Report on CERN's Research Programme by Task Force One

Pre-release

CERN, 8 February 2002
Updated: 15/02/2002 16:26

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Contents:

1. Introduction

The mandate of Task Force One is to review the CERN resources going into the Research Programme and to identify possible savings over the years 2003 to 2006 and beyond.

A full report is in preparation. In this document we summarize the main arguments and results to provide the directorate with a preview on possible savings from the Research Programme. The work of the Task Force is still ongoing, however, we believe that the final results and conclusions will be essentially the same.

Given the short time available for our investigation, we have concentrated on five major subjects:

- the non-LHC experimental programme
- a reduction of accelerator running time
- possible savings in the LHC experiments (CORE money) including those resulting from a one year delay in LHC start up
- Savings in LHC computing costs at CERN, both from a delay in start-up and from reduced needs of the experiments
- Accelerator R&D

We have tried to estimate the total cost of an activity for CERN across the different divisions. However, we restrict this study to the divisions, in which the research programme is either located or from which major support is given, i.e. EP, IT, PS, SL, LHC, ST and EST.

2. Fixed Target Programme and other non-LHC experiments

The present plan for the non-LHC experiments until 2005 is summarized in Figure 1. We support the policy, as laid out in Figure 1, that experiments approved for data taking should not be stopped. There remain only a few experiments whose benefit/cost ratio is high. The scientific life at CERN can thus be maintained until the beginning of the LHC physics.

At the SPS, three experiments are scheduled to take data in 2002 and 2003. NA48/1 to search for rare K_s decays and NA48/2 to study charged kaon decays, using the same set-up upgraded with a transition radiation detector. The new NA60 experiment will perform measurements of dimuon production, in p-A and heavy ion collisions. The existing NA49 experiment will study the production of charged hadrons and neutral strange particles in a search for the deconfinement transition predicted by lattice QCD.

Only one fixed target experiment, COMPASS, is foreseen to continue beyond 2003 to study hadron structure and hadron spectroscopy with high intensity muon and hadron beams.

At the PS, the hadron production experiment HARP will finish data-taking in 2002. DIRAC measures the lifetime of $\pi^+\pi^-$ atoms to test low-energy QCD predictions. This run will finish in 2002, a one year extension for πK atoms should be decided on scientific grounds.

Only the three experiments using the Antiproton Deceleration facility to study anti-hydrogen and the ISOLDE radioactive beam facility are planned to continue beyond 2003. The n-TOF facility, mostly with European Union funds, has an approved programme until the end 2003 only. CAST, a non-accelerator axion search telescope will take data from 2002-2004.

