...... managing ATLAS

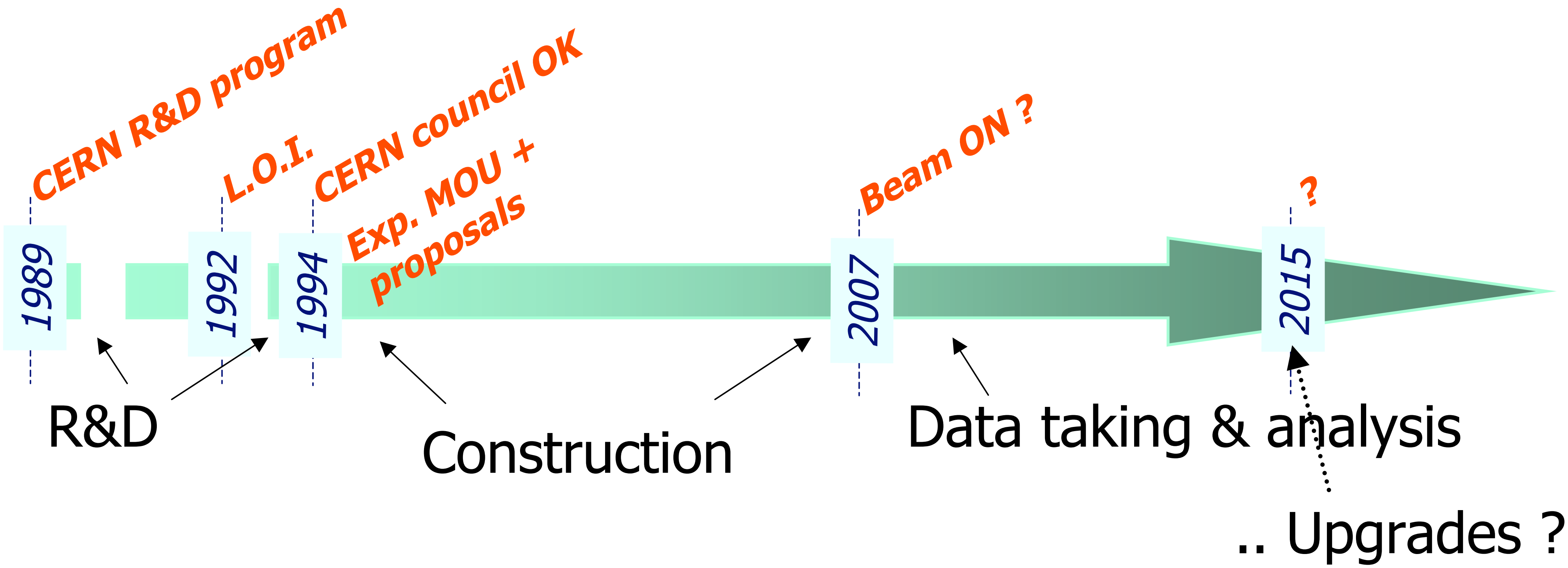
Marzio Nessi , CERN

La Londe les Maures, 16th June 2006

From the early 90ties the HEP community has focalized most of its resources and energies on the LHC project

- ✓ A new machine (pp, 7 TeV + 7 TeV)
- ✓ A very ambitious experimental program (ATLAS, CMS, LHCb, Alice)

A global project spanning over 25-30 years



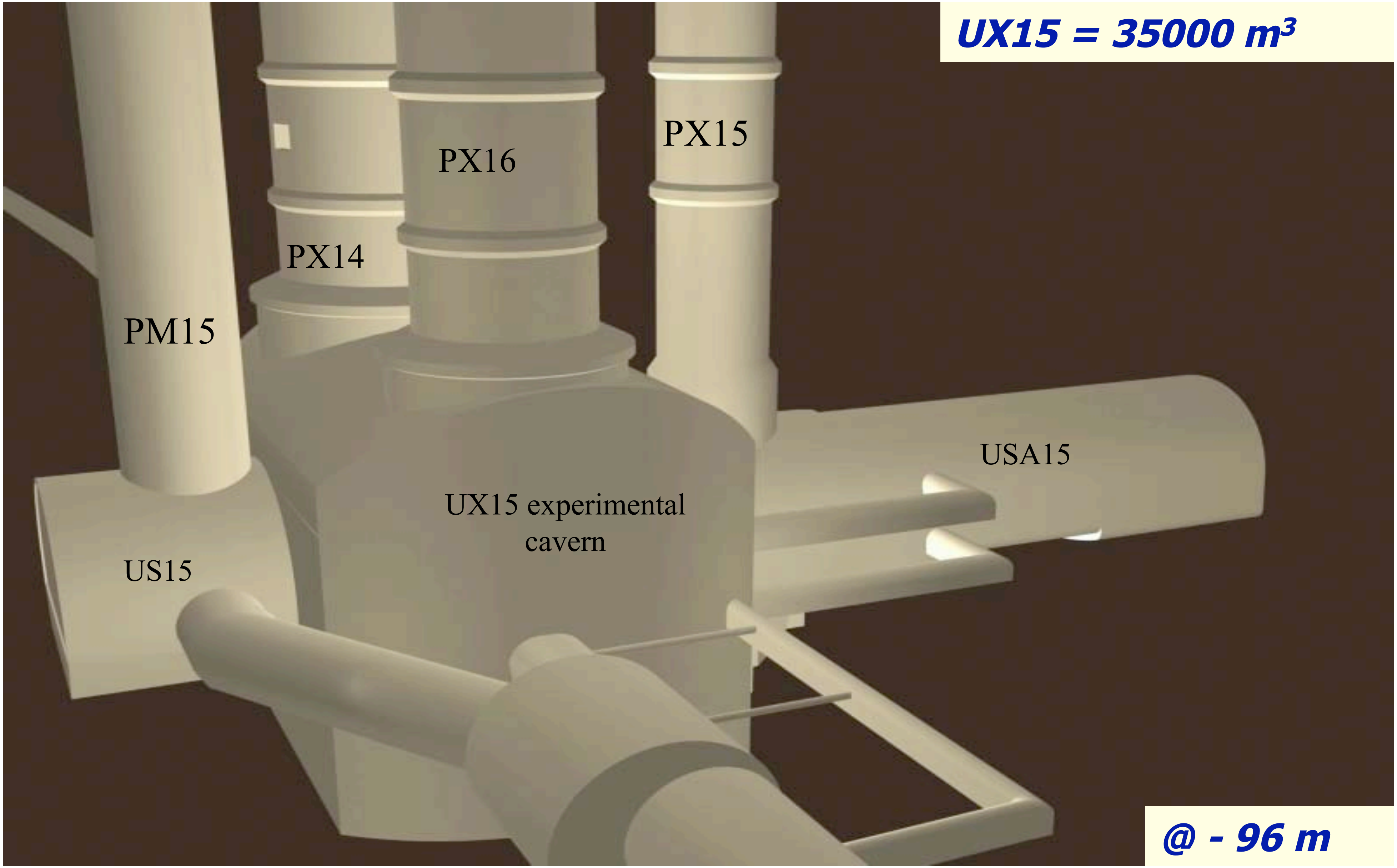
Why global ?

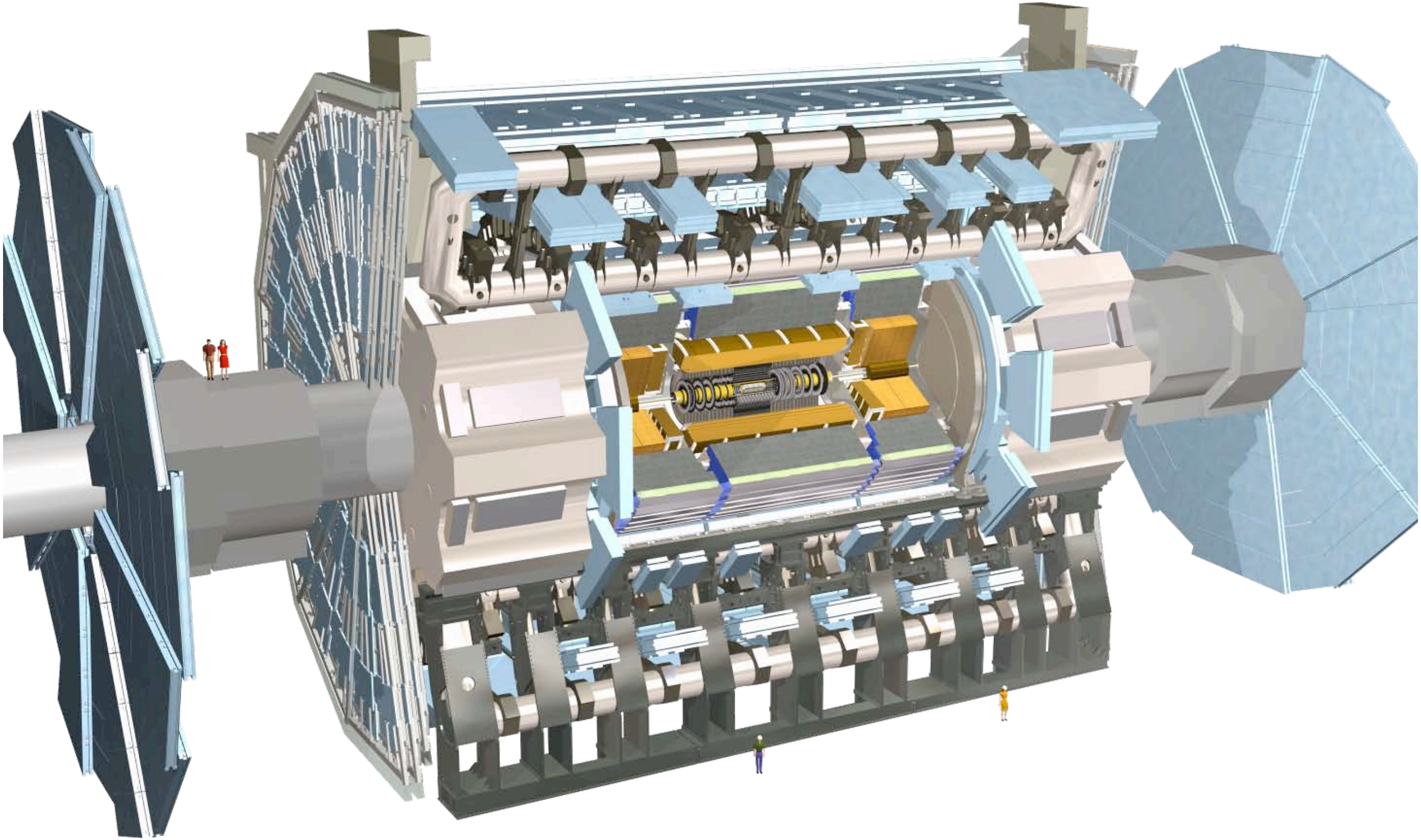
35 nations
158 istitutions
~1650 scientists

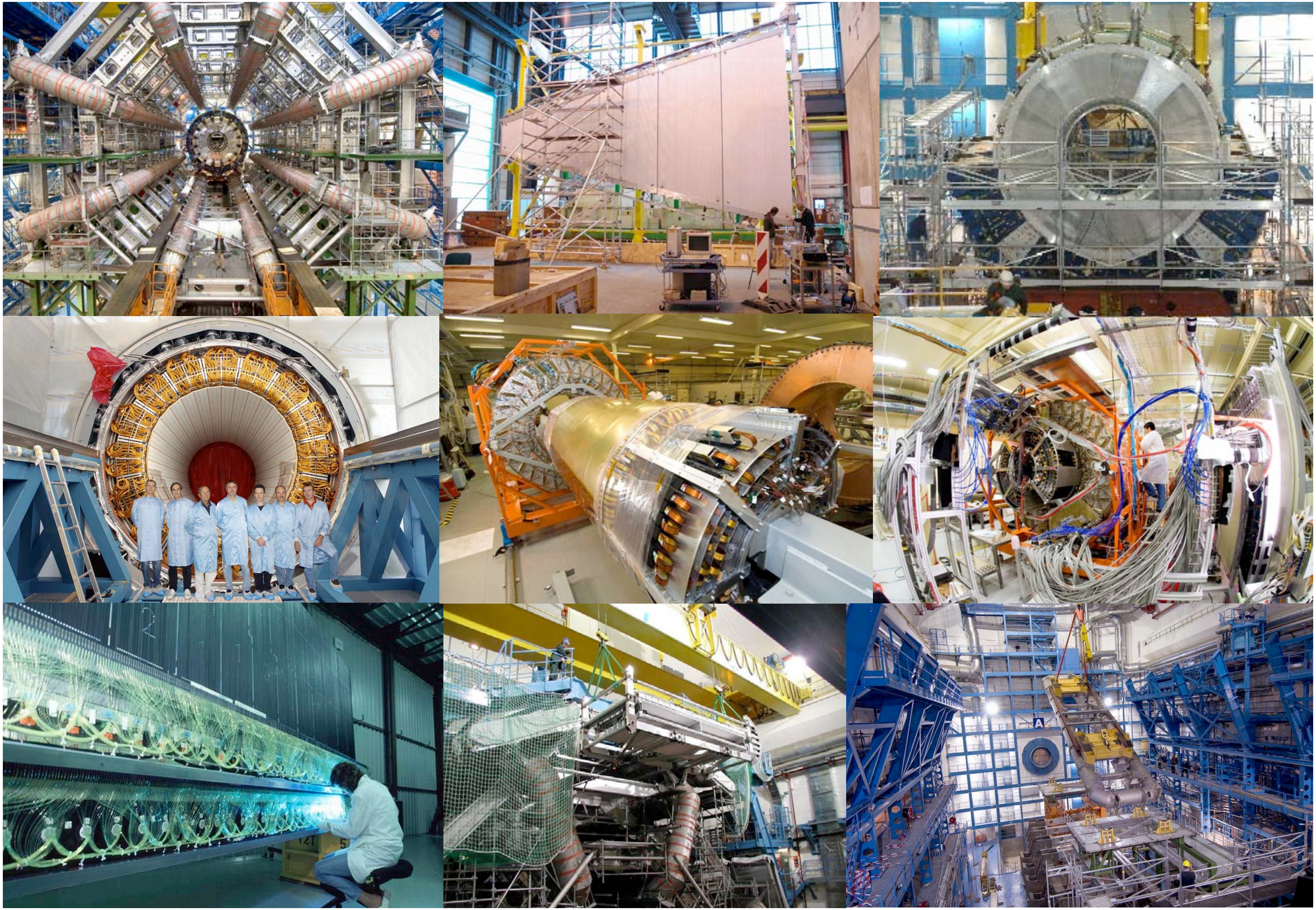
Albany, Alberta, NIKHEF Amsterdam, Ankara, LAPP Annecy, Argonne NL, Arizona, UT Arlington, Athens, NTU Athens, Baku, IFAE Barcelona, Belgrade, Bergen, Berkeley LBL and UC, Bern, Birmingham, Bologna, Bonn, Boston, Brandeis, Bratislava/SAS Kosice, Brookhaven NL, Buenos Aires, Bucharest, Cambridge, Carleton, Casablanca/Rabat, CERN, Chinese Cluster, Chicago, Clermont-Ferrand, Columbia, NBI Copenhagen, Cosenza, INP Cracow, FPNT Cracow, Dortmund, TU Dresden, JINR Dubna, Duke, Frascati, Freiburg, Geneva, Genoa, Giessen, Glasgow, LPSC Grenoble, Technion Haifa, Hampton, Harvard, Heidelberg, Hiroshima, Hiroshima IT, Indiana, Innsbruck, Iowa SU, Irvine UC, Istanbul Bogazici, KEK, Kobe, Kyoto, Kyoto UE, Lancaster, UN La Plata, Lecce, Lisbon LIP, Liverpool, Ljubljana, QMW London, RHBNC London, UC London, Lund, UA Madrid, Mainz, Manchester, Mannheim, CPPM Marseille, Massachusetts, MIT, Melbourne, Michigan, Michigan SU, Milano, Minsk NAS, Minsk NCPHEP, Montreal, McGill Montreal, FIAN Moscow, ITEP Moscow, MEPhI Moscow, MSU Moscow, Munich LMU, MPI Munich, Nagasaki IAS, Naples, Naruto UE, New Mexico, Nijmegen, BINP Novosibirsk, Ohio SU, Okayama, Oklahoma, Oklahoma SU, Oregon, LAL Orsay, Osaka, Oslo, Oxford, Paris VI and VII, Pavia, Pennsylvania, Pisa, Pittsburgh, CAS Prague, CU Prague, TU Prague, IHEP Protvino, Ritsumeikan, UFRJ Rio de Janeiro, Rochester, Rome I, Rome II, Rome III, Rutherford Appleton Laboratory, DAPNIA Saclay, Santa Cruz UC, Sheffield, Shinshu, Siegen, Simon Fraser Burnaby, Southern Methodist Dallas, NPI Petersburg, Stockholm, KTH Stockholm, Stony Brook, Sydney, AS Taipei, Tbilisi, Tel Aviv, Thessaloniki, Tokyo ICEPP, Tokyo MU, Toronto, TRIUMF, Tsukuba, Tufts, Udine, Uppsala, Urbana UI, Valencia, UBC Vancouver, Victoria, Washington, Weizmann Rehovot, Wisconsin, Wuppertal, Yale, Yerevan

