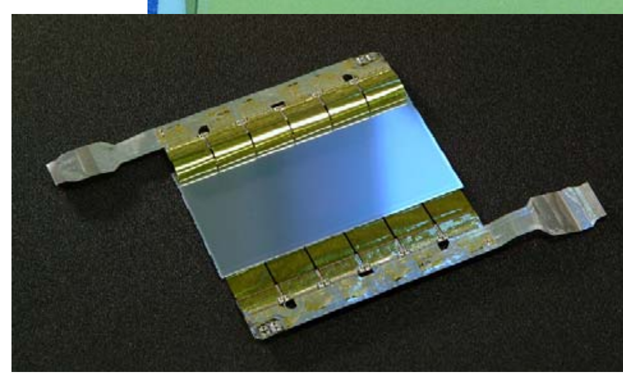
Inner Tracking System (ITS)

6 Layers with three different detector technologies:

Silicon Pixel Detector
Silicon Drift Detector
Silicon Strip Detector
ITS = SPD+SDD+SSD

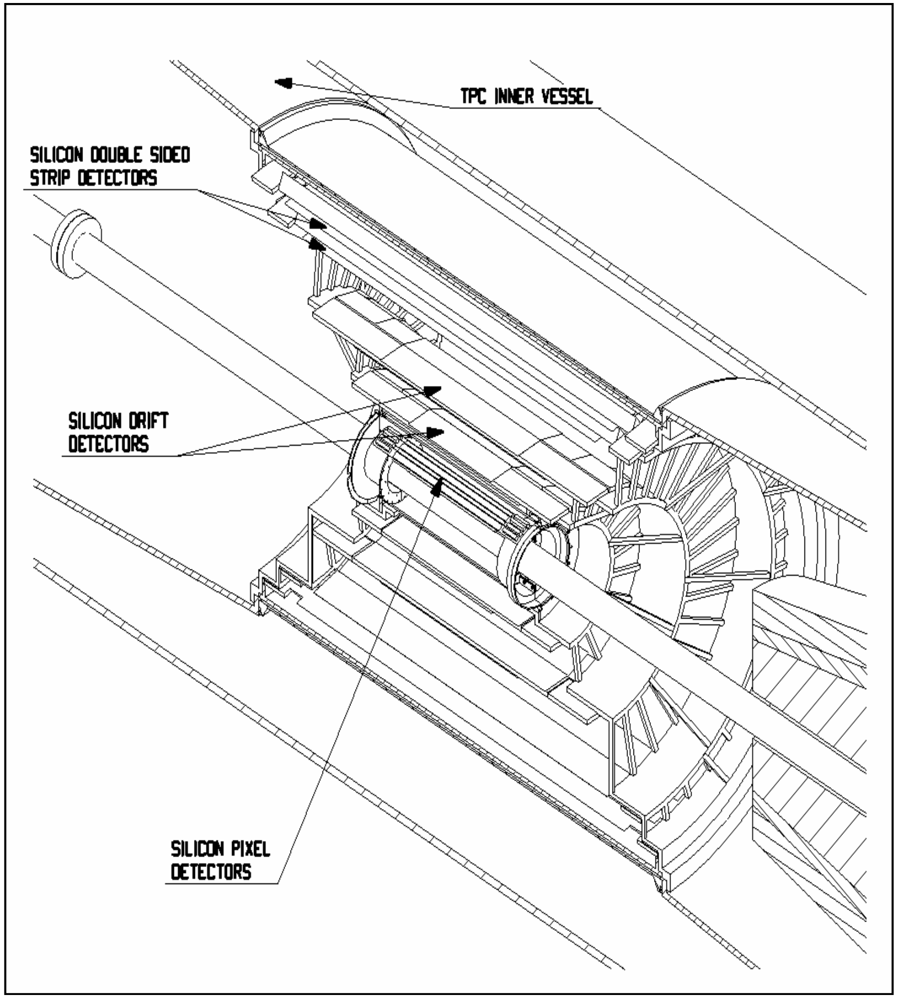






Layer		*R (cm)*	$\sigma r\phi$ (μm)	σZ (μm)
1	SPD	4	12	100
2	SPD	8	12	100
3	SDD	15	38	28
4	SDD	24	38	28
5	SSD	38	17	800
6	SSD	43	17	800

Inner Tracking System (ITS)



longitudinal coverage:

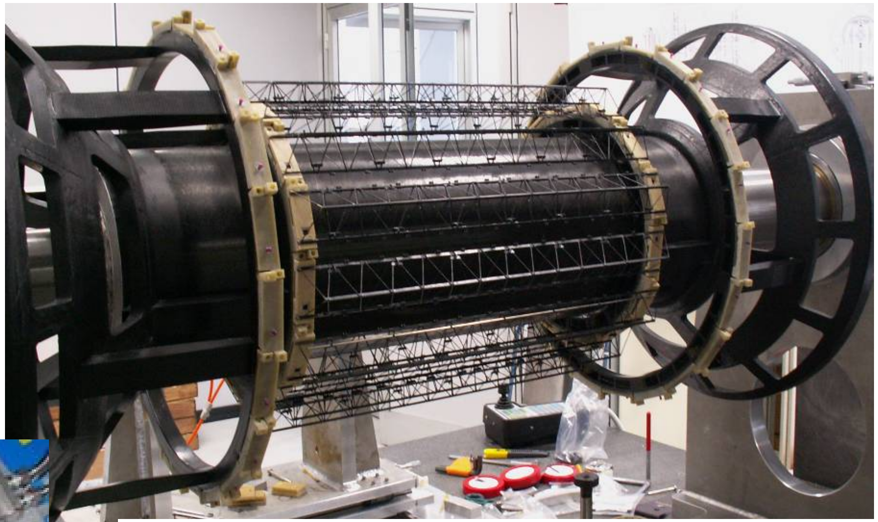
$|\eta| < 1$ (tracking), $|\eta| < 2$ (multiplicity)

Parameter		Pixels	Drifts	Strips
radius (inner plane)	cm	3.9	14.9	38.5
radius (outer plane)	cm	7.6	23.8	43.6
cell size ($r\varphi \times z$)	μm^2	50 × 425	294 × 150	95 × 40000
resolution ($r\varphi$)	μm	12	35	15
resolution (z)	μm	100	23	730
max. occupancy	%	2.1	2.5	4
max. expected dose (10 years)	krad	250	13	2
total area	m^2	0.2	1.3	4.9
total no. of channels		9.8 M	133 k	2.6 M
material budget (both layers)	% X_0	2.06	1.89	1.78

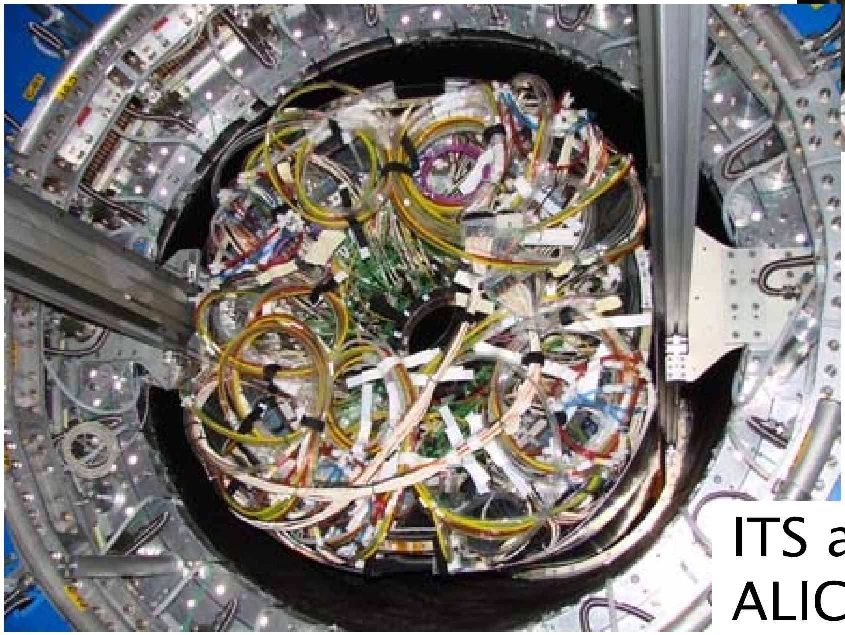
Inner Tracking System (ITS)

Number of readout channels: 9.8×10^6

Materialbudget: 7% X_0

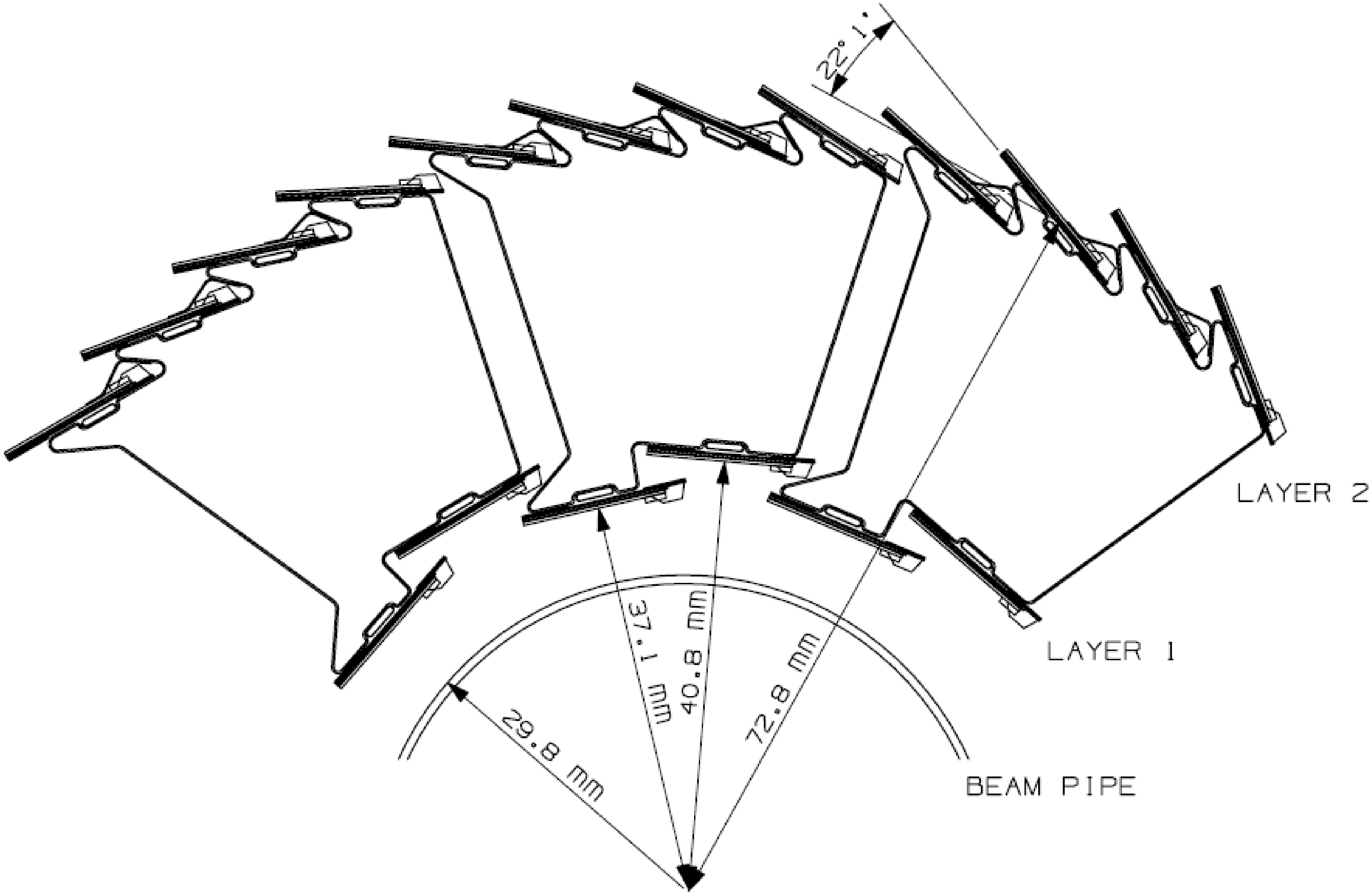


Support frame: carbon fiber

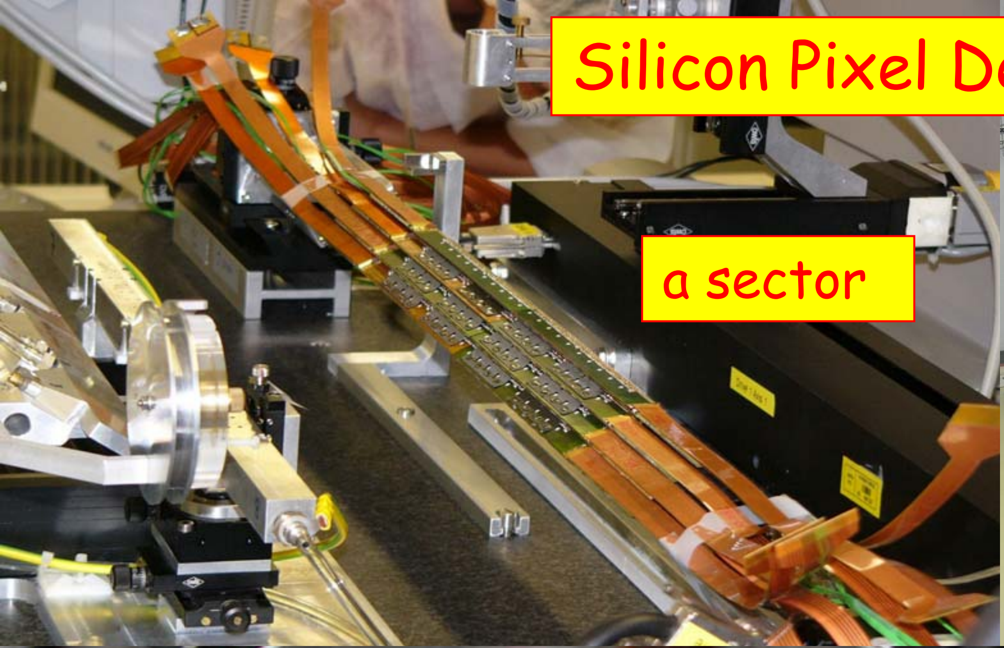


ITS as inserted in ALICE setup (15/3/07)

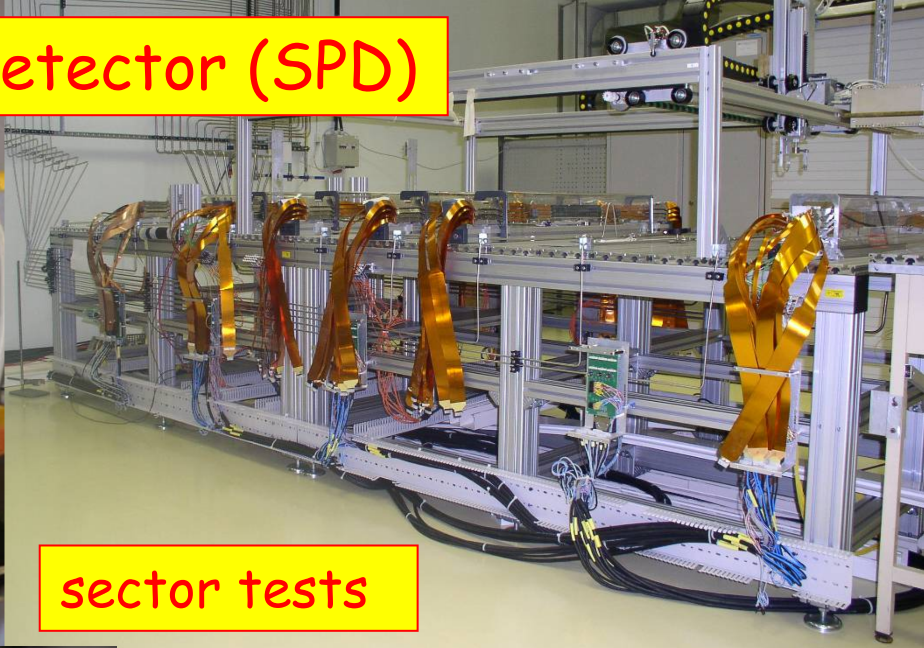
Silicon Pixel Detector (SPD)



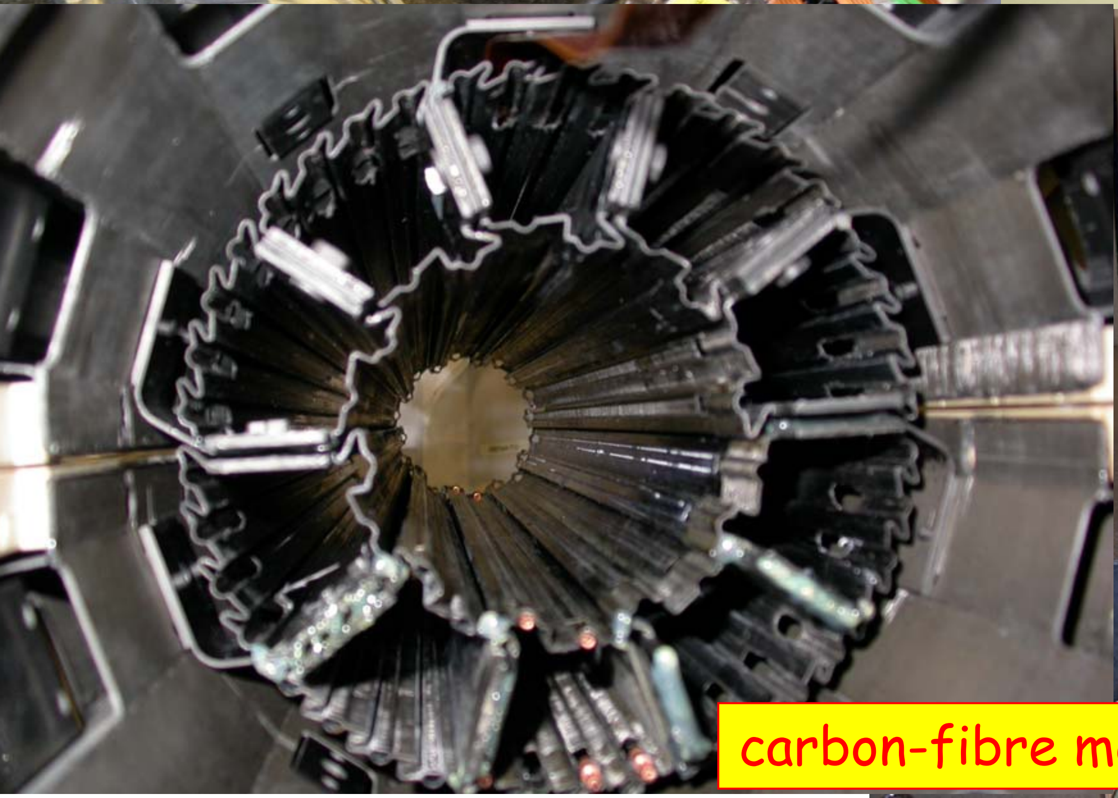
Silicon Pixel Detector (SPD)

