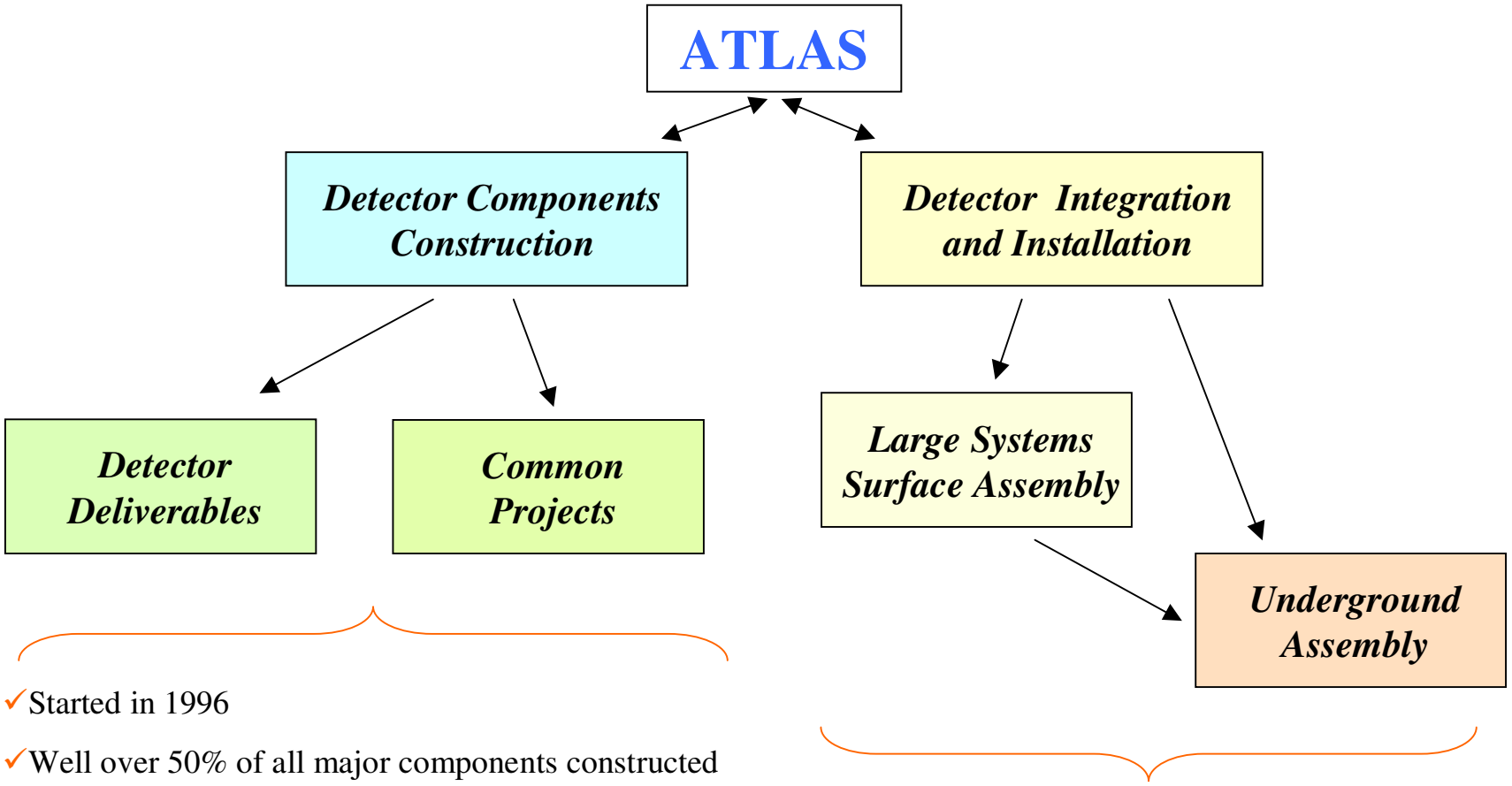
ATLAS and CERN/ST

2nd April 2003

Marzio Nessi

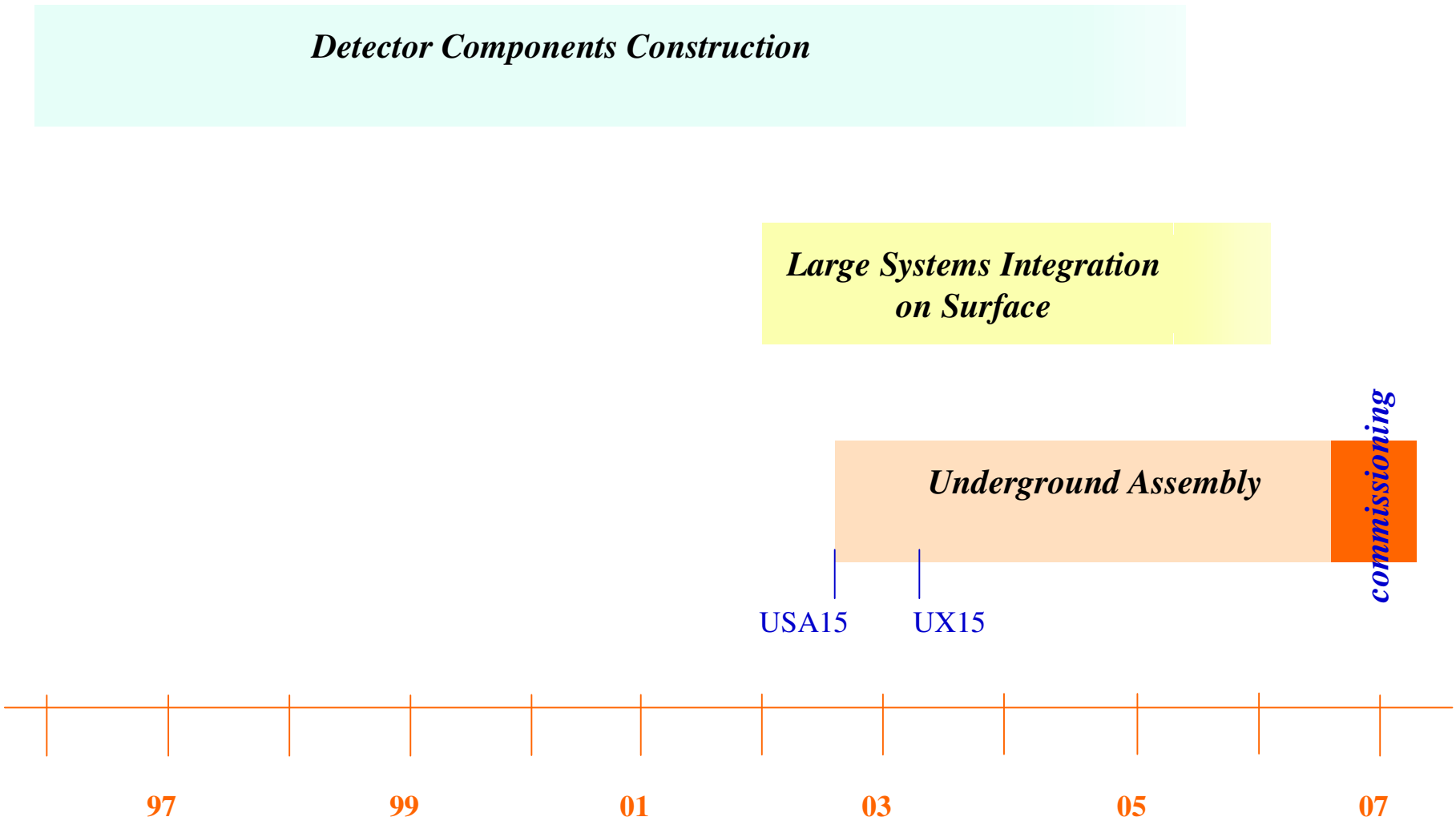
Today ATLAS project



- ✓Started in 1996
- ✓Well over 50% of all major components constructed
- ✓Some sub-detectors (like calorimeters) almost finished
- ✓Mid 2004 most of the components will be available
- ✓Construction schedule with 4 months installation float

- ✓*Started in 2002*
- ✓*Calorimeters preassembly on surface well advanced*
- ✓*Toroids integration at CERN advanced but critical*
- ✓*Area infrastructure on surface well advanced*
- ✓*Underground installation (USA15) started*

ATLAS Project Schedule



Large Systems Preassembly

Today at CERN (bldg 180, 185, 175, 191,…) we are assembling on the surface:

- ✓ *LAr Calorimeters (1 Barrel + 2 Endcaps)*
- ✓ *Tile Calorimeters (1 Barrel + 2 Ext. Barrels)*
- ✓ *Barrel Toroid individual Coils (8)*
- ✓ *Barrel Toroid Endcaps (2)*

- Mechanical integration
- Cryogenics integration
- Electrical integration
- Functional tests

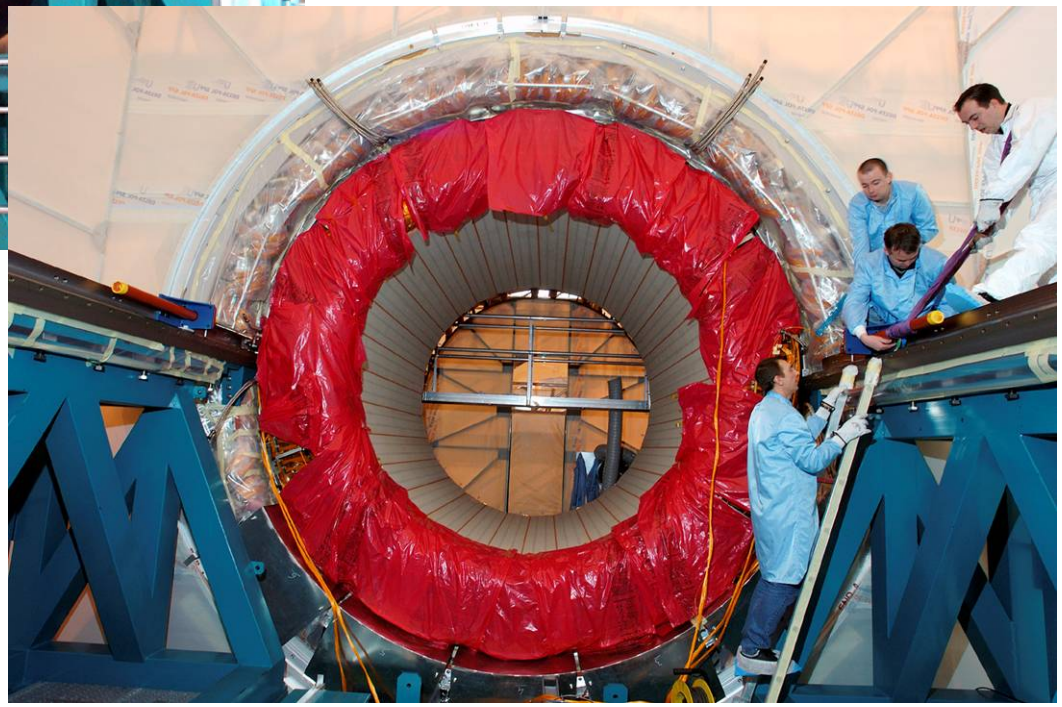
During 2003 at CERN (bldg BB5, SR1, 157,…) we will start the assembling and integration work for:

