Project Management in the ATLAS International Collaboration

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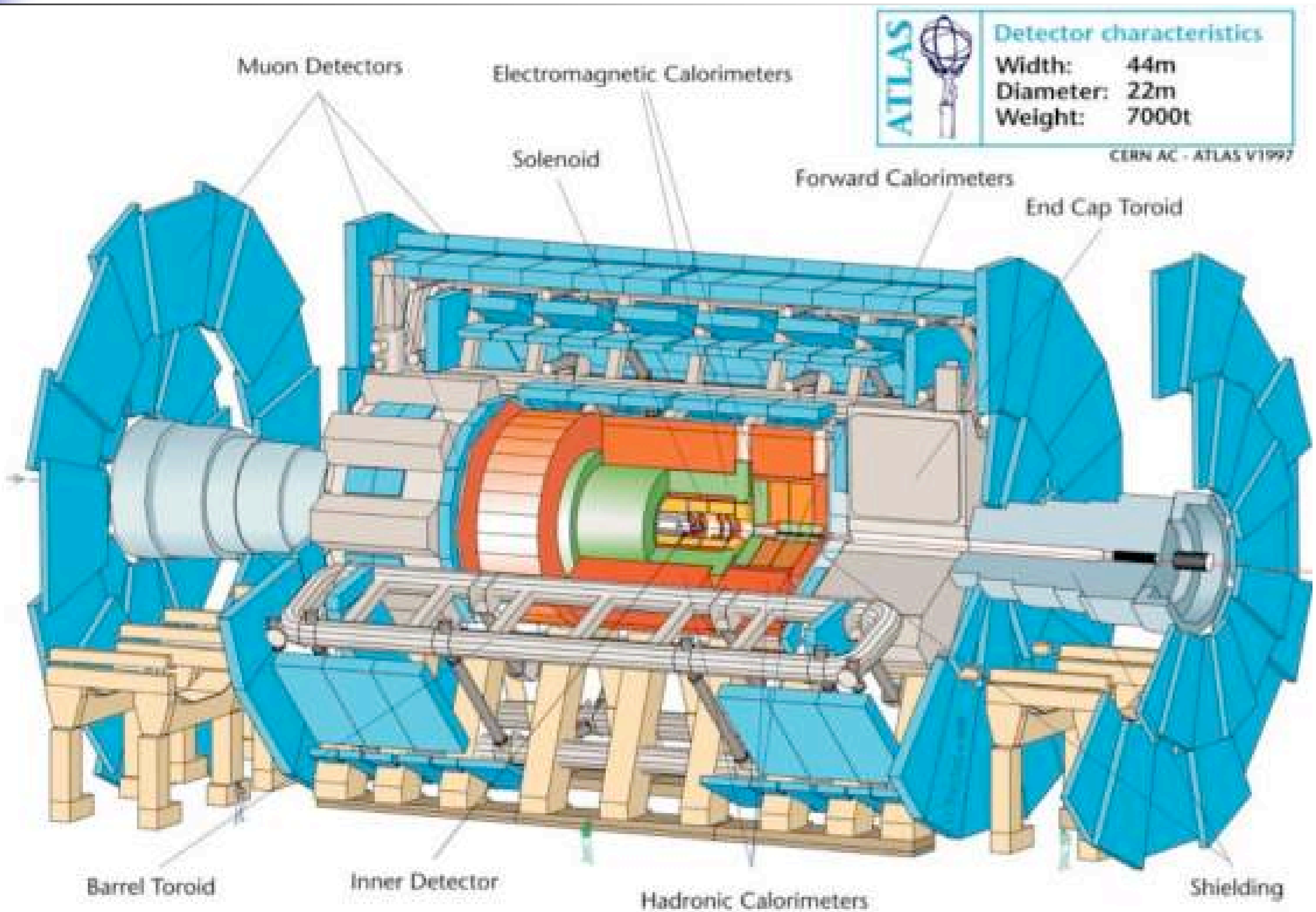
Thanks to Markus Nordberg, ATLAS Resources Coordinator for much of this material

A Toroidal LHC ApparatuS at CERN



ATLAS Now Past its Half-Way-Point!

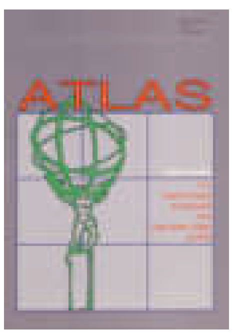






Foundations of ATLAS

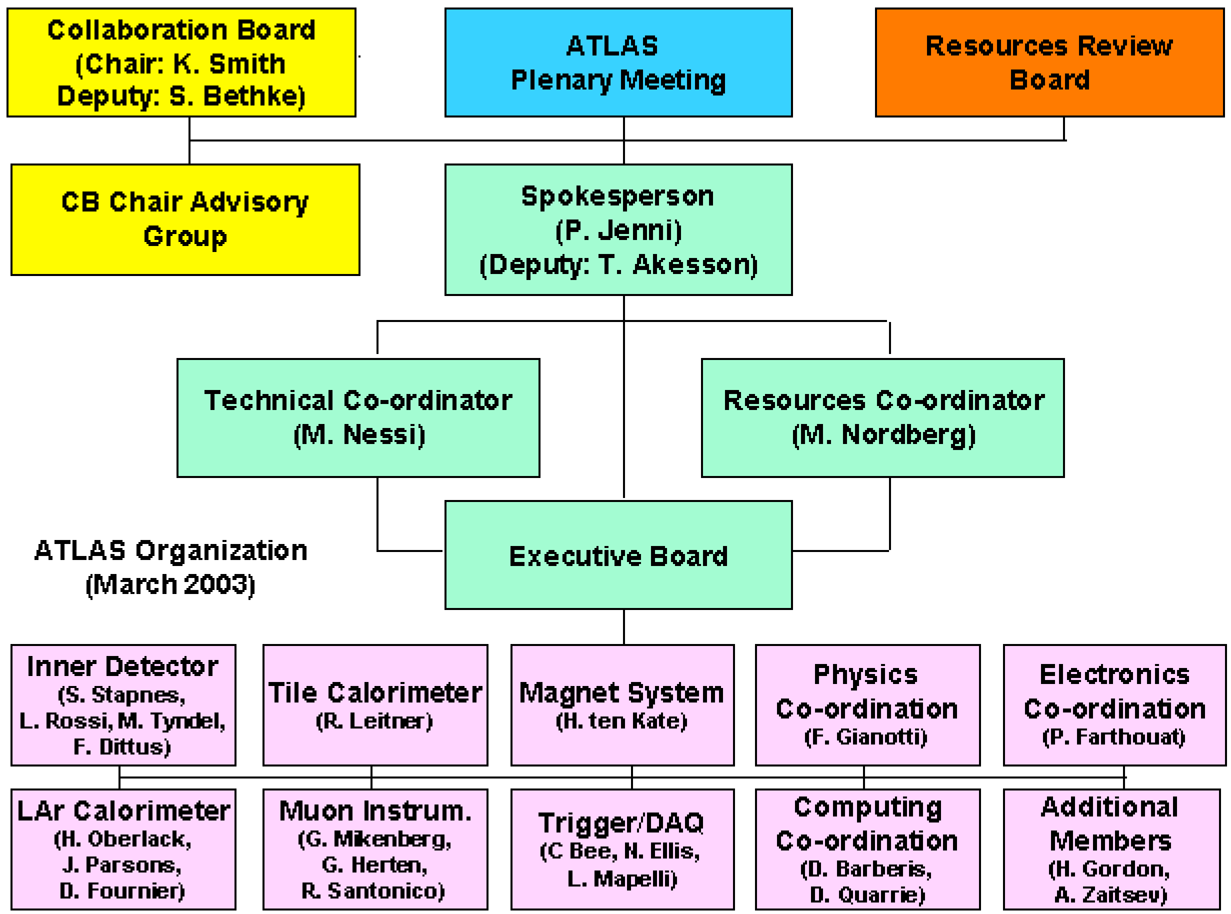
- Long history, R&D started in the late 1980's
- Merging of two general-purpose detector proposals in 1992 (Eagle, Ascot)
- ATLAS Letter of Intent signed in 1992
- Foundations of ATLAS defined in the Construction Memorandum of Understanding (MoU, RRB-D 98-44 rev.)
  - Construction capital: 475 MCHF (in 1995 ATLAS Swiss Francs; "CORE value")
    - 268 MCHF provided as "deliverables"
      - Institutes and their Funding Agencies commit to provide as in-kind, recognized CORE value
      - Deliverables reflect the core competences of the institutes providing them
    - Remaining 208 MCHF defined as common items, shared in proportion to deliverables
      - Includes items such as the Barrel & End Cap Toroids, LAr Cryostat & Cryogenics, detector access, support and shielding structures
      - So far, more than 55% provided as in-kind contributions
    - An additional 68 MCHF is now needed to complete the Initial Detector
    - Recognized CORE value does not include home institute infrastructure nor manpower (latter estimated at 5 310 man-years)
    - Note: ATLAS is not a legal entity. Relies heavily on CERN as Host Lab
  - Today, 149 participating institutes, 1600 authors, including 300 PhD students
  - 37 Funding Agencies from 34 countries; CERN both a participating institute and Host Lab