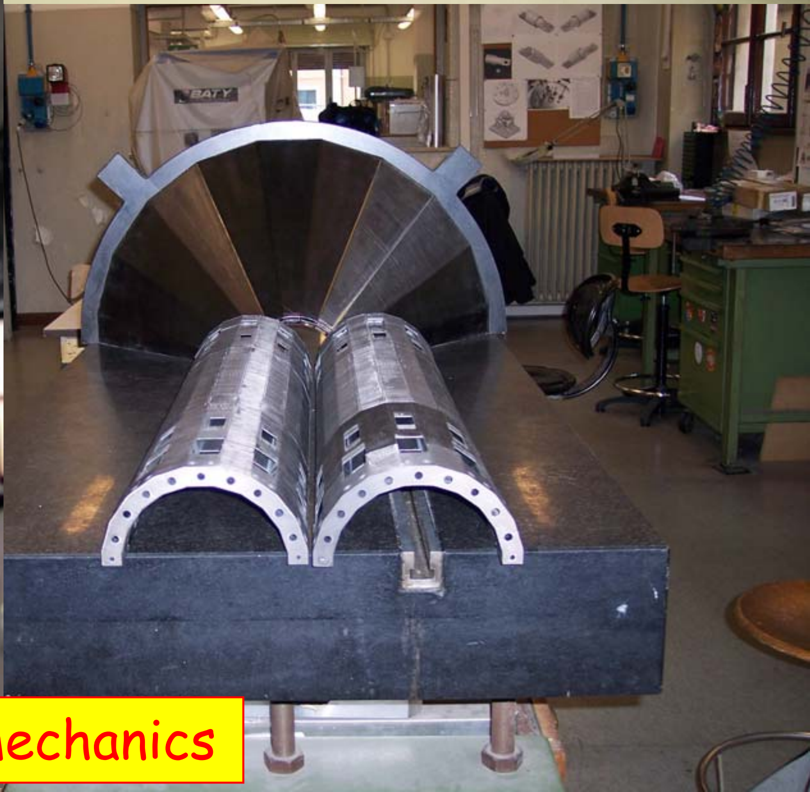


a sector

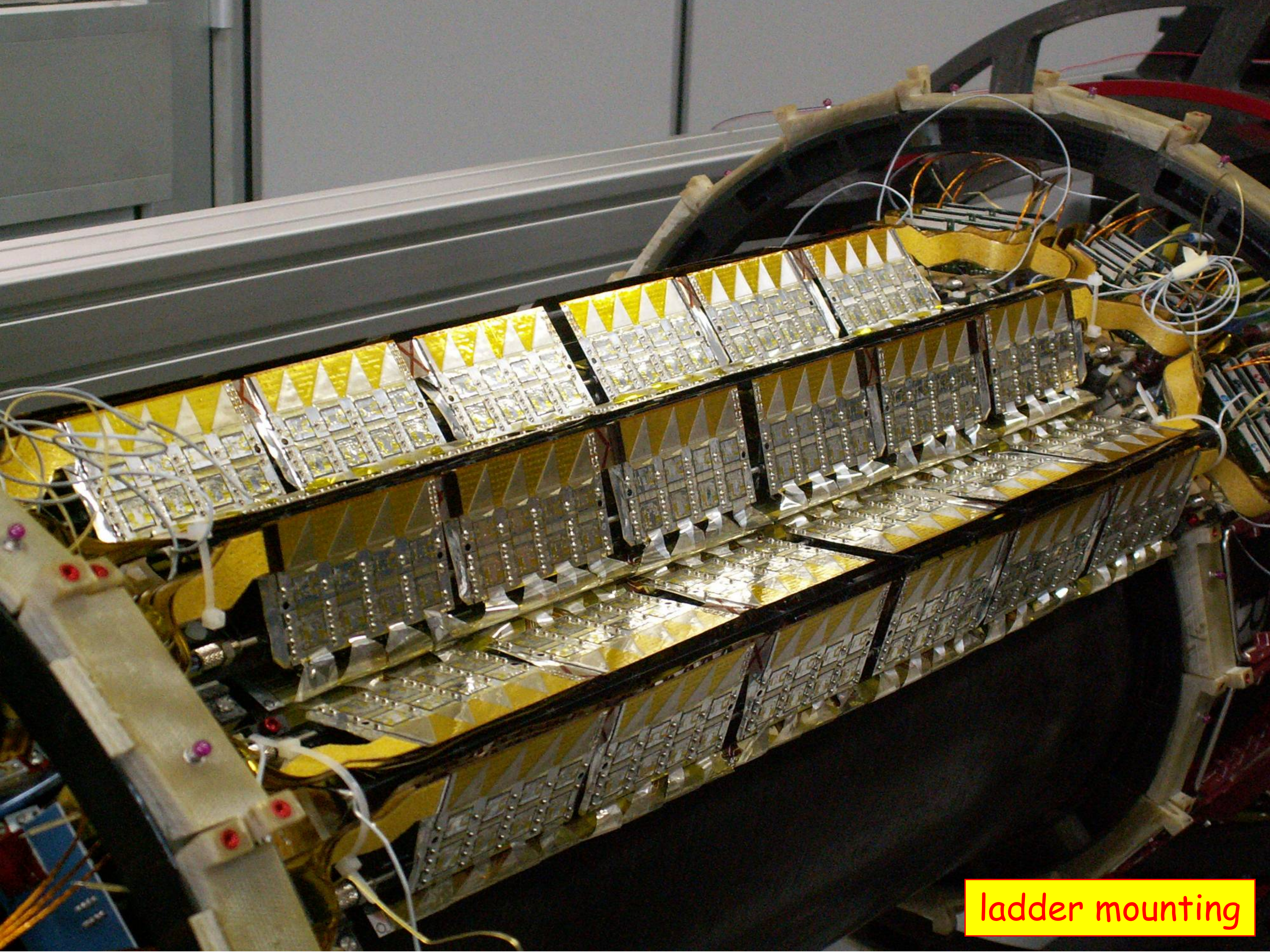


sector tests



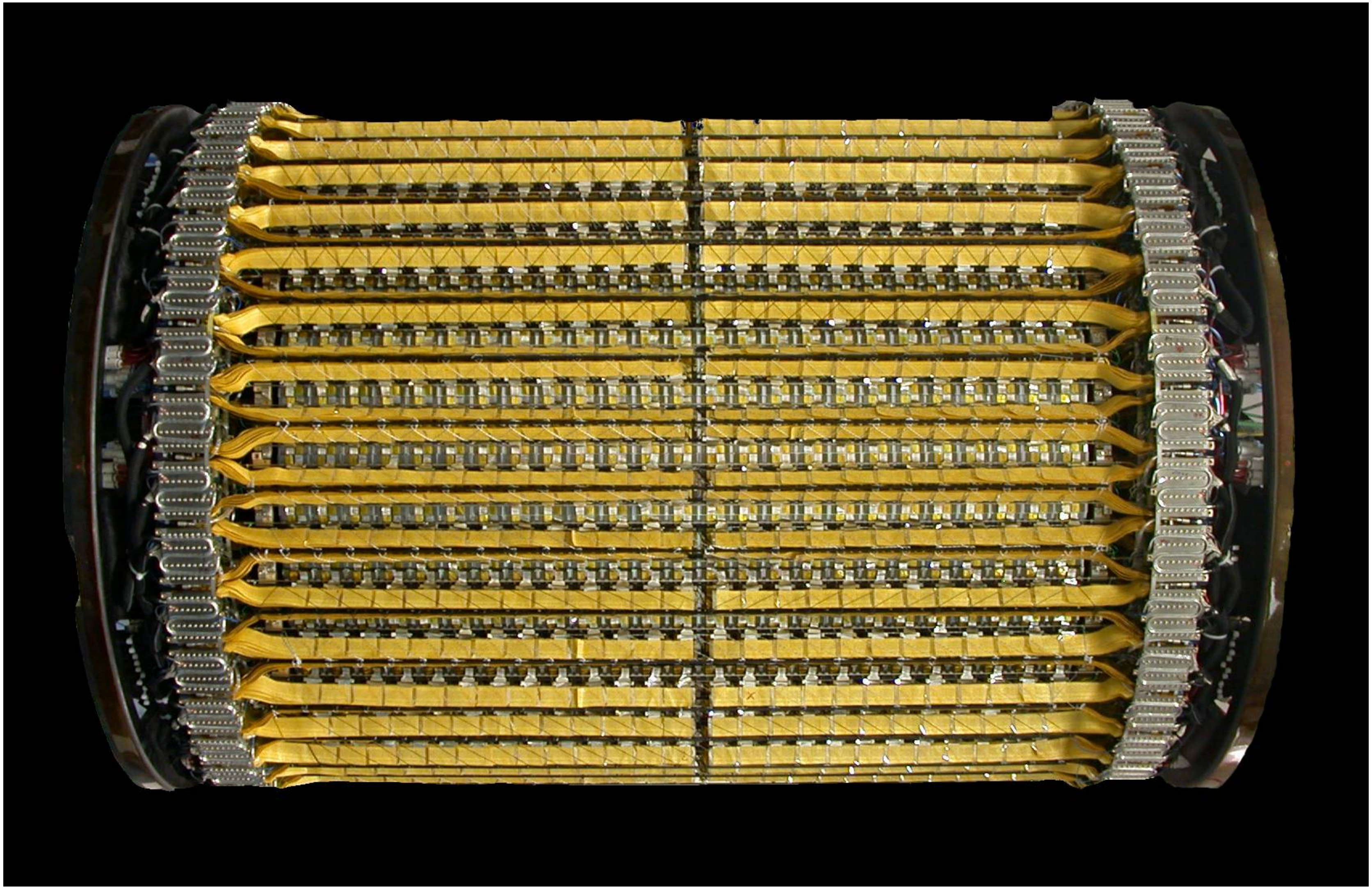


carbon-fibre mechanics

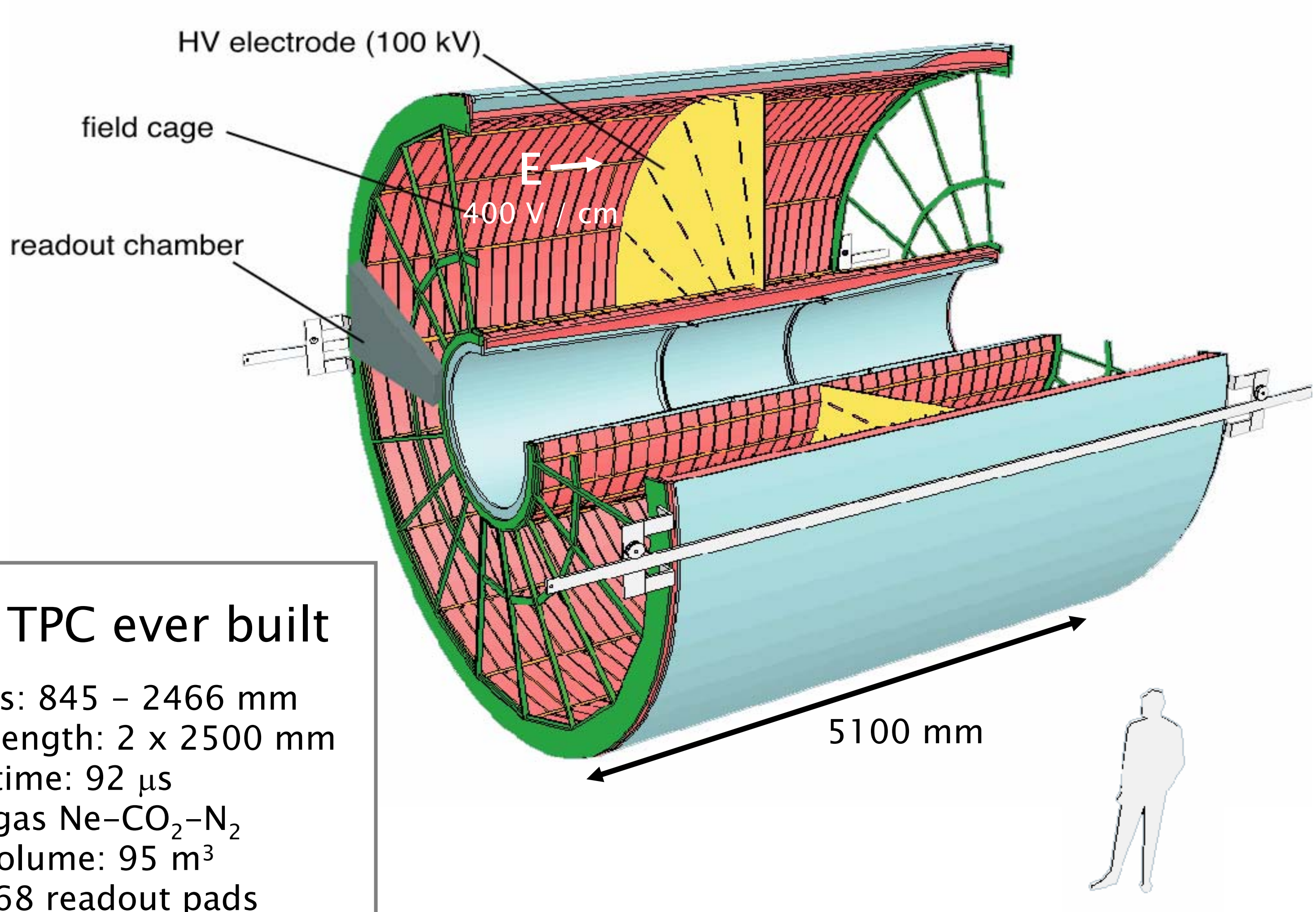


ladder mounting

Silicon Strip Detector (SSD)



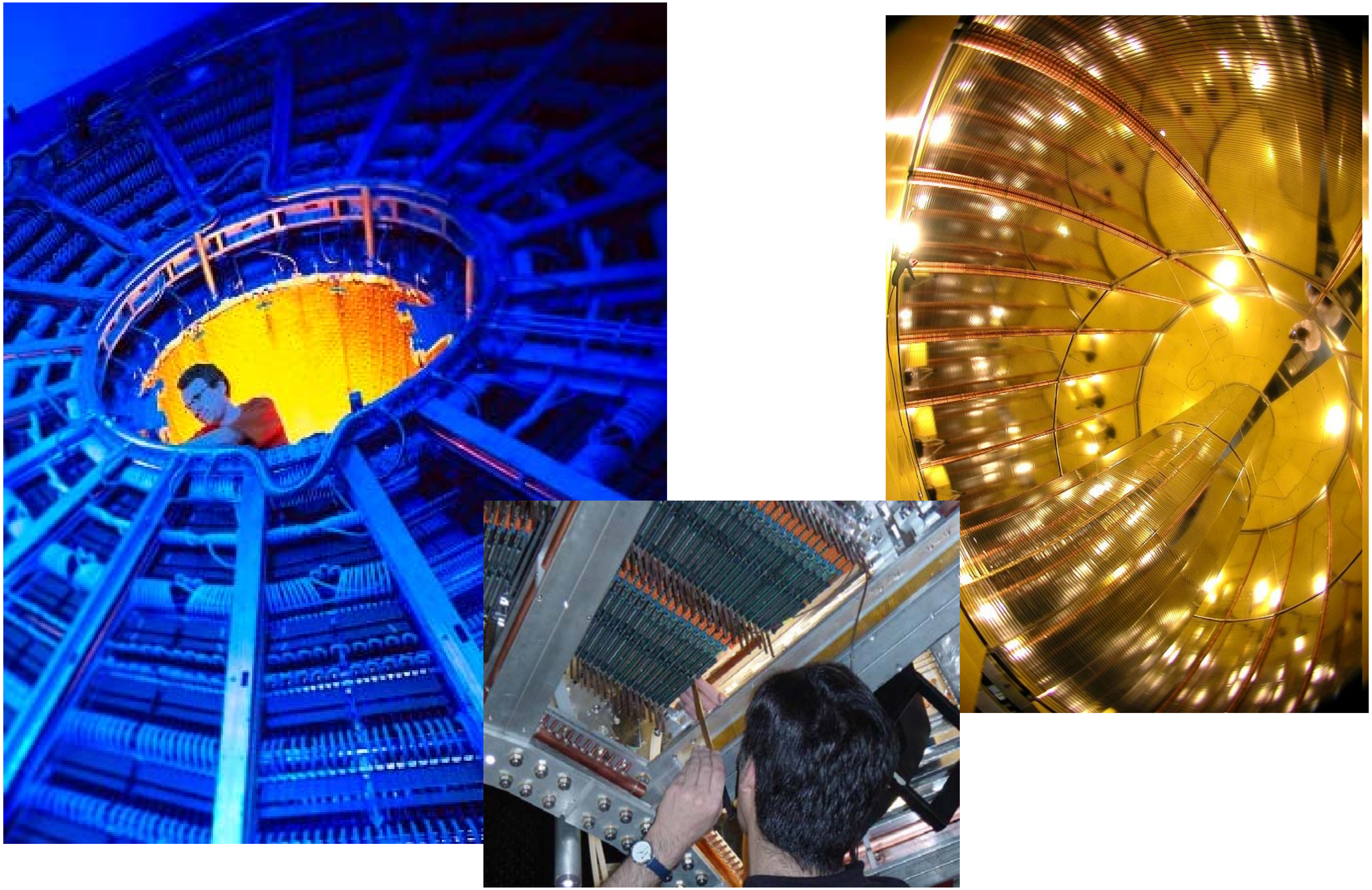
Time Projection Chamber (TPC)



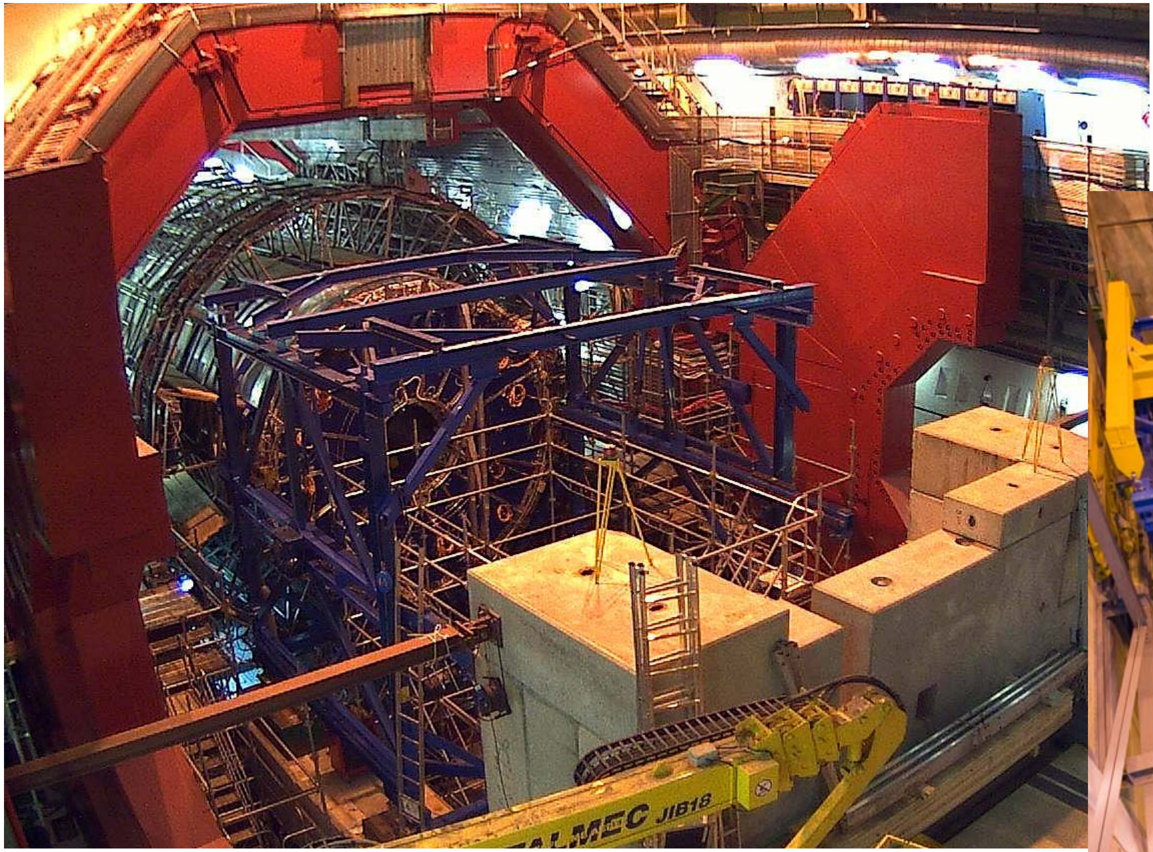
Largest TPC ever built

Radius: 845 – 2466 mm
Drift length: 2 x 2500 mm
Drift time: 92 μs
Drift gas $Ne\text{-}CO_2\text{-}N_2$
Gas volume: 95 m^3
557568 readout pads
Material: (η=0) 3% X_0

TPC assembly



Time Projection Chamber (TPC)



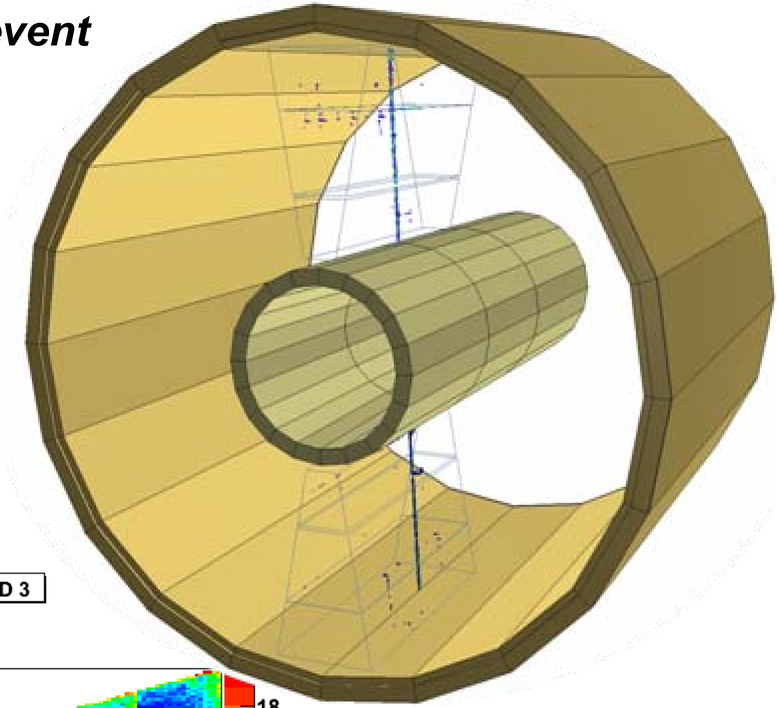
Lowering and insertion
of ALICE TPC (15/01/07)

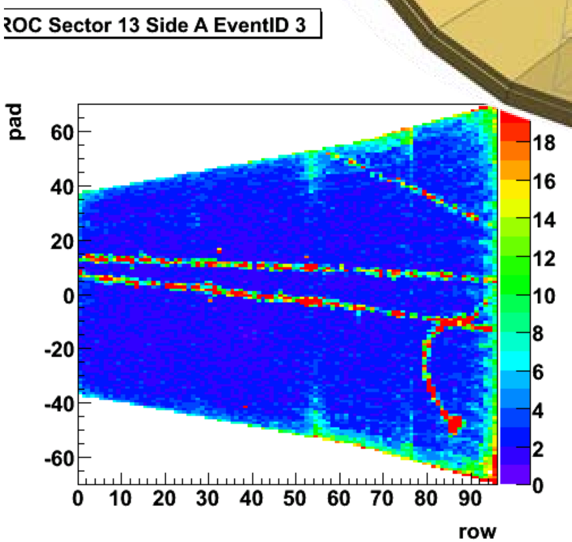
Time Projection Chamber (TPC)

TPC assembled and installed

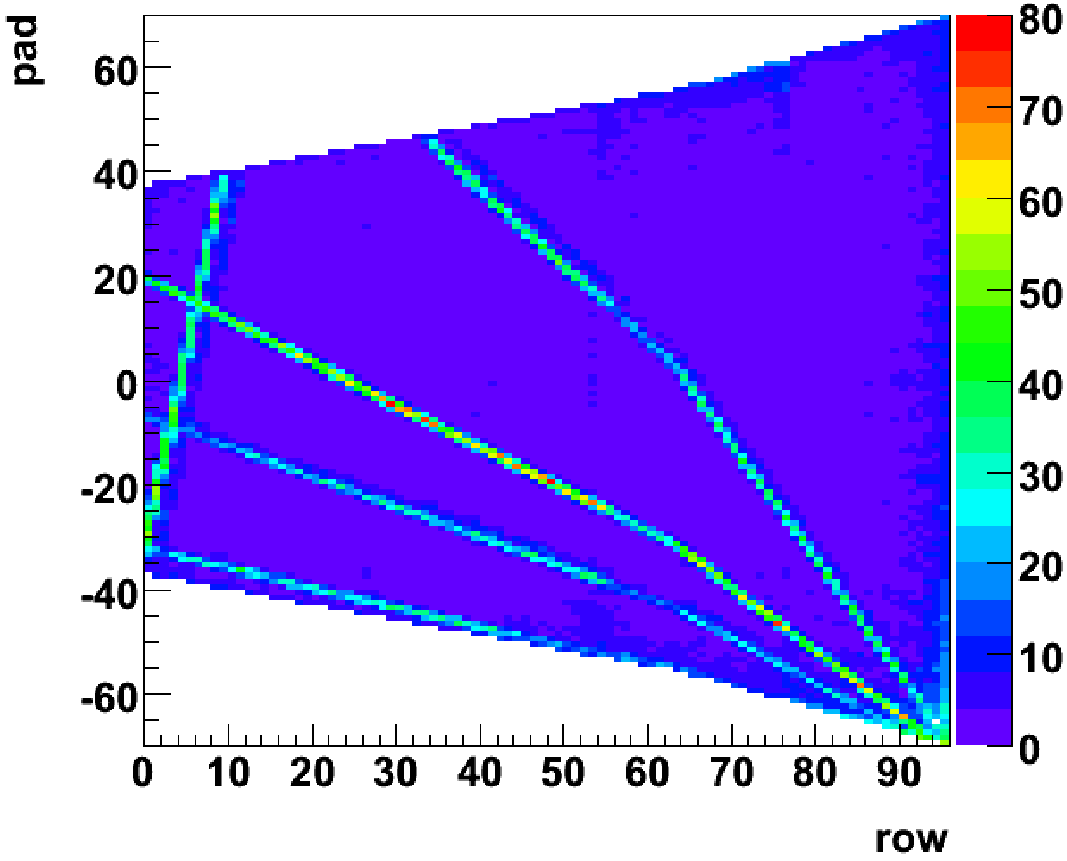
- Commissioning on ground
- Performance according to design specifications
- Ongoing: Installation of services
- Final commisioning until 11/2007

Cosmics event May 2006





TPC laser event



Transition Radiation Detector (TRD)

Purpose:

Electron-ID

Quarkonia $\rightarrow e^+e^-$
Heavy flavour

Some numbers:

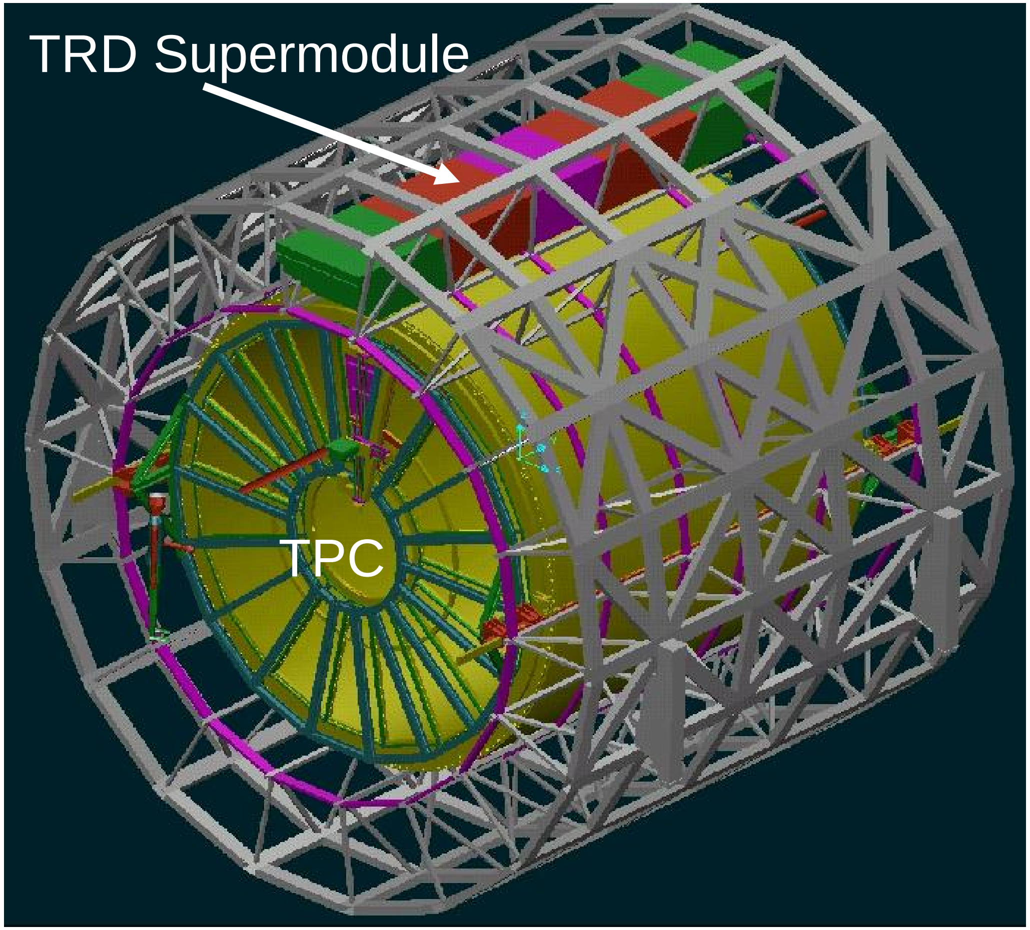
540 chambers

Total area: 736 m^2
(3 tennis courts)

Gas volume: 27.2 m^3

Resolution
($r\varphi$) 400 μm

Number of read out channels: 1.2×10^6



Transition Radiation Detector (TRD)

