CERN-RRB-2002-114
30th September 2002 - Annexe 2 Revised

ATLAS Completion Plan

1. Introduction

The ATLAS Collaboration has consolidated its plans for the staged initial detector configuration along the basic considerations presented at the previous RRB meetings (documented in ATLAS RRB-D 2001-121 and CERN-RRB-2002-025), taking into account the resources situation. Since almost two years the Collaboration has investigated staging scenarios for a situation where initially not all required resources to complete the full detector would be available, in spite of tremendous and highly acknowledged efforts by the Funding Agencies and Institutes. The present plan for an affordable staged initial detector, installed and commissioned by the end of 2006 and ready for the first beam in 2007, is based on these studies.

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 an overriding guideline. From a decade of detailed physics studies it is known that the main discovery goals of the LHC are difficult and demand a complex detector. It is therefore not surprising that staging is not a simple and straightforward matter. An important boundary condition is that after the few initial years the LHC is expected to operate for a long time at its high design luminosity, which will require robustness and redundancy against the high backgrounds, beyond the capabilities of the staged initial detector configuration. It is therefore mandatory to preserve a clear upgrade path in the plan, even more so when also considering that the only foreseeable far-future LHC machine upgrade will be in its luminosity beyond the current design.

The additional resources needed to complete the construction and to ‘commission and integrate’ (C&I) the initial detector as presented in the April 2002 RRB (CERN-RRB-2002-062) have been evaluated to some 68 MCHF. This amount does not include the cost increases on deliverables, the M&O costs and the computing costs. Since then the constructive interactions with the funding partners have shown that about 47 MCHF will be covered, and that there are good funding prospects based on ongoing requests of some 13.5 MCHF. The present plan is based on an availability of 47 MCHF additional resources. This means that the funding of even more components than presented at the April 2002 RRB need to be redirected initially in order to finish the construction and installation of the highest priority and most time-critical items. Inevitably this will reduce strongly the initial physics performance whilst still maintaining significant discovery prospects. The full LHC physics potential will have to be restored as soon as more resources will become available again.

2. Construction Completion and C&I Costs

A revision of the additional resources needed to complete the construction of the initial detector, including the C&I activities, was announced at the April 2002 RRB and amounts to some 68 MCHF (details were provided in the documents CERN-RRB-2002-025 and 062). As reported during this meeting these estimates were reviewed by the LHCC CORE committee for the construction completion costs, and by a combined CORE and RRB Scrutiny Group for the C&I part. Since then there have been only minor changes, and a very strong effort is being made to contain and constrain the costs whenever at all possible within the overall amount given at the last RRB. As already mentioned in April 2002, one new cost risk has been identified of up to 1.5 MCHF additional costs in the execution of the barrel toroid engineering contract which is not included in the above 68 MCHF. A joint effort is ongoing with the contract partner CEA to find solutions to minimize this projected possible over-cost by rearranging work packages.

The total construction completion costs amount to 47.3 MCHF, and are split into common (category A) costs of 35.6 MCHF and system-specific (category B) costs of 11.7 MCHF. A detailed breakdown of all contributing items is given in Annex 1. In summary they are:

Category A	Magnet System	19.6 MCHF
	LAr Cryostats and Cryogenics	2.3 MCHF
	Infrastructure and Supports	11.4 MCHF
	Missing Common Fund	2.3 MCHF
Category B	Inner Detector	4.0 MCHF
	LAr Calorimeter	3.6 MCHF
	Tile Calorimeter	1.8 MCHF
	Muon Spectrometer	2.3 MCHF

The total C&I costs have been estimated to be 20.9 MCHF, and are split into common costs (category A) of 10.1 MCHF and system-specific costs (category B) of 10.9 MCHF. For them the breakdown is:

Category A	Magnet System	4.7 MCHF
	Infrastructure and overall Integration	4.8 MCHF
	Trigger/DAQ and Controls	0.6 MCHF
Category B	Inner Detector	3.8 MCHF
	LAr Calorimeter	2.5 MCHF
	Tile Calorimeter	2.3 MCHF
	Muon Spectrometer	2.3 MCHF

The Collaboration has agreed to share the category A costs proportional to the overall CORE investment for the baseline construction (Construction MoU), with a minimum contribution corresponding to an extension of the ATLAS member fee of three years (see next section). The category B costs have been agreed to be shared in proportion to the CORE investment for the baseline construction within the detector (sub-)system in question. Based on these criteria a sharing per Funding Agency is proposed as indicated in the table of Annex 2.

The anticipated commitment profiles are shown in Figure 1, which include for completeness also the profile for the total maintenance and operation (M&O) costs.