- Muon Spectrometer (Barrel and Endcaps)
- Inner Detectors (3)

Work mostly done with Collaboration Manpower (eng, phys and tecs) + CERN services (ST/HM, EST/SU, LHC/ECR,…)

First half EM Barrel Calorimeter Cylinder insertion : Bldg 180

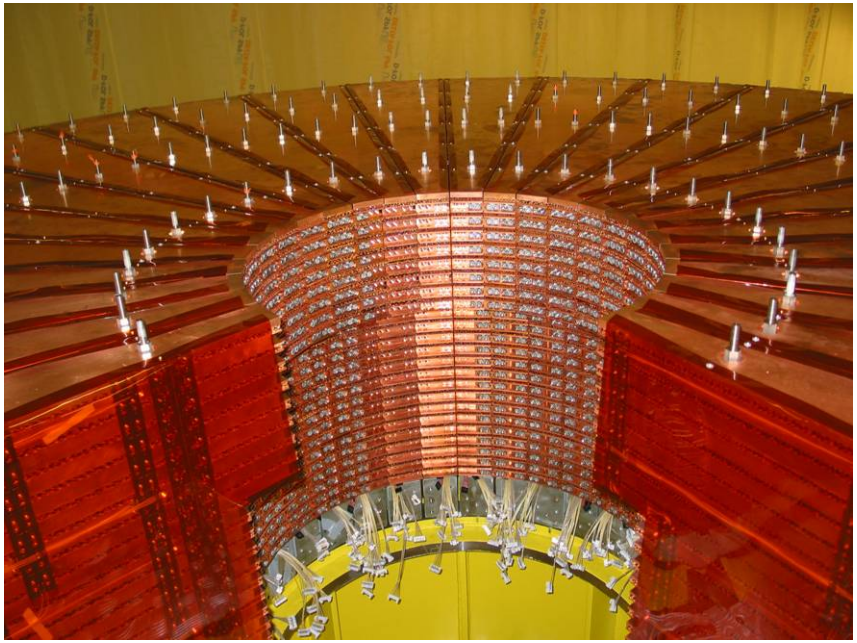
LAr EM half barrel in front of the cryostat



LAr EM half barrel after insertion into the cryostat

LAr hadronic end-cap calorimeters : Bldg. 180

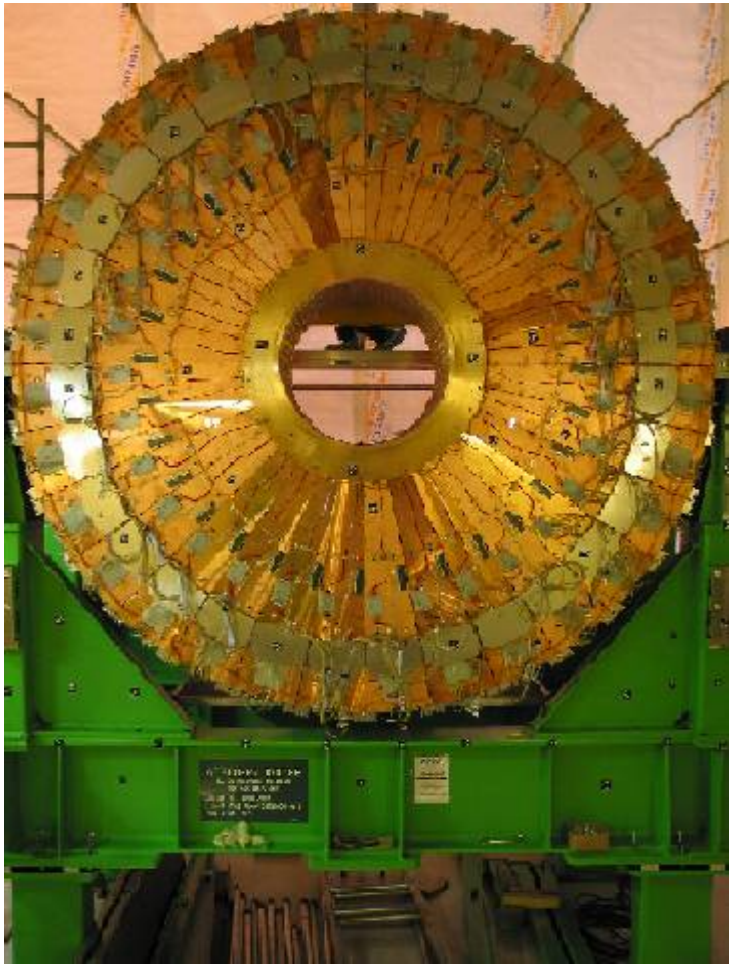
The LAr hadronic end-cap series production is completed, all 134 modules (including 6 spares) have been stacked



Assembly of the first HEC wheel (horizontal)

3 out of the 4 wheels are now pre-assembled and ready for insertion into the cryostat

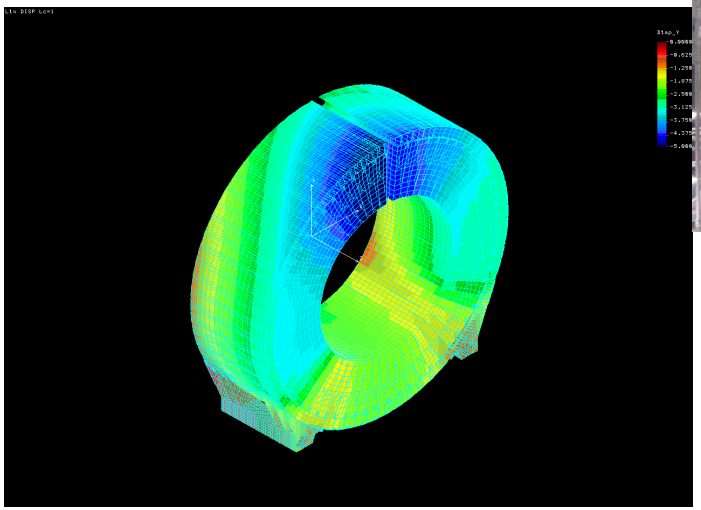
Insertion into the cryostat awaits the assembly of the first EM wheel (which has to enter first)



Assembled wheel in insertion stand (vertical)

Tile Calorimeter pre-assembly: Bldg. 185

Regular survey measurements are taken to compare actual and expected deformations during assembly of the cylinders



Pre-assembly of the first Extended Barrel, expected to be complete by end of April 2004

Central Solenoid: Bldg. 180

Solenoid field: 2T with a stored energy of 38 MJ

Cryogenics chimney tested in summer 2002

The solenoid is fully tested, and ready at CERN for integration into the common cryostat with the LAr barrel EM calorimeter by the end of 2003

Barrel Toroid Integration 1: Bldg 180

→ *2 cold masses ready*

→ cold mass #3,4 in preparation

→ *On schedule*

Barrel Toroid Integration 2 : Bldg 180

Cooling pipes inst.,Tie- rods, instrumentation : *ongoing coil 1&2*

Heat shields, insulation installation : *waiting for material*

Cryostats preparation : *just started*

Cryostat welding : *scheduled*

Cooling and B-tests : *first time: July 03-Sep03*

- Major problems of quality of cooling pipe welding just solved
- 3 months delay in the delivery of first Heat Shields

-> remains very critical, today just in time for installation

Encap Toroids : HMA (NL)

cold mass fabrication :

Web structures manufacturing 60% done

Pancake windings 8 of 16 done

First coil impregnated

The first of the two cold masses is expected to be delivered to CERN in October 2003, ahead of schedule

Endcap Toroids integration: Bldg 191

Heat shields

Installation of the super-insulation

The two vacuum vessels have been completed, delivered to CERN, and vacuum tested

They are being prepared to receive the cold masses

Production Concerns

Technical problems

→ ***See WWW top-worries list:***
http://atlas.web.cern.ch/Atlas/TCOORD/TMB/

- ✓ **Barrel toroid integration and coil tests (Heat shields,..)**
- ✓ **DMILL chips technology (6 types still in production)**
- ✓ **TRT on detector electronics boards (Webs, barrel PCBs)**
- ✓ **Production start-up of forward SCT modules**
- ✓ **TRT gas system**
- ✓ **TRT wheel assembly (schedule and resources)**
- ✓ **RPC chambers production**
- ✓ **Beam pipe activation**
- ✓ **Cables need timely procurement**

Schedule Concerns (components production)

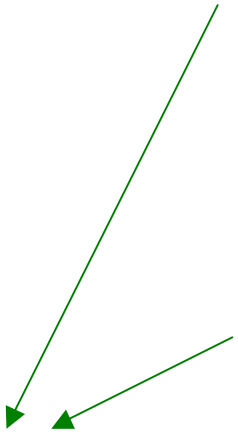
Production Schedule difficulties (with respect to ready for installation milestones = 4 months installation float)

Following system are using part of the 4-month float

- **ID Barrel:** **1.5 months (SCT 1.5 m, TRT 1m)**
- **ID Endcap C:** **2.0 months (SCT)**
- **ID Endcap A:** **4.0 months (SCT&TRT)**