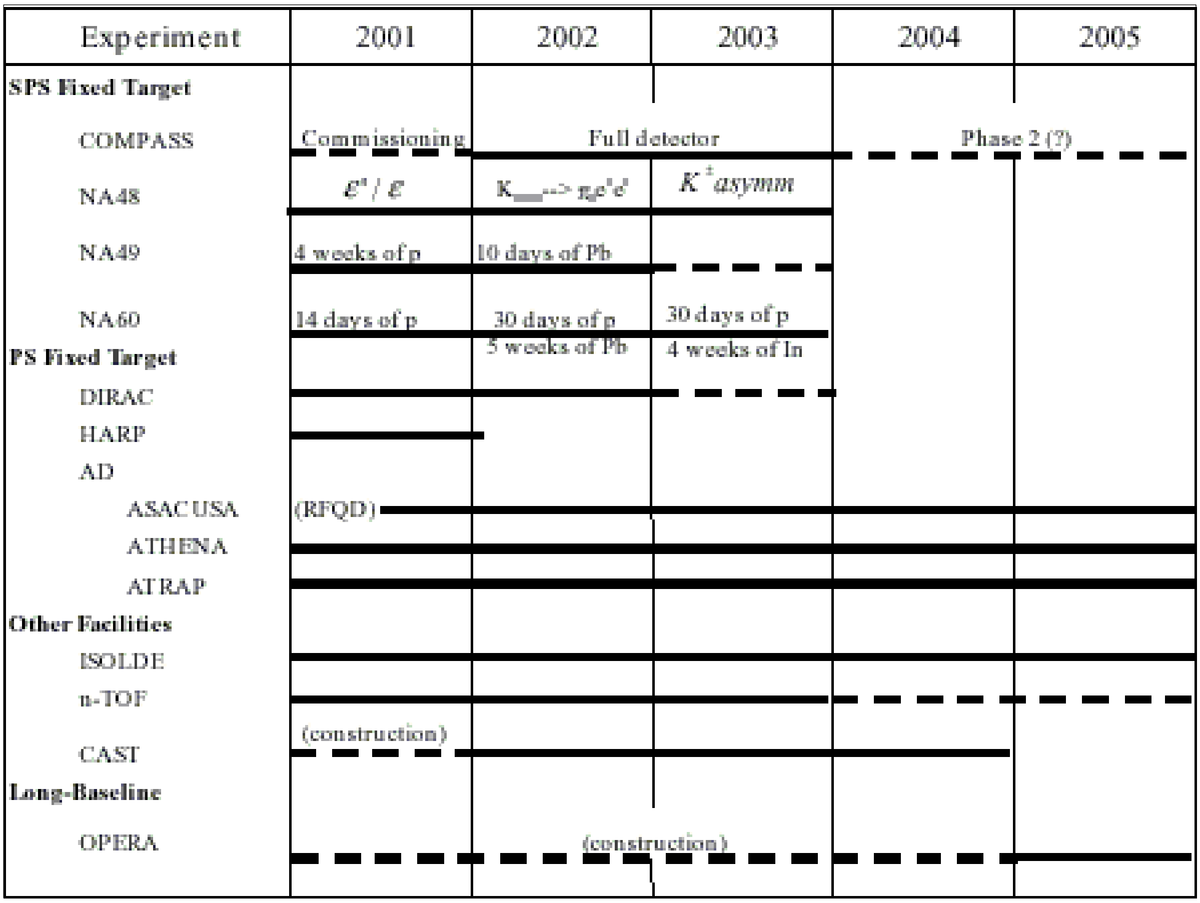

Figure 1 – The non-LHC Scientific Programme

The only new experiment under construction is the OPERA neutrino oscillation experiment to be installed at Gran Sasso in 2005 or 2006. It is expected to take data for about 5 years, in parallel with the LHC, using the CNGS neutrino beam.

We have tried to summarize the total resources provided by CERN to the experiments by including all divisions which provide major support, i.e. EP, IT, SL and PS. The 2002 material budgets, the number of staff, fellows and scientific associates are listed in Table 1. The total cost of the non-LHC programme is about 11 MCHF as compared to 71 MCHF related to the LHC experiments. Due to the termination of several experiments in 2003 the cost in 2005 for the non-LHC experiments is expected to decrease by a factor of 2, representing only 7 % of the total experimental activity.

Resources for research in EP, IT, PS and SL (in 2002)

	MCHF	%(CERN)	Staff (FTE)		F&A (FTE)	
LHC experiments (incl. support)	**72.4**	*13%*	**487**	*18%*	**82**	*16%*
non-LHC experiments	**11.5**	*2%*	**150**	*6%*	**48**	*10%*
(of which LEP)	0.8	*0%*	25	*1%*	17	*3%*
accelerator R&D	**4.8**	*1%*	**56**	*2%*	**16**	*3%*
EP+IT+PS+SL total	**88.7**	*15%*	**693**	*26%*	**145**	*29%*
CERN	**578**	**material**	**2663**		**497**	

Table 1: Distribution of resources by research activity in 2002 (money, staff, fellows and associates) in EP, IT, PS and SL divisions combined. The percentage is normalised to the total of CERN's materials budget and personnel.

