SCIENCE & TECHNOLOGY FACILITIES COUNCIL
PROJECTS PEER REVIEW PANEL

CMS Upgrade

Responses to Feedback from the Office

- Are there enough milestones to track a 6 year project? What are the key deliverables? We feel that a greater level of granularity would be appropriate.

- There are 14 milestones for WP2, 7 for WP3, and 8 for WP4. We feel this is appropriate, with more than one milestone per year for each WP. WP2 includes several documents in its milestones, since this will remain an R&D activity until a TDR for the Phase II upgrade is developed, and the date is not yet fixed.
- We note that all of the WPs are based on successful R&D over the last three years, with substantial progress in producing the hardware for WP1 (a fully working CBC ASIC), and WP3 (the expected final version of the trigger board MP7 is currently under test). The WP4 FED hardware will be based on the MP7 so is relatively low risk. In addition firmware and software, particularly the IPbus suite is in operation and adopted as a CMS standard, which the UK will maintain, so this infrastructure is already at an advanced stage.
- The key deliverables are identified, being included as the milestones.
- The PI and WP managers will continue to monitor progress constantly, and the R&D phase has been maintained on track, which also gives us confidence. If required, additional sub-milestones will be identified where there may be a risk of slippage but we feel this is best done after approval and once CMS TDRs and timescales are fully defined. This may be useful if the CMS schedule results in excess pressure on the UK deliveries but at present that does not appear to be the case.
- There have been suggestions in the past from STFC to identify 50% points in deliverables. However, this is very impractical since it is practically impossible to quantify reliably such things as intermediate stages of circuit or board design, firmware and software development. Monitoring is better done by adding extra milestones covering key details, where that is possible, and will be done if needed.

- It would be helpful to have the milestones identified in the proposal marked on the Gantt chart.
- The milestones are already in each of the Gantt charts.

- Can the dependencies between the work packages, and with the international project deliverables/milestones, be identified more explicitly. What is on the critical path?

- Each of the WPs is largely autonomous. However, the project has evolved during the R&D phase so that there is much complementarity and a natural overall coherence which works to our advantage. For example, the mini-T and MP7 trigger boards (WP3) are natural candidates for revision to provide FEDs for the pixel project (WP4) and the intermediate DAQ which will be needed to read out CBC-modules produced in WP2. This means much of the firmware and software can either be re-used or modified to adapt to slightly different, but similar, requirements. The IPbus control software-firmware provides a foundation stone used throughout the project and also by other CMS collaborators.
- So, in short, there are not significant dependencies between the WPs but there are opportunities to benefit in common from work done in individual WPs.
- At present, without a firm timeline for the Phase II tracker delivery, there is no critical path for WP2. However, the provision of the CBC is required early so that modules to be developed and

tested prior to large scale commitments. The tentative CMS Phase II tracker schedule has guided the timeline for WP2.

- For WP3, the critical path is not the UK contributions, but is defined by the infrastructure allowing the parallel trigger to be installed and evaluated after LS1 from 2015. This infrastructure is the optical transmitters and receivers, or splitters, which must be installed during LS1 to permit the trigger primitives to be transmitted to the processors, i.e. the MP7 and Time Multiplexed Trigger (or an alternative architecture). This is under detailed discussion in CMS at present, in view of the urgency and need to provide early funding.
- For WP4, unless there is a significant delay or unexpected difficulty in developing the pixel FED, the UK contributions should remain off the critical path. This will mostly be defined by the development of the pixel ROC (readout chip), and the module assembly. Hence sensor contracts, success in ROC (and TBM) ASIC development, and successful commissioning of new module assembly centres, with contracts for bump-bonding, will drive the schedule. There have actually been delays in the delivery of the first digital ROC and a few issues with the chip when it was delivered. However, as we have demonstrated in lab and a first beam test, these problems can already be worked round for the readout and are not expected to delay the DAQ development significantly.

- It would be useful to have itemised tables of the consumables and equipment costs, identifying which institution is requesting which item, for when we are considering the justification of resources.

- A detailed summary of the requests is included at the end of the document.

- We would like to have more of a commentary on the risk register in Appendix D. No contingency has been requested – is this because it is not needed? Most risks appear to be mitigated by working allowance. We would like to understand how this has been calculated.