Point 1 : ATLAS experimental area

Point 1 : underground experimental area

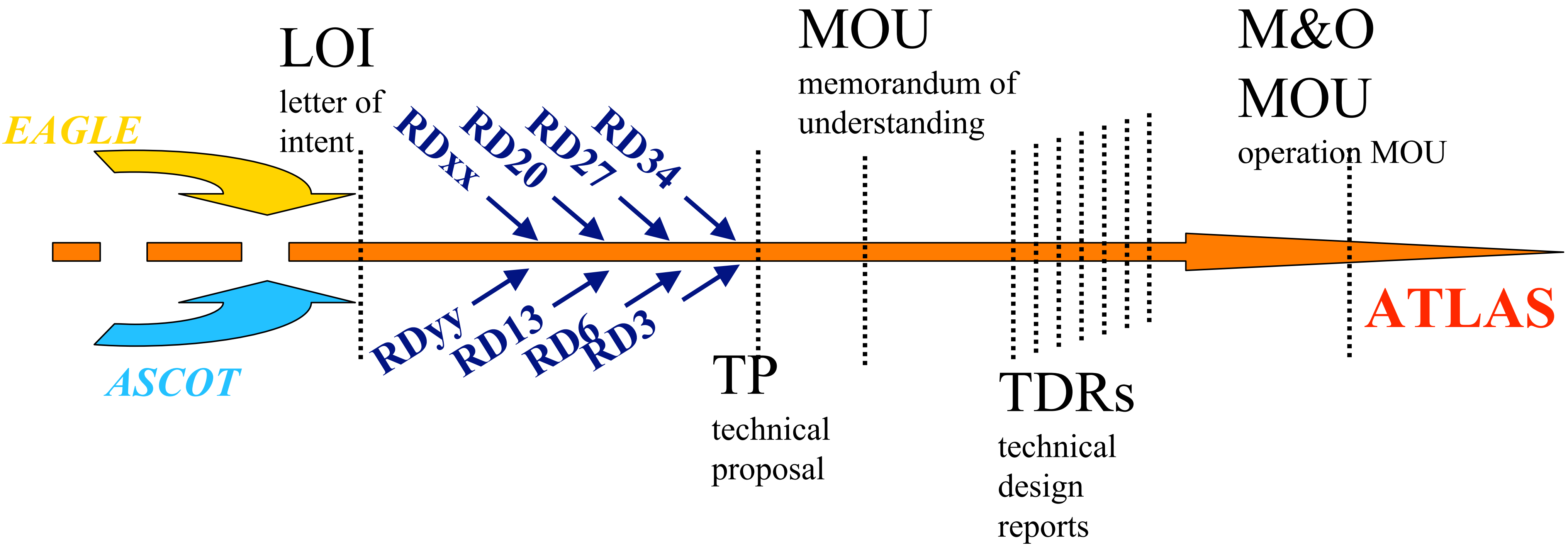




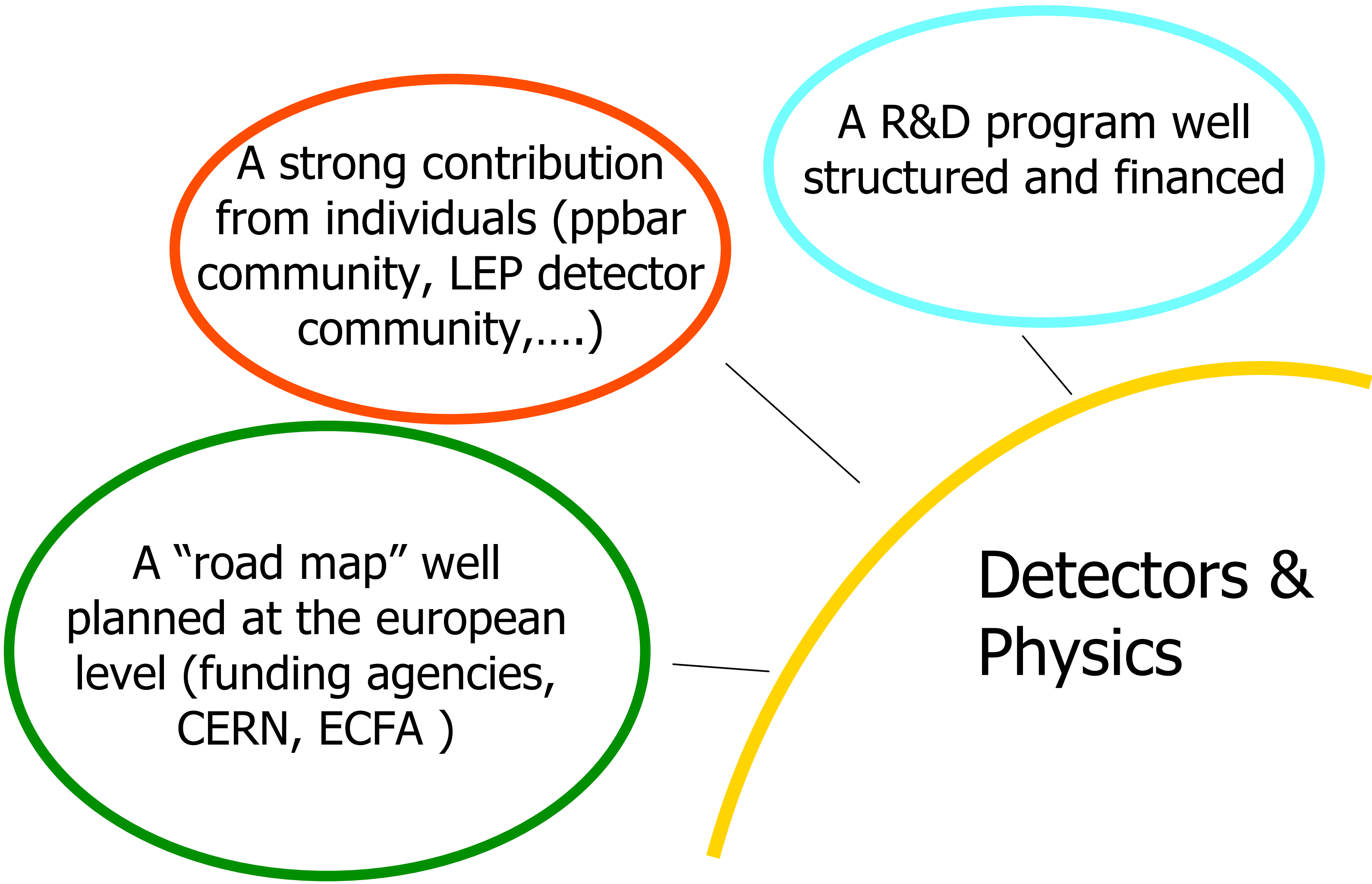


Planning, établissement et contrôle (t)

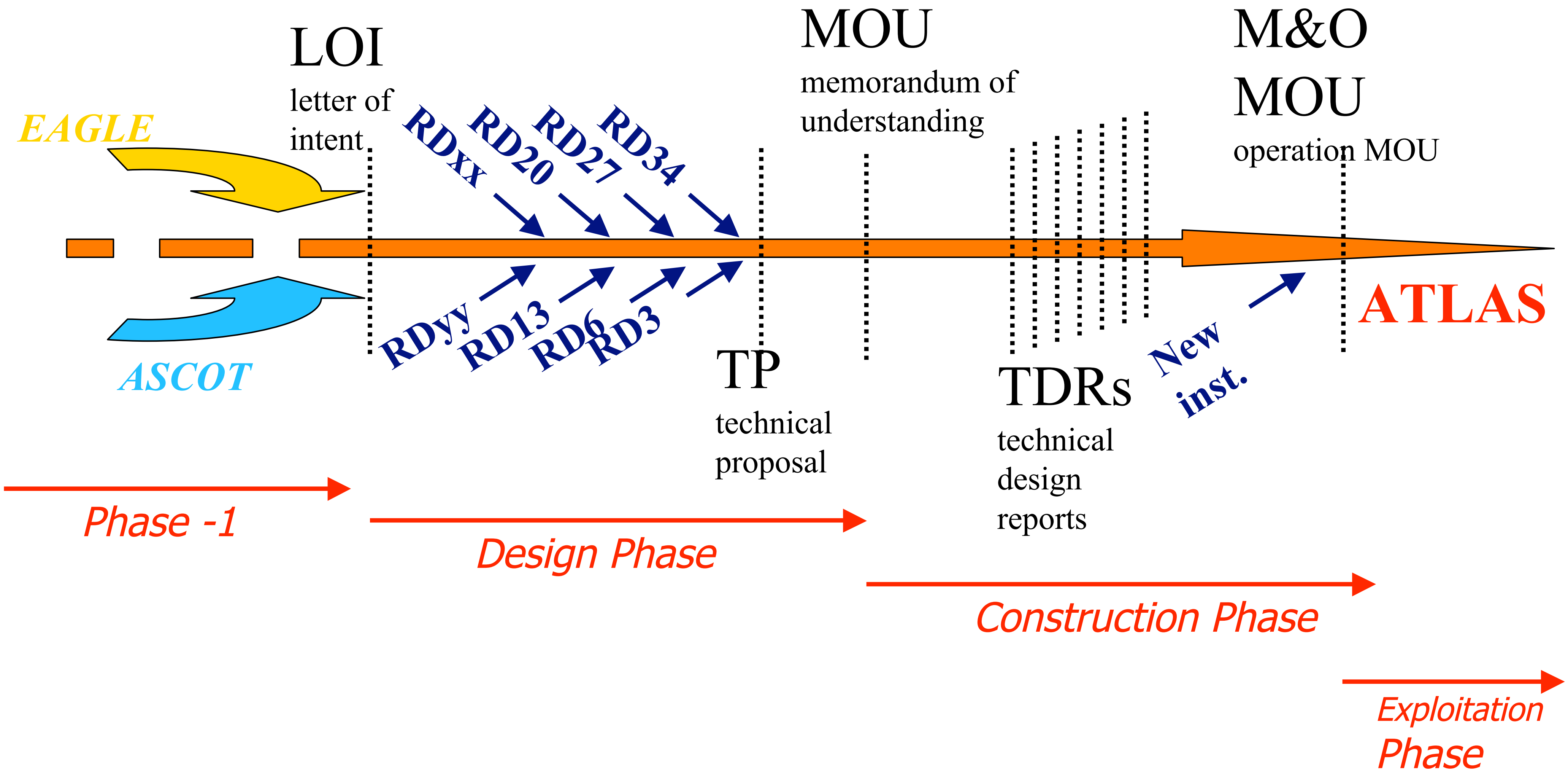
Evolution


LOI
letter of intent
EAGLE
ASCOT
RDxx
RD20
RD27
RD34
RDyy
RD13
RD6
RD3
MOU
memorandum of understanding
TP
technical proposal
TDRs
technical design reports
M&O MOU
operation MOU
ATLAS

Three components to get started with



Four phases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TP
technical proposal
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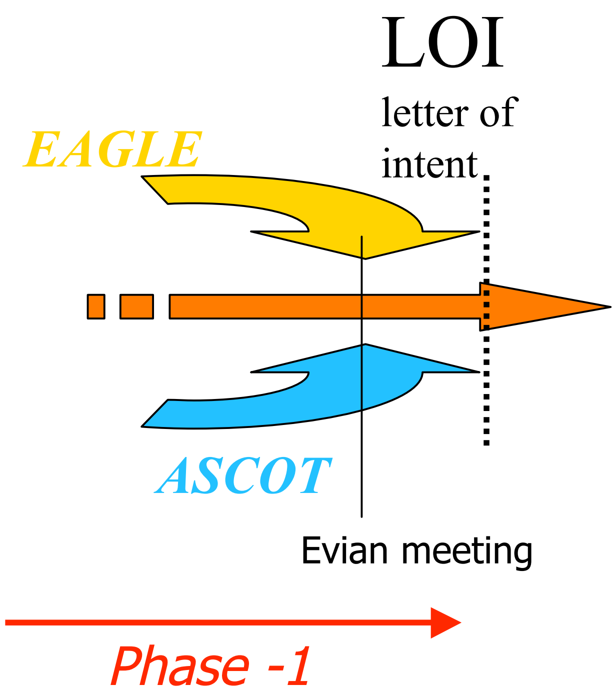
technical design reports
New inst.
ATLAS
Phase -1
Design Phase
Construction Phase
Exploitation Phase

Meaning of schedules and management

- This is an evolutive process
- Schedules and management of it have a different meaning at different moments in time
- Methods must also evolve as the project evolves
- Flexibility about the way all this is managed, is a must
- Many decisions or strategies look crazy a posteriori, but might be just right and the only solution at a given moment in time
- Managing such a long and complex project requires a visionary approach at some level

Phase -1 (1989-1992)



