CMS

Compact Muon Solenoid

FINANCIAL PLAN

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RRB14 22 April 2002

Update on Cost to Completion
- Sub-Detectors
- Commissioning and Integration

Proposal for Sharing of Cost to Completion

Staging / Savings / Additional Collaborators

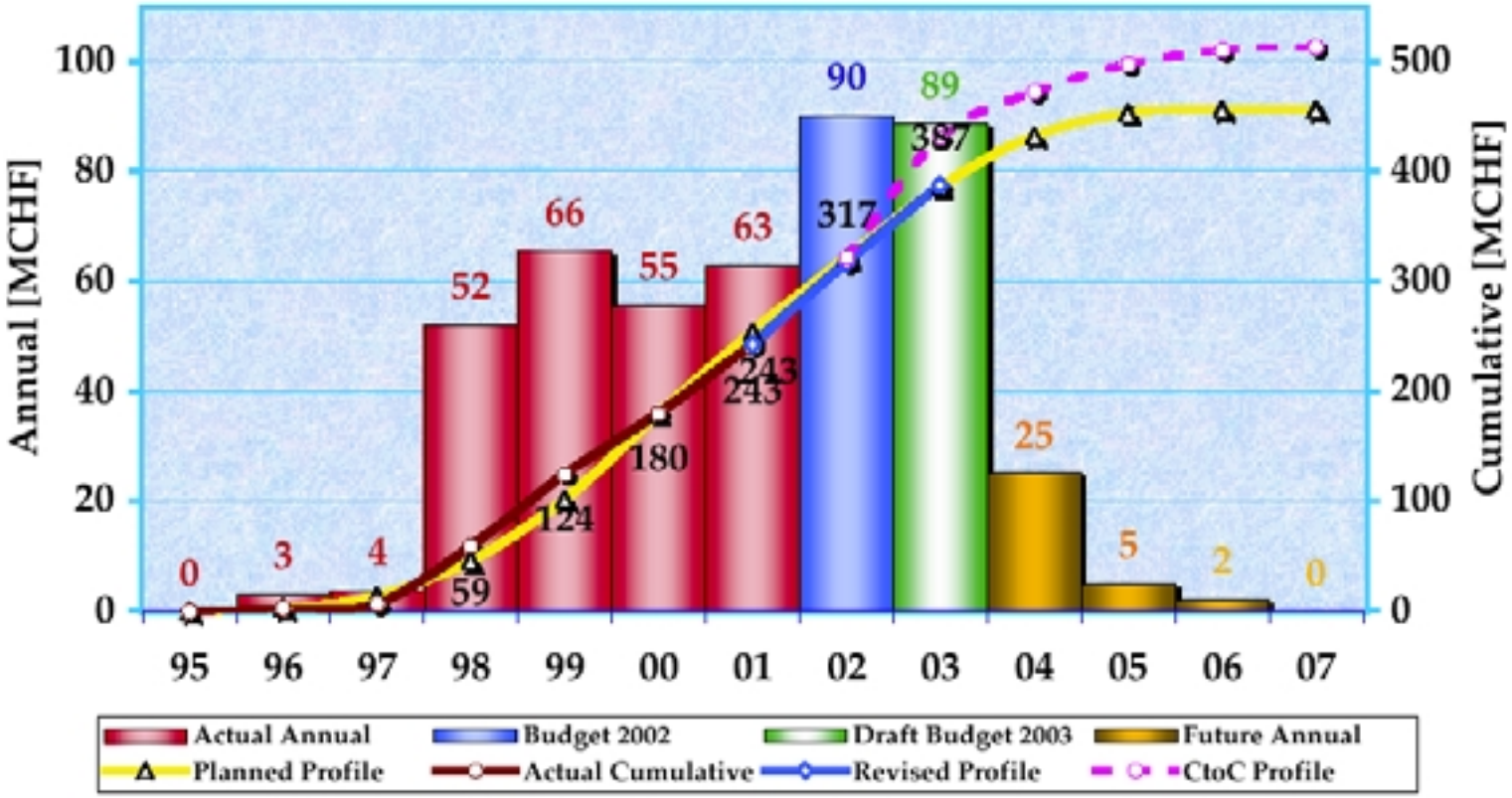
High Luminosity Upgrade

Desired Funding Profile

Ref: Document CERN-RRB-2002-010

Construction: Commitment Profile

Apr 02 RRB



By end of 2002 ~70% of the available funds will have been committed.
62.7 MCHF of additional funds need to be committed soon in order to have a complete initial low luminosity detector in 2007.