- We have followed the STFC guidelines here, namely that "the Contingency Reserve is for the unknown and unexpected things that can occur within a project and could not reasonably be predicted", while "the Working Allowance is used to cope with the uncertainties that occur in all projects".
- A summary of how the WA was calculated was given on p11 of the proposal, and further details in the discussion of individual WPs. There are likely currency fluctuations, mainly in the value of the US$, which are expected to affect the cost of FPGAs, and other components, and the ASIC manufacture costs. The other uncertainty which can be estimated is the likely success in board prototyping (now at an advanced stage) or sub-standard manufacture (which may not be the fault of the company) and yield (fraction of perfect boards) in manufacture. Similar provision was made for the ASIC manufacture. The amounts included in the WA can be read from the financial tables. We also made provision for extra staff effort in the WA and requested funds for external sub-contracts, again to minimise risk by recruiting experts.
- Thus, we do not request contingency, because we believe we have provided sufficient margin for reasonable difficulties through the WA. However, while we cannot by definition predict where contingency might be required, one obvious possible risk in the current economic climate is the possibility of more substantial currency value changes. A corollary risk is the possibility of another contributing agency having a shortfall in its funding. We would expect CERN to contribute to solving such problems as in the past.
- We believe that, for the present, the WA provision provides a better means of quantifying the cost safety margin in the project, rather than assigning costs to each individual risk, which is likely to lead to double counting or amounts which are very hard to quantify or shared with CMS (e.g. Risk 5.3: trigger objectives more difficult than anticipated). We note that our

assessment of the risks, following the STFC guidelines, did not lead to any risks outside the green range.

- We would like to see a cost analysis on the risk register so that we can better judge this, and understand how costs over-runs would be handled should any of the risks materialise. Also to understand STFC's exposure to risk in funding this, to help with programme planning.

- Please see the previous answer. We believe that the Working Allowance has been quite conservatively estimated and should allow for cost over-runs in the WPs we have described.
- Another possible risk is that the entire trigger or pixel upgrade project, or even the LHC machine, runs into difficulty and there is an overall shortfall in funding, and all agencies are requested to help. This is included in the Risk Register but we do not know how to quantify such risks in monetary terms. It would probably fall under the contingency heading.
- There is another level of possible risk in such large international projects, as already mentioned, which is the possibility of funding problems in contributing countries, which is clearly not unlikely at present. Again, this is listed in the Register but is not easily quantified.
- The RRB (twice per year) provides a means for STFC to monitor and discuss possible funding scenarios, which are regularly discussed and could be supplemented with the CMS collaboration if required. The CMS management, including Spokesperson and Resource Manager, are normally readily available and willing to discuss specific concerns of individual agencies. It is difficult to make a single statement which would cover all cost over-runs, which could materialise in many ways and not necessarily in the areas where the UK has direct involvement. Typically, for major issues, CERN becomes involved in the person of the Research Director, and negotiations with relevant agencies take place to resolve issues. This has worked well in the past, during LHC construction, when the challenges were probably more severe than we expect during the Phase I upgrade.

- WP4 (Pixel DAQ) appears to begin and end within the funding period. WP2 and WP3 end with first production modules of the Phase-II tracker and delivery of the track trigger prototype. It would be useful to have some understanding of the level and cost of UK involvement in the final build and implementation phase.

- WP4 does effectively end within the funding period, although we would expect the subsequent LHC operational period from 2019 onwards would require M&O and travel support, and consolidated grant staff effort, for exploitation.
- WP3 should deliver a working calorimeter trigger to CMS within the funding period (with subsequent exploitation) but the WP looks beyond LS2 to the even greater challenges of the Phase II CMS upgrade. After LS3, tracking information is expected to be utilised within the trigger, so it is natural to build on the preceding trigger work and WP2 ASIC and module development to begin the next stage of development to ensure there is an effective trigger from 2022.
- While the Phase I upgrade has been defined by an EoI (2007), Technical Proposal (2010) and TDRs in preparation for several sub-detectors, the Phase II upgrade is less well defined. A Tracker Phase II TDR is planned with an undefined date, but perhaps in 2017. The overall cost of the Phase II upgrade has not been estimated except in a broad-brush fashion for the EoI. At that time the overall upgrade construction costs, not including R&D, were estimated at about 175 MCH.
- The Phase II sharing is probably easier to anticipate. For the Phase I upgrade it has been almost universally accepted that cost sharing based on the PhD author list, which is revised annually, provides a good basis, and this has been endorsed informally, but quite willingly, by most

agencies at the RRB meetings, even if not all are able to provide all funds at present. The UK represents about 4% of the CMS PhD authors.