Drift chamber

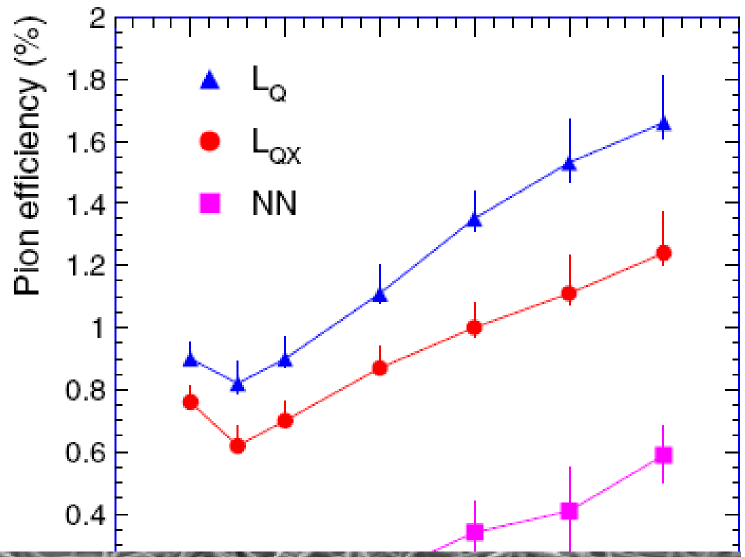
Gas: Xe–CO_2
Drift length: 3cm

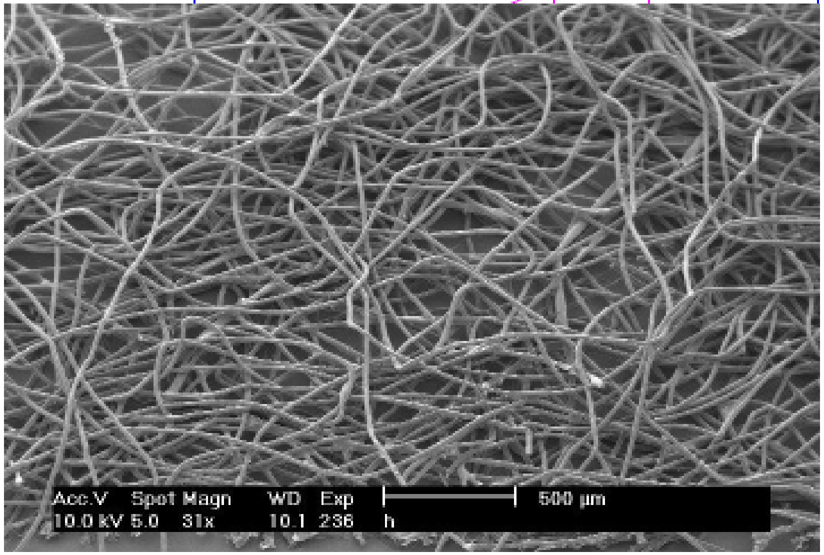
Radiator

Fiber/foam sandwich
PP, 17μm

e/π–discrimination ~ 10^{-2}

For 90% e–efficiency





first TRD supermodule

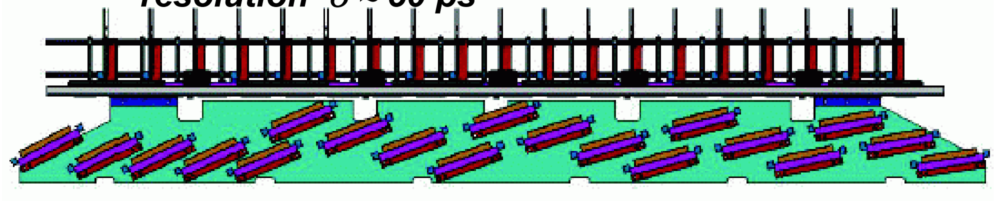
TRD

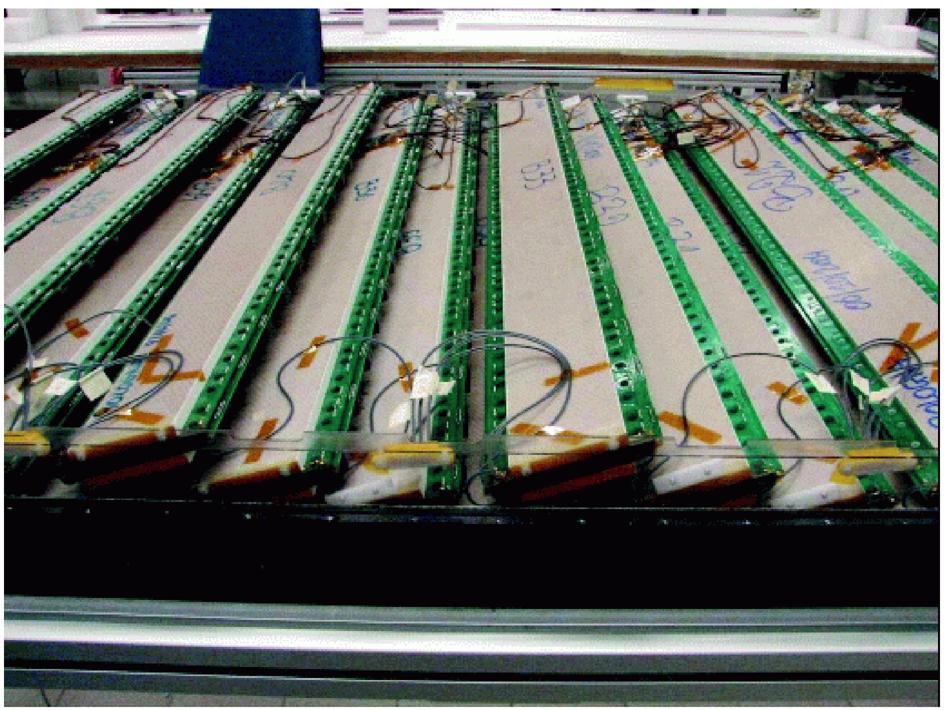
TOF supermodule
TRD Supermodule

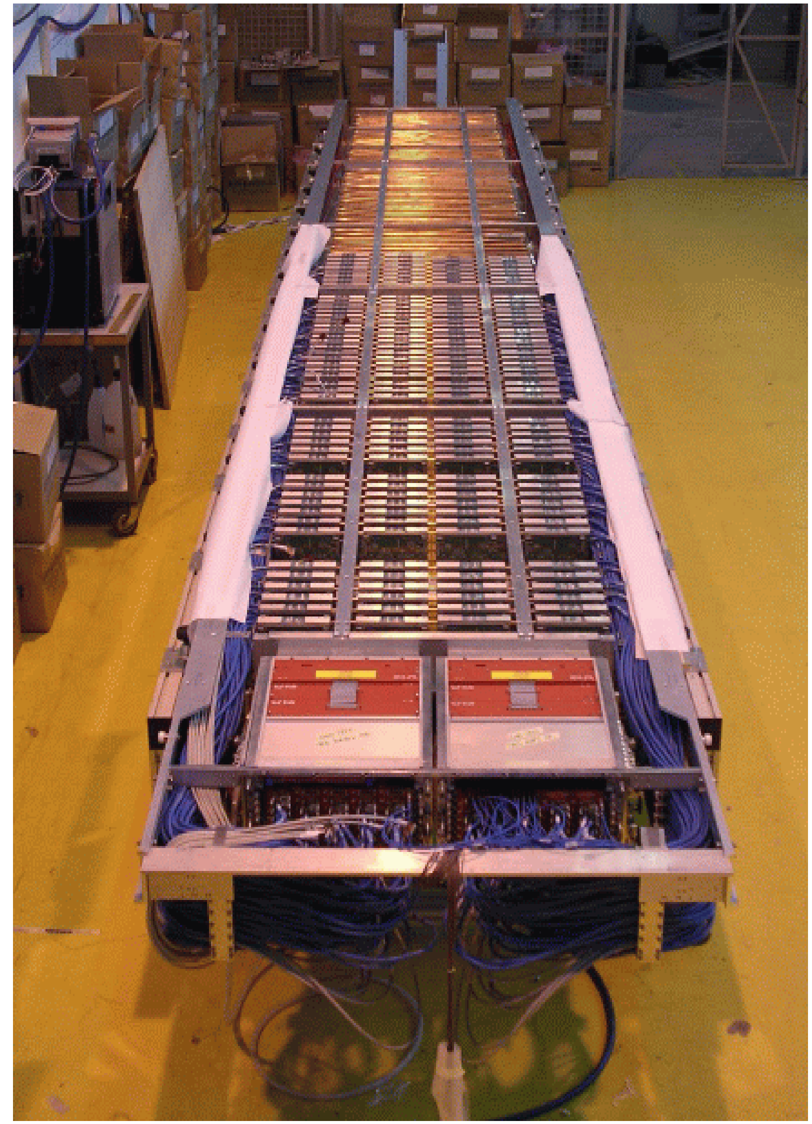
TOF

Multi-gap resistive plate chambers (MRPC)

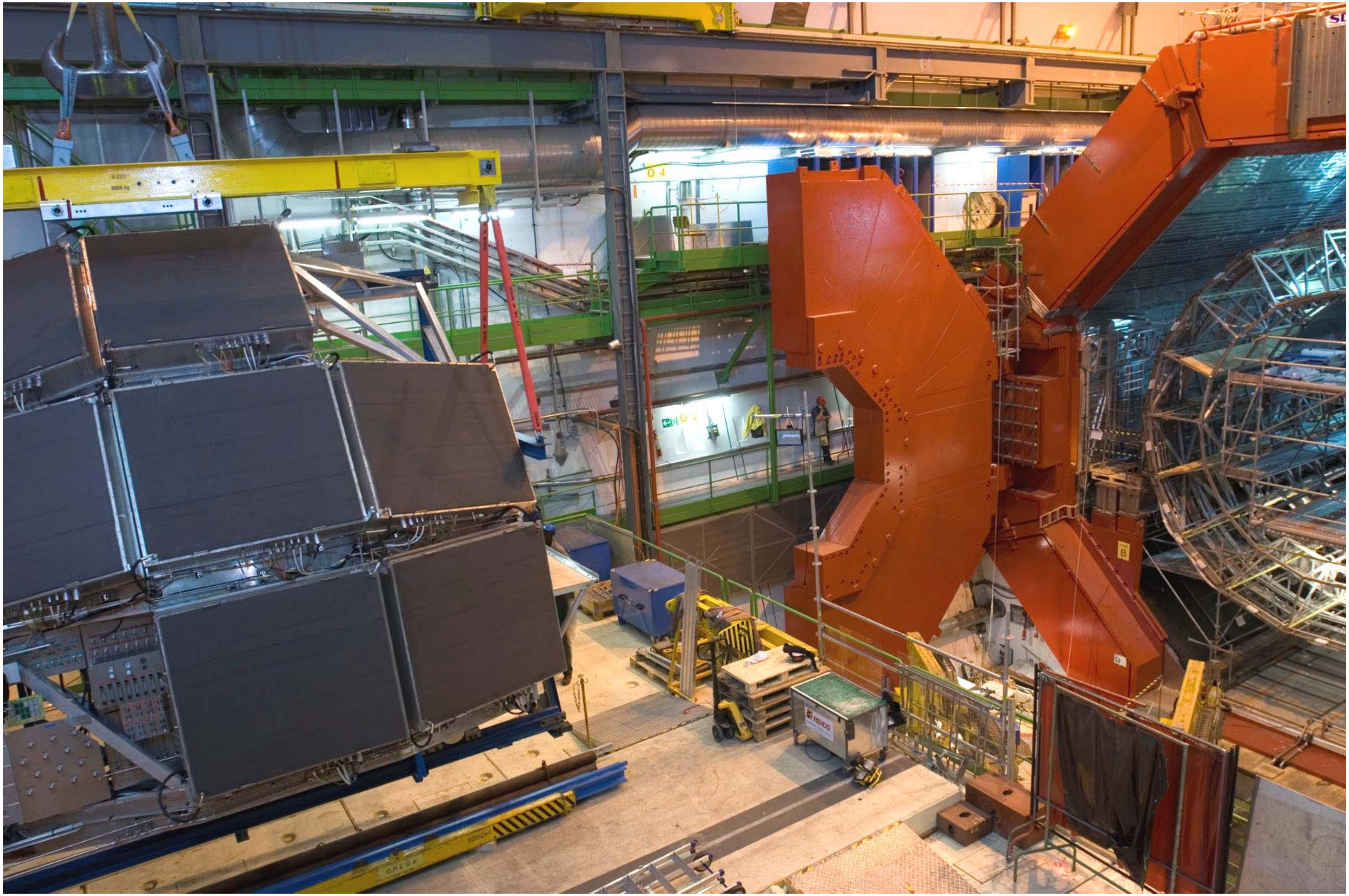
gaps:	***10 x 250 μm***
channels:	***>8000 channels per SM***
efficiency	***99.6%***
resolution	***$\sigma \approx$ 50 ps***



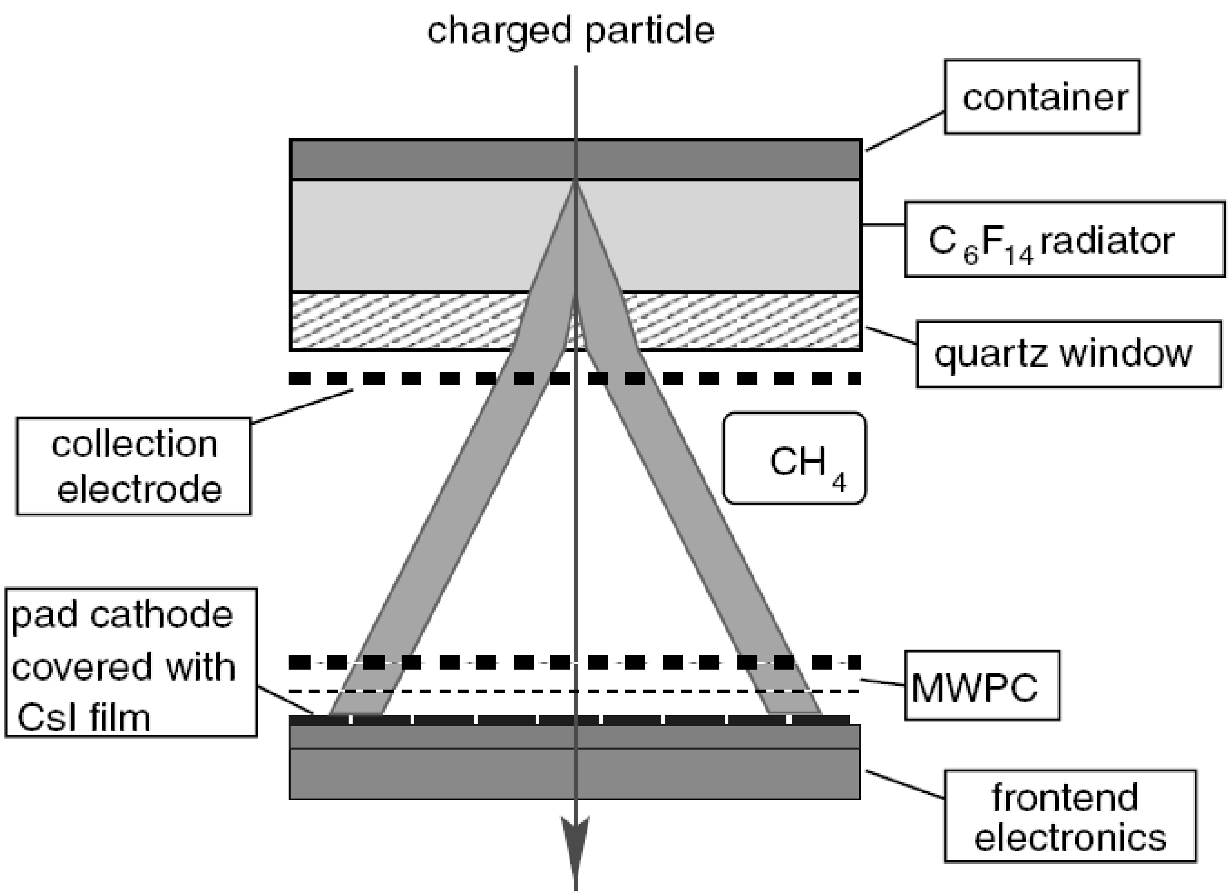




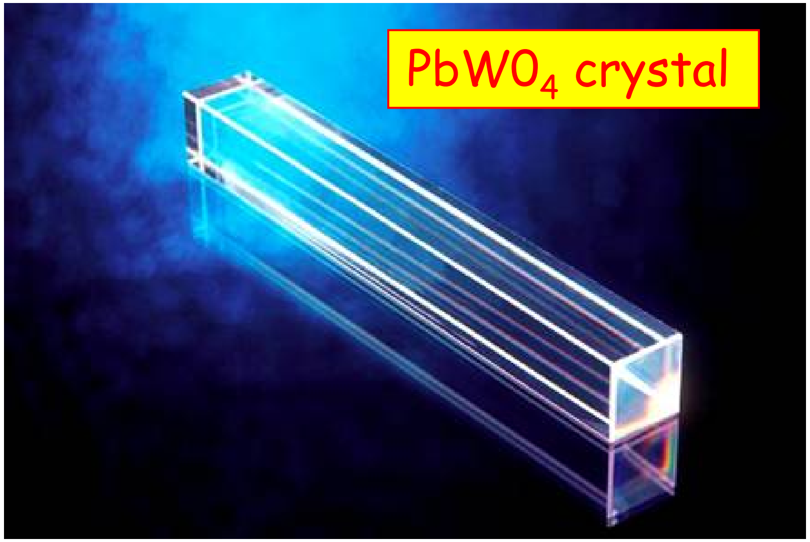
High Momentum Particle Id (HMPID)



High Momentum Particle Id (HMPID)



Photon Spectrometer (PHOS)



photons, neutral mesons, γ-jet tagging

dense $PbWO_4$ crystals (X_0 < 0.9 cm) at -25˚C

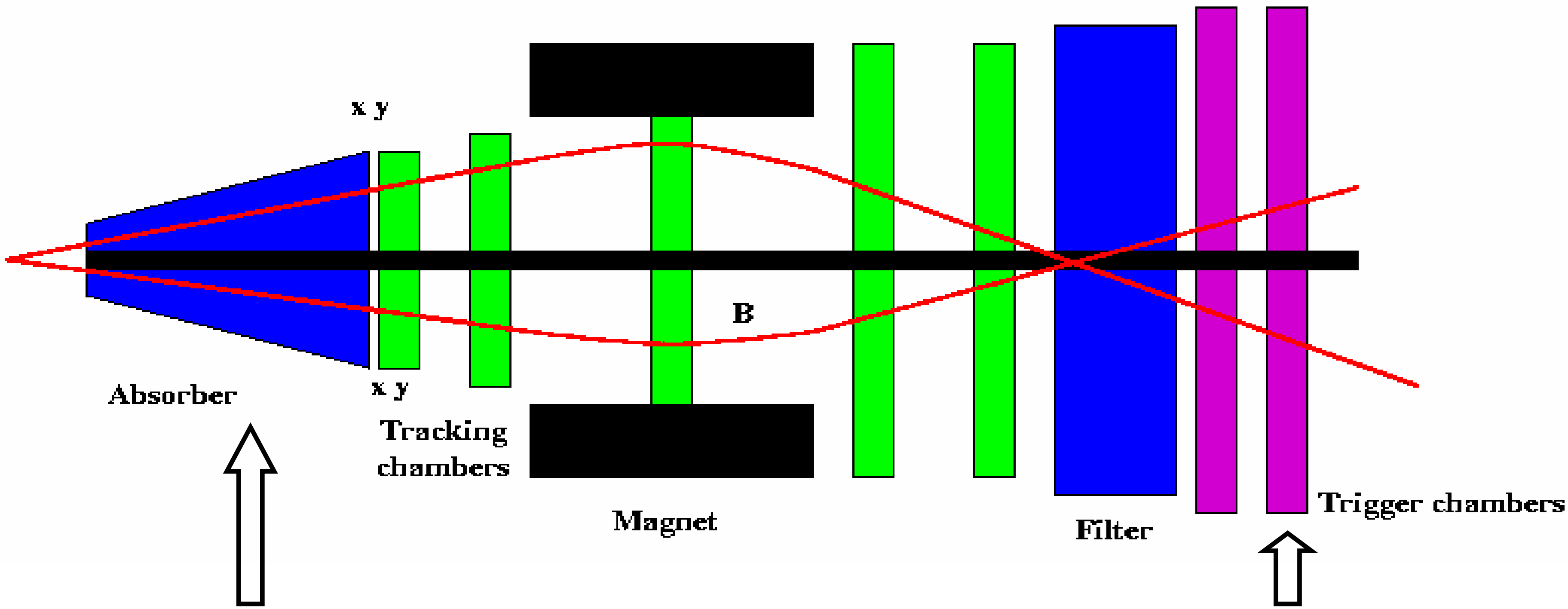
~18k channels, $8m^2$

good energy resolution

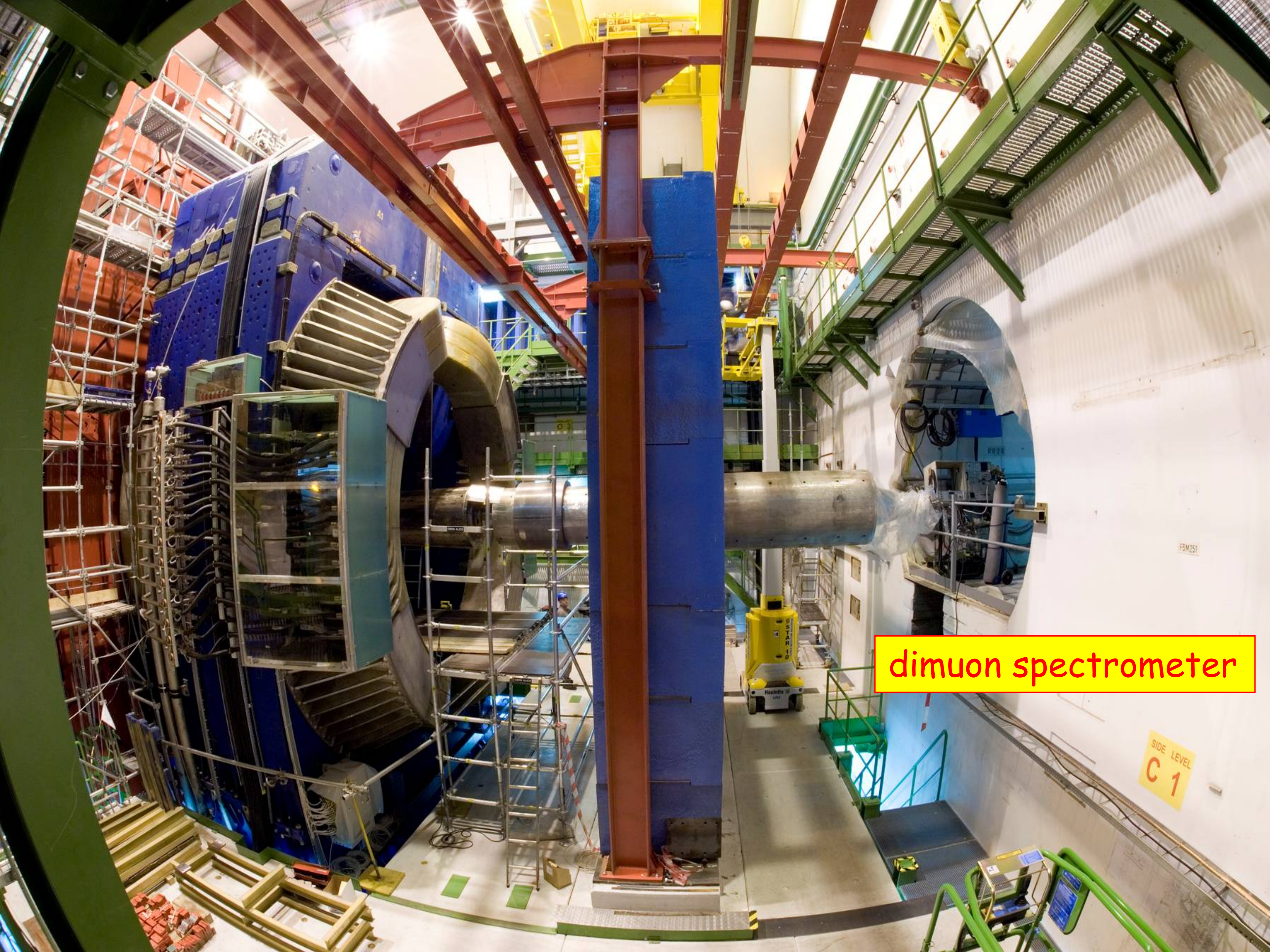
- ***stochastic: 2.7%/√E***
- ***noise: 2.5%/E***
- ***constant: 1.3%***

Forward Muon Spectrometer (MUON)

