Completion and Pre-Operation Costs for the Initial Staged ATLAS Detector

Strategy and Scenarios for Further Deferrals

Reminder of the construction completion and pre-operation costs presented at the October 2001 RRB

Consolidation and changes to these estimates

Strategy for deferrals to introduce flexibility in the supplementary funding

Revised costs to completion and proposed plan to proceed with the timely detector construction for the first physics run

Cost to Completion from the October 2001 RRB

At the last RRB the three components contributing to the 'Cost to Completion' for the initial staged detector configuration were reported, namely the construction completion costs, C&I and M&O

1) Construction completion costs

The construction completion costs with respect to the original cost planning of 475 MCHF (1995 prices with no explicit contingencies) were summarized as follows (in 2001 MCHF):

Net over costs in Common Projects		29.7
Magnet system	19.6	
Infrastructure and shielding	7.8	
LAr cryostats and cryogenics	2.3	
Additional CORE items		6.1
Non-covered CORE MoU funding		4.4
Additional non-CORE items		11.8
Total		52.0

(more details were given in ATLAS RRB-D 2001-121)

Profile of construction completion costs	2002	2003	2004	2005	Total
Payments	9.6	21.2	15.4	5.8	52.0

As explained in more details at that meeting, the main reasons evoked are

- **Technical developments since 1995**
- **Cost increases in industry, including contract evolutions and exchange rates**
- **Complexity of detector and infrastructure**

The pre-operation cost estimates were reported at the last meeting according to the scheme adopted for the LHC experiments as

***2) Commissioning and Integration (C&I)*,**
decentralized detector integration activities outside the ATLAS pit, now considered in their nature closer to construction completion, and

3) Maintenance and Operation (M&O)
with their nature specified in the draft M&O Memorandum of Understanding (CERN-RRB-2002-035)

(from ATLAS RRB-D 2001-121)

Nature of cost	2002	2003	2004	2005	Total
Pre-operation M&O	3.4	4.4	5.8	11.3	24.9
Pre-operation C&I	3.1	5.5	7.5	4.9	21.1
TOTAL (M&O and C&I)	6.5	9.9	13.3	16.2	46.0

The estimates included all categories, that means A, B and C for the M&O, and A and B for the C&I

Also the M&O A part is prior to the application of any cost adjustments (former rebates)

The main reasons and cost drivers identified by ATLAS for these projected expenses were reported to be

- **Technical services and manpower availability**
- **Complexity of the integration and commissioning tasks**

In all cases the schedule assumed was to have the initial staged detector installed for April 2006

The ATLAS Collaboration is aware of, and acknowledges strongly, the very major efforts made already by the Funding Agencies and the Institutes to cover the MoU deliverables (costs and manpower)

Computing costs for ATLAS and the common CERN LHC Computing Grid Project are under a separate evaluation, with their dedicated RRB session, and are not included in this presentation

Proposed Sharing Mechanism

The sharing mechanism for the various classes of supplementary costs as proposed by the Collaboration have been presented at the October 2001 RRB as well

Construction completion costs

The supplementary construction costs are divided into system-specific and commonly shared items

It is proposed that the common items (net over costs on the Common Projects, the additional non-CORE items under the responsibility of Technical Coordination, and the non-covered Common Fund) be shared amongst all Collaboration Funding Agencies based on the CORE contributions

An extension of the membership fee is proposed for the years 2004 – 2006 as minimum contribution

The system specific supplementary costs are proposed to be shared within the detector (sub-)system based on CORE investments, decided by the respective Institute Boards and reported to the RRB

C&I

The proposal is to share C&I (A) costs based on the overall CORE investment, and the C&I (B) costs based on the CORE investment within the detector (sub-)systems

M&O

The M&O (A) cost sharing is defined in the draft MoU for M&O (CERN-RRB-2002-035)

The proposal for the M&O (B) costs is a sharing based on the CORE investment within the detector (sub-)systems

Consolidation and Changes to these Estimates

In addition to the reviewing of part of these costs prior to the October 2001 RRB

- **LHCC CORE committee for the construction completion costs**
- **LHCC MAG committee for the status and cost of the magnet system**
- **RRB Scrutiny Group for M&O A**

further external and ATLAS internal scrutiny has taken place

External (reported by D Schinzel) scrutiny occurred for M&O B and C&I A and B

Internally, a CB group overviewed in particular the construction completion costs which fall under the responsibility of Technical Coordination (Common Projects and Infrastructure), including an evaluation of the planning and budget control of Technical Coordination

As a result of the external scrutiny, there have been some clarifications leading to reclassifications between categories, and between M&O and C&I