Table 2 summarizes the resources **after cuts** for non-LHC experiments in EP, PS and SL Divisions in 2002. The right half of the table collects information on investment, size of the collaboration and estimates for PhD students in the future when available. Energy costs are not included.

Resources for non-LHC experiments in EP, PS and SL

	EP budget (MCHF)	EP pers. (FTE)	PS budget (MCHF)	PS pers. (FTE)	SL (MCHF)	SL pers. (FTE)	2002-2006 budget (MCHF)	investment CERN (MCHF)	investment outside (MCHF)	committments CERN (MCHF)	institutes Greyboo	members Greybook	PhDs (future)
COMPASS	0.3	7.3	0.2	6	0.9	1	6.5	1.7	23.0	0.8	30	158	80
NA48/1(/2)	0.6	13.6	incl. In COMPASS		0.4	1	1.7	9.5	20.0	0.7	11	97	33
NA49	0.1	3	incl. in NA60			0	0.4			0.0	25	112	
NA60	0.4	8.2	0.2	6	0.2	1	1.2	0.2	0.3	0.1	10	60	12
DIRAC	0.3	2.5	0.2	3.5	0	0	0.9	0.9	2.2	0.0	18	95	10
HARP*	0.5	16.8	incl. In DIRAC		0	0	0.5			0.0	31	118	
ATHENA , ASACUSA	0.4	7	0.5	15	0	0	4.4	1.3	15.3	0.5	27	90	>15
ISOLDE	0.3	11.3	1.5	15	0	0	9		55.0	0.0	77	270	10
nTOF	0.0	1.5	0	0.5	0.3	3	0.9	2.0					
CAST	0.2	4.9	0	0	0.4	0	1.7	0.9	2.2	1.3	20	69	
OPERA	1.1	9	0	0		0	10.5			8.0	12	122	10
Total non-LHC	**4.3**	**85**	**2.6**	**46**	**2.2**	**6**	**37.7**						

LEP	0.8	**Chorus (terminated)**	0.1

***) not yet funded**

Table 2: Resources for non-LHC experiments in EP, PS and SL divisions in 2002

2.1. OPERA

Within the fixed target experimental programme at CERN, the OPERA experiment has a special position. It is the only experiment under construction, it will not be located on the CERN site and no major CERN investment has been made yet. Given the financial difficulties of CERN and the shortage of technical personnel, a possible withdrawal of CERN from the OPERA collaboration is discussed. Therefore, we elaborate the OPERA case in some detail.

The OPERA experiment has an overall cost of 95 MCHF of which 44 MCHF is the cost of the emulsion film supplied by the Japanese part of the collaboration.

The planned **CERN share of the core cost is 8.0 MCHF** (including 1.5 MCHF for hired technical support). The cost to CERN also includes **operation funds;** in this case 2.0 MCHF over the four construction years 2002-2005 for R&D and operation and a further 2.5 MCHF for the years 2006-2010 for data taking physics analysis and M&O.

The CERN group has taken or has planned to take a series of leadership-organisational tasks and important construction responsibilities. The most important one being to define, with industry, the emulsion-lead Brick Assembly Machine, supervise its construction and test the quality of the initial production. The staff for the foreseen task is at the moment of 9 staff FTE (physicists, applied physicists and technical staff) + 2 (to be hired by industrial service) technicians. The task force has studied various options and their foreseen consequences. The choice between these options involves a difficult weighting of CERN scientific priorities, which should be made at the appropriate level before a decision.

Option one: continuation at the foreseen level

The financial and manpower implications have been listed above, however the task force wants

- to stress that the cost and effort to build the BAM has not at this moment been evaluated in detail; there is therefore a strong risk that the commitment, if not bounded in a clear way, could escalate,
- to point out that even though the group is rather small, the number of tasks is large and this situation may make the control of the commitment size more difficult. The task force therefore recommends that even in the case of option one the number of responsibilities is decreased and that a partner (or common fund) takes the responsibility for cost overrun of the BAM,
- to insist that the group size should not be expected to decrease and therefore replacements of retiring or departing staff should be incorporated in the planning. Obviously, this would be difficult within the reduction of CERN staff complements until 2006!

