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Chapter 1

Introduction

This document sets out the organisation, cost estimate and time schedule of the ALICE Muon Chambers (MCH) Detector, Muon Identifier Detector (MID), the Fast Interaction Trigger Detector (FIT) Upgrade, the common read-out ASIC SAMPA and the common read-out (CRU) Projects as described in the TDR (CERN-LHCC-2013-019, April 15, 2014).

Within the ALICE upgrade program two common hardware developments are pursued. The SAMPA detector read-out ASIC will be used by the MCH and the Time Projection Chamber (TPC). The common read-out unit (CRU) is a hardware read-out platform which will be used by TPC, MCH, MID, Inner Tracking System (ITS), Zero Degree Calorimeter (ZDC) and Transition radiation detector (TRD).

Chapter 1 describes the MCH, chapter 2 the MID, chapter 3 the SAMPA ASIC, chapter 4 the CRU and chapter 5 the FIT. All chapters are organised in a similar manner where section 2 lists the participating institutes and shows the organisational chart for the management of the corresponding Upgrade Project. Section 3 provides explanations and justifications of cost estimates for the main cost items. The work breakdown structure (WBS) of the Upgrade projects is explained in detail in section 4, starting with an overview of all cost items and a responsibility chart for the allocation of funding. Then, for each level 1 cost item, details of the cost estimates are given in summary tables together with explanations of the underlying basis for

estimates. Section 5 describes the resource loaded schedule and section 6 deals with the manpower requirements necessary for the execution of the corresponding upgrade projects. An evaluation of the most relevant project risks is given in section 7.

Chapter 2

Muon Chambers - MCH

2.1 Project Organisation

The Muon Project Leader (PL) heads the MCH Project. He/she is assisted by the MCH Upgrade Coordinator (UC). The PL and UC are all members of the ALICE Technical Board and thus can assure the coherence of this project within the ALICE experiment in general. Issues of a financial, managerial and organizational nature are discussed and decided by the Muon Institutional Board. This board also endorses technical matters proposed by the PL or UC. The Project Leader and Upgrade Coordinator are ex-officio members of the Institutional Board. The Institutes participating in the MCH Upgrade Project, are listed in Tab. 2.1.

As shown in Fig. 2.1, the MCH Upgrade Project is organised into 4 Work Packages. The Work Package Coordinators are nominated by the Project Leader and endorsed by the MCH Institutional Board. They are members of the MCH Upgrade Coordination Board. The Project Leader and Upgrade Coordinator are ex-officio members of the MCH Coordination Board. Other scientists with dedicated technical expertise are also nominated “ad personam” by the PL to be members of the MCH Upgrade Coordination Board.