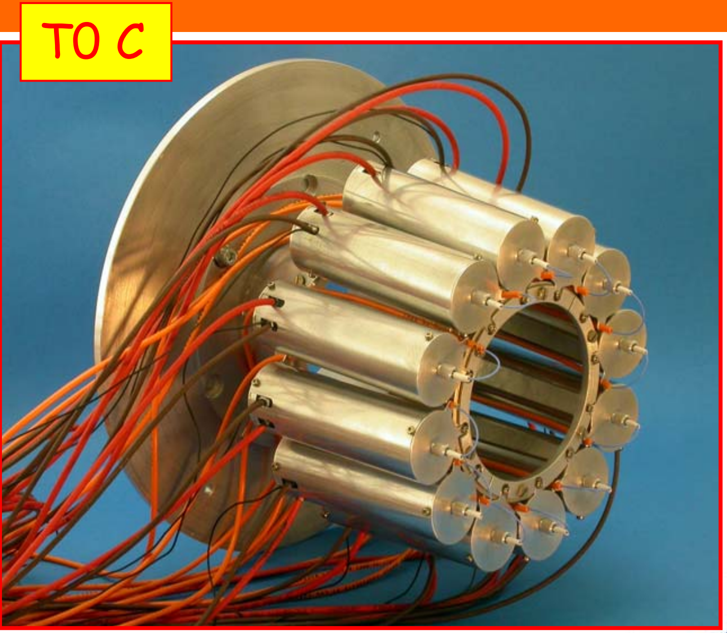
... aka Muon Arm

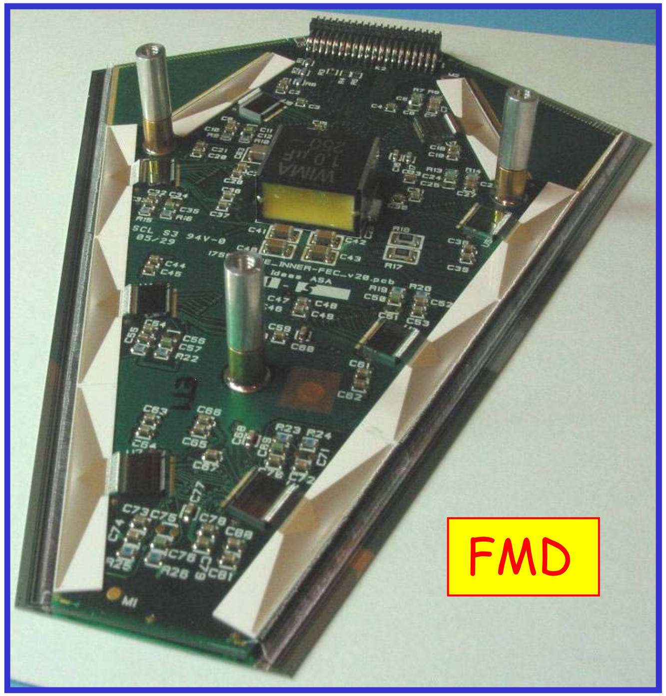


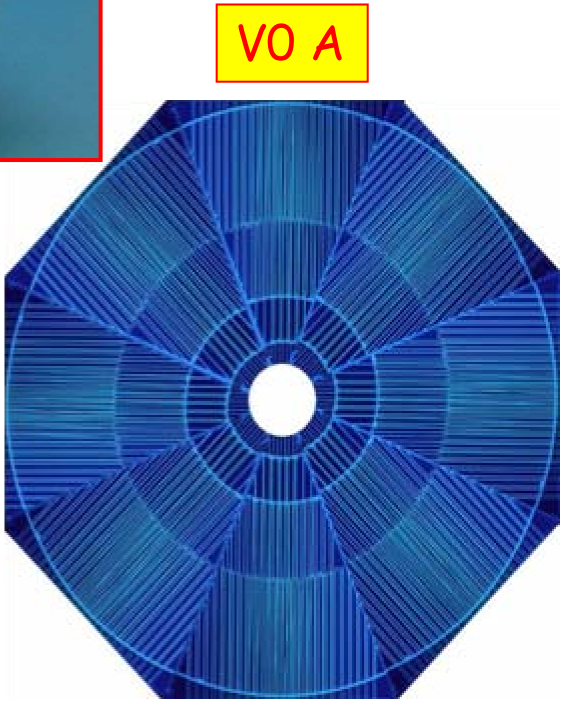
Dipole Magnet

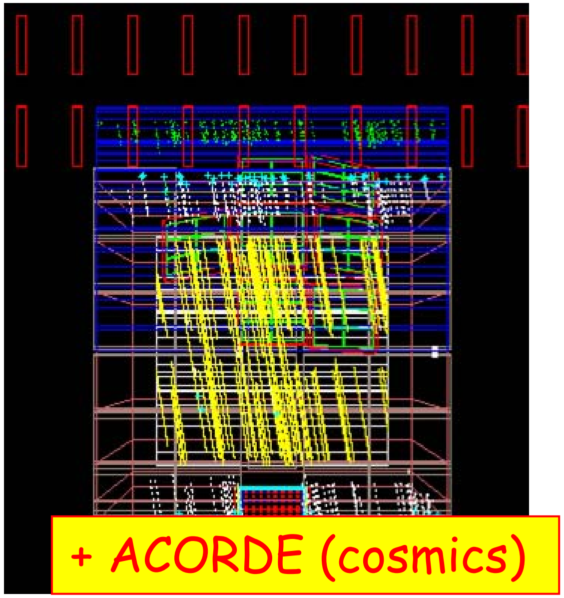

dimuon spectrometer
SIDE LEVEL
C 1

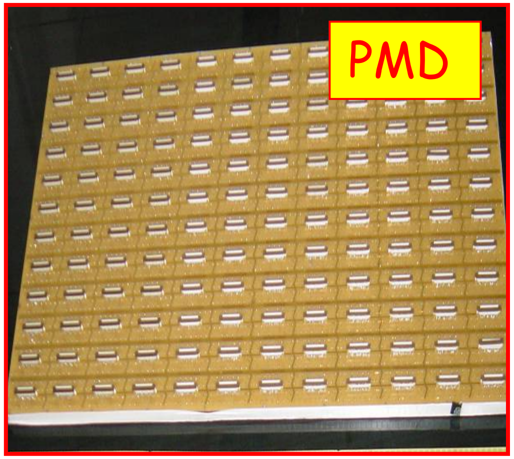
forward detectors



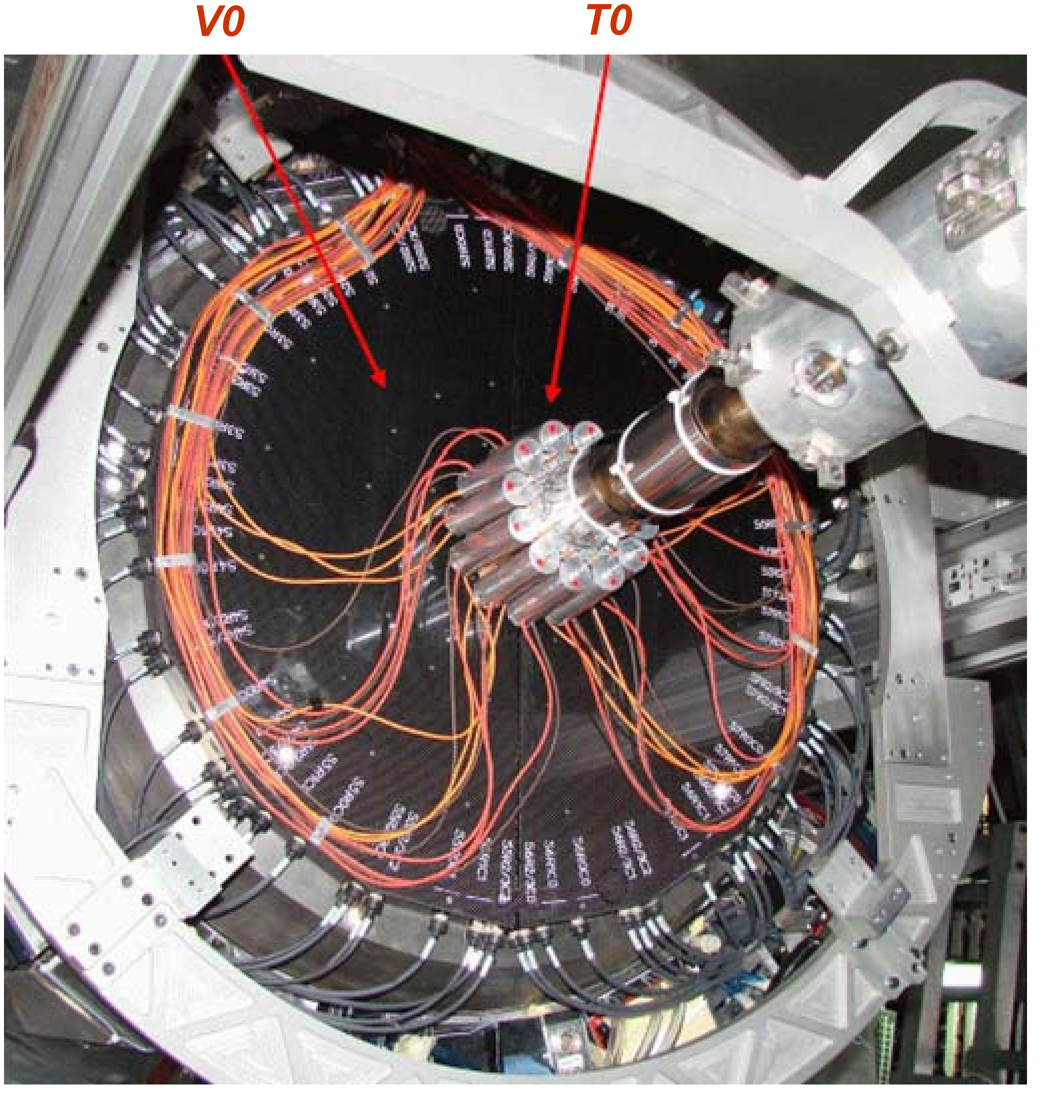








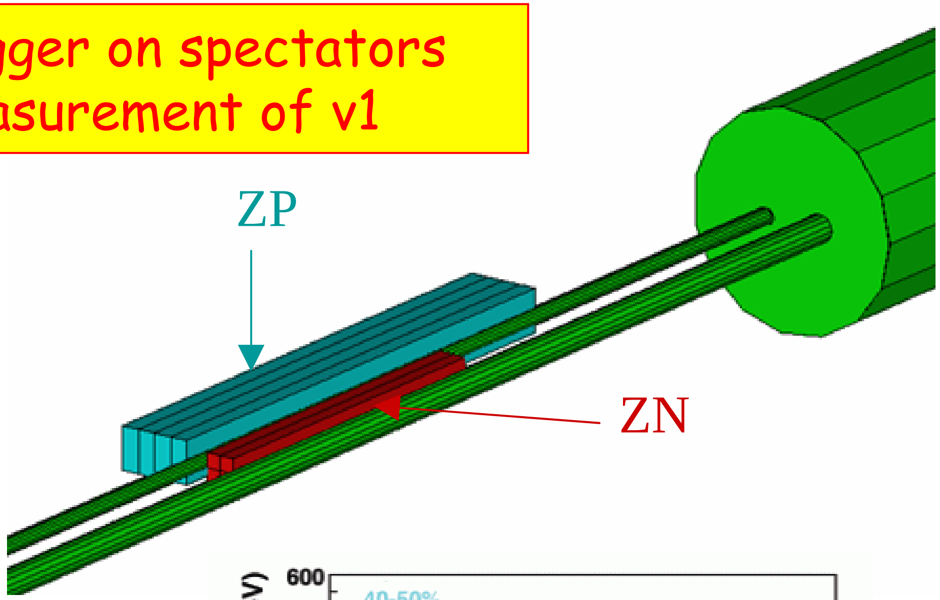
forward detectors

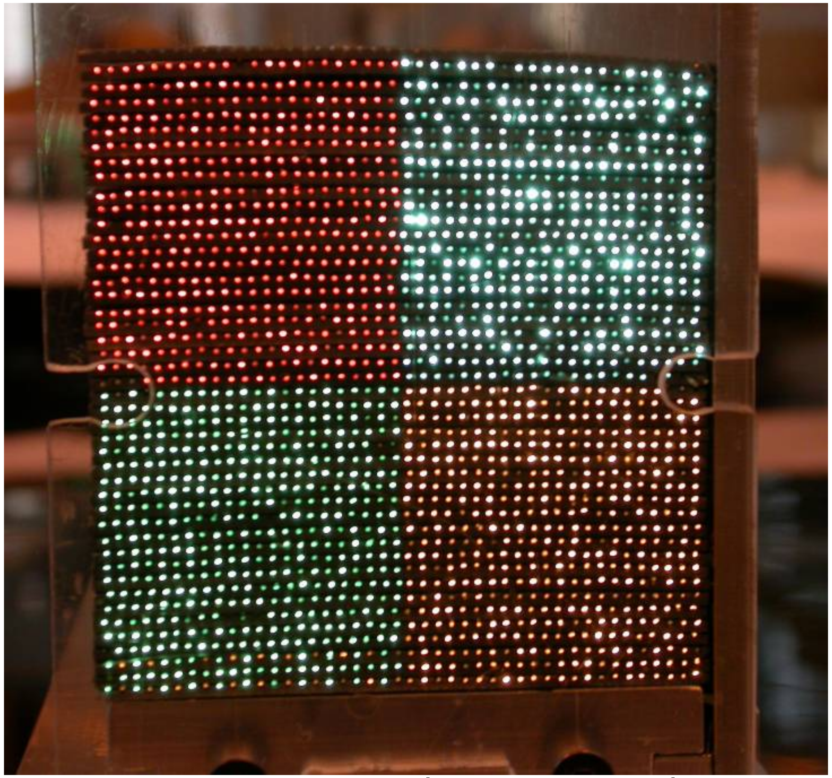


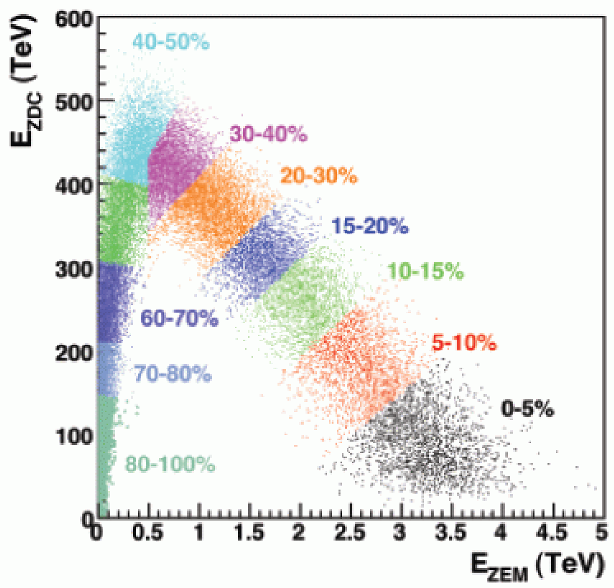
even more forward: Zero Degree Calorimeters (ZDC)

trigger on spectators
measurement of v1

6 calorimeters:
EM .... 8 m from IP
ZP ..... 116 m from IP
ZN ..... 116 m from IP







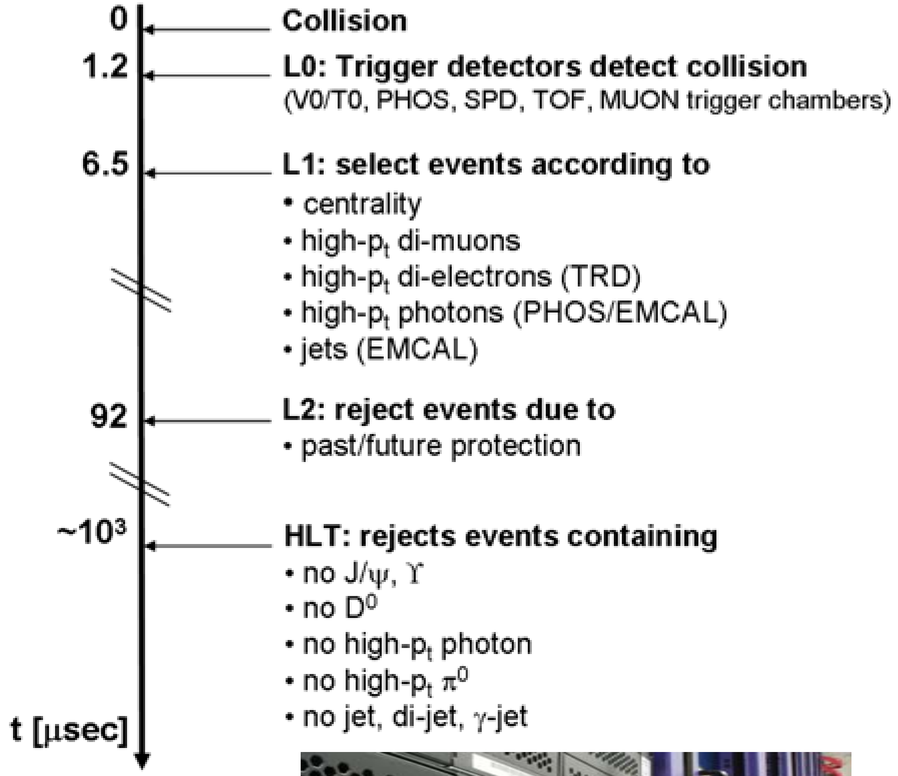
Trigger

Hierarchical architecture

- L0, L1, L2, and HLT

High Level Trigger (HLT)

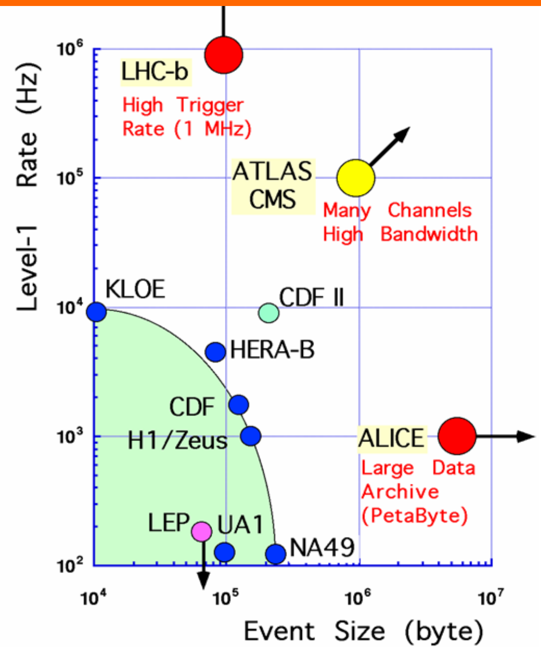
- Online reconstruction using ~500–600 PCs + FPGAs
- Input rate 200Hz (central Pb–Pb) → up to 20 GByte/s
- Generate physics trigger (e.g. jets, Upsilons, D^0, ...)
- Online data compression
- Calibration tasks



Number	L0 (Pb–Pb)	L0 (pp)	L1 (Pb–Pb)
1	V0 minimum bias	V0 minimum bias	TRD unlike e pair high p_T
2	V0 semi-central	V0 high multiplicity	TRD like e pair high p_T
3	V0 central	V0 beam gas	TRD jet low p_T
4	V0 beam gas	T0 right	TRD jet high p_T
5	T0 vertex	T0 left	TRD electron
6	PHOS MB	T0 vertex	TRD hadron low p_T
7	PHOS jet low p_T	PHOS MB	TRD hadron high p_T
8	PHOS jet high p_T	PHOS jet low p_T	ZDC 1
9	EMCAL MB	PHOS jet high p_T	ZDC 2
10	EMCAL jet high p_T	EMCAL MB	ZDC 3
11	EMCAL jet med p_T	EMCAL jet high p_T	ZDC special
12	EMCAL jet low p_T	EMCAL jet med p_T	Topological 1
13	Cosmic Telescope	EMCAL jet low p_T	Topological 2
14	DM like high p_T	Cosmic Telescope	
15	DM unlike high p_T	DM like high p_T	
16	DM like low p_T	DM unlike high p_T	
17	DM unlike low p_T	DM like low p_T	
18	DM single	DM unlike low p_T	
19	TRD pre-trigger	DM single	
20		TRD pre-trigger	
21			
22			
23			
24			

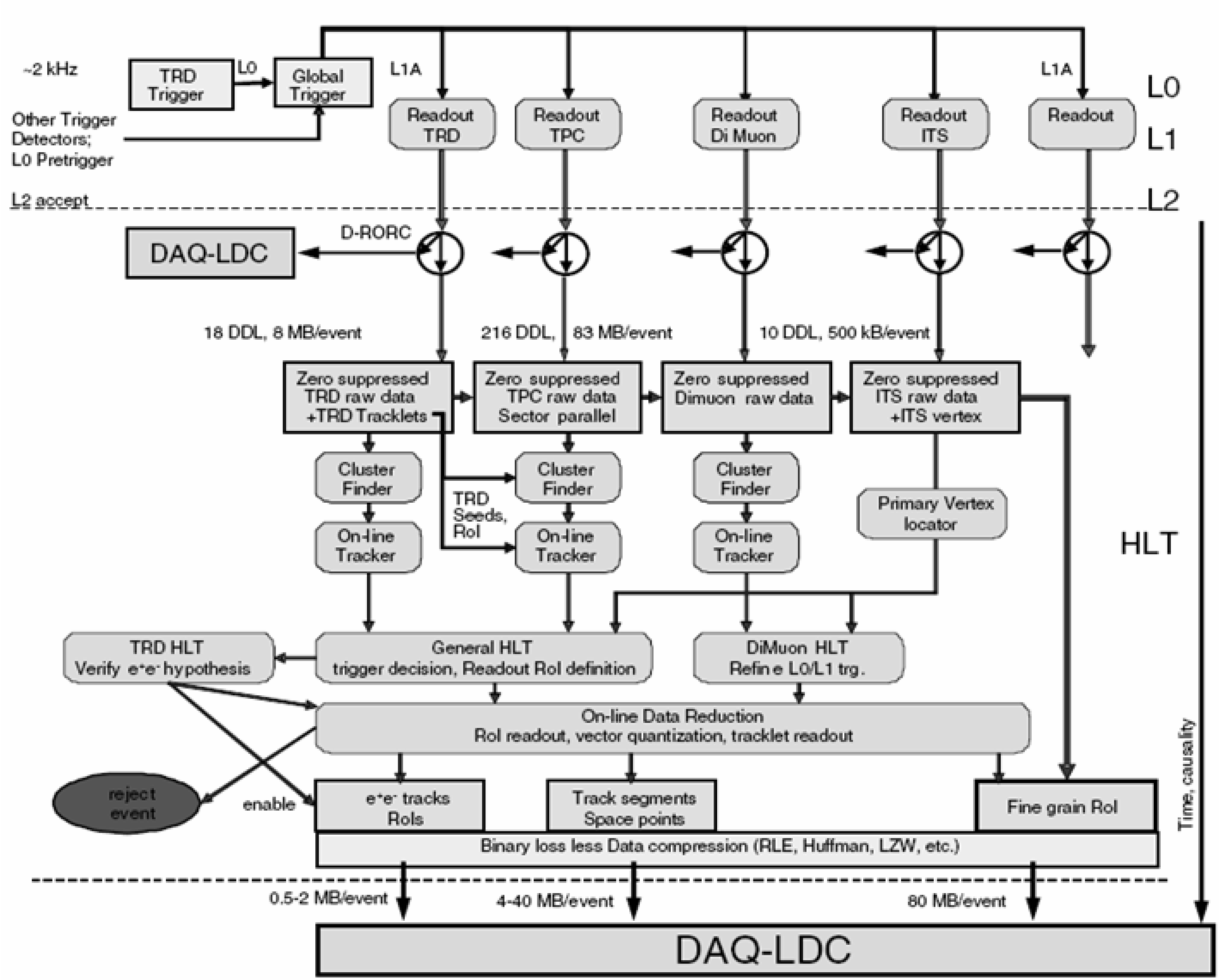
DAQ

Detector	pp (kB)	Pb–Pb (MB)
ITS Pixel		0.140
ITS Drift	1.8	1.500
ITS Strips		0.160
TPC	2450.0	75.900
TRD	11.1	8.000
TOF		0.180
PHOS		0.020
HMPID		0.120
MUON		0.150
PMD		0.120
Trigger		0.120
Total	2500	86.500

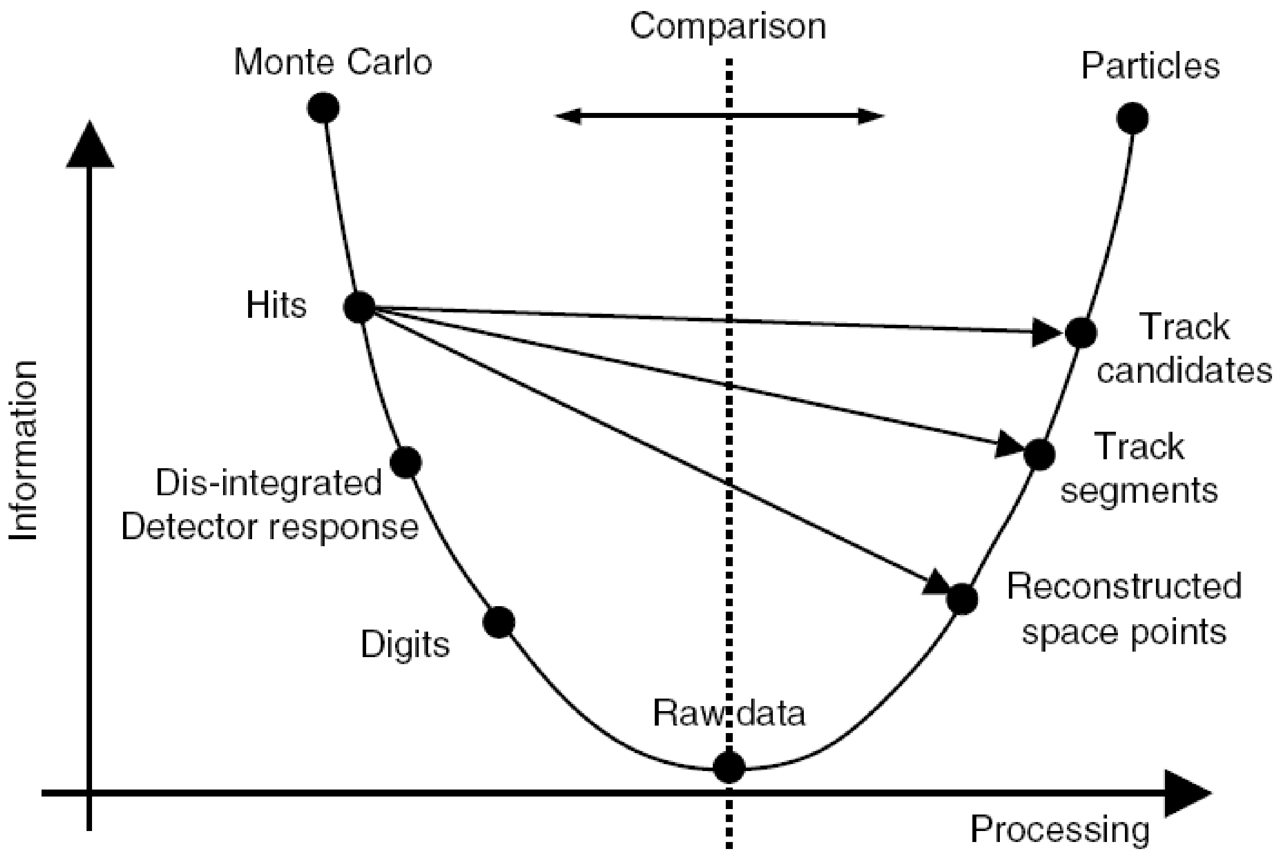


	Scenario 1 Rates (Hz)		Scenario 2 Rates (Hz)		Scenario 3 Rates (Hz)		Scenario 4 Rates (Hz)	
	Maximum	DAQ	Level 2	DAQ	Level 2	DAQ	Level 2	DAQ
Central	10^3	20	10	10	20	20	20	20
Minimum-bias	10^4	20	10	10	20	20	20	20
Dielectron			100	100	200	20	200	20
Dimuon	1000	650	1600	1600	1600	1600	1600	1600
Total throughput (MB s^{-1})		1250	1400	1400	700			