ATLAS Governance Structures as Defined by MoU

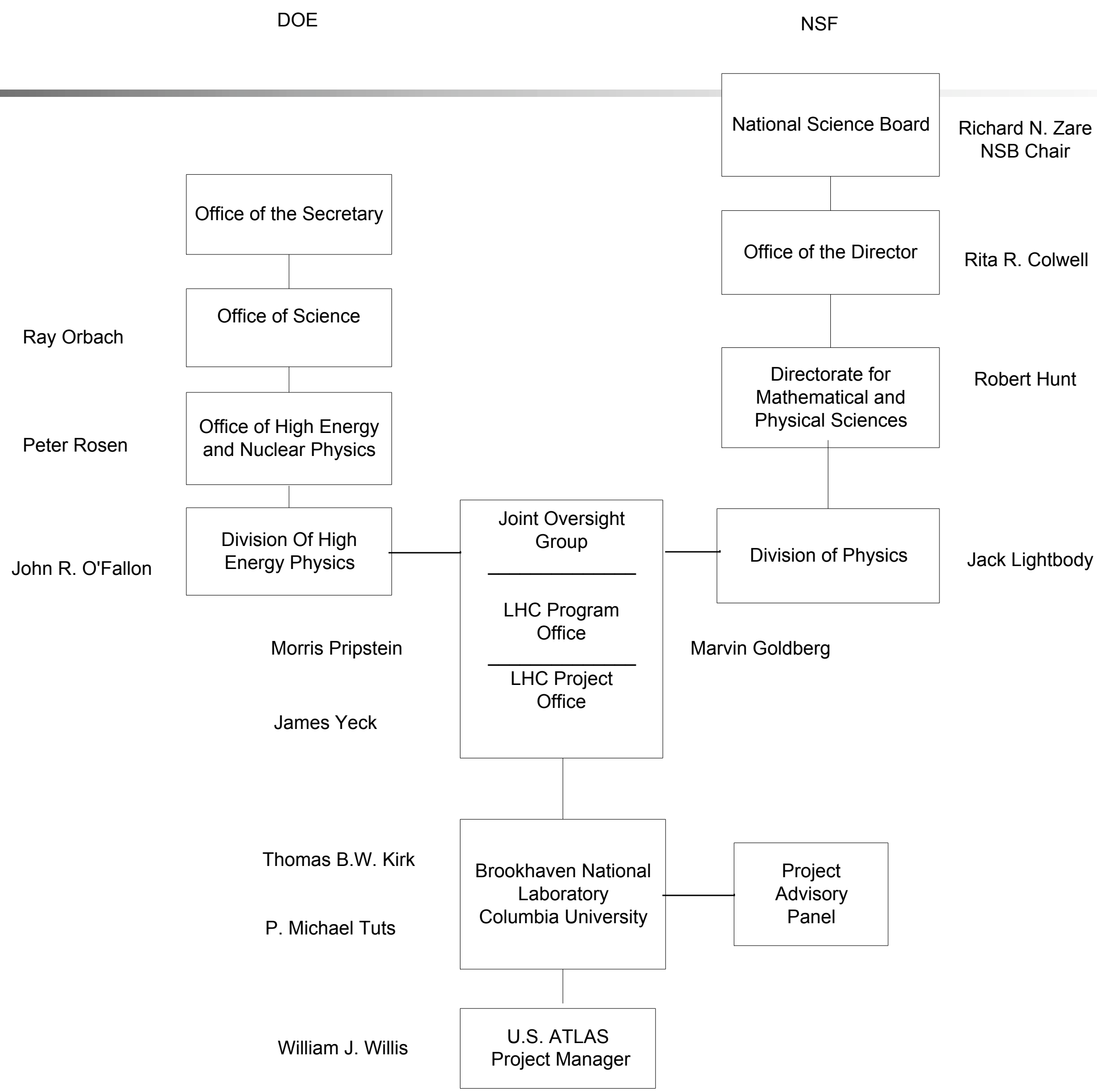
- The **Collaboration Board** (CB) is the policy and decision making body of the ATLAS Collaboration
- The **Spokesperson** (SP) is responsible to globally overview all aspects of the ATLAS Project and represents ATLAS with respect to CERN, Funding Agencies and other outside bodies
  - Note: SP chosen in consultation with CERN
- The **Technical Coordinator** (TC) is responsible for all technical aspects of the ATLAS construction, in particular integration and Common Projects
- The **Resource Coordinator** (RC) is responsible for the overall resources planning, including the Common Fund
  - Note: Both TC and RC approved by CERN
- The **Executive Board** (EB) directs the execution of the ATLAS Project and the communication between the ATLAS management and the systems. The systems have each an **Institute Board** (IB)
- The **Resources Review Board** (RRB) is the Funding Agency (FA) body responsible for the pluri-annual monitoring of the ATLAS resources