- ✓ Proto Collaborations (4-5 formed, fusions forced)
- ✓ Clear definition of the scientific goals
- ✓ Practically all technological concepts already there
- ✓ Personal relations and history of individuals as a basis
- ✓ Enthusiasm of individuals as the driving force

- ✓ planning:
  - completely unrealistic, driven by political reasons (SSC)
  - better defined in the subdetectors with R&D experience
  - integration work, common infrastructure ignored
- ✓ cost:
  - top-down approach
  - global figure suggested by the top CERN management

.... Some notes

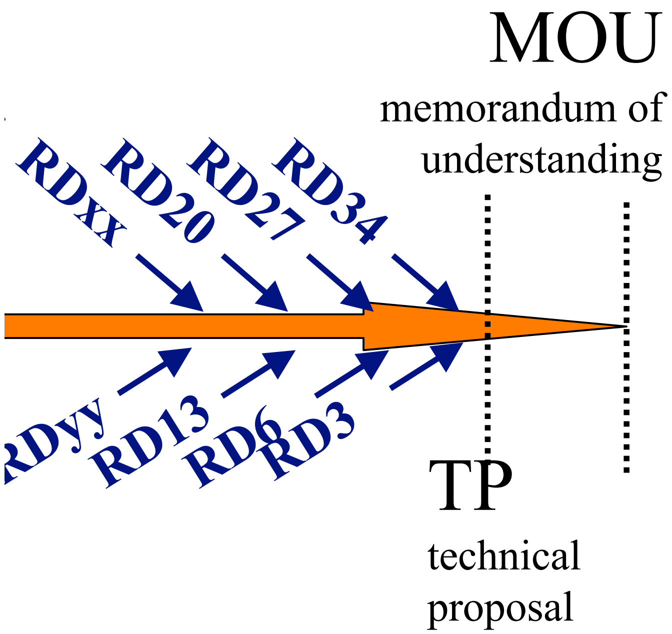
- If the project is authorized in 1992, construction of the LHC could be completed by the end of 1997 *(page 13, Design study of the LHC, CERN 91-03, 2 May 1991)*

- The preliminary cost estimate refers to the complete detector and amounts to 370-450 MCHF depending on the final choices of the muon magnet system and detector subsystem options *(page 104, ATLAS LOI, CERN/LHCC/92-4, 1 October 1992)*

- The complete detector installation is estimated to take 18 months *(page 78, ATLAS LOI, CERN/LHCC/92-4, 1 October 1992)*

- The installation of services and cables can be terminated and everything be prepared for the final global tests at the end of the year 2002 *(page 197, ATLAS TP, CERN/LHCC/94-43, 15 December 1994)*

Design phase (1992- 1996)



- ✓ Collaborations evolving fast (LEP, SSC joining in)
- ✓ Work mostly done inside the R&D CERN program
- ✓ Several competing solutions, difficult tech. choices
- ✓ Collaboration as a catalyser
- ✓ Collaboration mostly dealing with the magnet project

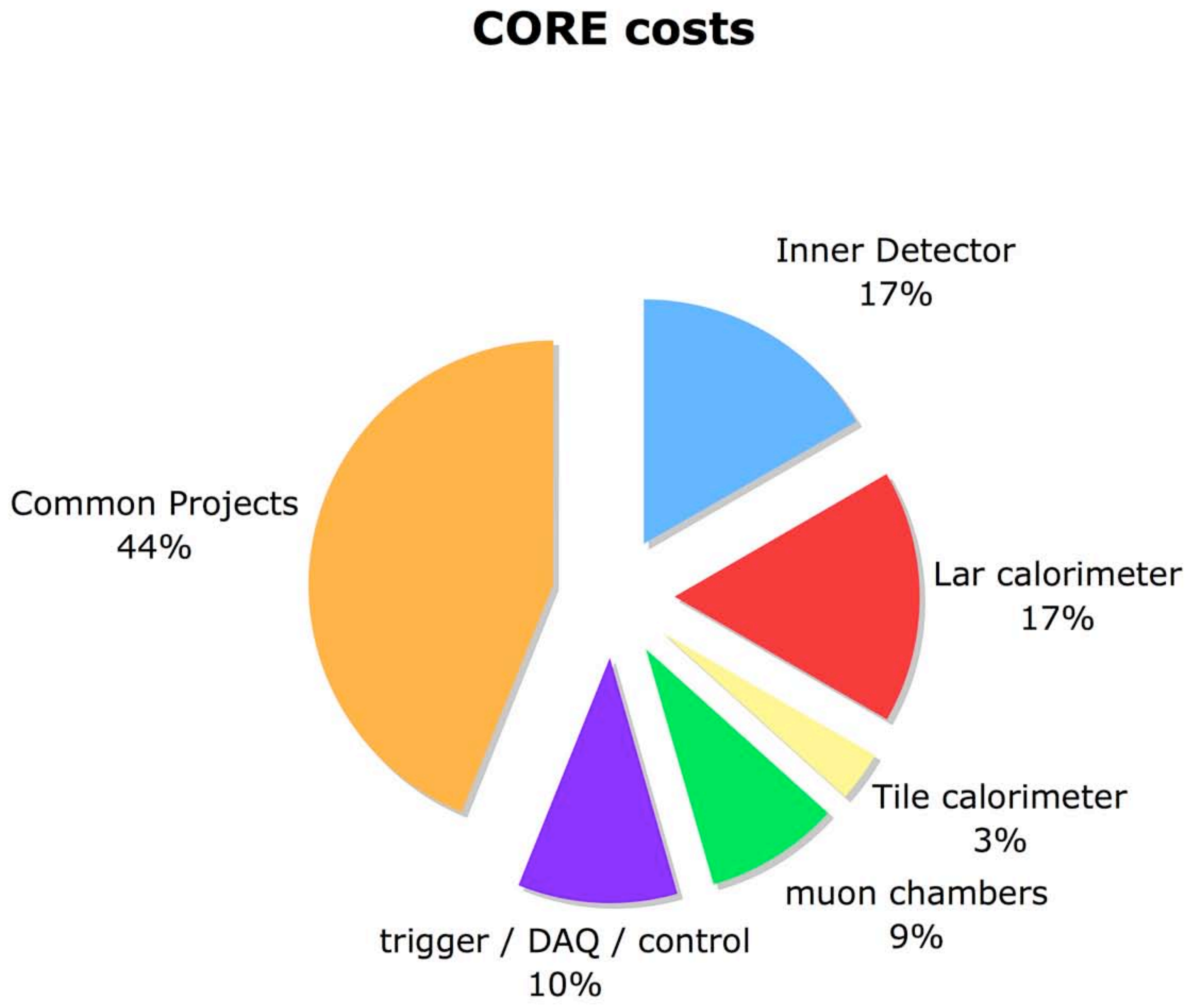
- ✓ planning:
  - R&D projects tuned to be ready for the TP
  - overall planning adapted to LHC schedule (2003@TP)
  - integration work, installation still under estimated
- ✓ cost:
  - top-down approach (465 MCHF for material costs)
  - subsystems design to cost
  - MOU and RRB (resource review board) define start

R&D period

(ATLAS LOI, 1992)

Detector Subsystem	R&D and Pre-prototype Activity	Comments
Inner detector - vertexing and innermost tracking	RD19 Si pixel detectors RD20 Si micro-strip detectors RD8 GaAs detectors	All are part of the baseline design, and R&D is needed to optimize integrated design
- outer tracking and electron identif.	RD2 Si strip and pad detectors RD6 TRD straw detectors RD28 micro-strip gas counters	All are part of the baseline design, and R&D is needed to optimize integrated design
	RD7 scintillating fibres	Alternative, R&D is needed to confirm the feasibility of the scheme
Em calorimeter and preshower detector	RD3 LAr Accordion	Baseline barrel, baseline option end-cap R&D is needed to optimize design
	P44 LAr TGT	Alternative barrel, baseline option end-cap R&D is needed to demonstrate feasibility
	RD1 scintillating fibres	Alternative, only reduced R&D is needed
Hadronic calorimeter	RD1 scintillating fibres RD3 LAr Accordion P44 LAr TGT Scintillator tiles pre-prototype	All are baseline options, and R&D is required to arrive at a decision before the Technical Proposal
Forward calorimeter	Liquid scintillator and High pressure gas pre-prototypes	Both are baseline options, and R&D is required to arrive at a decision before the Technical Proposal
Muon system - tracking detectors	RD5 honeycomb strip chambers High pressure drift tubes Jet cell drift chambers	All are baseline options, and R&D is required to arrive at a decision before the Technical Proposal
- trigger detectors	RD5 resistive plate chambers	Same comment as above
- general aspects	RD5 punch through, em showers etc	
Trigger - level 1	RD5 muon triggers RD27 calorimeter triggers, system aspects	
- level 2	RD2 and RD6 electron track triggers RD11 EAST general architectures	
- level 3	RD13 general architectures	
FE electronics	RD12 general read-out systems RD16 FERMI digital calor. FE/read-out RD29 DMILL radiation hard electronics (detector specific FE electronics R&D is included in the corresponding projects)	
DAQ system	RD13 general DAQ and readout RD23 optoelectronic signal transfer	

ATLAS Costs sharing



How was costs and its sharing finally decided

- *Overall cost envelop known within 10-20%*
- *Systems build up a cost estimation bottom up, trying to defend their % share of the ATLAS project*
- *Technical management acts as a system and comes out with its costs estimation of the services, magnets and common infrastructure --> common projects*
- *Iterative process which ended in the previous chart distribution*
- *Final overall cost negotiated with the CERN management*

How to share within a system?

- Each group finds the topic of interest (mostly already decided in the R&D collaborations)
- Each institute negotiates with its funding agency the value of its contribution
- Long series of meeting to brainstorm who does what and at which cost
- The problem is that the sum of the money put forward by the single institutions was higher than the total allowed cost. For some items nobody was interested
- Concept of deliverables : once an institute takes a responsibility for a given item this becomes a deliverable (fixed cost). Nobody will further investigate the final price. Each institution will have to find a way to finance it up to the end.
- How to account for the manpower costs (not industrial)? Every system does it differently. Mostly not accounted for (not even as FTE) to avoid discriminating between different funding approaches (i.e. difference very important between the way the US and Europe deal with manpower costs)

How to share common projects costs

- 44% of the entire construction work belong to common projects
- Decision to manage it centrally. Project leadership given to the Technical Coordinator
- Each funding agency contributes proportionally to their valued contribution in the 5 detector systems
- Each institution contributes a minimal membership fee of 12.5 KCHF per year, for the entire construction period … this produces a minimal amount of cash

How to share the common work?

- *Common projects centralized*
- *Normally it is up to the CF funding agencies to contribute in cash or not*
- *Possibility to contribute in kind (same deliverable concept), taking the risk of overcosts to be absorbed by the funding agencies*
- *Many in kind contributions in place (pending RRB acceptance)*
- *Very effective solution that minimizes all management activities … but point of view schedules it is very difficult to handle*

But when technical problems arise, most institutions come back asking for central financial help

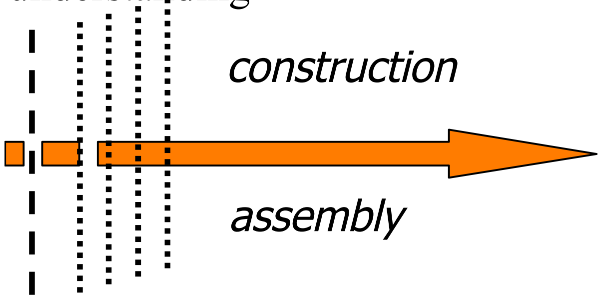
RRB (resource review board)

- Model taken from LEP, 1 delegation per funding agency.
- Each funding agency has the same voting power, independent of their contribution
- The RRB monitors in first place the way common resources are collected and spent
- Spending authorization once per year, previous acceptance of the proposal for the year to come
- RRB pushing for national in-kind contributions, management playing the game
- RRB allergic since the beginning to cost changes/increases
- 2 meetings/year …. some very difficult (~ 1999 to 2001)

Construction phase (1996-2007)

MOU

memorandum of understanding



TDRs

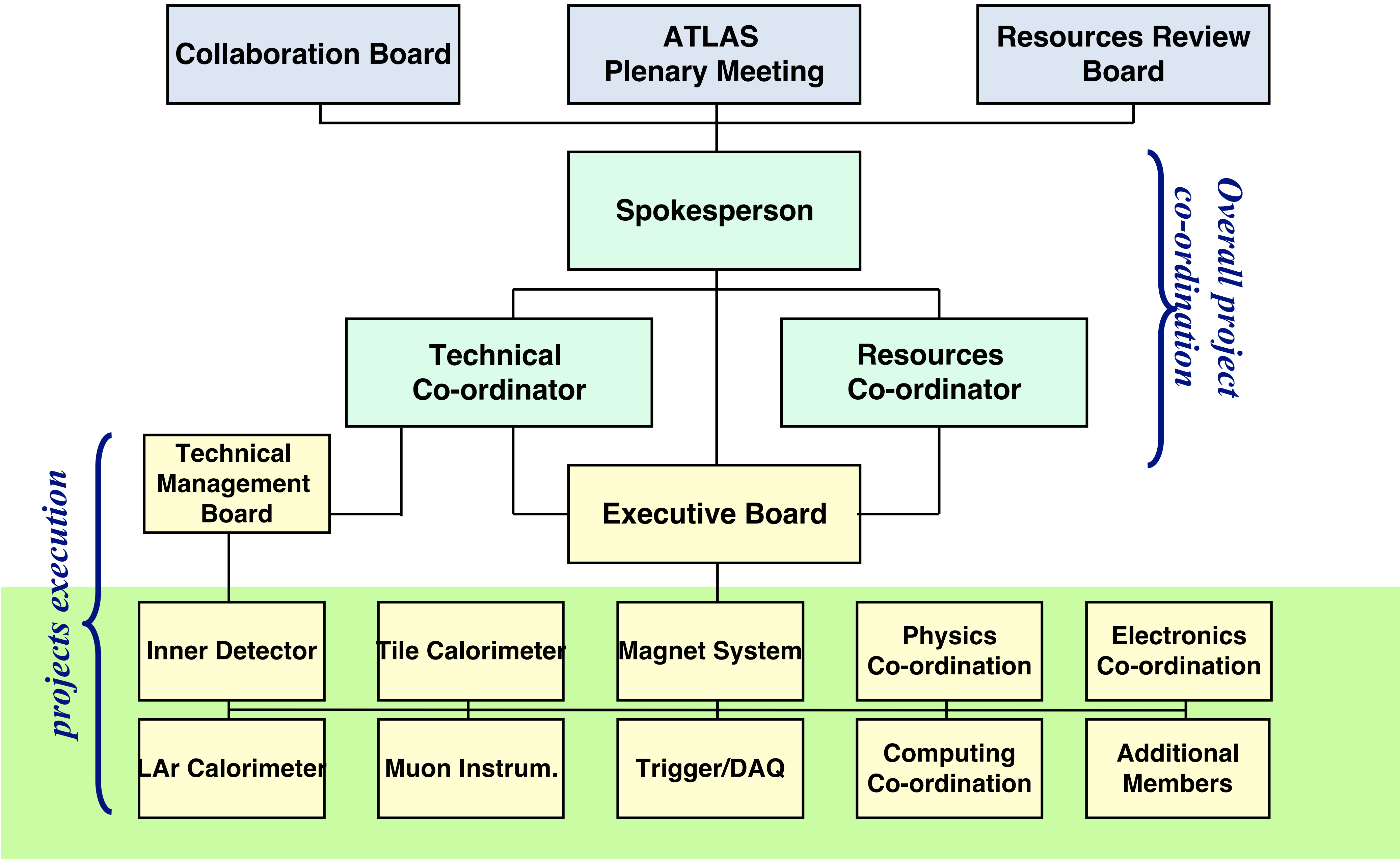
technical design reports

- ✓ MOU process bottom up (1996), final version dated 1998
- ✓ Systems leaders and institutes capable to commit their own resources, with minimal checks back to the funding agencies. Process iterative.
- ✓ Commitments strong and persistent
- ✓ Then one by one all systems through the TDR process, starting from the calorimeters
- ✓ TDRs based on the concept of module 0 as bench mark of the final technology … this has made ATLAS very strong on systems development
- ✓ initial planning:
  - very aggressive since the beginning, but badly monitored
  - review process as fundamental ingredient
- ✓ cost:
  - permission to spend money bound to the review process