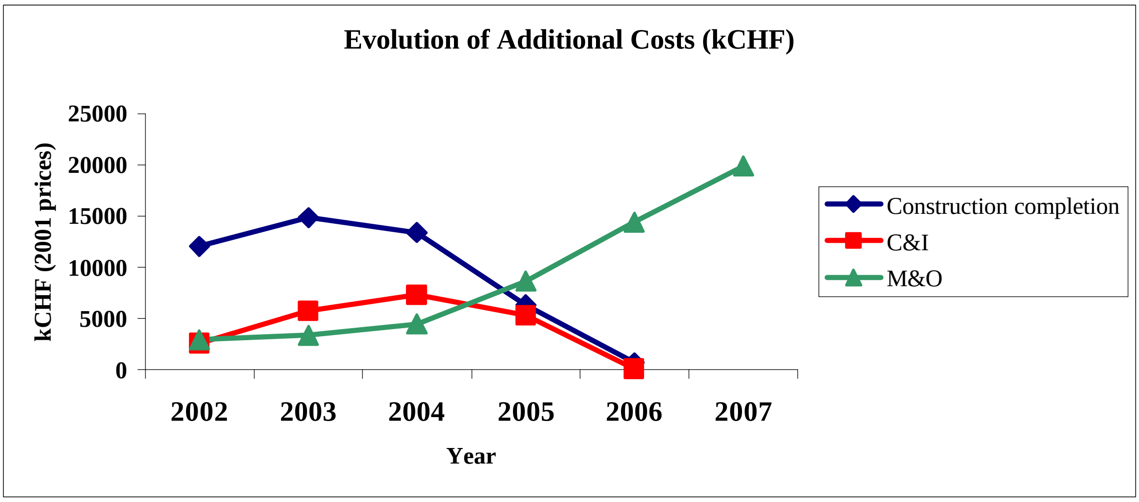

Figure 1

3. Completion and C&I Funding

Many fruitful and constructive interactions took place with the funding partners of the Collaboration, either directly with the Funding Agencies or via the ATLAS network of National Contact Physicists relating to their Funding Agency. Following the conclusions of the RRB meeting in April 2002, the availability for completion funding was established for two different categories.

The actual planning can only be based at this stage on the first category, namely the resources for which the Funding Agencies are able to take a commitment at this RRB under the same premises as specified in the initial Construction MoU (ATLAS RRB-D 98-44 rev.). Included in this first category of completion funding is the obligation of the minimal cash contribution arising from the extension of the collaboration member fee over the three years 2004 to 2006, as a continuation of the principle established in the Construction MoU (Article 6.3). This amounts to 12.5 kCHF per year and per voting ATLAS Institution.

The second category lists the resources for which there is a good prospective through ongoing funding requests that they might become available, either still before the LHC start-up or shortly after. However, no commitments can be made at this stage for resources from this second category, and therefore the initial detector configuration cannot call upon them.

The current completion funding situation with respect to both categories is detailed in the table of Annex 2. The total for the first category amounts to 47 MCHF, and for the second to 13.5 MCHF of the needed 68 MCHF. The ATLAS Collaboration is very grateful to all those Funding Agencies which are able to commit already at this stage significant amounts of fresh resources. Without this generous support ATLAS could simply not plan for a viable initial detector.

It is well understood that the situation is expected to evolve with time. In many cases Funding Agencies have expressed their best efforts to secure additional resources reaching their proposed share, but were not able to achieve this within the time scale imposed by this RRB meeting. The process of firming up further commitments for completion resources will certainly extend over the coming years. This would then allow the ATLAS Collaboration to gradually improve the expected performance of its initial detector, thereby becoming capable of exploiting more fully the LHC physics opportunities. It is foreseen that the funding situation will be updated regularly for the future RRB meetings. This would then also include additional resources from possible collaborators newly joining ATLAS.

The profile of the pledged completion contributions (first category) is shown in Figure 2, compared to the payment profile needed for the initial detector described in the next section.

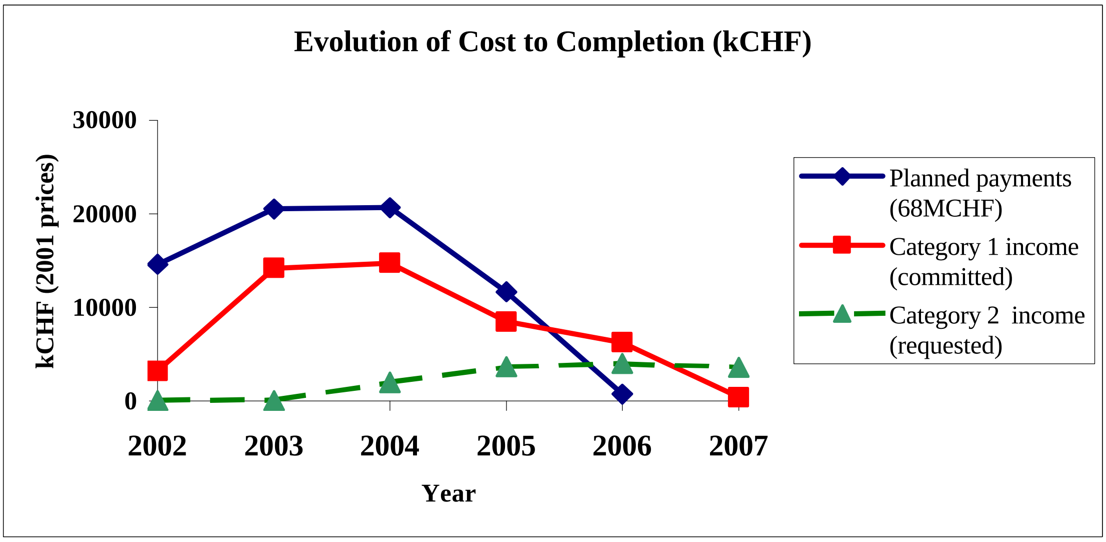

Figure 2

A cash flow problem is anticipated for the years 2004 to 2006. The ATLAS management is negotiating solutions with CERN and other Funding Agencies for this problem, in addition to using the small remaining flexibilities from the baseline construction funding.