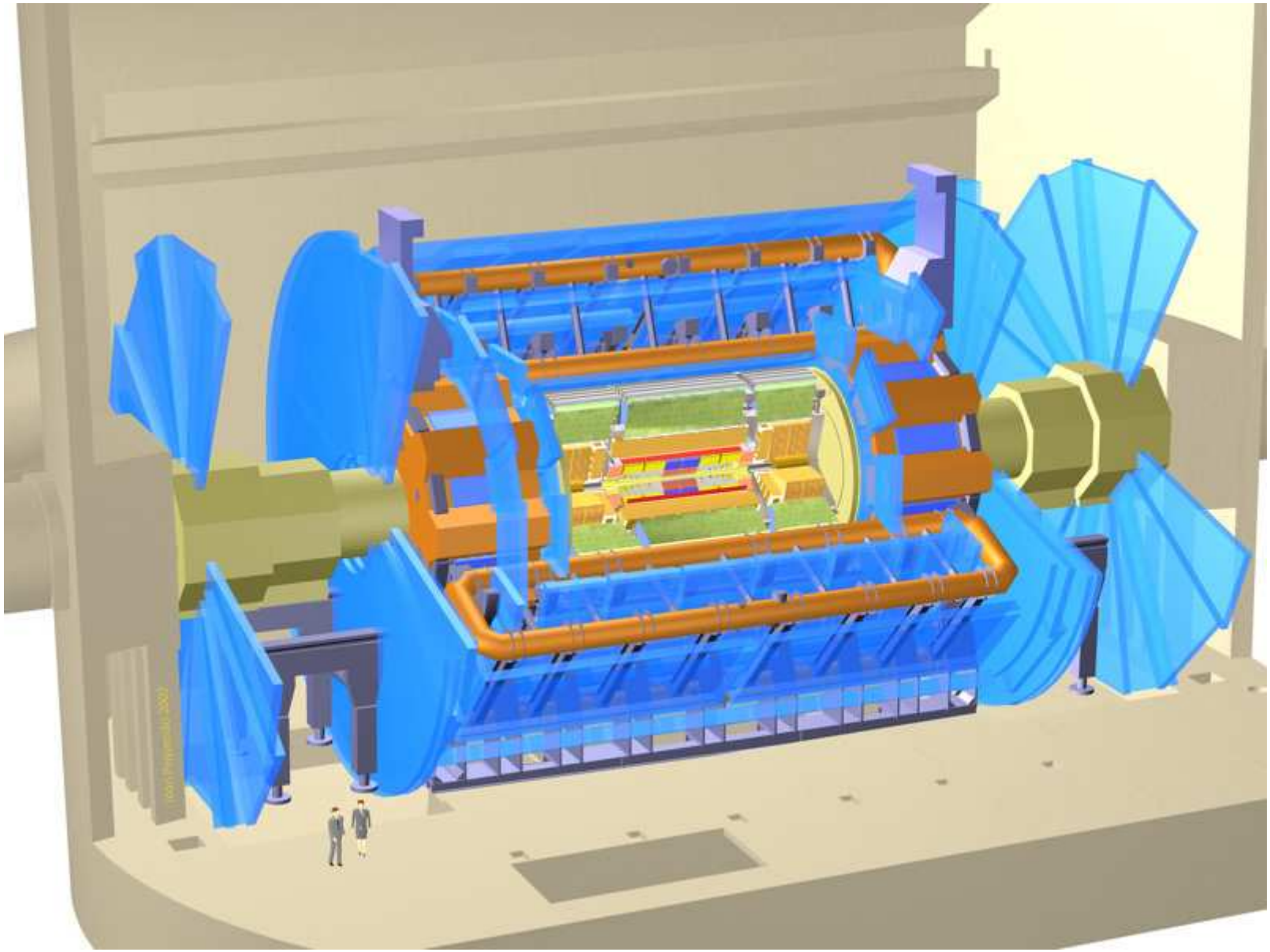
- **LAr Barrel:** **2.0 months**
- **LAr Endcap C:** **1.5 months**
- **LAr Endcap A:** **1.0 month**

- **Barrel Toroid:** **4.0 months (last 2 coils)**



Corrective actions to restore some of the installation time contingency will be investigated during summer 2003, when the entire production chain is fully understood!

ATLAS



Installation Constraints

- Starting mid April 2003, ST/CE will deliver an empty cavern for the ATLAS Detector: UX15.

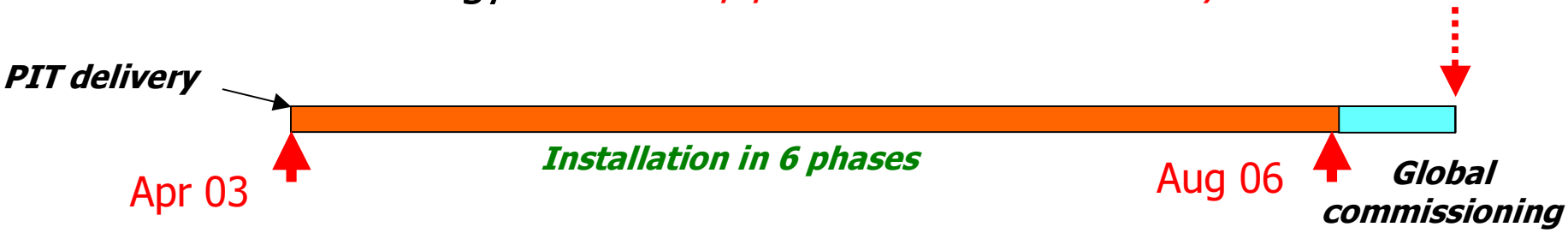
- For cost reasons in 1995 it was decided to have 2 access shafts instead of a very large one: *PX14 (diameter 18m) and PX16 (diameter 12.6m).*

- ATLAS will be lowered piece-by-piece and assembled 92 m underground during 3.5 years. The maximal weight allowed by the single surface crane is 280 tons. Underground we will have two 65-ton cranes.

- For cost reasons the surface building SX1 has been kept minimal, with just sufficient space to receive and lower down material. All necessary components will have to be delivered to POINT 1 in a "just-in-time" fashion. Space will always be a critical issue.

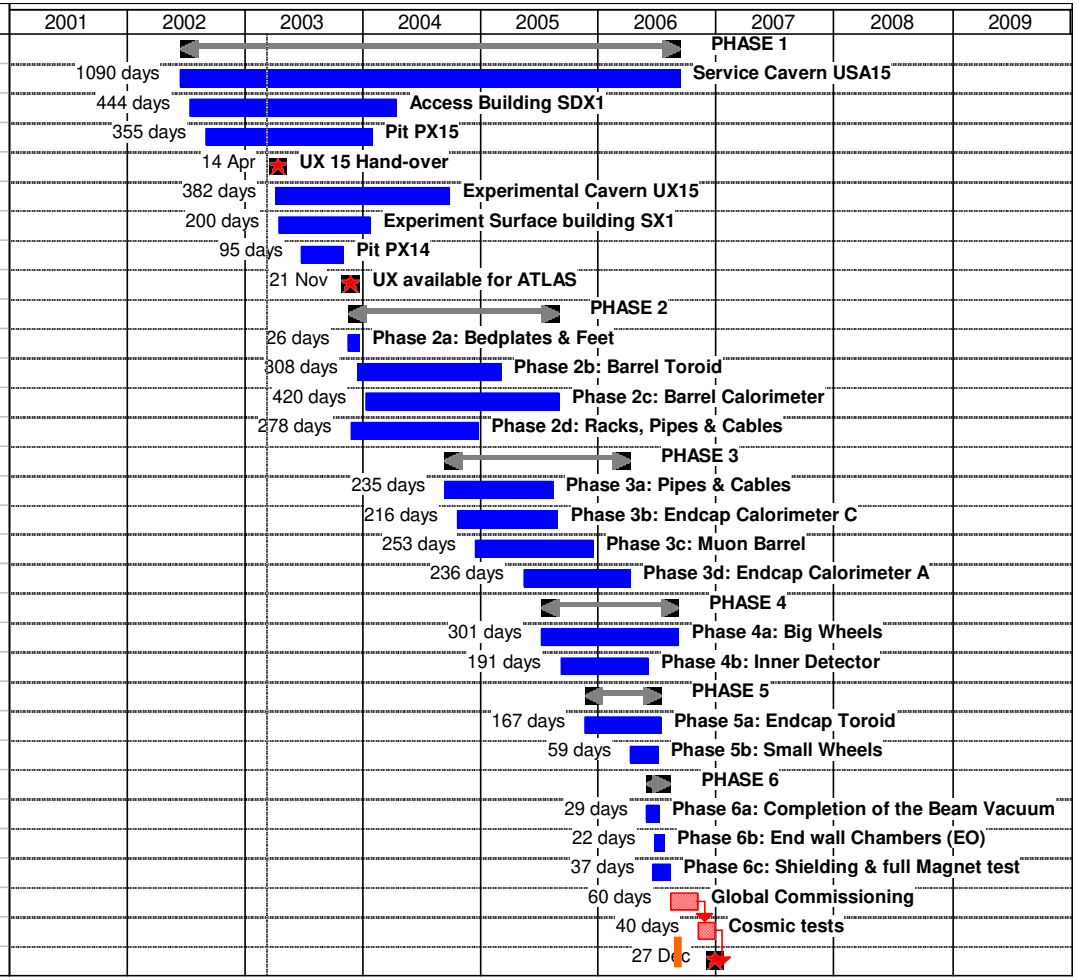
Installation in Phases

- ✓ 6 phases: - *Infrastructure*
  - *Barrel Toroid + Barrel Calorimeters*
  - *Barrel Muon Chambers + Endcap Calorimeters*
  - *Inner Detectors + Muon Big Wheels*
  - *Endcap Toroids + Muon Small Wheels*
  - *Vacuum pipe, shieldings, closing*
- ✓ For each phase:
  - Clear mandate and goals
  - Work organized in **Work Packages (WP)**
  - Functional tests as early as possible
- ✓ Schedule strategy : *vacuum pipe and detector closed by …….. Dec 2006*



Installation Schedule v. 6.0.5

Name	Start	Finish
PHASE 1: Infrastructure	10 Jun '02	8 Sep '06
Service Cavern USA15	10 Jun '02	8 Sep '06
Access Building SDX1	10 Jul '02	8 Apr '04
Pit PX15	2 Sep '02	28 Jan '04
UX 15 Hand-over	14 Apr '03	14 Apr '03
Experimental Cavern UX15	5 Apr '03	24 Sep '04
Experiment Surface building SX1	14 Apr '03	21 Jan '04
Pit PX14	23 Jun '03	31 Oct '03
UX available for ATLAS	21 Nov '03	21 Nov '03
PHASE 2: Barrel Toroid & Barrel Calorimeter	14 Nov '03	26 Aug '05
Phase 2a: Bedplates & Feet	14 Nov '03	19 Dec '03
Phase 2b: Barrel Toroid	12 Dec '03	28 Feb '05
Phase 2c: Barrel Calorimeter	9 Jan '04	26 Aug '05
Phase 2d: Racks, Pipes & Cables	24 Nov '03	20 Dec '04
PHASE 3: End-cap Calorimeters & Muon Barrel	7 Sep '04	5 Apr '06
Phase 3a: Pipes & Cables	7 Sep '04	9 Aug '05
Phase 3b: Endcap Calorimeter C	20 Oct '04	25 Aug '05
Phase 3c: Muon Barrel	14 Dec '04	9 Dec '05
Phase 3d: Endcap Calorimeter A	10 May '05	5 Apr '06
PHASE 4: Big Wheels & Inner Detector	6 Jul '05	31 Aug '06
Phase 4a: Big Wheels	6 Jul '05	31 Aug '06
Phase 4b: Inner Detector	5 Sep '05	30 May '06
PHASE 5: End-Cap Toroid & Small Wheels	17 Nov '05	10 Jul '06
Phase 5a: Endcap Toroid	17 Nov '05	10 Jul '06
Phase 5b: Small Wheels	7 Apr '06	28 Jun '06
PHASE 6: Beam Vacuum, End wall Chambers, Shield	24 May '06	7 Aug '06
Phase 6a: Completion of the Beam Vacuum	24 May '06	3 Jul '06
Phase 6b: End wall Chambers (EO)	21 Jun '06	20 Jul '06
Phase 6c: Shielding & full Magnet test	16 Jun '06	7 Aug '06
Global Commissioning	8 Aug '06	30 Oct '06
Cosmic tests	31 Oct '06	27 Dec '06
ATLAS Ready For Beam	27 Dec '06	27 Dec '06



Installation Considerations

- Complex installation sequence and assembly of many sub-components underground → logistical, safety, conflicts … issues.

- The Air-Core Toroid concept implies a major interference of components, access and services in a very large volume and inside the detector.