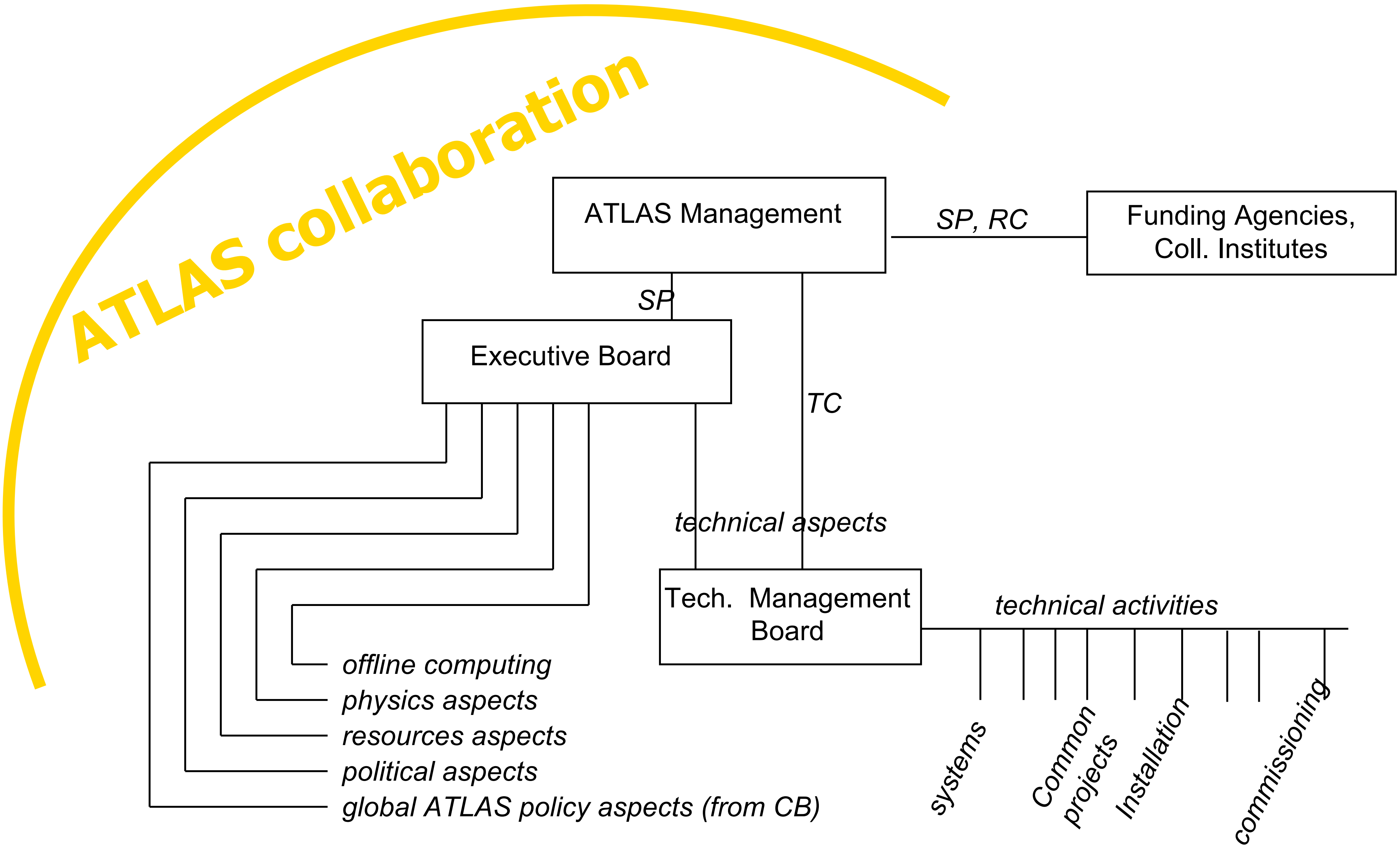
TDRs

- Starting from the calorimeters in 1996, all systems write their technical design report
- = technical specification which defines totally the project.
- Module 0 concept to validate the technical choice and give credit to the planning, strong importance given to tests in beam
- Integration TDR just in 1999, concept there, but details missing
- Individual systems schedule adapted to the official LHC start up. All major steps of production well defined and realistic, but not sufficiently detailed
- Schedule optimistic with no contingency, no time to solve problems and assuming perfect financing timing
- Community was just starting to use tools like MSproject for planning!

Project Organization



…. In practice



ATLAS collaboration
ATLAS Management
SP, RC
Funding Agencies,
Coll. Institutes
SP
Executive Board
TC
technical aspects
Tech. Management
Board
technical activities
offline computing
physics aspects
resources aspects
political aspects
global ATLAS policy aspects (from CB)
systems
Common
projects
Installation
commissioning

TCn Organization (from 2000)

activities

- A) TC project office
  - Schedules +Milestones
  - Resources
  - PPT/CDD EDMS/WWW
  - QA office
  - Review office
  - GLIMOS
- B) CERN Divisional relations
  - Interface to EP/Div
  - EP Interface for outsourcing
  - LHC machine
  - CERN team resources
- H) Commissioning
- C) Systems Construction Liason
  - Follow up office
  - Inner detector
  - LAr calorimeter
  - Tile Calorimeter
  - Muon System
  - Luminosity monitors
  - Test Beam
- D) Electronics and Signal processing
  - Follow up office
  - DCS
  - TDAQ
  - Mass-storage
  - Detector DB
  - Front End Electronics
  - Computing support
- E) Common systems
  - Follow up office
  - Magnets / B-Fields
  - Cryostats
  - Cryogenics
  - Supports / movements
  - Shielding / Rad. Map
  - Vacuum pipe
- F) Integration and Installation
  - Configuration control / Space
  - Services
  - Safety projects
  - Infrastructure
  - Subsystems installation
  - Survey and alignements
  - Technical support
  - Opening and Access
- G) Logistics + experimental areas
  - PIT area organization
  - Experim. area infrastructure
  - General services
  - Logistics support
  - PIT logistic
  - Control room
  - Power and racks
  - Assembly/ Storage Areas

Organization during construction

- ✓ Matrix structure; every institute is responsible of the work which has been assigned to him; The concept of "deliverables" was introduced

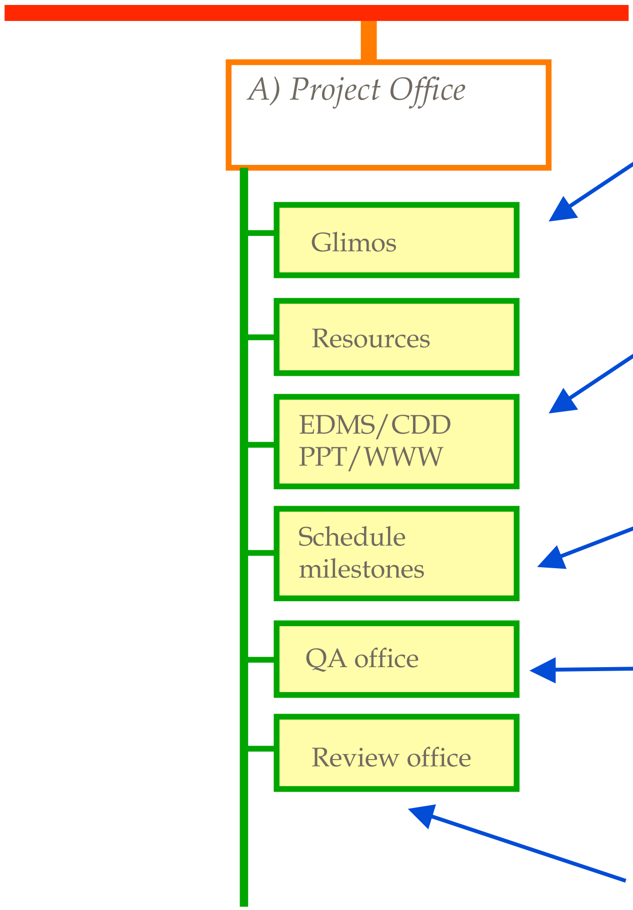
- ✓ Groups of interest formed (systems, subsystems, working groups,..). Each sub(system) has its own internal organization which reflects in a smaller scale the ATLAS organization. Each system has a project leader and an institute board which manages activities and resources. System resources are not managed centrally. Institutes very independent!

- ✓ About 45% of the ATLAS project consists of common activities (magnets, structures, cryogenics, integration, installation and commissioning). Technical Co-ordination handles all this with central common funds. Part of this is again assigned via in-kind deliverables.

- ✓ The monitoring of the project is the job of the Collaboration Board. All management positions are assigned by election. Re-election possible with 2/3 majority.

  TC monitors the technical execution of the system activities (including schedules) and reports to EB and CB

Project Office



ATLAS safety officer

Safety rules, link to TIS, safety agreements,…

Management tools and procedures

Handling of documentation, approval process, WWW pages,…

ATLAS schedules and milestones

Coherent and dynamic approach across ATLAS via PPT (project tracking system),…

Engineering change requests organization

Handling of ECRs, QA rules and planing,…

Large review effort of all collaboration activities

DRs, PRRs, PARs, ASSOs schedules, procedures,.….

How to control the schedule ?

✓ Production :

- *>1000s production work packages*
- *scattered worldwide*
- *concept of deliverables (55%), central contracts (45%)*
- *outside institutions keep strong autonomy*

✓ Assembly/installation :

- *converging to CERN*
- *a lot of resources sharing*
- *strong interference and dependences across the project*
- *very complex schedule, need to adapt to fast changes in production and changes imposed by technical problems*
- *high expectation from users (institutes) which confuse ATLAS with CERN*

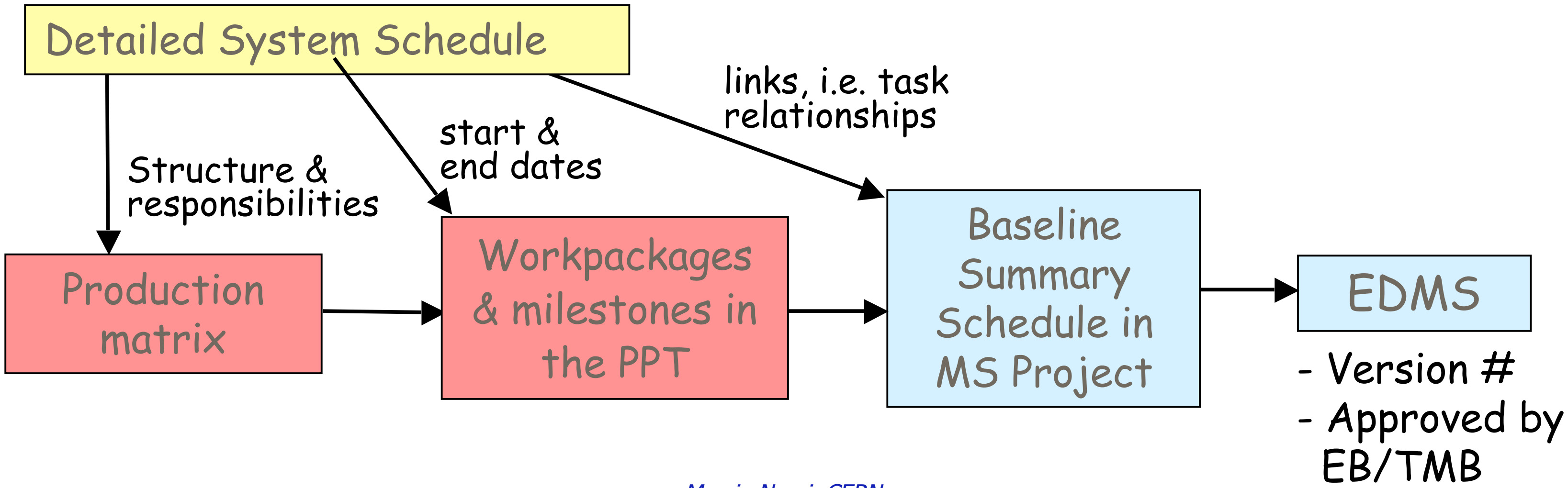
…. During production

- Components delivery schedule depends on the overall installation schedule
- We introduced the concept of ready for installation milestones (delivery at CERN 4 months before it is actually needed) as an internal contingency
- RFI as practical interface between production and installation
- We forced recovery plans to save these RFIs at any moment
- It took 1 year to impose the concept and have everybody on board
- Important was to get each producer to buy in and at the same time to share with us their internal schedule
- No system was strong enough to fully control fully internal production schedule