- We would like to understand how the proposed activities fit into the overall upgrade plan for CMS. Who is coordinating the CMS upgrade? An organogram illustrating the overall management and oversight scheme would be useful. Are there any non-UK partners in any of the proposed activities and if so, at what level? What are the interfaces with the wider CMS upgrade effort? It would be helpful to see a picture of the overall work breakdown structure, highlighting the WPs that the UK is leading and illustrating how they fit into the wider programme. What is the UK cost-share of the proposed upgrades to CMS and how does this compare to the relative size UK groups within the collaboration.

- The upgrade project is being treated as a sub-project within the overall CMS management structure (see the organograms at the end of this document) to provide coordination, financial and strategic overview and monitoring. Each sub-detector is however essentially autonomous and individually responsible for its own upgrade management. The upgrade project managers are responsible, with sub-detector project managers, for carrying out reviews, and reporting to the CMS MB.
- The management and organisation of the Tracker Phase I (pixel) upgrade is described in a chapter of the TDR. This is not yet a public document but should be available in September in time for the LHCC and PPRP meetings. This outlines the costs, schedule and WBS. "*The detailed cost estimate of the Phase-1 upgraded Pixel detector has been established, with about 200 individual items in the Cost Book, on four levels of a Work Breakdown Structure (WBS).*" Some pages from the final draft TDR chapter are appended below, which summarise the pixel project management.
- WP4 represents a Level 2 line item in the Pixel WBS, identified as DAQ.
- However, there is no WBS for the overall upgrade, as it is and will be defined by sub-detector projects, which will be described in each TDR. There is a very detailed WBS for the common items, which is currently under detailed scrutiny for costs, but this not thought to be of direct interest to the PPRP, although could be made available if required.
- In parallel, there are overall coordination tasks under the umbrella of technical coordination and central DAQ. At present most of the focus is on LS1, when many activities having a bearing on the Phase I upgrade must be completed, such as installation of the new beam pipe. There is a very detailed schedule for this, but it is not the subject of a written document and the costs and sharing are under the overall responsibility of CMS, along with the upgrade project management, and presently the subject of detailed discussions while most funding agencies are individually approving their own contributions.
- All the upgrade projects are international and thus shared. This is described in the proposal on p8, and in the individual WP descriptions. In some areas, there is close liaison and sharing of similar responsibilities. In others, groups or agencies have independent responsibilities which can be managed largely autonomously in the framework of management of the sub-detector. This is the case for the pixel FEDs in WP4. For WP3, the UK is proposing to deliver the calorimeter trigger, taking the lead. The proposal describes the collaborative arrangements which affect the L1 trigger. In the case of WP2, the UK has a leading role once again in defining the readout system and contributing unique components, particularly the CBC, to modules which then become a shared responsibility.

- As explained in the previous answer, for the Phase I upgrade it has been agreed to share the overall cost of ~64MCHF in proportion to each agency fraction of the PhD author list. (Traditionally the costs are material contributions only, and do not include staff.) This is not possible for every agency in the current climate but CERN is contributing slightly more than expected, so the UK contribution should – subject to PPRP approval of our material request for WP3 and WP4 – be very close to the author list expectation.

- Are there any review points (e.g. what are the decisions that need to be taken and when? Are there any external decisions in the international project that could affect things?)

- The review points which affect our contributions have been described in the proposal. For the pixel project (WP4), it is accepted that the UK will contribute the FEDs as described, obviously subject to UK approval. In WP3, there is a pending decision on the architecture but, as stressed, the UK hardware is agnostic on the architecture choice. None of the decisions are "external" but should be made within the sub-detector projects in a collaborative manner.

Institute non-staff cost requests

- **Bristol**

Bristol has requested an annual budget of ~£15k to in support of its activities in work packages 2, 3 and 4 of the proposed project. We intend to deploy these funds in a flexible manner, and in conjunction with the group's baseline consolidated grant funding, allowing us to respond to short-term needs of the project as required. The main categories of expenditure are likely to be as follows:

- Construction and testing of minor items of hardware in support of integration activities or test beam runs, i.e. fabrication or rework of PCBs or modules, £8k per annum.
- Acquisition of commercial crates, modules or components required for tests of UK-produced hardware, firmware, or software. For instance, to allow testing of online control system components with new FPGA families or uTCA components, or to provide DAQ infrastructure for beam tests, £5k per annum.
- Maintenance of CMS upgrade-specific equipment in our lab, e.g. ongoing replacement of PCs, consumables for our temperature and humidity controlled test and storage chambers, £2k per annum.
- Acquisition of software licenses for hardware and firmware development. All such licenses are currently donated free-of-charge by vendors, but we cannot depend on this situation lasting indefinitely.