ATLAS Organization, March 2003



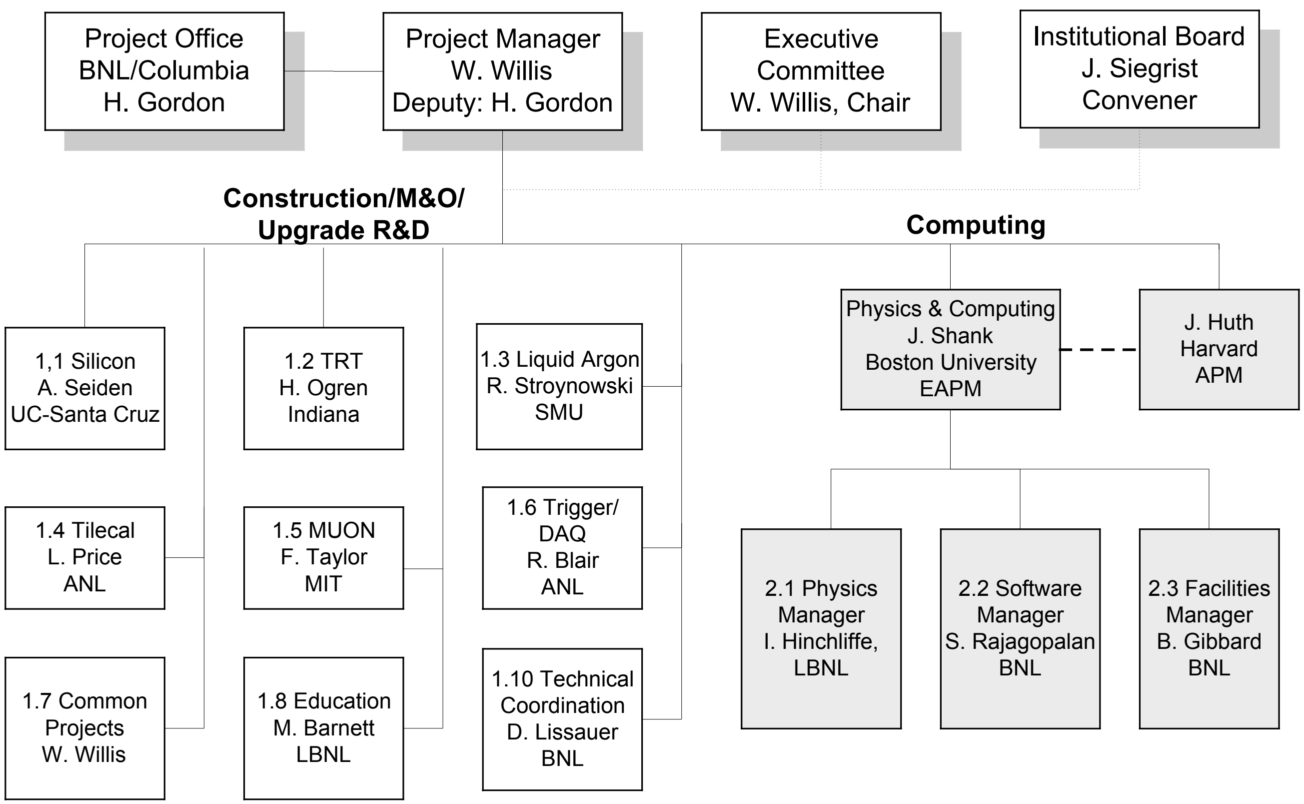
DOE – NSF – U.S. ATLAS Organization

Appendix 7-3: DOE-NSF-U.S. ATLAS Organization

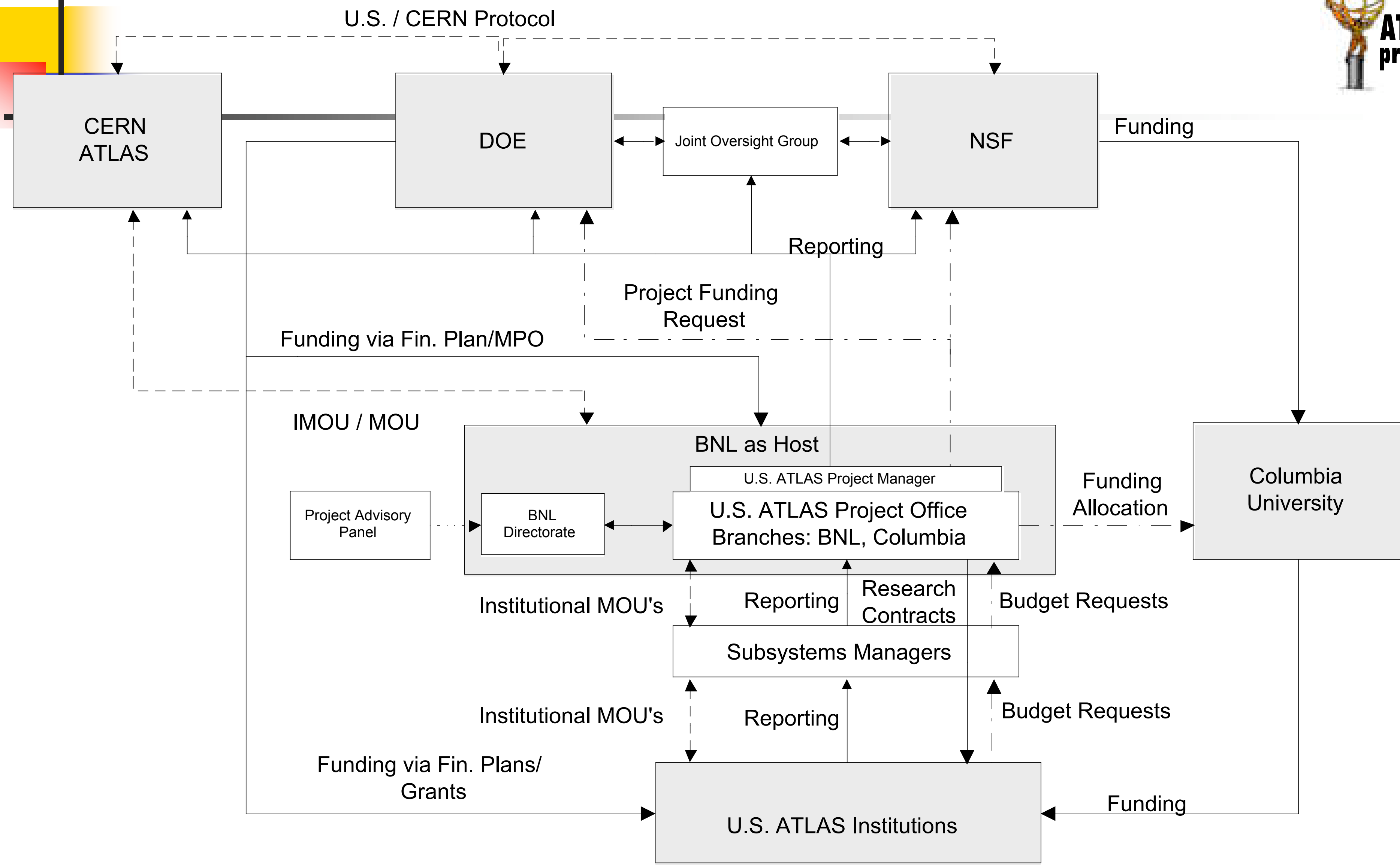


U.S. ATLAS Organization

U.S. ATLAS Organization



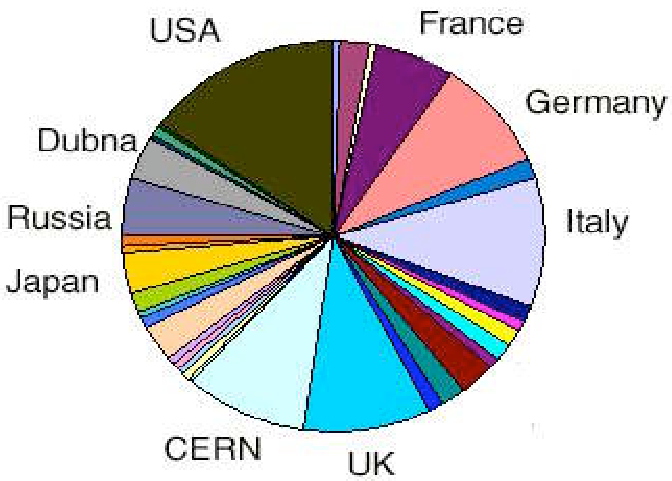
Funding and Reporting in U.S. ATLAS



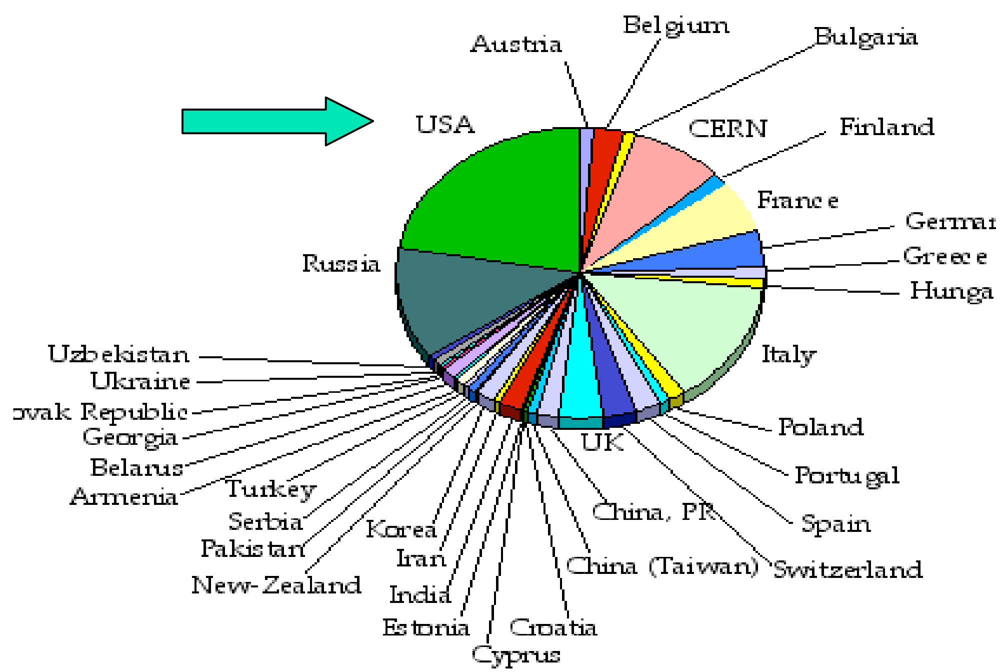
LHC Collaborations

US

ATLAS



CMS



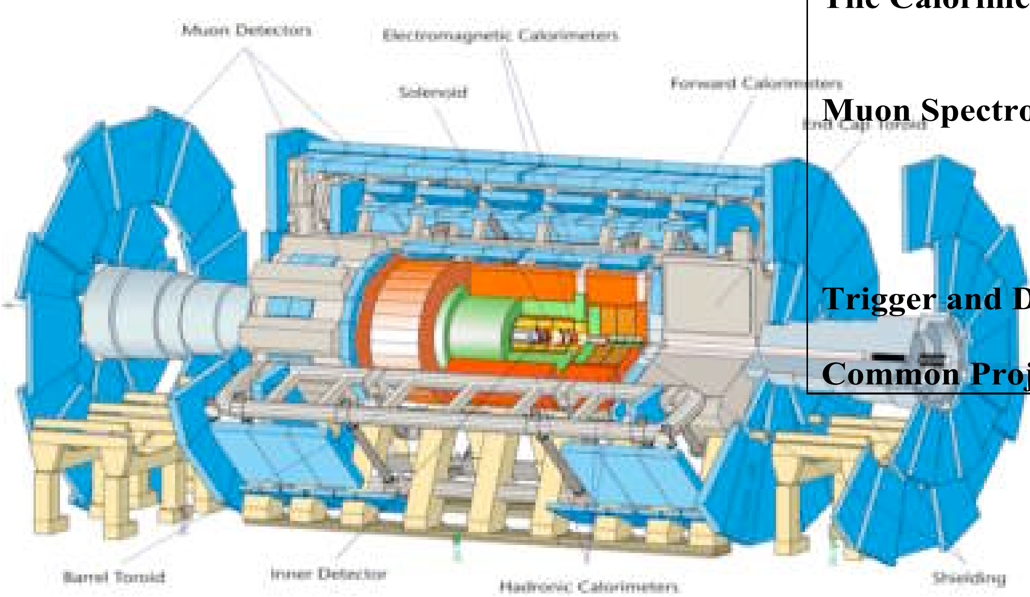
1849 Physicists and Engineers
34 Countries
147 Institutions

The US provides about 20% of the author list in both experiments

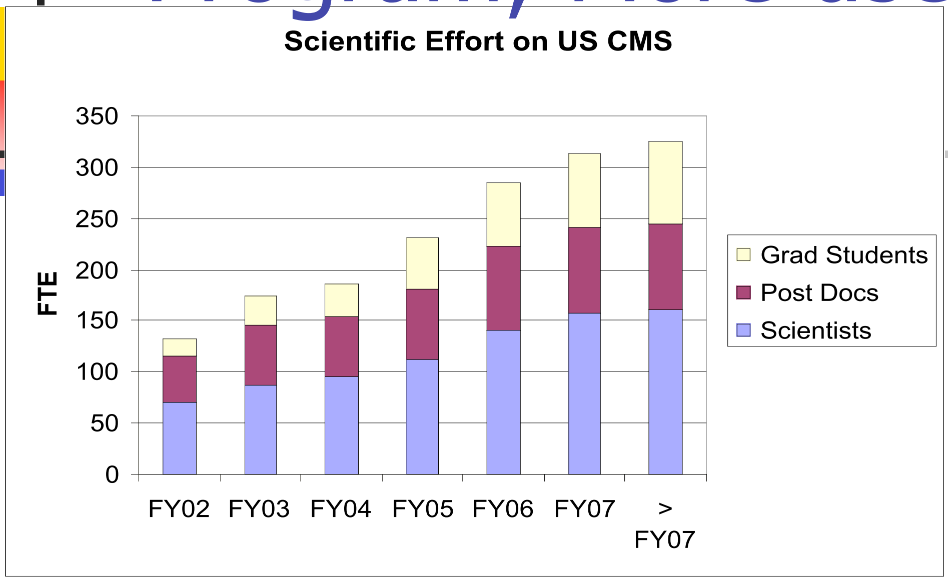
…and about 5% of the machine construction