Option two: withdrawal of CERN from Opera

The savings are about **12.5 MCHF** and about **6 FTE** over the coming 2002-2010 period. This would have serious consequences for the collaboration and the programme:

- The financial impact is important. The loss of money would have to be compensated by the other collaborators.
- There is physics and technical expertise in the present CERN group, which would be sorely missed.
- A CERN withdrawal may start a snowball effect with other institutions reducing or cancelling their participation.

Other options:

The task force has also studied an option where CERN would limit its participation to a technical responsibility in the BAM. We think that such a participation without involvement of research physicists is not in the interest of CERN and of the experiment. A participation at the presently foreseen FTE level, but with considerably reduced financial CERN support, (compensated by outside support) was considered.

However, we think that such **a marginal involvement is less advisable than a clear decision between option one and two.**

3. SPS and PS running time reductions

In this chapter we discuss possible savings from a reduction of SPS and PS running in the years 2003-2006. Two options are studied, firstly, a reduction of the annual running time (here also PS running is included) similar to the 2002 running and secondly a complete stop of the SPS accelerator for a full year.

3.1. Boundary Conditions

3.1.1. Test beams for LHC experiments

After receiving information from the four LHC experiments, it became apparent that a reduction of the annual test beam time at the SPS by one month could be accommodated by an increase of parallel testing and of efficiency.

A one year stop, however, imposes difficult constraints on most of the LHC experiments with the following consequences:

- The one year stop cannot be before 2005 (which anyhow is the year preferred by SL division)
- SPS proton running in 2004 cannot be reduced.
- The end of the 2004 running should be as late as possible in the autumn.

Note that such a stop in 2005 makes the planning of the testing of the CMS crystal calorimeter very difficult. It could imply the construction of a spare calorimeter module to pursue useful tests after completion of the installation.

3.1.2. SPS Fixed Target experiments

Two heavy ions experiments NA60 and NA49 are only approved for running in 2002 and 2003. Therefore, the reductions have little impact on this approved programme. NA48/2 is approved for 2003 only and is not endangered by the reduction.

The first phase of COMPASS is approved until the end of 2004. An eventual extension could only start in 2006, which, in the opinion of the task force, is not a too severe blow to the programme.

3.2. Savings

The largest savings come from electricity and water, in materials and through the redeployment of staff replacing industrial services. We consider three components:

3.2.1. Beam time reduction by 1 month in 2003 and 2006

The total saving is estimated to be 6 MCHF and comes from the following contributions:

Division	**Source of savings**	**Savings**
SPS	Electricity and water	2.0
SL	Materials and Industrial Services	0.5
PS	Electricity and water	0.5
	Total per year (MCHF)	**3.0**

Table 3: Yearly savings in MCHF from 1 month beam reduction

3.2.2. Complete SPS stop in 2005

Stopping the SPS for a full year brings significant savings with contributions from several divisions:

Division	Source of savings	Savings
ST	Electricity and water	8.6
	Cooling and ventilation	1.2
	Monitoring and access	0.3
	Electrical engineering	0.3
	Transport, facility management	0.5
	Total	10.9
SL	Industrial Services	4.4
	Industrial Services equivalent of staff reallocation (77 FTE x 80 kCHF)	6.1
	Reduced Materials and Operations for SPS	3.8
	Shift/piquet allowances (personnel budget)	0.5
	Total	14.8
LHC	Cryogenics running for SPS	1.1
PS	Fraction of exploitation budget	0.4
	Grand Total (MCHF)	**27.2**

Table 4: Savings in MCHF from complete SPS stop in 2005

3.2.3. Savings by stopping the PS

The task force has looked briefly at possible gains from a decreased PS running, although the exploitation budget in this case is much smaller (1.5 MCHF). Furthermore the PS complex is used, also in 2005, for ISOLDE, the AD, and useful test beams. The cost to benefit ratio (or rather savings to inconveniences) does not speak in favour of such a stop. We have therefore included the PS in the yearly reductions (Table 3) but not in the full year stop.