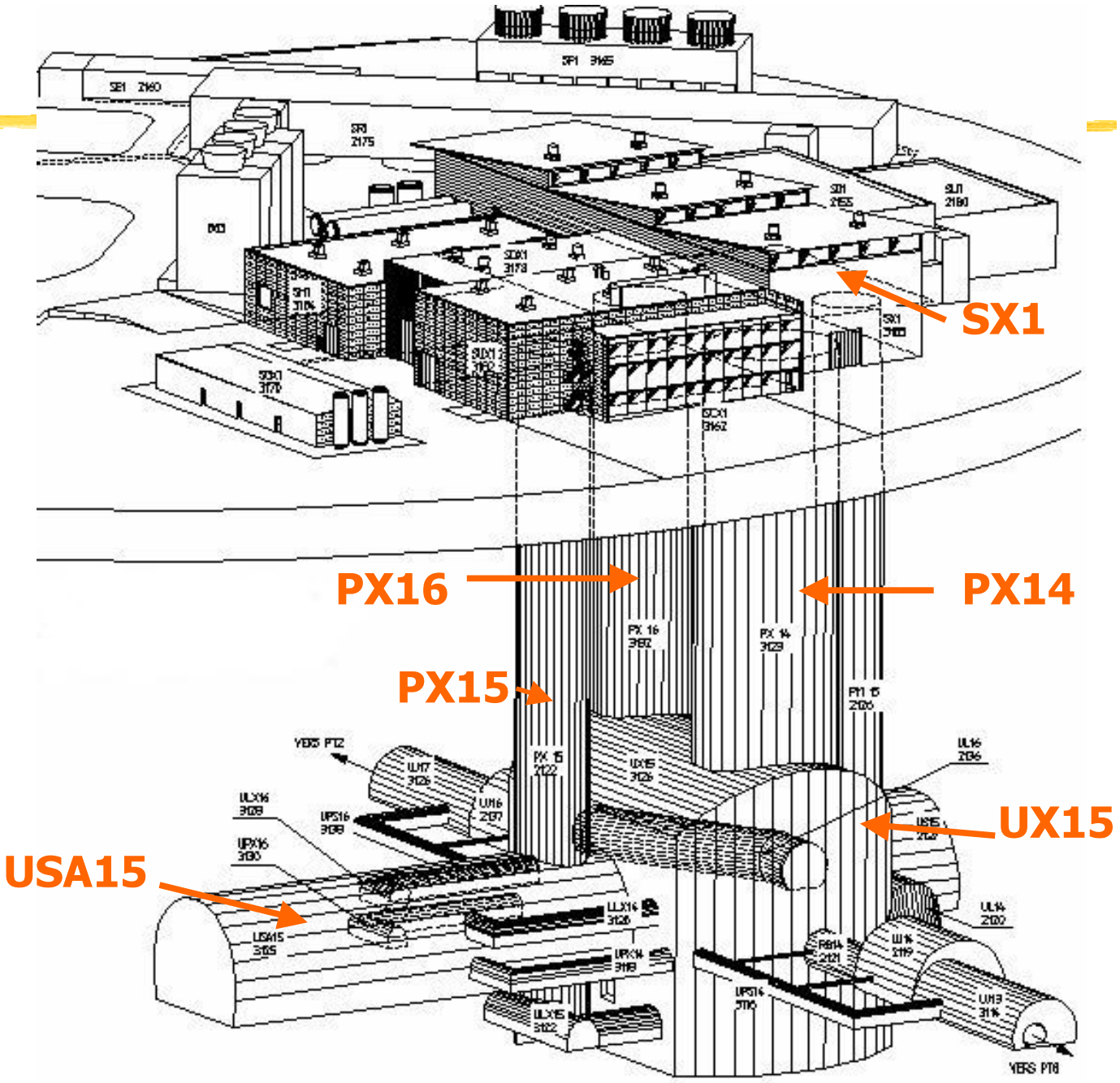
Our strategy:

→ ***Correct configuration control:*** we created in 2001 a central office; with it many problems have been solved while a few items remain to be worked out.

→ ***A work coordination organization at POINT 1:*** ATLAS EXPERIMENTAL AREA MANAGEMENT (EAM)

→ ***A complete planning of all tasks, with high granularity:*** *This is done through a central TCn office. Today we have ~ 2000 individual tasks.*

POINT 1



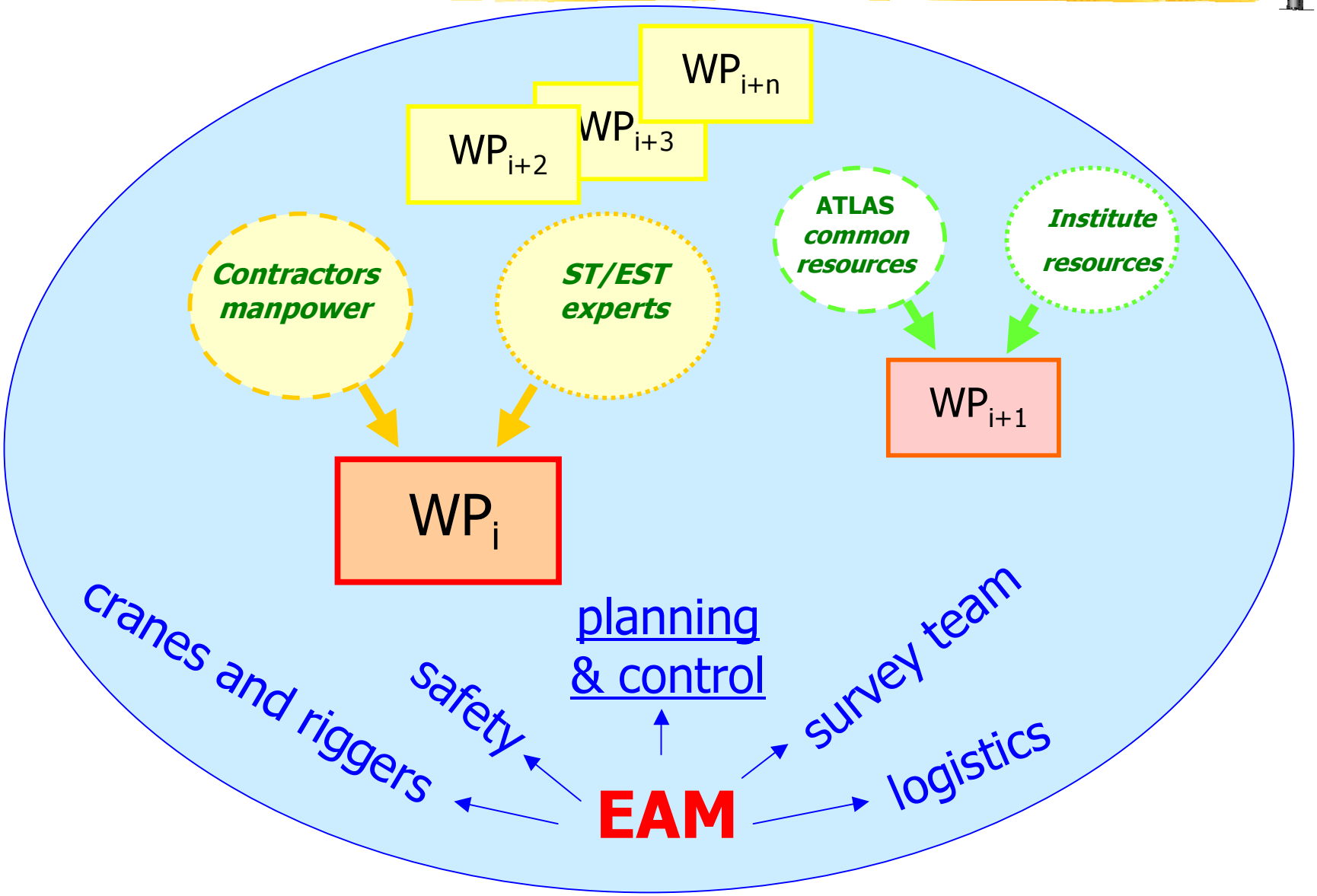
Installation Organization

- ATLAS TCn (in consultation with ST, EST and EP leadership) takes responsible for the proper coordination of the installation and commissioning of the detector and its services underground.
- The installation work is organized in Work Packages (WP's).
- The technical responsibility for each WP is with the experts for the system which is being installed (for the detector and for the infrastructure).
- The resources associated to a given WP are defined case-by-case and are a mixture between subcontractors work, technical sector experts, central TCn resources and specific Institute resources. The exact sharing has been agreed upon with the various groups.
- The interplay between WPs and basic services is managed by a dedicated organization which takes care of the overall work organization at POINT 1:

Experimental AREA Management (EAM)

Active since October '02….working well

EAM Organization at Point 1



ATLAS EAM Installation Organization

- Work site installation consists in organizing a succession and cohabitation of more than 1900 Tasks, spread over 3.5 years

- The organization on site of WP's is coordinated by EAM (Experimental Area Management), a team of 11 persons (from ST/EST/ EP) since Oct 2002

- Weekly EAM meeting with EAM team and work conductors (minutes on http://atlas.web.cern.ch/Atlas/TCOORD/Activities/Logistics/G1/EAM_minutes/eam_minutes_index.html)

- About 50 WP's have already been processed, a WP becomes active 2 months before it starts.

- The status of active WP's can be monitored on EDMS doc 359483 on https://edms.cern.ch/document/359483/1