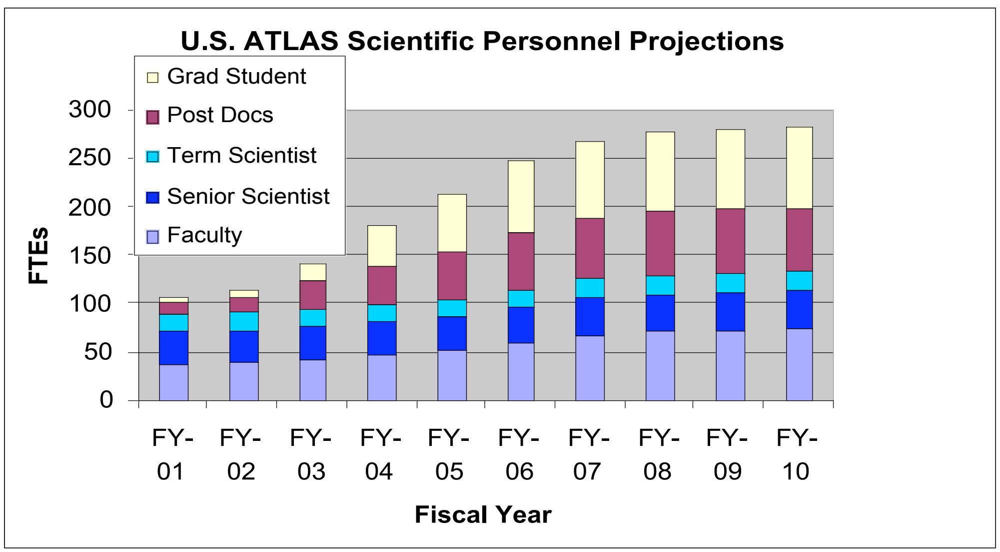
The U.S. ATLAS Collaboration

Subsystem	Institutions
Silicon	UC-Berkeley/LBNL, UC-Santa Cruz, Iowa State, New Mexico, Ohio State, Oklahoma, SUNY-Albany, Wisconsin
TRT	Duke, Hampton, Indiana, Michigan, Pennsylvania
Liquid-Argon Calorimeter	Arizona, BNL, Columbia, Pittsburgh, Rochester, Southern Methodist U., SUNY-Stony Brook
Tile Calorimeter	ANL, Chicago, Illinois-Champaign/Urbana, Michigan State, UT-Arlington
Muon Spectrometer	Boston, BNL, Brandeis, Harvard, MIT, Michigan Northern Illinois, SUNY-Stony Brook, Tufts, UC-Irvine, Washington
Trigger and DAQ	ANL, UC-Irvine, Michigan State, Wisconsin
Common Projects	All institutions



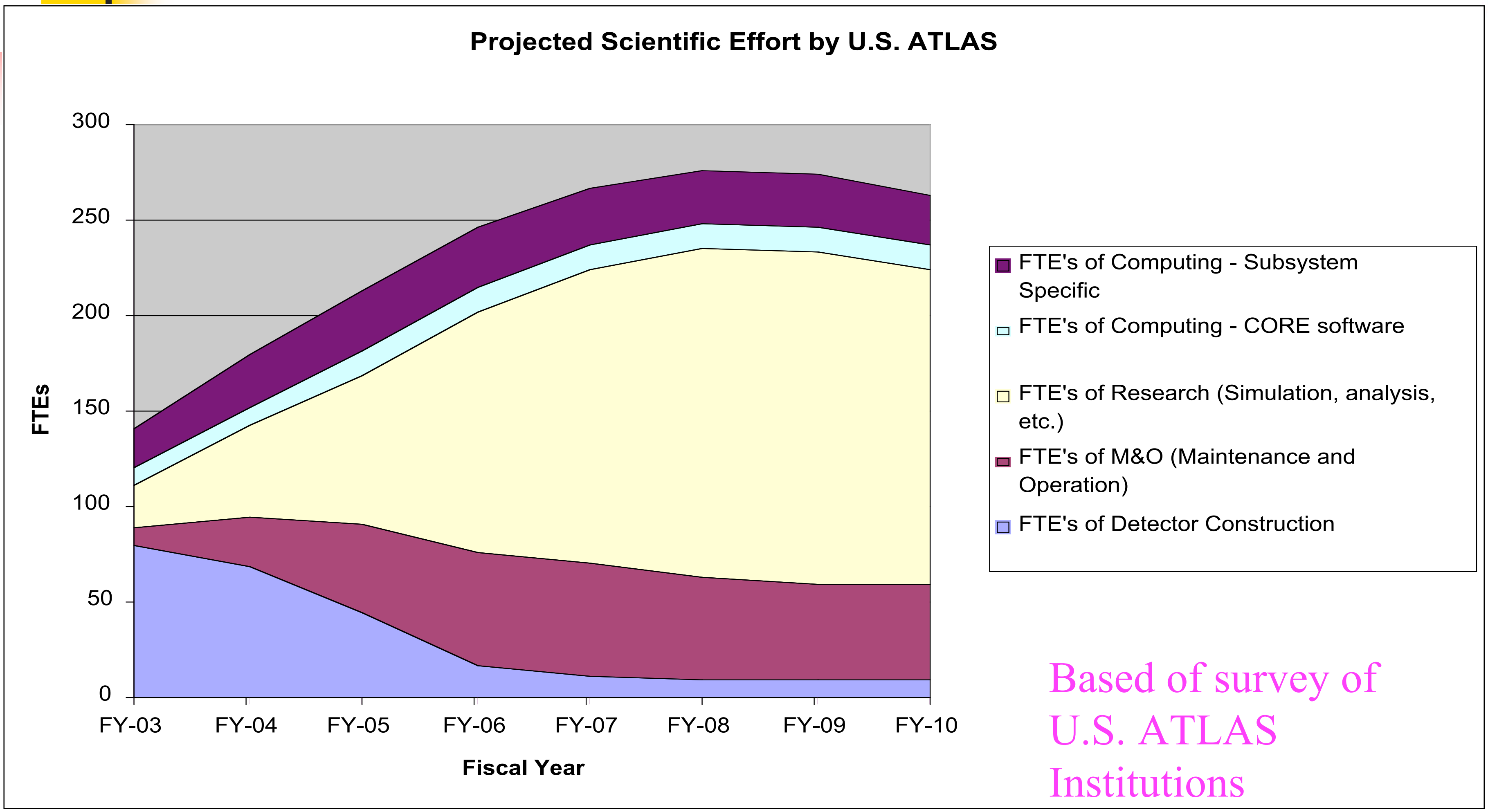
LHC a growing part of the U.S. HEP Program; More users on the way





Projections of Scientific Effort:

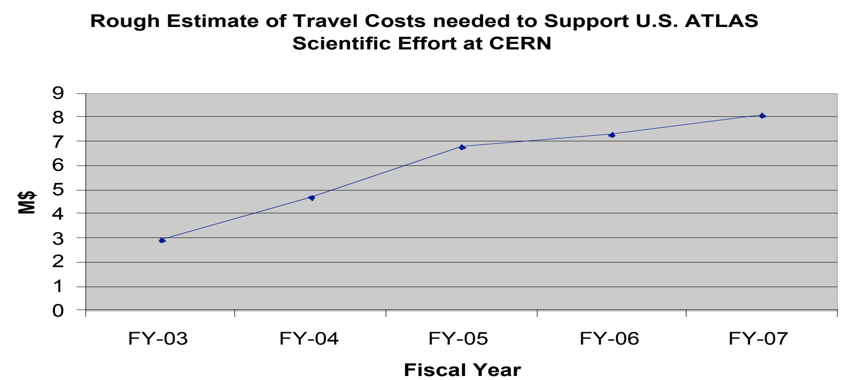
It is expected that the scientific effort will grow by a factor of two and will be a critical part of the overall U.S. experimental particle physics effort.

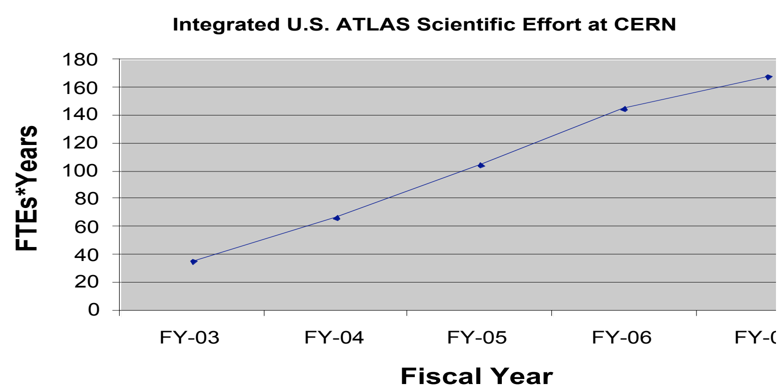


Based of survey of U.S. ATLAS Institutions

Base Program Support is Needed for U.S. Scientists working at CERN

- Data from our U.S. ATLAS Survey shows needs increasing (U.S. CMS has similar needs so just multiply by 2)
  - Raw data is number of trips and average length of time of each trip.
- However, DOE funding for proton research is eroding: e.g. less than flat-flat from FY03->FY04 (see J. O'Fallon's talk at HEPAP, March 7, 2003)
  - ANL, BNL, LBNL cut even more
- This should come from redirection but the travel cost/trip is more expensive than travel in the U.S.
- Another issue is the funding of faculty who would like to spend a year at CERN. There is no way to pay for the traditional _ salary as when visiting Fermilab for example. Some such visits will be critical and CERN will not support them.