4. Initial Detector Configuration

The initial detector configuration for which ATLAS will plan from now on, and which fits into the completion funding envelope defined in the previous section, is based on the studies carried out over the past years. The overriding physics criteria and boundary conditions have already been recalled in the introduction, and have been presented to the RRB in previous meetings (ATLAS RRB-D 2001-118). In terms of physics priorities for the first run they are:

- SUSY (supersymmertry) potential requires full calorimeter coverage;

- Standard Model Higgs searches, including the low mass region overlapping with the LEP limit and in direct competition with the Tevatron collider experiments, imply in addition electron and muon detection and measurements over a large rapidity range (rather than full radial high-luminosity redundancy over limited rapidity) and efficient b-tagging;
- MSSM Higgs searches already at low luminosity need in addition tau-lepton identification.

These criteria should also enable the detector to be ready for unexpected discovery physics, the most important aspect of the first LHC physics run.

A meaningful detector needs the full Magnet System; no reasonable staging has been identified that would be possible in this case. Furthermore, one has to recall that the construction of the barrel toroid is critical for the overall schedule, and in order to have a balanced magnetic force configuration it would not be possible to consider temporary operation with only one end-cap toroid.

The initial Inner Detector configuration will defer the second of the three pixel layers (not the B-layer) and its associated read-out electronics as well as the outermost end-cap TRT wheels (type – C wheels). A pixel layer instead of an SCT layer was chosen for staging in order to minimize the future re-installation down-time.

Full Calorimeter coverage is required for the initial LHC physics, in particular for the important Higgs and SUSY searches. As a side-remark it is also needed mechanically to shield the muon chambers within the ATLAS air-core magnet system. The limited staging that is implemented concerns a reduction of read-out drivers (RODs). Further staging will be implemented for the instrumentation with the so-called cryostat-gap scintillators used for energy corrections in the transition regions between barrel and end-caps.

The staging in the Muon System affects the so-called EES and EEL MDT chambers, including supports and electronics, in the transition region between barrel and end-caps. Furthermore only half of the CSC layers (mechanics and electronics) will be part of the initial detector.

The forward region shielding design has been optimized such that a staging can be implemented for the low-luminosity running during the first years of running.

Already in the early staging plans it was foreseen to postpone part of processing power initially foreseen to be covered as Common Projects in-kind contributions.

These staged components for the initial detector configuration, namely

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

will ‘liberate’ 8.0 MCHF of resources which will be redirected towards covering over-costs on the common items from the list of Annex 1. As reported already in CERN-RRB-2002-025, these 8.0 MCHF break down into 4.0 MCHF from staged Common Project processors, 3.0 MCHF from components of the staged pixel layer, and 1.0 MCHF from the staged high-luminosity shielding. The staged initial detector has further components missing, but their corresponding funding will not be available in time for the initial detector. These components are staged because they are either part of the low-priority US management contingency components (US scope increases most likely not possible before the availability of future upgrade funding), or are based on baseline funding parts expected to be only available late in the funding profile, or finally because of a remaining overall CORE funding short-fall as reported at previous RRB meetings.

Given these 8 MCHF that can be redirected, an uncovered gap of 13 MCHF still remains when comparing the completion funding commitments of 47 MCHF (Section 3) to the total completion and C&I costs of 68 MCHF (Section 2). This gap will have to be covered for the initial detector by further deferrals of scalable processing power and components from the High-Level-Trigger (HLT) and DAQ system.

The HLT/DAQ processors and network bandwidth can be scaled down at the price of reduced input capacity from the level-1 triggers, which in turn means applying higher physics trigger thresholds and giving up collecting data for some physics channels. The baseline HLT/DAQ system is designed to handle a level-1 input rate of 75 kHz. A cost-scaling model has been developed for the anticipated performance of the HLT/DAQ system. The cost scaling behaviour is shown in Figure 3.