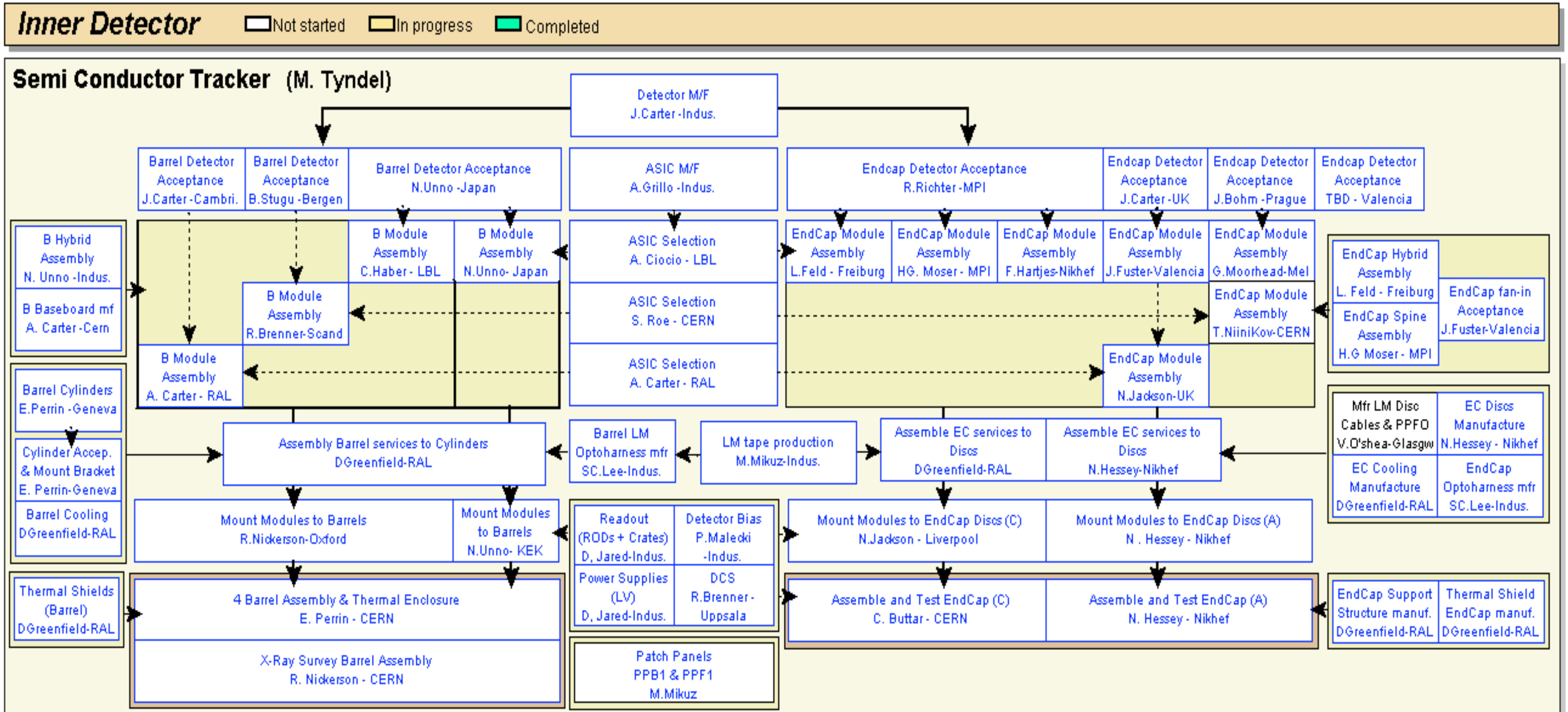
Production schedules

We maintained a Summary Schedule for each ATLAS (Sub-) System and Activity.
The Summary Schedules:

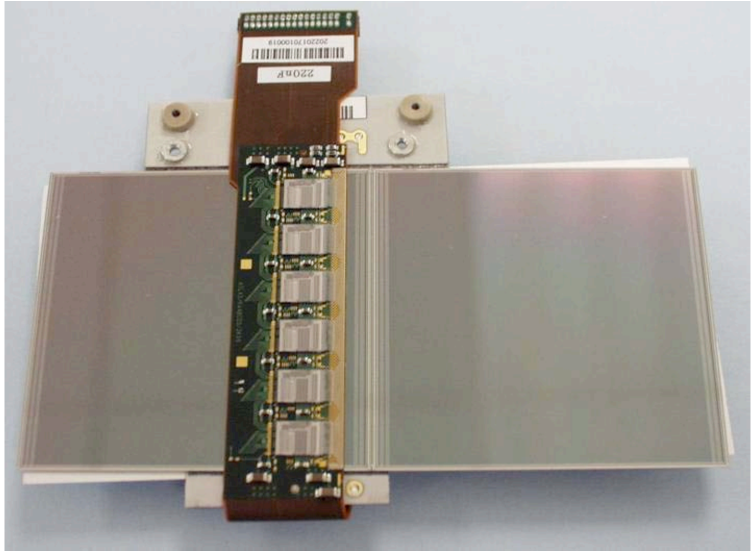
- *consist of major milestones and Work packages stored in PPT (project progress tracking system)*
- *are scheduled in MS Project*
- *are formally approved (baselined) by EB and stored into CERN EDMS*
- *are loaded into the PPT for progress tracking*
- *are updated tri-annually by importing actual and estimated dates from the PPT*
- *are linked to the Installation Schedule via Ready For Installation milestones*
- *consist of a new set of LHCC milestones*



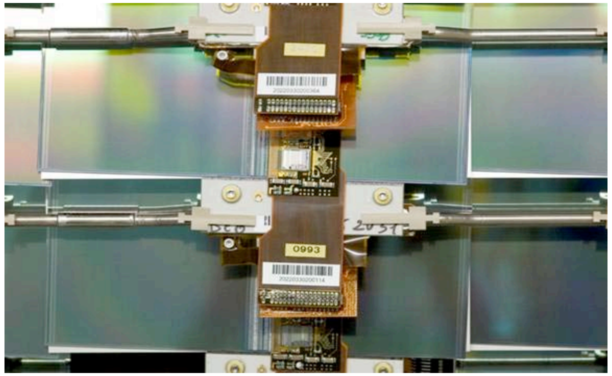
Example SCT tracker

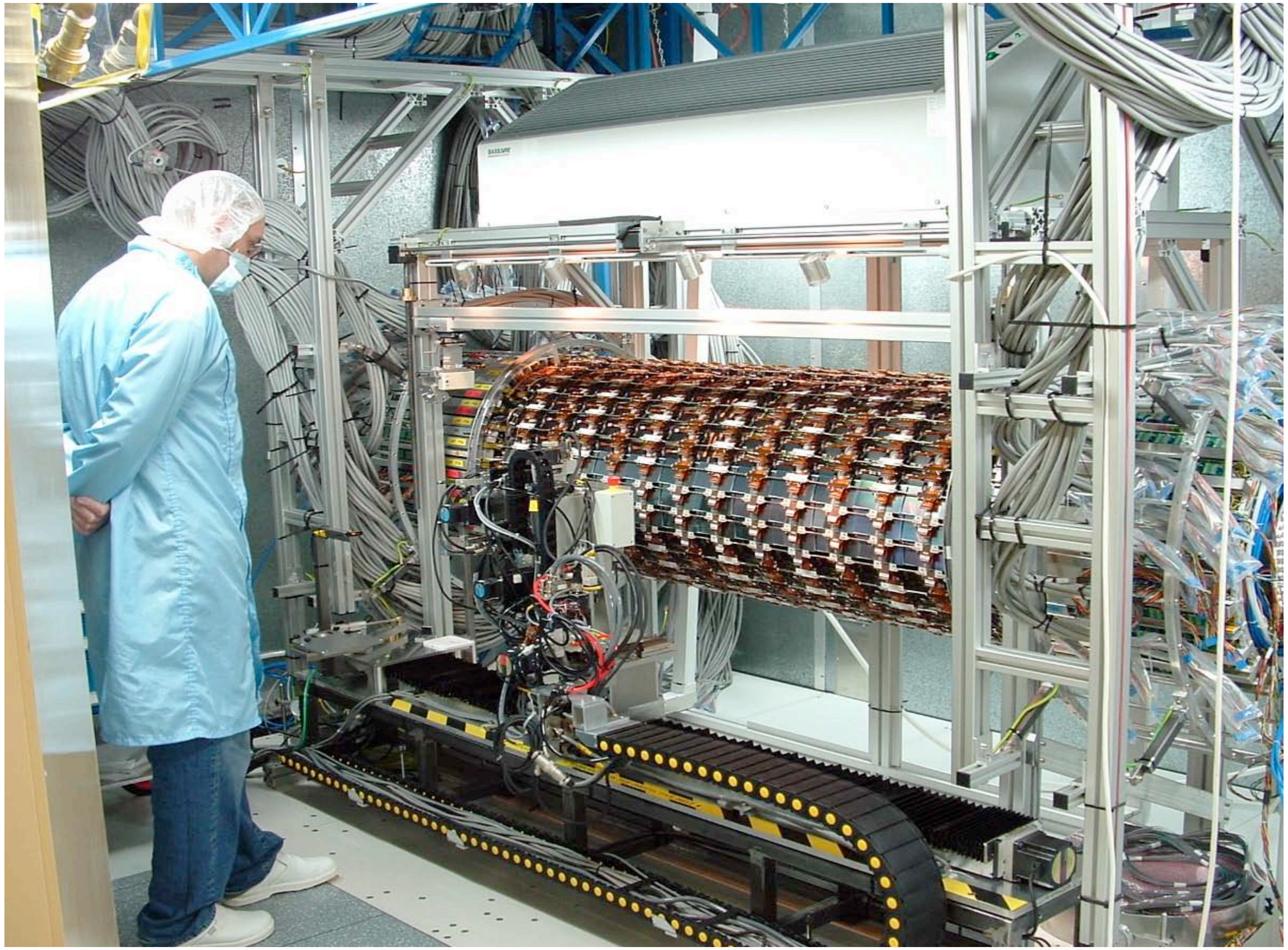


SCT barrel



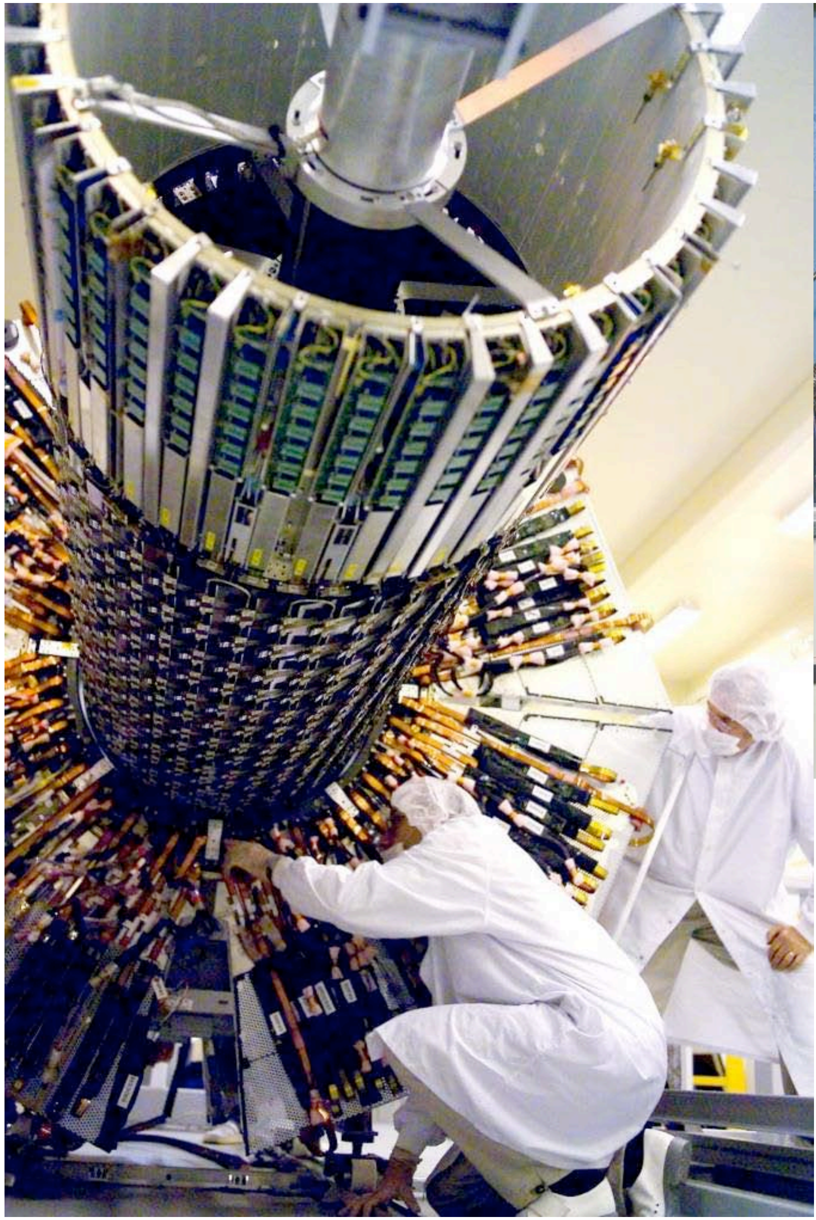
All sensors procured, all modules have been produced (final yield > 90%). Sensor alignment and position tolerance typically +/-5 μm

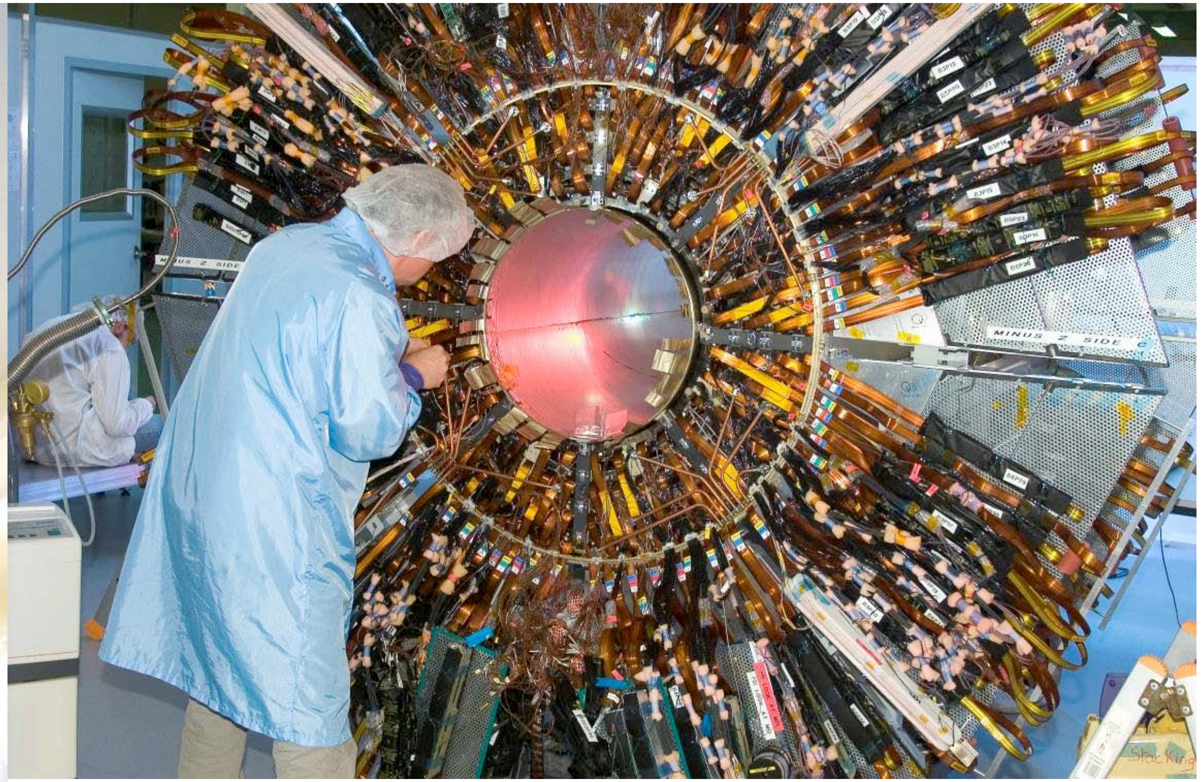




Macro-assembly of the modules on the support cylinder using a dedicated robot. Support cylinders equipped with services