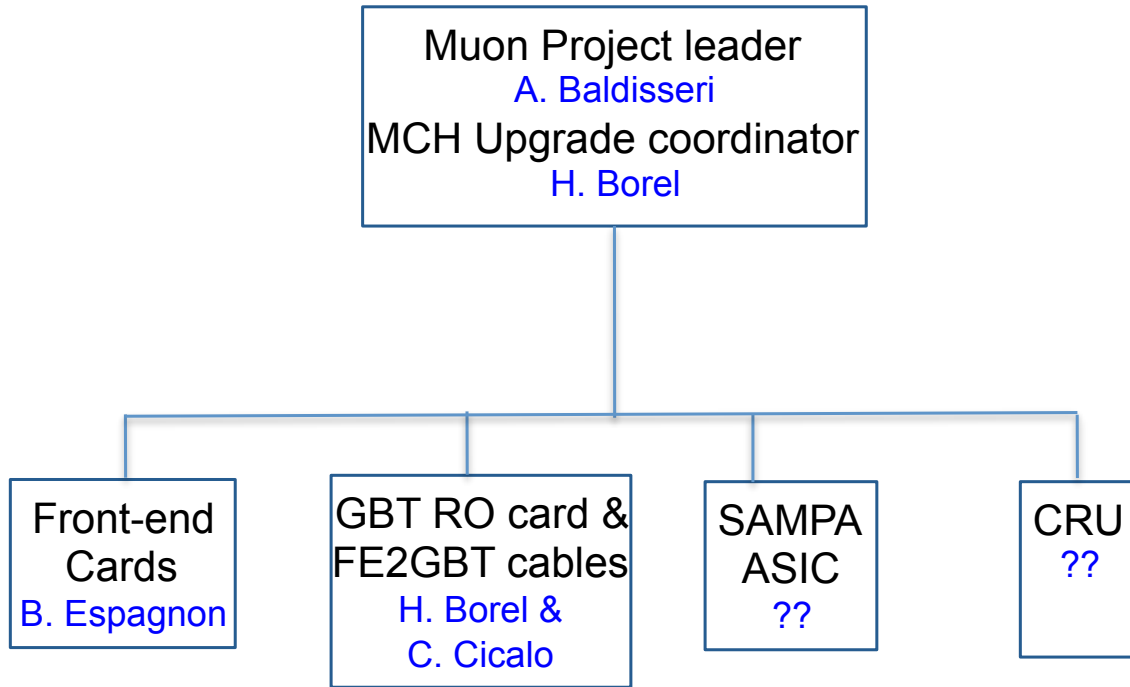


Figure 2.1: The MCH Upgrade Coordination board.

Country	City	Institute
Brazil	São Paulo	UNICAMP, Universidade Estadual de Campinas
Brazil	São Paulo	IFUSP, Instituto de Física, Universidade de São Paulo
Brazil	São Paulo	EPUSP, Escola Politécnica, Universidade de São Paulo
France	Orsay	IPNO, Institut de Physique Nucléaire d'Orsay, IN2P3/CNRS
France	Saclay	SPhN, Service de Physique Nucléaire, CEA-IRFU Saclay
Hungaria	Budapest	Wigner Research Centre for Physics, Institute for Particle Nuclear Physics
India	Kolkata	VECC, Variable Energy Cyclotron Center, Department of Atomic Energy
India	Kolkata	SAHA Institute of Nuclear Physics
India	Kolkata	Bose Institute
India	Aligarh	Aligarh Muslim University
India	Mumbai	Bhabha Atomic Research Centre
Italy	Cagliari	INFN and Università degli Studi di Cagliari

Table 2.1: Institutes participating in the MCH Upgrade Project.

2.2 Budget Explanation and Justification

This chapter addresses important design choices and their possible impact on the project cost and schedule. In order to minimise the overall upgrade effort on development and cost, the MCH upgrade design reuses the existing chamber design including the infrastructure such as data transmission via printed circuit boards, cooling, mechanics and power supply systems. These considerations have been taken into account for the front-end electronics data interface, power consumption and the on-detector read-out architecture. As a result the front-end cards are designed to be compatible with the existing chamber connectors and layout. The MCH read-out architecture follows the ALICE common approach shared with a majority of upgraded detectors.

2.2.1 Front-end cards & SAMPA

The presently used front-end ASIC is inappropriate for the upgrade operation conditions due to the increased interaction rate. The same situation applies for the ALICE TPC front-end electronics. In order to reduce the overall effort, the MCH and TPC projects develop a common read-out ASIC, called SAMPA. The differences in specifications, such as the different signal polarity and dynamic range are taken into account by the implementation of programmable parameters in the ASIC. For the MCH application the SAMPA specifications on noise or data bandwidth provide a comfortable margin. Chapter 3 deals with the SAMPA project in detail. Each Front-End card will host 2 SAMPA ASICS.

2.2.2 E-link & GBT Read-out card

The standardised front-end links use the versatile e-link and GBT components. This electrical and optical, radiation tolerant serial transmission link set is developed by the CERN Electronics Design Group.