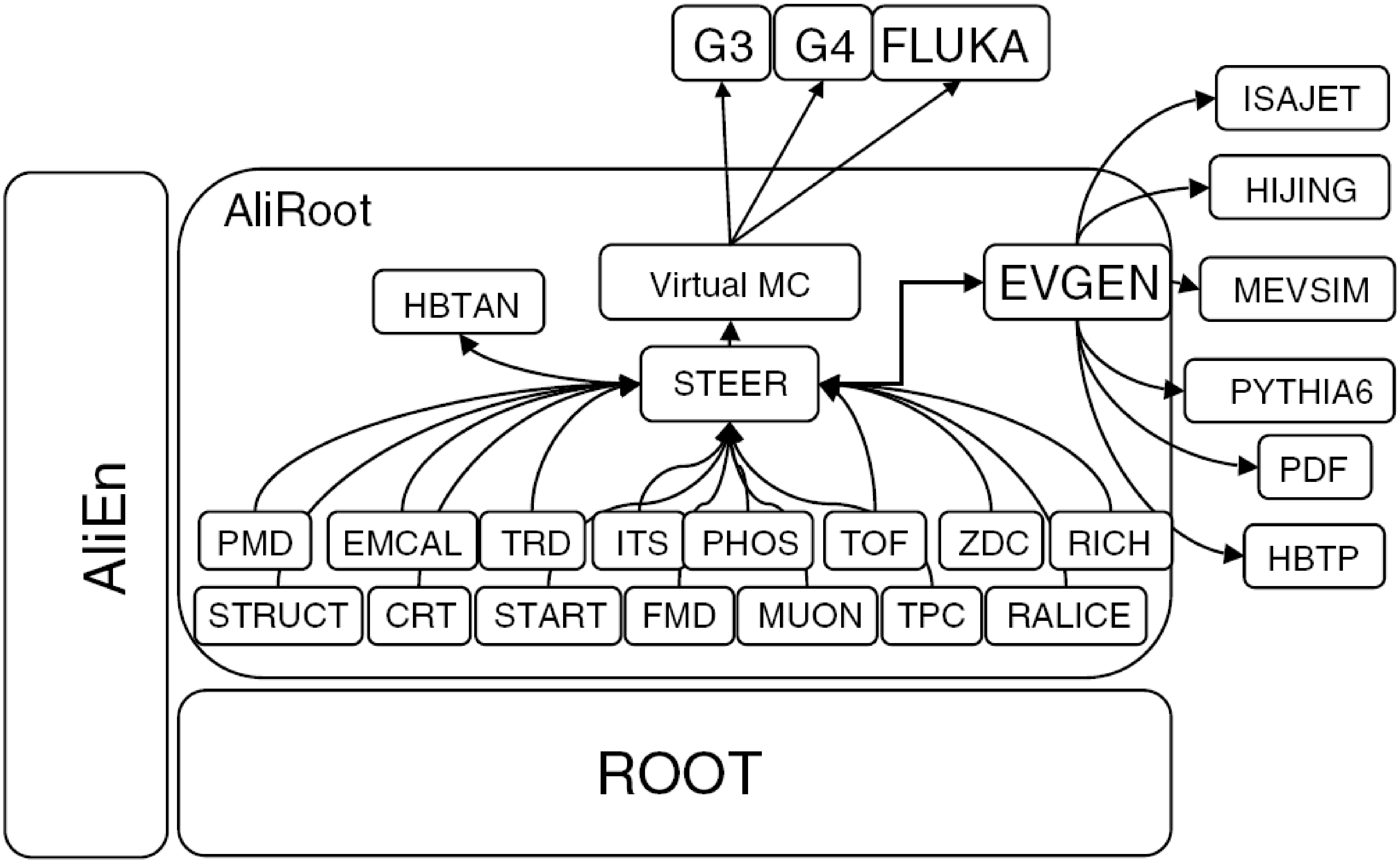
High Level Trigger (HLT)



Data processing aka offline

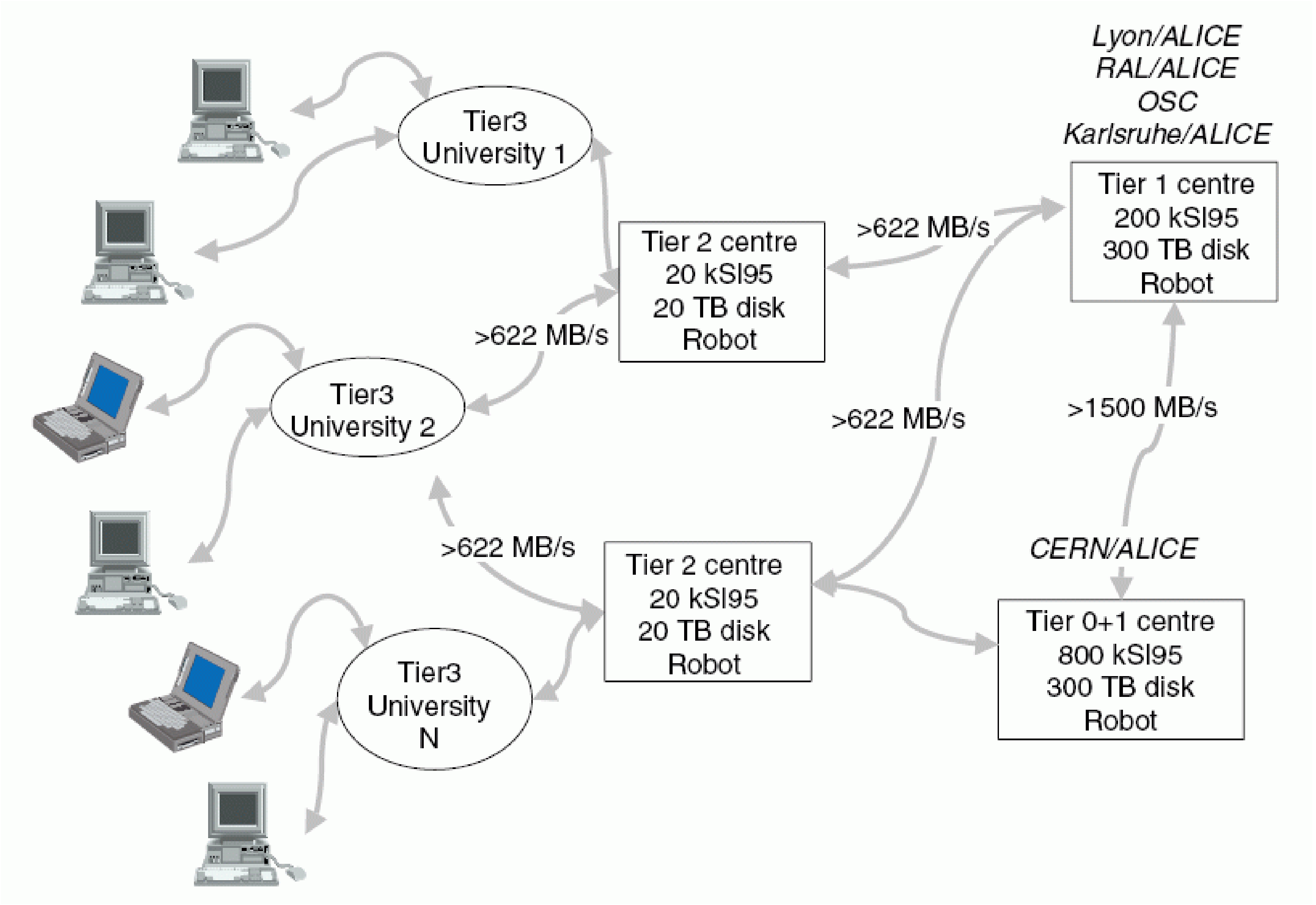


Aliroot



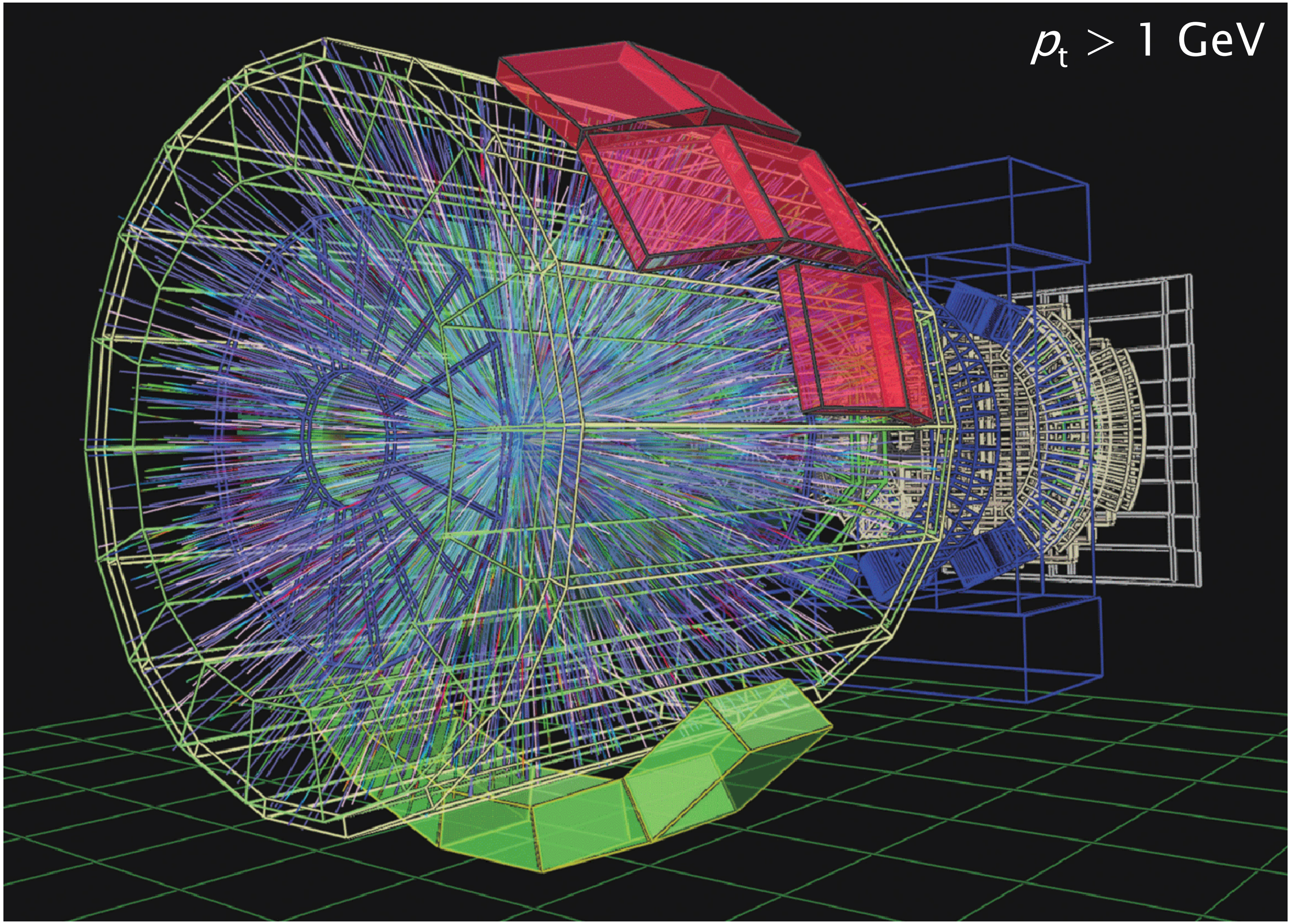
G3
G4
FLUKA
ISAJET
HIJING
AliRoot
AliEn
Virtual MC
EVGEN
MEVSIM
HBTAN
STEER
PYTHIA6
PDF
PMD
EMCAL
TRD
ITS
PHOS
TOF
ZDC
RICH
HBTP
STRUCT
CRT
START
FMD
MUON
TPC
RALICE
ROOT

Grid



Tier3
University 1
Tier3
University 2
Tier3
University
N
>622 MB/s
Tier 2 centre
20 kSI95
20 TB disk
Robot
>622 MB/s
>622 MB/s
Tier 2 centre
20 kSI95
20 TB disk
Robot
>622 MB/s
Lyon/ALICE
RAL/ALICE
OSC
Karlsruhe/ALICE
Tier 1 centre
200 kSI95
300 TB disk
Robot
>1500 MB/s
CERN/ALICE
Tier 0+1 centre
800 kSI95
300 TB disk
Robot

ALICE Event Display



central barrel tracking

Efficiency

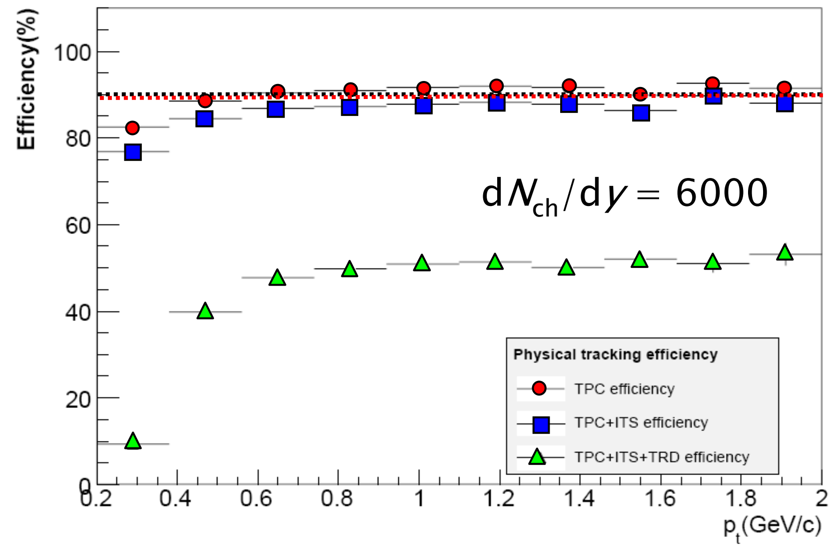
Approaches TPC acceptance (90%)

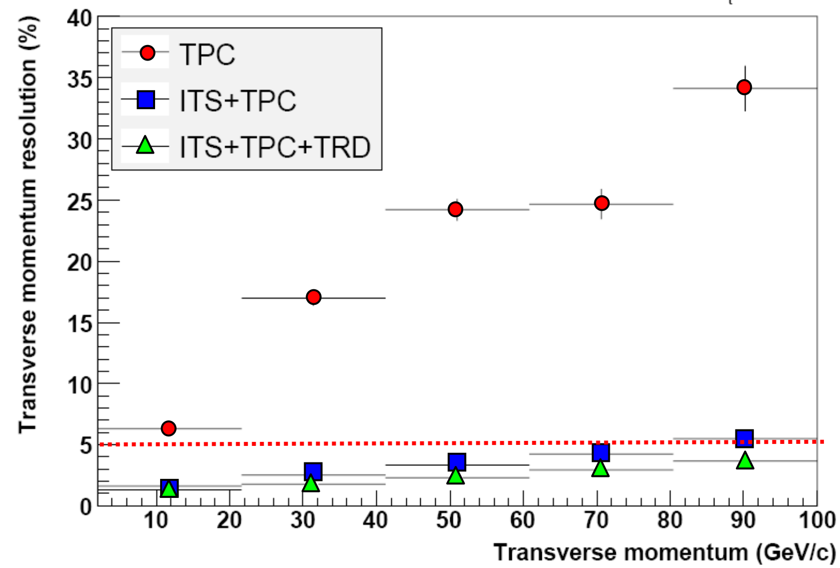
Only very little dependence on track multiplicity

Momentum resolution

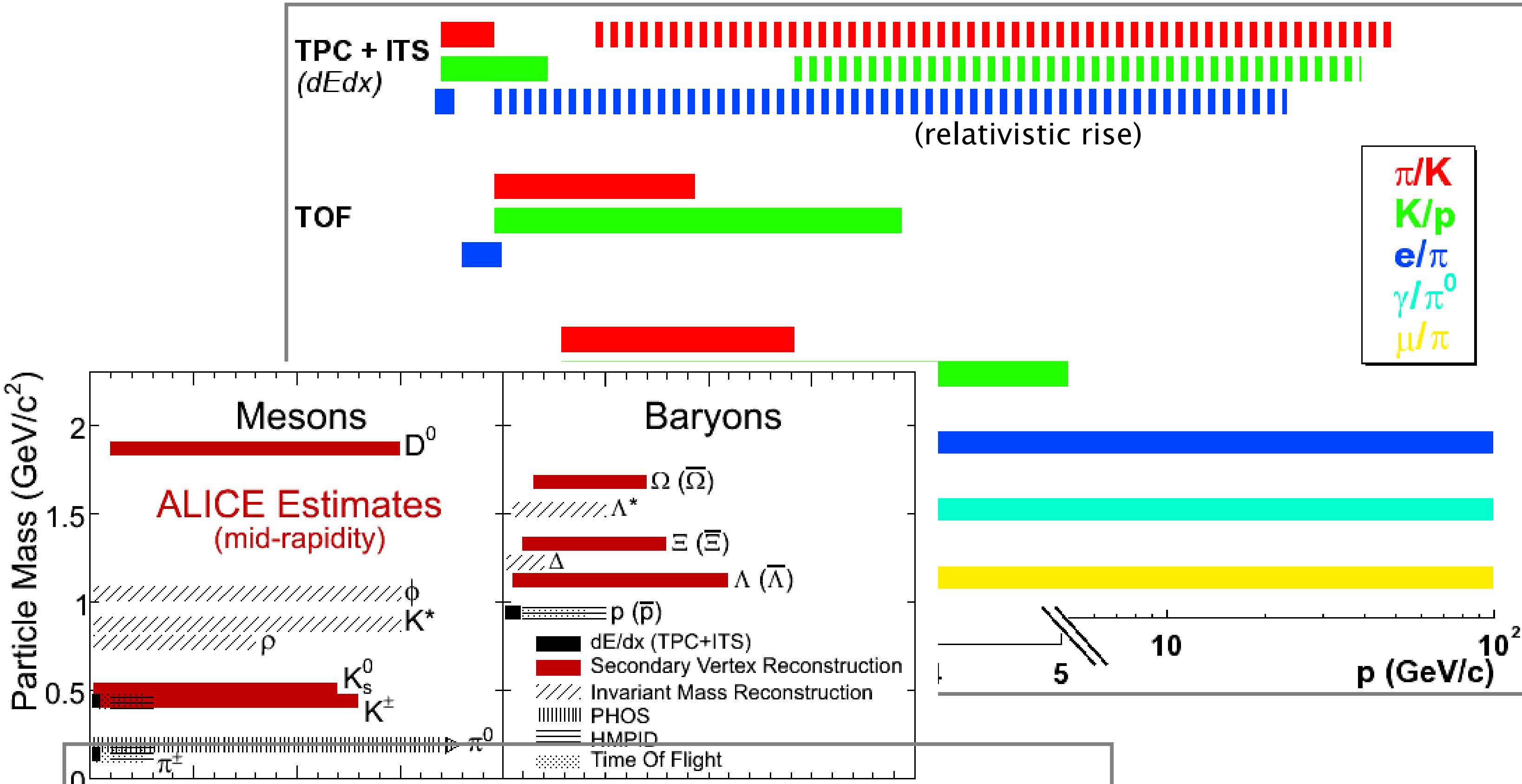
Long lever arm
ITS + TPC + TRD
(4cm $< r <$ 3700cm)

$\delta p_t / p_t \leq 5\%$
at $p_t = 100$ GeV/c
and $B = 0.5$T





PID Capabilities

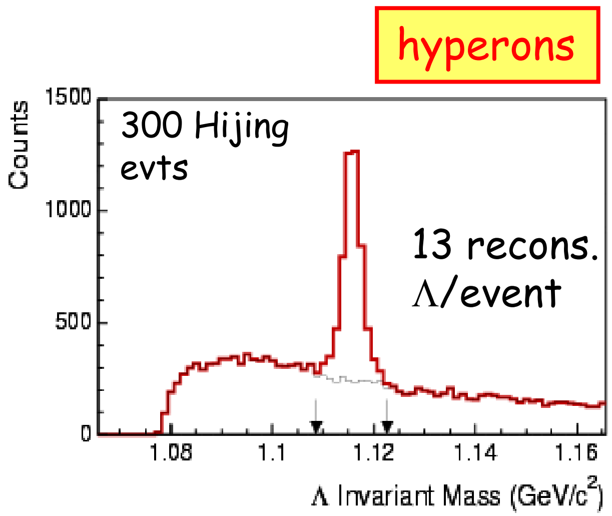


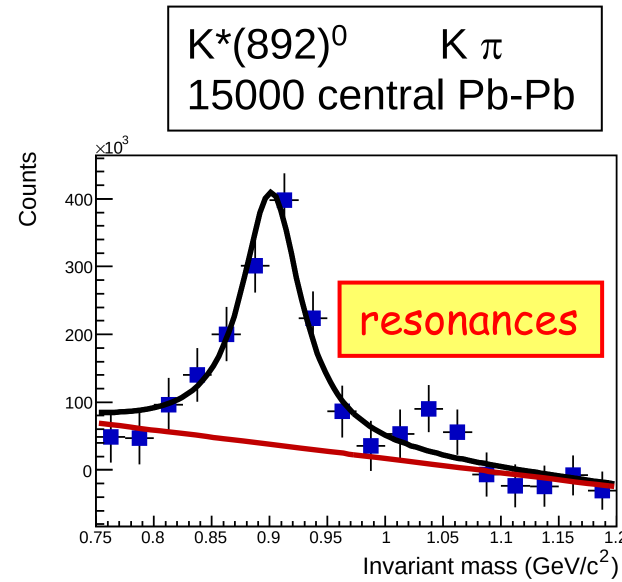
TPC: $\sigma(dE/dx) = 5.5(pp) - 6.5(Pb\text{-}Pb)\%$

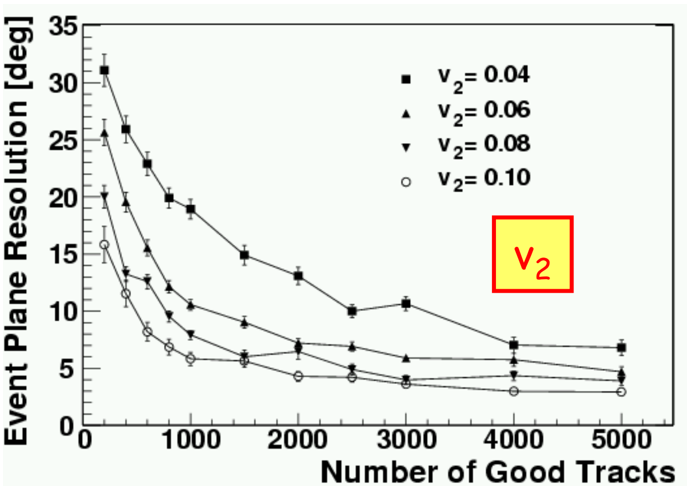
TOF: $\sigma < 100$ ps

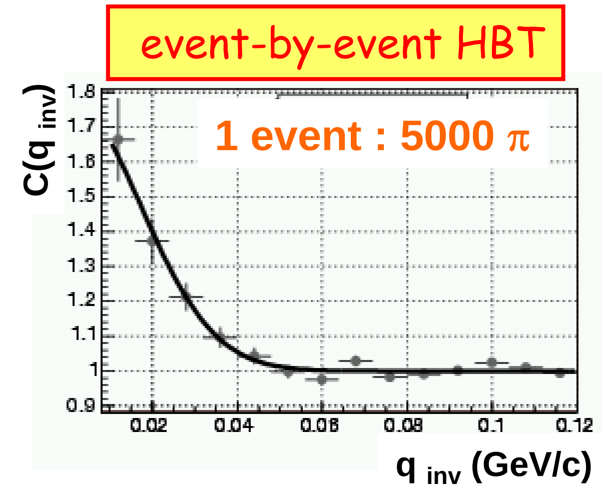
TRD: π suppression $\approx 10^{-2}$ @ 90% e-efficiency

Soft physics









Day 1 @ LHC: event multiplicity at y=0

- generic trends in $dN^{ch}/d\eta$
  - extended longitudinal scaling
  - self-similar trapezoidal shape

$\Rightarrow$ $dN^{ch}/d\eta\big|_{\eta=0} \propto \ln\sqrt{s_{NN}}$

- Saturation models predict

Armesto, Salgado, Wiedemann, PRL94 (2005) 022002

$$\frac{1}{N_{\rm part}}\frac{dN^{AA}}{d\eta}\bigg|_{\eta\sim 0} = N_0 \sqrt{s}^{\lambda} N_{\rm part}^{\frac{1-\delta}{3\delta}}$$

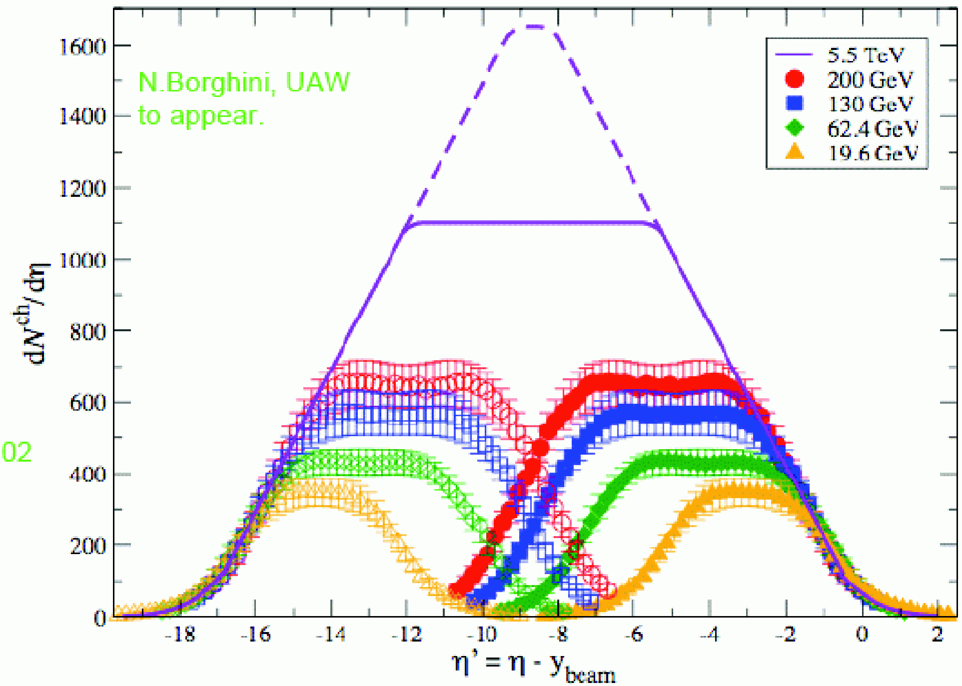
$\Rightarrow$ $dN^{ch}_{LHC}/d\eta\big|_{\eta=0} \approx 1650$

or Kharzeev, Levin, Nardi, NPA747 (2005) 609.