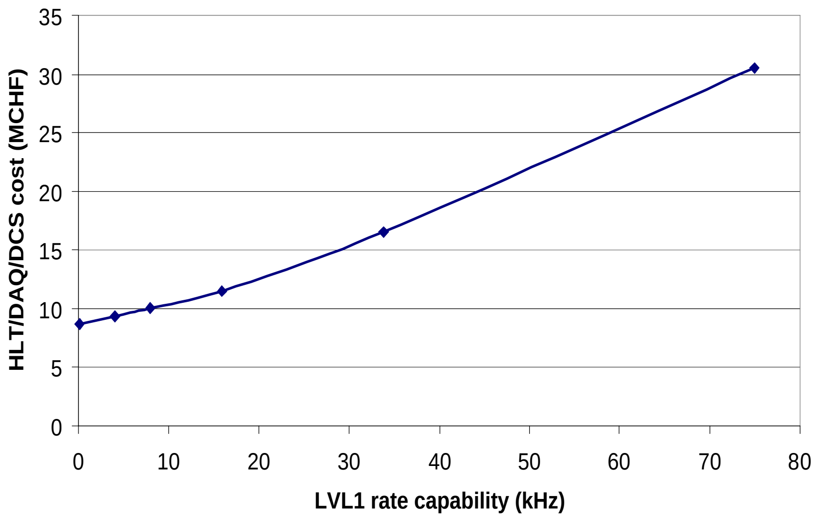

Figure 3

It is worth pointing out that this cost model still has large uncertainties, which are expected to be at least partially resolved in the HLT/DAQ Technical Design Report (TDR) due for submission in mid-2003. The staging of 4 MCHF worth of Common Project processors plus an additional 13 MCHF from the HLT/DAQ system budget to be redirected to cover missing resources for the total completion and C&I costs, as explained above, imply that the level-1 rate capability will have to be limited to 23 kHz for the start-up running.

5. Physics Performance of the Initial Detector

The physics performance of the initial detector is affected by the staging of detector components and by the initially reduced performance capability of the HLT/DAQ system. Both effects have been studied and iteratively discussed with the LHCC, in particular also during the recent third Comprehensive Review for ATLAS (CERN/LHCC 2002-024). To a large extent these two cumulative effects factorize and can be quantified separately.

The impact of the staging of the detector components has already been presented in ATLAS RRB-D 2001-118, and has been studied in particular for the most important example of the low-mass Higgs detection. While ignoring possible small penalties on the pattern recognition performance coming from the less robust tracking systems already at low luminosities, typical degradations in signal significances have been evaluated to be up to 10%, meaning that up to 20% more luminosity needs to be integrated at LHC in order to compensate for the losses. Some examples are given in the Table 1 below.

Staged items	Main impact expected on	Loss in significance
One pixel layer	$ttH \rightarrow ttbb$	~ 8%
Cryostat Gap scintillators	$H \rightarrow 4e$	~ 8%
MDT	$A/H \rightarrow 2\mu$	~ 5% for m ~ 300 GeV

Table 1

It is worth noting that some other physics channels may well be affected more strongly, for example due to a deterioration of the b-tagging performance by ~ 30%. The TRT wheel type-C staging will degrade the ID momentum resolution by a factor 1.5 in the end-cap pseudo-rapidity regions of about 1.8 to 2.2.

The additional impact on the physics of the initially reduced HLT/DAQ capability is large and has been evaluated more recently. With the resources available the bandwidth capacity of the system will be reduced from 75 kHz to 23 kHz input rate from the level-1 trigger. The level-1 trigger system is very flexible in terms of composing an optimal selection within given rate boundary conditions. The priorities guiding this choice are unambiguous: ATLAS will try to preserve as much as possible its potential for high-transverse momentum and discovery physics.

The best current estimate of the level-1 trigger rate from physics studies, before any reduction, is about 45 kHz *without* any safety factors as contingency, which is needed because of the cross-section uncertainties, for a machine luminosity of 2 x 10^{33} $cm^{-2}s^{-1}$. Almost 20 kHz are due to a dedicated B-physics trigger (low transverse momentum single muons), and the rest to triggers able to select high transverse momentum discovery channels.

The necessary initial reduction to 23 kHz, including some contingency, can only be achieved by giving up the dedicated B-physics trigger, and rising some of the trigger thresholds for the discovery physics. A very reduced programme of B-physics is still possible for channels triggered by di-muon events, but many channels will be either lost or the statistics will be reduced by large factors.

The most prominent impact for the discovery physics will be the need to raise the single electron threshold, typically from 25 to 30 GeV in transverse momentum. This will remove an important safety margin for many physics analyses, and translate for example into a further loss of 6% (in addition to the Pixel staging effect of Table 1) of signal significance for the low-mass Higgs channel ttH $\rightarrow$ ttbb. Another typical price to pay for increased trigger thresholds is an even weaker overlap of search sensitivities with the FERMILAB Tevatron Collider experiments, in particular in searches for hypothetical new heavy particles in the mass range below one TeV.

ATLAS is investigating how to use best the spare capacity for times when the LHC machine luminosity will be below the value stated above.

6. Completion of the High-Luminosity Detector

The LHC is expected to reach its design luminosity, here referred to as high-luminosity, after only a few years of initial data taking. It can be anticipated that the machine will then operate for a decade at its maximum capabilities, and perhaps this will be followed at some future time by the only foreseeable LHC upgrade, namely with luminosities even beyond its current design. Besides restoring the HLT/DAQ processing and background rejection power, running at the LHC design luminosity will require not only complete angular coverage, but also complete tracking devices with all layers along the tracks as in the baseline ATLAS TDR design in order to address the full LHC physics potential. Some of the reasons have been recalled in ATLAS RRB-D 2001-118. For example, full resolution is required in the Muon Spectrometer for the discovery of high-mass objects, and full tracking redundancy is required for pattern recognition and efficient b-tagging in the Inner Detector in the presence of pile-up and radiation backgrounds as expected at design luminosity.