In each case, our estimate of expenditure is based upon experience from the R&D phase. Total expenditure at Bristol on the listed items has been around the £10k per year level over the last three years, and is expected to increase as we enter the construction and integration phases of the project.

- **Brunel**

Brunel requested £3k per year. The funds should cover supporting the online/offline software and database integration effort at Brunel which requires a dedicated database server, recurrent ORACLE licence costs and dedicated storage space . Storage requirements will grow throughout the project period and hardware will need to be replaced after four years.

- **Imperial College**

Some details were already given in the proposal, namely for WP2:

- FE chip test setup custom hardware and components - £60k (£10k / year)
- funds for manufacture of test systems hardware, including fine-line printed circuit board (PCB) production, interface PCBs and components, prototype hybrid manufacture, wafer test probe card manufacture, custom mechanical assemblies and electronic circuits associated with test structure, prototype and final module testing and integration and commissioning. £10k per year.
- Module assembly costs - £86k (£14.3k / year)
- The costs of the other components of the SS-Pt module will be shared with our collaborators at an estimated cost of 20kCHF/year, based on quotations.

We emphasise that it is hard to provide a fully itemised list, since test systems have to be modified or even re-designed to accommodate unexpected features which show up only when testing a prototype chip or system. Cost estimates therefore have to be realistic knowing that not everything can go smoothly. The activities that will need test setups to be constructed include:

- year 1 (2013-14): ongoing CBC2 chip test activities in the lab, CBC2-based module testing in lab and test beam
- year 2 (2014-15): CBC2 module tests (lab, irradiation and test beam) ongoing, CBC3 test setups to be prepared, CBC3 wafer probe test system

- year 3 (2015/16): CBC3 chip testing, CBC3-based module testing (lab, irradiation and test beam), CBC4 test setup preparation, CBC4 wafer probe test system
- year 4 (2016-17): ongoing CBC3-based module testing (lab and test beam), CBC4 chip testing
- year 5 (2017-18): ongoing CBC3/4 chip/module testing, production readiness tests, CBC4 production test hardware preparations
- year 6 (2018-19): ongoing production test, contributions to modules assembly, preparations for modules acceptance tests activities.

Each test setup typically requires construction of a specialized board (fine-line for wire-bonding, probe card for testing on wafer) plus peripheral boards for introducing test signals and for readout and control interfacing. Simple double-sided printed circuit boards can be produced relatively cheaply using the Imperial in-house facility. More sophisticated PCBs, or fine-line chip carrier PCBs, produced commercially can range in price from £100 to ~ £1k depending on complexity (size, number of layers). Costs are often dominated by NRE as numbers of boards required are usually few. Wafer probe card manufacture is done commercially, for which we estimate ~ £1k.

Test beam activities require mechanical assemblies to house and position modules, provide cooling, long distance cabling from beam area to counting room, and additional electronics to transfer signals over relatively long distances (not necessary in the lab).

There will be a need to construct specialized setups for radiation testing, where non rad-hard interface circuitry has to be avoided in the radiation area, and high vacuum tolerant systems may be required for SEU testing. Additional costs anticipated with WP2 chip and module testing are:

- Adapt chosen DAQ platform for CMS upgrade so procure µTCA crates and controllers
- Procurement and/or replacement of PCs and power supplies associated with test setups
- Wafer thinning and cutting costs.
- Packaging and shipping costs of wafers, chips and modules to test sites and collaborators.

For WP3 and WP4, Imperial requests £5k per year for the first three years.

- £2.5k per year is for PCs. We currently use ~8 PCs (mix of portable, desktop & rack), but this would increase as the project grows. Y1 would need a couple of rack PCs, followed by the replacement of 4-6 existing PCs (desk & portable) in Y2/Y3. The remainder is used for shipping, small test cards, test cables and adapters, fibre cleaners, tools (soldering irons, clippers, multi-meters, etc), equipment calibration and specialised rework.