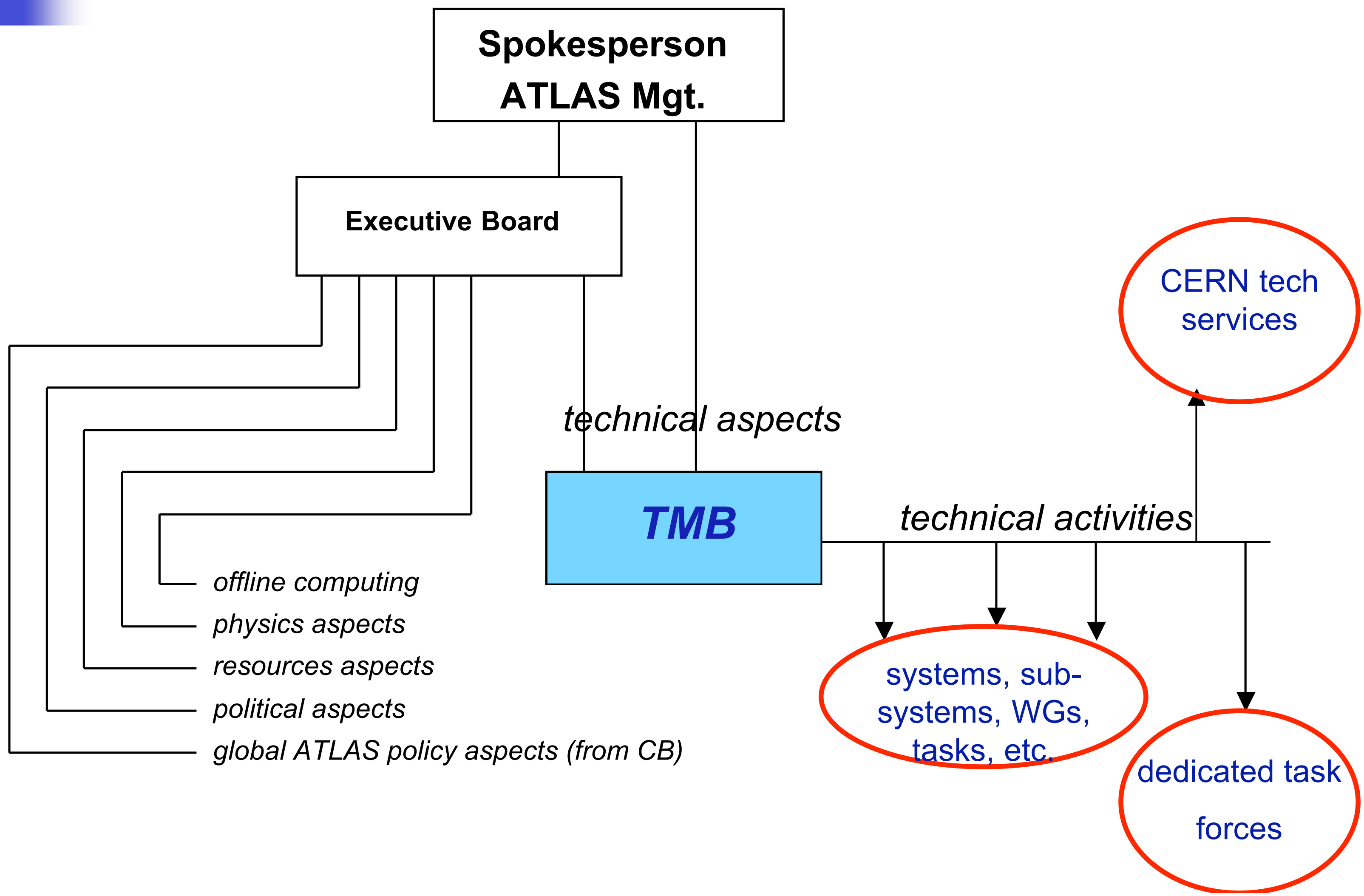


U.S. ATLAS Deliverables - Examples

(Continued)

WBS #	Task	Quantity	MoU ref.#	CORE Value (kCHF)	Short Description of U.S. ATLAS Goals for U.S. Deliverables & Expectation from Non -U.S. ATLAS Collaborators
1.3.2.2	HV	7 Production			HV feedthrough s for barrel(2) and endcap (4) + 1 spare ~800 channels per feedthrough. Feedthrough will end on one side with bare cable and on the other side at the decoupling box. ATLAS will help in the installation and the routing of cables.
1.3.3	Cryogenics	1 Refrige rator. 1 15kl N_2 storage dewar, 2 cryogenic liquid transfer lines, 17 liquid quality meters			BCP 25 defines the US deliverables for this WBS as: 1 - Liquid Nitrogen Refrigerator, consisting of Compressor Station, Nitrogen Cold Box, Phase Separator Dewar, Cryogenic Instrumentation and Controls, Compressor Piping, Transfer Lines, Warm Piping, and Capacity Measuring Equipment. Excluded is Vent Piping, Compressor piping for PX16 Shaft, Process Control System, Process control Wiring in PX16 Shaft 2 - Liquid Nitrogen Transfer Lines between ground level dewar and Phase Separator Dewar, Nitrogen Gas Supply Buffer Storage Tank. 1 – 15,000 liter Liquid Nitrogen Storage Dewar 17 - Quality meters
1.3.4	Readout Electrodes & Mother - boards				Contribution to the readou t electrodes and the design, fabrication and delivery of the motherboards system for the Barrel EM calorimeter
1.3.4.1	Readout Electrodes	Level of Effort	2.2.2.4 and 2.4.2. 32%	3690 max cap	U.S. will participate in the design at a level of effort. R &D on large electrodes, industrial prototypes and production. Contribution is capped at 3.69 MCHF. BCP 26 increased the US contribution to ~3.69M CHf, ($2.555M). **Non-U.S. ATLAS is responsible for the procurement, testing of the readout electrodes**
1.3.4.2	Motherboard System	100% EM Barrel	2.2.3.1 100%	1230	This include 100% of the summing boards (SB), alignment boards (AB), motherboards (MB) and high voltage (HV) boards for the barrel EM calorimeter. We will deliver the number of boards stated be low + 5% which should cover any spoilage during installation.

Technical Mgmt Board Dedicated to Technical Matters



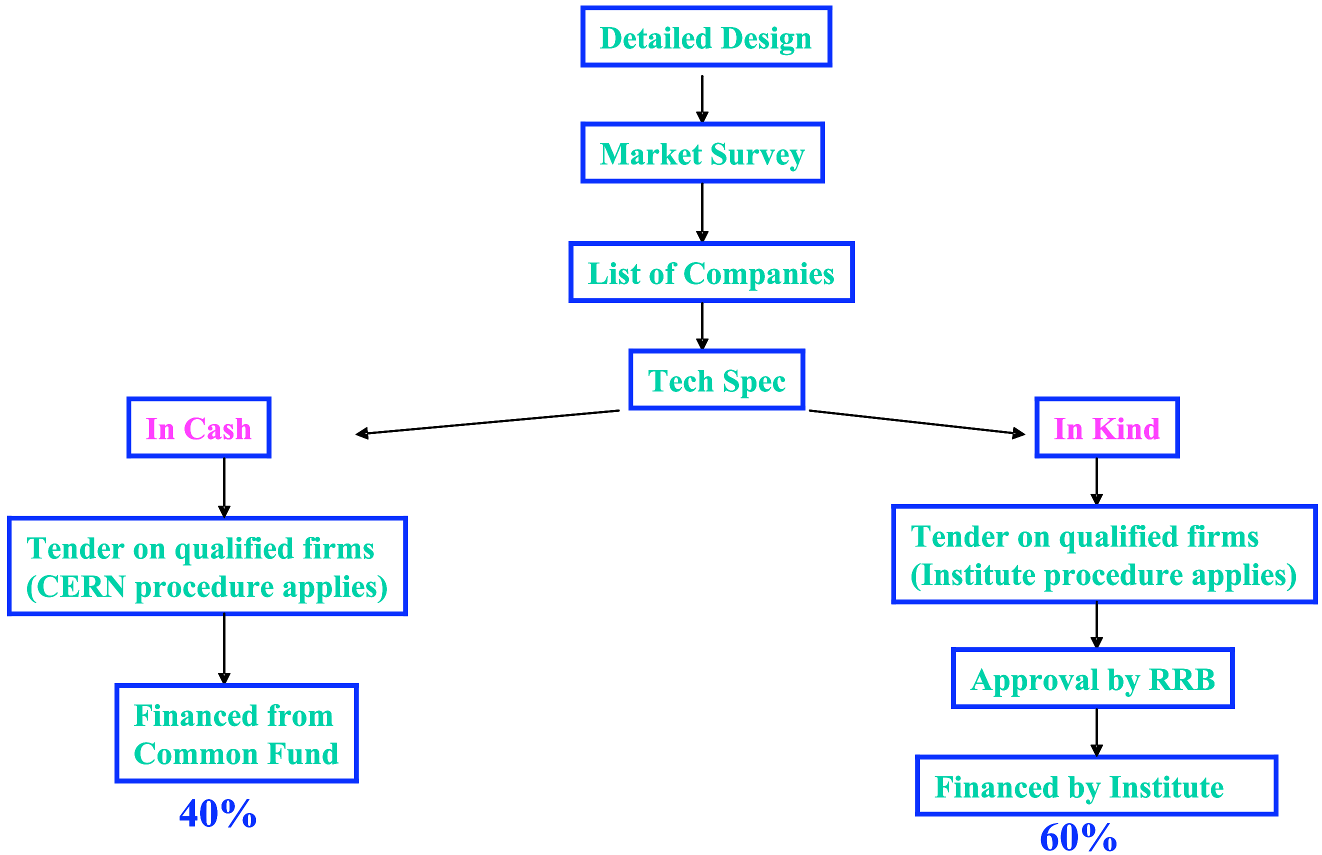
ATLAS Governance "Philosophy" - Consensus, Harmony versus **Management** (U.S. system)

- Provide maximum autonomy for systems =>
- Decentralized decision making
- Short-term nominations (2 years; 2/3 majority to support extension)
- Democratic process ("1 institute, 1 vote")
- Nominations by individual expertise rather than by demographic considerations
  - Note: SP has influence on the Project Leader selection process
- Go for minimum administrative overhead
- Try to obtain as much in deliverables/in-kind as possible
  - Dedicated procedures for handling Common Project contributions
  - Distributed risk (FA's to share the financial risks)

ATLAS Common Projects

- Common Projects (CPs) are managed centrally (Technical Coordination, Resource Coordinator)
- CPs include items which fall outside the scope of initially pledged MoU in-kind contributions (i.e. deliverables) by institutes
  - Magnets, cryogenics
  - LAr cryostats and cryogenics
  - Detector access, shielding and support structures
  - Part of TDAQ processors
- FA's contribute to CPs either in-kind or in cash; encouraged to deliver as in-kind
- These contributions are approved in the RRB to ensure
  - Minimum amount of centralized cash and risk
  - Attributed value is in accordance with the CORE value (Cost Book 7.0)
  - Financial and contractual responsibilities are clarified (internal ATLAS Agreements)
  - Technical and managerial responsibilities clarified (internal ATLAS Agreements)
  - Conformity with general specifications and CERN procedures (purchasing, safety etc.)