It should be noted that a large part of the savings comes directly or indirectly through reduction of industrial services and care should be exercised not to double count part of the sum with savings evaluated by Task Force 3.

4. Savings in CORE costs of LHC Experiments

CERN's contribution to the CORE cost of the LHC experiments is 215 MCHF. The additional funding (CORE and others) requested from CERN, according to the Cost to Completion Document, amounts to about 80 MCHF (about 50 MCHF for the detectors, 20 MCHF for the experimental areas and 10 MCHF for additional manpower for installation). This does not include off-line computing which is handled separately (see chapter 5).

4.1. ATLAS and CMS

The collaborations have since some time developed staging scenarios for the initial detector configuration, to cope with over-costs of their experiments. The ensuing saving, amounting to about 15 MCHF for each experiment, is used to cover supplementary costs in parts of the detector (e.g. the ATLAS toroids or the CMS ECAL), which are essential for the detector operation right from the beginning. Most of the money from this staging has already been committed to these purposes. The experiments hope to cover the short-fall by additional funding expected to arrive in time for the high luminosity LHC run (otherwise a very strong descoping remain for these conditions).

Task Force 1 has investigated whether some real savings of CERN money, and not just staging, could be obtained. The following areas have been identified:

- ATLAS will save about 2 MCHF by staging part of the ATLAS Trigger/DAQ processors (as planned) and by the reduced processor cost given a one year delay.
- CMS will save about 0.8 MCHF by delaying the purchase of the CMS Trigger/DAQ processors by one year.
- B-physics will be studied extensively by the dedicated LHCb experiment whereas ATLAS and CMS were designed primarily for the high-p_T programme. By limiting the study of B-physics to LHCb ATLAS could save about 3 MCHF by the consequent reduction in trigger rate. This comes from a saving in the trigger processors and in the offline computing (the latter is not taken into account in chapter 5). A similar saving cannot be obtained from CMS, since the gain from descoping the B-physics program has already been absorbed in the present over-cost estimates.

In summary, CERN could save about 6 MCHF from ATLAS and CMS, taking into account the LHC delay of one year and the delayed purchase of the staged items, as well as a descoping of the B-physics program.

4.2. LHCb

The experiment has no cost overrun. The CERN share of the LHCb cost not yet committed is about 19 MCHF. This includes CORE cost and M&O and operation over the years 2003-2007. LHCb currently includes about 64 CERN FTE.

Staging the detector construction does not entail big savings of CERN money. On the other hand staging of the trigger/DAQ processors and of the offline computing (see chapter 5) allows some real savings due to the decreasing cost of the components.

Assuming LHC starts in April 2007 and LHCb too, the CERN money saving could be about 0.4 MCHF. This would come from a reduced level 1 trigger rate by a factor of two (0.28 MCHF), which is independent of the LHC start-up time, and from the delayed purchase of the trigger/DAQ farms (about 76 kCHF).

If LHCb started in April 2008, the additional savings of CERN money (compared to a start-up in 2007) would be 55kCHF from the delayed purchase of trigger/DAQ farms plus about 1.3 MCHF from computing.

4.3. ALICE

The uncommitted part of CERN's share for ALICE is about 15 MCHF. This includes CORE cost and part of M&O over the years 2003-2007. This money is mainly foreseen for the infrastructure and for the construction of the muon arm. The ALICE manpower currently includes about 90 CERN FTE.

A one or even two year delay of ALICE will not save any CERN CORE money, since items subject to cost decrease with time are not funded by CERN.

4.4. Total CORE savings

The savings of CERN CORE money for the LHC experiments amounts to about 6.5 MCHF.

