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ALICE Cost to Completion

Introduction

At the meeting of the Resources Review Board in October 2001, a preliminary estimate of the additional funds needed for the completion of the ALICE detector was quoted to be between 6.3 and 6.9 MCHF. This amounts to about 5.5% of the total CORE cost as documented in the Memorandum of Understanding (ALICE RRB-D 00-41). These numbers were quoted under the assumption that some 2 MCHF of cost reductions could be found in the area of common items (e.g. Infrastructure, Services, Installation). The Collaboration Management announced at that stage its intention to complete this review to determine more precisely the Cost to Completion (CtC) and to present the results to the Resources Review Board meeting in April 2002.

It is useful to point out that several elements contribute to the present CtC:

- Over- or underfunding as documented in the Memorandum of Understanding.
- Technical developments: Changes in design specifications after additional R&D since the date of the different Technical Design Reports (submitted starting August 1998).
- Cost variations. Several cost estimates which, at the time of the Memorandum of Understanding, were genuine estimates are now based on commercial tendering procedures.
- Availability of technical manpower and support at CERN. Earlier assumptions about cost and availability of technical support have had to be adjusted due to the decrease of, in particular, manpower resources available at CERN.
- Expected shortfall of funding.

The present document gives details of the CtC for detector related cost in section 1. Section 2 gives the breakdown of the additional Common Cost and section 3 presents a proposal for the sharing of these costs between the different Funding Agencies.

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1 - Detector related Cost

Table 1 gives the details of the CtC for the different detector systems. The CtC is composed of three elements:

- Over- or underfunding as documented in the Memorandum of Understanding ('MoU')
- Cost variations: revised cost estimates based, in most cases, on commercial tendering ('Var').
- Funding shortfall ('Fund')

The number and cost of the electronics racks needed by the different detector systems was significantly underestimated. The resulting cost increase (total = 875 kCHF) is distributed pro rata to the different detector systems. The increased cost for electronics racks is included in table 1 under the heading 'Var'.

CORE	*Detector*	*MoU*	*Var.*	*Fund.*	*Total*
1.1	Si Pixel	125	145		270
1.2	Si Drift	-81	411		330
1.3	Si Strip	702	273		975
2.1	TPC		250		250
2.2	TRD		0		0
2.3	TOF		0		0
2.4	HMPID		130		130
2.5	PHOS		20		20
3	Forward		18		18
4.1	Muon Track.		303		303
4.2	Muon Trig.		33		33
4.3	Muon Magnet	-533	628	-87	8
4.4	Muon Absorber	-658	-800	2,572	1,114
5.1	DAQ		40		40
	HLT		230		230
	Totals	***-445***	***1,681***	***2,485***	***3,721***

Table 1: Cost to Completion of ALICE Detectors (kCHF)

Si Pixel

The Silicon Pixel system was underfunded at the time of the MoU by 125 kCHF. A cost increase of about 100 kCHF of the frontend chips is caused by the particularities of the contract with the supplier which results in the purchase of a larger number of wafers than is actually needed. The need to replace copper R/O links with optical links adds some 25 kCHF. Additional cost for racks is 20-kCHF. A second engineering run for the frontend chip will not be made.

Si Drift

Tendering for the Silicon Drift detectors has been completed and the MoU price estimate has been exceeded by 120 kCHF. A cost increase of 180 kCHF for the Low / High voltage Power Supplies is expected. Together with a few miscellaneous cost increase due to design changes (10 kSF) the CtC is expected to be 330 kCHF, including the additional cost for racks of 20 kCHF.

Si Strip

The Silicon Strip detector system was underfunded in the MoU by 702 kCHF. Tendering for the double sided Silicon Strip detectors has been completed and the corresponding contracts have been placed. The total contractual cost of the detector modules is about 250 kCHF higher than estimated, essentially due to the need to distribute the production of the 2000 detectors over 3 different suppliers. Additional cost for racks is 20kCHF.