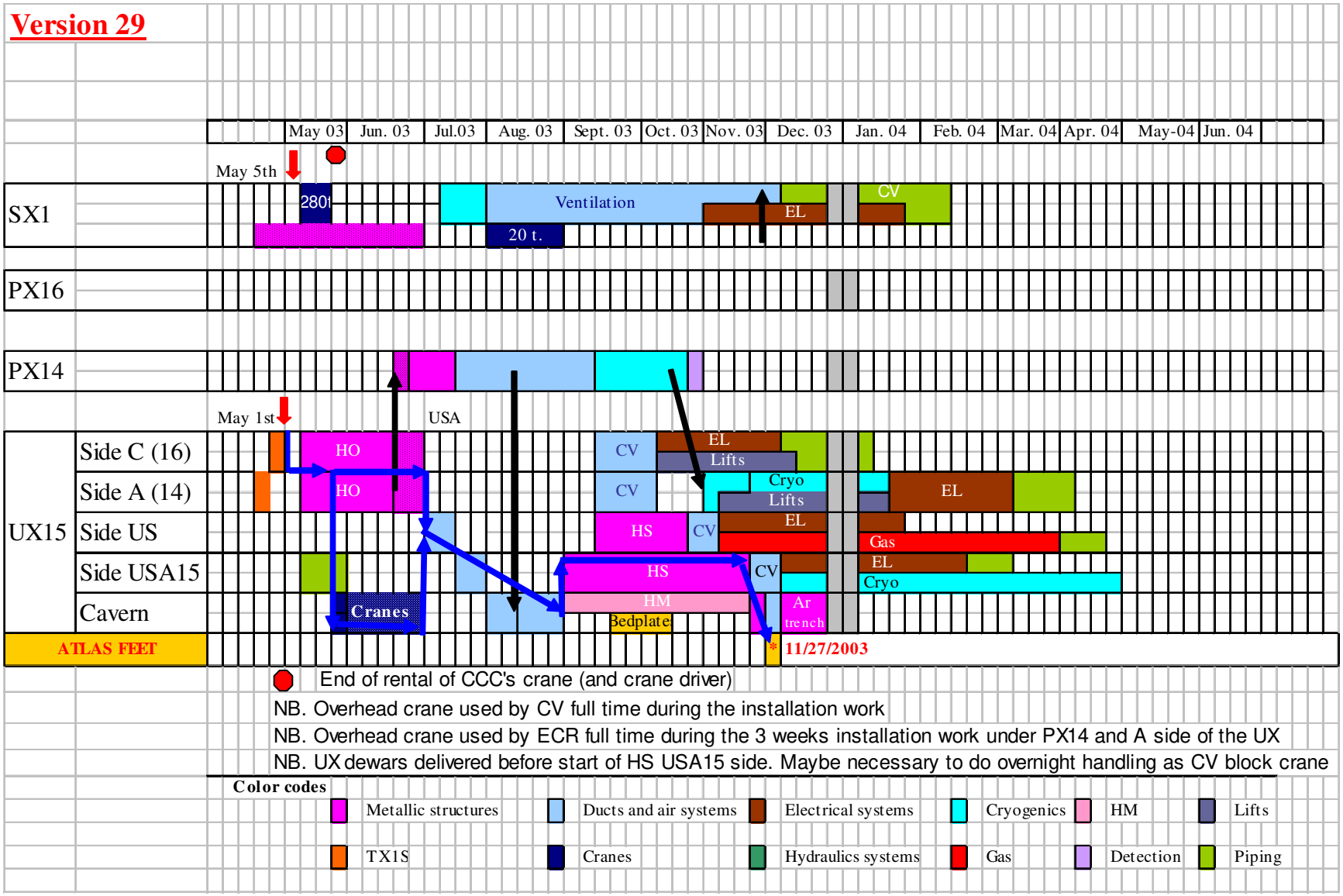
USA15 instrumentation

- Metallic structures well advanced
- Service pipes installed
- Installation of cable trays waiting for installation
- Electronic racks ordered

UX15 Cavern

- final delivery April ’03
- first step TAS shielding + washers
- …. then infrastructure
- November ’03 start with detector installation

UX15 Infrastructure installation



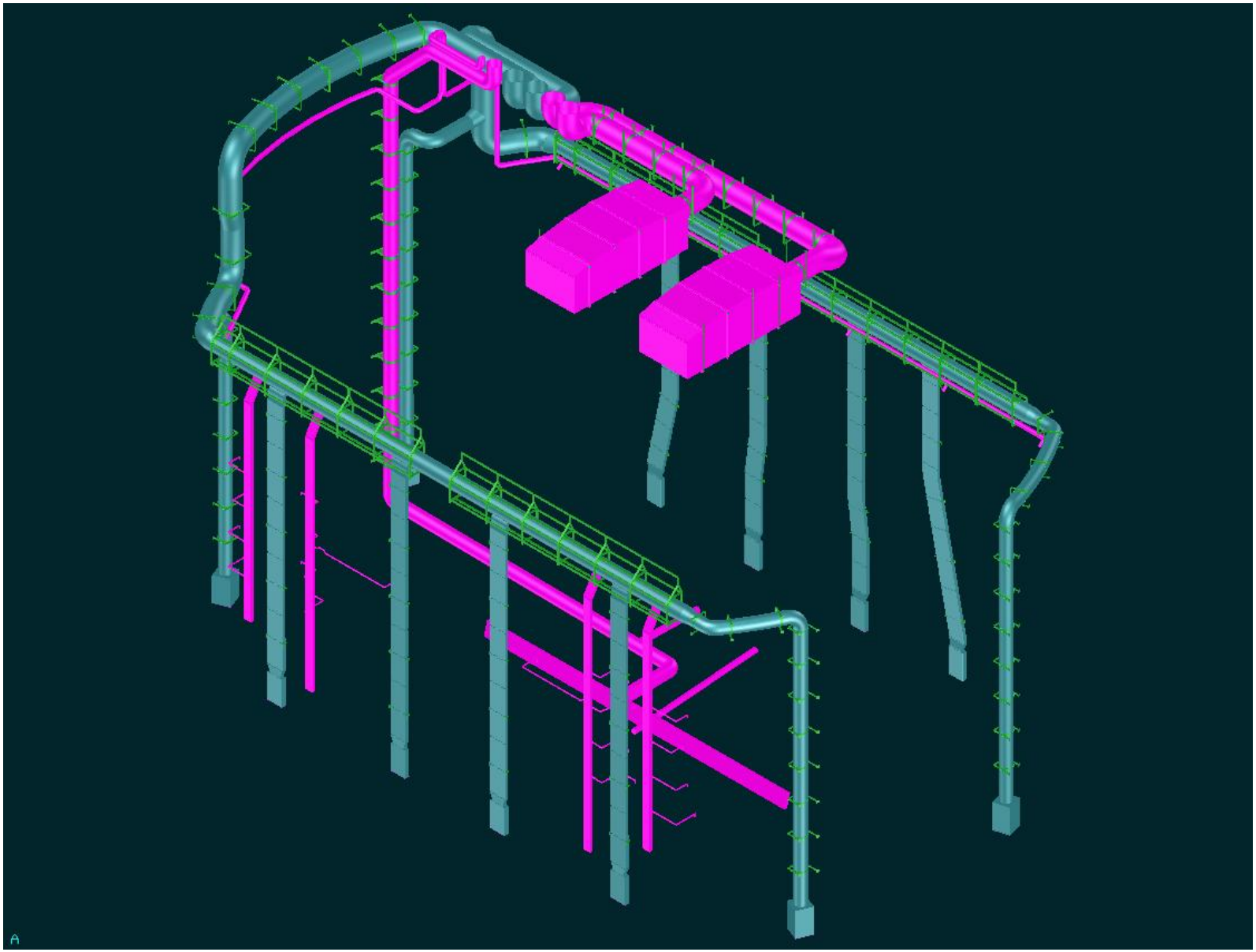
Infrastructure Installation

- Very critical, starting now…detector installation needs most of the infrastructure in place
- Most of the work is done within CERN contracts, under the supervision of ST, EST and LHC/ECR
- In these weeks we are reviewing with our technical sector colleagues the installation methods and the readiness in order to avoid surprises
- It will be very difficult to absorb delays, the only possible solution will be extra shifts and more parallel work

Infrastructure Installation

- ST/CE - TAS shielding washers installation
- ST/HM - all transports (normal and special), all crane manipulations.
  - all cranes/lifts installation
- EST/IC - most metallic structures
- ST/CV - HVAC systems
  - primary cooling systems and piping
  - detector cooling units
  - compress air system
  - detector piping work?
- EST/SU - all survey work
- LHC/ECR - magnets and LAr cryogenics (with EP/TA3)

ST/CV HVAC work in UX15



Infrastructure Installation

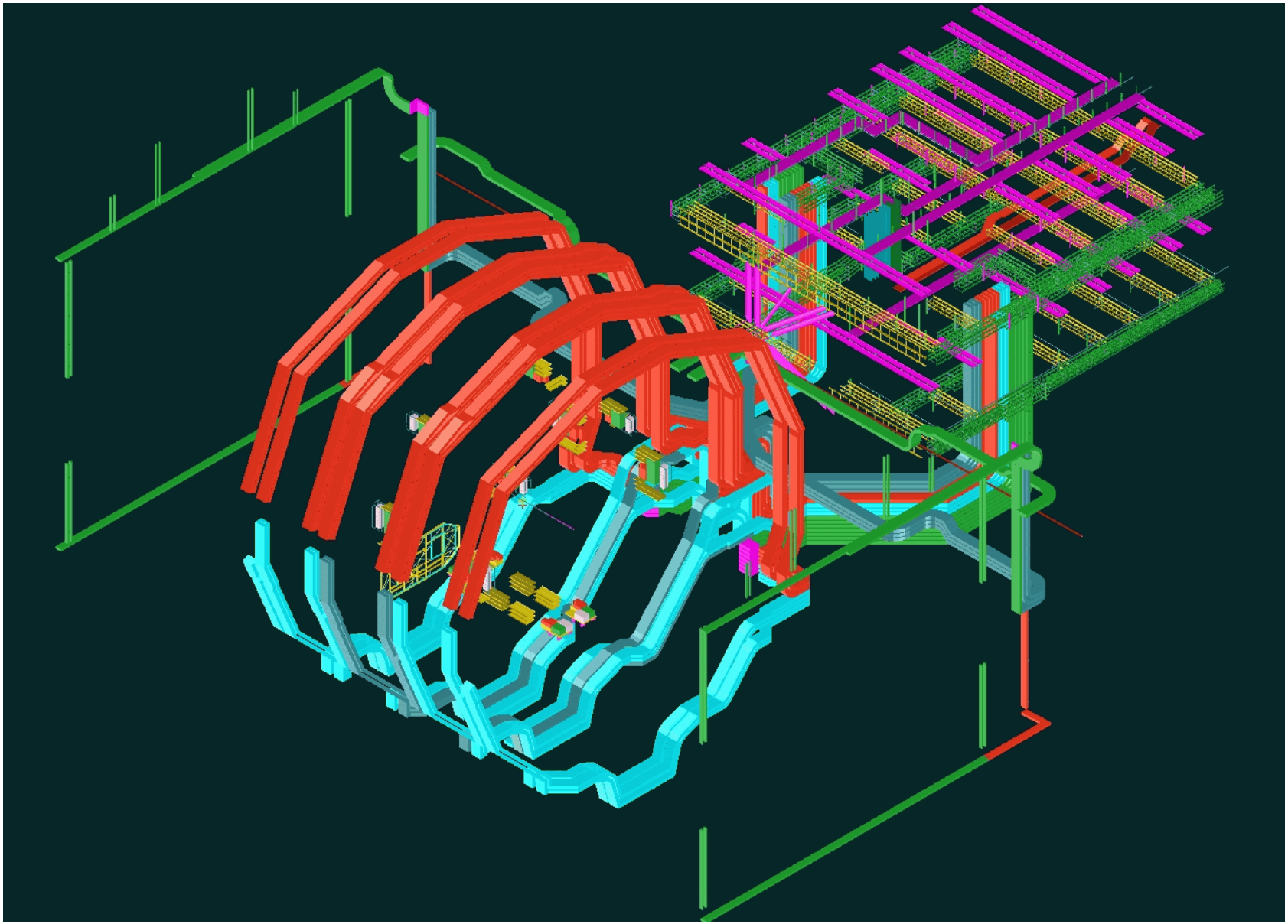
- ST/MA - safety detection systems
  - access structures
  - detector sniffer system
- EST/ISS - equipment database
- LHC/VAC - beam vacuum system
- EP/TA1 - gas distribution systems
- EP/TA3 - magnets control system
- ST/EL - electric power distribution (incl UPSs)
  - detector cabling ?