5. Savings from LHC computing at CERN

5.1. General remarks

We used the following input for our analysis:

- Report of the Steering Group of the LHCC Computing Review, CERN/LHCC/2001-004, commonly referred to as "Hoffmann Review".
- Proposal for Building the LHC Computing Environment, CERN/2379/Rev, July 2001, voted by Council in September 2001.
- Written answers by the four experiments to specific questions on Computing
- Results of discussions with experiment representatives
- Input from the LHC Computing Grid project leader (Les Robertson).

We underline that the Hoffmann review had to take into account many variables with substantial error margins and no explicit contingency. Therefore, numbers can vary both ways. We would like to stress that this is reflected in the large discrepancies between ATLAS and CMS in expected event numbers, reconstruction time and numbers of simulation events needed.

The experiments have progressed in some areas in the understanding of their computing needs, but there are still a lot of uncertainties in the computing model as far as reconstruction and analysis strategies are concerned. A review planned by the LHCC of computer needs of the four experiments is therefore very topical. An update of the computing hardware cost evolution must proceed in parallel.

5.2. Present Funding Model

The essential cost figures for computing at CERN from the Council paper are:

Item	**Cost (MCHF)**	**Comment**
Tier0 and Tier1	72.3	See annex 4 of CERN/2379/Rev
Outsourced Support	17.6	
External Networking	12.0	
Infrastructure	42.4	
Additional Personnel	21.9	Table on page 2 of CERN/2379/Rev
Total	**166.2**	
Funded by IT Division's budget	48.5	Assumes increased fund for IT
Short-fall	**117.7**	

Table 5: Funding Model for LHC Computing according to Council Paper

The short-fall of 117.7 MCHF was rounded up to the famous 120 MCHF.

It should be stressed that any reduction of the contribution to LHC computing from the IT baseline budget from the levels assumed in CERN/2379/Rev will necessarily result in an increase of the missing 117.7 MCHF.

5.3. Savings

The savings come from two sources, which we present separately:

- A delay of one year in the start-up of LHC.
- Specific savings suggested by the four experiments.

For the moment, we only investigated savings in computer hardware allocated to the experiments (**72 MCHF**) for Tier0 and Tier1 systems at CERN. Savings in the other areas can be expected, but it will take more time to make a sensible estimate.

Delay of the LHC start up by one year:

The savings on the computer hardware amount to 30% using Moore's Law (confirmed by the estimates of the time evolution of hardware cost listed in the reports mentioned above). The resulting costs of the Tier0 and Tier1 systems at CERN, integrated over the years 2006-2008 instead of 2005-2007, are listed in the first three lines of Table 6.

Specific additional savings (summarized in Table 6):

ATLAS:

Reduction of events to tape and processed from **270 Hz to 160 Hz** achieved through higher thresholds and improved algorithms.

We computed the savings as follows: a saving of 110/270 for tapes, tape I/O and first reconstruction CPU. A reduction of only 10% is assumed for the remainder of the CPU and the disks since a higher proportion of the events to tape will satisfy the first off-line selection given these higher thresholds. The second reprocessing is stretched from 3 to 6 months and the number of analysis jobs is reduced. These additional savings amount to **4.7 MCHF.**

CMS:

Events to tape are reduced from 100 Hz to 70 Hz. The reduction in Level 1 trigger rate from 100 kHz to50 kHz reduces the output of the High Level Trigger from 100 Hz to 70 Hz, if the thresholds in this HLT are not modified. CMS will still write 100 Hz to tape but will only process 70 Hz in the first instance.
We computed the savings following the same method as for ATLAS but NOT reducing the Tapes or Tapes I/O. The reduction factor in CPU was 30/100 for the first reconstruction and 10% for CPU and disks. This additional saving amounts to **2.3 MCHF**

LHCb:

Reduction of events to tape from **200 Hz to 100 Hz.** They estimate that at the beginning of the running the luminosity will be low, thus automatically reducing the event rate to tape. During this time the High Level Trigger algorithms will be refined such as to reduce the fraction of events accepted when the luminosity increases. These two compensating effects should allow data taking with a rate of no more than 100 Hz at any time. LHCb estimated the savings per hardware category in their submission to Task Force 1 and we have corrected them for the reduction due to a one year delay.

