STATO DI LHC E
PRIMO ANNO DI FISICA

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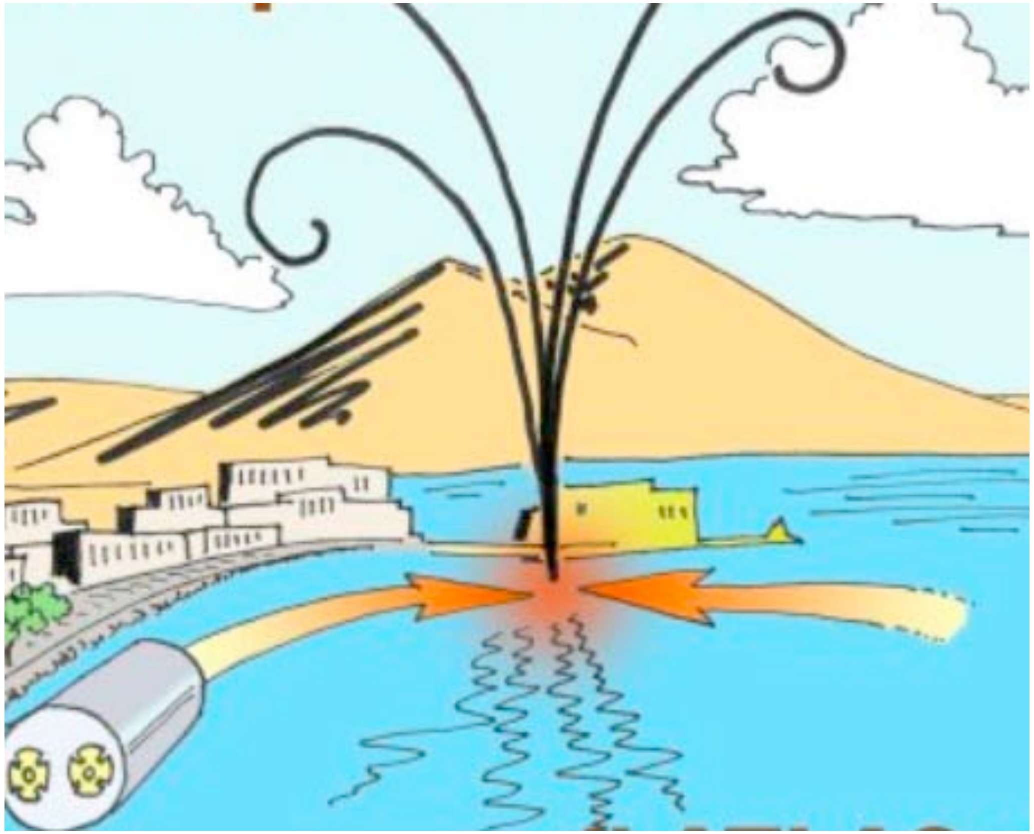
NAPOLI 11 APRILE 2007



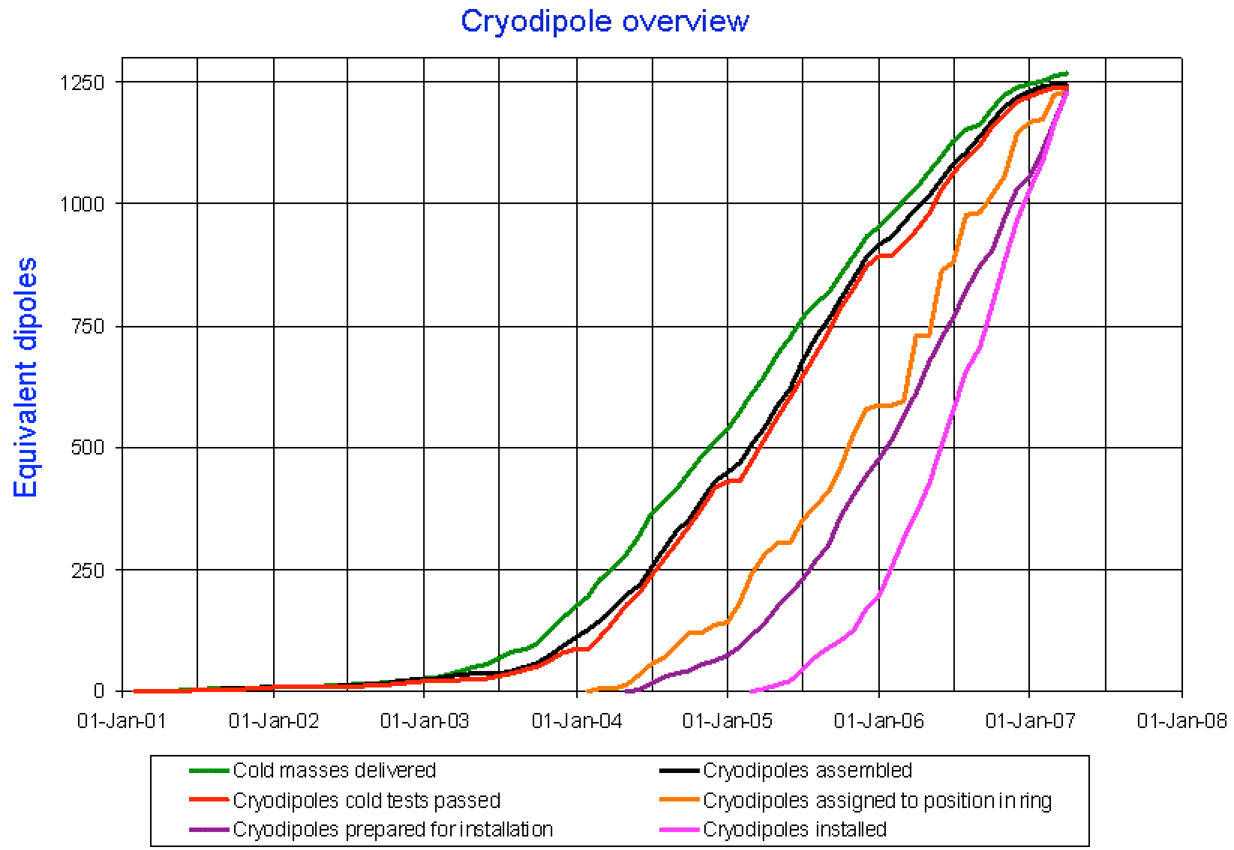
STATUS OF LHC

Status of LHC : Cryodipoles

Install Last Dipole - end March

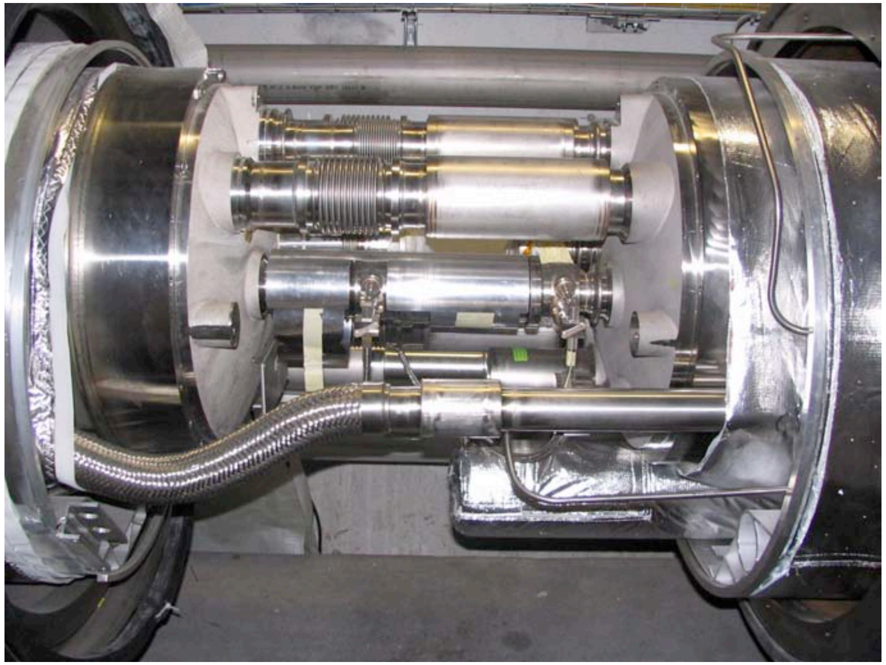
LHC Progress Dashboard

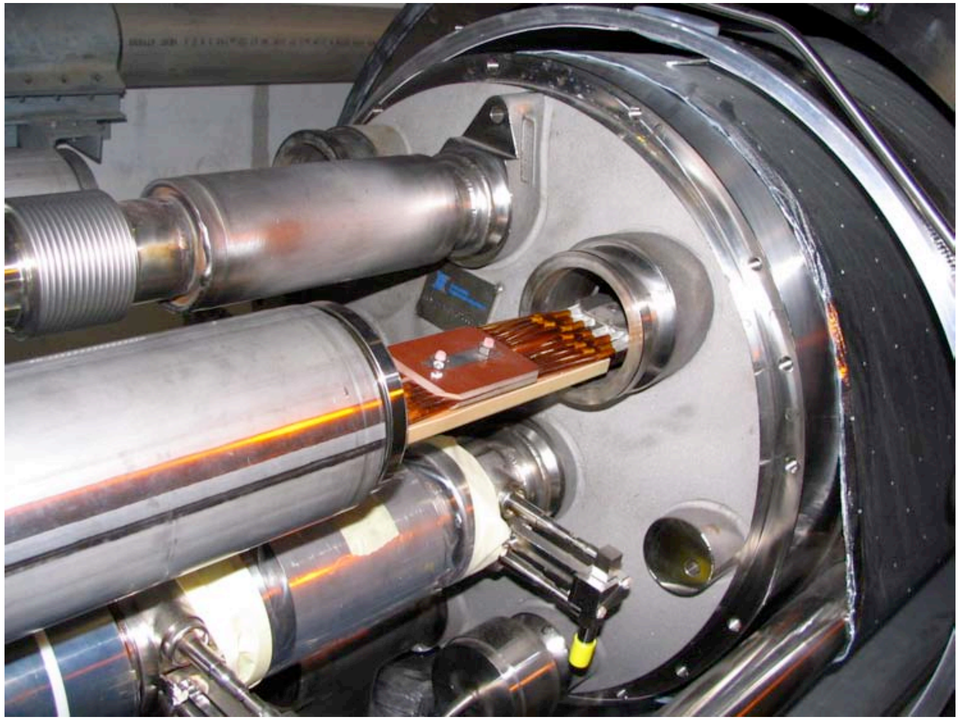
Accelerator Technology Department



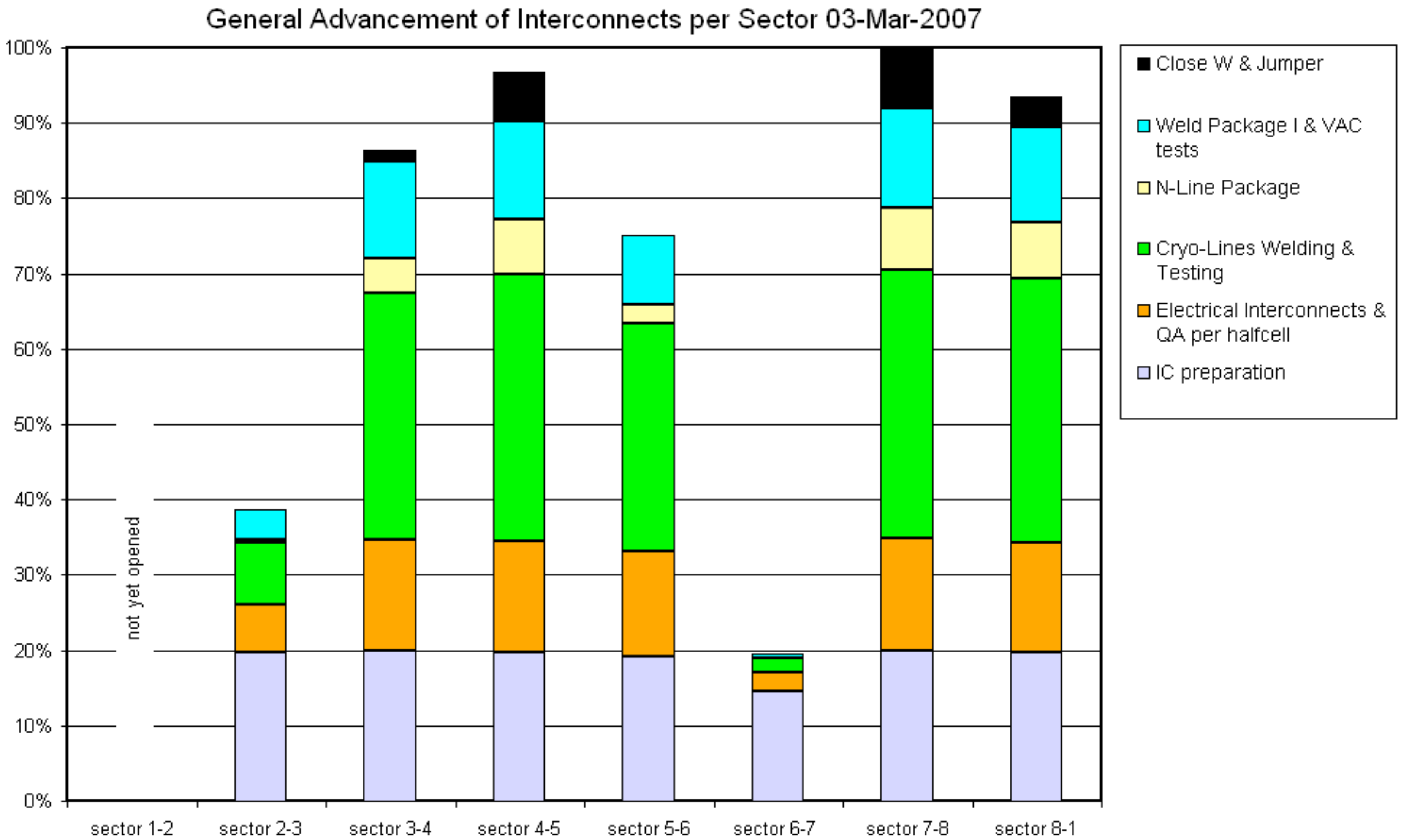
Updated 31 March 2007 Data provided by D. Tommasini AT-MCS, L. Bottura AT-MTM

Dipole Interconnections





Status of LHC: Interconnections



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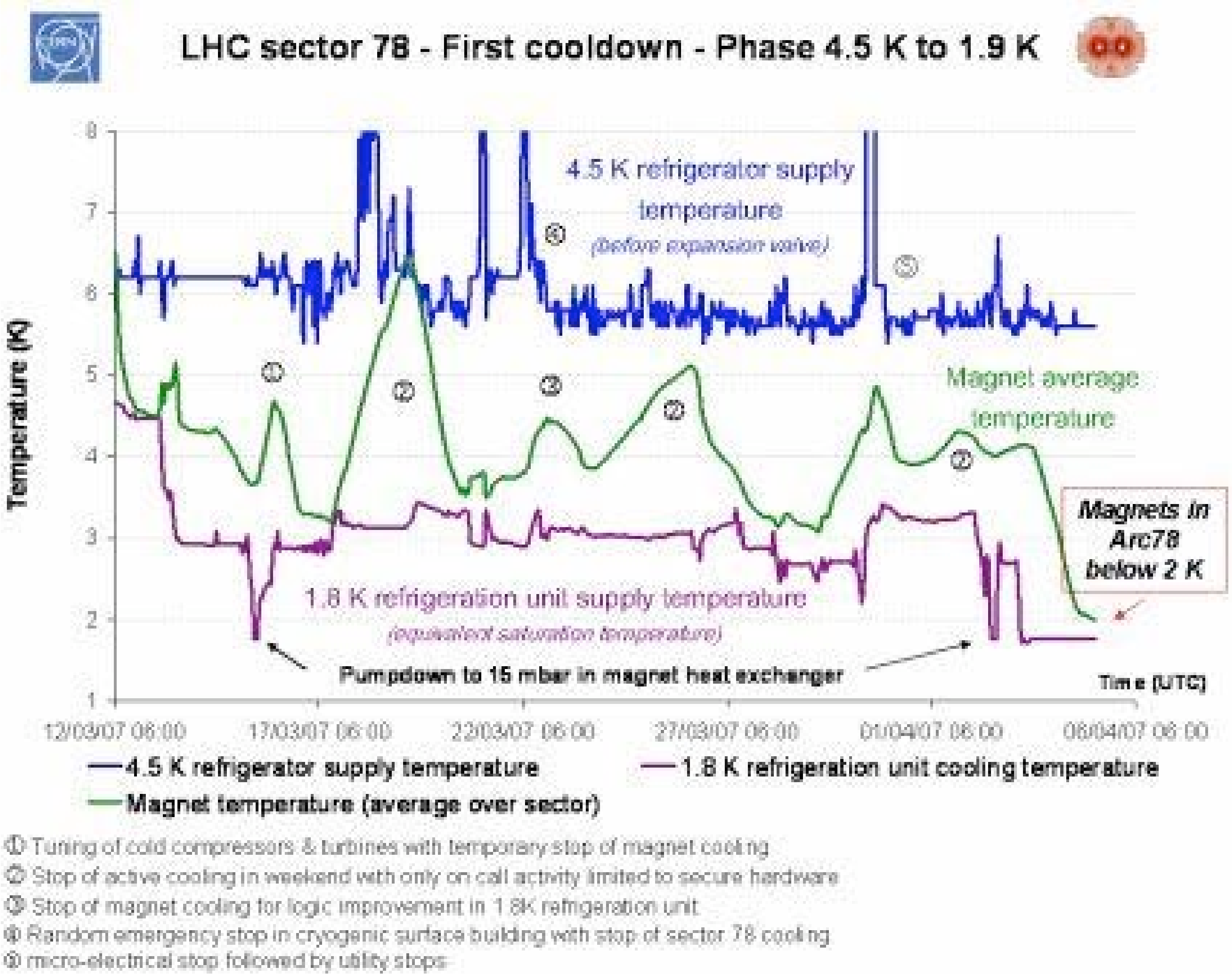
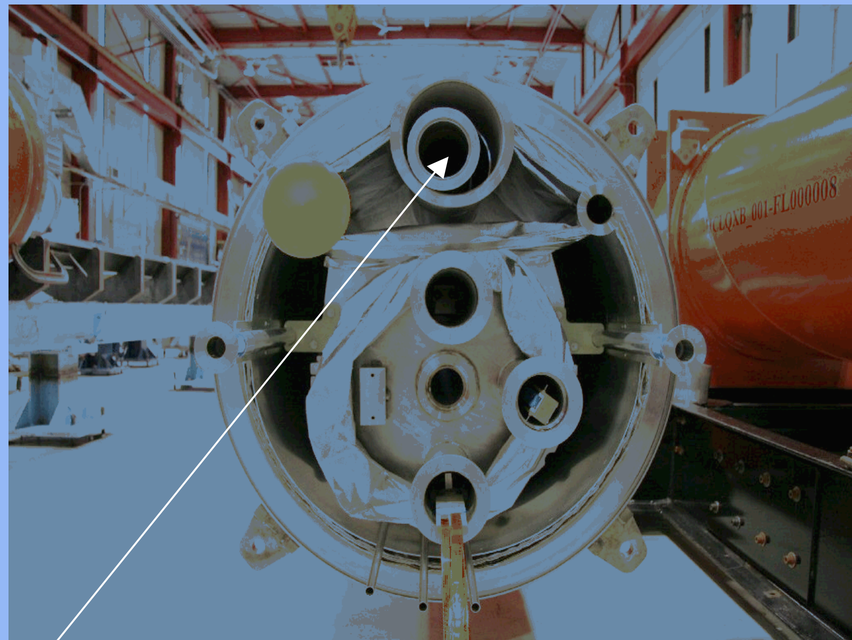
Status of LHC: Cool down sector 78



Pressure Test of Sector 8-1

- During the pressure test of Sector 8-1 (25 November 2006) the heat exchanger tube in the inner triplet failed at 9 bar differential pressure.
- The inner triplet was isolated and the pressure test of the whole sector was successfully carried-out to the maximum pressure of 27.5 bar.

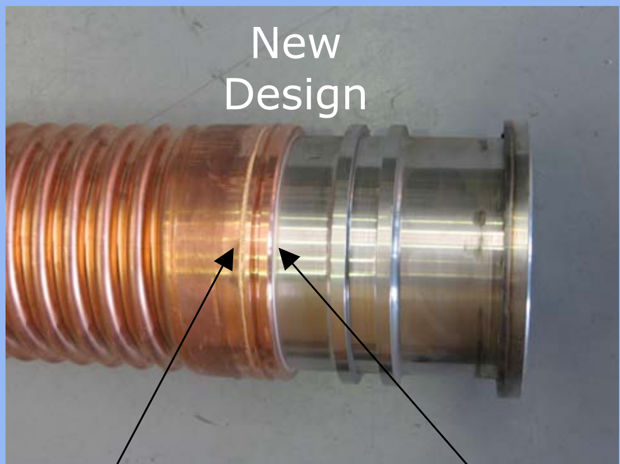
Cryo-magnet Assembly



External Heat Exchanger

Inner Triplets at LSS5L





Inner Triplet Repair

- New high quality heat exchanger tubes are being installed in all 24 inner triplets (starting with Sector 4-5)
- Production of new tubes has been completed
  - Acceptance tests give a buckling pressure of 84 bar.
- Repair schedule for inner triplets has been consolidated.
  - Work is advancing according faster than plan.

Status of LHC: Triplet pressure test

On the evening of March 27 there was a mechanical failure of the inner triplet during the pressure test.

Triplet was being pressured at 25 bar (per specs). Design spec is 20 bar corresponding to pressure rise during a quench.

The failure was in Q1, the quad closer to the IP

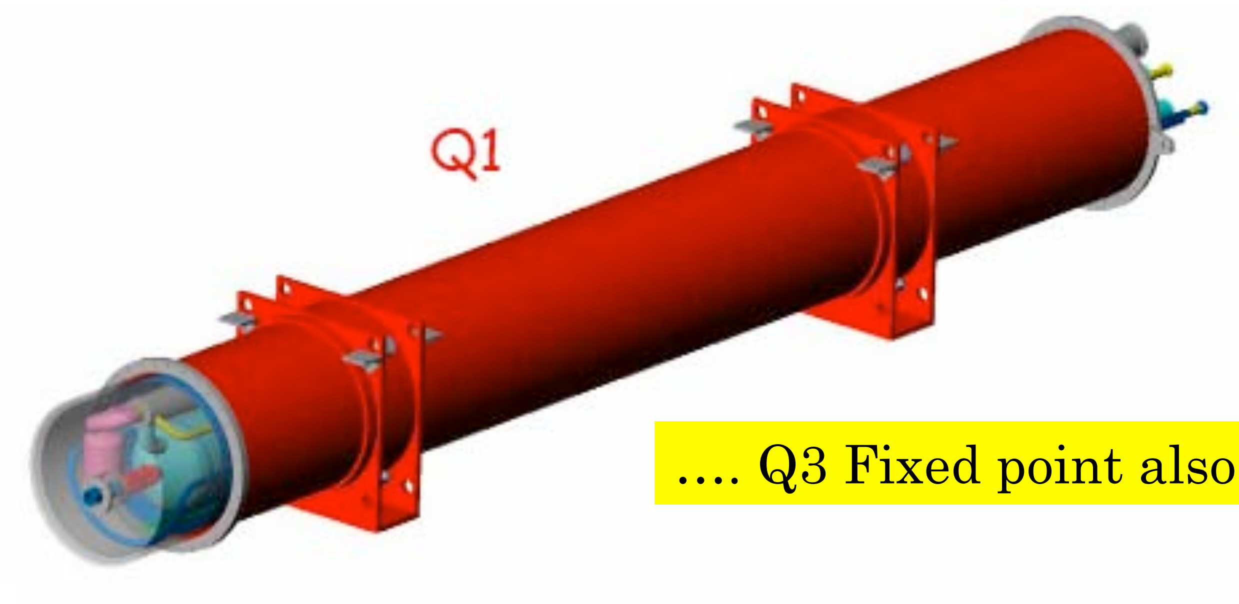
Q1 moved 13 cm toward the IP leaving damaged bellows, interconnect to Q2 on its wake.