Also, the internal refinements and scrutiny have decreased somewhat both the M&O and C&I evaluations

Summaries of the revised total M&O and C&I estimates

REVISED ATLAS M&O (A, B, C) ESTIMATES (MCHF)								
	Cat	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**TOTAL**
Inner Detector	B	0.4	0.4	0.4	1.1	2.6	3.5	**8.2**
LAr	B	0.1	0.1	0.0	0.5	1.0	1.8	**3.5**
Tile	B	0.1	0.1	0.1	0.1	1.0	1.0	**2.3**
Muons	B	0.3	0.3	0.3	0.5	1.6	1.7	**4.7**
TDAQ	A	0.4	0.4	0.9	1.8	3.6	4.6	**11.6**
CP/General	A	1.0	2.0	3.1	5.0	8.1	8.3	**27.5**
Category C	C	0.6	0.6	0.7	0.6	0.8	0.8	**4.0**
TOTAL		2.9	3.8	5.5	9.5	18.5	21.5	**61.8**
					21.8			
RRB (Oct 2001)		3.4	4.4	5.8	11.3	23.0	24.7	**72.6**
					24.9			

REVISED ATLAS C&I (A, B) ESTIMATES (MCHF)								
	Cat	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**TOTAL**
Inner Detector	B	0.8	1.1	1.2	0.7	0.0	0.0	**3.8**
LAr	B	0.5	0.6	0.8	0.6	0.0	0.0	**2.4**
Tile	B	0.3	0.7	0.8	0.7	0.0	0.0	**2.3**
Muons	B	0.2	0.5	1.1	0.5	0.0	0.0	**2.3**
TDAQ	A	0.0	0.0	0.1	0.5	0.0	0.0	**0.6**
CP/General	A	0.9	2.8	3.8	2.0	0.0	0.0	**9.5**
TOTAL		2.6	5.7	7.6	5.0	0.0	0.0	**20.9**
					20.9			
RRB (Oct 2001)		3.1	5.5	7.5	4.9	0.0	0.0	**21.1**
					21.1			

Comparing the integrals 2002 to 2005, the M&O has decreased by 3.1 MCHF and the C&I has slightly decreased by 0.2 MCHF (note that the M&O totals include the C part and A is before cost adjustments)

Concerning the construction completion cost items reported at the last meeting, and given in detail in the annexed tables of CERN-RRB-2002-025, there are no significant cost changes to be reported

It has to be recalled, however, that the construction completion costs presented have no explicit contingency built in their evaluation

Very strong and explicit serious efforts are being made to contain and constrain the costs whenever at all possible within the overall amount given at the last RRB

As a recent example one can mention the reorganization of the BT integration-1 work, following the difficulties with the contractor (see M Nessi's presentation), where the cost limitation played a crucial role, accepting a higher risk than in a possible more expensive, new fully industrial, solution

A reduction of the costs counted against the Collaboration has resulted from an iterative assessment with the Experimental Area Group for items which are included in the LHC machine over costs (for all experiments); they amount for ATLAS to 4.9 MCHF as detailed in the annexed tables

One additional cost risk has been identified very recently (and was not included in October 2001), namely a 1.2 to 1.5 MCHF additional cost in the execution of the barrel toroid engineering contract

A joint effort has started with the contract partner CEA to find solutions to minimize this projected possible over cost by rearranging work packages

One can recall (Annex 8.A of MoU) that CEA has already demonstrated its support to ATLAS with a special contribution of 1 MCHF concerning the BT engineering, as advance to future contributions

Strategy for Deferrals to Introduce Flexibility in the Supplementary Funding

The ATLAS Collaboration fully acknowledges that, in spite of tremendous and encouraging efforts made by the Funding Agencies to find fresh resources, it is necessary to prepare a contingency planning in case some of these resources would be missing before the start-up of the experiment

Along the request made by the CERN Management, following up on the last RRB, two scenarios were worked out for the cases that less resources would become available from the Collaboration than the 98 MCHF total supplementary costs announced at the last RRB, namely 78 MCHF ('scenario A'), or 58 MCHF ('scenario B')

The spirit of this evaluation was to demonstrate the priorities, and to introduce a plan for the required flexibility to face reduced supplementary funding

The term of 'deferrals' is used in the following as a mechanism to redirect the funding to the completion construction costs of highest-priority and time-critical item from items that could eventually be added at a later stage

These actions, if necessary, would ensure timely construction of the most vital components

Inevitably, this would be at the cost of initially strongly reduced physics performance, depending on the level of deferrals