2.2.3 Common Read-out Unit

The MCH detector upgrade design has adopted the ALICE common read-out architecture, which uses standard front-end links and the ALICE common read-out unit (CRU) to concentrate the data and provide a connection to the ALICE standard link to the online systems (DDL3) and to the standardised timing and trigger distribution link (TTS). The standard front-end links use the versatile link and GBT components. This approach reduces the overall development by benefiting from centralised versatile link component developments and the development of the common read-out unit used by a large number of upgraded ALICE detectors.

2.3 Cost Chart

Table 2.2 shows the Work Breakdown Structure (WBS) chart for MCH Upgrade Project. The tasks of the WBS have been broken down in 6 level 1 subgroups referring to either main detector subcomponents or to the most essential parts and services foreseen to be installed in the MCH.

Cost estimates are provided for each level 1 task and are understood as to be CORE costs, including detector components and production costs, as well as industrial or outsourced manpower for production, but not costs for personnel and basic infrastructures of the participating institutes. In addition, costs for R&D are not included in the estimate. The aforementioned cost for outsourced manpower has been estimated with 100 kCHF per man year (220 working days). All estimates based on offers or quotes in foreign currency have been converted into Swiss francs using the exchange rates of February 2014 (cf. Table 2.3).

More detailed information on the cost estimate for the level 1 items are given in the following sections. The expected spending profile, based on the detailed cost estimates and the project planning, is shown in Tab. 2.4. Table 2.5 shows the cost breakdown structure together with the expected funding contributions.

Activity	MaterialCost (kCHF)	Manpower Cost (kCHF)	TotalCost/item (CHF)
1. Front-end cards	745	0	39
1.1. Design & Prototyping	x	x	xx
1.2. Qualification	x	x	xx
1.3. Production	x	x	xx
1.4. Test	x	x	xx
1.5. Installation	x	x	xx
2. SAMPA ASIC	1178	?	31
3. GBT Read-out Cards	271	0	471
3.1. Design & Prototyping	x	x	xx
3.2. Qualification	x	x	xx
3.3. Production	x	x	xx
3.4. Test	x	x	xx
3.5. Installation	x	x	xx
4. FE2GBT cable (E-link)	285	0	15
4.1. Design & Prototyping	x	x	xx
4.2. Qualification	x	x	xx
4.3. Production	x	x	xx
4.4. Test	x	x	xx
4.5. Installation	x	x	xx
5. Optical fibers	172	0	300
5.1. Production	x	x	xx
5.2. Installation	x	x	xx
6. CRU inputs	182	?	316

Table 2.2: Cost breakdown structure of the ALICE MCH upgrade, divided into material cost and cost for externally hired manpower.

Table 2.3: Exchange rates used in the cost estimates.

1 EUR	1.23 CHF
1 USD	0.9 CHF

Year	2014	2015	2016	2017	2018	2019
Spending [kCHF]	24	73	786	778	0	0

Table 2.4: Expected spending profile for the ALICE MCH upgrade. **% Missing SAMPA and CRU spending profiles**

Activity	Country:Inst	Financing	Country:Inst	Financing (k)
1. Front-end cards	France/IPN Orsay	745		
2. SAMPA ASIC	Brazil/	1178		
3. GBT Read-out Cards	France/CEA Irfu	271		
4. FE2GBT cable (E-link)	Italy/INFN Cagliari	285		
5. Optical fibers	??	172		
6. CRU inputs	India/SAHA + Aligarh	182		

Table 2.5: Cost breakdown structure of the ALICE MCH upgrade, including expected funding from the different contributors.

	#FEC	x% Spares	Total
Station 1	3600	15	4140
Station 2	3500	15	4025
Station 3	2460	15	2830
Station 4	3400	15	3910
Station 5	3740	15	4300
Total	16500	15	19000

Table 2.6: Quantities of Front-end cards needed for the different detector parts.

2.3.1 Front-end cards

The price estimation is based on the PCB price of the present front-end card (MANU). Table 2.6 shows the required quantities of front-end cards in the different MCH stations.