Status of the triplet (30th of March)

Q1 internal supports are broken, bus work is damaged including Q2 interconnect.

Status of Q1 cold mass TBD.

Status of Q2 and Q3 TBD. No evident damage (visual)



.... Q3 Fixed point also damaged

Triplet: Diagnosis

Because of their location Q1 and Q3 are subject to substantial longitudinal forces (tons) under pressure. This pressure broke the supports in Q1.

There is no evidence that the longitudinal forces generated by asymmetric loading were accounted for during the engineering design.

There is no evidence that the longitudinal loading was ever raised as an issue during the 4 design reviews.

ANSYS calculations completed on March 28 both at FNAL and CERN show that the support structure is well beyond shear strength at 20 bar

Triplet: plans (as of March 30)

The goal is to fix so that it does not delay LHC startup

Sector 5 pressure test is continuing with the triplet out of the loop. Whether cool down will wait for triplet TBD.

Both CERN and FNAL are pursuing possible fixes

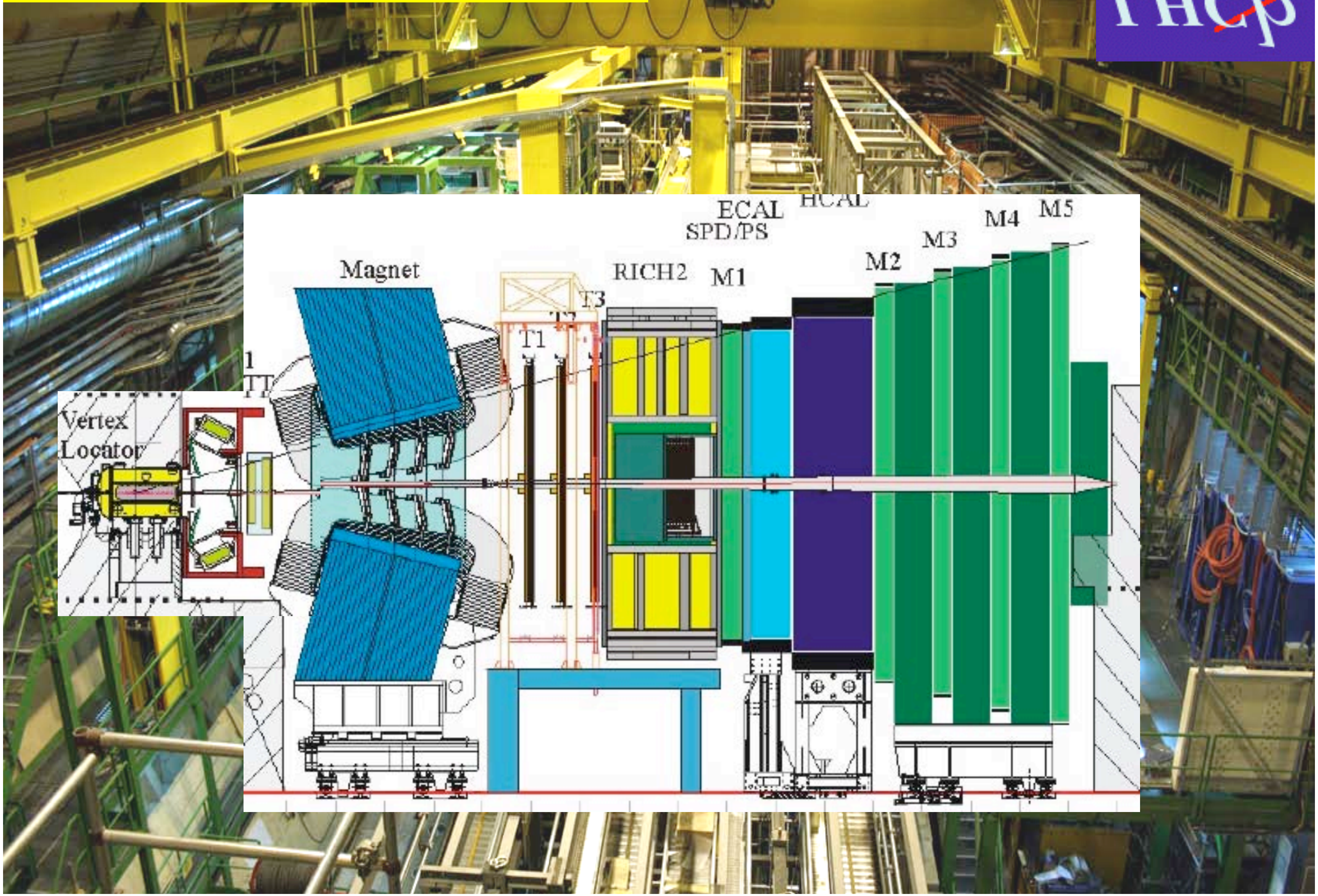
- Goal is an in-situ repair
- CERN is looking at moving the fixed point at magnet end
- FNAL is looking at independent anchoring of the existing fixed points
- Intermediate goal is to have repair implemented so that triplet can participate to the pressure test 1L8R scheduled for June 1st

Not for the 2 damaged magnets point @5

Solution "almost" found - to be validated

Review of the triplet in ~ 2 weeks

STATUS OF LHCb



Status of LHCb

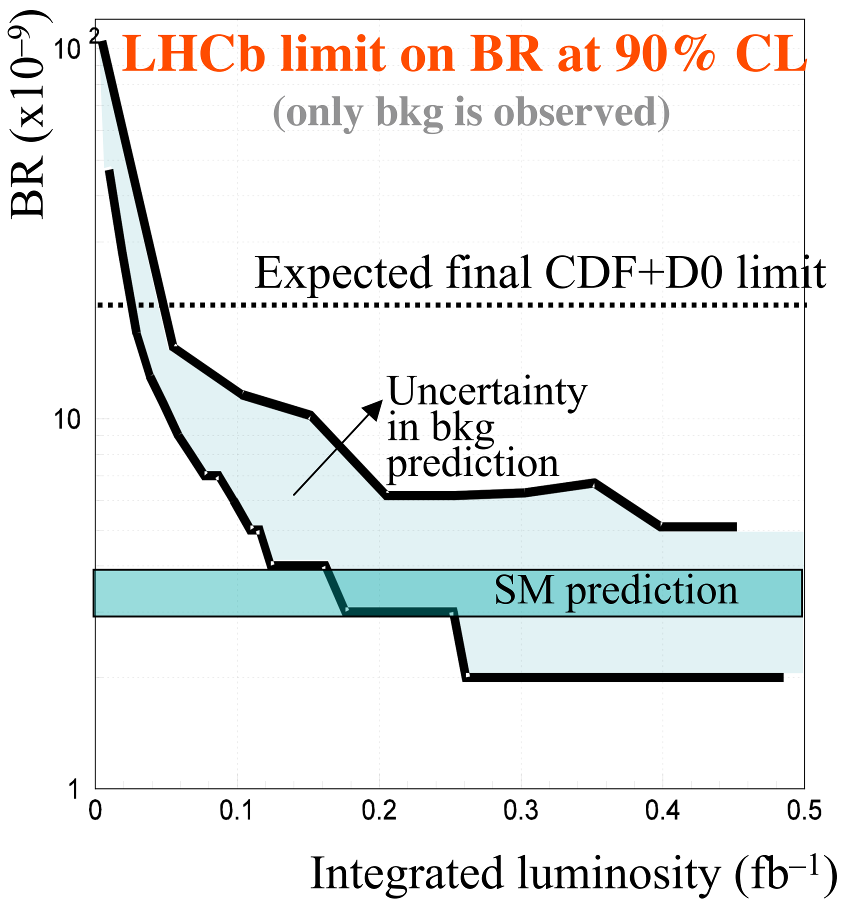
In general, good progress has been made over the last year, although LHCb has accumulated delays of few months in some areas.

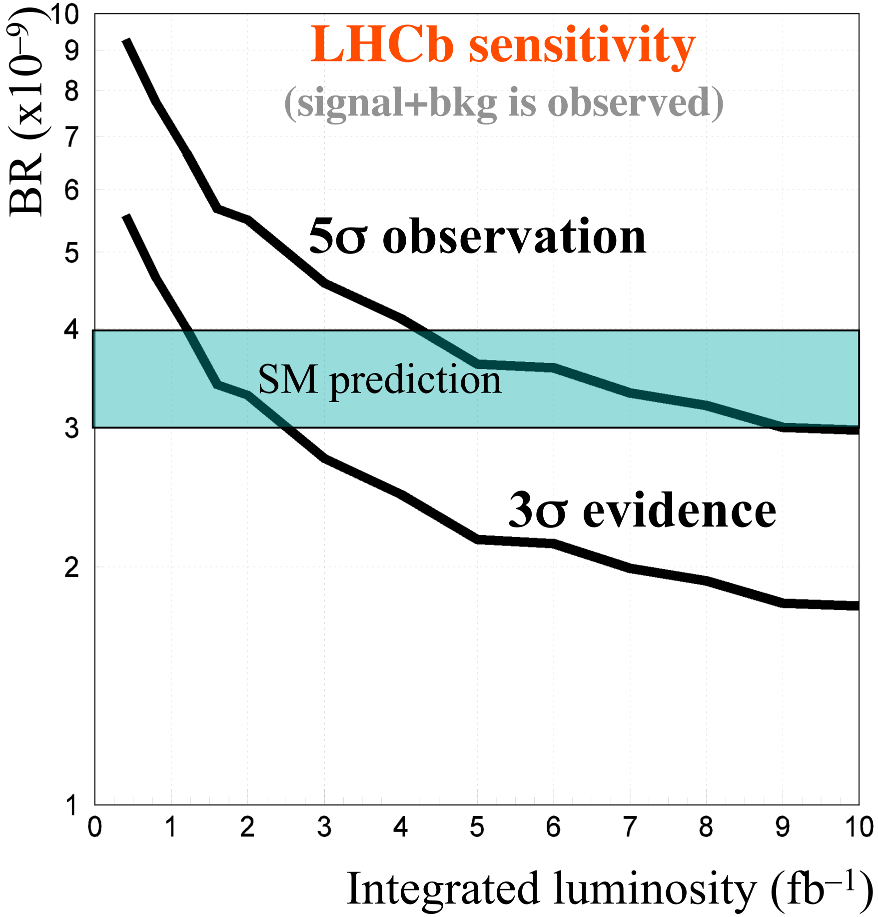
- All major and heavy structures are installed,
- OT, RICH2, ECAL and HCAL are very close to be ready for a 'global' commissioning ,
- Beam Pipe installed and vacuum tested on the 4th of April,
- RICH1, VELO, IT and TT need still some -but short- installation time.

Installation of Muon system and PS/SPD cabling will still continue for a few months.

They are confident that we will be ready for the LHC start up

$B_s \rightarrow \mu^+\mu^-$

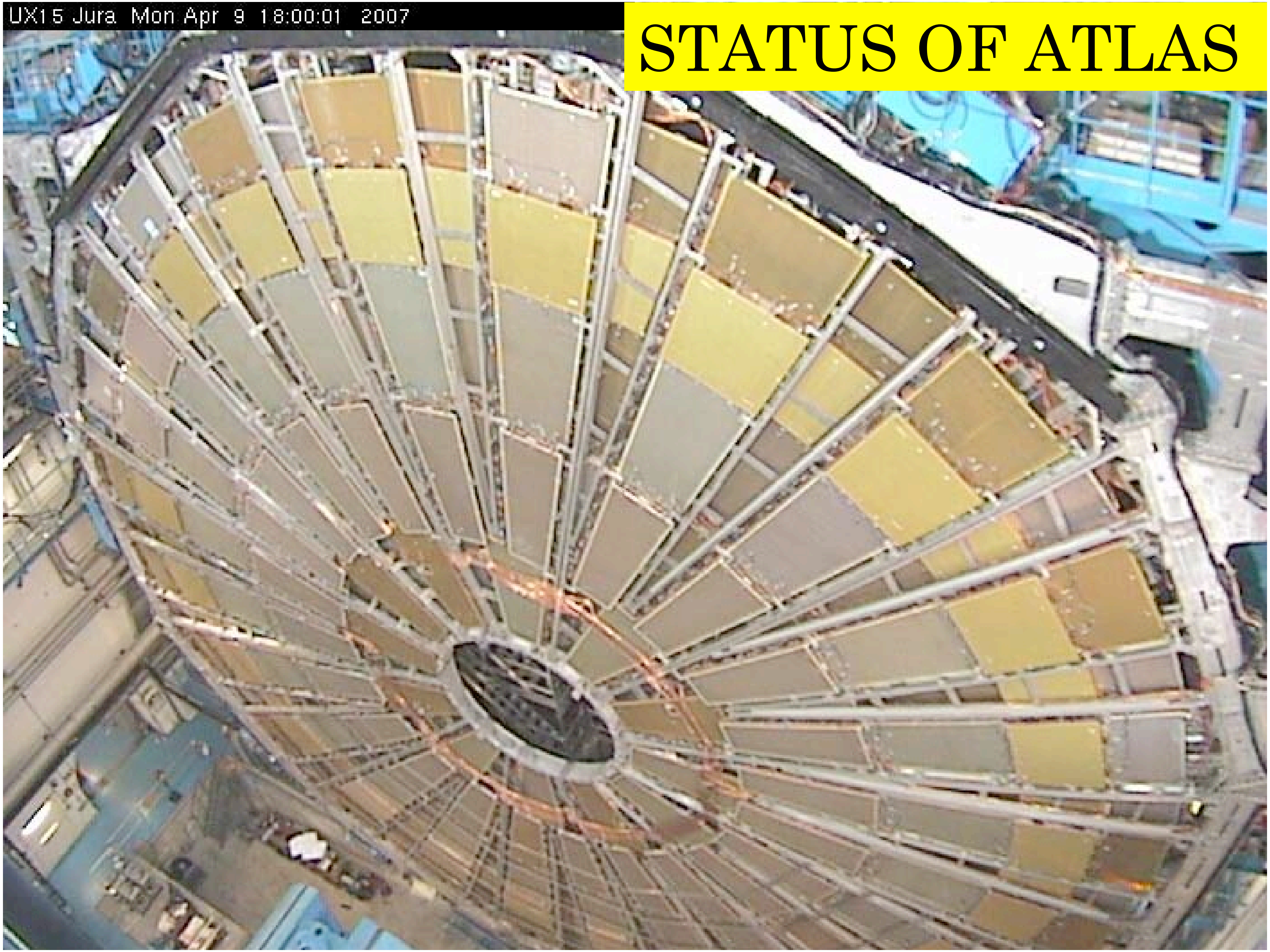




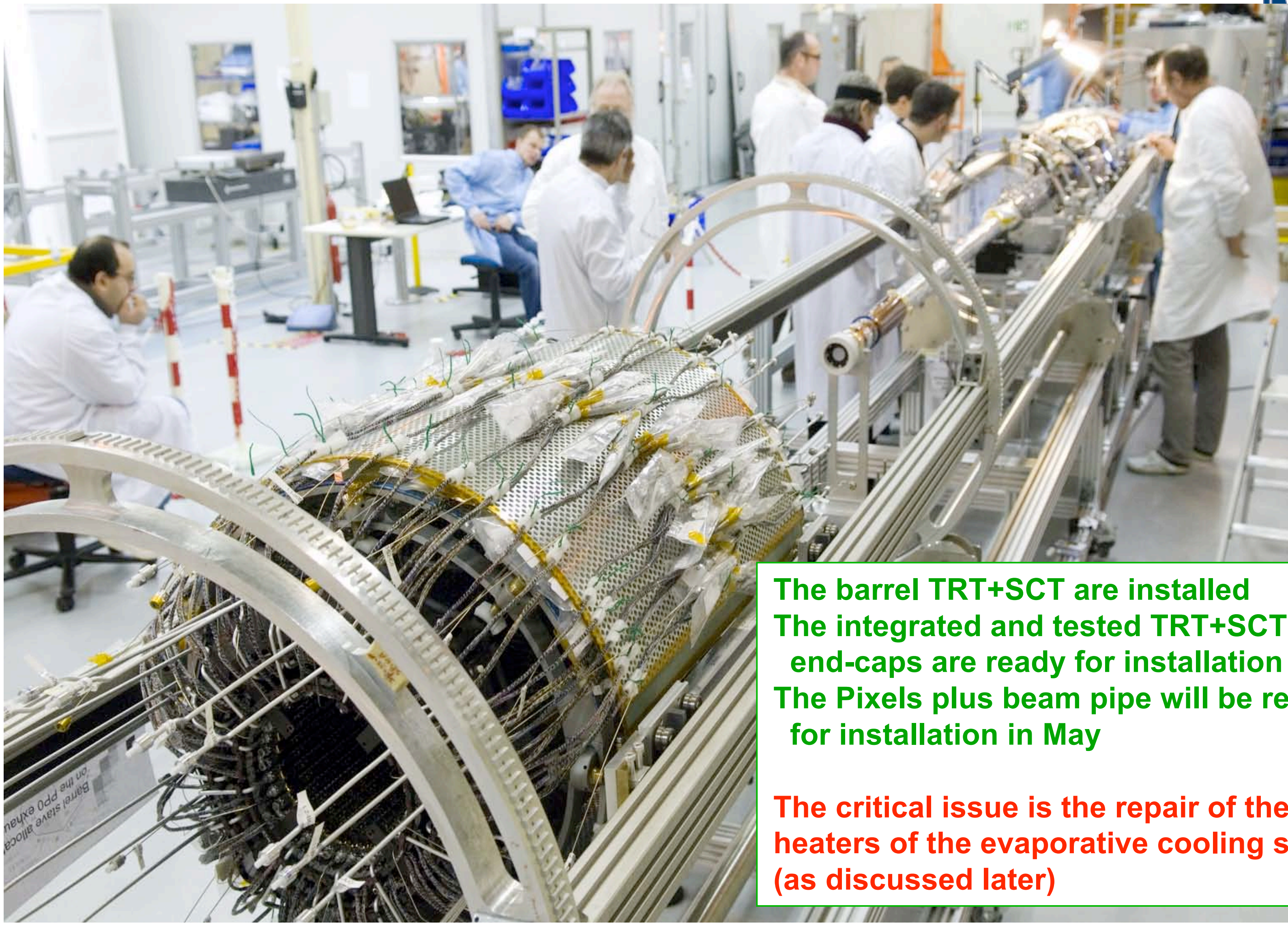
0.05 fb^{-1} ⇒ overtake CDF+D0
0.5 fb^{-1} ⇒ exclude BR values down to SM

2 fb^{-1} ⇒ 3σ evidence of SM signal
10 fb^{-1} ⇒ >5σ observation of SM signal

STATUS OF ATLAS



ATLAS - Inner Detector status



The barrel TRT+SCT are installed
The integrated and tested TRT+SCT end-caps are ready for installation
The Pixels plus beam pipe will be ready for installation in May

The critical issue is the repair of the heaters of the evaporative cooling system (as discussed later)

ATLAS Pixel detector integration (barrel, end-caps and beam pipe)

ID heater problem in the ID evaporative cooling system

Two failures

Corrosion discovered in some heaters localized at the Thermo-Couple inserts

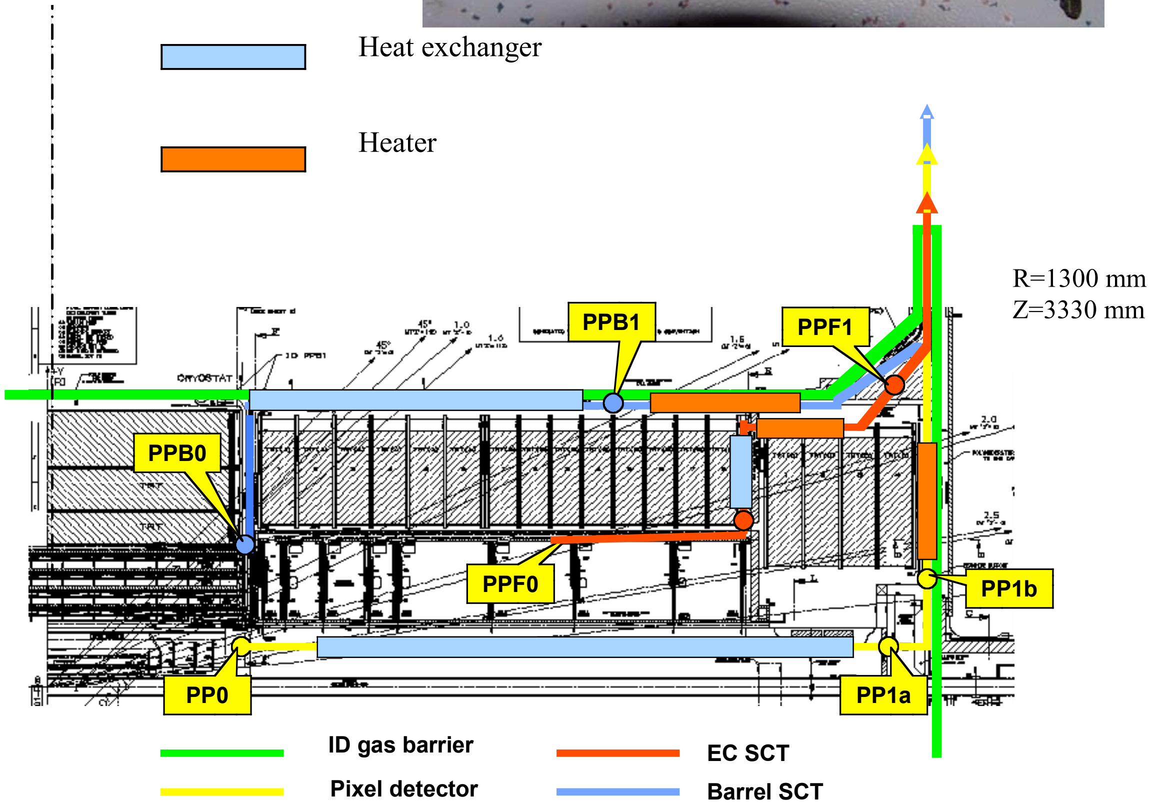
One heater failed (burned) catastrophically in the pit during commissioning on February 17