SCT barrel

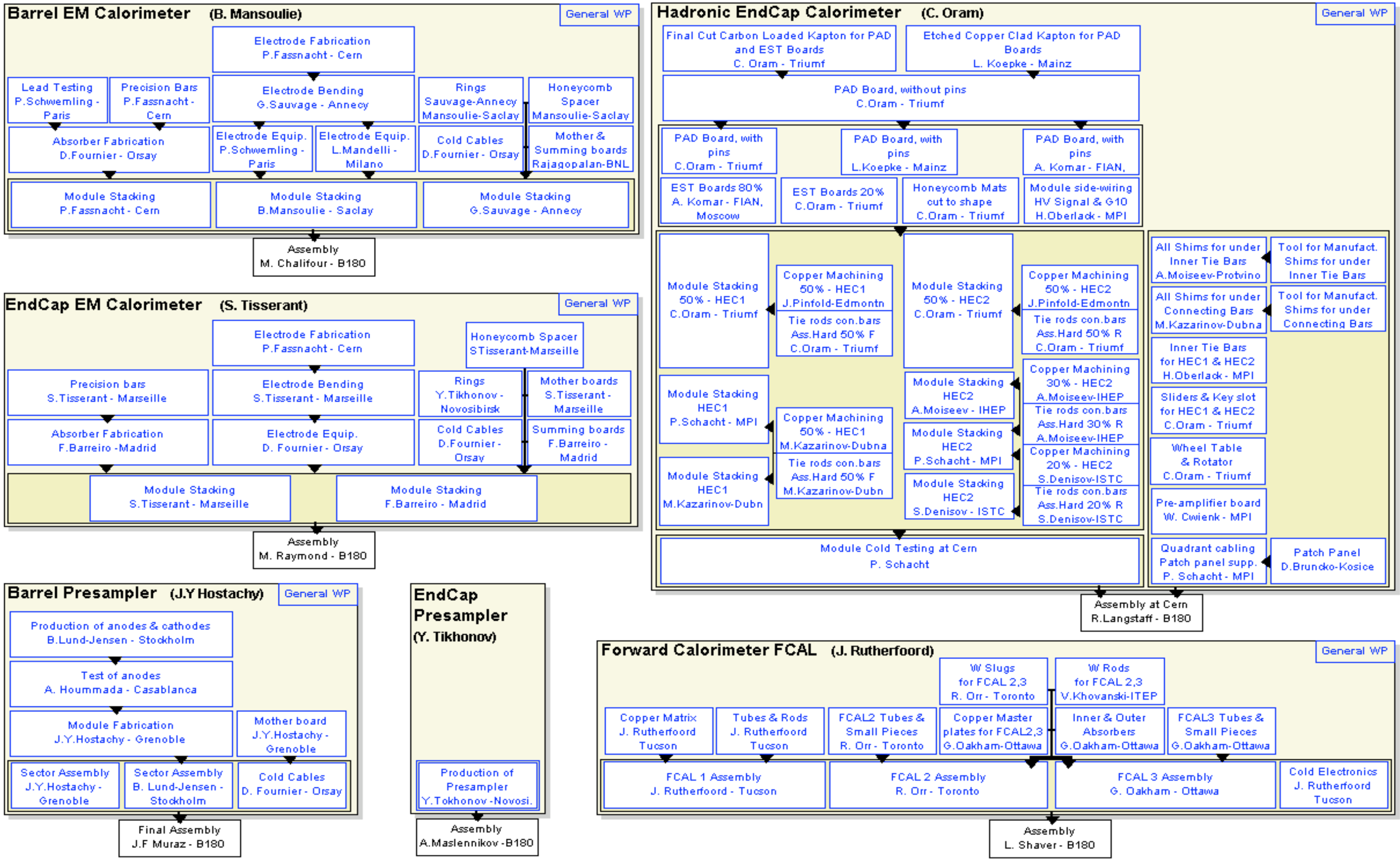




The pictures show different stages of the integration of the four barrel SCT cylinders

The cylinders have been tested: 99.7% of all channels fully functional

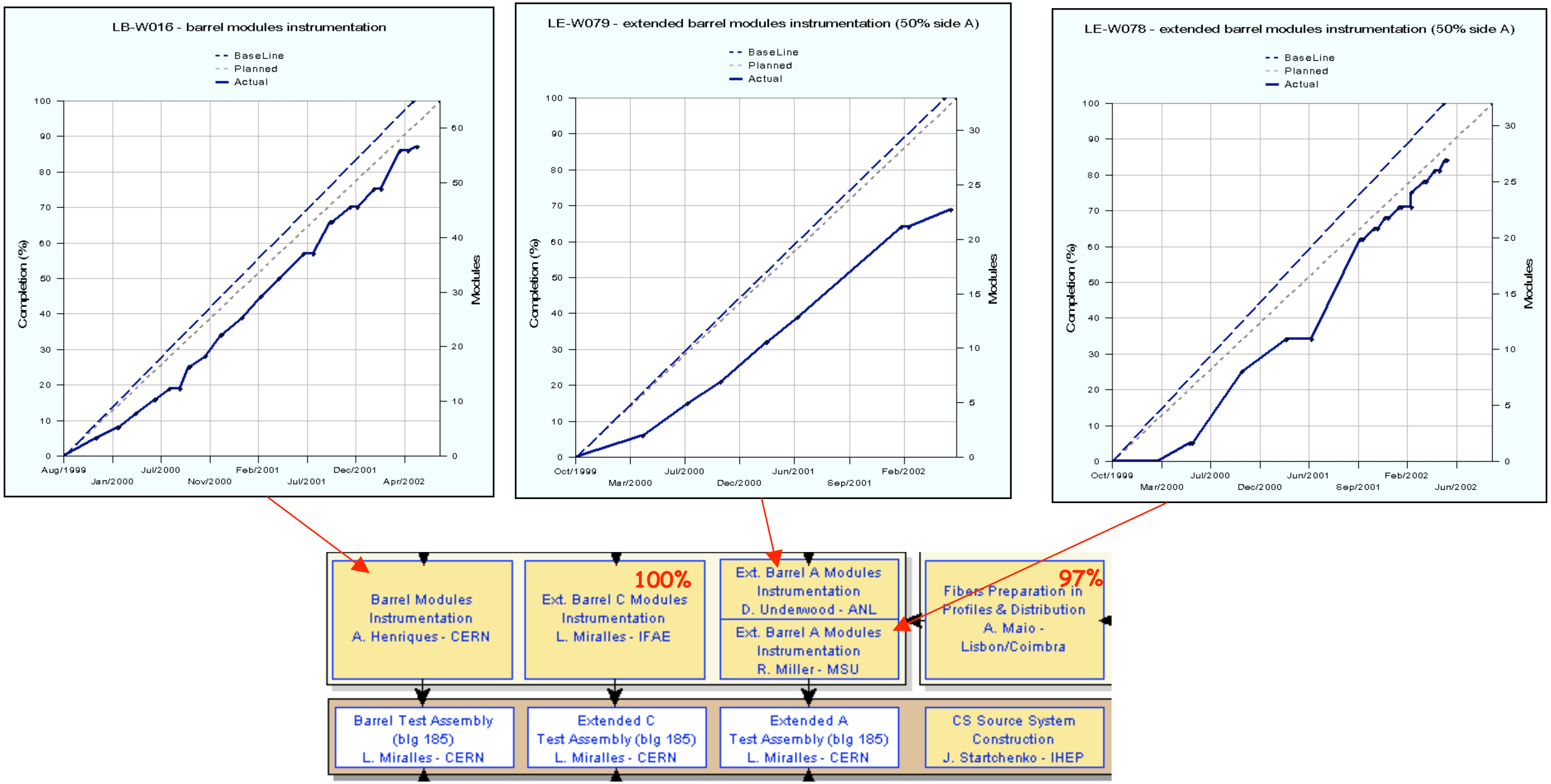
Example LAr calorimeter mechanics



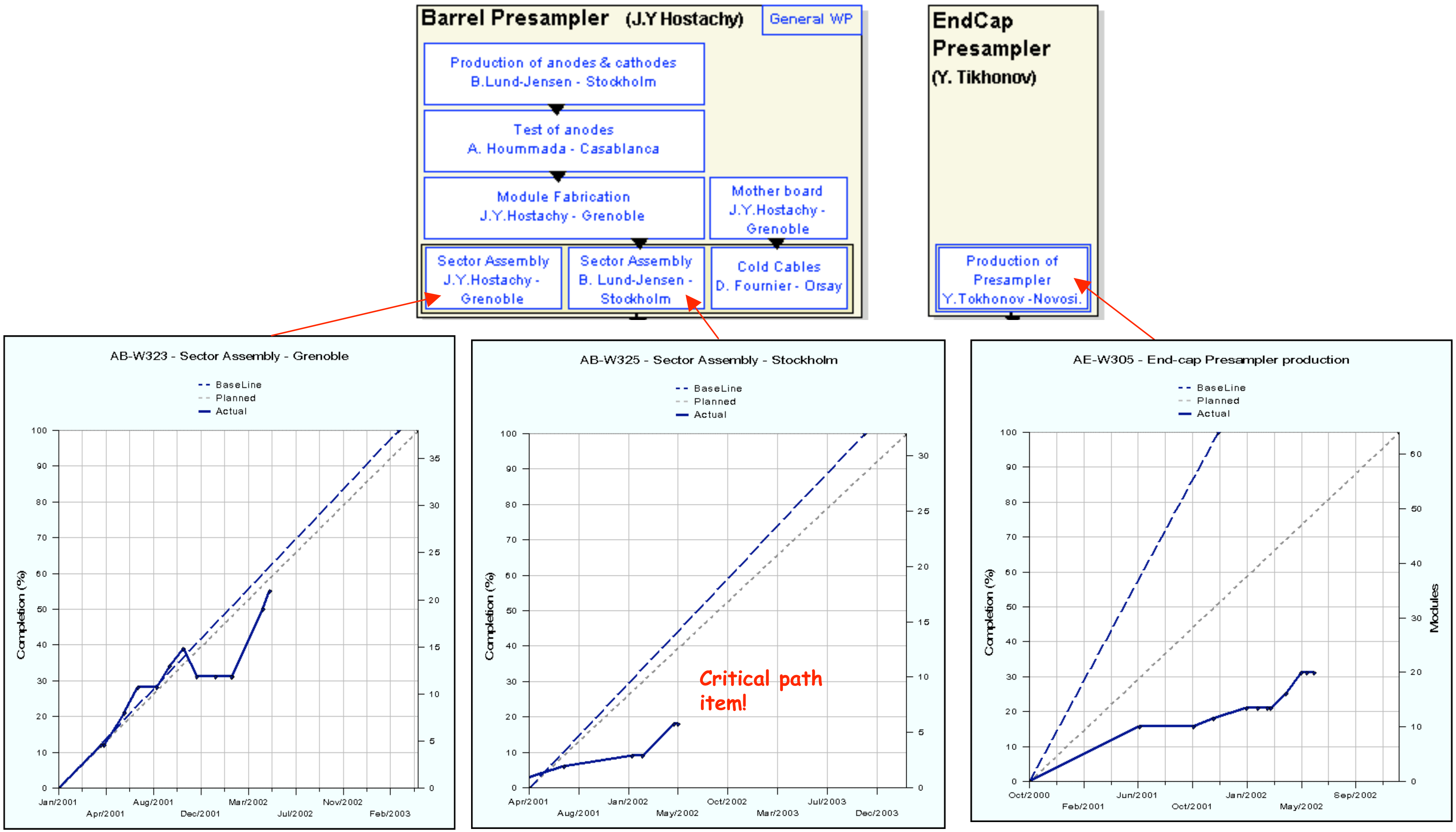
Method

- Once the matrix is establish (including production milestones) we activated the reporting
- Every month the work-package responsible is triggered to fill in a written report and justify achievements and delays and fill in a % of work done (units, assemblies,..) and comments on milestones achievements
- The report is going to the project leader concerned who accepts or rejects the report
- We monitor every 3 months the projects globally, reporting to the collaboration the overall progress and flagging the critical path, proposing recovery actions
- 97% of the WP holders agreed to it, for the remaining 3% took 2 years to adapt to it
- We could not monitor costs, because of the huge differences in facing the concept of deliverables
- Detector systems and common project went though the same process

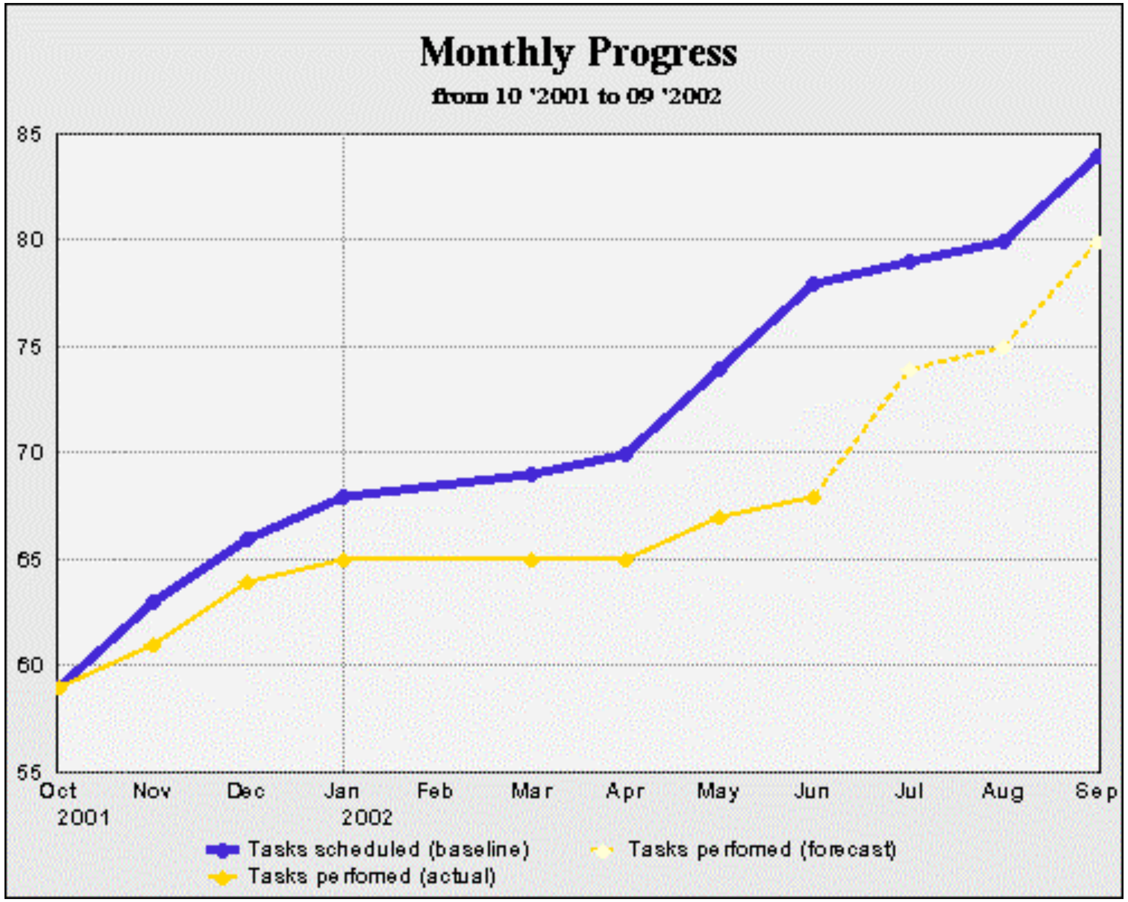
Reports (logbook text + graph)



Spotting problems



Monitoring milestones



- Curves diverging due to delays in the production of Drawers, Digitizers, and Adder cards.