2.3.2 GBT read-out cards

The price estimation is based on the current prices of the existing components (GBTx, VTRx, SCA) and on the PCB price. Table 2.7 shows the required quantities of GBT cards in the different MCH stations.

2.3.3 Front-end cables (FE2GBT)

The unit prices are based on an offer by xx. Cables are standard, acceptance criteria,..

	#ROC	x% Spares	Total
Station 1	115	15	132
Station 2	115	15	132
Station 3	80	15	92
Station 4	80	15	92
Station 5	110	15	127
Total	500	15	575

Table 2.7: Quantities of GBT read-out cards needed for the different detector parts.

	#SAMPA	x% Spares	Total
Station 1	7200	15	8280
Station 2	7000	15	8050
Station 3	4920	15	5660
Station 4	6800	15	7820
Station 5	7480	15	8600
Total	33000	15	38000

Table 2.8: Quantities of SAMPA ASICs needed for the different detector parts.

2.3.4 SAMPA

Section ?? deals in detail with the SAMPA project. The cost estimate for the SAMPA is based on 33000 SAMPA plus 15% spares for a total of 38000 ASICs. Table 2.8 gives an overview of the quantity of chips needed for the MCH stations. It is planned to build 15% spare ASICs. **If a production yield of 70% is assumed, this results in a number of 53000 ASICs to be produced. The number of chips per wafer is approximately xx, which leads to a number of xx wafers.** Section ?? shows the cost estimate for the SAMPA ASIC manufacturing, packaging and testing.

2.3.5 Common read-out unit

Each GBT card is linked through an optical fiber to an input of a CRU. The number of CRU inputs is therefore the number of GBT cards, 575 (500 + 15 % spare). Each CRU can have 24 inputs resulting in a total of 25 CRU.

2.3.6 Fiber installation

The optical fiber installation between the cavern and the upstairs control room will occur during Long Shutdown 2. **installation financing: amount ?? on which account : M-O B ?? .**

2.3.7 Power Distribution and Cooling

The cooling system was designed to dissipate the heat produced by electronics and to keep all the stations in a stable environment. The heat dissipation of the electronics amounts to 2.5 kW in station 1, 2.5 kW in station 2, 1.6 kW in station 3, 2.4 kW in station 4 and 2.7 kW in station 5, corresponding to a power consumption of the front-end card of less than 15 mW per channel.

Air cooling was chosen with different solutions for stations 1 and 2, with their specific closed environment and quadrant design, for station 3 located in the dipole, and for stations 4 and 5 placed in an open environment. We will keep this cooling infrastructure.

Concerning the present low voltage power supply, twenty-eight WIENER PL500/F12 power supplies are used to deliver low voltages to the detectors. Each power supply consists in 12 independent channels which are presently gathered in groups of three voltages (- 2.5, 2.5 and 3.3 V) needed for the present electronics. These power supplies will be reused for the upgraded electronics, with a rearrangement of the mapping.

2.3.8 Detector Control System

The Detector Control System (DCS) is used to power and control the low voltage power supplies, the HV voltage power supplies (which will be identical and with the same mapping than presently) and to monitor the gas flow and the temperature sensors, as now. The DCS signals are transmitted optically from the CRU to the