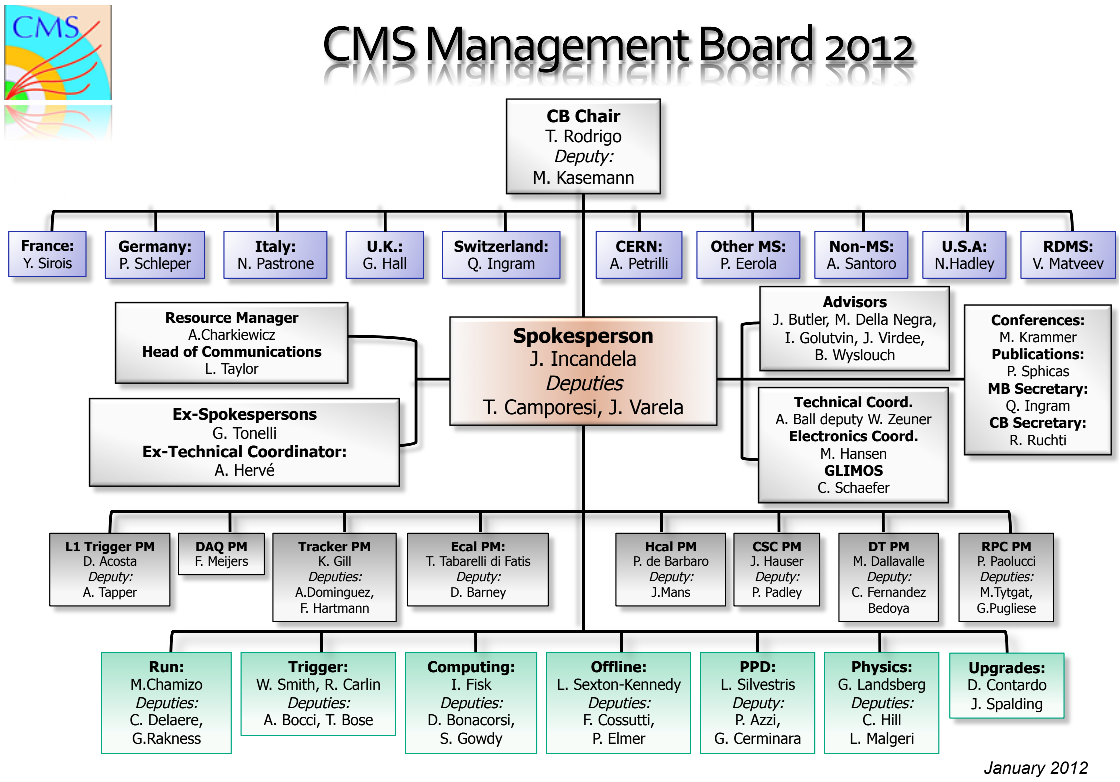
- RAL

The RAL PPD request is for £15k in the first year, followed by £8k in subsequent years, with £5k in the final year of the project. In addition we request £5k per year for RAL TD for four years.

The RAL PPD requirements are

- two µTCA crates with µCTA Control Hub (MCH) - one for WP4, one for WP3: £7000 each
- software licenses: e.g. ISE for laptops (not covered by site license) £7500
- general consumables £9000
- DAQ-link specific hardware £6000
- pattern generator for external trigger and module emulation, capable of sending 400 MHz test pattern: £1500
- oscilloscope with high enough sample rate for 400 MHz signals (WP3 and WP4), £14k
- PCs (rack-mounted), £ 9000