Summary PPT (status 2003)

1509 EB & LHCC milestones

817 Workpackages

Project	Official		System			Total	
	ATLAS LHCC Milestones ATLAS EB Milestones		Standard ATLAS WorkPackages ATLAS System Milestones			All	
ATLAS Detector	1509 876 active, 66 due.	.csv	958 578 active, 112 due.	(817 wp)	.csv	2467 found 1454 active, 178 due.	.csv
1 - Vacuum Beam	33 24 active, 1 due.	.csv	8 none active.	(8 wp)	.csv	41 found 24 active, 1 due.	.csv
2 - Inner Detector	312 237 active, 17 due.	.csv	138 73 active, 2 due.	(137 wp)	.csv	450 found 310 active, 19 due.	.csv
3 - Solenoid Magnet	10 2 active, none due.	.csv	none found.			10 found 2 active, none due.	.csv
4 - LArg Calorimeter	273 142 active, 7 due.	.csv	205 120 active, 30 due.	(178 wp)	.csv	478 found 262 active, 37 due.	.csv
5 - Tile Calorimeter	96 25 active, none due.	.csv	143 60 active, 36 due.	(141 wp)	.csv	239 found 85 active, 36 due.	.csv
6 - Toroid	47 18 active, none due.	.csv	115 81 active, 20 due.	(33 wp)	.csv	162 found 99 active, 20 due.	.csv
7 - Muon Spectrometer	355 209 active, 19 due.	.csv	95 72 active, 4 due.	(81 wp)	.csv	450 found 281 active, 23 due.	.csv
8 - Shielding	37 28 active, 4 due.	.csv	19 11 active, 5 due.	(19 wp)	.csv	56 found 39 active, 9 due.	.csv
9 - Support Structures	104 72 active, 11 due.	.csv	37 11 active, 4 due.	(37 wp)	.csv	141 found 83 active, 15 due.	.csv
10 - DAQ, Trigger, Control	142 66 active, 2 due.	.csv	92 59 active, 2 due.	(92 wp)	.csv	234 found 125 active, 4 due.	.csv
11 - ATLAS Offline Computing	29 10 active, 1 due.	.csv	none found.			29 found 10 active, 1 due.	.csv
12 - ATLAS Technical Coordination	2 2 active, 2 due.	.csv	74 64 active, 9 due.	(65 wp)	.csv	76 found 66 active, 11 due.	.csv
13 - ATLAS General Facilities	69 41 active, 2 due.	.csv	32 27 active, none due.	(26 wp)	.csv	101 found 68 active, 2 due.	.csv

Review process

- Centrally organized (TCn): One review officer running most of the reviews
- Reviewers selected within ATLAS
- Several levels of reviews :
    - *Design reviews*
    - *PRR : readiness reviews which give the permission to spend money*
    - *Advancement reviews : to check progress (10%, 50%)*
    - *ASSO : overall monitor of large subprojects from the organization point of view*
- PRRs requested by the funding agencies to release construction money
    - very intense process, review scheduled as milestone in the PPT system
    - at the beginning very opposed by the systems
    - at the end systems asked for it, in particular when problems raised
- CERN man. organizes a parallel review structure, which has never made a substantial impact in the process (LHCC), but was/is good at the RRB level

Did it work?

- Yes, at least we got a realistic and always up-to-date picture
- Objective picture without intermediate management interpreting the status
- All was WWW published to allow the collaboration to check on it
- At some point it was used also by the systems to make propaganda!

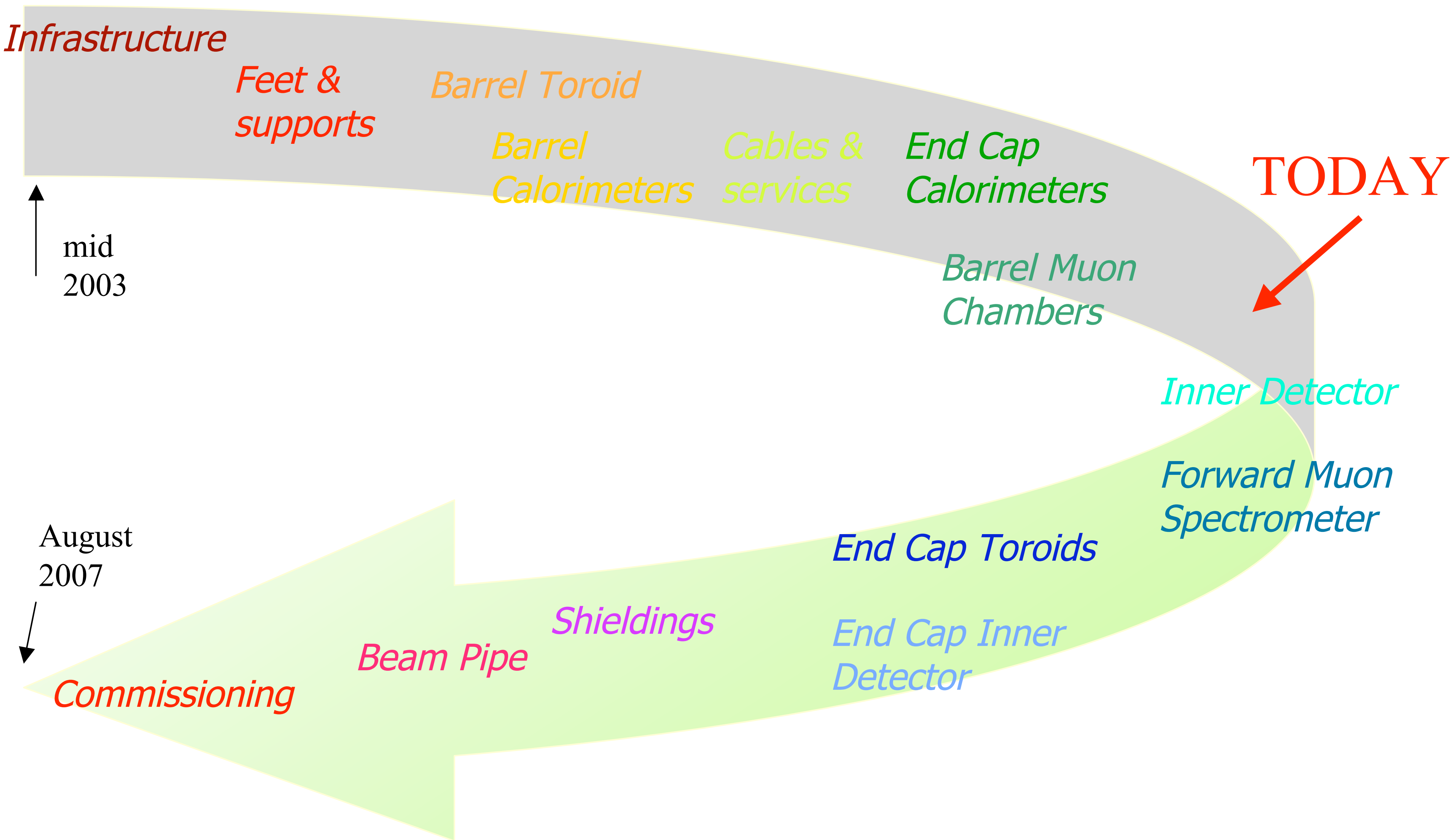
- Very heavy procedure
- A lot of traveling for reviews and for triggering actions

- Last 5% difficult to monitor, because the definition of the end of a job is a difficult concept with different interpretations (reworks, repairs,..).

- This system + a monitoring of the resources spent was then adopted for the machine (EVM) …. Impossible to adapt it to the experiments !

- Impossible to adapt it to the installation work!

Installation underground



Installation and commissioning

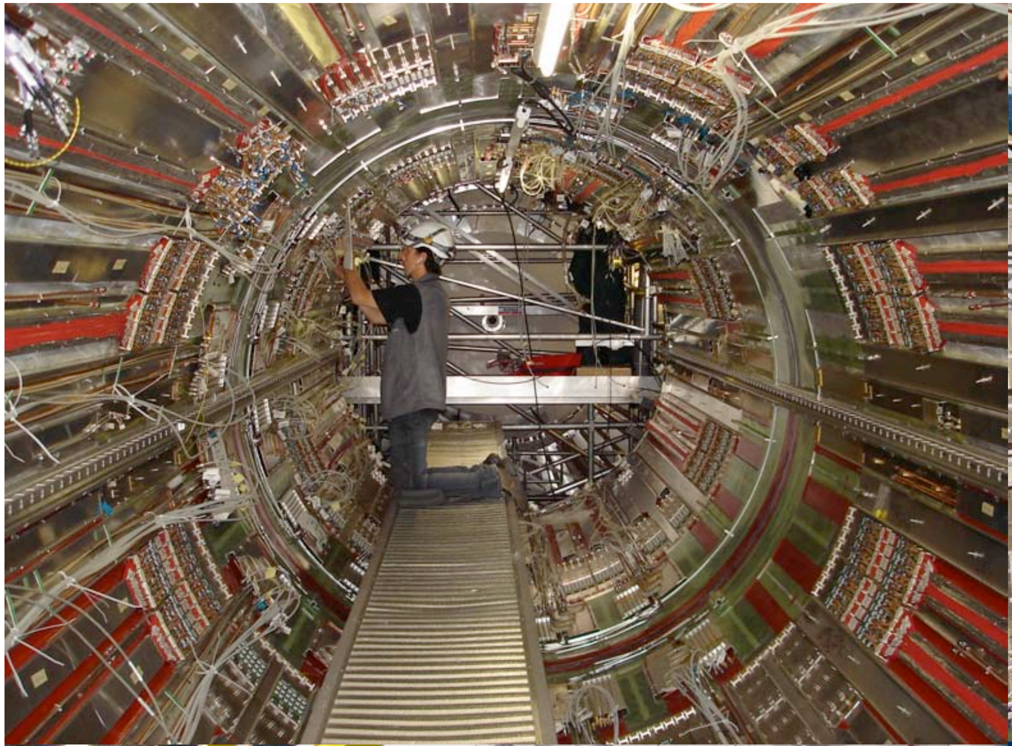
- Very different from production

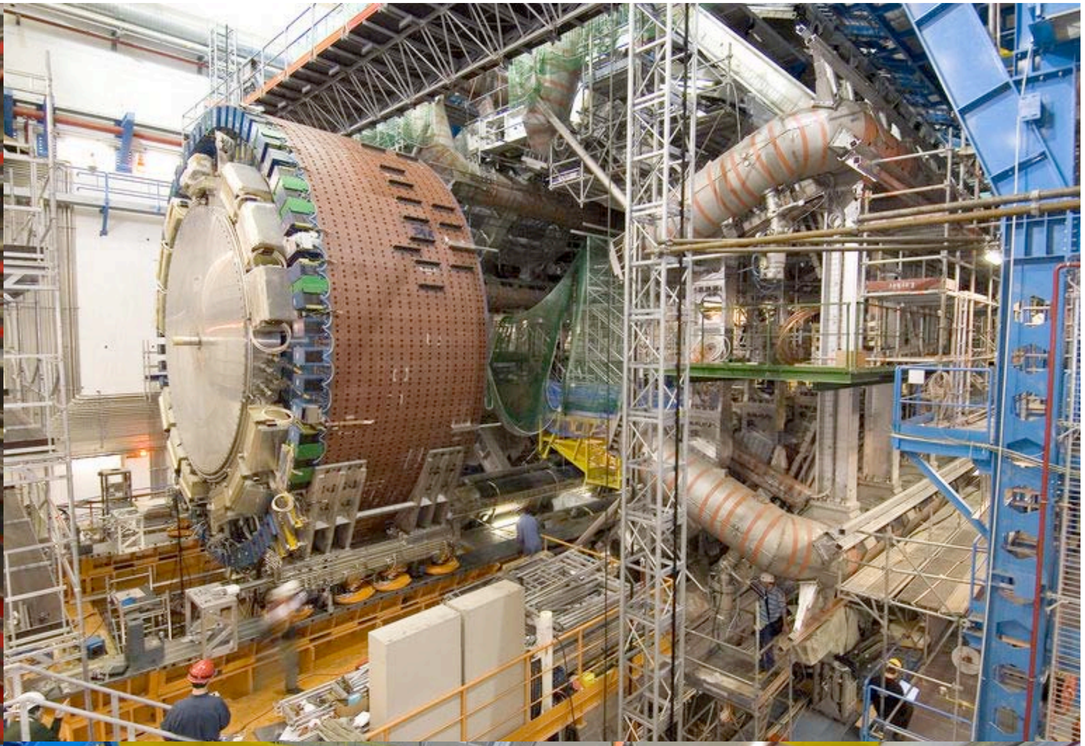
- Main issues are:
  - Cohabitation of activities
  - Configuration control (to avoid geometrical conflics (we work at the mm level))
  - Safety
  - Avoid lost of time, no way to take out installed parts
  - Correct level of information sharing
  - Avoid damages to installed equipment
  - Dependences across activities

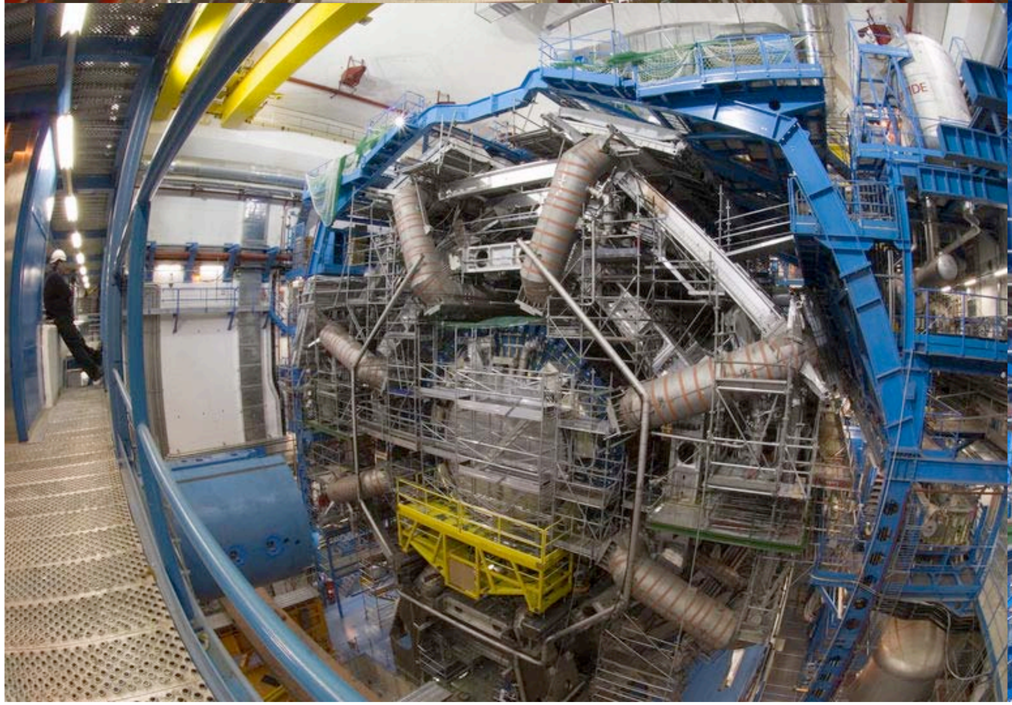
- Large amount of personnel sharing the same logistics (today ~250 at Point 1)