Financial Plan

- Initial detector for Physics in 2007: Complete CMS except 4th Endcap Muon station (ME4) and 3rd Forward pixel disks.
- At RRB13 best estimate of Cost to Completion for this initial detector was presented, indicating a global shortfall of 67.9 MCHF.
- Additional saving/staging of ~5 MCHF have been identified reducing the shortfall from 67.9 MCHF to 62.7 MCHF.
- Preliminary discussions with Funding Agencies indicate that this reduced shortfall could be covered with additional funds.
- 62.7 MCHF is our best estimate of the additional funds needed to complete CMS. We will stick to this estimate. CMS will then build-to-cost and cap the shortfall to this value.

Evolution of Cost to Completion

	RRB13 (Oct 01)			RRB14 (Apr 02)		
	Cost (kCHF)	Funding (kCHF)	Shortfall (kCHF)	Cost (kCHF)	Funding (kCHF)	Shortfall (kCHF)
1. Magnet	124,120	120,900	3,220	124,120	120,605	3,515
2. Tracker	77,636	70,200	7,436	77,636	70,740	6,896
3. ECAL	111,860	87,800	24,060	111,860	87,625	24,235
4. HCAL	44,400	42,400	2,000	47,414	47,414	0
5. Muons	71,300	58,000	13,300	68,388	58,095	10,293
6. Tridas	37,700	37,700	0	37,410	37,410	0
7. Computing	3,600	3,600	0	3,600	3,600	0
8. Infrastructure	28,100	24,800	3,300	28,105	24,930	3,175
9. C&I	12,450		12,450	14,650		14,650
Xtra Work SX5	2,200		2,200			0
TOTAL	513,366	445,400	67,966	513,183	450,419	62,764

Shortfall reduced from 67.9 to 62.7 MCHF and capped to 62.7 MCHF

- 2 MCHF saving in the Hadron Calorimeter (HCAL) by reducing the number of longitudinal samplings. Cost & Funding re-evaluated but no new shortfall (balanced)
- 1.5 MCHF of staged spending: the number of electronics channels has been reduced in endcap muon station ME1/1.
- 1.5 MCHF of staged spending: re-stage the electronics of ME4/1: the cost of the initial detector discussed at RRB13 (Oct 2001) contained the restored ME4/1.

Commissioning and Integration (C&I)

9.	**Commissioning and Integration (C&I)**		**14.65 MCHF***
	(Extra Work in SX5 (2.2 MCHF) has been absorbed into C&I)		
9.1	Additional facilities for commissioning on surface		3.16 MCHF
9.1.1	Mixed water cooling	0.30	
9.1.2	Gas distribution	0.10	
9.1.3	Control Room (Barrack) Refurbishment	0.08	
9.1.4	Smoke detection	0.15	
9.1.5	LV system (1 generator)	0.15	
9.1.6	Temp. 10t lifting equipment in SDX	0.20	
9.1.7	Electrical and fiber optical cabling in SX5	0.20	
9.1.8	Common Electronics	0.80	
9.1.9	Pre-cabling, Pre-testing facilities	1.00	
9.1.10	Basic DSS for equipment protection	0.08	
9.1.11	Semi Clean Room (200 m2)	0.10	

Commissioning and Integration (C&I)