TPC

Contracts for the production of most of the elements of the Field Cage have been placed. The cost has increased by about 300 kCHF. A contract for the development and production of the ALTRO chip has been signed. This successful development has resulted in a cost saving for the TPC. As a result the TPC is expected to be completed with only a slight cost increase of 250 kCHF, due to the increased cost of electronics racks (200 kCHF) and a special platform for the Laser calibration system (50 kCHF) which had to be added.

TRD

The cost of the full Transition Radiation Detector (TRD) is 15,08 MCHF. The TRD as approved by the LHCC covers slightly more than one half of the full coverage. In the MoU the TRD is only about 50% funded. The missing funds for the full coverage TRD have not been taken into account in the CtC.

TOF

An addendum to the Technical Design Report for the Time of Flight (TOF) detector is due mid 2002 and no new cost evaluation has been made since the date of the original Technical Design Report (February 2000).

HMPID

The cost of the LV Power Supplies is expected to increase by 80 kCHF, the cost of the gas system and cooling by about 25 kCHF. The additional cost for racks is 25 kCHF.

PHOS

The price of the lead tungstate crystals was estimated at the time of the MoU to be 3 CHF per cm^3. The market price is currently around 3.5 USD per cm^3, an increase of almost a factor 2. The Collaboration has decided not to include the cost increase of the PHOS in the CtC, only the additional cost for electronics racks (20 kCHF) is considered.

Forward Detectors

No additional cost other than the cost of electronics racks (18 kCHF).

Muon Arm

Muon Tracking: The cost of the chamber frames is expected to increase by 250 kCHF. The additional cost for electronics racks is 53kCHF

Muon Trigger: No cost increase other than the additional cost of electronics racks (33 kCHF)

Muon Magnet: The yoke of the Muon Magnet is being produced by Russian industry under the joint supervision of CERN and JINR. The coils are under construction by French industry. The overall cost of the Magnet has increased by 620 kCHF, due to the industrial production of the coils (340 kCHF), the cost of the coil support (205 kCHF) and additional cost for engineering (75 kCHF). This increase is compensated by an overfunding of 533 kCHF and the transfer of 707 kCHF of French funding from the Muon Absorbers. About 620 kCHF of funding from JINR has been transferred to the TRD. The quoted CtC of 8 kCHF is due to the cost of racks.

Muon Absorbers: The Muon Absorbers have undergone a number of significant design changes in order to reduce the cost. The present planning calls for the separate procurement from industry of the different elements of the Absorbers and subsequent assembly using the facilities of one of the ALICE member institutes. The total estimated cost, based on an evaluation by industry, is 3,553 kCHF for the Absorbers and 376 kCHF for the Muon Filter. This is about 800 kCHF less than estimated at the time of the MoU. The funding, however, has had to be revised. The contribution of 707 kCHF from France has been transferred to the Muon Magnet and a realistic estimate of the funds available from Russia is 1,230 kCHF. Taking into account the original overfunding of 658 kCHF this leads to a CtC of 1,114 kCHF.

DAQ

No additional cost other than the cost of electronics racks (40 kCHF).

HLT

No additional cost other than the cost of electronics racks (230 kCHF).

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2 - Common Cost

Table 2 presents the CtC of the Common Items. It should be noted that the major contribution to the CtC under this heading is due to the increased cost of both internal CERN services and the manpower needed for the preparation of the experimental infrastructure and installation.

CORE	*Detector*	*MoU*	*Var.*	*Fund.*	*Total*
3.4	FMD			170	170
3.5	T0			30	30
6.1.1	Local Area	0	755		755
6.1.2	Common support Structures	0	-585		-585
6.1.3	Services	0	170		170
6.1.4	Vac. chamber	0	320		320
6.1.6	Installation	-237	2,335		2,098
6.2.1	L3 Magnet	0	207		207
	Totals	***-237***	***3,202***	***200***	***3,165***

Table 2: Cost to Completion of Common Items (kCHF)

Forward Detectors (FMD, T0)

Since the Greek Institutes have announced their withdrawal from the Collaboration, those forward detectors (FMD and T0) with a significant Greek involvement are now underfunded. Some of the Greek responsibilities could be redistributed within the Collaboration, however a shortfall of 200 kCHF could not be absorbed. Since this is an issue facing the Collaboration rather than any particular Funding Agency, the Collaboration has agreed to include this funding shortfall into the Common Cost.