$\Rightarrow$ $dN^{ch}_{LHC}/d\eta\big|_{\eta=0} \approx 1800-2100$

Both consistent with main trends at RHIC, but …

PHOBOS, PRC74 (2006) 021901; W. Busza .



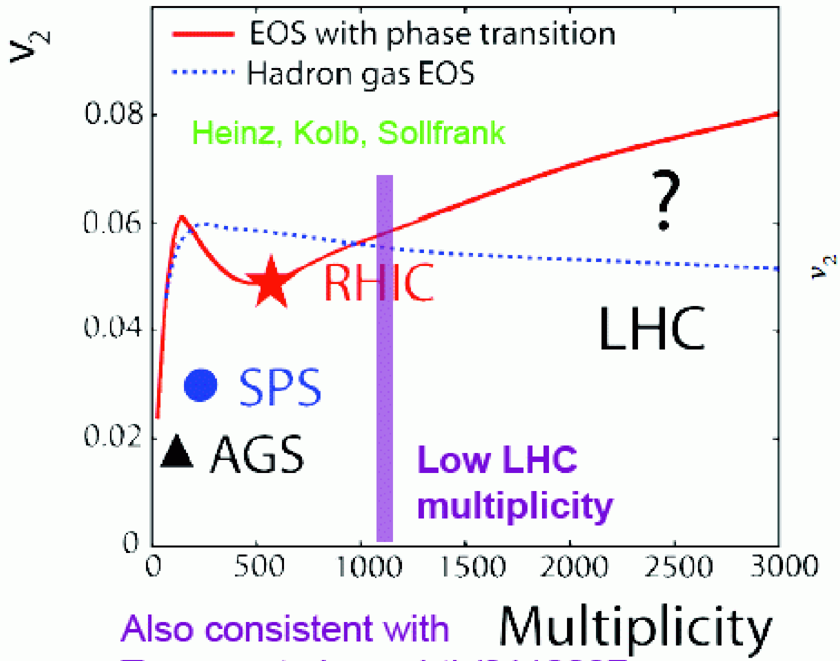
Extrapolations to LHC deviate from so-far generic trends in data

$\Rightarrow$ Impact for understanding the dynamical origin of soft physics at RHIC and LHC.

LHC tests the hydro-paradigm

- Hydro prediction for low LHC multiplicity

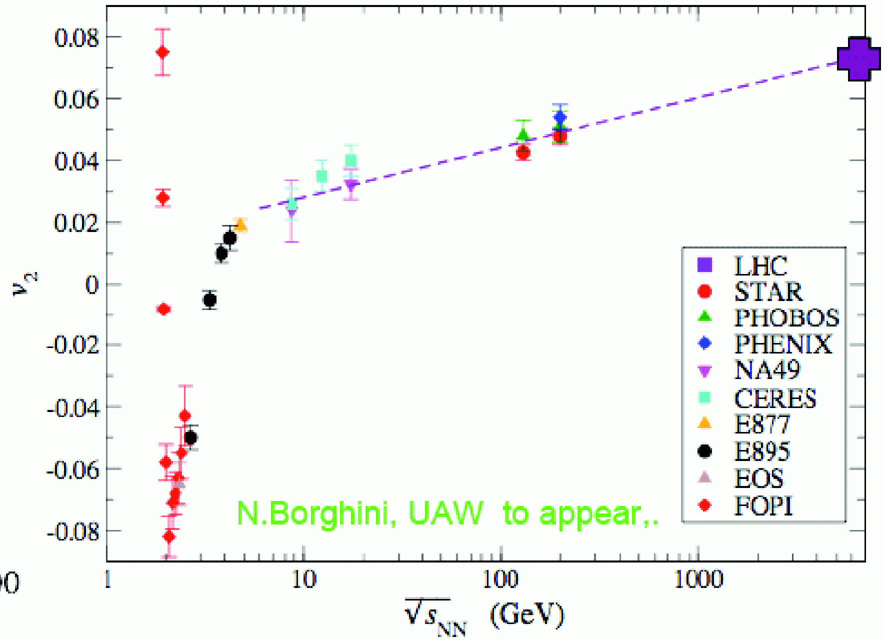
$$v_2 \approx 0.055$$



Also consistent with Teaney et al., nucl-th/0110037

- Extrapolation of generic RHIC trend

$$v_2 \approx 0.075$$



(In)consistency with generic trend ⟷ Characterization of microscopic dynamics underlying collectivity

Open charm and beauty

goal:
measure parton energy loss in QGP

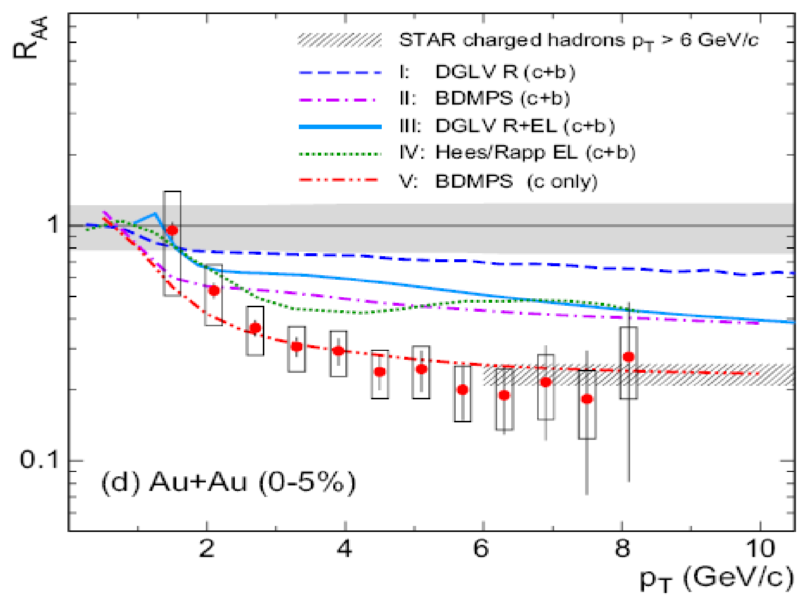
expectation:
energy loss color dependent (different for quarks and gluons)

energy loss flavour dependent (smaller for heavy quarks)

advantage at LHC:
high abundance of c and b (direct reconstruction possible)

c/b

System	p+p	Pb+Pb (5% cent)
$\sqrt{s_{NN}}$ (TeV)	14	5.5
NN cross section (mb)	11.2 / 0.5	6.6 / 0.2
Shadowing	---	0.65 / 0.85
Total multiplicity	0.16 / 0.007	115 / 4.6



RHIC: Non-photonic electrons used to estimate charm

Open charm and beauty – detection channels

Open charm:

$D^0 \to K^- + \pi^+$ ($c\tau$ = 123 μm, BR = 3.8 %)
See next slides

$D^+ \to K^- + \pi^+ + \pi^+$ ($c\tau$ = 312 μm, BR = 9.5 %)
Pb+Pb (central): $S/B \approx 0.1$, $S \approx 10^4$ D^+ in 10^7 central events

$D \to e^\pm (\mu^\pm) + X$

D_s, ...

Open beauty:

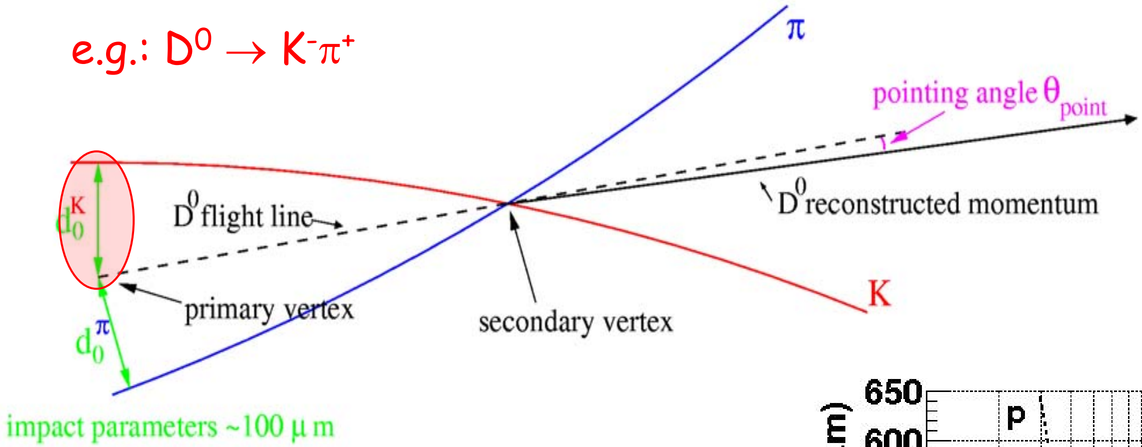
$B \to e^\pm (\mu^\pm) + X$ ($c\tau \approx 500$ μm, BR = 10.9 %)
(+ $B \to D (\to e^\pm (\mu^\pm) + X) + X'$, BR ≈ 10%)
See next slides

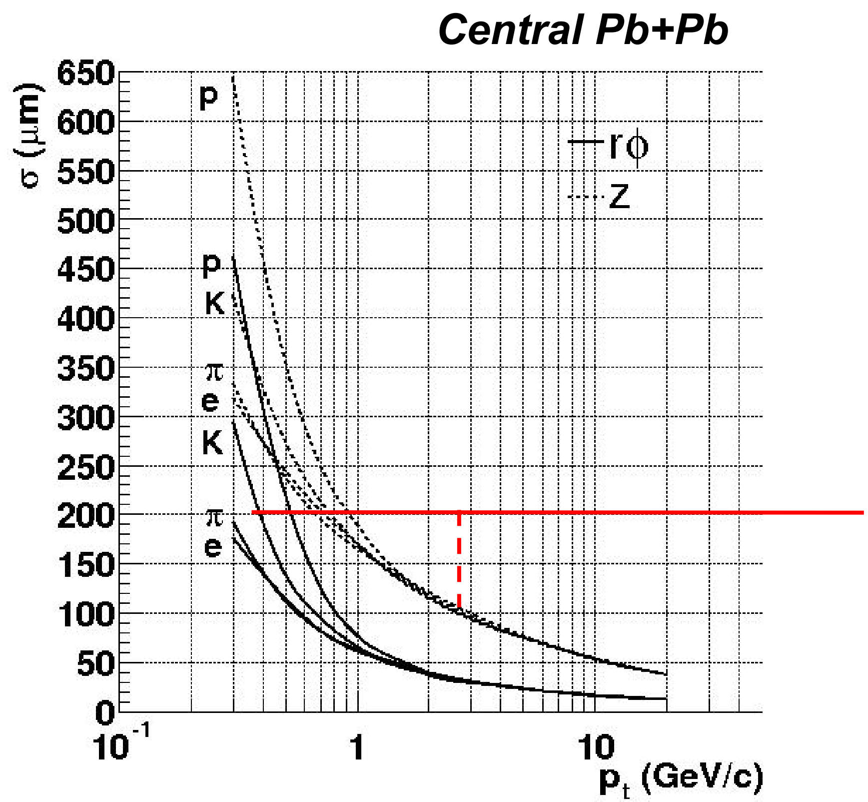
$B \to J/\psi (+ X) \to e^+e^-$ ($c\tau \approx 500$ μm, BR = 0.07 %)

...

Impact parameter reconstruction

e.g.: $D^0 \rightarrow K^- \pi^+$





D mesons

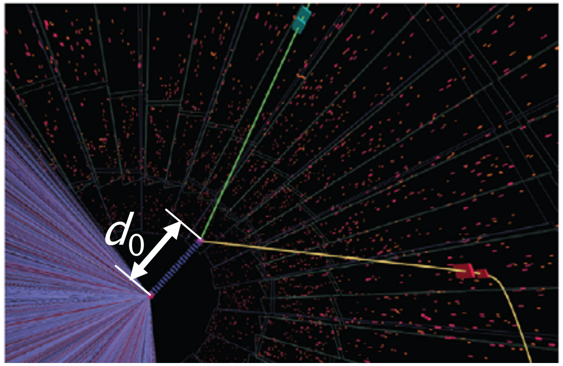
Example: $D^0 \to K^- \pi^+$

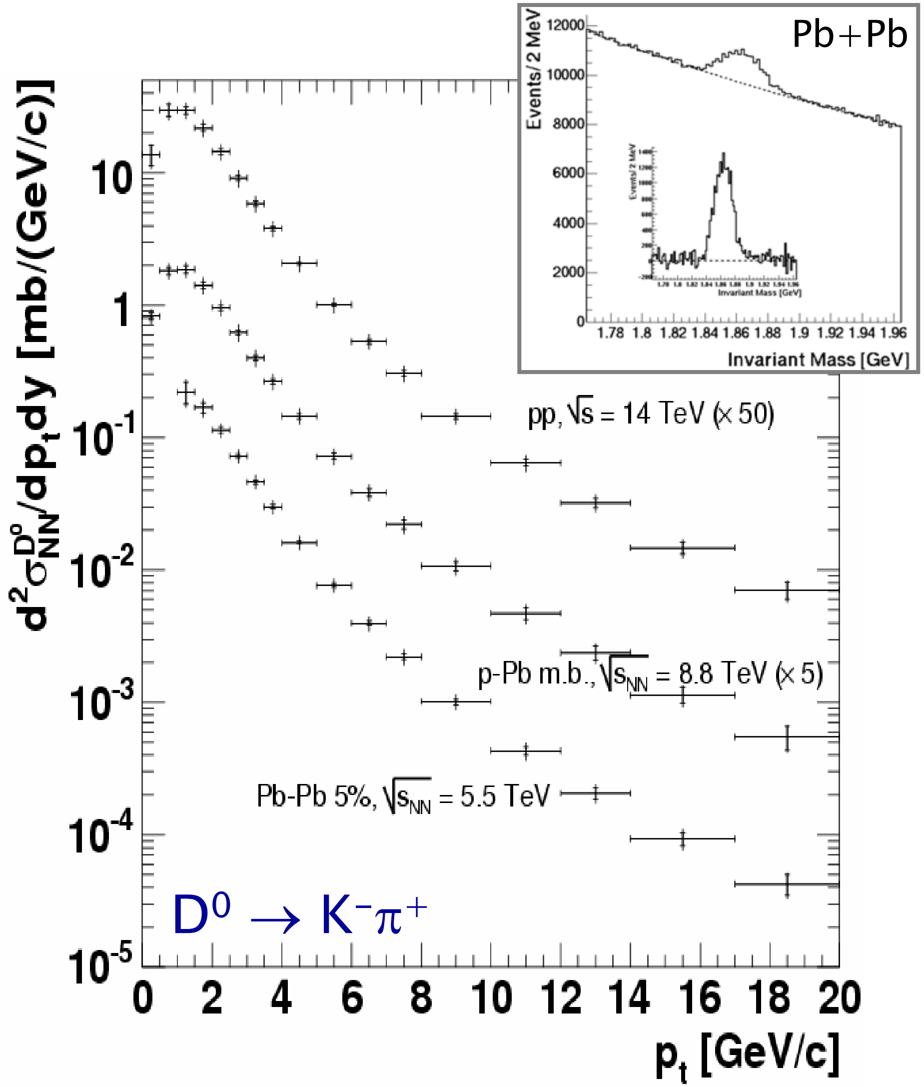
Full reconstruction of D-decays

Separation of charm and beauty

S/B ≈ 10%
Significance ≈ 40
(1 month Pb+Pb running)

Similar in p+p



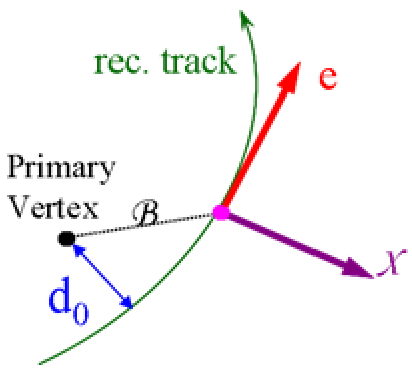


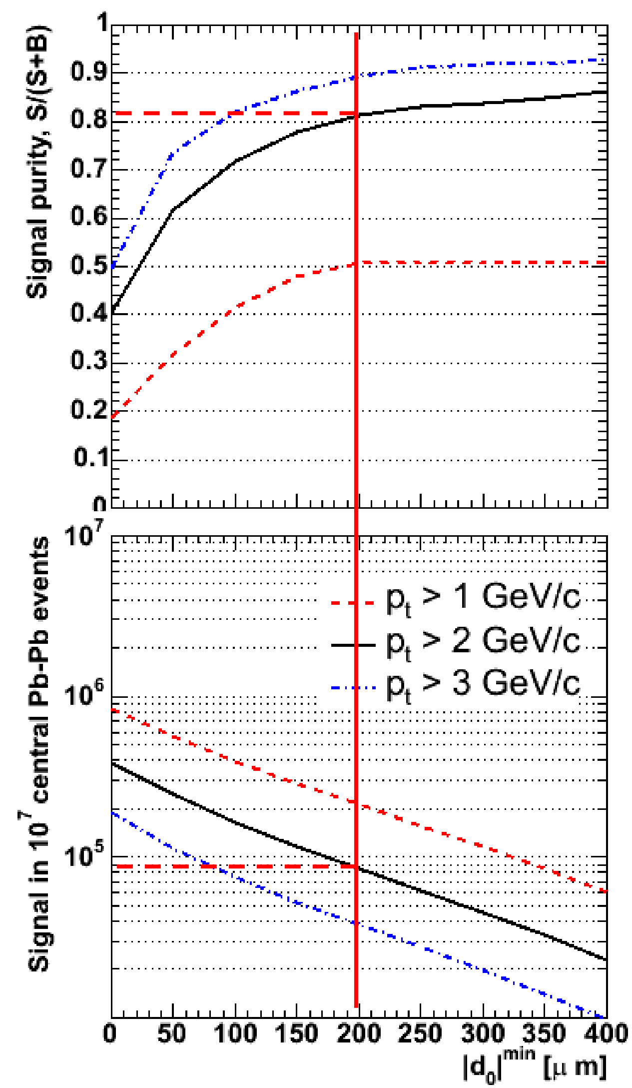
B mesons

Example: B → $e^{\pm}$ + X

e–Identification: TRD
Impact parameter: ITS

Impact parameter cut:
$d_0 > 200\ \mu m$, $p_t > 2 GeV/c$
→ 80% purity
→ 8×10^4 $e^{\pm}$ from B's
in central Pb+Pb
(1 month Pb+Pb running)





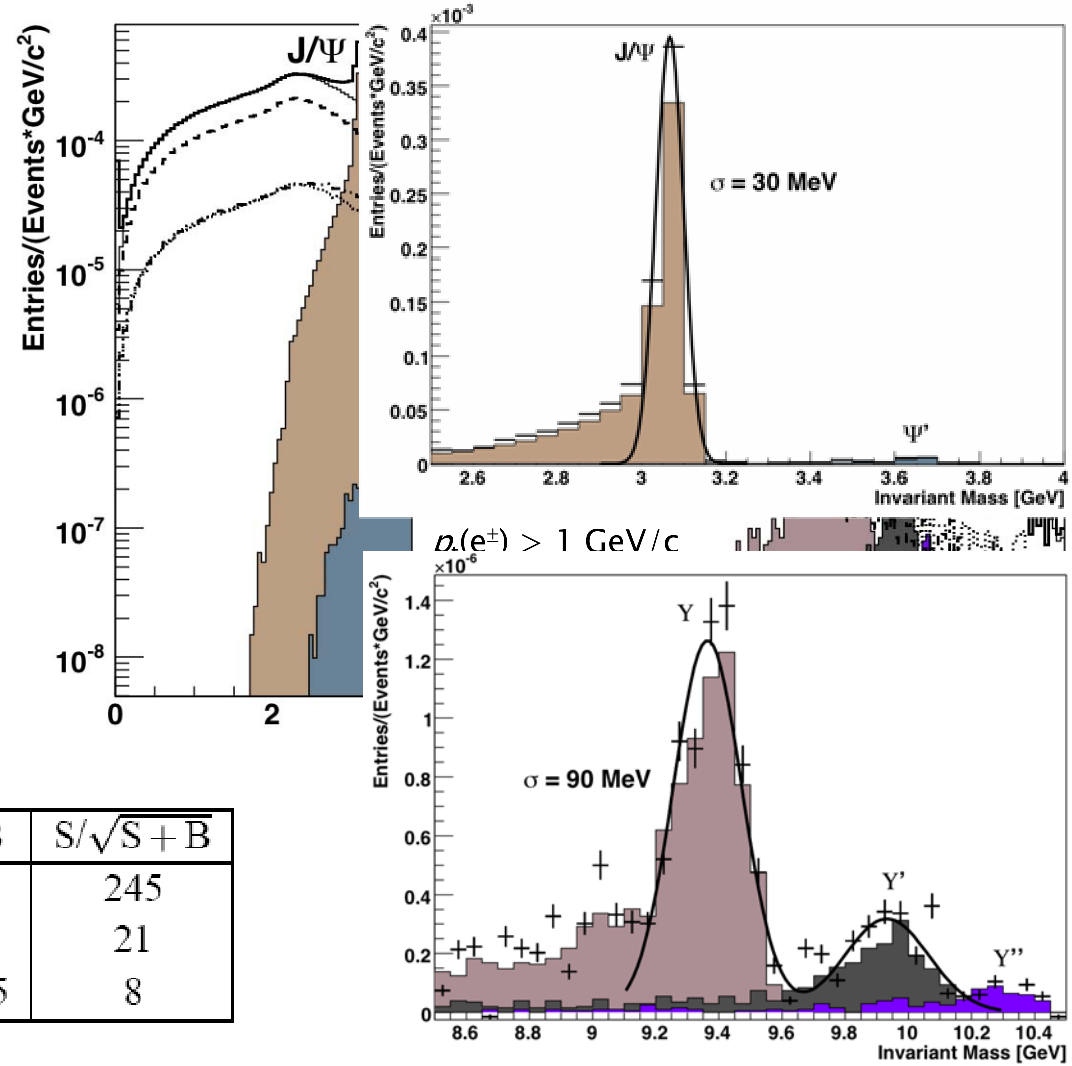
Quarkonia in dielectron channel

Central barrel

ITS+TPC+TRD
$-0.9 < \eta < 0.9$

e–ID with TRD

Resolution:
$\sigma_m(J/\psi) \approx$ 30MeV
$\sigma_m(\Upsilon) \approx$ 90MeV



Di–electron in central barrel

State	S ($\times 10^3$)	B ($\times 10^3$)	S/B	$S/\sqrt{S+B}$
J/ψ	110.7	92.1	1.2	245
Υ	0.9	0.8	1.1	21
Υ'	0.25	0.7	0.35	8

Quarkonia in dimuon channel

MUON-arm

Forward region
$2.4 < \eta < 4.0$

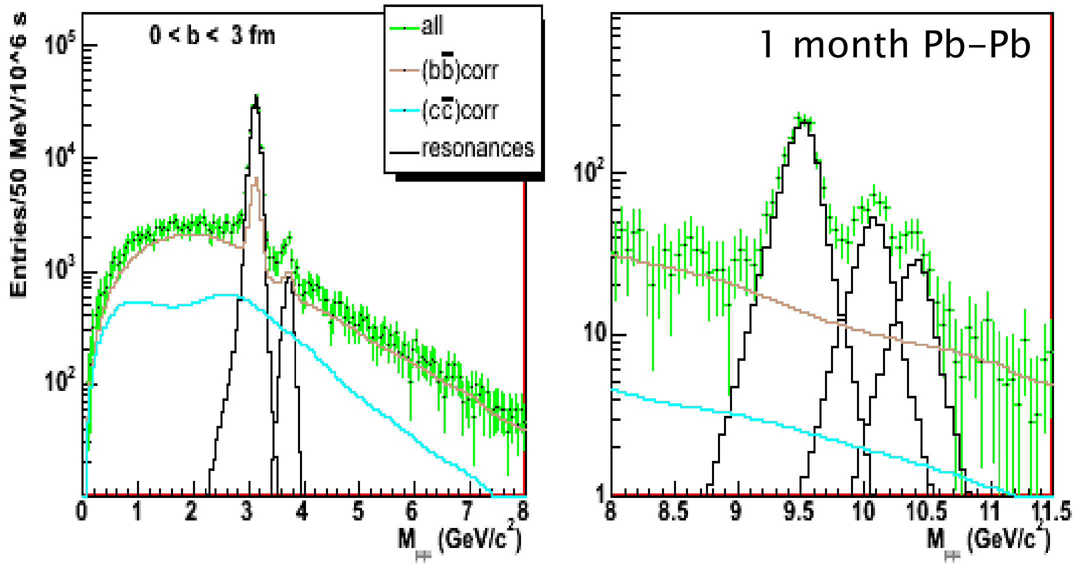
Resolution:
$\sigma_m(J/\psi) \approx$ 70MeV
$\sigma_m(\Upsilon) \approx$ 100MeV

Sensitivity
($e^+e^-/\mu^+\mu^-$)

J/ψ, Υ, Υ' : High with normal stat.