The plan of the ATLAS Collaboration is in the first place to restore the HLT/DAQ capability as soon as additional funding becomes available. The aim is to design the system in such a manner that this will become possible in a gradual (scalable) way without major shutdown requirements on the detector. Very high priority will also be given to the completion of the staged high-luminosity shielding in the forward directions, which can be added in a standard shutdown of the LHC. The Collaboration anticipates that the funding for these two items will be covered with the completion resources of the second category (see Section 3), which might become available close to, or only shortly after, the LHC start-up.

Restoring the other staged components of the full high-luminosity TDR ATLAS detector will require resources beyond the ones discussed so far. The intention is to define upgrade projects to enhance the high-luminosity physics potential of ATLAS. For this process one will make use as much as possible of existing tooling and infrastructure where applicable. Installation of these upgrade components will require one of the standard yearly shutdowns of the LHC, which currently are expected to last for a period of about 5 months.

In summary, the estimated CORE values (material only) of the missing components of the initial detector presented in this document are:

Common Project processors	4.0 MCHF
Differed HLT/DAQ components	13.0 MCHF
High-luminosity forward shielding parts	1.0 MCHF
Total with priority from completion funds (category 2)	18.0 MCHF
Components of one Pixel layer	3.0 MCHF
Outermost TRT end-cap wheels (assembly)	0.7 MCHF
ID electronics and cables associated with these	2.6 MCHF
Part of the LAr ROD system	1.5 MCHF
Tile gap scintillator	0.6 MCHF
EES and EEL MDTs	3.0 MCHF
Half of the layers of the CSCs	1.0 MCHF
Total for which future upgrade funding will be required	12.4 MCHF

These estimates do not include related manpower costs, which will depend on the actual circumstances and arrangements for the execution of the upgrade projects.

7. Conclusions

A completion plan for the initial ATLAS detector has been presented, based on the funding level that the funding partners are able to commit to at this stage. The plan is based on trying to maximize the highest-priority discovery physics potential for the initial LHC running with the currently expected resources, and the possibility to gradually complete and upgrade the detector afterwards towards the performance that will be required for the high design luminosity running of the LHC.

The plan implies that the funding of several components from the baseline TDR detector is redirected initially in order to finish the construction and installation of the highest priority and most time-critical items. Inevitably this will strongly reduce the initial physics performance whilst still maintaining significant discovery prospects. The full LHC physics potential will have to be restored as soon as more resources will become available.

The RRB is invited to approve this plan. It is foreseen that there will be regular status reports and updates at the forthcoming RRB meetings on the execution of the ATLAS completion plan.

Annex 1 Detailed item table of the construction completion costs, an update of the Annex Table 1 of CERN-RRB-2002-025.

Annex 2 Table showing the completion funding proposal, new funding commitments (category 1), and new funding requests as prospects (category 2) from each Funding Agency.

Version 4.2

Last update = 26/09/02

Construction Completion Cost Item List

Nature of Cost	Item Description	History and Justification	Funding Agency involved	To be provided as	Contract Info	Commit. Date	MCHF Cost Overrun	Payment Profile <=2002	2003	2004	2005	>=2006	Contact Person
		IK stands for 'in-kind'											
1.1. Barrel Toroid Magnet	1.1.1. Engineering	Recognition of LASA engineering work (0.8) + US installation coordinator (0.4). IK contribution agreed by the April 2001 RRB for INFN.	INFN/LASA, US	cash	TMOU add.3	RRB Apr-01 Oct-99	**1.2**	0.8	0.2	0.2			G. Volpini
	1.1.2. Warm structure	***Core cost = 2.6, current cost 4.1 .*** Cost increase due to an increase in the market price of AL and an increase of the volume. Several parts for shimming have also been added. The procurement of the AL forget pieces will be done with a CF contract to be placed with Samara (Russia). All mechanical work will be done in JINR as an IK contribution.	RF, JINR, CERN, CF	partially IK		May-02	**1.5**	0.1	1.4				H. ten Kate
	1.1.3. Coil casing	***Core cost = 10.5, current cost = 12.5 .*** Net cost increase in AL and welding qualification + 2 years inflation.This contract is indexed. Sharing of extra costs accepted by D and CH as part of an additional IK contribution. Contract running with Alstom Suisse.	D, CH	IK	CERN-F278 CD1000628 CD1180767 CD1000664 CD1000679	Jun-01	**2.0**	1.0	1.0				H. ten Kate
	1.1.4. Integration 1&2	***Core cost = 5.0, current cost = 5.6 .*** Integration 1 contract higher after competitive tendering (+1.1), partially compensated by a cost effective cryostating by JINR. Contract running with JINR(RF) for integration 1+2. BDT contract cancelled. New contract with Technicatom. Work has re-started in April '02 at CERN bldg 180.	CF	CF	CERN-F372 CERN-K758	Jun-01	**0.6**		0.3	0.3			H. ten Kate
	1.1.5. Pancakes and radiation shieldings	***Core cost = 11.5, current cost = 11.9.*** Coil pancake transports (0.16) and radiation shielding and integration (0.25) over-costs	CF	CF		Jan-02	**0.4**	0.2	0.2				H. ten Kate