ALL simulation is moved to outside labs (so far planning was for 20% to be done at CERN), reducing the quoted amount by the 30% of Moore's law for the one-year delay. Note, that this has not been discussed at the level of the collaboration.

These actions generate additional savings amounting to **1.7 MCHF.**

ALICE:

The event size is reduced from **1 MB to 0.2 MB** during pp running. Alice will take this data at low luminosity and can avoid pile-up events. This reduces the total storage for pp data from 1.2 PB to 0.3 PB per year. When adding the 1.5 Pbytes in Pb-Pb running, the saving is 0.9/2.7.

We computed the savings by applying this factor to the disk and tape cost, reduced by the savings in delaying by one year. The CPU used for processing pp is negligible and therefore no savings are possible. The tape I/O cannot be reduced as its size is dictated by the Pb-Pb running. The savings amount to **1.2 MCHF.**

Summary of savings (Tier0 and Tier1 only)

	ATLAS	**CMS**	**LHCb**	**ALICE**	**TOTAL**
Original Cost (2005-2007)	24.0	23.0	7.0	18.0	72.0
Cost 1 yr delay (2006-2008)	17.5	15.9	4.9	13.0	51.3
Savings 1 yr delay	***6.5***	***7.1***	***2.1***	***5.0***	***20.7***
Cost after additional savings (2006-2008)	12.8	13.6	3.2	11.8	41.4
Additional savings	***4.7***	***2.3***	***1.7***	***1.2***	***9.9***
Total savings	**11.2**	**9.4**	**3.8**	**6.2**	**30.6**

Table 6: Cost breakdown (MCHF) for the four LHC experiments for different options

As can be seen the total saving amounts to 30.6 MCHF, a reduction not far from a factor of two as compared to the original cost.

Possible further savings could come from a reduction of the ATLAS event size through the introduction of zero-suppression (currently under investigation), from the optimisation of reconstruction programs leading to reductions in processing time and, in ATLAS, excluding special triggers to study B physics (see section 4.1).

6. Accelerator R&D

The present Medium Term Plan (MTP) foresaw the following topics in accelerator R&D:

- CLIC study and CTF3 project,
- Neutrino Factory study,
- Super-conducting RF cavity developments,
- LHC upgrading.

The resources foreseen to be allocated were at the level of **7 MCHF** and **55 FTE** per year during the next four years. A document written before the increase cost to completion of LHC came to light, stressed the need for an additional 25 MCHF spread over eight years and 70 FTE’s. In view of the present financial problems, not only will the additional resources requested not be made available, but the resources planned for in the MTP have been scrutinized to identify savings.

Task Force 1 met several times with J-P. Delahaye. He pointed out that the majority of the R&D effort is concentrated on CLIC. The heart of the programme is the development of accelerating structures providing high fields. Theoretical work is needed on the development of such structures as well as building facilities to test them such as CTF3, which is due to replace the presently running CTF2. Several institutes are collaborating with CERN on building CTF3. He outlined a strategy based on concentrating the reduced R&D resources on CLIC, which he justified with the following arguments:

- It is imperative to validate the CLIC technology as soon as possible in order to help define a world-wide strategy of accelerator construction.
- A number of institutes are collaborating on the project and are awaiting confirmation that CERN will pursue this development.
- The CTF2 facility is limited to 16ns long pulses instead of the 100ns pulses required by CLIC. At these short pulse lengths the structures do not show any damage from the high voltages they are subjected to. CTF3, which will provide 100ns long pulses, is needed to determine whether any damage to the structures occurs at the required longer pulse lengths.