→ Repair needed before insertion of the end-caps and the Pixel detector

Intense activity (including the industry making heaters for nuclear plants) to modify and qualify the heaters, as well as to develop a backup solution

→ Impact on overall ATLAS schedule

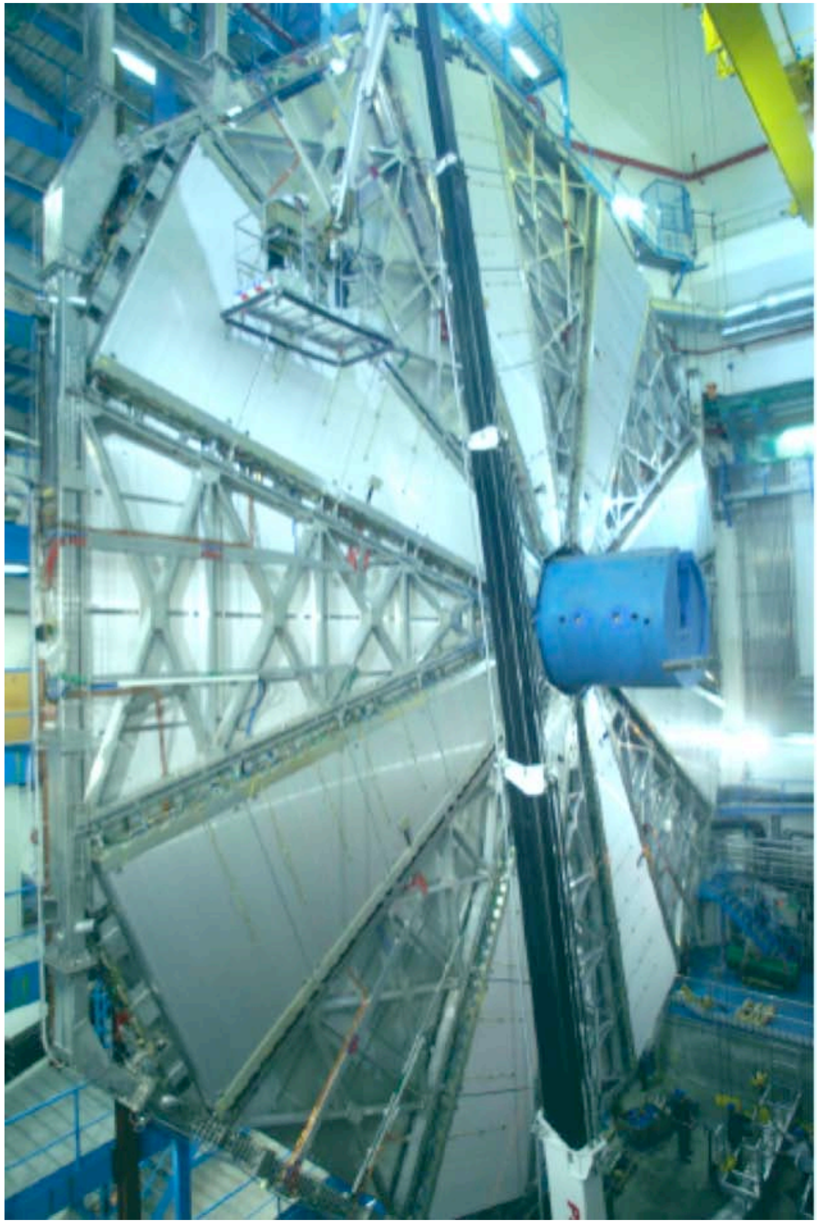
About 200 thin tubes total, 2 cm diameter, with a heater element



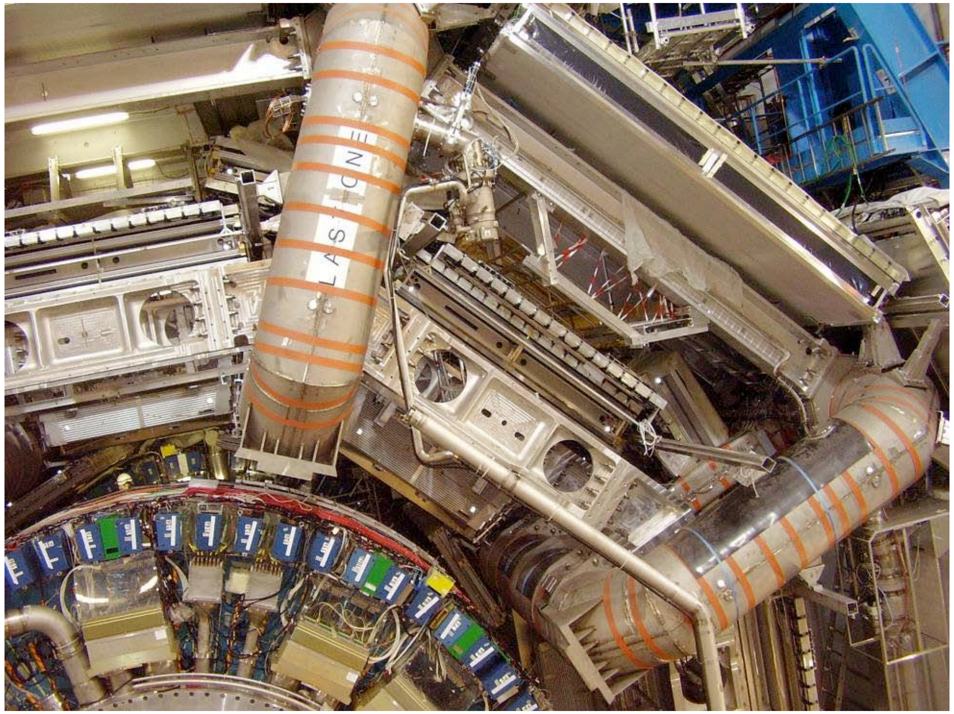
ATLAS - Muon system status

Muon barrel chamber installation is nearing completion (~ 95% done)

End-cap muon installation is now progressing in parallel on both sides

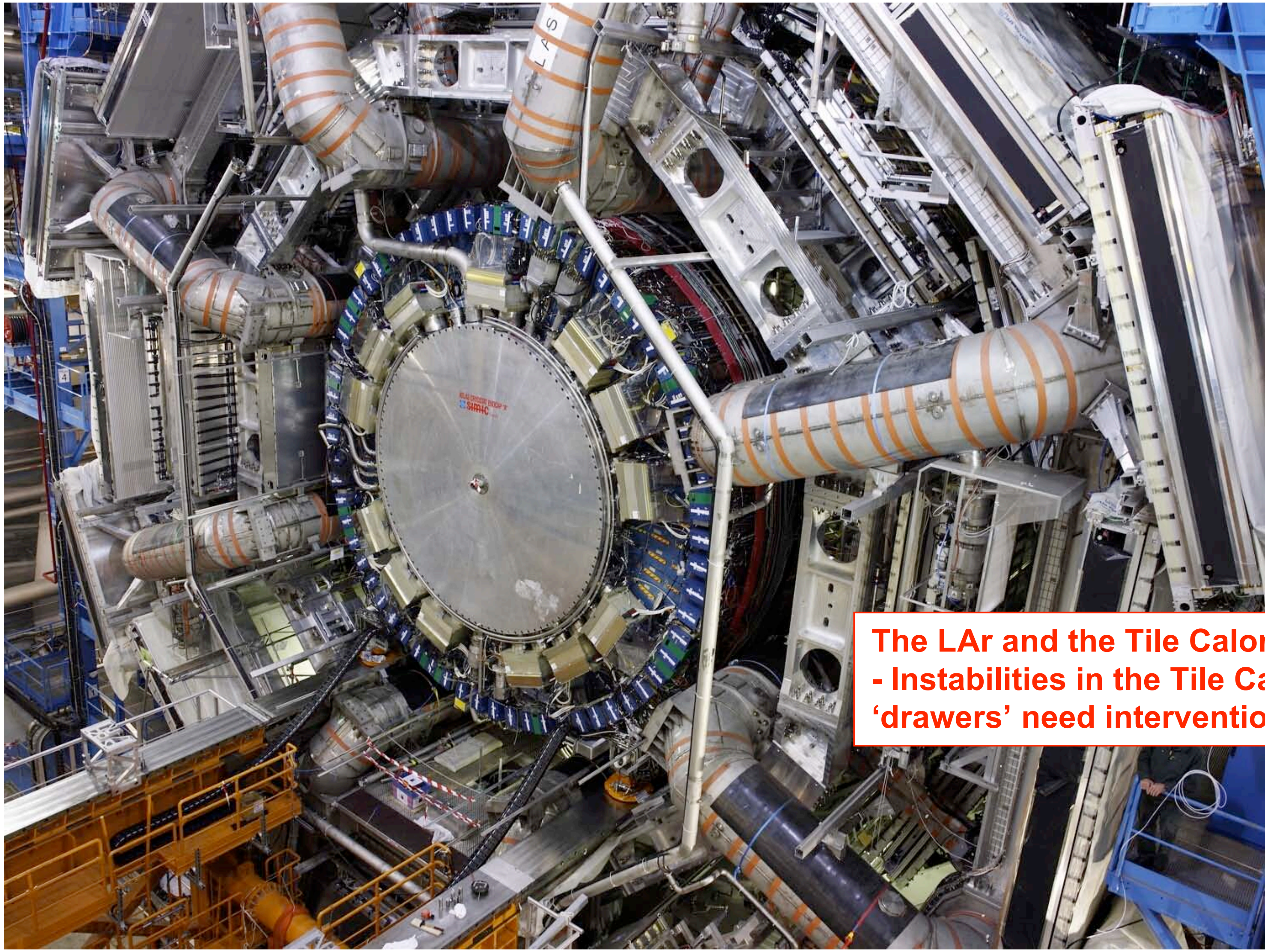


First complete MDT Big Wheel



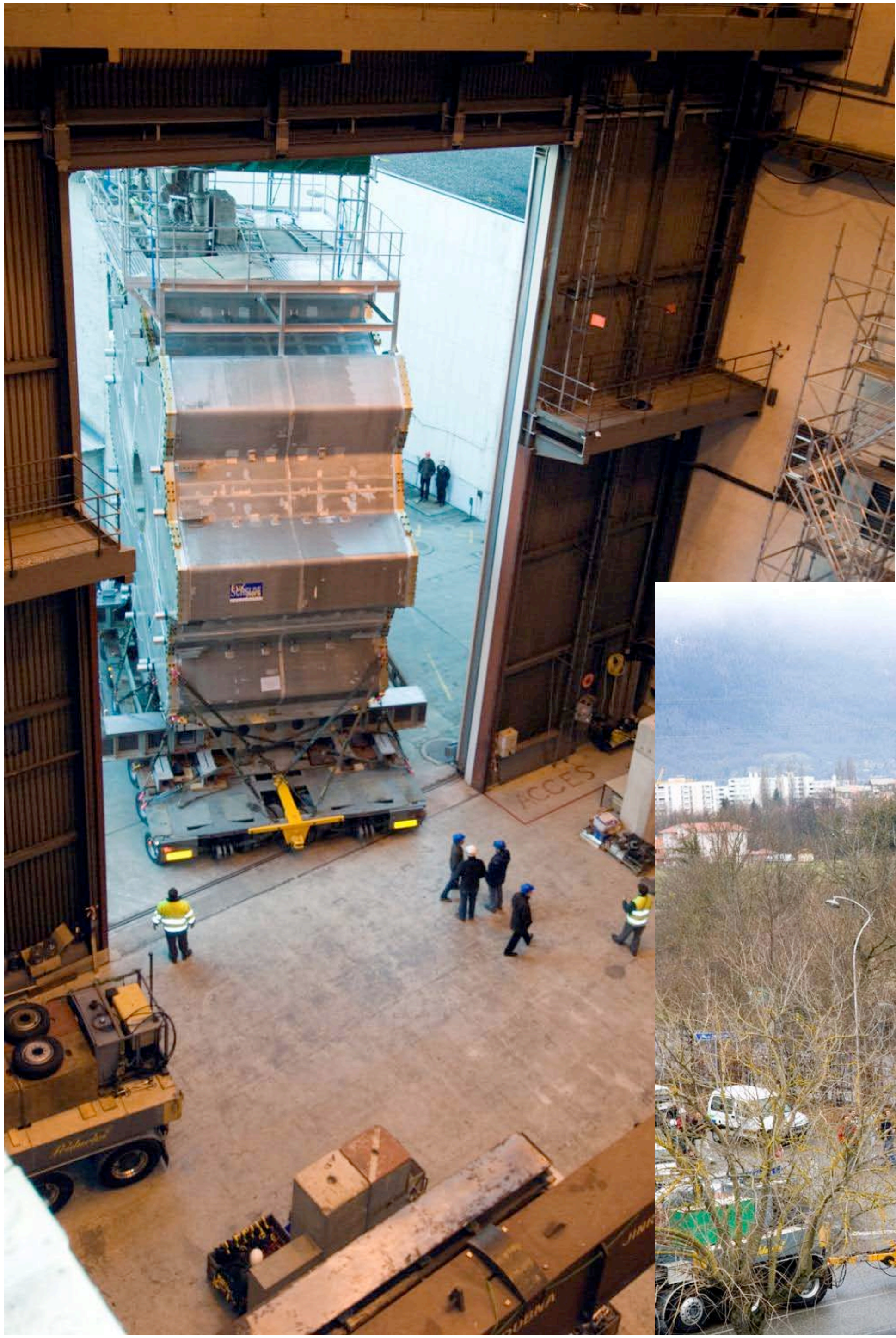
Barrel muon stations

Calorimeter status



The LAr and the Tile Calorimeters
- Instabilities in the Tile Calorimeter 'drawers' need interventions

ATLAS side A (with the calorimeter end-cap partially inserted, the LAr end-cap is filled with LAr)

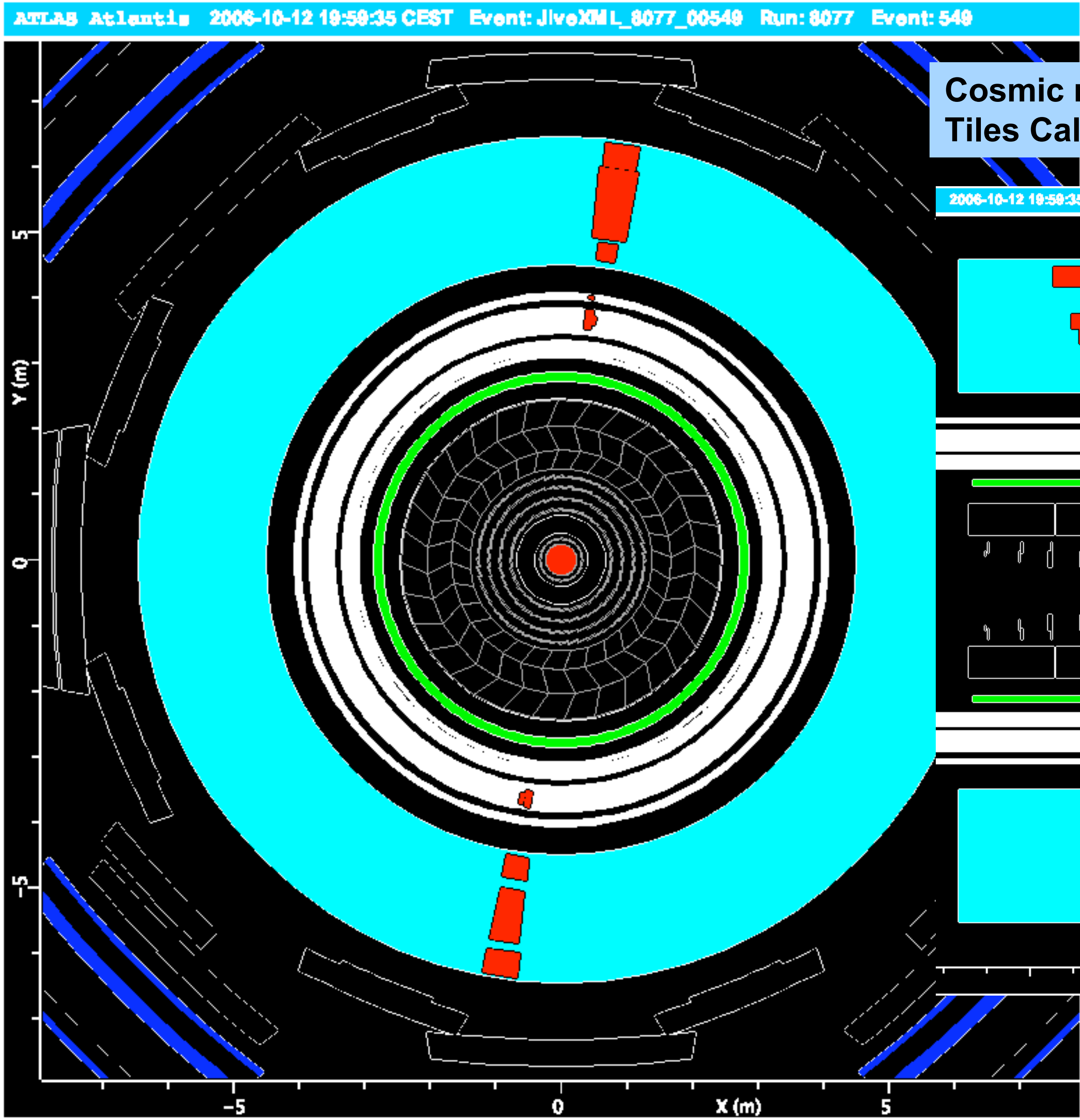


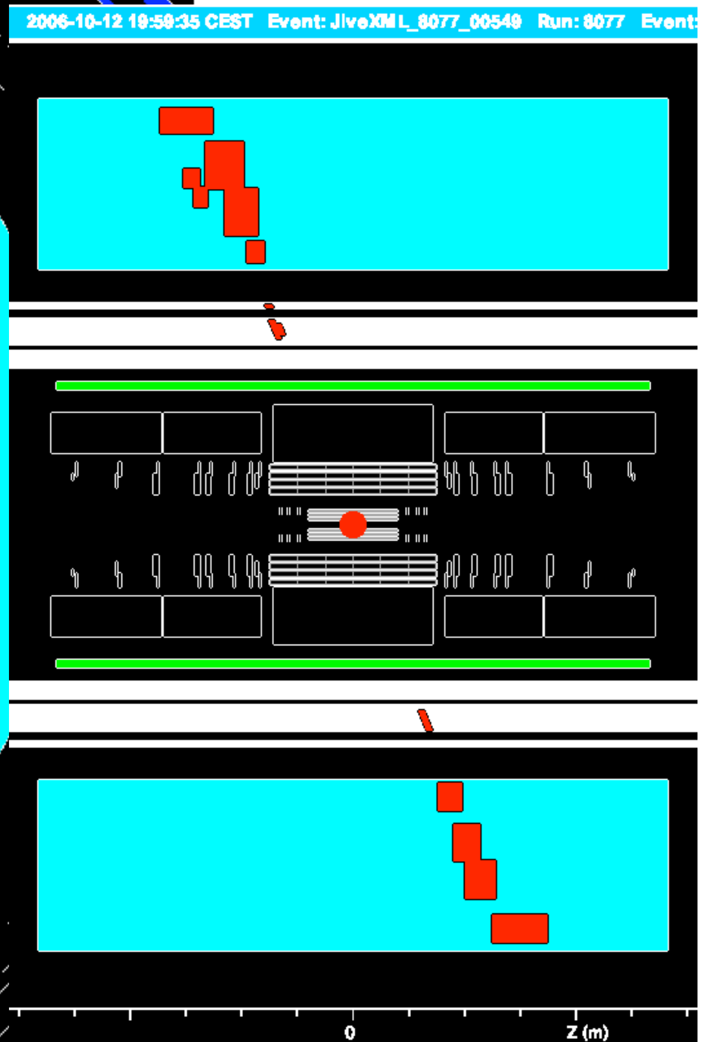
End-Cap Toroids

The first End-Cap Toroid has been transported from Hall 191 to the outside test station in front of Hall 180 where it is being mechanically cold tested at LN temperature (cool-down went smoothly)

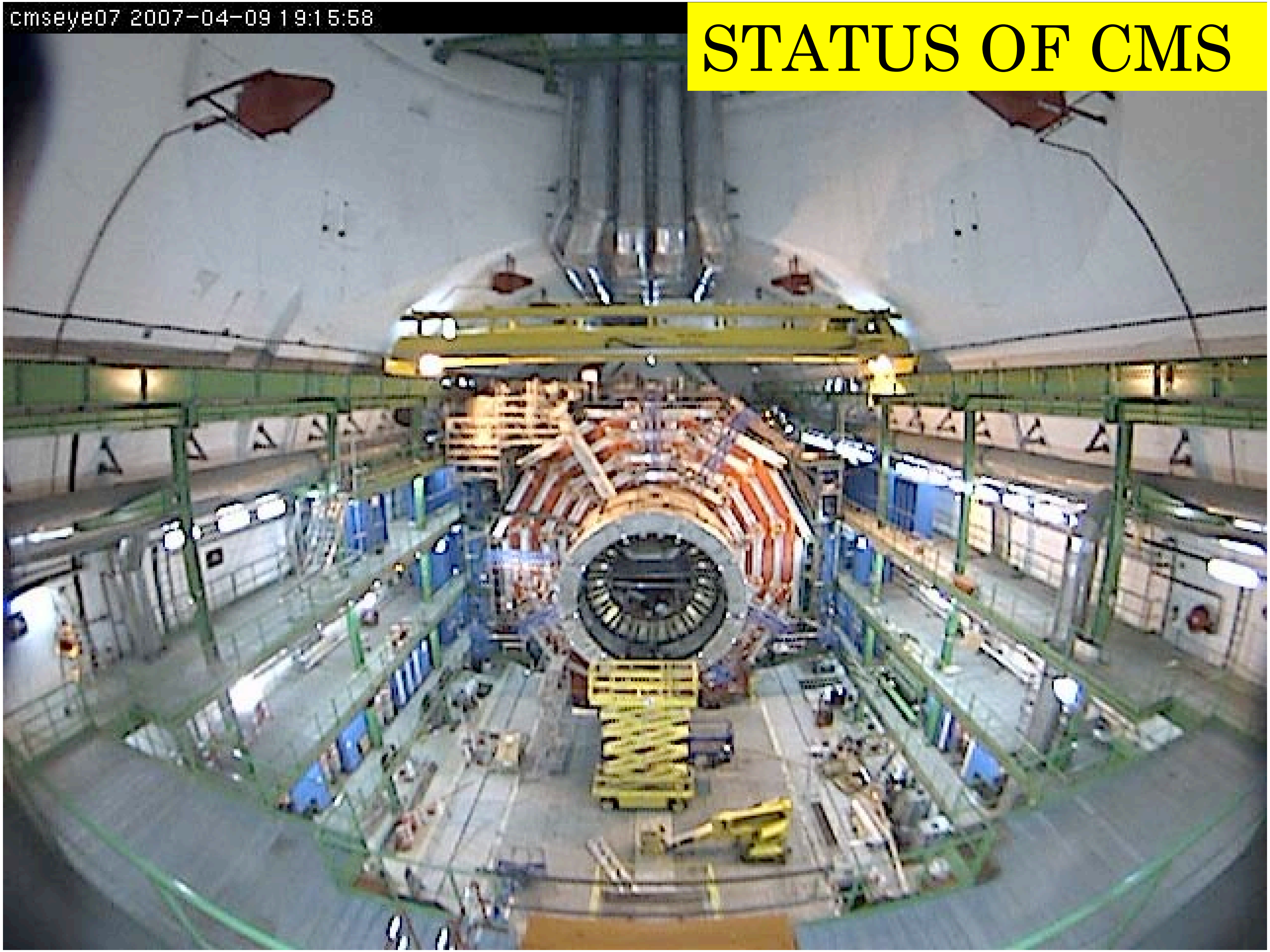
The integration of the second ECT is well advanced (cold mass has already been inserted in vacuum vessel)