ANNEX 1

Nature of Cost	Item Description	History and Justification	Funding Agency involved	To be provided as	Contract Info	Commit. Date	MCHF Cost Overrun	Payment Profile <=2002	2003	2004	2005	>=2006	Contact Person
	1.1.6. Vacuum vessels	***Core cost = 5.3, current cost = 5.8 .*** Transportation option in contract taken (+0.38), extra material necessary for supports reinforcements (+0.12). Contract running with Felguera (S).	S, SP	CF	CERN-F298	Feb-01	**0.5**	0.4	0.1				L. Miralles
	1.1.7. Tie rods	***Core cost = 0.5, current cost = 1.1 .*** Low temperature safety proof loading at 10K of all 64 tie rods required (+0.18), contract signed with Kurchatov(Russia). Extra material for heads and axis (+0.42).	RF, CERN, CF	IK, CF	CA1101601 CERN-K570	Oct-00	**0.6**	0.2	0.4				H. ten Kate
	1.1.8. Cryoring	***Core cost = 1.1, estimation = 1.6 .*** Very complex in nature and requirements. IK by CEA agreed.	IK CEA	IK		Sep-02	**0.5**		0.2	0.3			H. ten Kate
	1.1.9. Installation	***Core cost = 1.4, estimation = 2.4.*** Additional manpower needed wrt original planning, additional complexity on tooling. e ATLAS will do the project organization, design workpackage agreed with CEA. Tooling expertise and renting from company.	CF, IK Spain ?	CF, IK	MS phase	Oct-02	**1.0**			1.0			H. ten Kate
1.2. End Cap T. Magnet	1.2.1. Engineering & inspection	***Core cost = 7.8, estimation = 15.3 total for items below.*** Exchange rate effect (contract with RAL in Pounds at a rate of 1.83 vs average of 2.5).	CF	CF	CERN-K414	Jun-97 Jan-02	**1.7** **1.2**	1.7 0.4	0.3	0.3	0.2		H. ten Kate
	1.2.2. Additional central engineering	Additional RAL manpower needed wrt original planning for design and follow up. Also redesign of common vacuum system to avoid hardware extra cost. Option in the initial CERN-RAL contract.	CF	CF	CERN-K414	Dec-96	**2.1**	1.2	0.2	0.3	0.2	0.2	H. ten Kate

Nature of Cost	Item Description	History and Justification	Funding Agency involved	To be provided as	Contract Info	Commit. Date	MCHF Cost Overrun	Payment Profile <=2002	2003	2004	2005	>=2006	Contact Person
	1.2.3. Cryogenics engineering	Additional RAL engineering requested for common proximity cryogenics system (from design to installation and commissioning). Partially redesign effort to avoid 5 MCHF overcost.	CF	CF	CERN-K414	Oct-00	**1.7**	1.0	0.3	0.3	0.1		H. ten Kate
	1.2.4. Cold mass	To reduce risk and increase safety redundant cooling system cold mass added to the initial specifications (+0.6). Additional manufacturing cost for extra conductor cleaning (+0.2) and small parts (+0.2). Main contract with HMA running via NIKHEF.	CF	CF	TMoU, Add2 CERN-K686	Nov-99 Dec-00	**1.0**		0.4	0.3	0.3		H. ten Kate
	1.2.5. Assembly, integration and controls	Additional construction budget for cold mass integration (+1.0), super insulation (+0.2), tower section (+0.1), and various small parts (+0.3).	CF	CF		Dec-02	**1.6**	0.6	0.4	0.3	0.3		H. ten Kate
	1.2.6. Cryogenics / External system	***Core cost = 10.5, estimate = 11.5 .*** Overcost on main commercial contract for refrigerator (0.4) and additional pipework (0.6).	CF	CF	CERN-F410	Jun-01	**1.0**		0.1	0.4	0.5		F. Haug
	1.2.7. Cryogenics / Proximity & Installation	***Core cost = 3.5, estimate = 4.5 .*** Overcosts on the manpower needed for installation (+0.2), PCS controls (+0.6), varia (+0.2).	CF	CF	tendering phase	Oct-02	**1.0**		0.1	0.4	0.5		F. Haug
1.3. LAr Cryostat & Cryogenics	1.3.1. Various items	Design and cost update, see C+C document ref. DF-17/06/02.	IN2P3, MPI? IK, CF	CF, IK		Dec-01 Mar-03	**1.0**	0.3	0.7				P. Pailler
	1.3.2. Integration	Add. manpower needed wrt original planning for end-cap design and follow-up (0.65). Additional cost on slow controls (0.65). IN2P3 IK contribution under discussion.	IN2P3	IK		Oct-02	**1.3**	0.7	0.6				D. Fournier