9.2	Detector installation, opening and access facilities			3.84 MCHF
9.2.1	Duplication of tooling		0.12	
9.2.2	Dummy end flanges (EB, EE, SE)		0.20	
9.2.3	Magnet closing system		2.00	
9.2.3.1	grease pads	0.40		
9.2.3.2	corner & closing pieces	0.75		
9.2.3.4	winches for 10m opening in UX5	0.85		
9.2.4	Control for magnet and power supplies		0.42	
9.2.5	Beam-pipe & vacuum tooling, beam pipe support		0.32	10 m opening
9.2.6	Floor Plates for UX5		0.48	
9.2.7	Cherry Pickers and Access Platforms		0.30	
9.3	General Services			7.65 MCHF
9.3.1	Workshops		0.60	
9.3.2	Heavy Transport		2.42	5 ops 02-04, 7 in 05, 5 in 06
9.3.3	Survey		0.43	
9.3.4	Infrastructure for Storage		0.30	
9.3.5	Extra engineering design for integration and cabling		1.40	
9.3.6	CMS Technical support team		2.50	Installation base team

Sharing of Costs to Complete

We are not asking for further investments from Switzerland, since it has to provide an exceptional investment of 86.5 MCHF and participates in addition, together with CERN, to the Engineering Center.

We propose to divide the shortfall of 62.7 MCHF into a common part of 21.3 MCHF (14.6 C&I + 3.5 Magnet + 3.2 Infrastructure, corresponding to an increase of 6% of the investment) and a detectors part of 41.4 MCHF (corresponding to an increase of 11.3% of the investment).

We request all funding agencies to contribute at least 17.3% of their capital investment as indicated in the next table (Table 4 of the distributed Financial Plan document CERN-RRRB-2002-010).

Preliminary indications from many Funding Agencies are positive.

		CP= C&I, Magnet, Infrastr.	Tracker	ECAL	HCAL	Muons	TriDAS	Tot. Det.	Total CMS
Austria (1)		141	459					459	600
Belgium		290	580					580	870
Brazil		500							500
Bulgaria (as a CERN Member State)		35				71		71	106
CERN		5,000		8,500				8,500	13,500
China		500				200		200	700
Croatia		16		33				33	49
Cyprus		35		71				71	106
Estonia		16							16
Finland		290	580					580	870
France	CEA	340		660				660	1,000
	IN2P3	1,000		3,000				3,000	4,000
Germany		833	870			1,000		1,870	2,703
Greece		291		589				589	880
Hungary		58							58
India		256		518				518	774
Iran		500							500
Italy		2,200	4,500	1,700		4,500		10,700	12,900
Korea		152				306		306	458
Pakistan		143				285		285	428
Poland		175				353		353	528
Portugal		117		235				235	352
RDMS	Russia	900		1,350				1,350	2,250
	Dubna Member States								
Serbia		400							400
Spain		350				1,000		1,000	1,350
Switzerland	Universities								
	ETHZ								
	PSI								
Taipei		136		274				274	410
Turkey		58							58
United Kingdom		530		1,000				1,000	1,530
USA (2)	DOE	6,000		6,200		2,800		9,000	15,000
	NSF								
Completion Cost (1)		**21,300**	**6,900**	**24,200**		**10,300**		**41,400**	**62,700**
Extra Contributions (2)		**21,262**	**6,989**	**24,130**		**10,515**		**41,634**	**62,896**
Balance (2) - (1)		**-38**	**89**	**-70**		**215**		**234**	**196**

Additional contribution from US

The good cost performance of the US groups has allowed the release of funds reserved for contingency. They have been able to contribute extra items, which were not part of their MoU obligations. For the period 1998-2001 these extra contributions amount to 9.4 MCHF including 3.8 MCHF of cost book deliverables.

For the rest of the construction period it is assumed that a similar good cost performance could lead to an extra contribution of 15 MCHF of cost book deliverables. Indeed 2.8 MCHF have already been commited in 2002 to procure ME1/1 electronics.

The priority list for the use of released US contingency is outlined in the CMS Steering Committee with all the sub-detector Project Managers. It has been agreed that US should help first the HCAL, then Muon-CSCs followed by ECAL, rather than the Tracker (as was hoped in the addendum to MoU describing the silicon tracker funding).

~20 MCHF Staging/Savings ?