For RAL-TD we anticipate spending the £5k per year on µTCA crates and maintenance, including replacement power supplies, and CMS specific infrastructure, such as MCH and AMC cards, necessary to remain compatible with other users in firmware development. We also require suitable PCs and DAQ links identical to those to be used in CMS, and commercial FPGA boards during development.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B. Wyslouch
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Deputies:
C. Hill
L. Malgeri
Upgrades:
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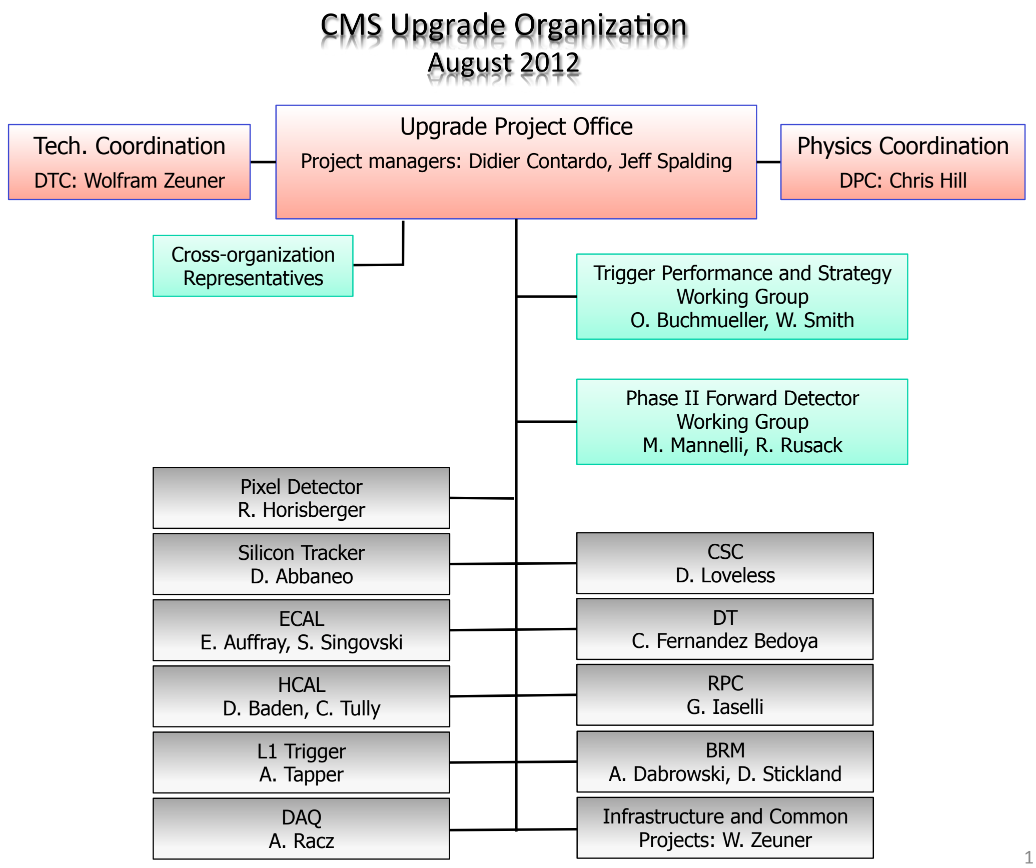
January 2012


CMS Upgrade Organization
August 2012
Tech. Coordination
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Upgrade Project Office
Project managers: Didier Contardo, Jeff Spalding
Physics Coordination
DPC: Chris Hill
Cross-organization
Representatives
Trigger Performance and Strategy
Working Group
O. Buchmueller, W. Smith
Phase II Forward Detector
Working Group
M. Mannelli, R. Rusack
Pixel Detector
R. Horisberger
Silicon Tracker
D. Abbaneo
ECAL
E. Auffray, S. Singovski
HCAL
D. Baden, C. Tully
L1 Trigger
A. Tapper
DAQ
A. Racz
CSC
D. Loveless
DT
C. Fernandez Bedoya
RPC
G. Iaselli
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39. **Rice University, Houston, Texas, USA**
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40. **Rutgers, the State University of New Jersey, Piscataway, New Jersey, USA**
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A. Kharchilava, A. Kumar

42. **Texas A&M University, College Station, Texas, USA**
R. Eusebi, I. Osipenkov, S. Sengupta

43. **University of California, Davis, Davis, California, USA**
M. Chertok, J. Conway, F. Ricci-Tam

44. **University of California, Riverside, Riverside, California, USA**
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45. **Vanderbilt University, Nashville, Tennessee, USA**
W. Johns

12.2 Project Organisation

The Phase 1 Pixel upgrade is a subproject of the overall CMS Tracker Project. Therefore, its organization fits within the general organization of the Tracker project. The general Tracker project organization is shown for reference in Fig. 12.1. Names of people holding the different roles are the ones at the time of writing.

In compliance with the CMS Constitution and with the Tracker project Constitution, the Tracker Institution Board is the highest decision-making body in the Tracker Project. The Tracker Project Manager, appointed by the CMS Spokesperson, heads the project and is assisted by two deputies and the Tracker Resource Manager.

A number of Boards oversee, steer, endorse, etc., as appropriate, specific managerial, organizational or technical matters. Among these boards, the one specifically concerned with the management of the Pixel Phase 1 Upgrade project is the **Phase 1 Upgrade Management Board** (**Phase-1 MB**).

From the construction organization point of view, the Phase 1 Pixel detector can be subdivided into three main areas:

1. the Forward Pixel (**FPIX**) system, including all in-detector parts, structures and components specific to the end Disks;
2. the Barrel Pixel (**BPIX**) system, including all in-detector parts, structures and components specific to the Barrel;

3. Common Systems and Integration (**CSI**), including all in-detector parts and components which are the same in FPIX or BIX or are however procured through a single common procedure, the off-detector services (such as power supplies and cooling plants) and all the integration interfaces. CSI is also the interface to the CMS Technical Coordination.