Nature of Cost	Item Description	History and Justification	Funding Agency involved	To be provided as	Contract Info	Commit. Date	MCHF Cost Overrun	Payment Profile					Contact Person
								<=2002	2003	2004	2005	>=2006	
1.4. TC Infrastructure	1.4.1. Shielding elements	**Core cost = 5.2, estimation 7.4 .** The overcost is mostly in the JF and JD shielding for which a too low estimation was done in '95. The JF has been recently re-engineered and optimized in term of weight (1100 tons) and cost. This project can be factorized in several sub projects, for which IK contributions are possible.	possible IK + CF	CF, IK CZ	MS phase	May-03	**1.2**			0.6	0.6		V. Hedberg
	1.4.2. Shielding elements	Redefinition and reduction of the Russian deliverables agreed by the '5+5' CERN - Russia meeting.		cash		May-03	**1.0**			0.5	0.5		M. Nordberg
	1.4.3. Traction systems	***Core cost = 0.5, estimation = 2.1 .*** This system in '95 was based on a different technology. Today the plan is to use air-pads with an hydraulic power plant behind (+1.3) for all movements (calorimeters, toroids, shieldings, trucks,..). New in this list is the traction system of the big wheel system (+0.3).	possible IK + CF	CF	MS phase	Jul-02 Oct-02	**1.6**		0.5	0.7	0.4		M. Hatch
	1.4.4. Access structures	***Core cost = 0.4, estimation = 1.5 .*** Regroups overcosts mostly due to new items in this list (access lifts to the inside of the detector, removable scaffoldings for access to the ID and calorimeters, added complexity to the gangways inside the muon system,..).	possible IK + CF	CF	MS phase	Feb-03	**1.1**			0.6	0.5		M. Hatch
	1.4.5. Support structures	***Core cost = 0.1, estimation = 1.5 .*** Regroups initially unforeseen support structures like : big wheels support brackets and access bridges (0.6), truck support structure inside the trenches (0.3), shielding supports (0.2), interfaces between calorimeters (0.3).	CF	CF	MS phase	Oct-02	**1.4**	0.3	0.6	0.5			M. Hatch

Nature of Cost	Item Description	History and Justification	Funding Agency involved	To be provided as	Contract Info	Commit. Date	MCHF Cost Overrun	Payment Profile <=2002	2003	2004	2005	>=2006	Contact Person
	1.4.6. Muon wheel supports	HO metallic structure, unfunded part inside the muon system (0.7) and part of CERN metallic structures contract. Additional costs on big wheel support structure underfunded by the muon system. The big wheel went through an important change in the complexity of the design and in the mechanical requirements in 2000-2001 (0.8).	possible IK + CF	CF	MS phase	Jan-02 Jun-02	**1.5**		0.5	0.5	0.5		F. Butin
	1.4.7. Electrical distribution	Additional contribution to UPS (0.2).	CF	CF		Jun-05	**0.2**				0.2		K. Potter / Ph. Fartouat
	1.4.8. Vacuum chamber	Cost increase in the Be beam pipe (+0.6).	CERN budget area, CF	CERN, CF	MS phase	Dec-02	**0.6**		0.6				R. Veness
	1.4.9. Flexible support carriers	Flexible supports for services and cables for the moving detectors as the endcaps calorimeters and toroids, material (0.75) and installation (0.65). D IK contribution for the material accepted by October RRB.	possible IK + CF	CF, IK?		Mar-02	**1.4**		0.65	0.75			M. Hatch
	1.4.10. Varia - racks, cable trays,..	***Core cost = 1.8, estimated = 2.5.*** Additional racks in US,USA,UX,SCX,SD and cables trays and junction boxes.	CF	CF	MS phase	Aug-02	**0.7**		0.4	0.3			J. Inigo-Golfin
	1.4.11. Safety detectors	Additional safety items (fire detection/extinguishing in detector area (1.3) assumed to be CERN responsibilities. 0.7 from CERN infrastructure. Additional items like racks smoke detection (0.7) in CF.	CF	CF	MS phase	Aug-02	**0.7**		0.7				K. Potter / G. Benincasa

Nature of Cost	Item Description	History and Justification	Funding Agency involved	To be provided as	Contract Info	Commit. Date	MCHF Cost Overrun	Payment Profile					Contact Person
								<=2002	2003	2004	2005	>=2006	
1.5. Systems	1.5.1. ID tooling, test stations, assembly	IDGEN: integration tools (0.2), TRT: cooling, power supplies, cables in SR1 (0.4), assembly tools(+0.25) SCT: readout, cooling, powersupplies, cables in SR1 (1.0) PIXEL: readout, cooling, powersupplies, cables in SR1 (0.6), B-layer tooling (0.15), insertion tooling (0.15), tools to install barrels and disks in global supports (0.2).	ID system	IK possible+ Syst. CF		Oct-02	**3.0**	0.4	1.1	1.2	0.3		S. Stapnes
	1.5.2. LAr integration parts, cryostat transports	Test stations for commissioning, integration work in bulding 180 and in ATLAS (0.6).	LAr system	Syst. CF		Apr-02 Apr-03	**0.6**	0.1	0.2	0.2	0.1		H. Oberlack
	1.5.3. TileCal tooling, cooling, trigger cables	Additional items not in CORE in '95: assembly tooling, including overcost on saddles (0.8), cooling plant (0.20), power supplies (0.6), trigger cables (0.2). Overcost are mainly due to an increase in the specification requirements and updates in the design. Non magnetic steel for the saddles, radiation tolerance for the power supplies.	Tile system	IK possible+ Syst. CF	MS phase	Sep-02 Jan-03	**1.8**	0.3	0.8	0.6	0.1		R. Leitner
	1.5.4. Muon CSM modules, small wheels support	Electronics modules CSM for MDT chambers (2.0). Small wheels integration work (0.3).	Muon system	IK possible+ Syst. CF		Oct-02 Oct-03	**2.3**		0.2	1.3	0.6	0.2	G. Mikenberg
	1.5.5. ID installation tooling	Installation tooling (trolleys (0.04), rails on cryostat (0.04), thermal pads and gas monitoring (0.07), lifting frame and installation tooling, scaffolding (0.11), PIXEL installation tube temporary support an dthermal plug (0.04).	ID system	IK possible+ Syst. CF		Apr-03	**0.3**	0.2	0.1				S. Stapnes
	1.5.6. LAr EM End-Cap components	Funding for various components not covered.	LAr system	IK possible+ Syst. CF		Jun-00	**0.7**	0.7					D. Fournier