After RRB13 the Director of Research requested CMS to prepare plans for the case where 20 MCHF of the shortfall is not covered (with respect to the RRB13 shortfall of 67.9 MCHF) BUT with the hope of getting it later.

Staging/Saving already applied for 1st Physics Run			**~5 MCHF**
HCAL:	Reduce no. of longitudinal samplings	2.0 MCHF	
ME1/1a:	Reduce no. of electronics channels	1.5 MCHF	
ME4/1:	re-stage electronics	1.5 MCHF	
Additional Staging Considered for 1st Physics Run			**~8.5 MCHF**
TRIDAS:	Start with 50% of DAQ Capacity	8.0 MCHF	
Infrastructure:	SCX Cooling and Ventilation Plant	0.5 MCHF	
Additional Saving Under Technical Evaluation			**~5 MCHF**
LV Supplies:	Use 400Hz, 400V system Decision in June 2002.	5.0 MCHF	
TOTAL Staging/Savings			**~ 18.5 MCHF**

Additional Collaborators

Serbia	Corner Pieces Magnet	approved in Mar CMS Week 400 kCHF protocol agreement
Milan, INFN	ECAL	approved in Mar CMS Week
Naples, INFN	RPCs	approved in Mar CMS Week
Brazil	YE4+ farm	YE4 funded (500 kCHF), application in 2002
Ireland	ECAL electr.?, farm	Visited CERN 18-19 Feb Expect application in mid-02
Mexico	Silicon Tracker	Expect application soon
NZ	farm+Pixels	Applic. received, Pres. in June Visit at CERN S. Thompson
Thailand	ME electronics boards	in progress
US-NP (HI)	TriDAS, farm	Successful workshop in MIT 8.02 Proposal submitted to DoE March 15

0.9 MCHF already in Financial Plan.

High Luminosity Upgrades

10.	**Items (upgrades) for high luminosity**	**~ 19 MCHF**
10.1	ME4/2 mechanics and electronics	9.2
10.2	ME4/1 electronics	1.5
10.3	ME4/1 assembly in PNPI	0.5
10.4	Restore ME1/1a electronics	1.5
10.5	Neutron Shielding (extra)	1.0
10.6	3rd Forward Pixel Layer	~2.5
10.7	5th endcap RPC layer	~2.0
10.8	Extra Installation Costs	~1.0

The decision to build many of these items will only be taken after inspection of the first physics data. This upgrade cost comes on top of the 62.7 MCHF shortfall. A plan for the funding of the upgrade will have to be worked out in due time. Basic ingredients are new collaborators or upgrade plans by funding agencies willing to upgrade items in which they have been working on.

Reallocation of Sub-detector Shortfalls

The shortfall for each sub-detector has been reallocated, whenever possible, to contracts that can be placed later.

1.	**Magnet**	**3.2 MCHF**	**Common Project**
	Heavy Lifting Operation	3.2	2004
2.	**Tracker**	**6.9 MCHF**	
	Silicon Sensor Procurement	0.5	2004
	Cables Installation	1.5	2004
	Cooling Plant	0.8	2004
	Power Supplies	1.9	2004
	Front-end Drivers (FED)	1.9	2005
	Front-end Controllers (FEC)	0.3	2005
3.	**ECAL**	**24.2 MCHF**	
	Endcap crystals	11.0	commit in 2002/2003
	Barrel Crystals	9.0	Reimburse loan from DAQ 3 in 05, 4 in 06, 2 in 08
	Electronics	3.0	2003-2004
	Electronics Spares	1.2	2005

Reallocation of Sub-detector Shortfalls

4.	**Muons-DT**	**3.6 MCHF**	
	Sector Collector +Power Supplies	2.2	2004
	Power Supplies	1.4	2005
5.	**Muons-CSC**	**2.8 MCHF**	
	ME1/1electronics	2.8	002 Done US
6.	**Muons-RPC- Barrel**	**1.6 MCHF**	
	Cooling System	0.25	2003
	Gas piping (need 02)	0.5	2003 Repay loan from HV
	HV system	0.6	2003
	Others	0.25	2004
7.	**Muons-RPC- Endcaps**	**2.3 MCHF**	
	RE1 panels	0.2	2002 China?
	Cooling System	0.3	2003
	HV system	0.7	2003
	VLSI, cables	0.3	2003
	Gas piping (need 02)	0.3	2005 Repay loan from CF
	Kapton (need 02)	0.3	2005 Repay loan from CF
	RE bakelite (need 02)	0.2	2005 Repay loan from CF