- An effective scheduling process is mandatory, without caos after few weeks (difficult for physicists to accept)

We started mid 2003







Strategy

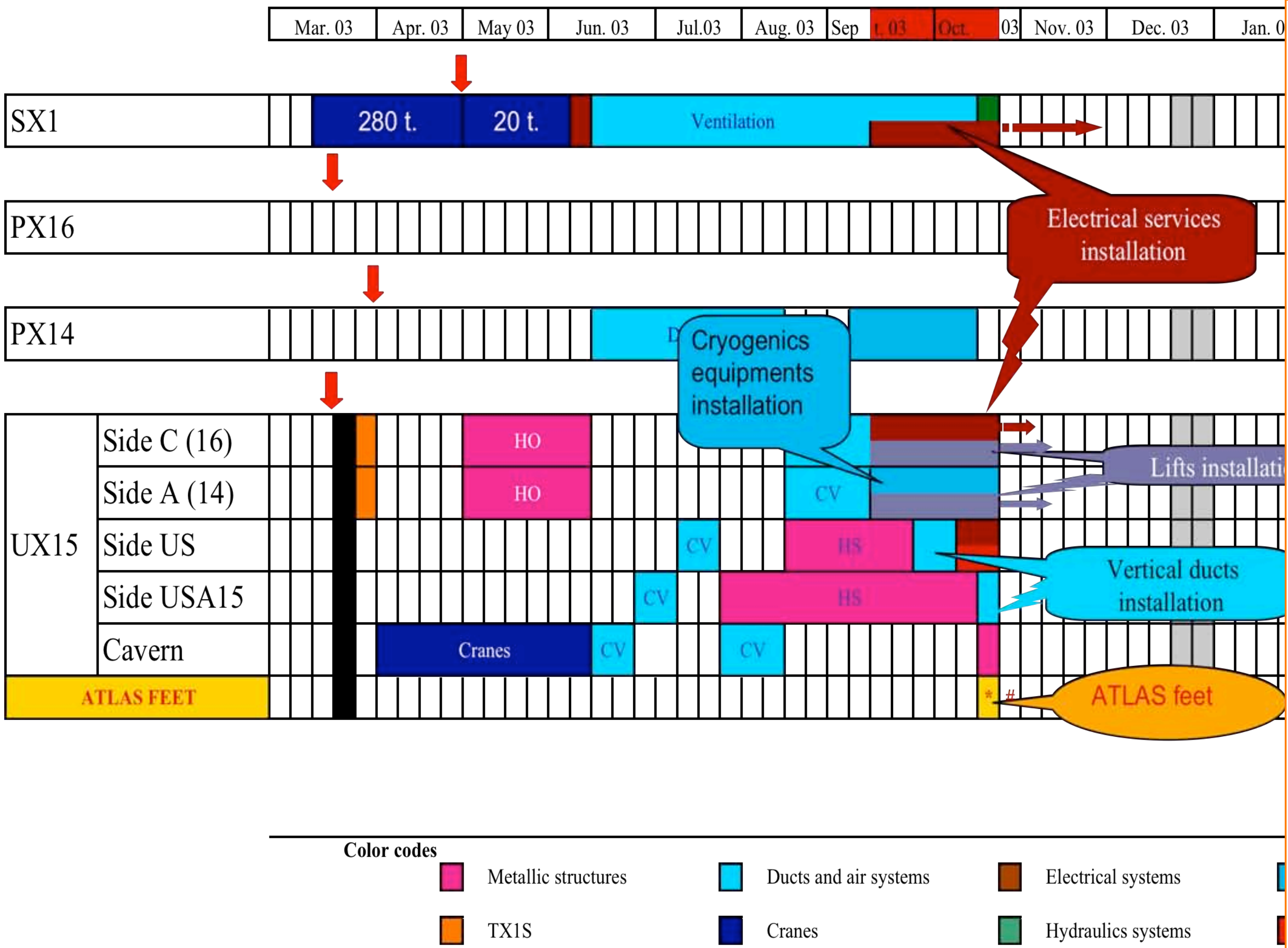
- ✓ Overall planning has been worked out in detail in 2003 (~2000 tasks)
- ✓ …. Then re-adapted on a regular basis to reality (every 6-8 months)

- ✓ We maintain a detail schedule of all tasks for the next 3 months and this is updated every Monday (in MSproject format)

- ✓ We run every week 1 hour discussion with each individual systems, to explain, push and then tune the process
- ✓ Every week we work out the logistics operations of the week and every day at 8:00 we adapt it to the needs.

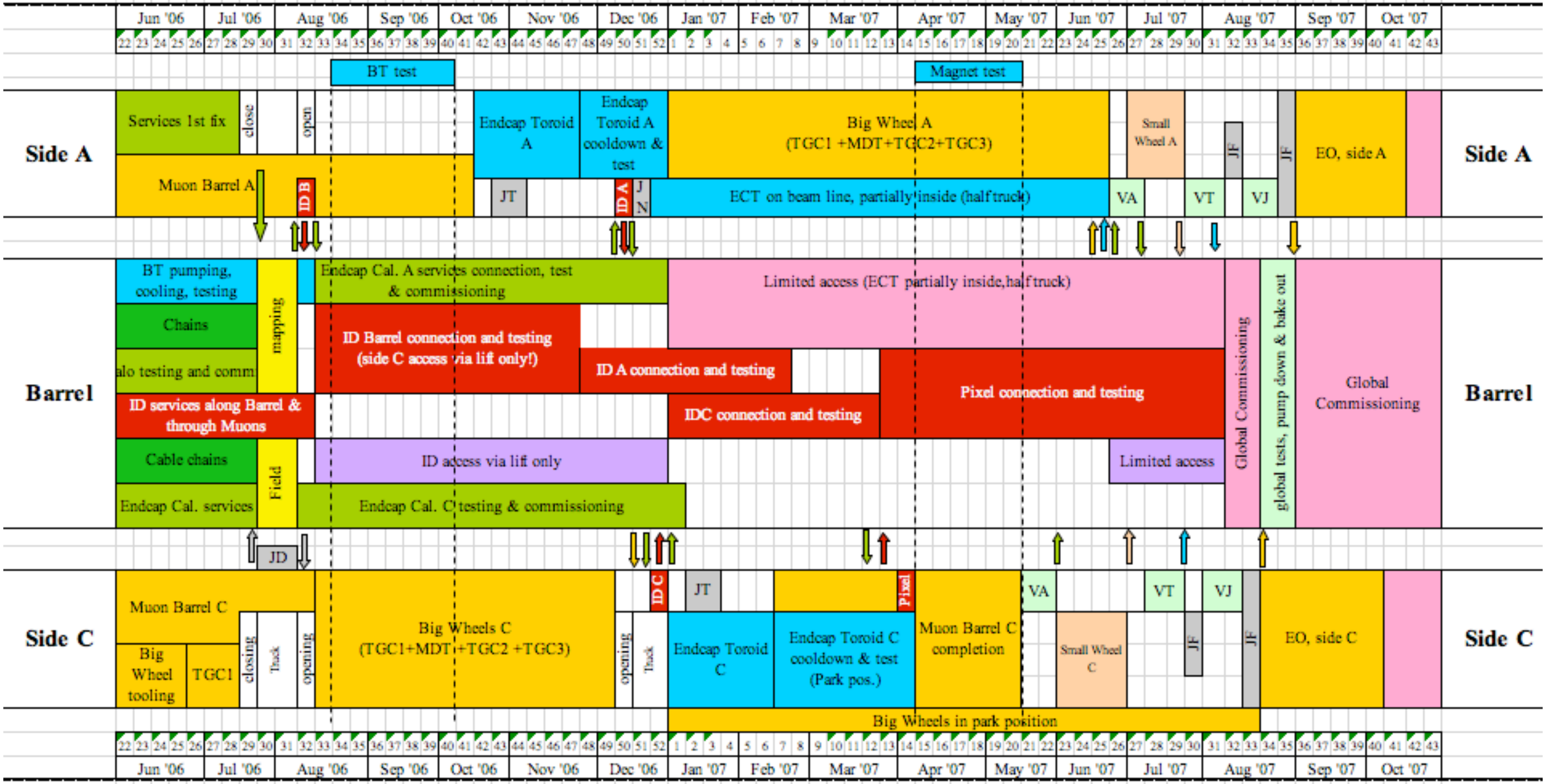
- ✓ We centrally control most of the resources needed for this operation (manpower and support material) … if not, all this would never work!
- ✓ We keep the system always in an excited state

Installation schedule



- ✓ We keep a full MS project version with best knowledge of the process
- ✓ This version is of no use for non experts, just few people profit from it. Used to find dependencies
- ✓ Best way to communicate the schedule is a pictorial view, were people can easy find their job and time assigned to it
- ✓ We then keep a very detailed schedule with all possible details and relations for the next 3-4 months to come …. and people use this
- ✓ Process to complicate and most partners in the process do not want to know, they just trust us! They just need to know when they can have access

ATLAS Installation schedule ver. 8.0



Daily follow up

Monday :	***09:30 - 10:30***	Toroid installation
	14:00 - 15:00	Schedule (next 3 months)
Tuesday:	***08:00 - 09:00***	Muon installation
	09:00 - 10:00	Point 1 management (EAM)
	10:00 - 11:00	Counting rooms management(CRM)
	11:00 - 12:00	Commissioning
Wednesday:	***08:30 - 09:30***	ID installation
	09:30 - 10:30	Calorimeters installation
Thursday:	***09:00 - 10:00***	Services installation
Friday:	***09:00 - 10:00***	Forward muon installation

On the ATLAS agenda system,
minutes/actions on EDMS/agenda system,
possibility to connect by phone

Work organization

- All work organized in Work Packages (WPs) independently if executed by external firms, ATLAS users, CERN staff : everybody follows the same rules (infrastructures installation , detector components installation, services installation, commissioning activities). WP definition very formal process, with documentation, analysis session and in situ readiness inspection

- Working forces strategy:

  - *Infrastructure WPs assigned to industrial contracts. Today in UX15 confined to the blue access HS/HO structures.*

  - *Cryogenics mostly assigned to specific groups (CERN/EA/ECR, ATLAS/Grenoble, ATLAS/CEA, ATLAS/BNL). Work where necessary subcontracted to specialized firms, under strict ATLAS/CERN supervision.*

  - *Detector components installed by ATLAS TCn technical pool (25-30 FTE, mixture of CERN staff and collaboration manpower centrally organized)*

  - *Services installation subcontracted to industrial contracts outside the detector. Executed by ATLAS TCn specific teams on the detector (cabling, pipes, bus-bars, cable trays, access structures,..) (today ~ 35 FTE)*

Work organization(2)

✓ Working forces strategy (2):

- *All transports, craning activities executed inside CERN TS contracts (firm DBS), 7 crane drivers permanently at Point 1 + CERN and DBS supervisors*

- *All special transports, special manipulations on specific ad-hoc contracts with specialized firms (CERN based contracts)*

- *Scaffolding constructions subcontracted to specialized firms or to qualified and certified TCn technicians where appropriate (on the detector). Final check by Swiss Work Inspectors or CERN safety coordinators.*

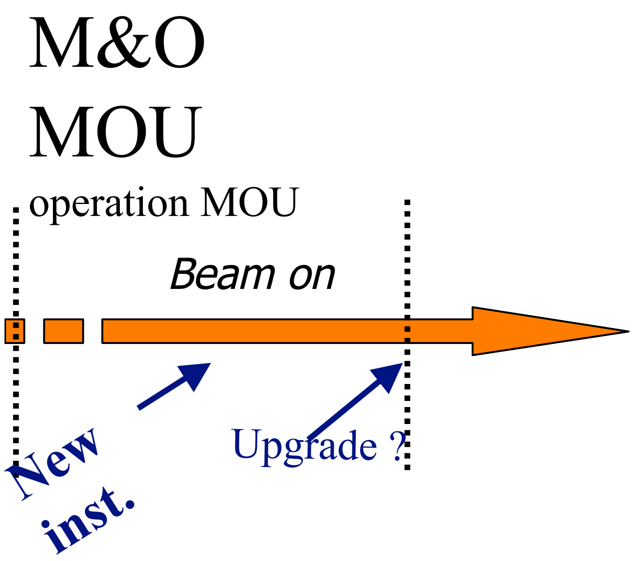
- *Commissioning WPs organized formally and executed by collaboration specialized manpower (systems experts) or CERN support groups.*

Many actors (WPS) present at Point 1 and underground at the same time (up to 50 activities) and working in parallel, some time sharing the same logistic resources

Work organization(3)

- All Work Packages (WP) are directly supervised by a CERN or ATLAS local supervisors
- All planning activities steered by 2 planning officers (1 for the detector + commissioning, 1 for infrastructure). Overall schedules and milestones + expanded and detailed schedule for the next 3/4 months activities (daily granularity) steered centrally
- Detector installation and detector commissioning coordination in place and active in preparing, analyze and coordinating the various WPs
- Onside overall supervision active (mostly to enforce safety, 5 FTE):
    - for installation : EAM (Experimental Area Management)
    - for commissioning : CRM (Counting Rooms Management)
- Safety matrix in place and active in situ, frequent inspections (from GLIMOS+CERN safety coordinators every week, incl. written report)

Operation phase (2008-2020)



- ✓ Detailed planning just started
- ✓ Today first estimation call for ~150-200 FTE present at point 1 over 1 day, working on shifts
- ✓ Transition from construction to operation difficult. People might have lost the main motivation
- ✓ Already working on the Upgrade (2016) of some components (in particular Inner Detector)
- ✓ The collaboration will keep expanding

✓planning:

- Even more dynamic, continuous changes, 24/24 h, 7/7 d
- This time the master clock is given by the beam
- Schedule officer very important, need to be a physicist to understand the entire process

Conclusion (personal opinion)

- *Very complex project to manage ! Very different from any other project of this scale*
- *Methods and style have to adapt and evolve with the project*
- *Production different from Integration*
- *I doubt there is a unique way to do it*

- Schedules drivers are : communication, motivation and factorization
- Un-expected problems or events can not be scheduled (you would add an fantastic contingency in time and resources)
- The master schedule has to change and evolve regularly to reflect reality

- *Reviewing process very important and has to be part of the master schedule*
- *Important to have few individuals capable to overview the entire project and capable to react to the first sign of problems*

- It is nevertheless a fantastic adventure …… I do not regret any moment!!