Nature of Cost	Item Description	History and Justification	Funding Agency involved	To be provided as	Contract Info	Commit. Date	MCHF Cost Overrun	Payment Profile <=2002	2003	2004	2005	>=2006	Contact Person
	1.5.7. LAr HEC and FCAL components	Funding for components not covered, mainly in the absorber structures	LAr system	IK possible+ Syst. CF		Sep-02	**0.1**	0.1					H. Oberlack
	1.5.8. LAr Electronics	Funding for various components not covered, mainly power supplies and FE crates components.	LAr system	IK possible+ Syst. CF		Dec-02	**1.0**	0.1	0.3	0.3	0.2	0.1	H. Oberlack
1.6. Systems infrastructure	1.6.1. ID SR-building for (pre-)assembly, integration	Construction of a large clean area for ID assembly in SR1.	ID inst.	internal loan	IT-2937	Apr-02	**0.6**	0.5	0.1				S. Stapnes
	1.6.2. LAr integration clean room area in B180	Construction of large clean room area in bldg 180 for barrel and endcap LAr assembly. Arranged as a payment advancement within the community. Work in execution.	LAr inst.	internal loan		Jan-01	**1.2**	0.1	0.2	0.3	0.3	0.3	H. Oberlack
1.7. Common Projects	1.7.1. Missing contributions to Common Fund	Funding missing after 2 new institutes, one partial withdrawal.	CF	CF		RRB Apr-01	**2.3**	0.2	1.1	1.0			M. Nordberg
TOTAL overcosts							**47.2**	**11.6**	**15.0**	**13.5**	**6.4**	**0.8**	

ANNEX 1

Revised Annex 2 for CERN-RRB-2002-114

(all in kCHF)

Funding Agency	Cost to Completion proposed sharing			Member fee 2004-6	New funding (category 1) including member fee	New funding requests as prospects (category 2) without commitment from FA
	Total	**Constr.**	**C&I**		**Total**	**Total**
Armenia	**46**	28	18	38	**38**	
Australia	**355**	242	113	75	**75**	280
Austria	**67**	52	15	38	**67**	
Azerbaijan	**22**	17	5	38	**38**	
Belarus	**44**	35	10	75	**75**	
Brazil	**43**	27	16	38	**38**	
Canada	**2123**	1528	595	263	**263**	1860
China NSFC+MSTC	**144**	99	45	38	**144**	
Czech Republic	**305**	187	118	113	**305**	
Denmark	**420**	291	129	38	**38**	382
France IN2P3	**5954**	4176	1778	225	**3500**	2454
France CEA *)	**1960**	1379	581	38	**1000**	
Georgia	**22**	17	5	38	**38**	
Germany BMBF	**4517**	3250	1267	338	**3617**	900
Germany MPI	**1096**	761	335	38	**1096**	
Greece	**258**	172	86	113	**113**	145
Israel	**734**	497	237	113	**734**	
Italy	**6618**	4651	1967	450	**4000**	
Japan	**4362**	3029	1333	563	**563**	3799
Morocco	**38**	27	11	38	**38**	
Netherlands	**1920**	1368	552	75	**1920**	
Norway	**577**	391	186	75	**577**	
Poland	**130**	88	42	75	**75**	55
Portugal	**444**	265	179	38	**338**	106
Romania	**140**	85	55	38	**140**	
Russia	**3075**	2028	1047	263	**763**	500
JINR	**989**	626	363	38	**418**	
Slovak Republic	**69**	49	20	38	**38**	31
Slovenia	**222**	152	70	38	**222**	
Spain	**1710**	1109	601	113	**1710**	
Sweden	**1691**	1122	569	150	**150**	
Switzerland	**2360**	1701	659	75	**1400**	960
Taipei	**447**	319	128	38	**447**	
Turkey	**45**	35	10	75	**75**	
United Kingdom	**4355**	3064	1291	450	**2575**	1780
US DOE + NSF	**12263**	8437	3826	1238	**6200**	
CERN	**8611**	5968	2643	38	**13700**	
Serbia						300
Total	**68176**	47272	20905	5563	**46528**	13552

*) The commitment shown does not include a 1 MCHF additional engineering contribution provided on the initial BT contract (see MoU Annex 8.A)