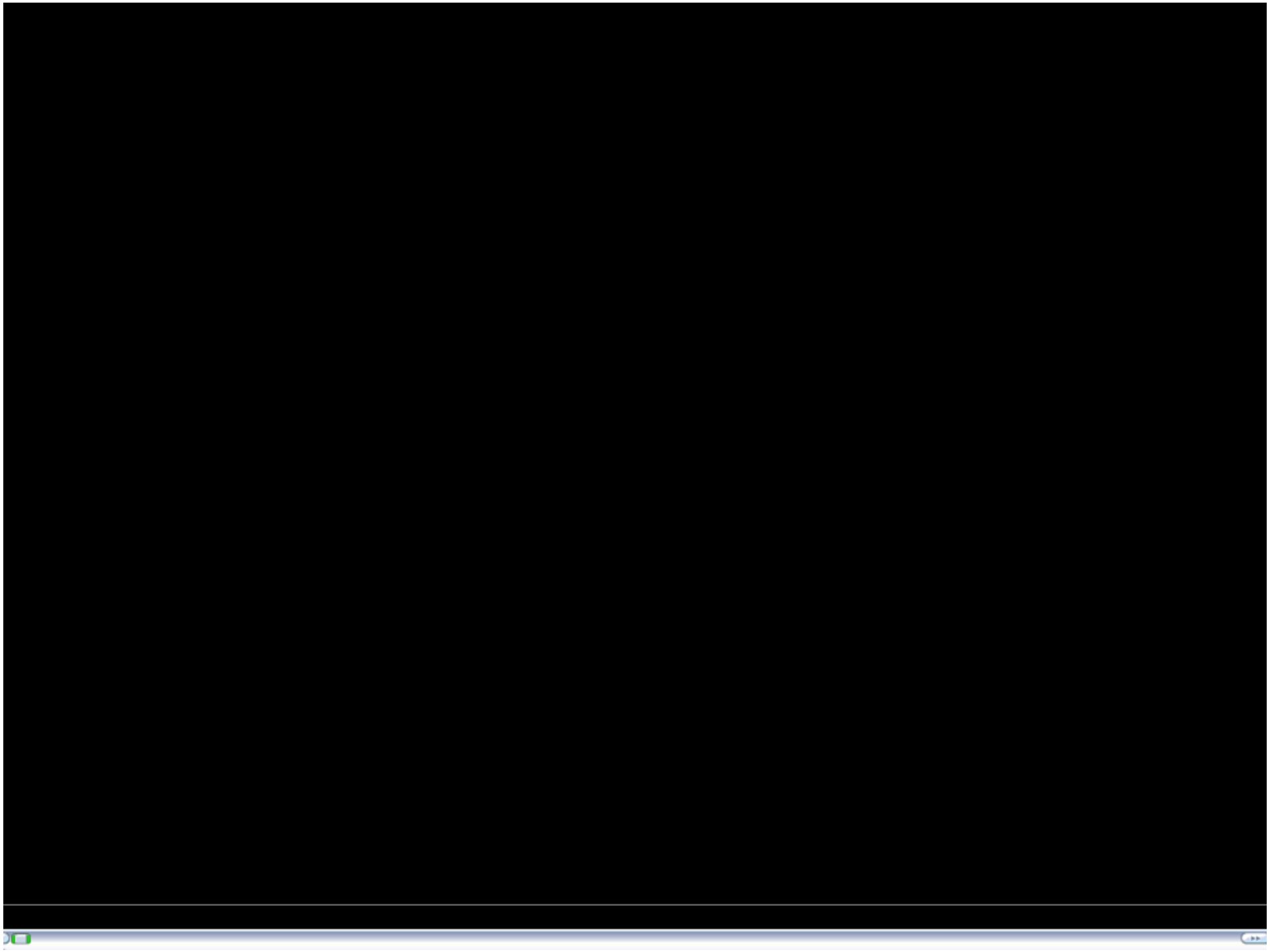
All this work is (will be) covered by internal agreements between ATLAS and the various groups/divisions

Detector Cabling

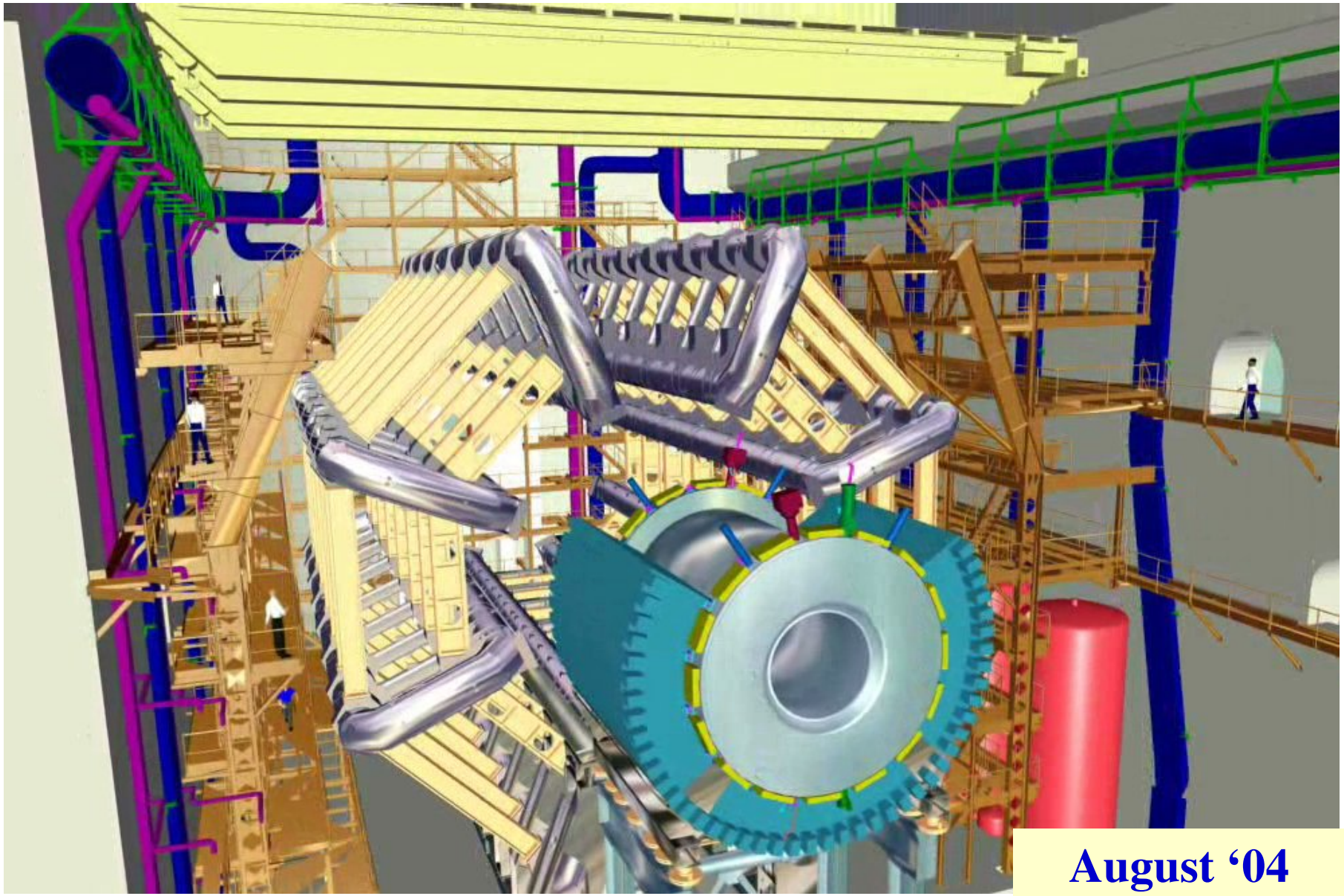
- One of the biggest challenges in front of us
- Little or no expertise left at CERN for detector cabling
- ~ 2200 km of copper and fibers cables
- We are interested in the ST/EL methods
- We will be limited by resources (few CHF/m available)
- Surface bundling as one possible strategy
- Complex routing inside the detector
- We are currently finalizing the cable trays layout and the racks layout (inside and outside the detector)
- We have developed interactive tools for routing optimization

Detector Cable Trays



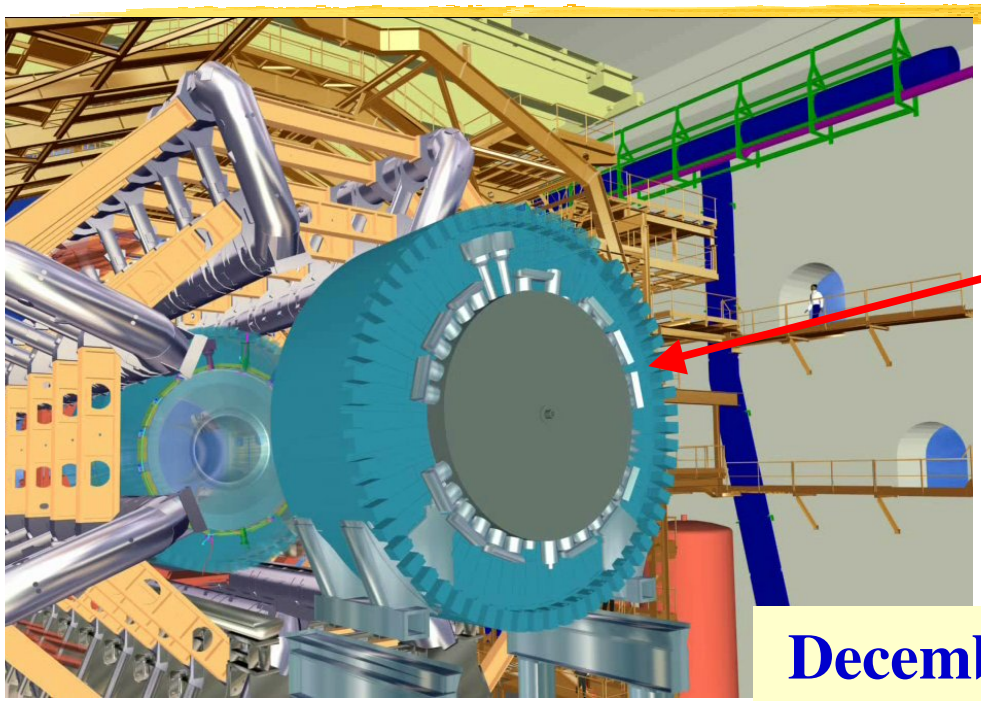


Installation sequence (Barrel Toroid + Barrel Calorimeter)