The construction activities in the three main areas are each coordinated by a specific **Technical Coordinator**.

This structure is indicated in Fig. 12.1. Each Phase 1 Upgrade technical Coordinator coordinates and oversees the actual day-to-day work of different Working Groups and Production Centres, distributed across most of the participating Institutes.

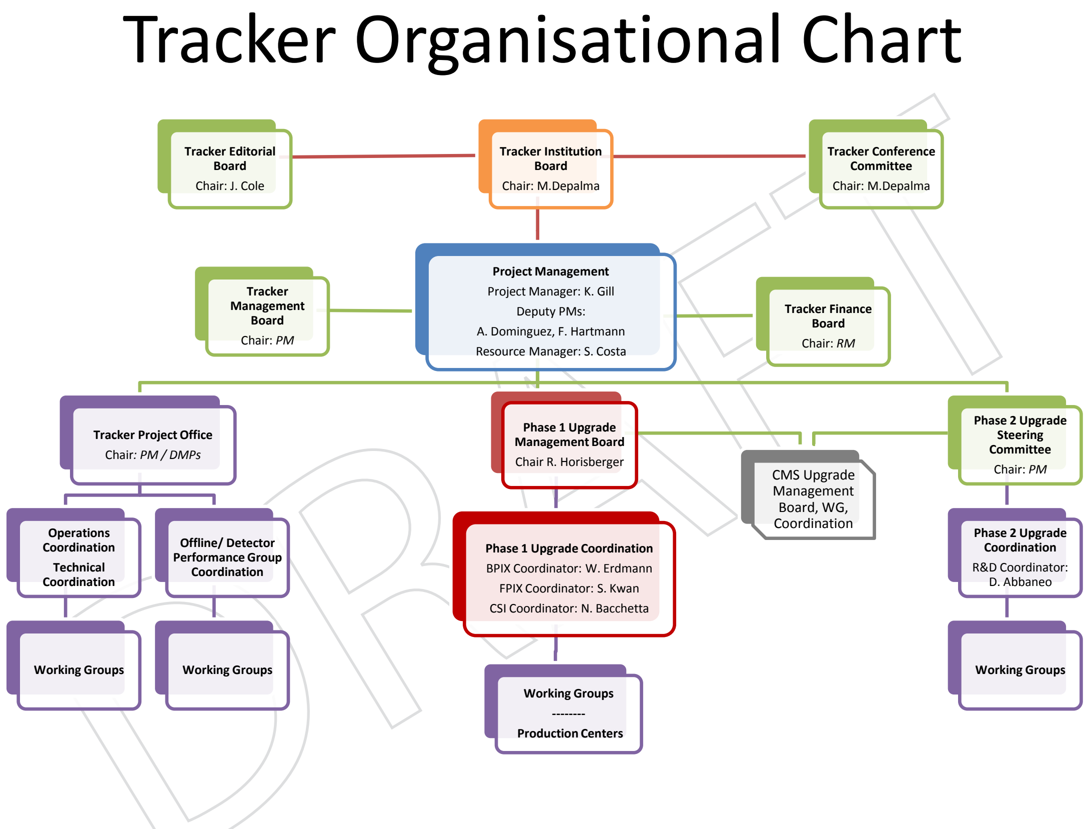

Figure 12.1: Tracker organizational chart.

12.2.1 Phase 1 Upgrade Management Board (Phase-1 MB)

This board evolved from a previously existing (up to January 2011) and now phased out Tracker Upgrade Steering Committee, which had steered the physics studies, simulations, and R&D activities leading to the Pixel-related sections of the CMS Upgrade Technical Proposal. Its members are the link persons to the Funding Agencies (FAs) supporting the construction of the upgraded Pixel detectors either with financial funds for Materials and Services (M&S), or with manpower available at the home Institutes, or both. This board is completed by a number of *ex-officio* members: the full Tracker Management Team, the Chairman of the Tracker Institution Board, the present Pixel detector Operation Managers, and the CMS Technical Coordinator.

The concept that inspired the composition of this board is that representatives of the main Funding Agencies in the Pixel Phase 1 Upgrade project share a common commitment and responsibility to deliver the upgraded detector. The responsibility for managing the project is shared by these agency representatives and with the Tracker Project Management team through their combined involvement in the Phase-1 MB.