Υ'': Needs 2-3 years high lum.

ψ' : Difficult



State	S[10^3]	B[10^3]	S/B	S/(S+B)$^{1/2}$
J/Ψ	130	680	0.20	150
Ψ'	3.7	300	0.01	6.7
Υ(1S)	1.3	0.8	1.7	29
Υ(2S)	0.35	0.54	0.65	12
Υ(3S)	0.20	0.42	0.48	8.1

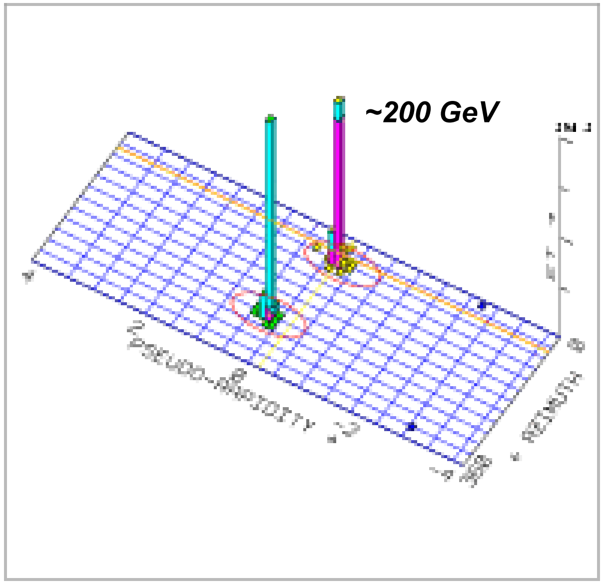
Jets

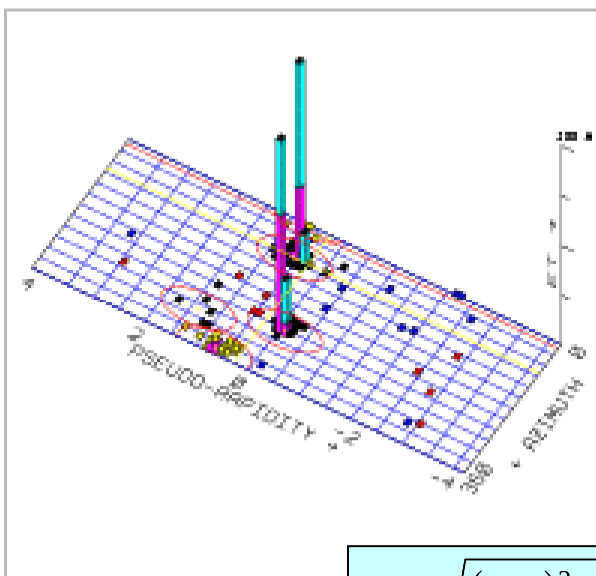
1 month of running	
E_T >	N_{jets}
50 GeV	2.0×10^7
100 GeV	1.1×10^6
150 GeV	1.6×10^5
200 GeV	4.0×10^4

- *jet suppression*
- *fragmentation function*
- *jets in high multiplicity environment*
- *calorimetry or charged tracks*

jets in p+pbar at 1.8 TeV

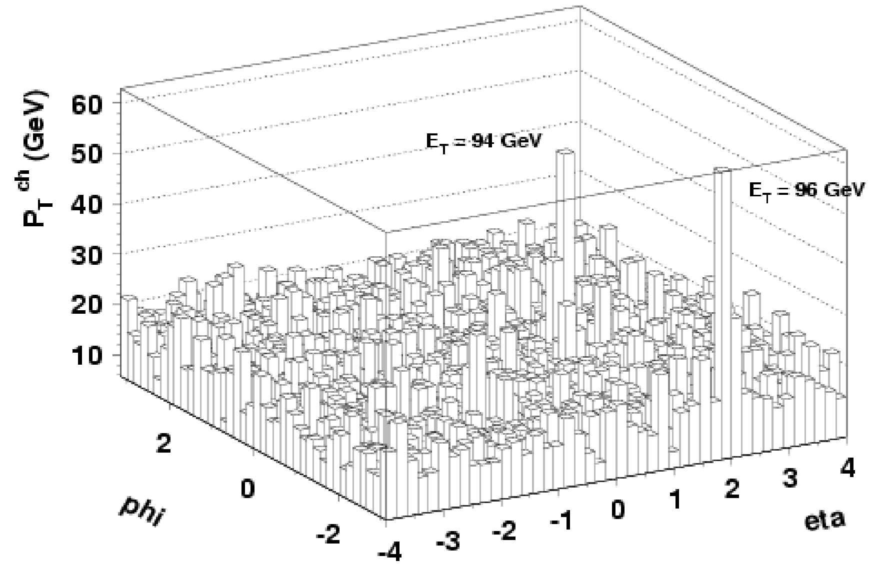
CDF, PRD 64 (2001) 032001

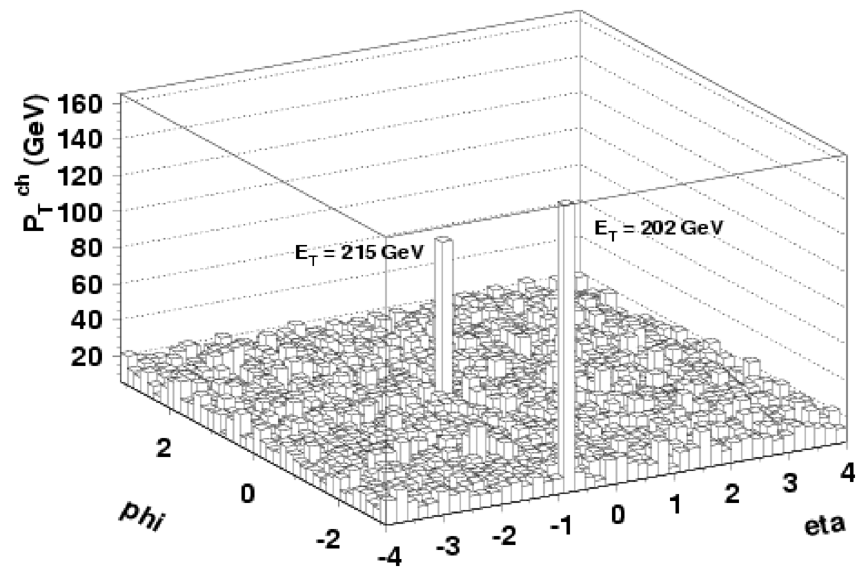




$$R=\sqrt{(\Delta\eta)^2+(\Delta\phi)^2}$$

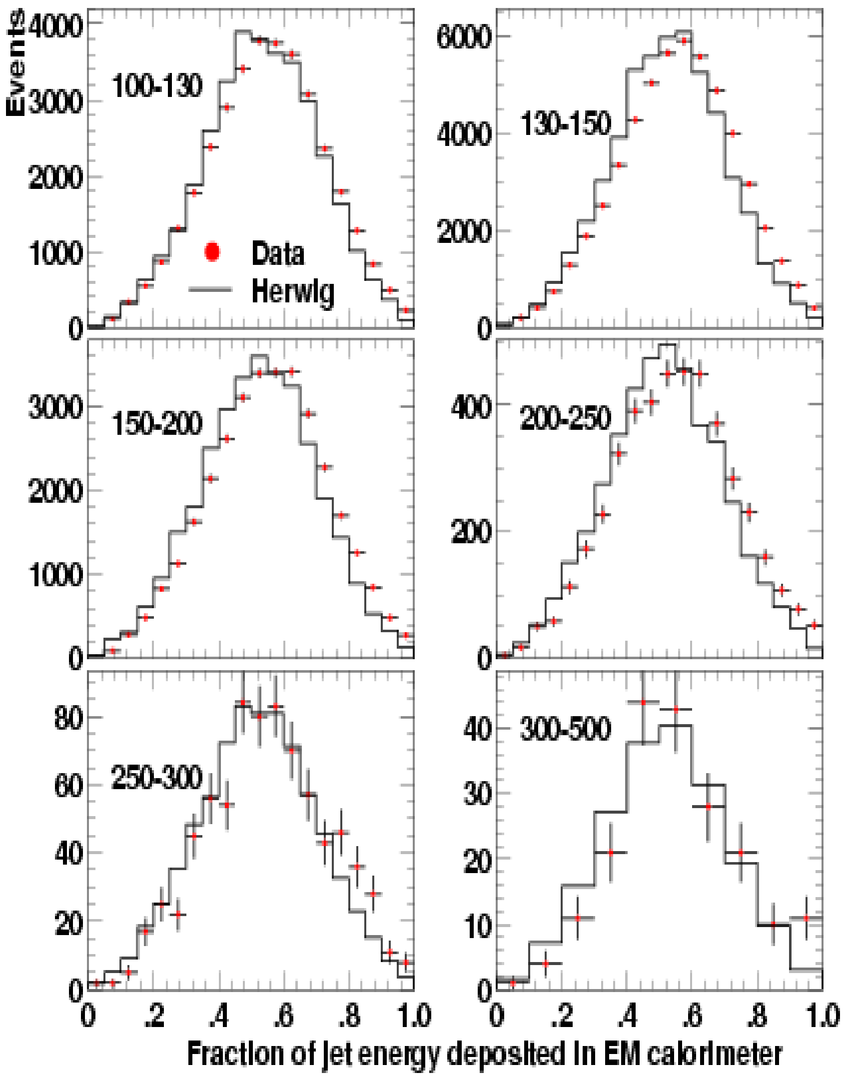
jets in Pb+Pb at 5.5 TeV (ALICE sim)

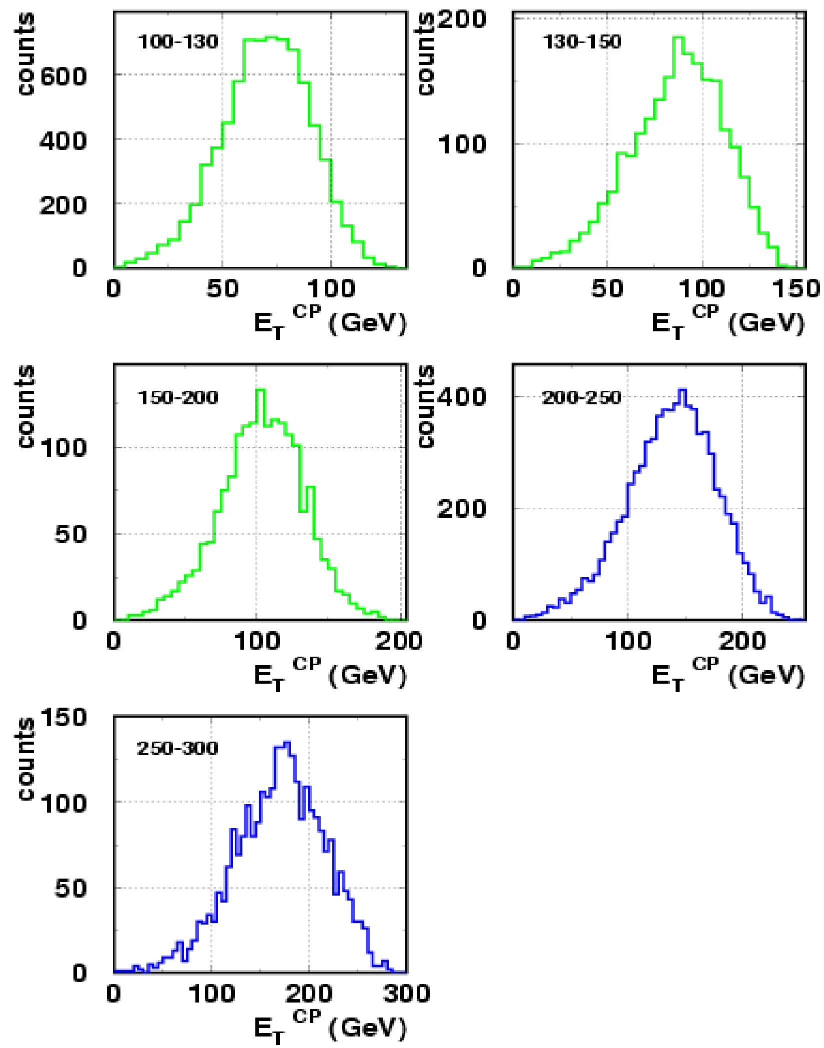




jets with an EM calorimeter (CDF)

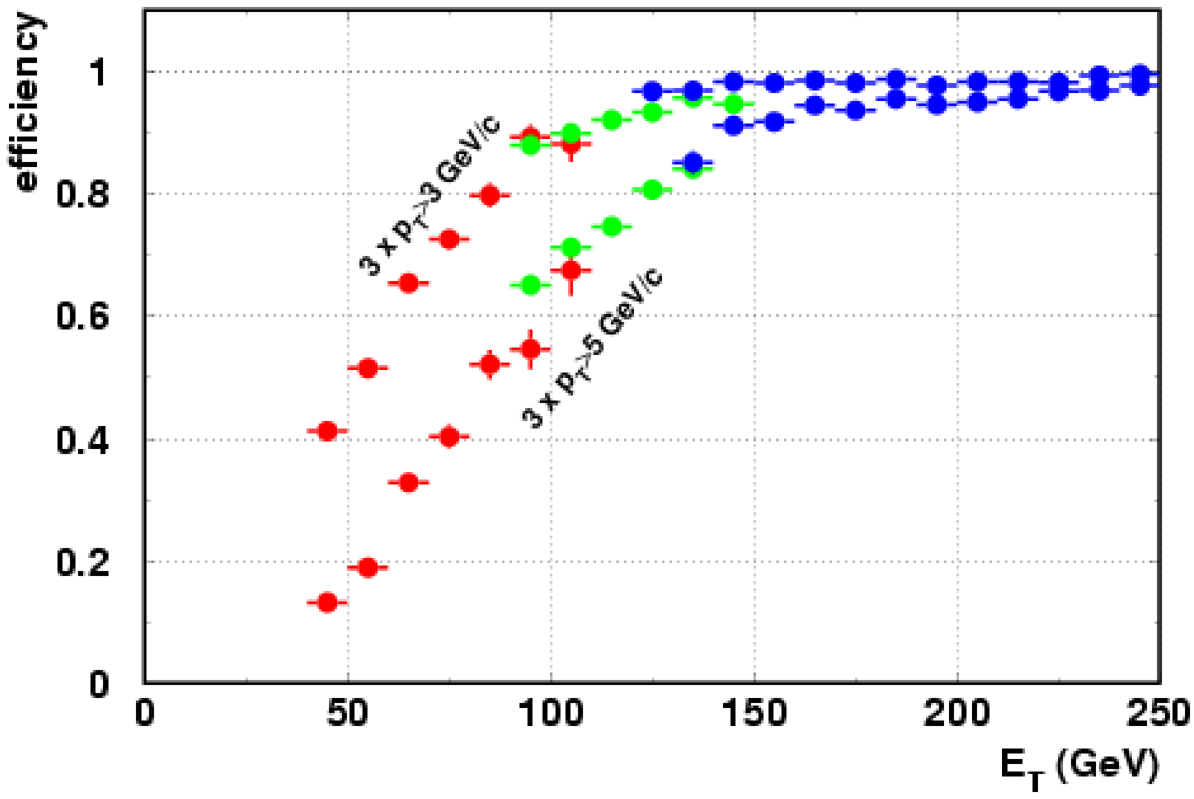
jets with charged particles (ALICE ITS+TPC+TRD)





fraction of jet energy in form of charged particles

Jets with ITS, TPC, TRD – TRD trigger

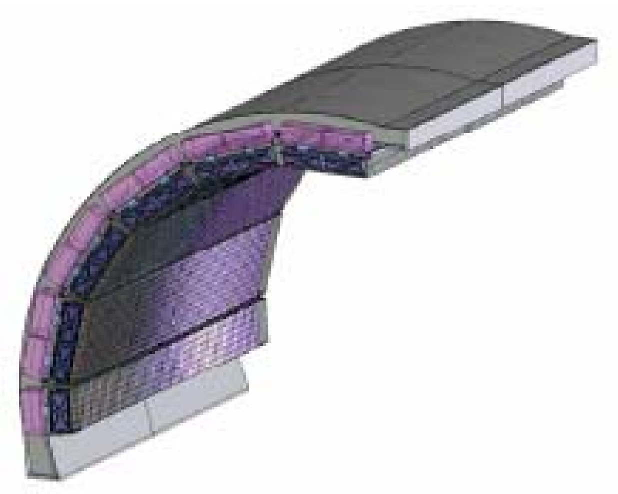


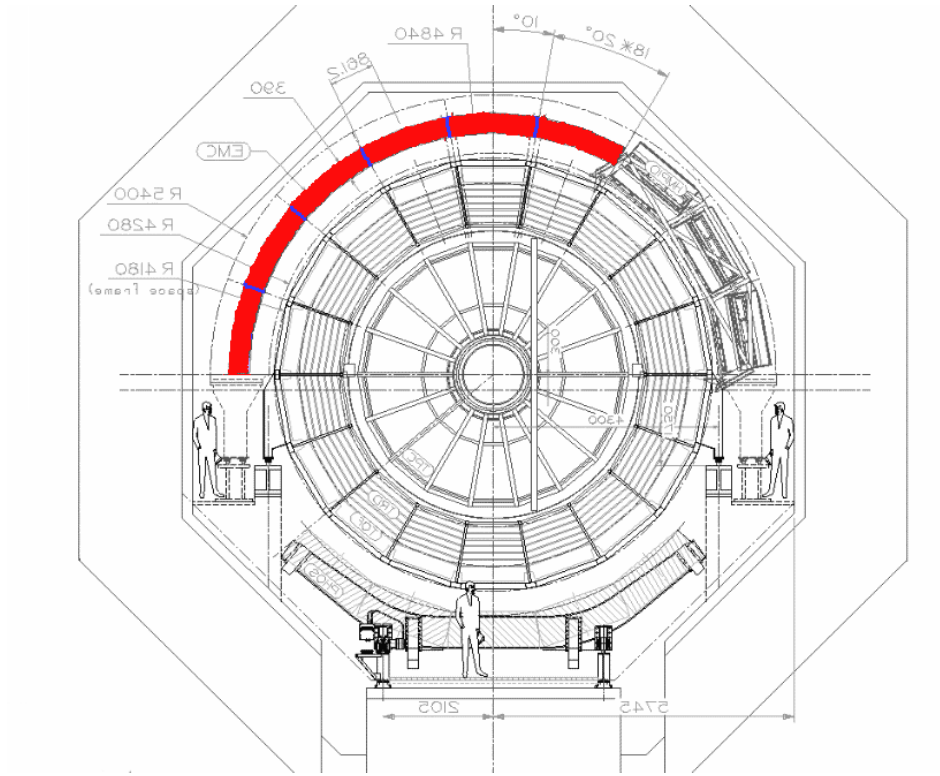
trigger condition:

3 charged particles with $p_T > p_T min$ in one TRD module

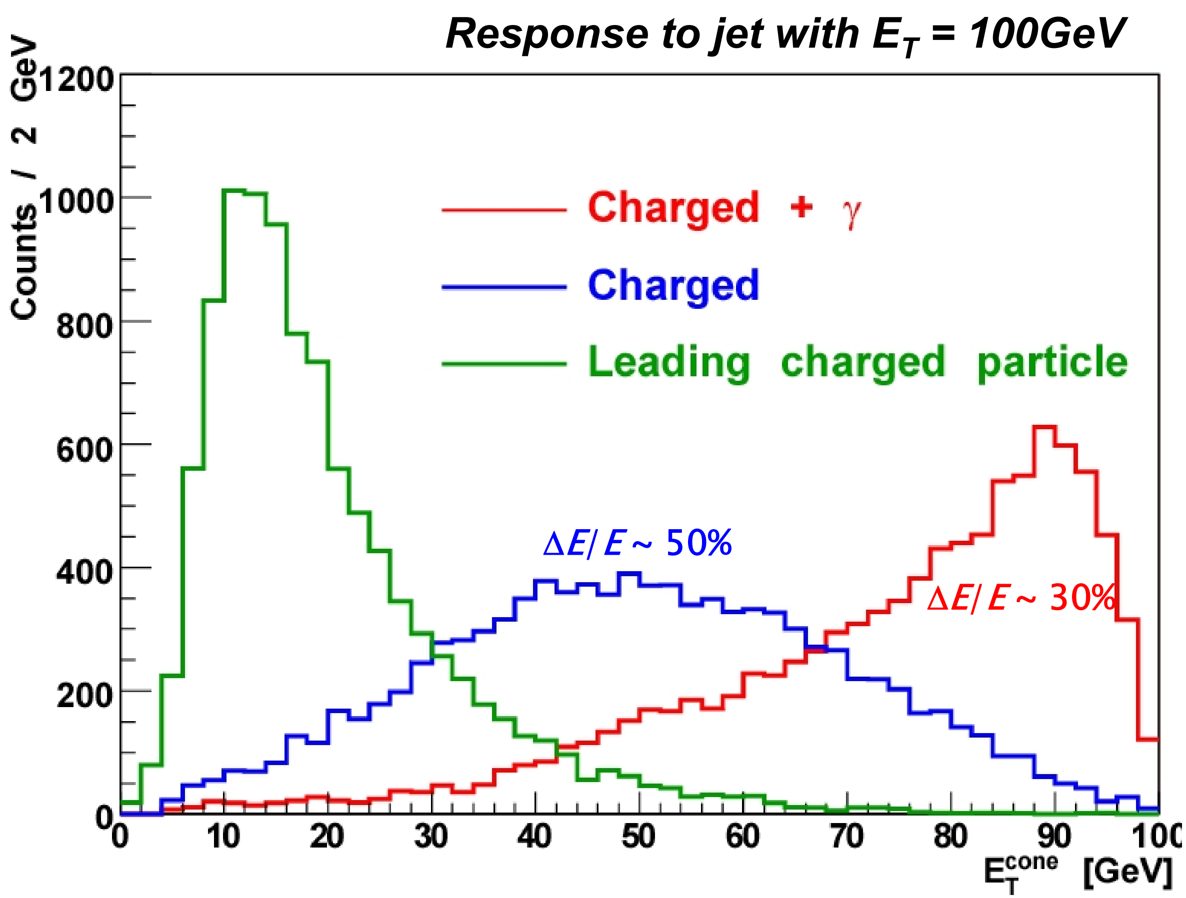
Jets with EMCAL

- ***EM Sampling Calorimeter - latest addition to ALICE by US, France, Italy***
- ***Pb-scintillator linear response***
  $-0.7 < \eta < 0.7$
  $60^o < \phi < 180^o$
- ***Energy resolution ~15%/√E***





Jets with both



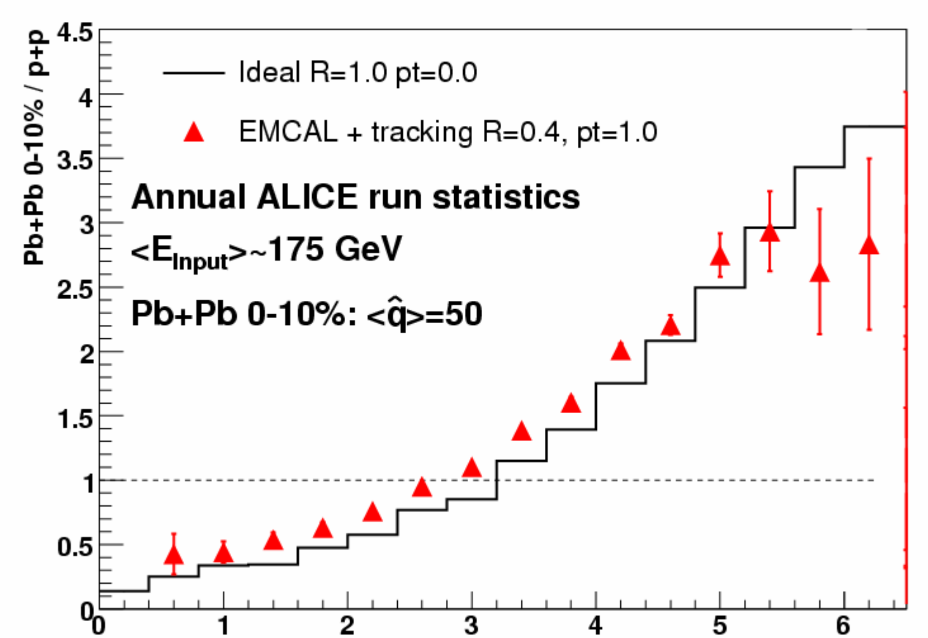
Jet fragmentation function

Sensitive to energy loss mechanisms

- Quenching of leading hadron
- Additional hadrons by gluon radiation
- Transverse heating