Reallocation of Sub-detector Shortfalls

8.	**Infrastructure**	**3.2 MCHF**	
	Forward Cylindrical Shielding around HF	0.5	2002 Iran?
	Neutron shielding ME Chambers	0.6	0.4 in 02, 0.2 in 03
	Beam Pipe	0.8	2003-2004
	YE4	0.5	2003 Brazil?
	YE4 ancillaries	0.1	2003 CERN
	FCS ancillaries	0.2	2003 CERN
	SCX Cooling and Ventilation (2nd phase)	0.5	2007

Critical Payments in 2002

Cost to Completion

Subdetector Items	**3.9 MCHF**	
ME1/1 electronics	2.8	Covered by US
RE 1 panels	0.2	China ?
Neutron shielding ME Chambers	0.4	**need resolution in this RRB**
Forward Cylindrical Shielding HF	0.5	Iran ?
C&I	**2.2 MCHF**	
Magnet corner pieces	0.4	Covered by Serbia
C&I requested at RRB13 for 02	1.8	**need resolution in this RRB**

We have not been able to cover 2.2 MCHF (0.4 subdetector, 1.8 MCHF C&I) with existing funds. CERN_CMS substitution funds can cover up to 0.6 MCHF. We need help from the collaboration to cover at least 1.6 MCHF. CERN may help with the cash flow.

CMS Financial Plan - Desired Profile

Assume a physics run in June 2007

(MCHF)	2002	2003	2004	2005	2006	2007	2008	2009	2010	SUM	Σ(02-07)
Construction	90.00	81.10	65.00	12.00	6.00					**254.10**	254.10
Cost to Complete	3.90	6.72	17.15	11.90	5.93	0.50	2.00			**48.10**	46.10
C&I	2.24	4.98	3.75	2.34	1.35					**14.65**	14.65
M&O Cat A	1.00	2.01	3.30	5.35	7.30	9.20	14.20	14.20	14.20	**70.76**	28.16
M&O Cat B		1.63	3.72	4.88	6.95	8.00	8.00	8.00	8.00	**49.17**	25.17
Hi L Upgrades						10.00	8.00			**18.00**	10.00
TOTAL	**97.14**	**96.43**	**92.92**	**36.47**	**27.53**	**27.70**	**32.20**	**22.20**	**22.20**	**454.78**	378.18

The M&O Cat B figures up to 2006 include the purchase of those electronics (~3 MCHF) that will not be available later.

The computing M&O cat A costs of order 1 MCHF/year (e.g. data storage etc) are not included, (see computing RRB) as of 2007.

Summary

- Initial detector for Physics in 2007 is the complete CMS except 4th Endcap Muon station (ME4) and 3rd Forward pixel disks.
- Additional saving/staging of ~5 MCHF have been identified reducing the shortfall from 67.9 MCHF to 62.7 MCHF.
- Preliminary discussions with Funding Agencies indicate that this reduced shortfall could be covered with additional funds.
- If the funding agencies can cover it CMS will stick to the remaining shortfall of 62.7 MCHF.

Conclusions and Requests

We are very grateful for the positive responses from many Funding Agencies w.r.t. funds required to cover the CMS shortfall.

Request for this RRB

We need additional funds for at least 1.6 MCHF from the collaboration to cover critical payments in 2002 (cost to completion funds). We have not been able to find more substitution funds within approved construction budgets.

Request for October 2002 RRB

•We request the Funding Agencies to commit to additional funds required. We will work together to finalise the CMS Financial Plan and move towards an amendment of the MoU to take into account the additional contributions.