This programme is budgeted at 4.29MCHF for 2002. It also employs 40 FTE’s. Of these, 16 are PS division accelerator physicists divided equally between overall CLIC work, hardware development and studies with CTF2 and, later, with CTF3. Three more accelerator physicists from SL division are working on delivering the linac beam to the detector. The remaining 21 are PS technical staff working mainly on running CTF2 and building CTF3.

In addition, some resources are provided for studies of a 2.2 GeV Superconducting Proton Linac (SPL) reusing LEP structures and klystrons. The physics interests of such an accelerator are:

- Produce a more brilliant beam for CNGS and LHC,
- Be the injector for a new generation of ISOLDE,
- Provide a high power proton beam to produce a neutrino “Super-beam”.

It is envisaged to build a 3 MeV front-end possibly joining with the 5 MeV IPHI project at Saclay. It could be built at Saclay and later moved to and operated at CERN. The CERN resources that would be required amount to 360 kCHF and 3 FTE in 2002.

It should be stressed that the above is a **MINIMAL** programme of accelerator R&D, especially for an accelerator laboratory of the importance of CERN. It's narrowness and limitations can only be justified by the present severe budgetary problems facing CERN.

In conclusion, the resources foreseen in the MTP, namely **7 MCHF** and **55 FTE**, have been reduced to **4.7 MCHF** and **43 FTE** in 2002 and similar numbers in coming years. The cost of CTF3 will decrease slowly over the years. We have assumed that this reduction will be used for other R&D activities, thus maintaining a constant accelerator R&D budget at the 2002 level. The total savings over the years 2003-2007 then amount to **11.5 MCHF** and **60-FTE-yrs.**

7. Conclusions

Non-LHC experiments:

- The Task Force supports the plan to continue the experiments approved for data taking in 2002 and 2003. At the SPS, only COMPASS should continue beyond 2003. At the PS only the ISOLDE and AD facilities should continue beyond 2003 (and n-TOF in 2004).
- A clear decision is needed to either continue with OPERA at the present level of support (with a clear statement that possible additional resources needed for the BAM or technical manpower cannot come from CERN) or to withdraw from the collaboration (with a savings of about 12.5 MCHF and 6 FTE/y). A partial withdrawal is not advisable.

SPS/PS running time:

We recommend to stop the SPS (and the experimental area) for the full year of 2005 and to reduce the running time in 2003 and 2006 to the level of 2002. The one year shut-down necessitates a compensation in 2004, e.g. only proton beams and maybe some more running time than in 2002/2003 to minimise the negative impact on the calibration runs of the LHC experiments (in particular CMS for its crystal calorimeter).

The PS, with operation costs about 1/6 those of the SPS, should run during all years, but with a 30% reduction like in 2002, to exploit the ISOLDE and AD facilities as best as possible, but with a 30% beam time reduction as in 2006.

In total, this could save about **33 MCHF** CERN wide, of which about 6 MCHF are in industrial services and about 14 MCHF in energy.

LHC experiments:

In general, staging of CORE parts of the detectors does not create savings except in the area of online and offline computing. A one year delay of the LHC brings a gain in the Trigger/DAQ processor costs and together with the descoping of a dedicated B-physics trigger for ATLAS, one could save about **6 MCHF** of CERN funds.

Potentially higher savings can be expected in the offline computing at CERN (Tier0 and Tier1). Together, a one year delay and the reduction in trigger rates could lead to a total savings of about **30 MCHF** for the four experiments. However, a large uncertainty has to be attributed to these estimates.

Accelerator R&D:

The foreseen yearly reduction from **7 MCHF** and **50 FTE** to **4.7 MCHF** and **43 FTE** (dominantly for CLIC/CTF3) in 2002 and beyond leaves a **MINIMAL** programme of accelerator R&D, especially for an accelerator laboratory of the importance of CERN. Its narrowness and limitations can only be justified by the present severe budgetary problems facing CERN.