Cosmic ray event triggered by the Tiles Calorimeter



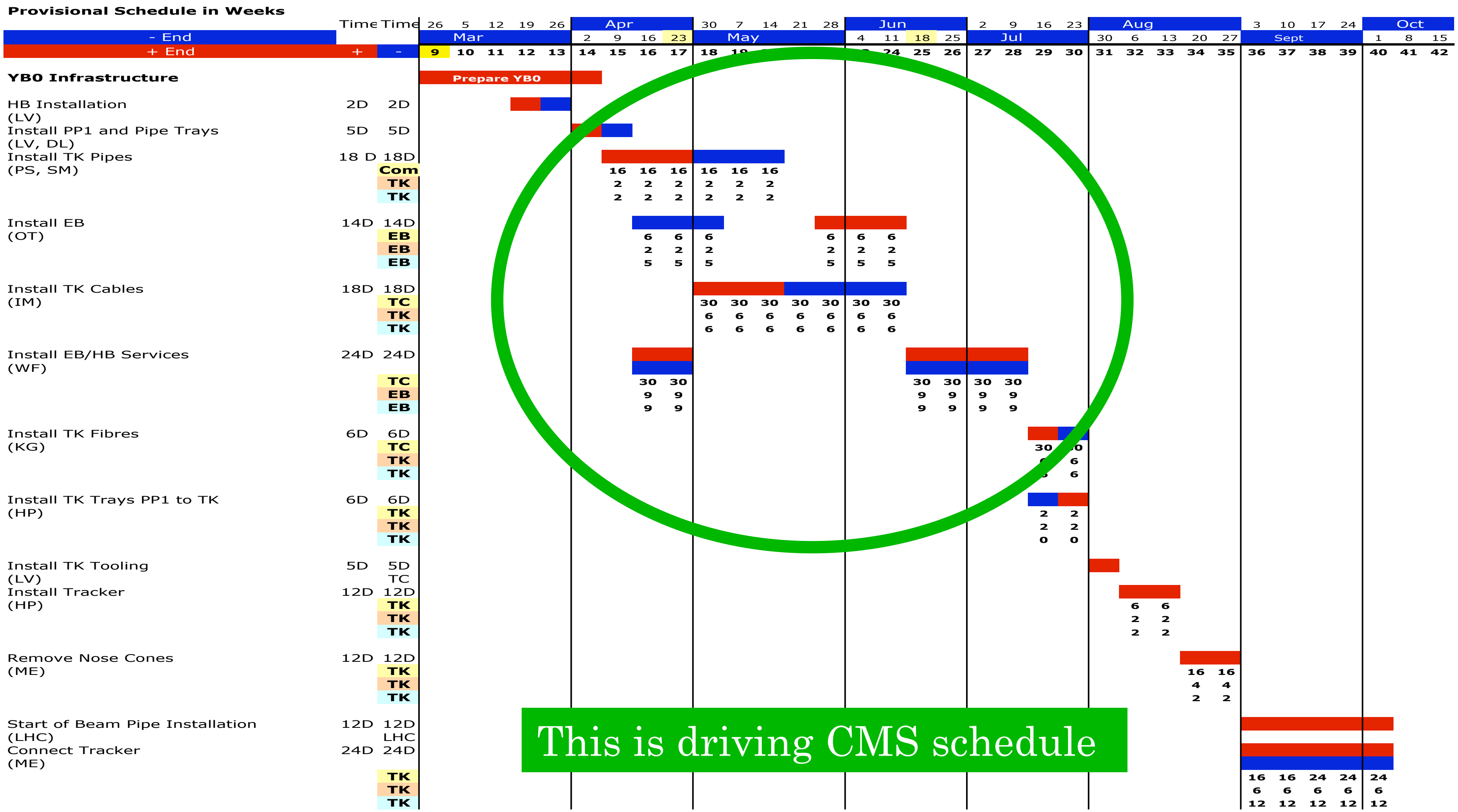


STATUS OF CMS



YB0 Lowering 28 Feb

YB0 Service installation schedule



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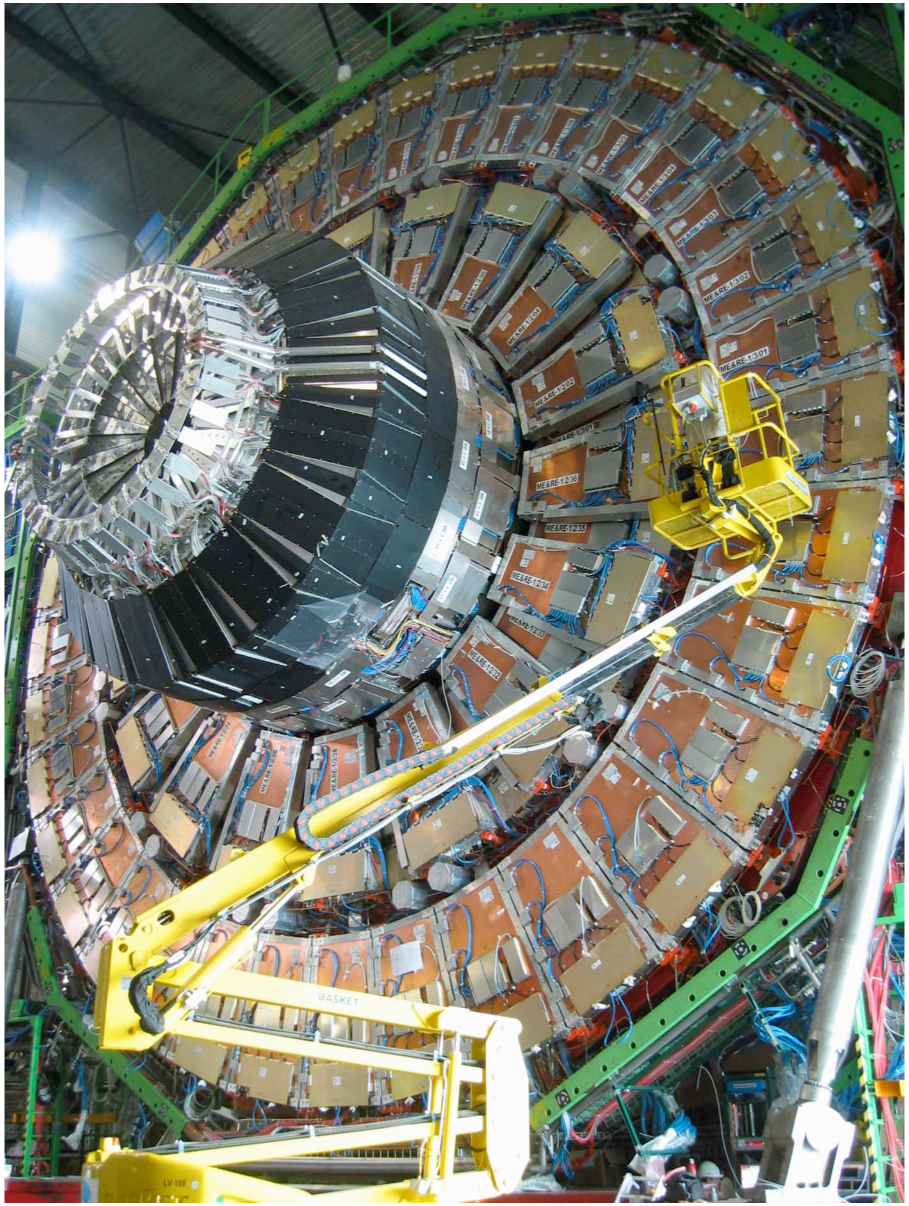
CMS- Installation of Endcap Chambers

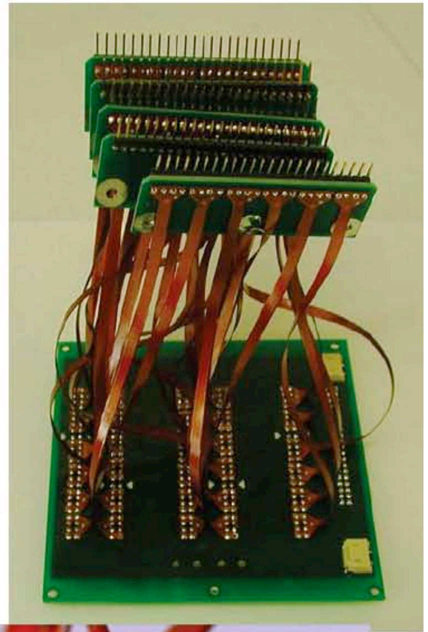
All Endcap Precision Muon Chambers now Installed (8 Mar).

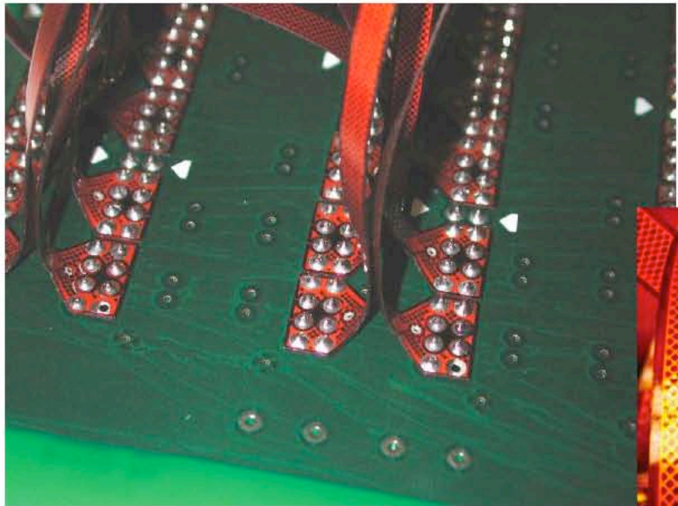
Remaining (14) Precision Barrel Chambers can only be installed after YB-1, YB-2 are lowered



Problem with ECAL MB's found in October 06

The faults seem to be happening at the level of the connection (hand soldering) between kaptons , VFE connectors and PCB on the Motherboards

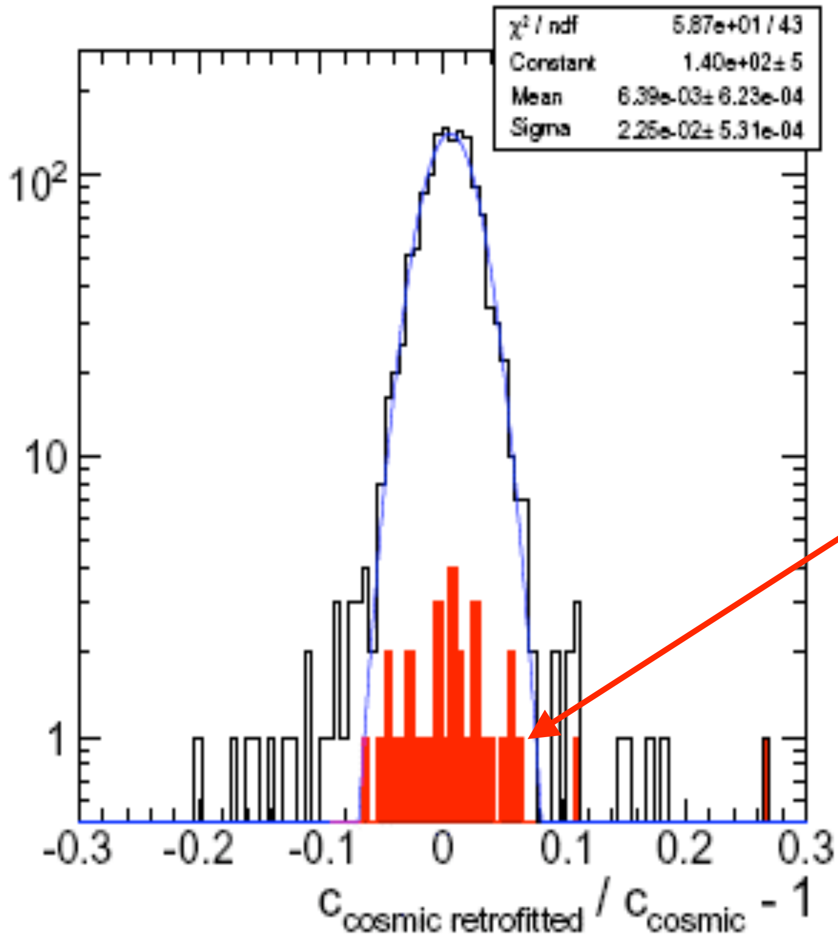




Calibration : comparison before–after reintegration

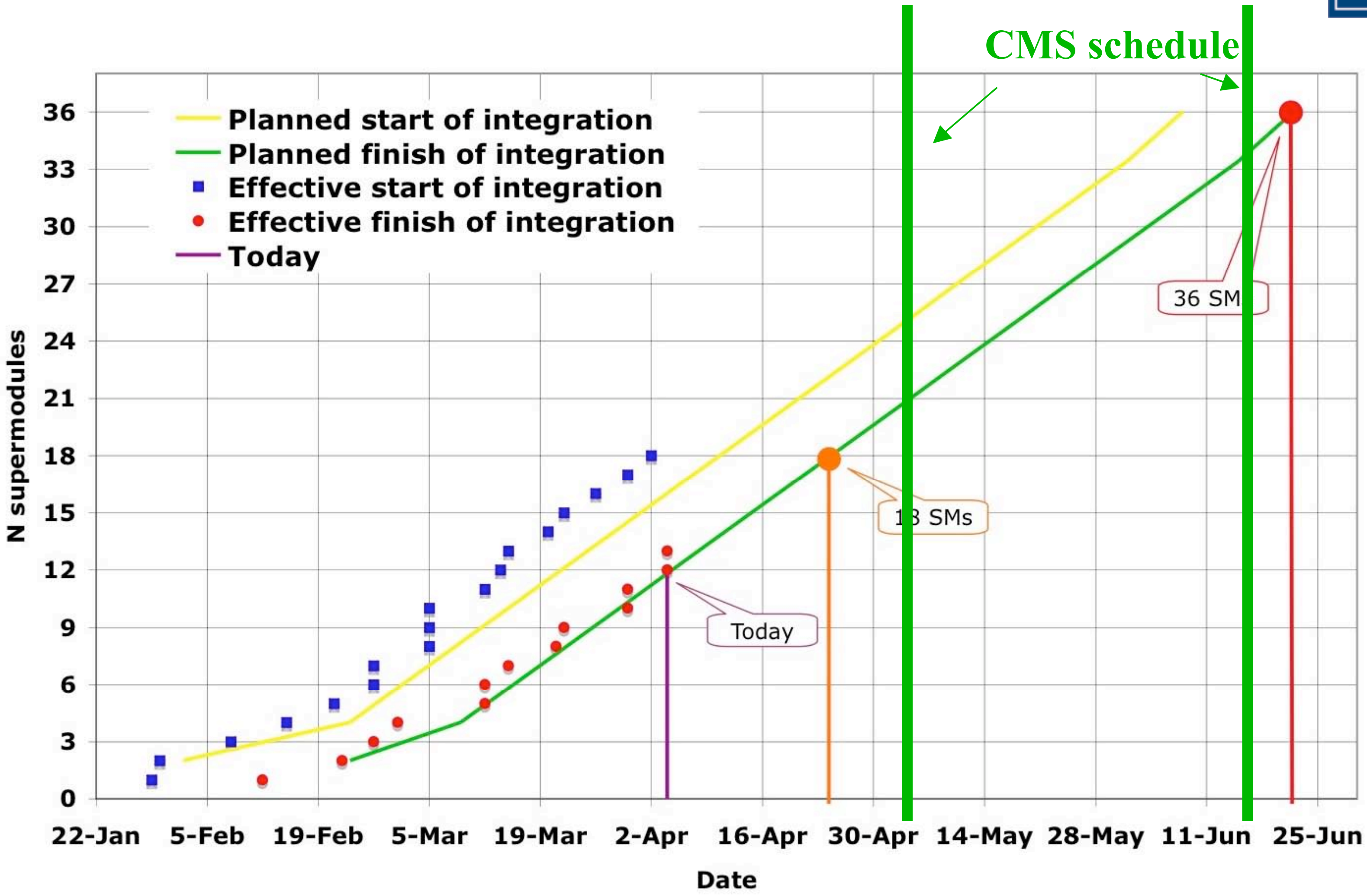
SM0 recalibrated with cosmic rays

No effect observed within statistical accuracy (2%)

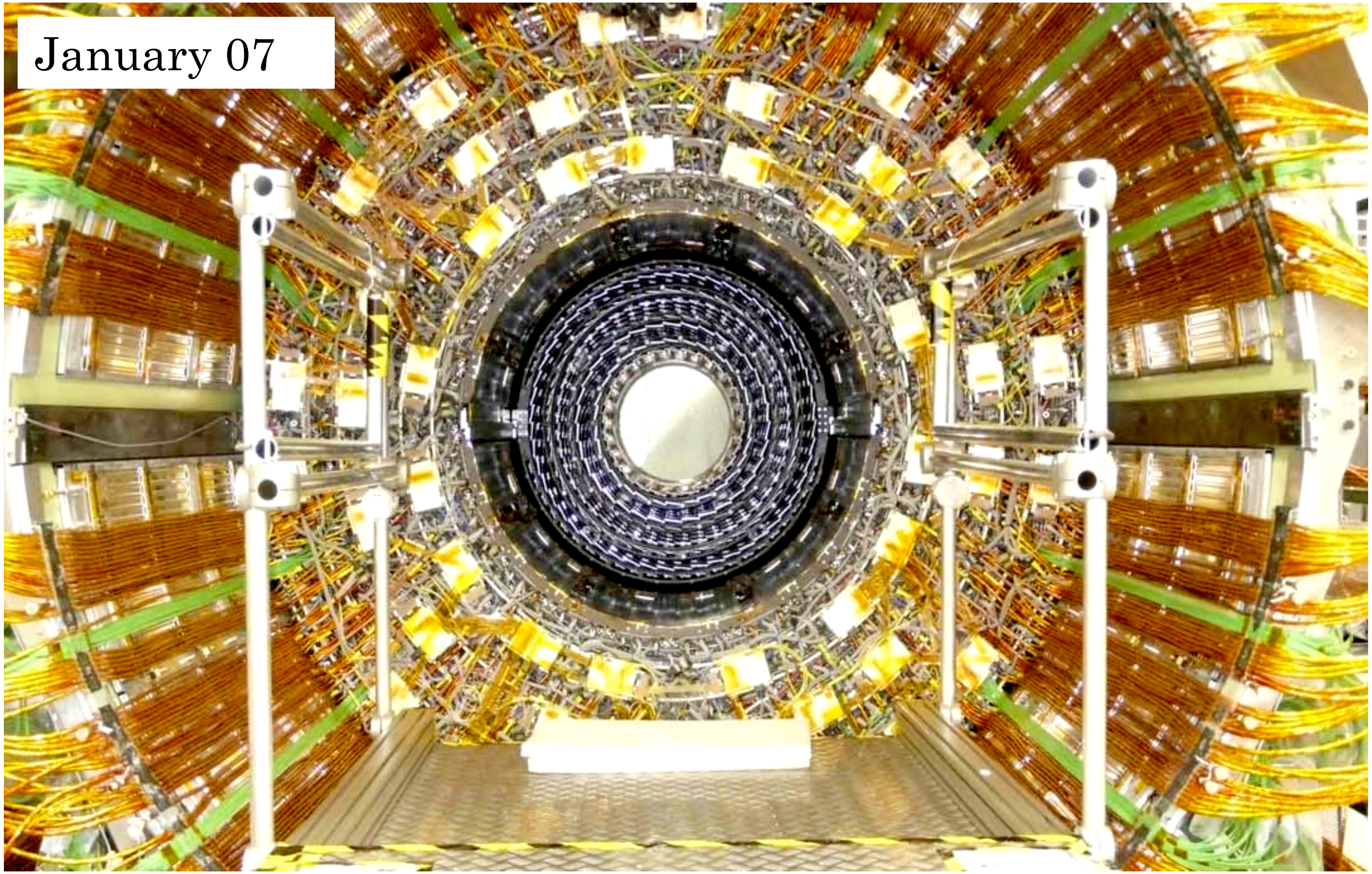


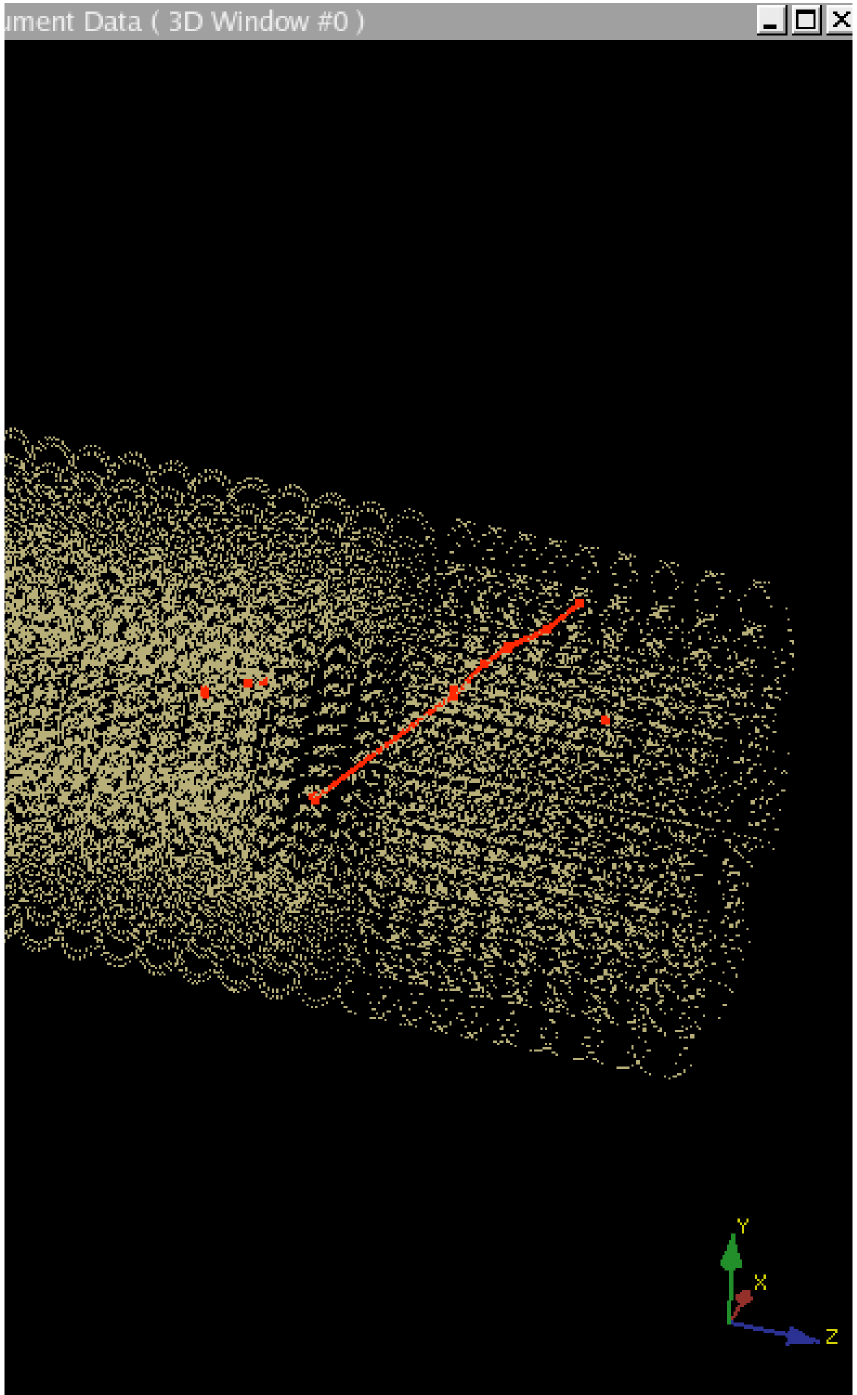
These few channels have different electronics cards