August '04

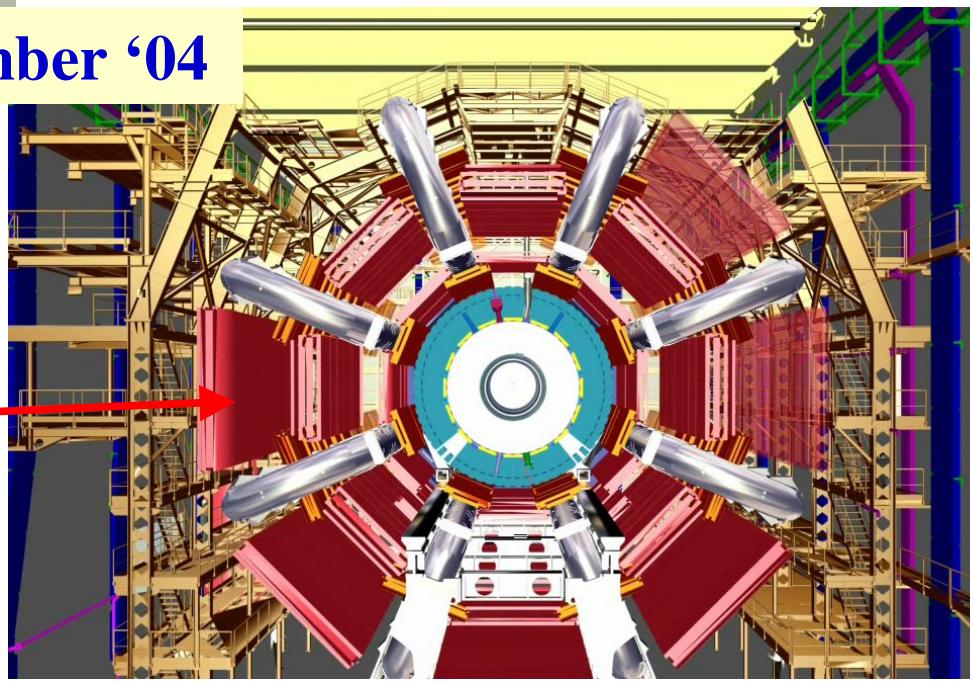
Installation sequence



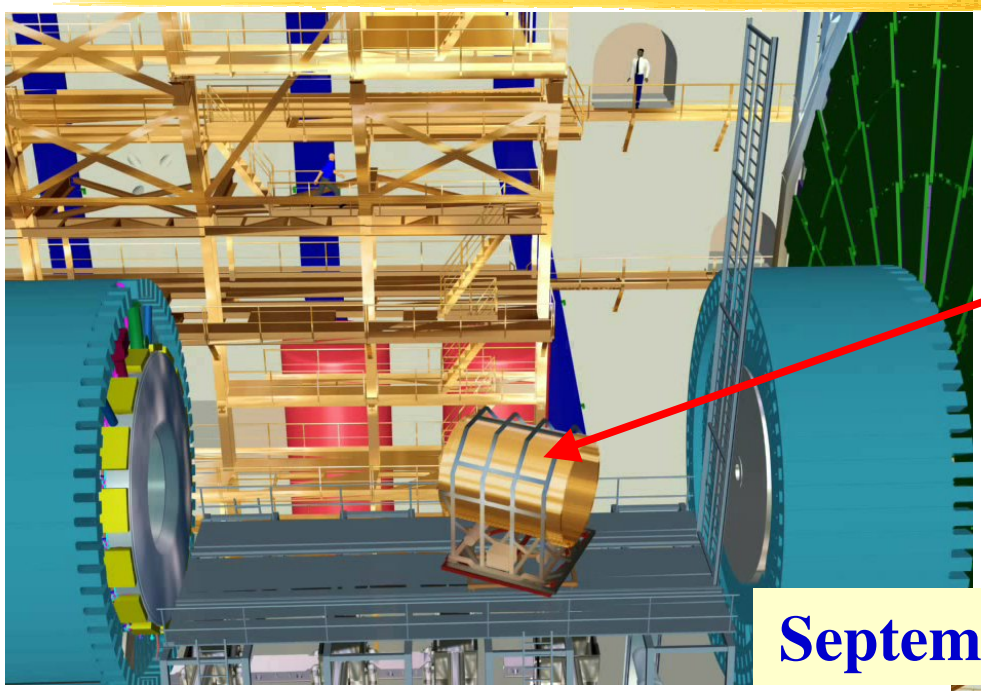
Side C : End Cap calorimeter installation

December '04

Side A : Barrel muon chambers installation

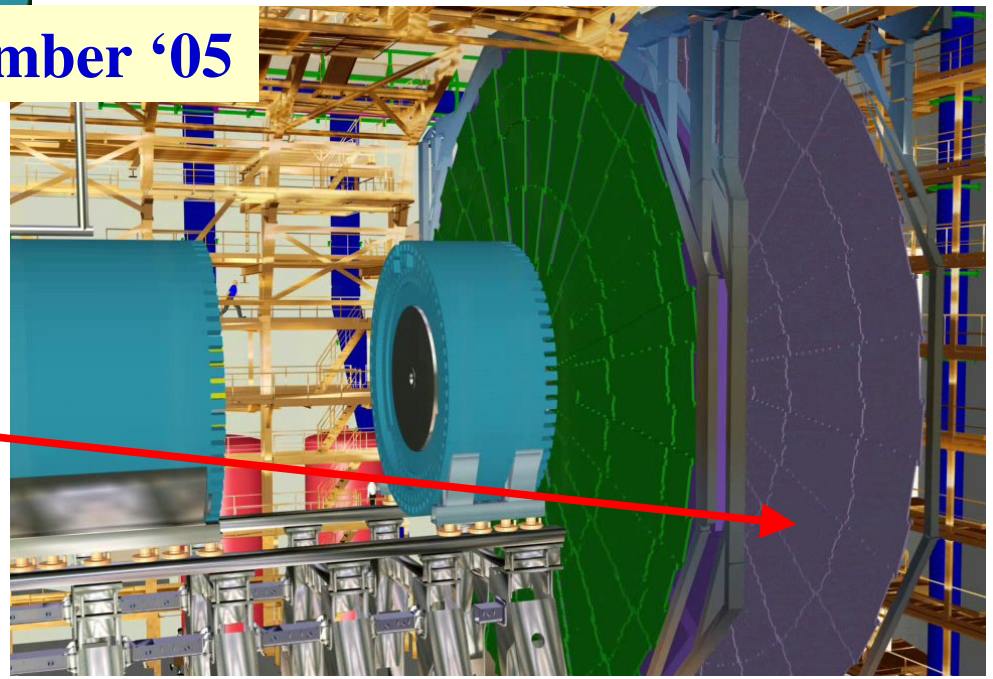


Installation sequence



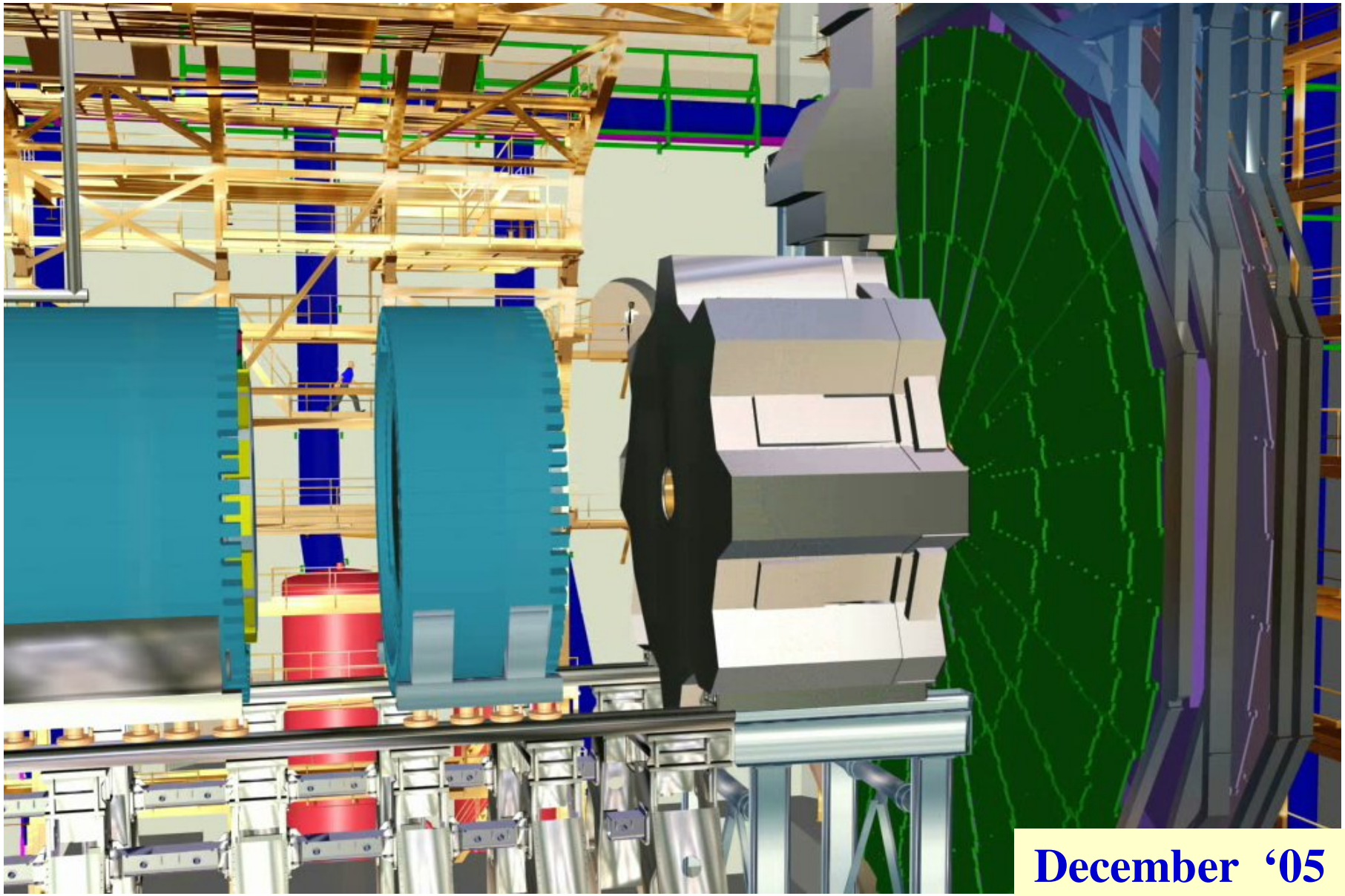
Side C : Barrel Inner Detector installation