ATLAS CP Approval Mechanism



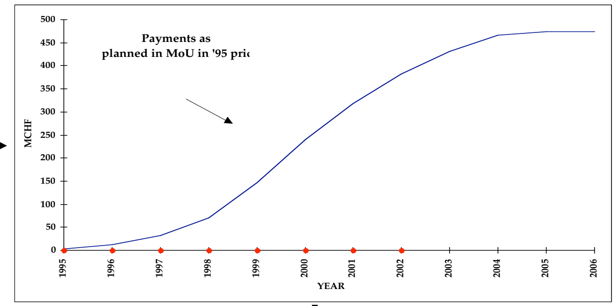
(RRB approval as part of annual ATLAS budget)

Courtesy of Paola Miele

Financial Reporting System of ATLAS

Financial Basis of Reference

MoU (RRB-D 98-44 rev.)
ATLAS Cost Planning Version 7.0

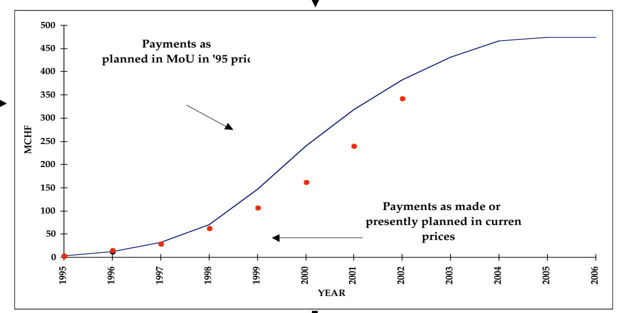


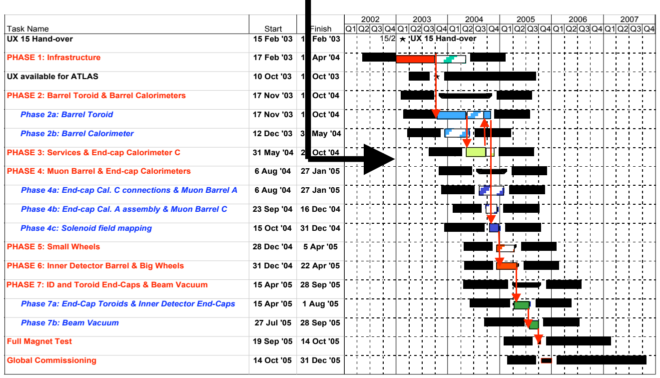
Pluri-annual Budget Planning Cycle with Systems

-by MoU item

-By Funding Agency (FA)/Institute

-By Year



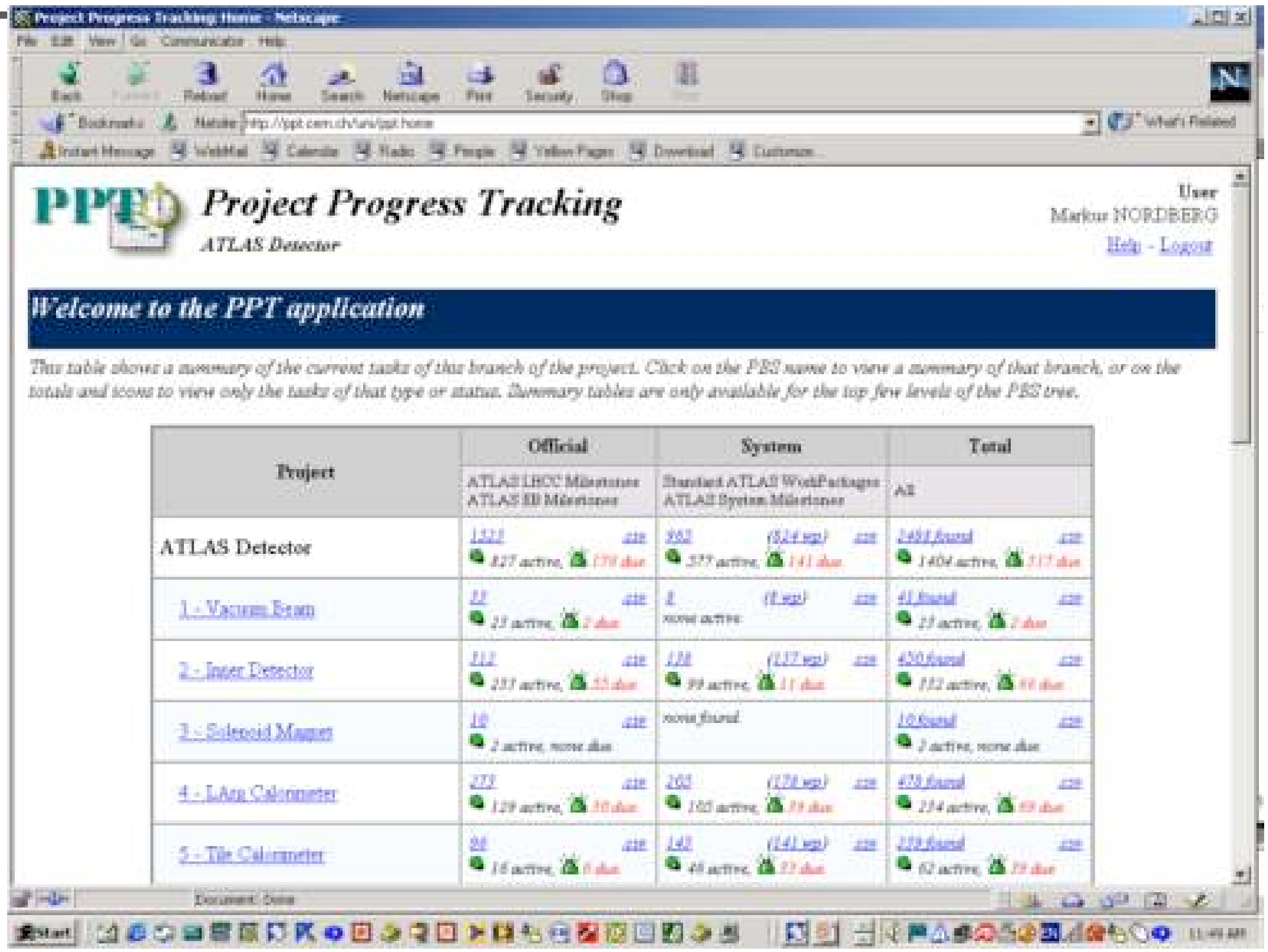


RRB Budget Reporting

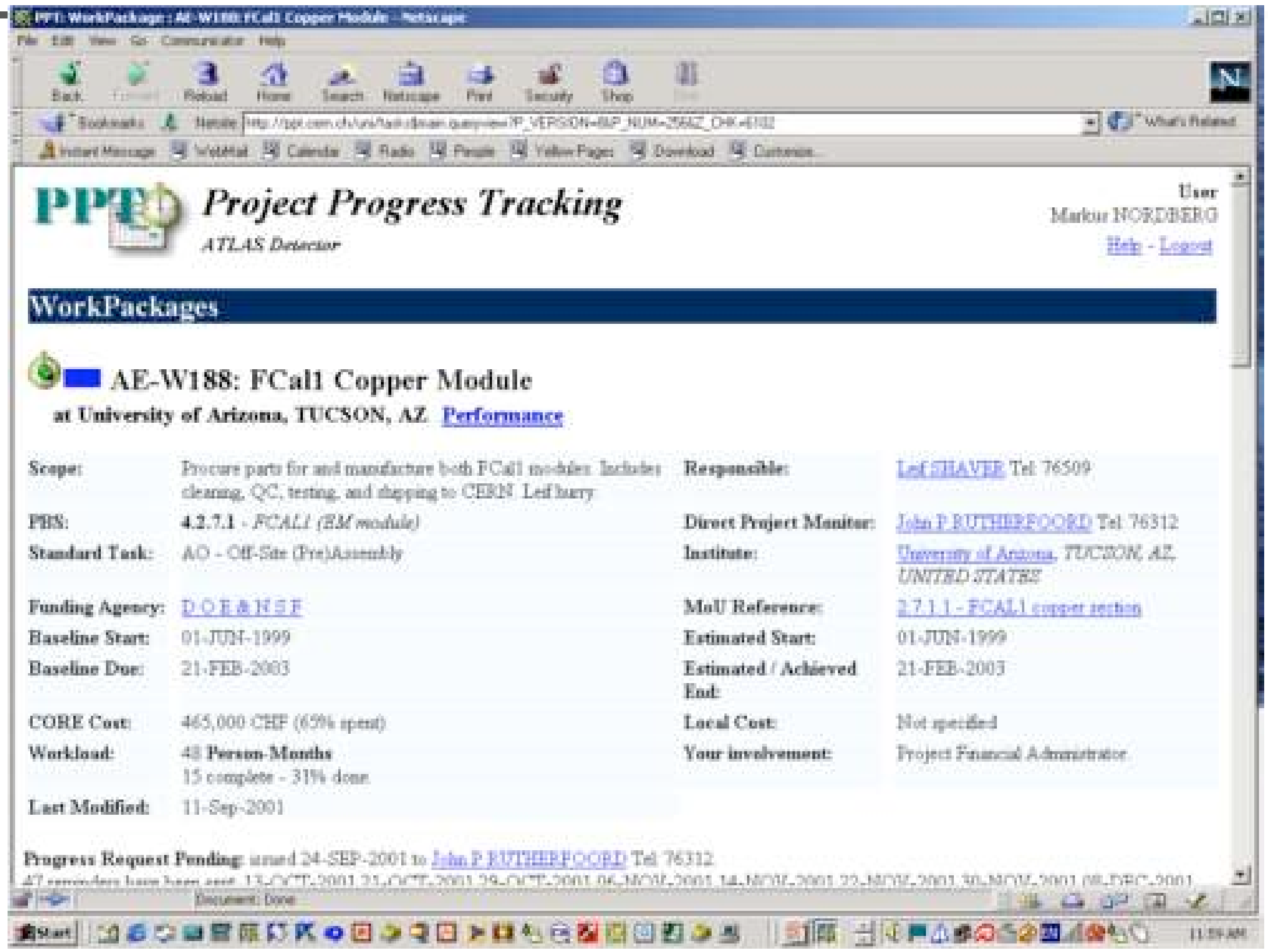
April: Endorse previous year's budget; Update current year's budget; Draft budget for following year