Observable:

- Ratio of fragmentation functions: $\dfrac{FF\,(\mathrm{Pb+Pb})}{FF\,(\mathrm{p+p})}$



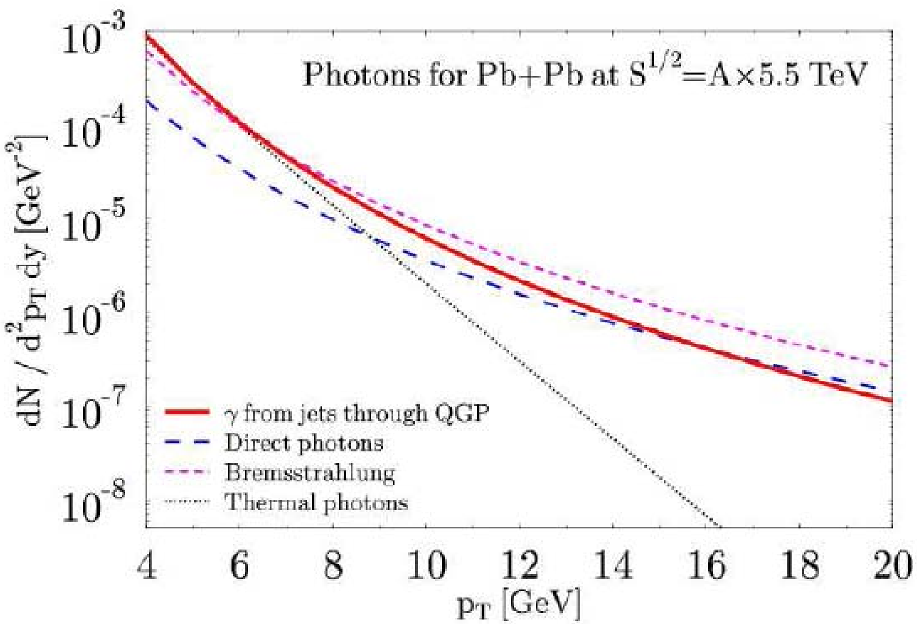
$$\xi = \ln\left(\frac{1}{z}\right) = \ln\left(\frac{E_t^{jet}}{p^{hadron}}\right)$$

Photons

PHOS - thermal photons (p_t < 5GeV/c)

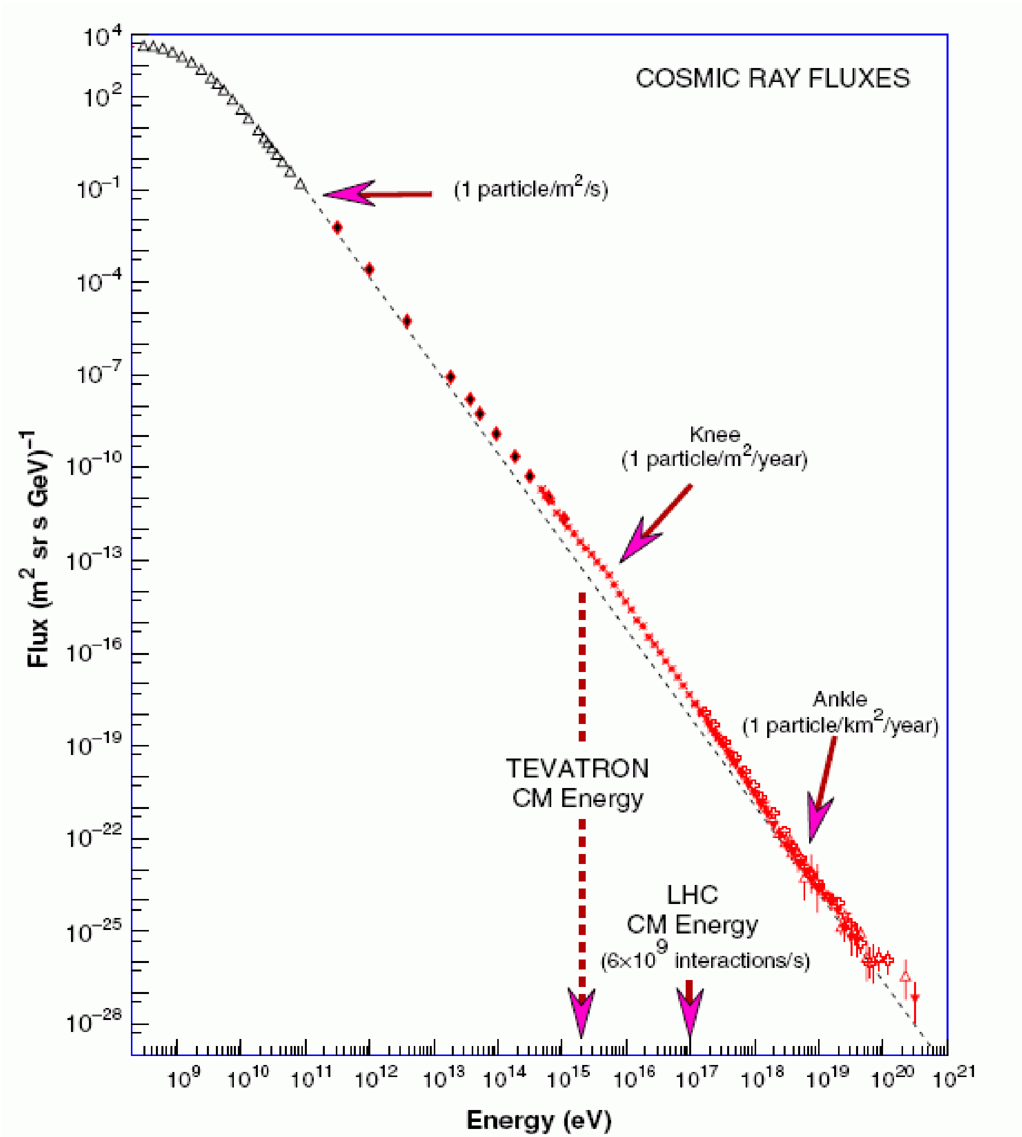
EMCAL - high energy photons

Central Barrel - $\gamma \rightarrow e^+e^-$



	p_t^{max} (1year) (GeV/c)		High-p_t trigger
	γ	π^0	
PHOS	~100 (shower shape)	~150 (inv. mass)	✓
EMCAL	~150 (shower shape)	~200 (inv. mass)	✓
Central Barrel	~20 ($\gamma \rightarrow e^+e^-$)	-	✓

Interactions at energies typical to cosmic rays



LHC machine parameters

	pp	Pb–Pb
Energy per nucleon (TeV)	7	2.76
β at the IP: β^* (m)	10	0.5
R.m.s. beam radius at IP: σ_t (μm)	71[a]	15.9
R.m.s. bunch length: σ_l (cm)	7.7	7.7
Vertical crossing half-angle (μrad) for pos. (neg.) μ-spectr. dipole polarization	150 (150)	150 (100)
No. of bunches	2808	592
Bunch spacing (ns)	24.95	99.8
Initial number of particles per bunch	1.1×10^{11}	7.0×10^{7}
Initial luminosity ($cm^{-2}\ s^{-1}$)	$< 5 \times 10^{30}$	10^{27} [b]

[a] For low-intensity runs β^* could be 0.5 m and $\sigma_t = 15.9\ \mu$m as in Pb–Pb.
[b] Early operation will be with 62 bunches and $\beta^* = 1$ m, which yields an initial luminosity of $5.4 \times 10^{25}\ cm^{-2}\ s^{-1}$.

ALICE running conditions

System	$\sqrt{s_{NN}}_{max}$ (TeV)	Δy	σ_{geom} (b)	$\mathcal{L}_{low}$ (cm^{-2} s^{-1})	$\mathcal{L}_{high}$ (cm^{-2} s^{-1})
Pb–Pb	5.5	0	7.7	1.0×10^{27}	
Ar–Ar	6.3	0	2.7	2.8×10^{27}	1.0×10^{29}
O–O	7.0	0	1.4	5.5×10^{27}	2.0×10^{29}
N–N	7.0	0	1.3	5.9×10^{27}	2.2×10^{29}
$\alpha\alpha$	7.0	0	0.34	6.2×10^{29}	
dd	7.0	0	0.19	1.1×10^{30}	
pp	14.0	0	0.07	1.0×10^{29}	5.0×10^{30}
pPb	8.8	0.47	1.9	1.1×10^{29}	
pAr	9.4	0.40	0.72	3.0×10^{29}	
pO	9.9	0.35	0.39	5.4×10^{29}	
dPb	6.2	0.12	2.6	8.1×10^{28}	
dAr	6.6	0.05	1.1	1.9×10^{29}	
dO	7.0	0.00	0.66	3.2×10^{29}	
αPb	6.2	0.12	2.75	7.7×10^{28}	
αAr	6.6	0.05	1.22	1.7×10^{29}	
αO	7.0	0.00	0.76	2.8×10^{29}	

ALICE general running plans

initial phase

- pilot Pb+Pb
- 1-2 years Pb+Pb
- 1 year p+Pb (or like)
- 1-2 years Ar+Ar

subsequent options

- pp at sqrt(s) = 5.5 TeV
- N+N or O+O or Kr+Kr...
- another pA
- lower energy Pb+Pb
- high stat full energy Pb+Pb

Subject: **Fermilab Statement on LHC Magnet Test Failure**
From: Robert Aymar <Robert.Aymar@cern.ch>
Date: 03/29/07 17:53
To: cern-staff (List of all staff members at CERN) <cern-staff@cern.ch> ,
users (CERN Users) <users@cern.ch> ,
cern-fellows (list of fellows presently at CERN) <cern-fellows@cern.ch>

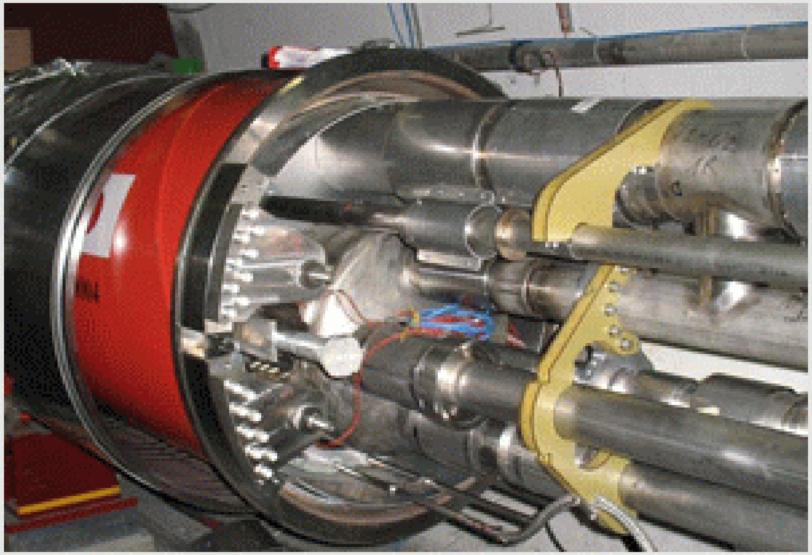
Dear Colleagues,

On Tuesday evening 27 March 2007, there was an incident during a pressure test involving one of the LHC's inner triplet magnet assemblies provided by Fermilab and KEK. No people were involved. The consequences of the incident on the LHC start-up schedule are not yet known. Details are available in a statement from Fermilab, with which CERN is in agreement, at
http://user.web.cern.ch/user/QuickLinks/Announcements/2007/LHCInnerTripl
et.html.

Regards,

Robert Aymar

July 20, 2007 — Inner Triplet Successfully Completes Pressure Test



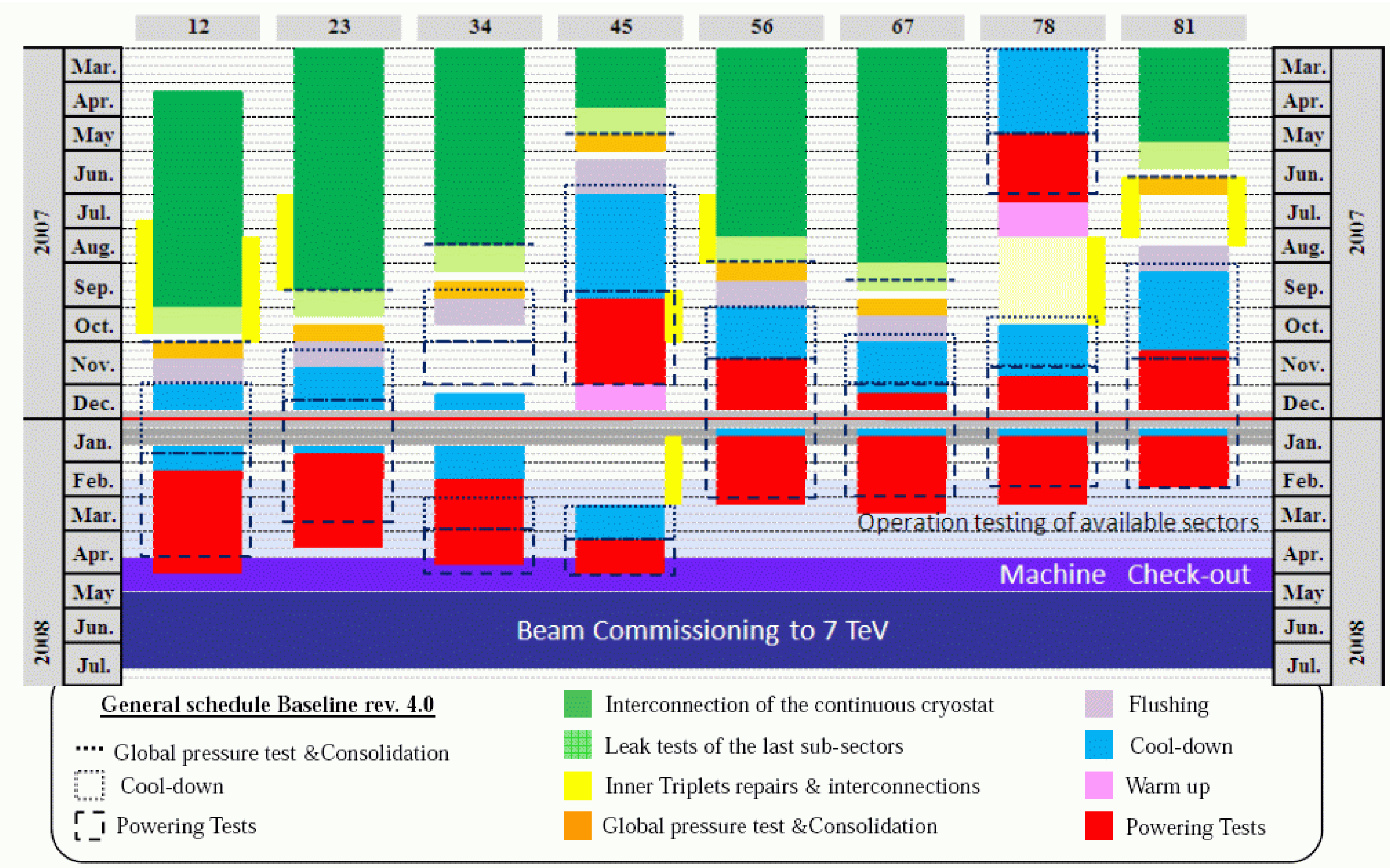
A Q1 magnet assembly with cartridges held in place by the four earlike brackets bolted to the outer flange.

An inner triplet assembly of quadrupole magnets at Point 8-Right of the LHC at CERN successfully completed a pressure test in the accelerator tunnel on Friday, July 13. The triplet, which included three quadrupole magnets and the associated cryogenic and power distribution box, or DFBX, met all test specifications at the requisite pressure of 25 atmospheres for one hour. The triplets will focus particle beams prior to particle collisions at each of four interaction regions in the Large Hadron Collider, now under construction at CERN.

The pressure test is designed to test the accelerator components in conditions that will occur during LHC operations. To withstand the asymmetrical forces generated by the pressure, the Q1 and Q3 magnets, at either end of the triplet assembly had each been fitted with a set of four metal cartridges. The cartridges reinforce internal support structures that broke in two such magnets during an earlier pressure test on March 27. The cartridges limit movement of the magnets inside their metal jackets, or cryostats.

Metal brackets attach the cartridges to one end of each of the affected magnets. The cartridges have a compound design consisting of an aluminum alloy tube and an Invar rod to allow them to function over a broad range of temperatures. Invar is a form of steel whose dimensions change very little in response to temperature differences.

LHS schedule as of Aug-2007



ALICE status Sep-2007

ACORDE: installed. DAQ, DCS, ECS connection ongoing

EMCAL: support ready to be installed.

FMD: 2/3 installed

HMPID: installed, going to measure cosmics

MUON: nearly completely installed

PHOS: first module under test with cosmics on the surface, installed in Nov

SDD: installed, tests ¾ done.

SPD: installed, electronics tests

SSD: installed, electronics tests and debugging

ALICE status Sep-2007

TOF: *sm0 and sm8 installed, cosmics*

TPC: *parking position because of ITS, long term electronics tests*

TRD: *sm8 installed, sm0 soon ready to be installed*

T0: *C-side installed (electronics not yet). A-side installed in Jan*

V0: *C-side installed (electronics not yet). A-side integrated with FMD3 in Oct, installed in Jan*

ZDC: *first ZDC installed, second one being installed now*

Startup configuration for 2007:

complete ITS, TPC, HMPID, MUON arm, PMD, V0, T0, ZDC, Accorde

partial PHOS(1/5), TOF(9/18), TRD (2-3/18), DAQ (20%)

Summary

Heavy ion physics will do a big step ahead with LHC startup

Era of precision measurements of the QGP matter

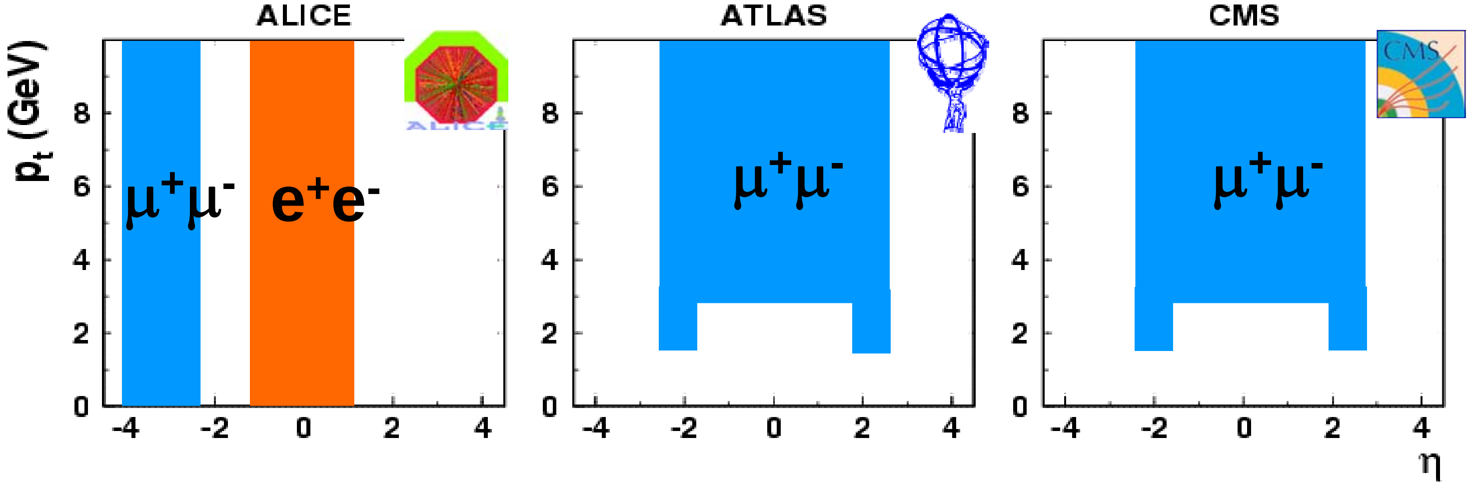
ALICE will be ready for data taking with the first pp run

Experimental setup is multi-purpose and flexible

Summary of *foreseen* ALICE physics:

ALICE Physics Performance Report, Vol. II,
J. Phys. G32 (11), 2137 (2006)

The End


ALICE
ATLAS
CMS
pt (GeV)
μ+μ-
e+e-
μ+μ-
μ+μ-
0
2
4
6
8
-4
-2
0
2
4
η

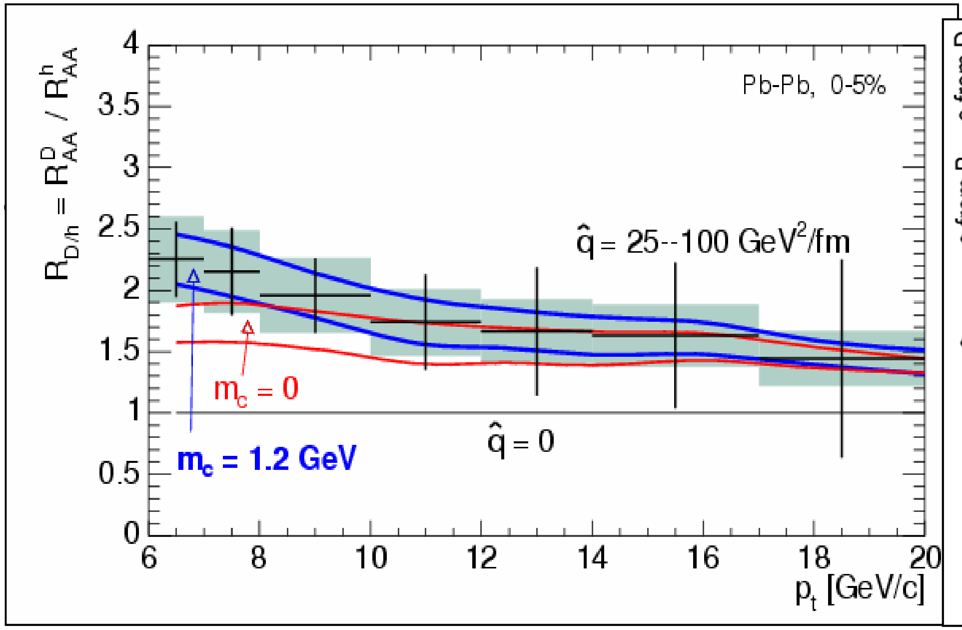
Expected performance on D, B R_{AA}

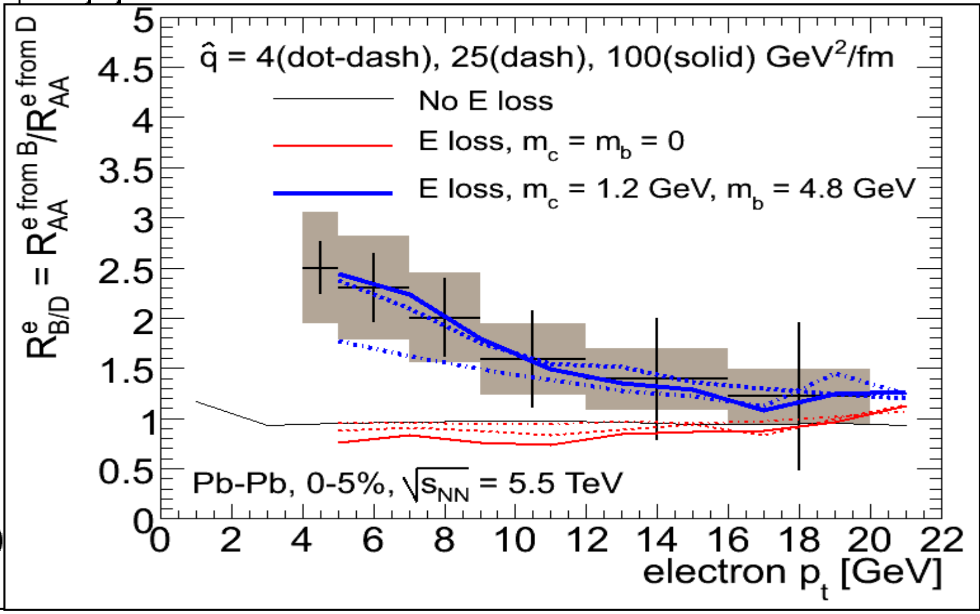
colour charge dependence

$$R_{D/h}(p_t) = R_{AA}^{D}(p_t) \big/ R_{AA}^{h}(p_t)$$

mass dependence

$$R_{B/D}(p_t) = R_{AA}^{\text{e from B}}(p_t) \big/ R_{AA}^{\text{e from D}}(p_t)$$





1 year at nominal luminosity
(10^7 central Pb-Pb events, 10^9 pp events)