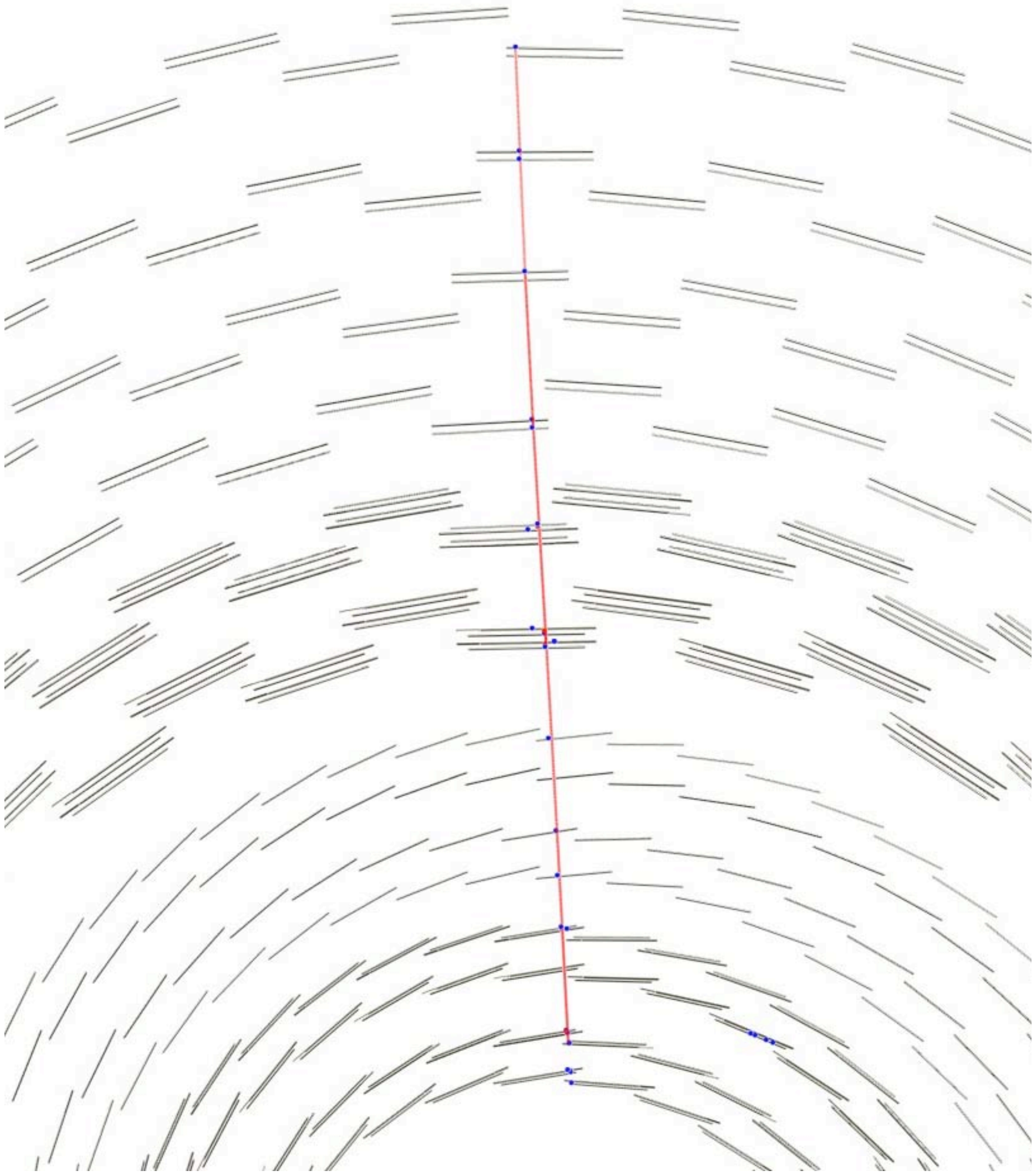
CMS ECAL Supermodules Integration Schedule



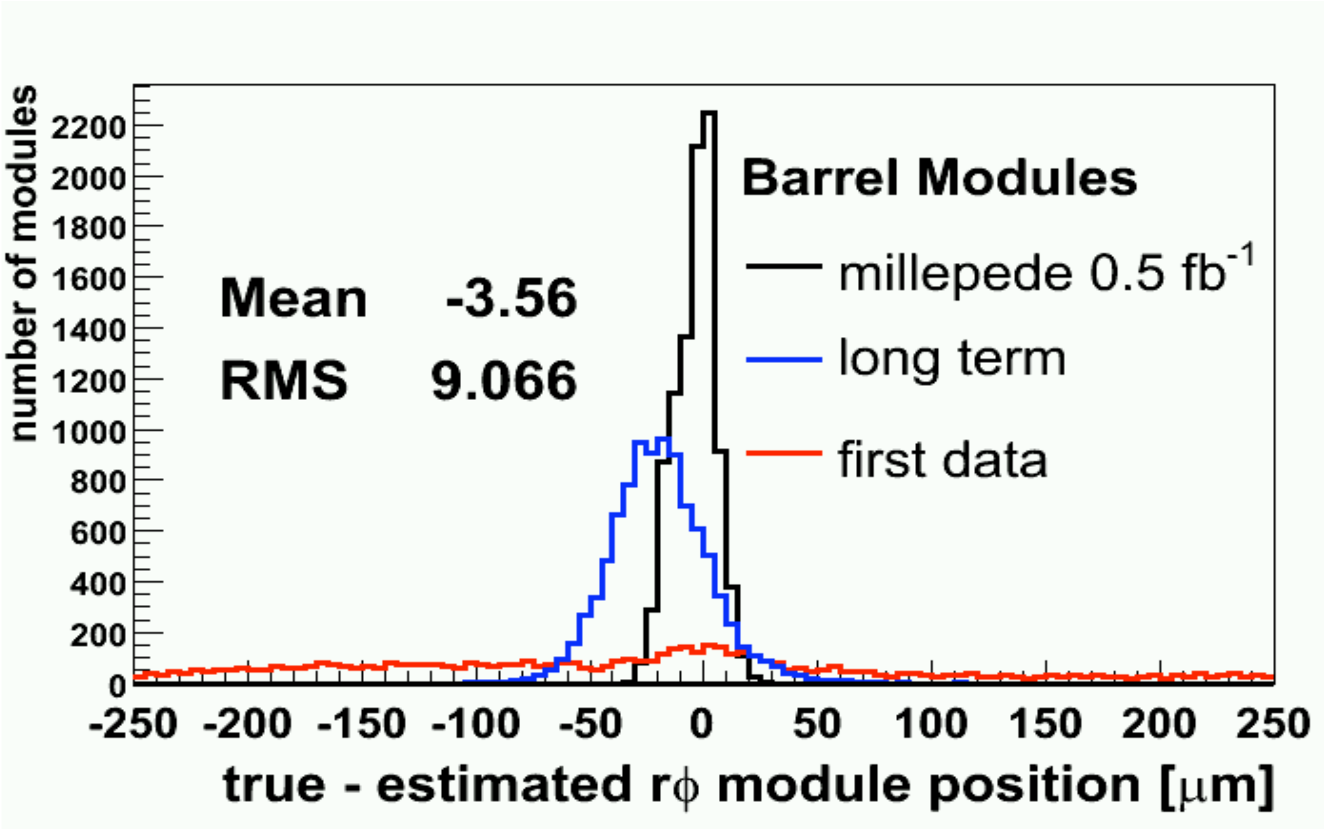
CMS tracker fully integrated




ument Data (3D Window #0)
Y
X
Z



CMS- Global Tracker Alignment with Millepede II



First time full pixel + strip alignment!

Results:

- *Better than PTDR "long term" estimate.*
- *Barrel RMS: 9 μm (in rφ) and no tails!*
- *End Cap RMS: 22 μm (in rφ) -*
- *CPU time: 1:40 Hrs Memory: 1.9GB*

Will it take place ?

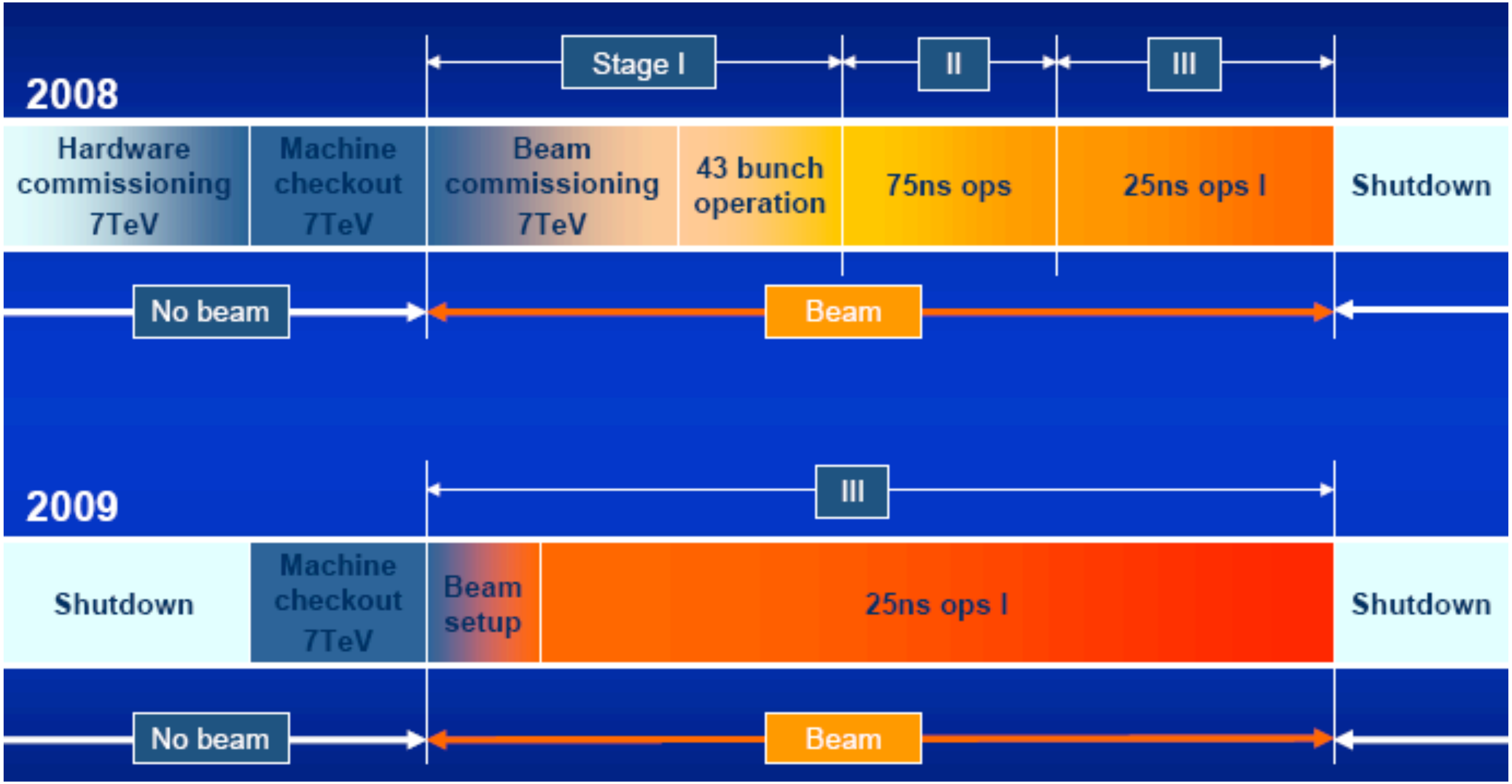
Objectives 2007 engineering runs

- Commission essential safety systems
- Commission essential beam instrumentation
- Commission essential hardware systems
- Perform beam based measurements to check:
  - Polarities
  - Aperture
  - Field characteristics
- Establish collisions
- Provide stable two beam operation at 450 GeV
- Interleave collisions with further machine development, in particular the ramp.

- Optics:
  - β^*= 11 m in IR 1 & 5
  - β^*= 10 m in IR 2 & 8
  - Limited by triplet aperture
- Crossing angles off
  - 1, 12, 43, 156 bunches per beam
- Separation bumps - two beam operation
- Shift bunches for LHCb
  - 4 out of 43 bunches, or 24 bunches out of 156
- Solenoids & Experimental Dipoles etc. off (to start with)

Provide a firm platform for the commissioning to 7 TeV and provide adequate lead time for problem resolution.

Beyond 2007



2008
Stage I
II
III
Hardware commissioning 7TeV
Machine checkout 7TeV
Beam commissioning 7TeV
43 bunch operation
75ns ops
25ns ops I
Shutdown
No beam
Beam
2009
III
Shutdown
Machine checkout 7TeV
Beam setup
25ns ops I
Shutdown
No beam
Beam

LHC Commissioning stages

Stage	Objective	k_b	N	β* 1,5 (m)	L ($cm^{-2}s^{-1}$)	E_{beam} (MJ)
HC	Hardware commissioning					
MC	Machine checkout					
A	Pilot physics run					
	Beam commissioning	1	$0.5 \rightarrow 1 \times 10^{10}$	11	10^{27}	0.01
	43 bunch operation	43	$1 \rightarrow 4 \times 10^{10}$	$11 \rightarrow 2$	7×10^{29}	$0.5 \rightarrow 2$
	156 bunch operation	156	$4 \rightarrow 9 \times 10^{10}$	2	1.1×10^{32}	$7 \rightarrow 16$
B	75 ns operation					
	Relaxed squeeze and crossing angle	936	4×10^{10}	11	1.1×10^{31}	42
	Performance optimised squeeze and crossing angle	936	$4 \rightarrow 9 \times 10^{10}$	$11 \rightarrow 2$	1.2×10^{33}	$42 \rightarrow 94$
C	25 ns operation					
	Moderate intensity	2808	4×10^{10}	2	3.8×10^{32}	126
	50 % nominal intensity, fully squeezed	2808	$4 \rightarrow 5 \times 10^{10}$	0.55	3.8×10^{33}	$126 \rightarrow 157$
D	25 ns towards nominal operation					
	Increasing intensity to nominal	2808	$5 \rightarrow 11 \times 10^{10}$	0.55	1×10^{34}	$126 \rightarrow 362$

$$L = \frac{N^2 k_b f \gamma}{4\pi \varepsilon_n \beta^*} F$$

LHC Commissioning stage A

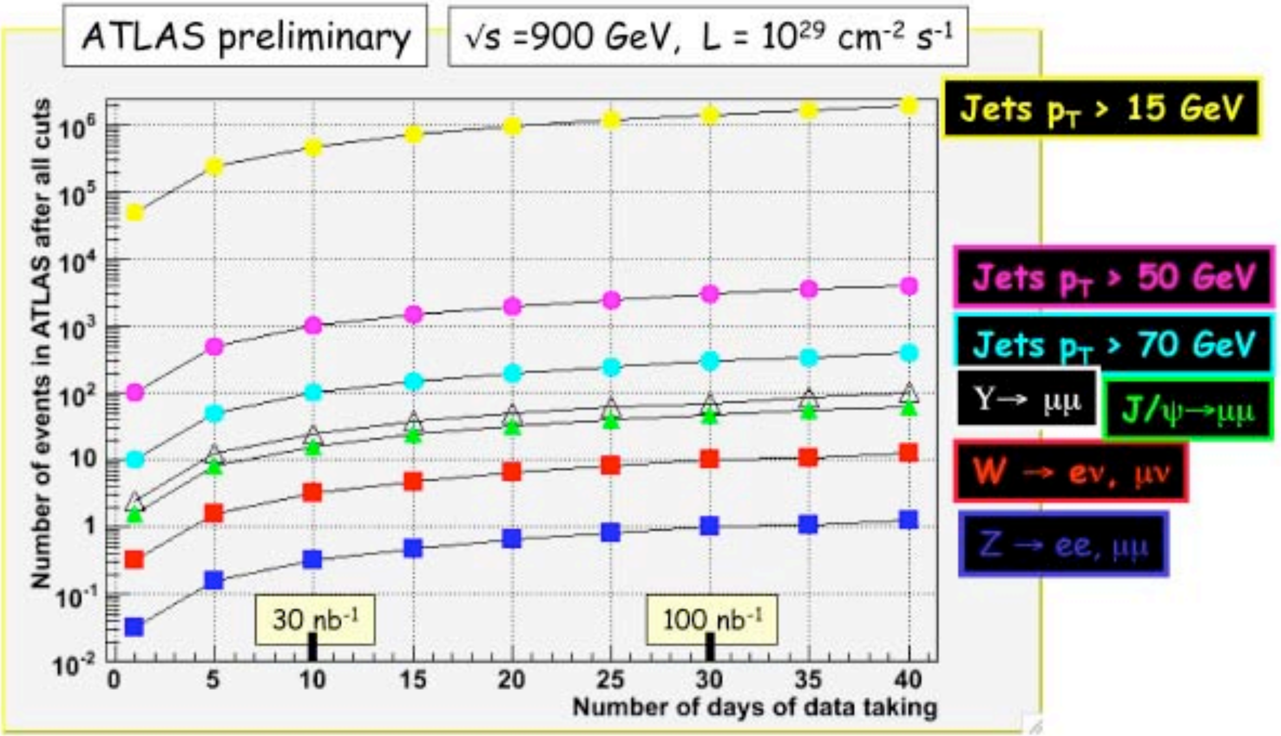
Phases for full commissioning Stage A (pilot physics run)

Phase	Description
A.1	Injection and first turn: injection commissioning; threading, commissioning beam instrumentation.
A.2	Circulating pilot: establish circulating beam, closed orbit, tunes, RF capture
A.3	450 GeV initial commissioning: initial commissioning of beam instrumentation, beam dump
A.4	450 GeV optics: beta beating, dispersion, coupling, non-linear field quality, aperture
A.5	Increasing intensity: prepare the LHC for unsafe beam
A.6	Two beam operation – colliding beams at 450 GeV
A.7	Snap-back and ramp: single beam
A.8	Bringing beams into collision: adjustment and luminosity measurement
A.9	7 TeV optics: beta beating, dispersion, coupling, non-linear field quality, aperture
A.10	Squeeze: commissioning the betatron squeeze in all IP's
A.11	Physics runs: physics with partially squeezed beams, no crossing in IP1 and IP5

Phases for proposed 2007 engineering run

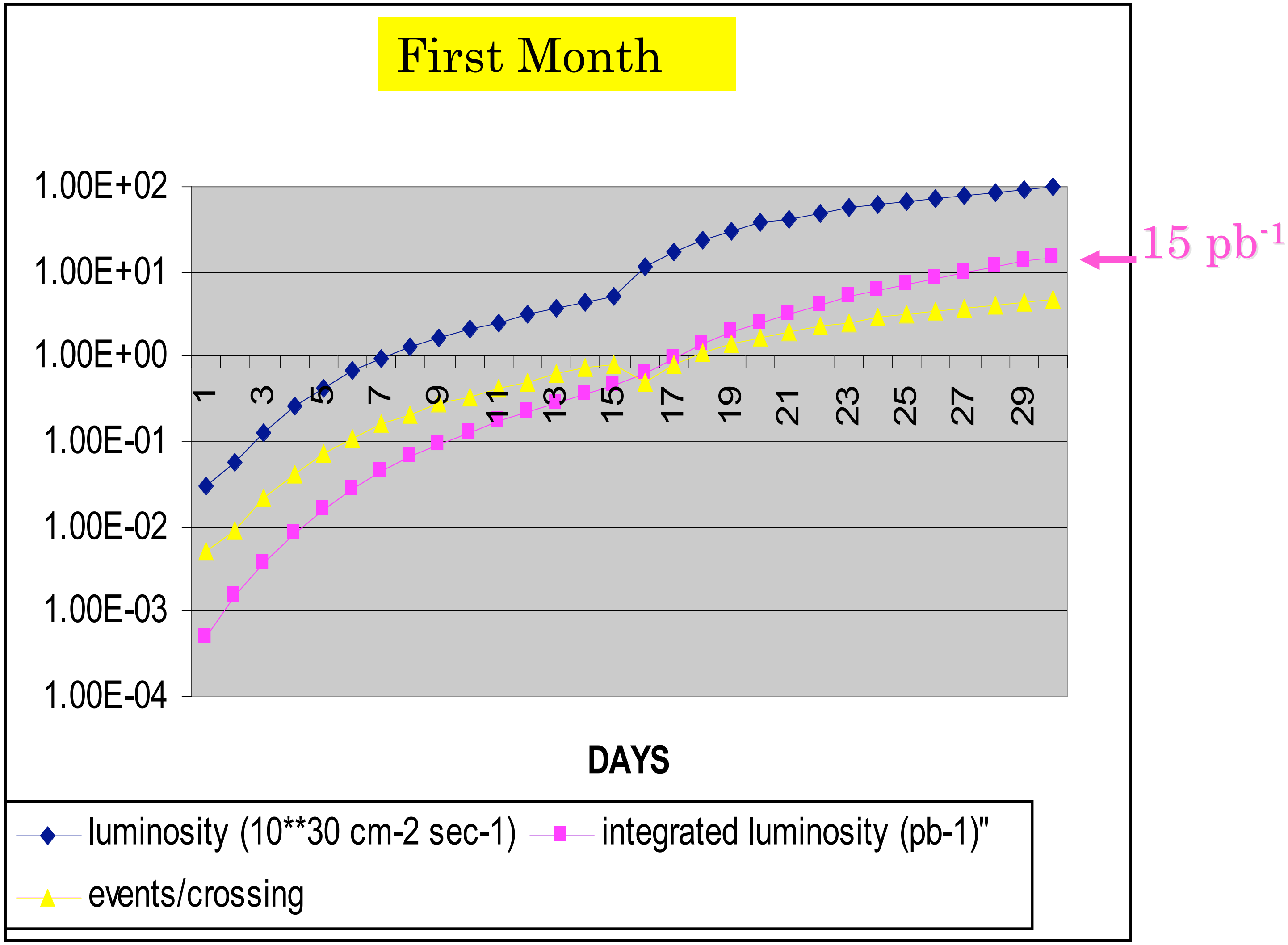
Phase		Beam time [days]	Beam
A.1	Injection and first turn	4	1 x pilot
A.2	Circulating beam	3	1 x pilot
A.3	450 GeV: initial	3	1 x pilot++
A.4	450 GeV: optics	4	1 x pilot++
A.6a	2 beam operation	1	2 x pilot++
A.6b	Collisions	1	2 x pilot++ →
		16	