September '05

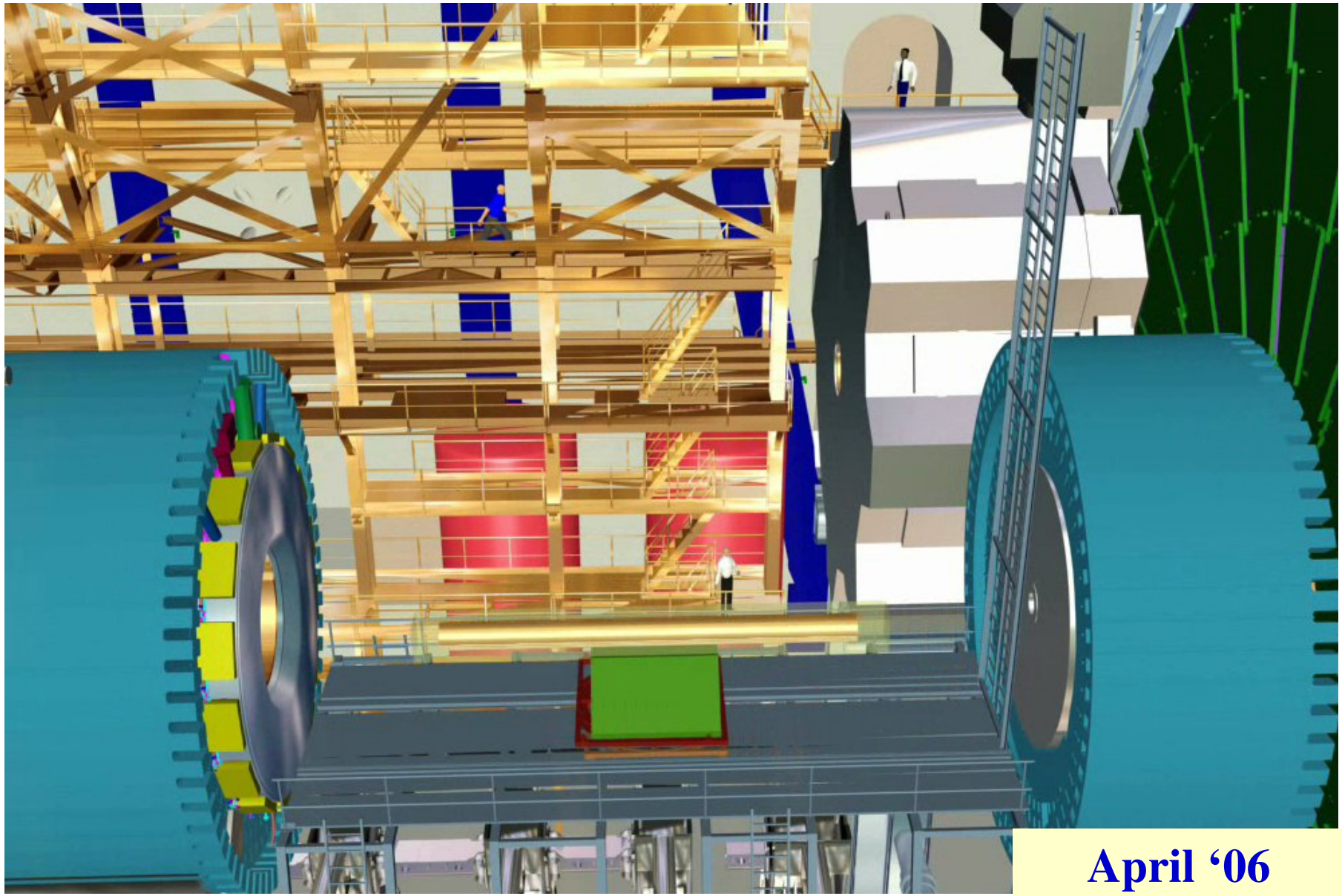


Side A : Forward muon chambers installation (Big Wheels)

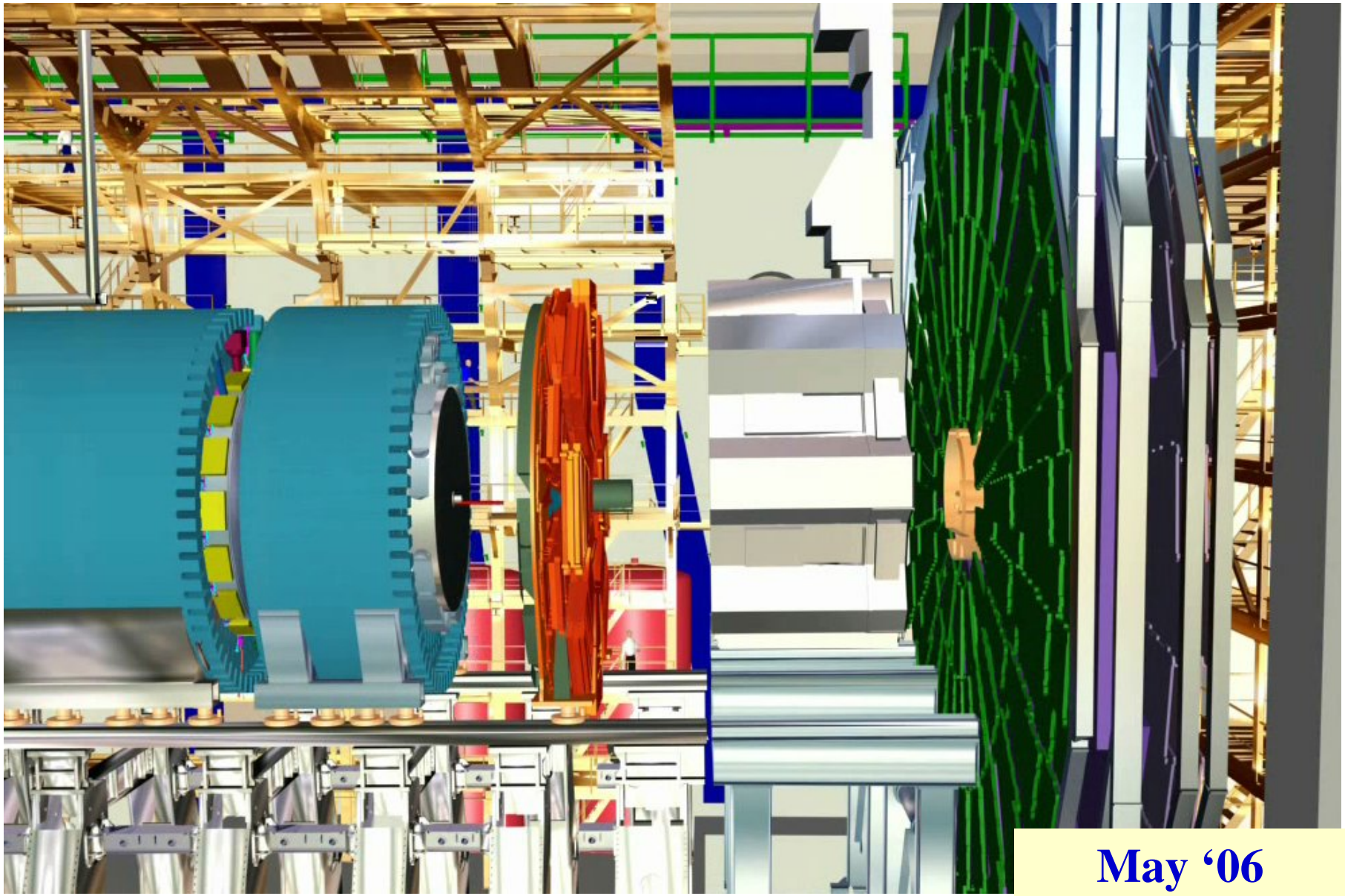
Installation sequence (End Cap Toroid C)



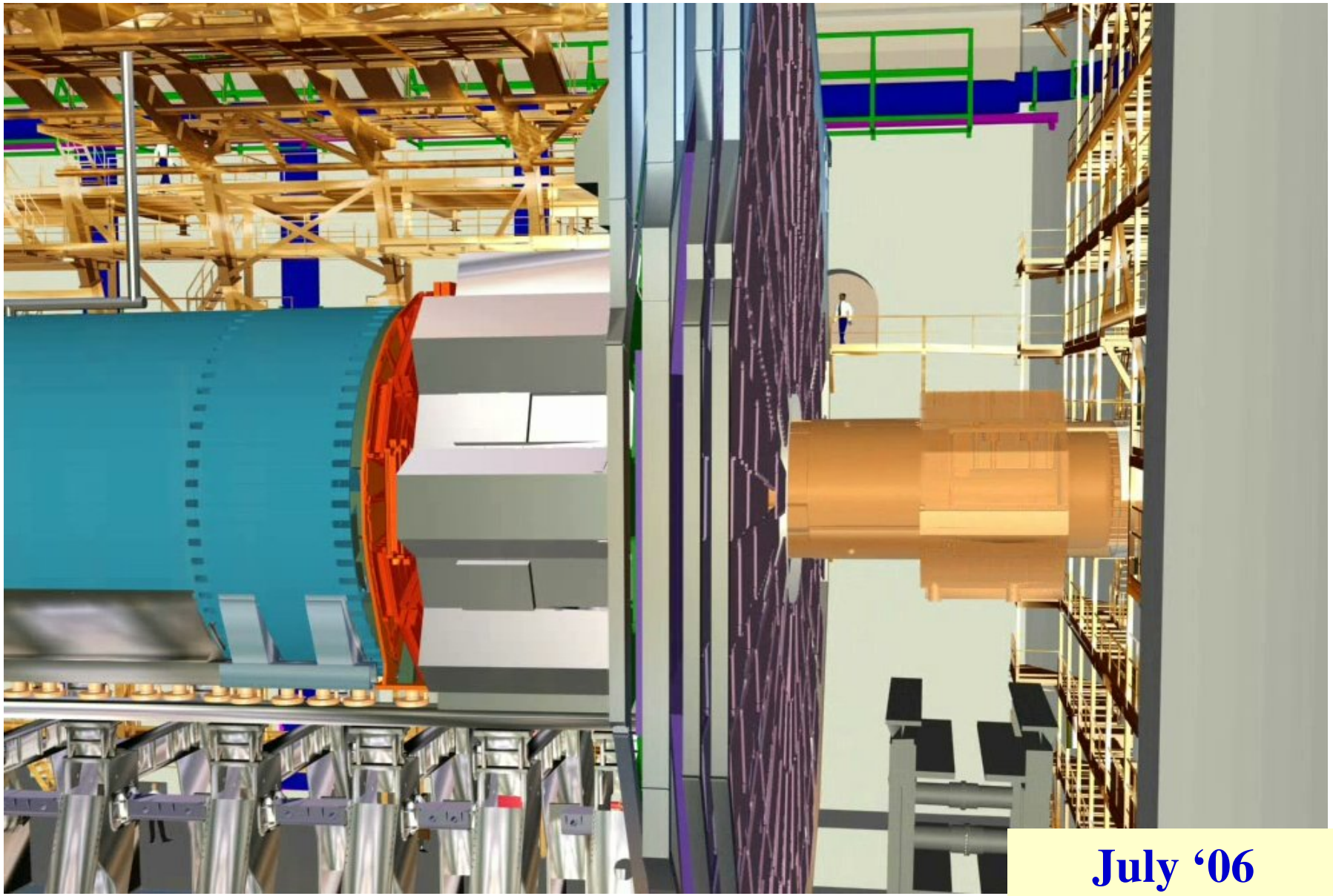
Installation sequence (Pixel detector + Be pipe)



Installation sequence (Small Wheel C)



Installation sequence (Forward Shielding C)



July '06

Summary

- ✓ ATLAS detector construction is well advanced and tuned to the installation schedule
- ✓ As much as possible all components will be assembled and tested on the surface. This work is well visible at CERN today
- ✓ Underground installation is starting. It is complex & time critical
- ✓ The management structures for it are in place and working
- ✓ CERN/ST is strongly committed to the infrastructure installation. Next 8 months will be very demanding.
- ✓ ATLAS has many intersection points with CERN/ST. Few more projects could still be finalized (piping, cabling,..)