October: Update current year's budget; Endorse budget for following year

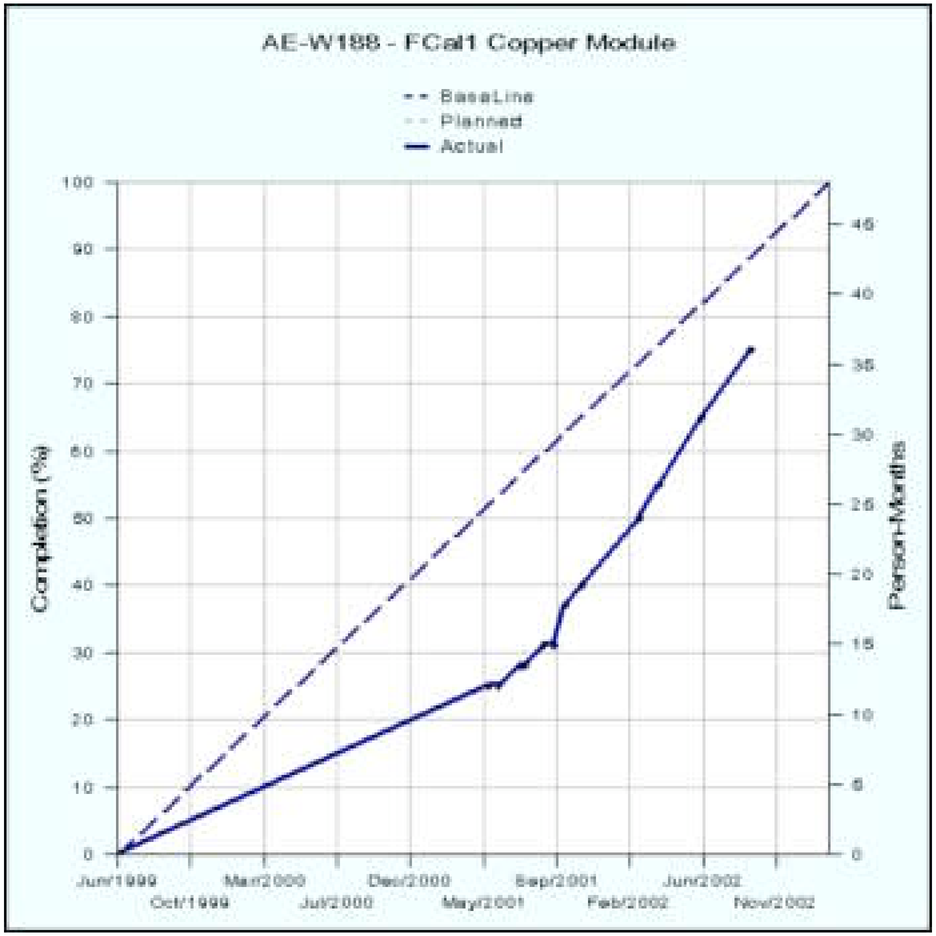
Progress Tracking System of ATLAS



Progress Tracking System of ATLAS (2)



Progress Tracking System of ATLAS (3)



FA Contributions to ATLAS as Defined in Updated MoU (MCHF)

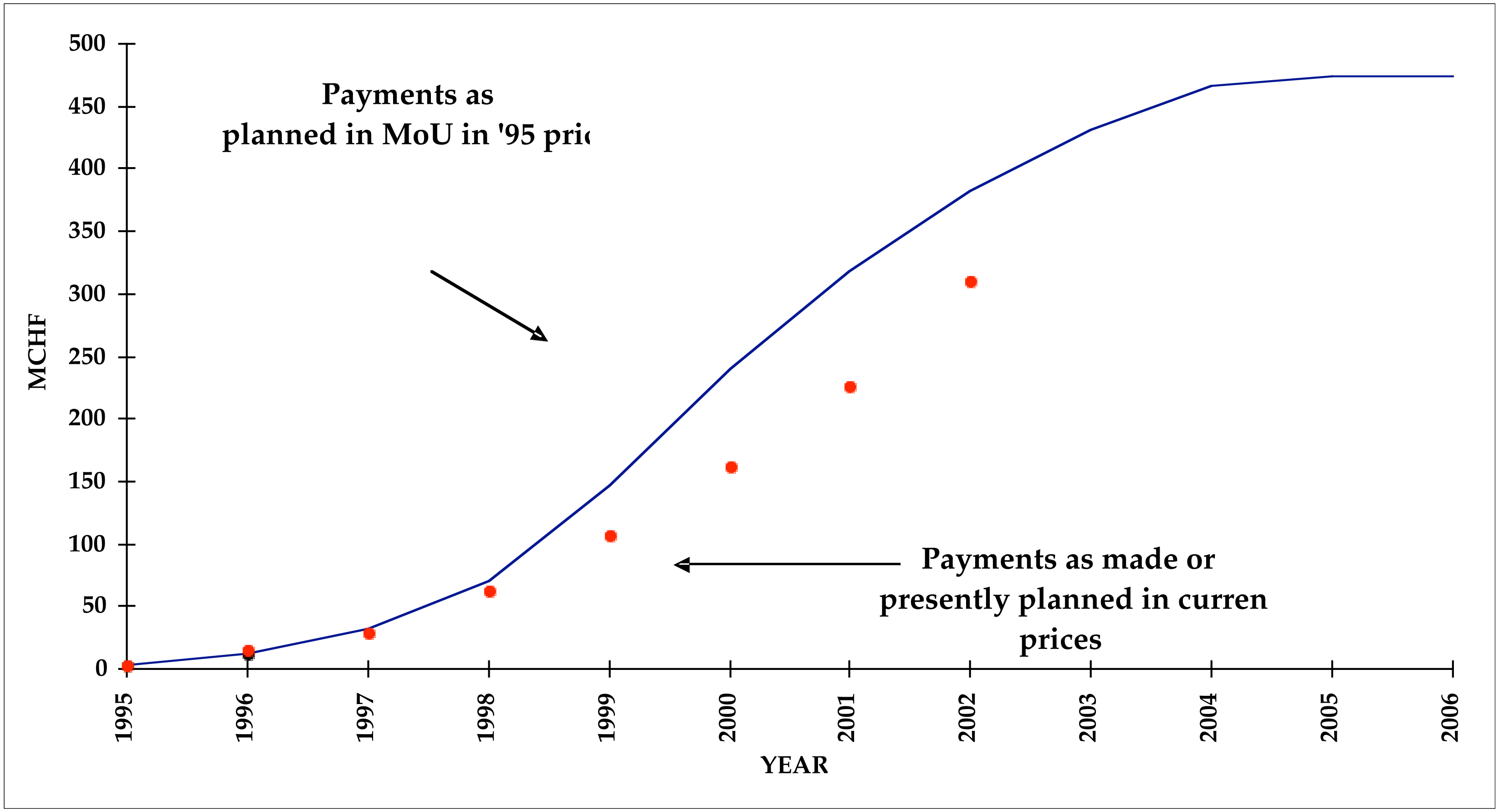
Funding Agency	Inner Det.	LAr Cal.	Tile Cal.	Muon cham.	Trigger/ DAQ/con	Common Projects	Total
Armenia			0.1			0.1	**0.2**
Australia	1.4					1.1	**2.5**
Austria					0.3	0.3	**0.6**
Azerbaijan						0.1	**0.1** total of new alloca
Belarus						0.2	**0.2**
Brazil			0.1			0.1	**0.2**
Canada	0.1	8.4				6.6	**15.1**
China NSFC+MSTC		0.3		0.3		0.4	**1.0**
Czech Republic	0.5		0.5			0.6	**1.6**
Denmark	0.9				1.0	1.4	**3.3**
Finland						0.1	**0.1**
France IN2P3	2.1	17.8	2.1			17.0	**39.0**
France CEA*		5.7		2.2		5.8	**13.7**
Georgia						0.1	**0.1**
Germany BMBF	7.9	3.2		2.5	4.7	14.2	**32.5**
Germany MPI	1.7	1.6		0.9		3.3	**7.5**
Greece				1.0		0.7	**1.7**
Israel				2.5	0.4	2.1	**5.0**
Italy	5.0	3.7	1.3	9.3	5.9	19.8	**45.0**
Japan	6.8			6.8	4.5	14.0	**32.1**
Morocco		0.2				0.1	**0.3**
Netherlands	1.8			3.0	0.9	6.7	**12.4**
Norway	2.4					1.8	**4.2**
Poland	0.4				0.2	0.4	**1.0**
Portugal			1.0		0.3	0.9	**2.2**
Romania			0.3			0.3	**0.6**
Russia	3.4	4.7	1.1	3.5		8.0	**20.7**
JINR	0.5	0.7	0.8	1.0	0.1	2.3	**5.4**
Slovak Republic		0.3				0.2	**0.5**
Slovenia	0.8					0.7	**1.5**
Spain	1.2	2.3	2.0			4.3	**9.8**
Sweden	3.1	1.5	0.9		0.6	4.7	**10.8**
Switzerland	4.9	1.1			4.0	8.5	**18.5**
Taipei	1.0	0.7				1.3	**3.0**
Turkey					0.2	0.2	**0.4**
United Kingdom	13.1				5.9	15.0	**34.0**
US DOE + NSF	12.0	16.9	3.6	8.8	4.0	35.5	**80.8**
CERN	9.0	8.6	3.0	1.5	11.5	27.4	**61.0**
Total	80.0	77.7	16.8	43.3	44.5	206.3	**468.6**
Rev. CORE detector cost	78.5	80.0	15.2	42.5	45.9	208.7	**470.8**
Total - cost	1.5	-2.3	1.6	0.8	-1.4	-2.4	-2.2