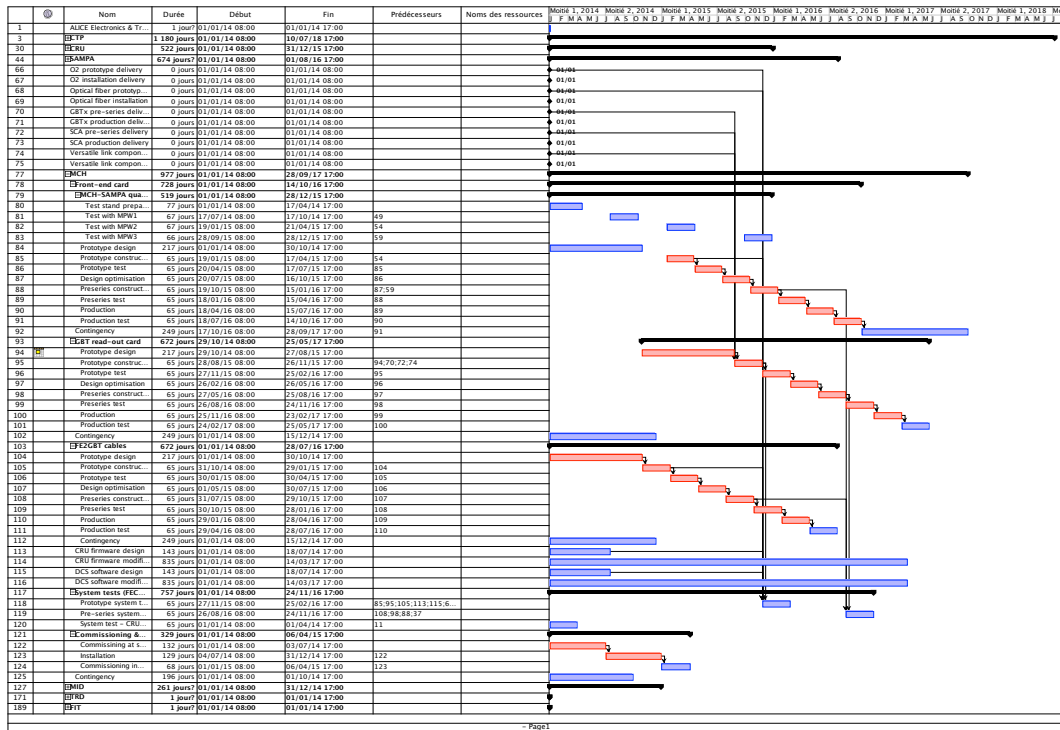


Figure 2.2: The MCH upgrade schedule.

GBT card and on dedicated electrical line between from the GBT-SCA component to the Front-End Card.

2.4 Schedule

A first draft schedule: dates have to be modified.

The MCH upgrade schedule is presented in Fig. 2.2.

2.5 Manpower

The estimated manpower available in the collaboration institutes, which is needed for the different activities, is shown in Tab. 2.9. The numbers are divided into physicists (PH), electronics engineers (EE) and technicians (ET) and others (OT).

Activity	Institute	Contact person	PH	EE	ET	Ot
1. Front-end cards	INP Orsay	B. Espagnon				
2014			0.5	1	1	0
2015			0.5	1.5	1.7	0
2016			0.5	1.2	1.7	0
2017			0.5	1.2	1.7	0
2018			0.5	1.2	1.7	0
2. SAMPA ASIC	x	x	x	x	x	x
3. GBT Read-out Cards	CEA/Irfu Saclay	H. Borel				
2014			0.5	0	0	0
2015			0.5	1.2	0	0
2016			0.5	1.2	0	0
2017			0.5	1.2	0	0
2018			0.5	1.2	0	0
4. FE2GBT cable (E-link)	INFN Cagliari	C. Cicalo				
2014			0.5	1.5	0	0
2015			0.5	1.5	0	0
2016			0.5	1.5	0	0
2017			0.5	1.5	0	0
2018			0.5	1.5	0	0
5. CRU	???	??				
2014			??	x	x	x
2015			??	x	x	x
2016			??	x	x	x
2017			??	x	x	x
2018			??	x	x	x

Table 2.9: Available manpower per institute and year (in FTE).

2.6 Risk Register

The different items do not present technical risks, except for SAMPA which has especially to demonstrate the parallel running of the signal sampling and data transmission. Different prototypes are foreseen.

SAMPA :

see section @.

Funding risks:

General schedule risks

The main possible risk concerning the schedule is the whole production and test of the SAMPA chips.