The Phase-1 MB supervises, reviews progress and defines planning and strategy for the Phase-1 Upgrade project; defines and manages the scope, the budget and the milestones of the project, as well as the sharing and responsibilities between different Funding Agencies involved resulting in an internal MoU. The Phase-1 MB meets several times a year, at least during CMS and Tracker weeks. Decisions are taken by consensus whenever possible.

In any important areas where consensus cannot be reached, or where there is a significant impact on the wider Tracker project, the Tracker PM can bring these matters to the Tracker Management Board for resolution.

12.2.2 Phase 1 Upgrade Project Leader

The Chairperson of the Phase-1 MB is selected among the members, by the members themselves (*ex-officio* members do not vote and cannot be selected) and is the *de-facto* Project Leader of the Phase 1 Upgrade subproject within the Tracker project.

The Chairperson represents the project on the CMS Upgrade Project Office. The Chairperson is endorsed by the Tracker PM, Tracker Institutions Board and CMS Upgrade Managers.

The Phase-1 MB Chairperson/Project Leader role is characterized by the following charge and deliverables:

- To lead the Phase-1 MB to define and manage the scope, cost and budget for the pixel upgrade, taking into account the LHC schedule, available resources, and interests of the groups involved.
- To lead the MB to define a set of project milestones and then steer the project to meet them, assuring the necessary flow of resources and information throughout the project.
- To work closely with the Phase-1 BPIX, FPIX and CSI Coordinators to review technical progress; manage the planning and strategy to deal well with problems and opportunities; establish and use appropriate documentation with reliable archiving for all relevant technical specifications of parts and interfaces, QA procedures, QC procedures and logistics.
- To prepare for reviews of important technical, engineering and procurement decisions, normally chaired by CMS Technical Coordination.
- To chair the Phase-1 MB, organize meetings, agendas, objectives, and follow-up with reports to the TIB.
- To work in partnership with the Tracker PM team to assure proper consideration of all decisions, including their impact on the Tracker project as a whole, with appropriate preparation of points for endorsement by the TIB.
- To work closely with the Tracker Resource Manager on all resource-related matters.
- To represent the Tracker Phase-1 Upgrade in the CMS Upgrade Project Office as well as in CMS Management and LHCC meetings.

Last but not least, the Phase-1 MB Chairperson has been responsible for assembling an editorial team and publishing this TDR.

12.2.3 Phase 1 Upgrade Technical Coordination Team

This team is composed of two detector construction Coordinators, one for BPIX, one for FPIX, and the Common Systems and Integration (CSI) Coordinator. These people lead the technical activities within the project. The Coordinators act as a team to ensure that:

- Realistic and detailed plans are prepared.
- Adequate resources and supervision are committed to the different activity lines.
- The planning is consistent with the project milestones, quality objectives and budget.
- Progress is properly monitored across the technical activities in all centres.
- Technical specifications for parts and interfaces between parts of the system are established, well defined, documented and followed.
- QA/QC procedures are established, well defined, documented and followed.
- Information flows properly within the project, to/from the Phase-1 MB and within the technical Coordination team, and that there is a central repository used to organize and archive project documents.

The CSI Coordinator will ensure that the common parts of the upgraded area, which are outside the normal supervision of the FPIX and BPIX Coordinators, are fully supported and properly integrated into the project such that the appropriate solutions are adopted by FPIX and BPIX. The Phase-1 BPIX and FPIX Coordinators, working together with the CSI Coordinator, should ensure that common solutions are implemented wherever it is appropriate.

The Coordinators convene technical steering groups of experts as necessary.

As seen in the global Tracker organizational chart, the Coordinators report to the Phase-1 MB, and the Tracker PM.

12.2.4 Role of the Resource Manager

The Resource Manager of the Tracker project has also the role of Resource Manager of the Phase 1 Upgrade subproject. His/her tasks include:

- Maintaining and updating the subproject Cost Book, starting initially from estimates of costs and funding, and progressively evolving it towards a detailed bookkeeping of actual expenses on one side, and FAs contributions on the other side.
- Elaborating and updating the cost time profile and the cost sharing among FAs.
- Taking care, together with the technical Coordinators and/or with the heads of Working Groups and/or the people responsible of the Production Centres, of procurements for the construction of the upgraded detector; specifically, the Resource Manager is responsible for the tendering process involved in common procurements performed centrally.
- Reporting regularly on construction expenditures to the Phase-1 MB, to the CMS FB, and preparing regular reports for the LHC RRB as required.