Rational and motivations for the planned strategy

Even if obvious, it must be stressed that the main goal, motivation and excitement for the LHC project is the extraordinary physics potential, and ATLAS has taken this as overriding guideline

From a decade of physics studies we know that the main discovery goals of LHC are difficult and demand a complex detector; it is therefore maybe not surprising that also staging and deferrals are not simple and straight-forward

Another important boundary condition is that after the initial few years LHC will operate for a long time at its high design luminosity which will require robustness and redundancy for the most vulnerable detector components (i.e. tracking), beyond the initial staged ATLAS detector configuration

It is therefore mandatory to preserve and prepare a clear upgrade path into the plan, even more so when considering that the only really foreseeable far-future LHC machine upgrade will be its luminosity beyond the current design

This has led ATLAS to evaluate the flexibility along the following path, in order of increasing detrimental impact on the initial physics potential

1) **Achieve as much as possible the physics potential of the initial staged detector as discussed before, albeit with restrictions in the pre-operation and commissioning preparation, and at the cost of giving up some internal contingency, and implementing further system-internal staging and savings**

   It was reported in RRB-2002-025 that the Scenario A could achieve to a close level the required performance for the main physics that ATLAS is committed to for the initial physics run (Higgs, SUSY, and exploratory searches for new physics in first place)

2) **If further funding limitations have to be accommodated for the first physics run, then strong additional deferrals of scalable High Level Trigger (HLT) and DAQ components would have to be implemented**

   In addition further severe system-specific staging and cuts would have to be made that would affect initially the operational integrity of the detector (reduced off-detector electronics, for example)

   More severe cuts on M&O and C&I would put important parts of the integration and commissioning phase into question and delay it, with the increased risks of starting LHC operation with a detector not fully tested beforehand

   Two cases for Scenario B have been studied, depending on the level of deferring HLT/DAQ processing power, simplifying one could classify them as
   - **the first level (10 MCHF) would jeopardize the B-physics capability**
   - **the second level (15 MCHF) would also cut into the basic high-p_T discovery physics**

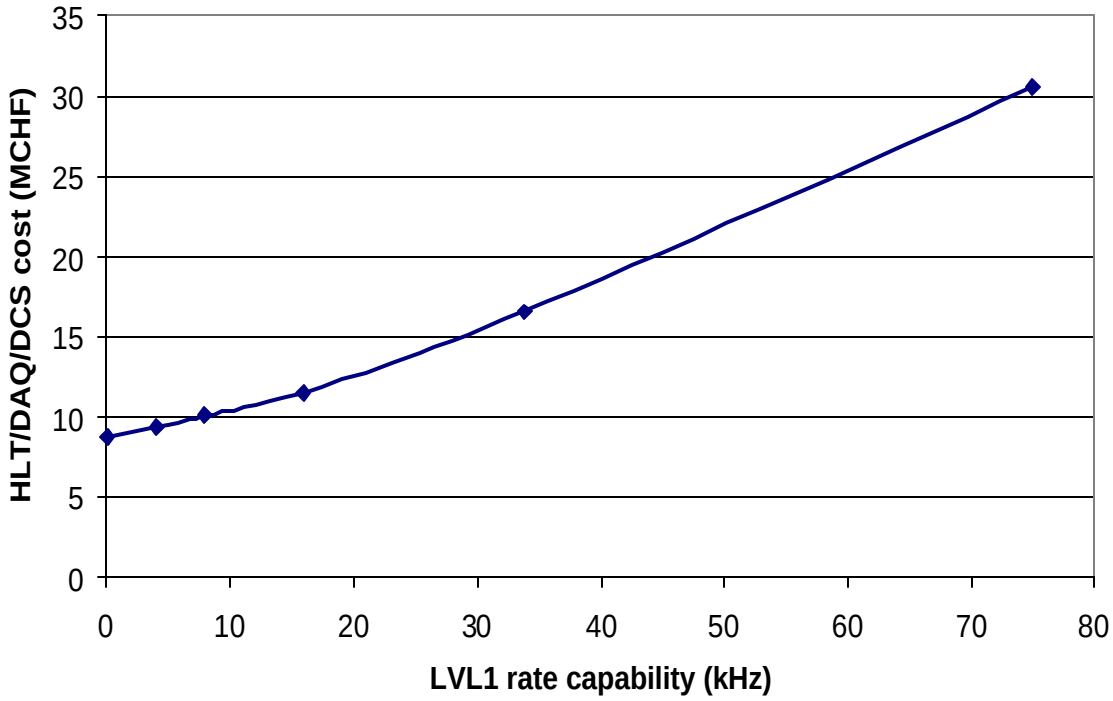
HLT/DAQ deferral scaling

The HLT/DAQ processors and network bandwidth can be scaled down at the price of reduced input capacity from level-1 triggers