Local Area

Significant cost increases have occurred in the items Site Preparation, Area Control and Supervision and Safety Installations, adding up to a total of 755 kCHF.

Common Support Structures

Despite the increased weight of the detector systems to be supported, the Common Support Structures (rails, space frame etc.) are presently expected to be significantly cheaper than originally estimated.

Vacuum Chamber

The cost estimate of the detector specific part of the vacuum chamber has had to be increased by almost a factor of two.

Installation

Estimates of the cost of installation work have been revised upward significantly. The cost of installation was allocated in the MoU to CERN, and, to lesser degree, to China NSFC. The additional funds needed are estimated to be 2,335 kCHF. The Collaboration has decided to pay for this additional cost out of common resources.

L3 Magnet

The repair of the corroded parts of the L3 cooling systems is expected to cost significantly more than originally estimated, partially compensated by the reduced cost of the upgrade of the control system.

3 - Proposed sharing

It is proposed to share the CtC between the different Funding Agencies according to the following guidelines:

- Common Cost is the responsibility of the Collaboration as a whole and should therefore be shared among the Funding Agencies according to their agreed total contributions to the experiment as documented in the Memorandum of Understanding.
- Detector related cost should be shared between the Funding Agencies committed to the construction of the detectors according to their share of the deliverables, again as documented in the Memorandum of Understanding.

In addition to the above guidelines, the Collaboration proposes to extend the period during which the membership fee (cf. MoU Article 6.3) of 5 kCHF per institute and per year was to be paid (1998 – 2005) for another year over and above the Common Fund contributions as specified in the MoU.

These guidelines do not cover the underfunding of the Inner tracking System (ITS) which, by its very nature, was not underwritten by any of the Funding Agencies. The Collaboration proposes to cover this funding shortfall (Silicon Pixel:125 kCHF and Silicon Strip: 700 kCHF) from CERN funds. In compensation, the CERN share of the additional common cost would be reduced to zero. It should be noted in this context that CERN's contribution to the Common Projects as documented in the MoU is larger by about the same amount than the required 10% of its total contribution.

The proposed sharing of the CtC following the guidelines above is presented in Table 3.

Funding Agency	***Detector***	***Common***	***Fee***	***Total***
CERN (Si Pixel, Strip)	825	0		825
CERN	520	0	5	525
Czech Republic	20	22	10	52
Denmark	54	44	5	103
Finland	35	37	5	77
France CEA	101	66	5	172
France IN2P3	499	322	25	846
Germany BMBF	189	465	25	679
Germany GSI	111	273	5	389
Hungary	5	22	5	32
Italy	729	594	55	1,378
Netherlands	60	82	5	147
Norway	51	51	15	117
Poland	1	37	15	53
Slovak Republic	15	26	10	51
Sweden	80	114	5	199
Switzerland	0	9	5	14
United Kingdom	5	59	5	69
Armenia	0	6	5	11
China NSFC	4	111	10	125
Croatia	0	7	10	17
India	150	111	15	276
JINR	90	111	5	206
Mexico	0	1	5	6
Romania	0	18	5	23
Russia	144	240	10	394
Ukraine	35	37	10	82
United States	0	4	15	19
Total	***3,723***	***2,869***	***295***	***6,887***

Table 3: Sharing of Cost to Completion (kCHF)

Conclusion

The total additional funds needed for the completion of ALICE amount to 3.721 MCHF for detector related cost and 3.165 MCHF for common cost or a total of 6.886 MCHF.

The Resources Review Board is requested to take note of the Cost to Completion of the ALICE experiment and accept the sharing as given in table 3 as a basis for discussion between the Funding Agencies and ALICE management.

It is understood that:

- ALICE will continue to make every effort to limit the cost of the detector;
- details concerning the nature of the contributions (cash or in-kind) as well as the timing will be the subject of consultations with the Funding Agencies.