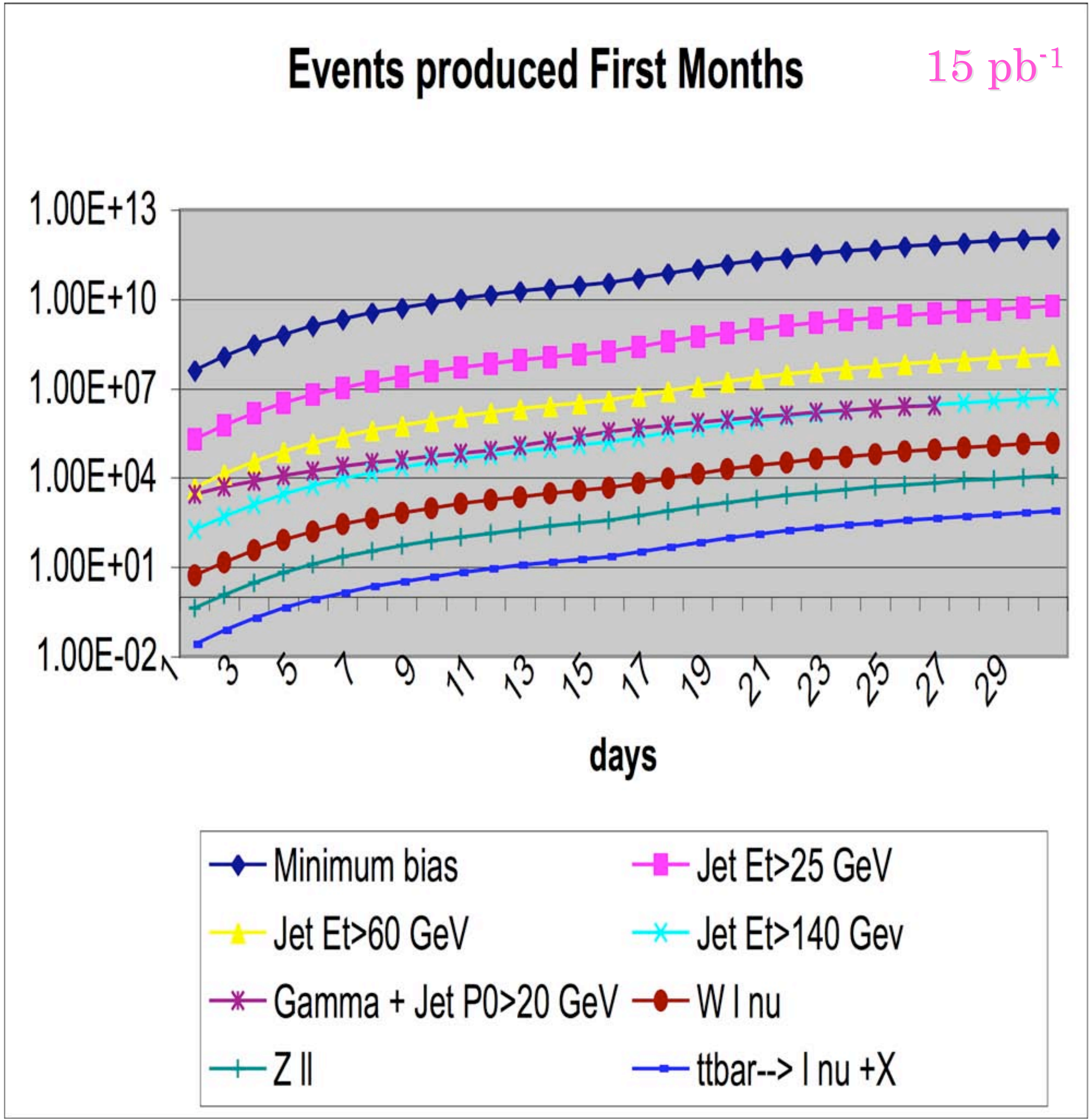
The engineering run i.e. few days at L= 10^{29}



The first Month

Efficiency = 20%





Eff jets =1

Eff W = 0.3

Eff Z = 0.5

Eff ttbar = 0.06

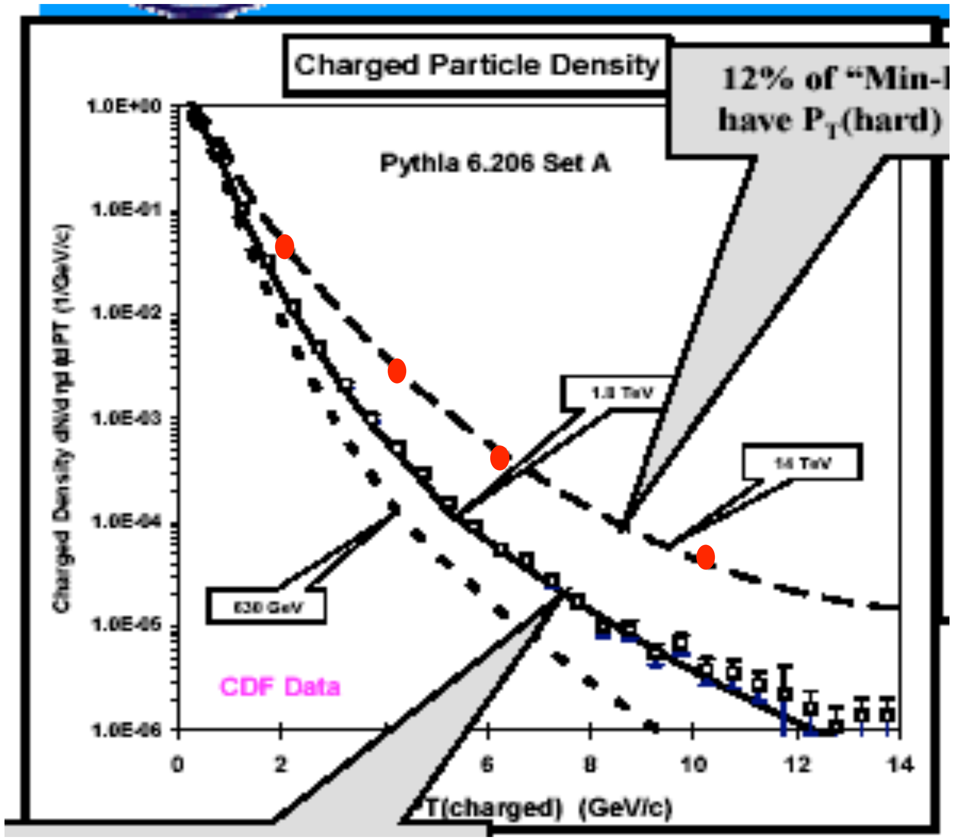
Minimum Bias Events

- Produced at very large rate since day1 5 kHz (0.01/bc)→ 500 kHz (1/bc)

- Almost possible to trigger random but scintillator plane would be very useful

- Can be acquired at high rate > .5kHz

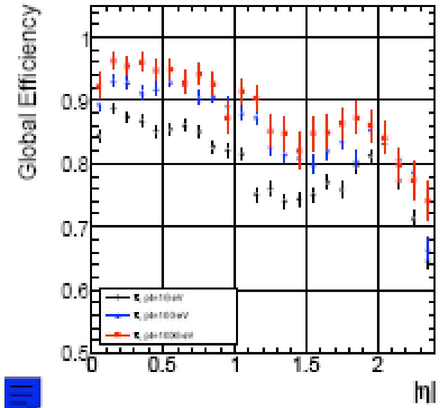
Minimum bias

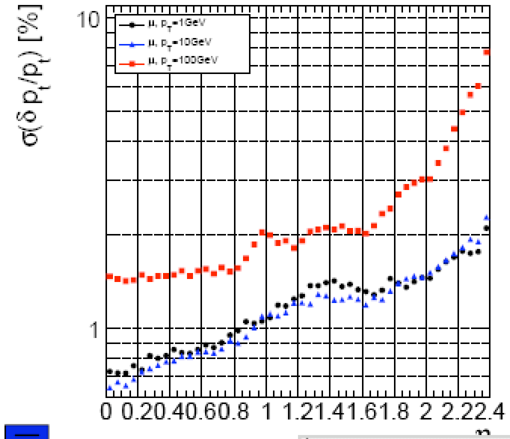


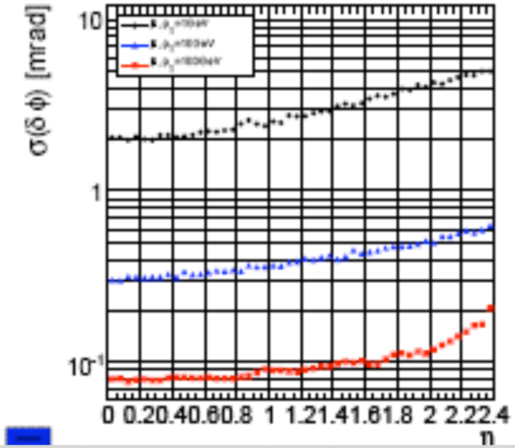
Low average Pt ~ 0.7 GeV/c

Low occupancy in the tracker

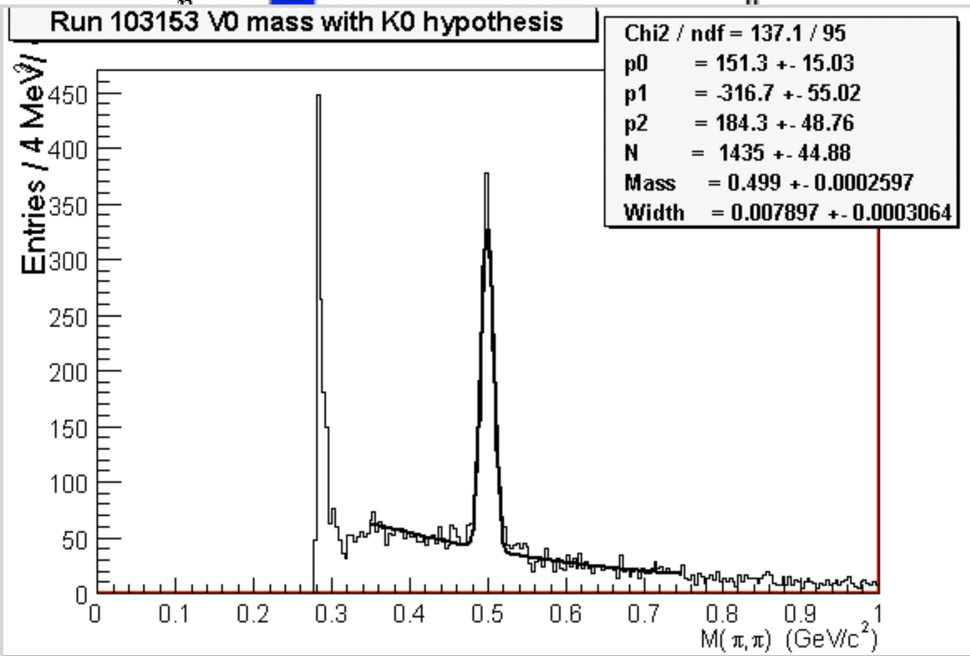
12 particles/event in the barrel (same number in the forward). 50% of them curl in the Tracker and 50% reach the outermost tracking layers (CMS)







1 GeV pions are reconstruct
momentum resolution and 2

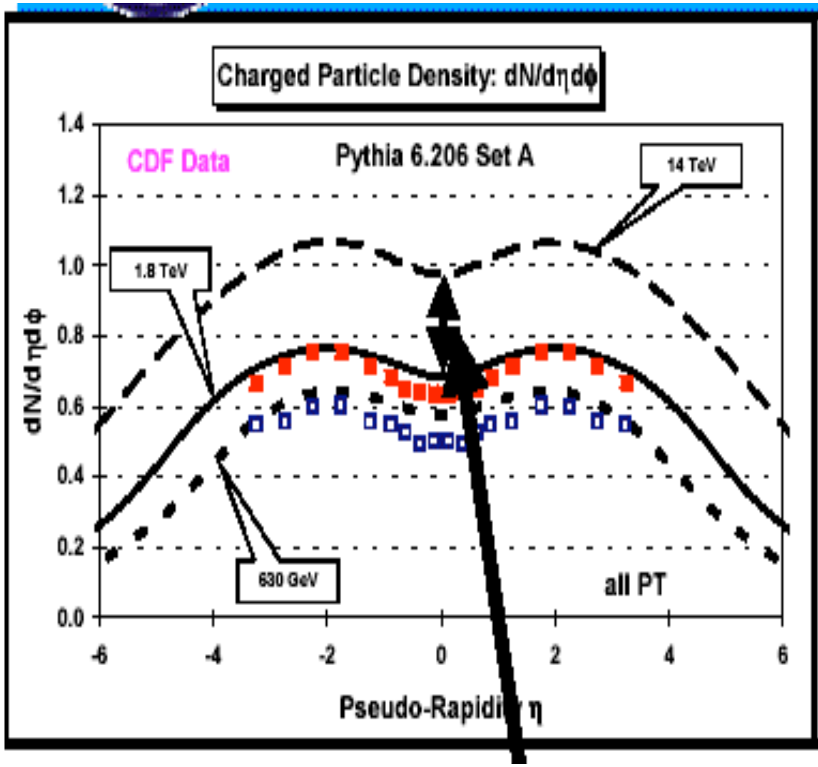


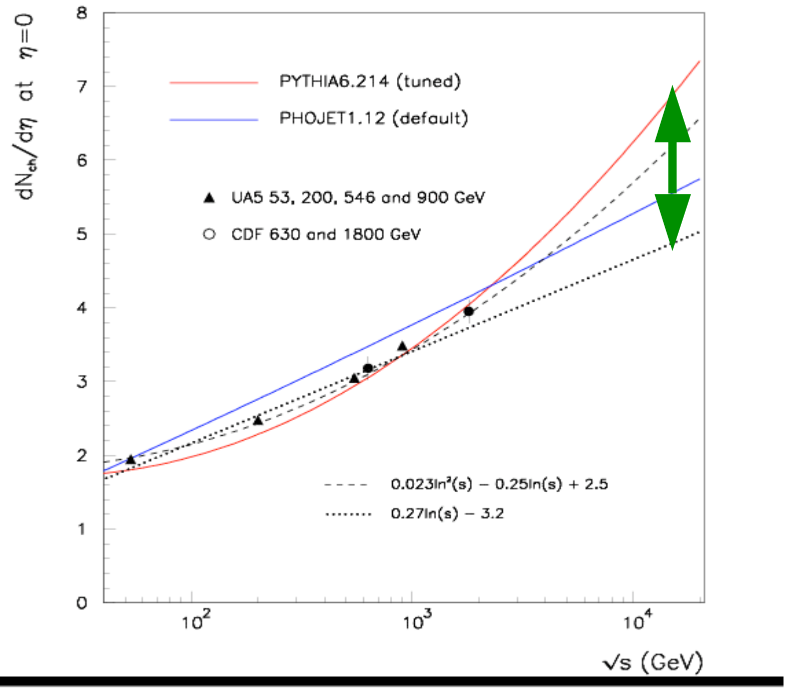
K0 mass peak for K0 decayi
with 1–2 % resolution.

Look at the bias in the mass
magnetic field description (a

Statistics limited only by DAQ and storage capacities

Minimum bias

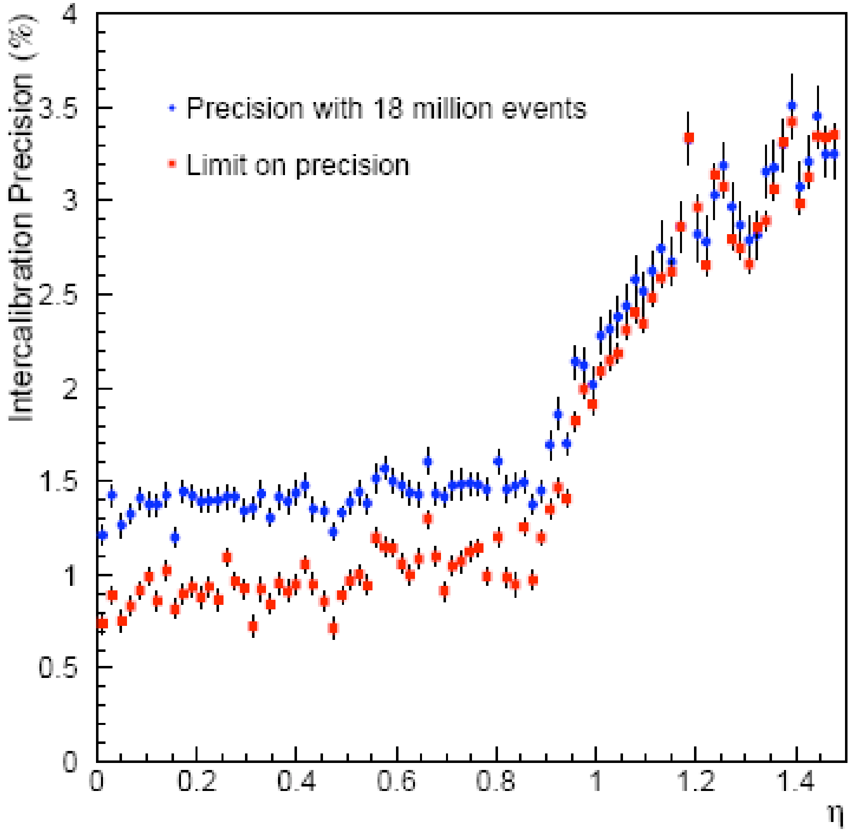




Need to measure charged particles in the tracker – no alignment needed since <pt> = 0.7 GeV …. But GOOD UNDERSTANDING OF TRACKING EFFICIENY AT LOW MOMENTA will be a challenge

Need to measure very early since very soon rate goes to 1 event per bunch crossing

Minimum bias – Ecal intercalibration

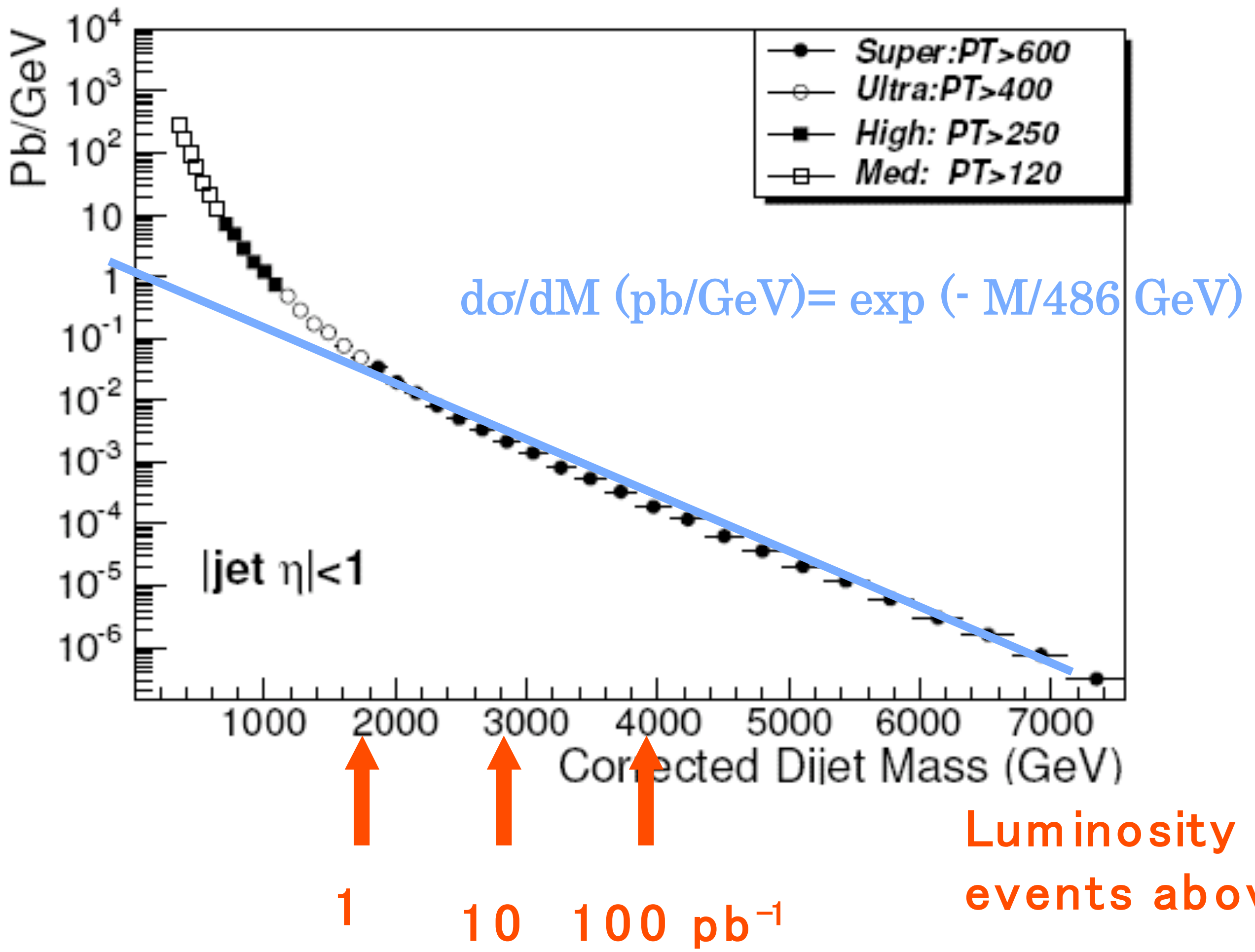


At 0.5 kHz 18 millions minimum bias events are collected in 10 h of data taking.