The baseline is designed to handle an input rate of 75 kHz, for an expected rate of 25 kHz of high-p_T discovery rate at the initial physics run (the rest is reserved for B-physics, and as a contingency for the very large rate uncertainties)

Case 1 (10 MCHF deferral, almost half of the HLT/DAQ investment) imposes a limit of 30-35 kHz, cutting B-physics

Case 2 (15 MCHF deferral) would require an input rate reduction to 10-15 kHz, imposing even cuts into the very basic high-p_T physics potential



	Number of components in full system	Number of components deferred in "-10M" scenario	Additional number of components deferred in "-15M" scenario
Deferred cost (MCHF)	0 MCHF	14 MCHF	19 MCHF
Readout Buffers	1620	405	0
Concentrator switches	530	328	101
Central switch ports	1594	1018	354
DAQ network interface cards	2938	1910	448
DAQ CPUs	1634	955	127
HLT processors	2763	1515	661
Disk (TB)	54	37	17
DCS Local Control Stations	33	0	16

Revised Costs to Completion and Proposed Plan to Proceed with the Timely Detector Construction for the First Physics Run

Proposed ATLAS plan

ATLAS' goal is to achieve the initial staged detector which has been shown to be adequate for reaching the performance needed for the physics potential of the initial LHC physics run, albeit at the cost of acceptably degraded signal significance (for example for the Higgs) and reduced robustness that will be required later at high luminosity

It is understood that any possible cost savings to the Collaboration will be implemented, in particular the reductions mentioned in this presentation

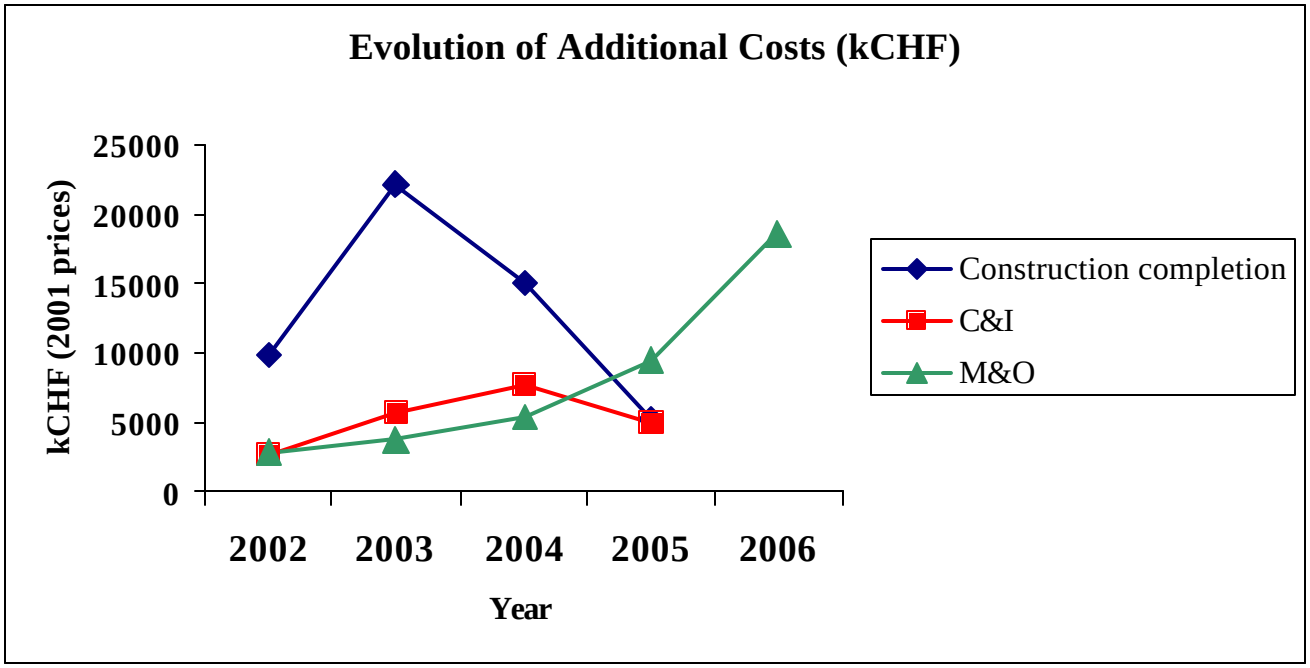
The revised framework for the ATLAS supplementary costs has therefore evolved since the October 2001 RRB where the total (construction completion, C&I and all M&O) was 98 MCHF:

October 2002 RRB		**98.0 MCHF**
Reductions of costs charged to the collaboration		**- 10.7**
Area infrastructure items	**4.9**	
Revised C&I	**0.2**	
Revised M&O	**3.1**	
Category C of revised M&O	**2.5**	
Supplementary costs April 2002 RRB		**87.3 MCHF**

This revised supplementary cost total includes the M&O (A and B) for which an agreement is being reached that it will be covered by all partners in the Collaboration (MoU for M&O)

The remaining Cost to Completion, namely construction completion and C&I costs, are

Revised supplementary cost	**87.3 MCHF**
M&O (A and B) integrated 2002 – 2005	**- 19.3 MCHF**
Cost to Completion (construction completion and C&I)	**68 MCHF**



With this funding ATLAS will be able to construct and commission its initial staged detector as described before and reviewed by the LHCC

Just to recall, the initially staged components are

One Pixel layer in the ID
Outermost TRT end-cap wheels (C-type)
Part of the LAr ROD system
Tile gap scintillators
EES and EEL MDTs
Half of the layers of the CSCs
Part of the Common Project processors
Part of the high luminosity shielding

This staging has created a contingency of 8 MCHF from components that will be required for the high-luminosity phase (processors, shielding and Pixel layer)

The other staged components, also needed for the high-luminosity phase, will be parts of future upgrade projects

Further contingency and flexibility in case of initially lower funding would have to be provided by deferrals, as discussed in the document RRB-2002-025

They would be

HLT/DAQ components	**up to 15.0 MCHF**
System-specific deferrals and reductions	**up to 6.7 MCHF**

In any case, ATLAS will continue to carefully minimize the C&I costs, there is a very strong motivation from the physics to keep these costs to a minimum when comparing with the impact of initially missing components

Many very constructive, and for ATLAS very encouraging, interactions took place with almost all of the Funding Agencies

In particular the National Contact Physicists (NCPs) are making the crucial link between the Funding Agencies and the ATLAS management

It is premature today to draw definite conclusion from these contacts whether the full requested level of supplementary funding can be reached ultimately or not, and with which time profile

This clearly will depend also on a quick resolution of the general LHC situation, and on the overall approach of the RRB towards the ATLAS plans

But already many letters, declarations of best intentions, and indications are demonstrating the continued, and additional, support to ATLAS, for which the Collaboration is sincerely thankful

From the replies and discussions it has also become clear that in several cases CERN's help on the cash profile would be needed, backed up by pledges from Funding Agencies or deferrals

Tentative sharing proposal

The sharing procedure as mentioned before has been applied, including a minimal contribution to the common construction completion item based on the proposed extension of the ATLAS member fee for 2004 – 2006 at the same annual level as currently agreed in the Construction MoU

Funding Agency	TOTAL kCHF
Armenia	47
Australia	319
Austria	64
Azerbaijan	42
Belarus	42
Brazil	56
Canada	2072
China NSFC+MSTC	146
Czech Republic	324
Denmark	419
Finland	0
France IN2P3	6297
France CEA	1958
Georgia	42
Germany BMBF	4627
Germany MPI	1161
Greece	271
Israel	765
Italy	7065
Japan	4240
Morocco	50
Netherlands	1954
Norway	514
Poland	125
Portugal	463
Romania	145
Russia	3212
JINR	932
Slovak Republic	67
Slovenia	200
Spain	1807
Sweden	1668
Switzerland	2193
Taipei	393
Turkey	46
United Kingdom	3964
US DOE + NSF	12456
CERN	8315
total	68,459

Today, the indications are that within a time frame of up to 2006/7 this funding will become within reach, and a considerable fraction (order 60%) is already expected to be met from those Funding Agencies having given an estimate, whereas for the rest new requests for upgrades and additional funding are already in preparation, or will soon be so

The next step, namely to present an overall definite plan with sharing and profiles, needs to be worked out urgently for the October RRB 2002 with the feedback from today's RRB

The ATLAS proposal is to ask the Funding Agencies to support its plan for achieving the initial staged detector for the first physics run in 2007 along the plan which includes the contingency and flexibility to accommodate late or less resources by deferrals

This plan would then be worked out in definite details for the October 2002 RRB

In the meantime, ATLAS would need to proceed on the most time-critical components for the magnet system and the infrastructure, which are required for any viable detector configuration

The ATLAS Collaboration is highly motivated to contribute its utmost to meet the remaining challenges in the detector construction and installation within this frame, but it will rely on your continued support to succeed together