Comment: A number of Funding Agencies have indicated possible additional contributions to the Common Projects

* This contribution by CEA does not include a special contribution of 1MCHF concerning engineering of the barrel toroid, to be considered as an advance on any possible future contributions

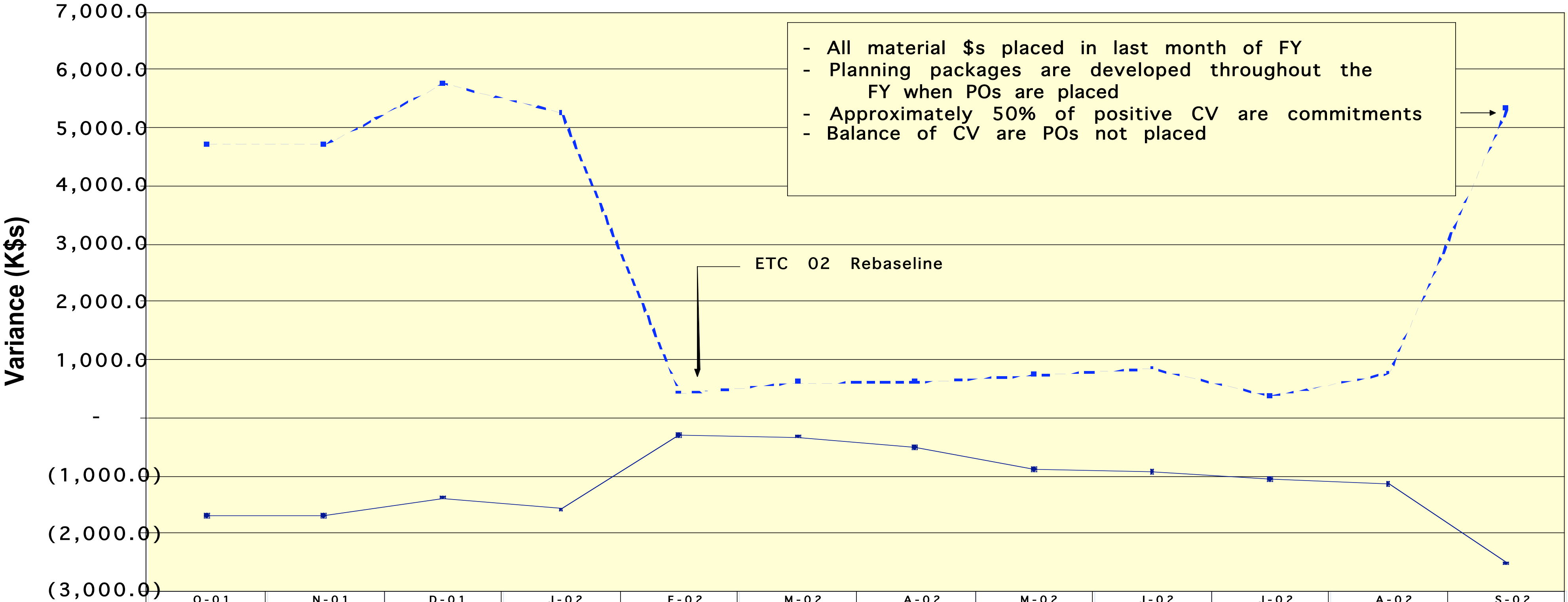
ATLAS project

Roll-Up View: Summary Progress of Payments (MCHF)



Schedule and Cost Variance

U.S.ATLAS
Schedule and Cost Variance



	O-01	N-01	D-01	J-02	F-02	M-02	A-02	M-02	J-02	J-02	A-02	S-02
SV	(1,697.8)	(1,697.8)	(1,382.0)	(1,585.9)	(318.7)	(326.9)	(514.4)	(883.9)	(948.7)	(1,076.2)	(1,155.5)	(2,512.2)
CV	4,728.9	4,728.9	5,783.0	5,270.9	430.9	610.2	620.7	743.2	855.3	382.4	772.6	5,351.5

Month - Year

Perceived Advantages of the ATLAS Approach

- Technical aspects
  - Technical challenges/problems solved where the recognized core competences are located ("complementary assets")
  - Institutes concerned able to maintain and further develop their skills
  - Institutes left to work on their deliverables and core competences (major part of technology interfaces well defined in the MoU) – and share the associated risks
  - The skills base of national industries get utilized (visibility, economic return)
- Administrative and financial aspects
  - Rather light financial reporting system (for CORE-values)
  - ATLAS Mgmt role monitoring, coordinating rather than centrally-driven execution => problem-solving at "grass-root level"
  - Minimal central administration
  - Funding Agencies left to honor their commitments and share the associated financial risks (they keep the contingencies)

Perceived Disadvantages of the ATLAS Approach

- ATLAS Mgmt has limited direct power => sometimes difficult to force people to follow (desired) decisions
- Slow in decision making; at times too democratic?
- Duplication (and sometimes waste) of resources across the institutes
- Difficult to know total cost of the Project
- Vulnerable to changes in Host Lab services and functions

Status of ATLAS Today

- More than 80% of resources committed, 60% allocated
- So far so good!
- Original start-up in 2005 has shifted to 2007 in line with delays with the LHC machine
- ATLAS needs 68 MCHF over and above 470 MCHF to complete the initial detector (over costs in deliverables not included)
- ATLAS has (separate) tools for milestones tracking and financial reporting
  - Question: to what extent are the observed difficulties independent of the tools used?
- Worries
  - Installation phase (starts in 2003) has many risks and uncertainties
  - Host Lab responsibilities not clearly defined (resources issues). But
    - We hope external pressure will help to clarify the matter
    - CERN intends to implement Earned Value Management in its budget planning and reporting systems. We hope this will help

Some Thoughts on Why Big Science Projects Encounter Similar Difficulties (European Perspective?)

- Compliance
  - There is a lot of high tech R&D involved, new bold ideas never tried before. Deliverables are difficult to spec (performance, interfaces, acceptance criteria etc.). Well established planning and costing practices are unable to capture that aspect in full - is this why scientists tend to ignore them and accept the risks?
  - Scaling costs are not necessarily linear. Scientists are not always experts in estimating costs to scale up from lab prototypes to full-fledged production items
  - Funding structures often prohibit multi-annual commitments. Global cost optimization (incl. e.g. future operation) is difficult
    - Note: US funding for LHC is an exception! A possible model for the future?
- Conformance
  - Long time spans. Difficult to generate sense of urgency today for a 10 year project
  - Scientists may not be the best managers of human resources (and there is a cost associated)
  - Sociology of Science: “It takes what it takes to give what it gives”. Can’t fix a price tag on that
- Completion
  - The division of responsibility between the product owner (contracting authority) and project owner (prime contractor) is not always clear. In some cases, the scientific community represents both

Questions asked by Linear Collider Task Force

Is there a strong central organization for your project? Does it work?

No! So far – we have not had a real crisis yet.

Will long term participation of the builders be encouraged? How will you arrange it?

Resources and control is in the hands of the individual institutes which have the resources. They then have strong ownership. But funding through a central project management has more flexibility (U.S. model).

What is the relationship of the builders of the equipment and the users of the equipment?

They are the same group – hence continuity is assured.

How will you select a site?

Not applicable here – but remember the SSC which failed for many reasons not alone was the "green field" site.

Questions asked by Linear Collider Task Force (2)

Will contributions be in kind or in cash or in people during construction? During operation?

For ATLAS the in kind contributions are extremely valuable. This encourages resources to be spent in the local country. Also gives more ownership.

How will you shift tasks between institutions as someone has trouble of some kind during construction? During operation?

We have had this problem several times – not always with complete success:

1) In the U.S. after a review we shifted responsibility and resources for a major piece of equipment from one institution to another. MUCH TRAUMA.
2) In ATLAS, a group did not like the way the technical work was going and so withdrew its resources – they were never replaced!
3) Recently CERN has announced that they will not meet their commitment for a deliverable – shifting needs for funds to other countries e.g. U.S.

Is there a common fund? What is it used for?

Yes – there is a “Membership Fee” of 12.5kCHF/year/scientist (for 11 years) to insure that the collaborators are really participating. Plus a common fund for Common Projects which are too large for a given institution.

Questions asked by Linear Collider Task Force (3)

How is contingency managed?

ATLAS has NO contingency funds (almost). In the U.S. the central management has control of the contingency. It started at 50% for the construction project.

What motivated the labs to participate in construction? In operation?

Physics opportunity.

What fraction of each participating labs resources go into your project?

There are some contributions from the "base program" – physicists salaries and support (travel), a few engineer s and technicians. However, there is a lot of pressure on the base program for high energy physics.

Lessons learned - what did you do right, what would you do differently next time?

Conclusions

- ATLAS is a large and complex project. It is proceeding well …
- … despite delays (20%) and over costs (>14%) w.r.t the original plan of 1996
- Its governance structures and decision-making processes are decentralized. In-kind contributions and collective risk sharing is encouraged
- Its Funding Agencies are left to honor their commitments
- Its progress reporting tools are separate for milestones and resources
- Would non-scientists ever undertake such projects? If so, would they do much better?