Similarly for HCAL

Dijets

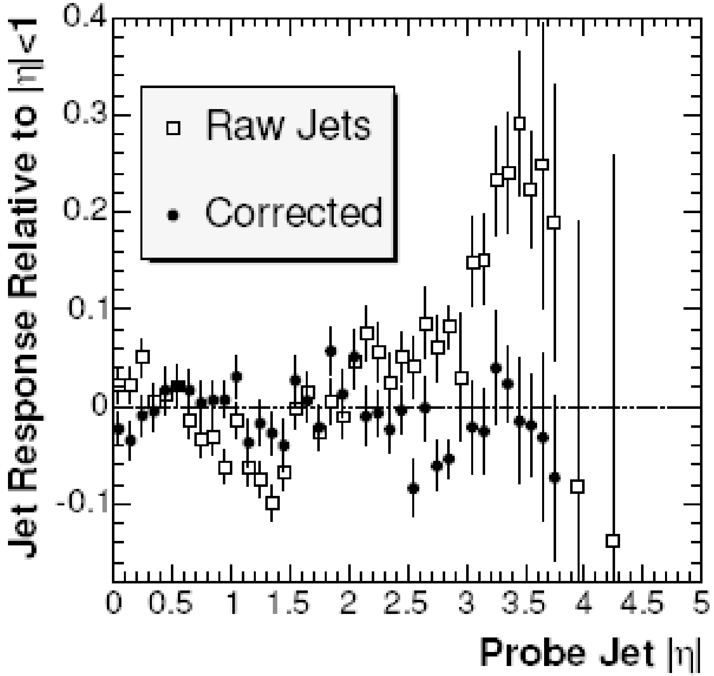
◆Produced at high rate can be recorded at rate lager than 100 Hz. Physics interest is in the high mass tail.

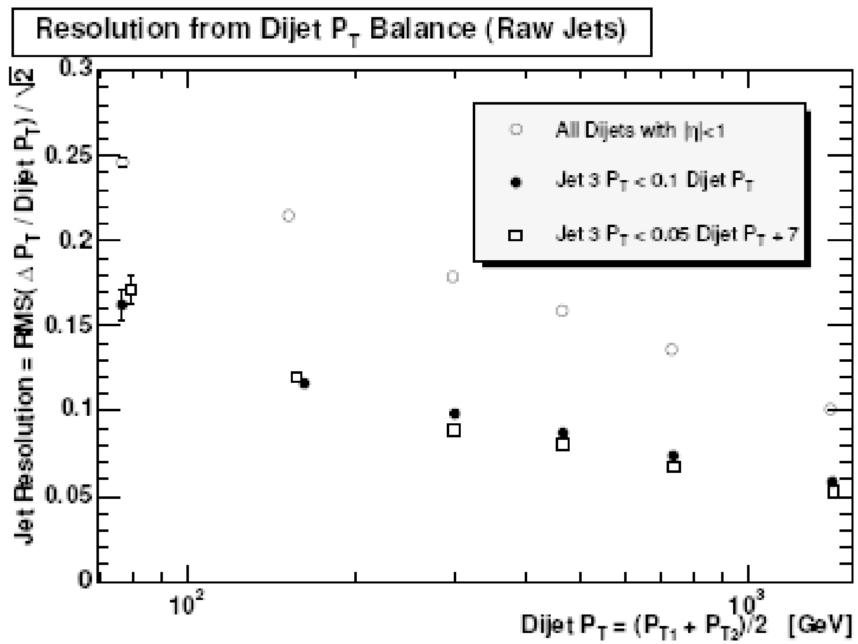


Di-Jet resonances ?

Calibrations ?

Jet Calibration with dijet balancing





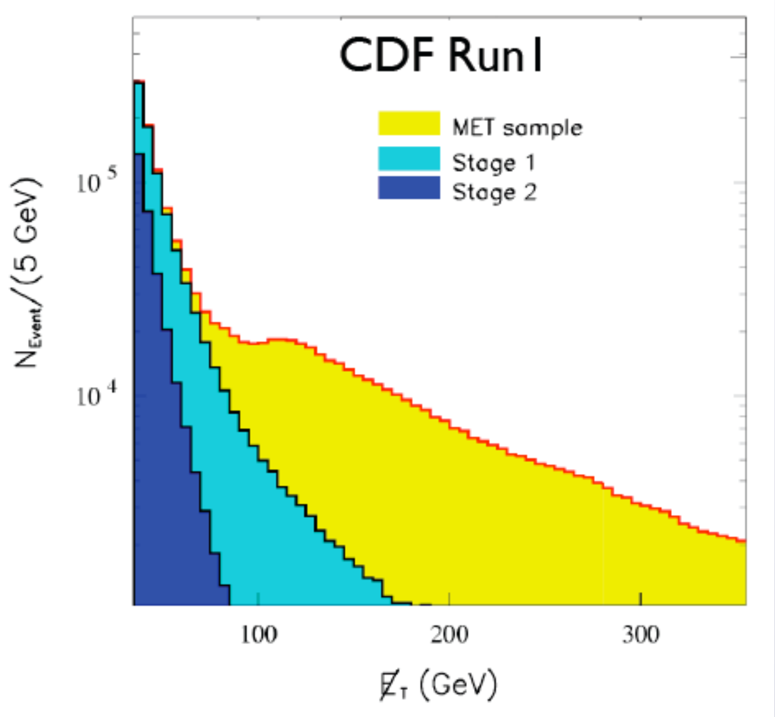
R. Harris AN 05/034

- We can quickly equalize at "low Et" and then we run out of statistics
- One must assume equalization holds at higher energy (but data vs MC needed for this)

How can we use Dijets for detector calibration?
QCD and Fake Missing E_T

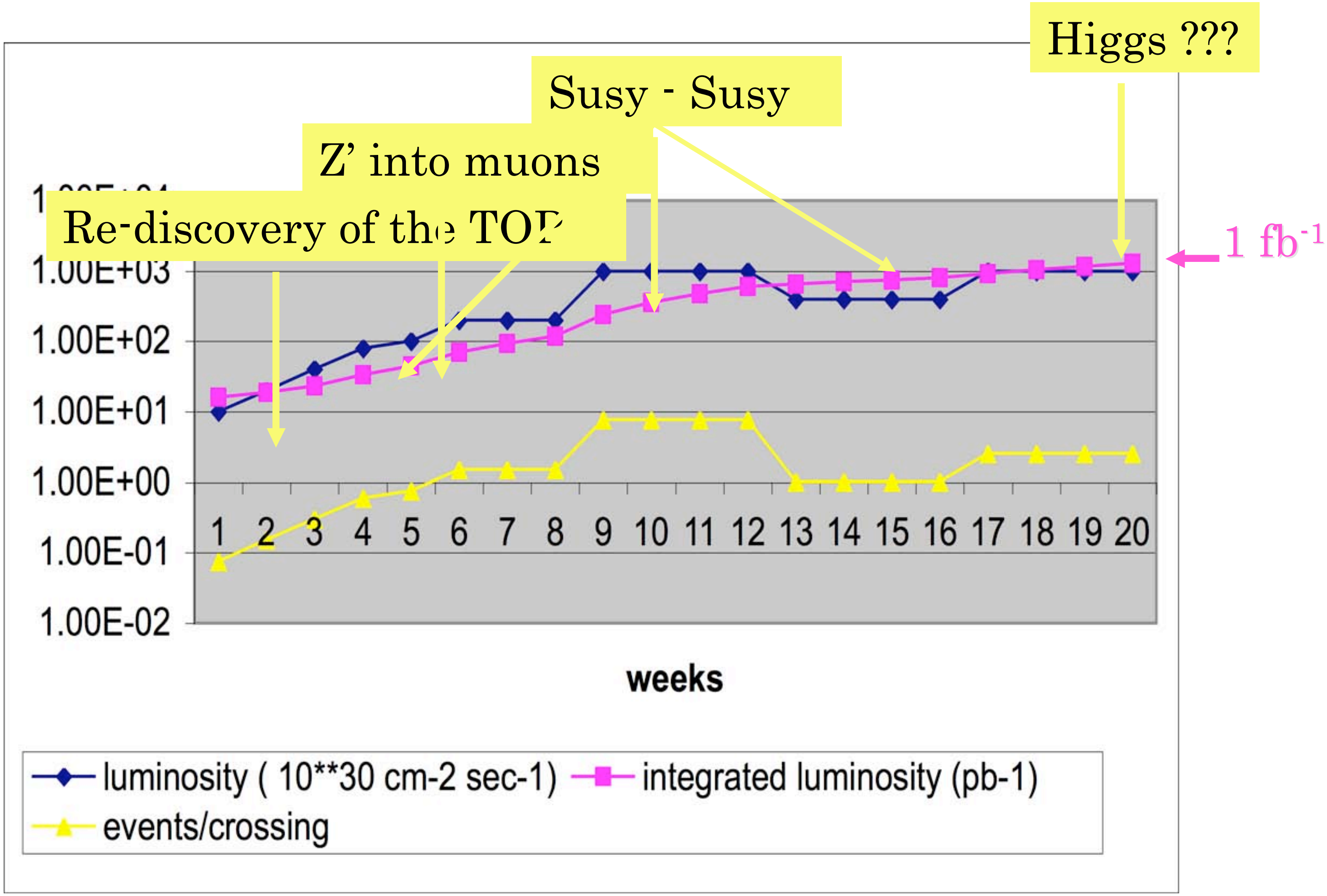
- Caused by lack of detector hermeticity, dead channels, non-gaussian tails to jet energy distributions (high tail from pile-up, low tail from dead material, punch-through etc.)
- Hardest background to estimate.
  - Simulations require detailed understanding of detector performance (not easy with little data).

This will be the challenge !



The first Year

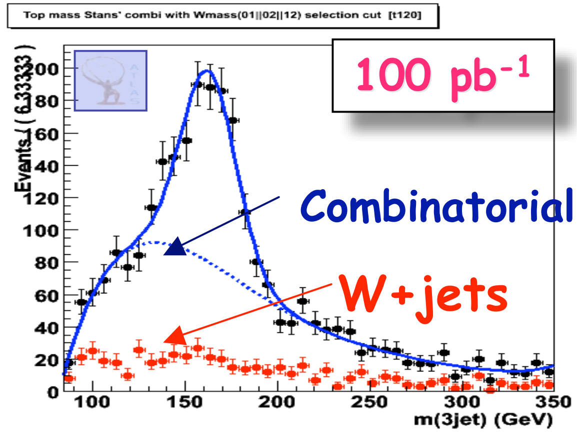
Efficiency = 20%



LHC Top Physics: day one

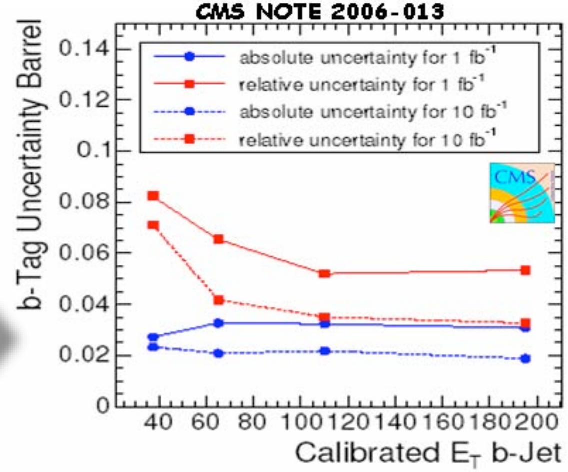
1) Top properties and basic SM physics at $\sqrt{s}$ =14 TeV

- Estimate of σ_{top} ~ 20% accuracy
- Start to tune Monte Carlo
- Measure m_t ⇨ feedback on detector performance
- Top decay properties



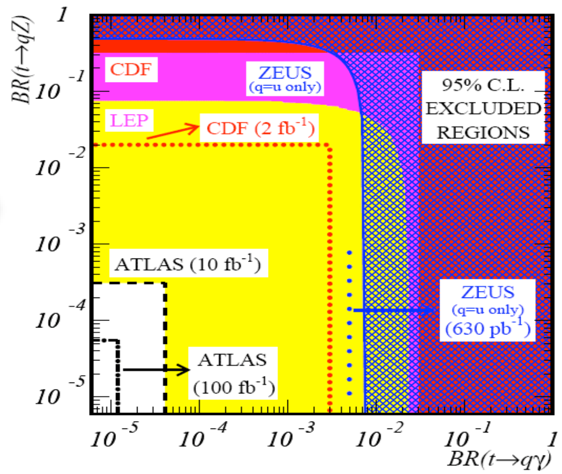
2) Understand/calibrate detector tt → blνbjj

- Light jet energy scale from W →jj, (< 1%)
- b-tag efficiency (~ 5%)
- Missing energy calibration



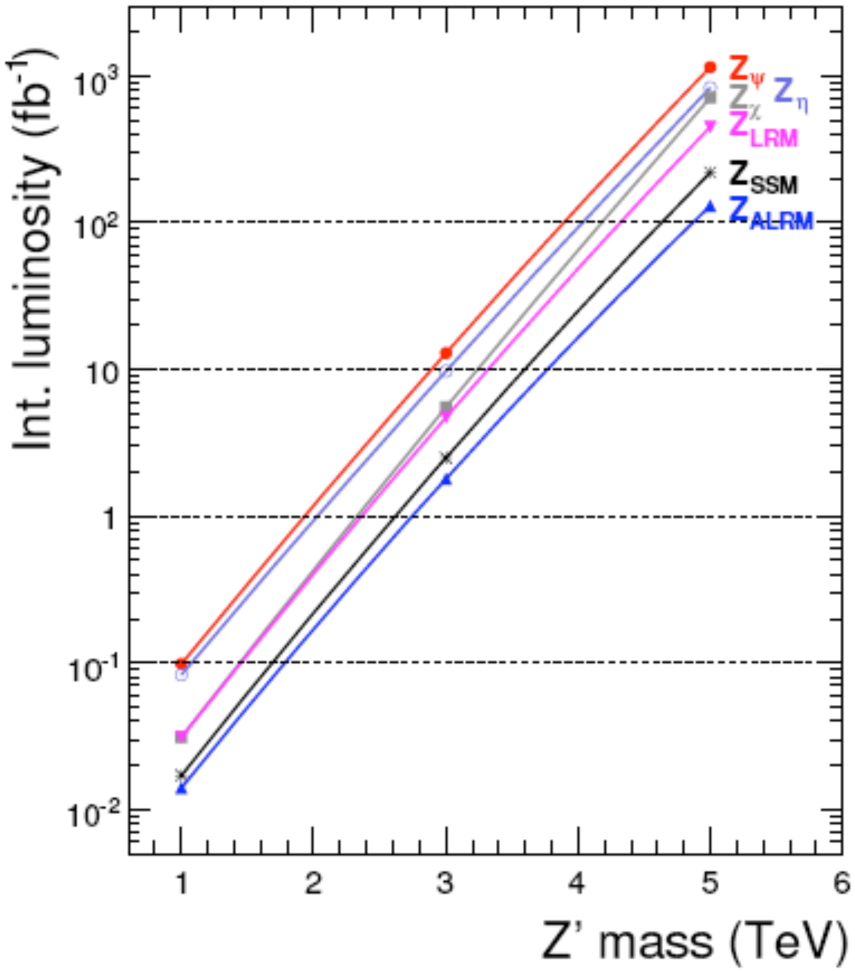
3) Prepare for new physics:

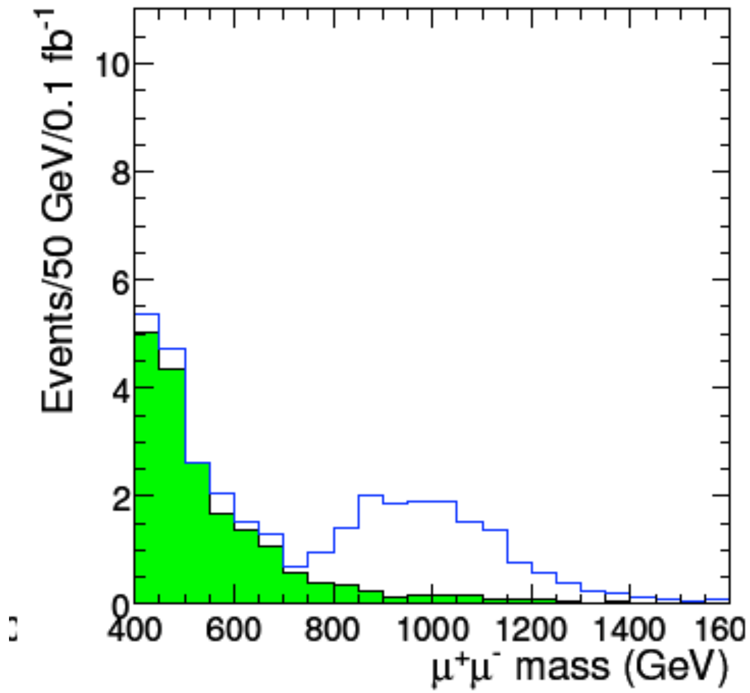
- Resonances, MSSM higgses, SUSY, FCNC
- Measure differential cross sections ($d\sigma/dp_T$, $d\sigma/dM_{tt}$) sensitive to new physics



Courtesy : P. Ferrari

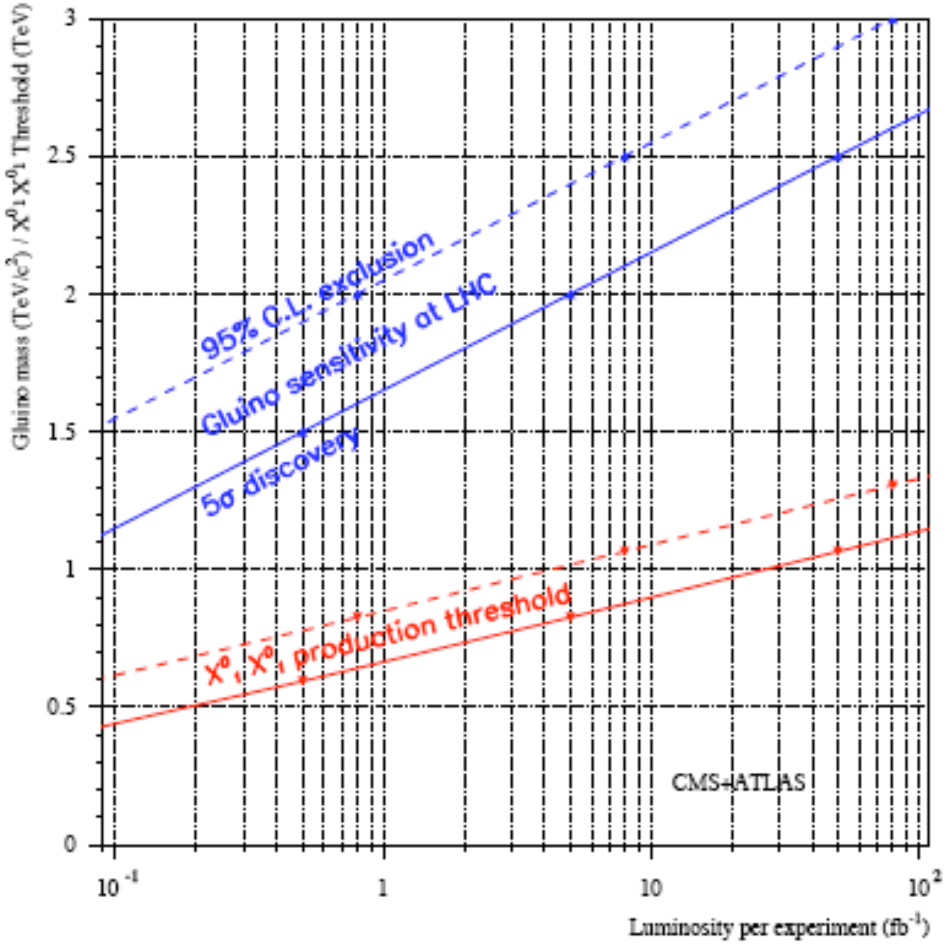
Z' resonances





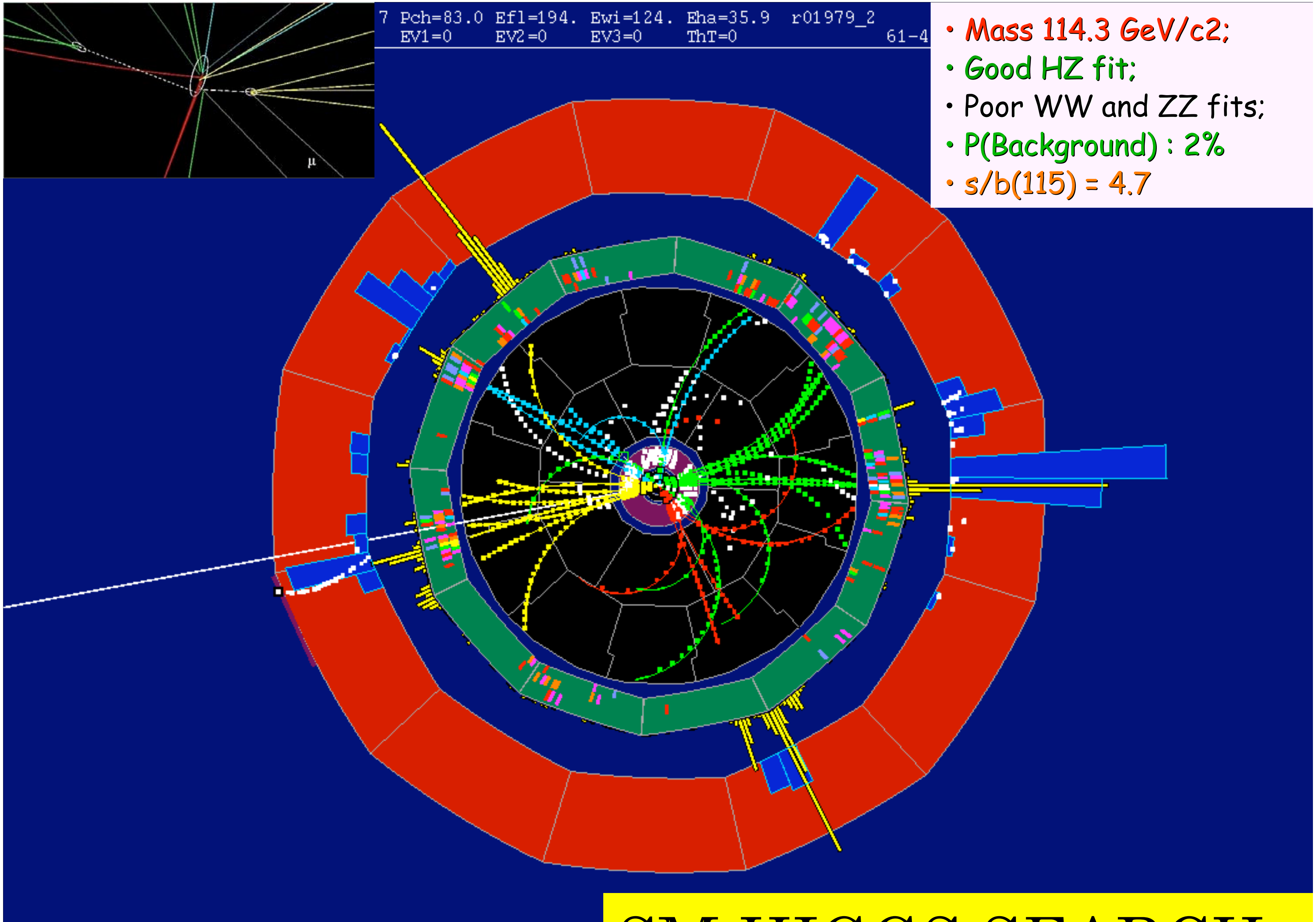
Initial alignment scenario

Super Symmetry



The reach for gluino detection at LHC as a function of the (calibrated !) integrated luminosity per experiment

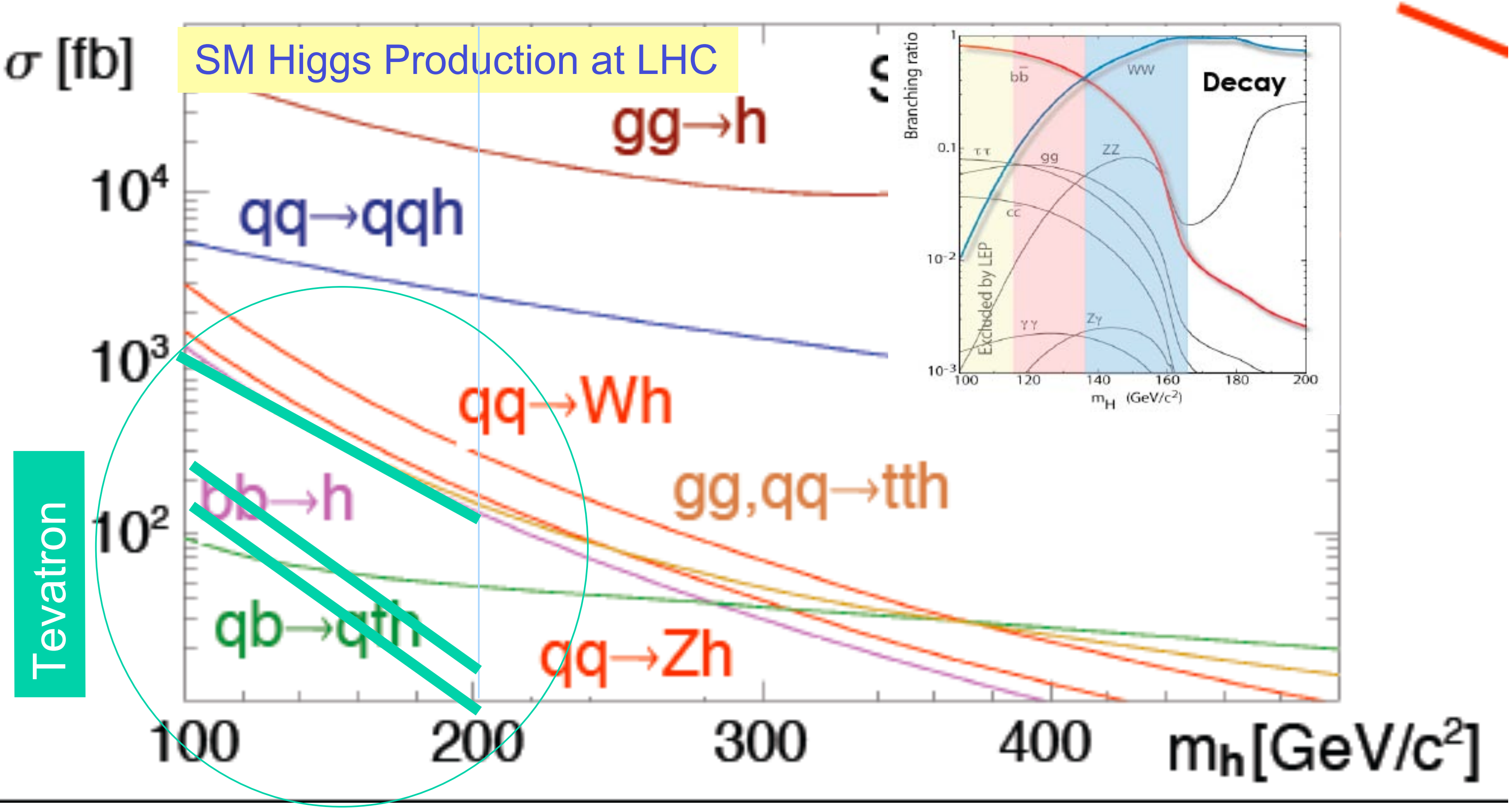
JJ Blaising et al input 54 at council-strategygroup.web.cern.ch/council-strategygroup



- Mass 114.3 GeV/c2;
- Good HZ fit;
- Poor WW and ZZ fits;
- P(Background) : 2%
- s/b(115) = 4.7

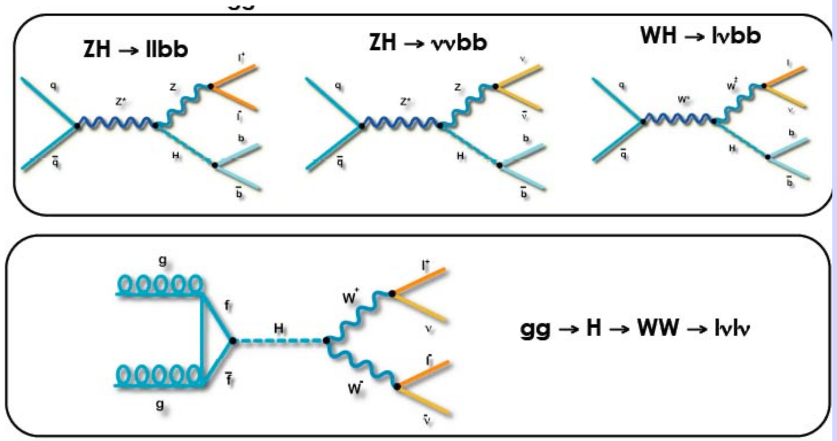
SM HIGGS SEARCH

SM Higgs Production X-section TeV/LHC



Channels in Higgs Search

Tevatron

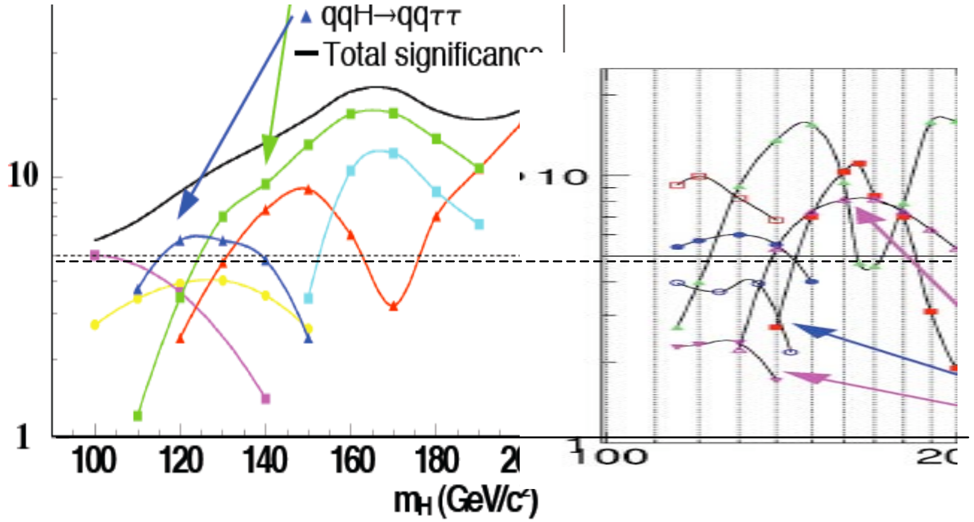


Very small rate : concentrate on channels with high Higgs Br

Significance 30 fb-1

ATLAS

CMS



Large Rate: signals with smaller BR

Atlas : qqH--> qqWW, qqττ

Atlas: H-->ZZ,WW,γγ

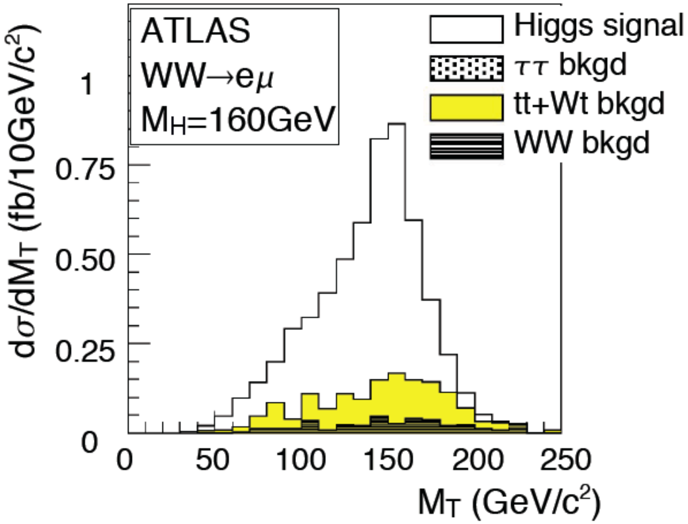
CMS: H--> γγ , ZZ, WW

CMS: qqH--> qqττ,qqγγ

Number of Events in 1 fb-1

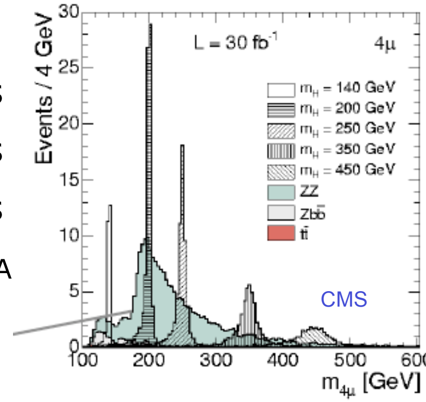
Tevatron

	Produced	Selected	Background
ZH-->llbb	5	1	100
ZH-->ννbb	15	2	300
WH-->lνbb	30	3	500
H-->WW-->llνν	20	4	300



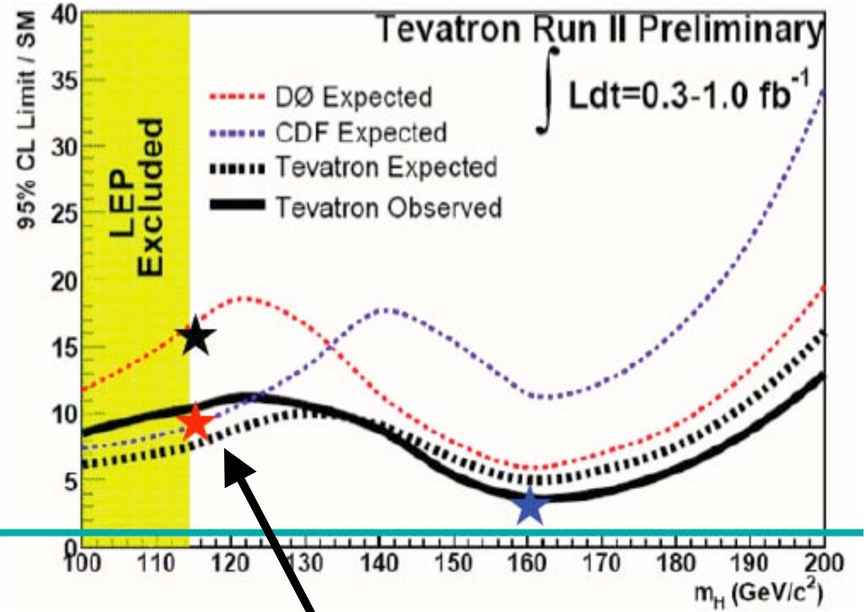
LHC

	Produced	Selected	Background	
H(135)-->γγ	86	30	300	CMS
H(140)-->ZZ*-->llll	13	3	500	CMS
H(160)-->WW-->llnn	2300	45	30	CMS
qqH(160)-->qqWW-->qqllnn	280	4	1	ATLA



SM Higgs at the Tevatron

Analysis	CDF limit ($1fb^{-1}$) factor above SM observed (expected)	D0 limit ($1fb^{-1}$) factor above SM observed (expected)
ZH → νν bb @ 115 Technique: M_{jj}	16 (15)	40 (34)*
WH → lν bb @ 115 Technique: M_{jj} Technique: ME	26 (17)	★ 10 (9) ★ 13 (10)
ZH → llbb @ 115 Technique: NN2D	★ 16 (16)	33 (34)
H → WW → lνlν @ 160 Technique: ΔΦ (l,l) Technique: ME	9 (6) ★ 3.5 (5)	4 (5)

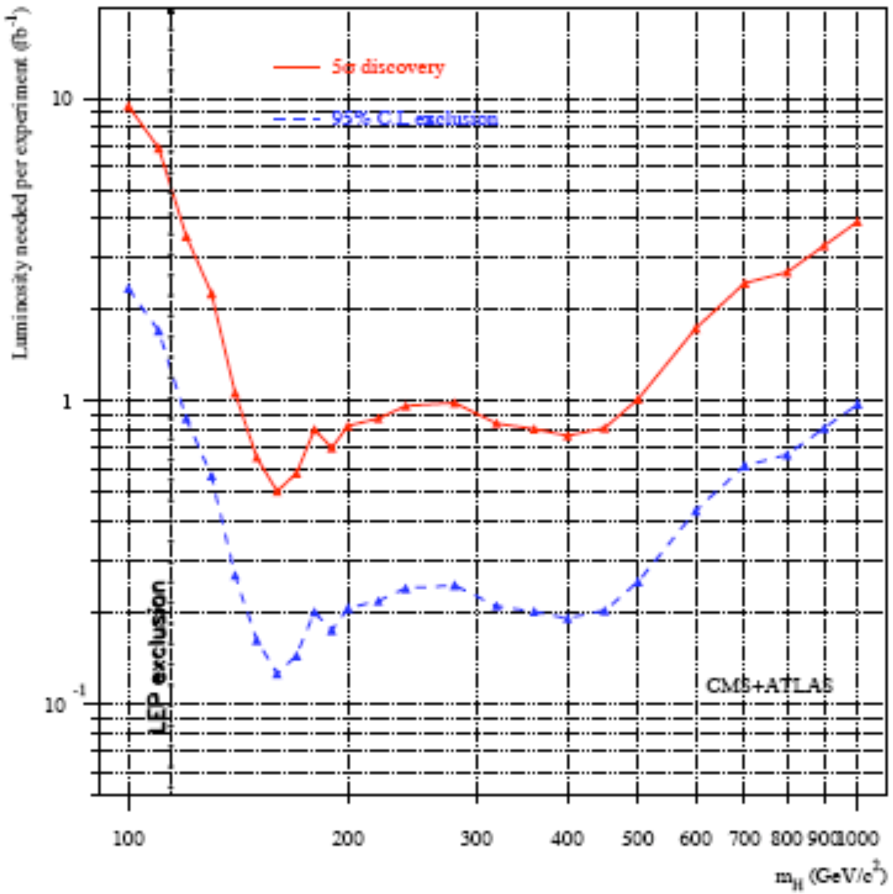


★ ★ ★ not included in the plot

How To Extrapolate to 8 fb-1 ?

WATCH AT THE EXCESS

SM Higgs @ LHC

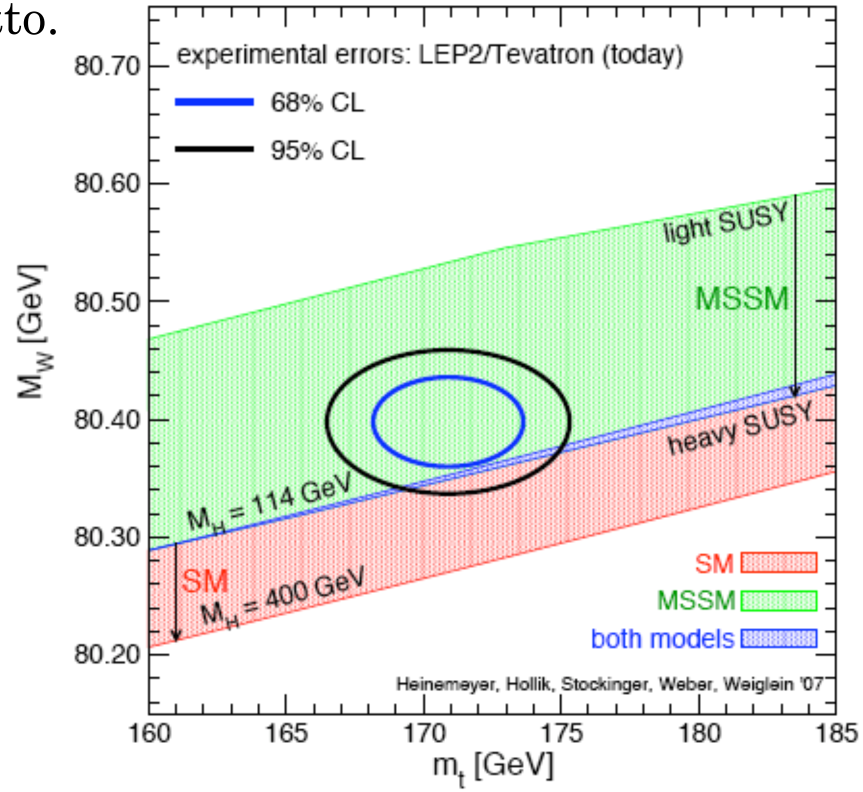


Integrated (and calibrated) luminosity per experiment as a function of the Higgs mass needed for a 5 σ discovery or 95% exclusion

JJ Blaising et al input 54 at council-strategygroup.web.cern.ch/council-strategygroup

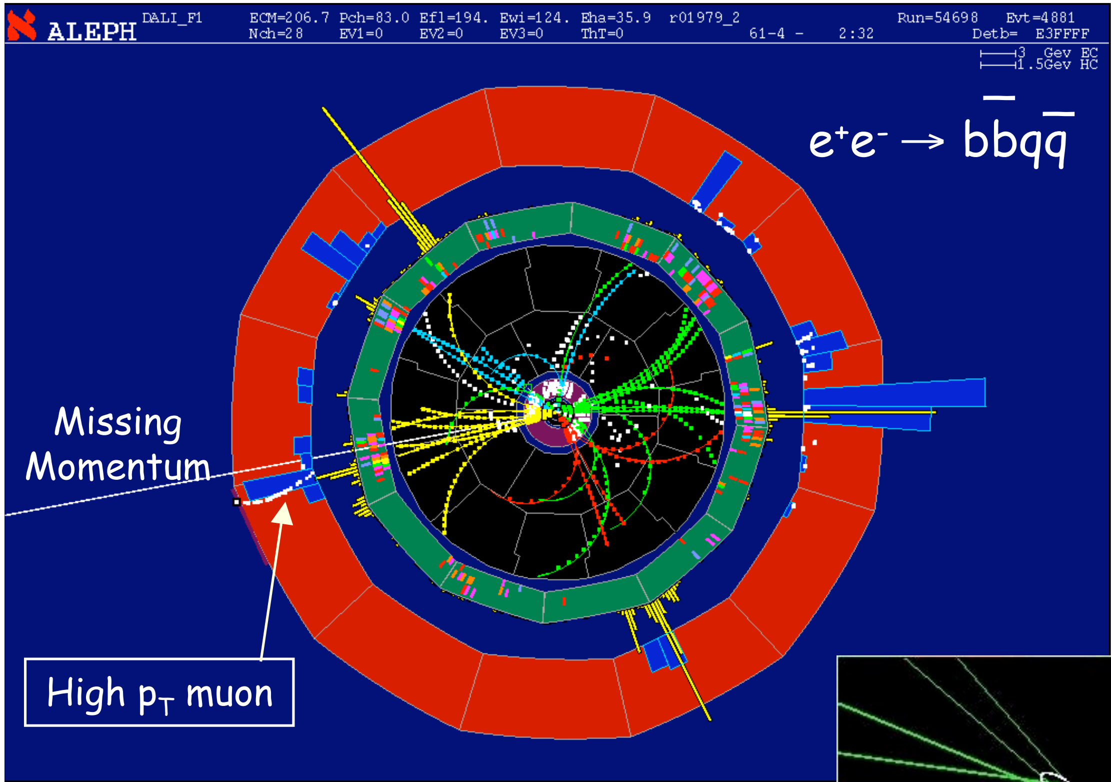
Conclusioni

- Tutti (o quasi) stiamo aspettando con ansia la partenza di LHC
- Gli avanzamenti nell'ultimo anno sono stati eccezionali
- Le molte review non sempre garantiscono la qualita'
- La qualita' dei sottorivelatori testati con i cosmici a fine costruzione e' migliore delle aspettative
- La lunghezza del periodo del periodo di costruzione e la meta vicina ci fanno dimenticare quanto complesso sia il tutto.



- Ma l' Higgs e' davvero a 115 GeV ?

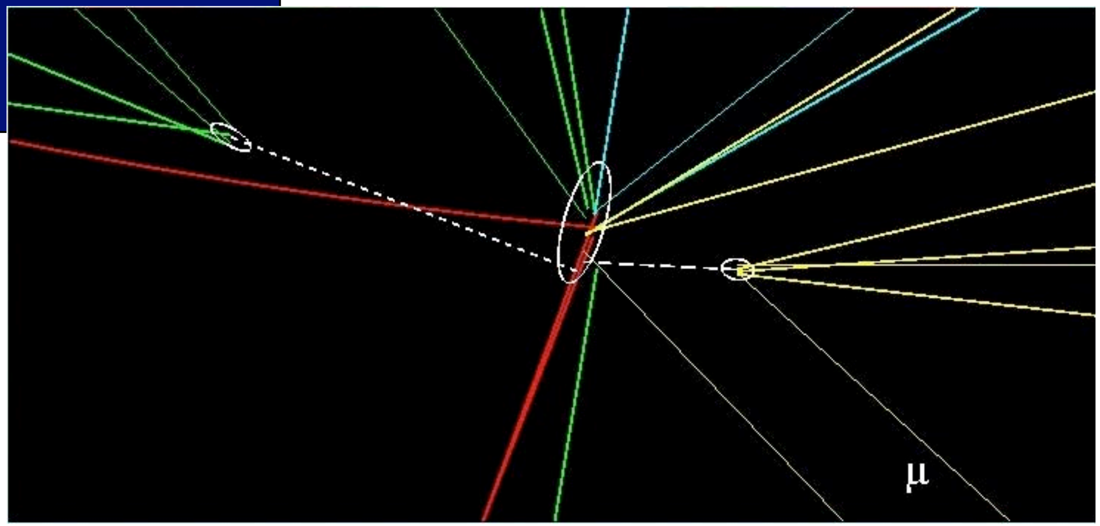
First pb^{-1}'s above 206 GeV:
First thrills at 115 GeV/c^2



First Candidate Event
(14-Jun-2000, 206.7 GeV)

- Mass 114.3 GeV/c2;
- Good HZ fit;
- Poor WW and ZZ fits;
- P(Background) : 2%
- s/b(115) = 4.7

The purest candidate event ever!



b-tagging
(0 = light quarks, 1 = b quarks)

- Higgs jets: 0.99 and 0.99;
- Z jets: 0.14 and 0.01.