## WP4: Radiation Hard Semiconductor Detectors

*(1) How is this WP fitting in your experiment program?*

R&D on rad-hard silicon sensors is one of the key issues for the Tracker Upgrade. A large and well-structured project has been put in place by CMS. The CERN group is participating with a substantial role, which would not have been possible without the facilities and the expertise of the DSF. The WP is extremely useful for CMS, and in particular for the CERN group.

*(2) Are the deliverables expected end of 2011 meeting your requirements?*

The cooperation between CMX and DT is profitable for both groups, and will hopefully continue throughout 2011 and beyond. The agreed workplan is perfectly in line with the needs of CMS.

*(3) Which resources are you able to inject in that particular project either to reach completion of new requirements or to customise or to integrate? With which time scale?*

CMX has assembled a small but effective team working on silicon R&D, which profits, when needed, from the technical support of the group.

*(4) How do you see the long term future (beyond 2011) of this WP ? (e.g. extension, reduction, re-focus, conversion to service, absorption in experiment specific upgrade projects, ...).*

It is highly desirable that the CERN group maintain a relevant role in the development of the silicon detectors for the upgraded Tracker, given the importance of the project and the availability of expertise both in DT and in CMX. This requires for the future that financial resources be made available to CMS directly. In practice the transition is already smoothly happening, since a fraction of WP4 funds have been allocated to CMS as soon as a well-defined R&D program has been put in place by CMS.

*(5) General comments*

Good communication between CMX and DT and a wise management of the financial resources have avoided any barrier or competition between “generic R&D” and “experiment-driven R&D”. To be taken as example of good practice.

## WP5: Micropattern Gas Detectors

*(1) How is this WP fitting in your experiment program?*

CMS has recently launched a study to explore the possibility of using triple GEM detectors in the high-rapidity region of the Muon system, profiting from the infrastructure and expertise developed in the context of WP5. It is too early to estimate the likelihood that this study may eventually lead to a construction project, and, in that case, which would be the timescale.

*(2) Are the deliverables expected end of 2011 meeting your requirements?*

The work planned so far should be completed by early 2011, and the support of the

DT group is essential. A possible continuation beyond this first phase will depend on the interest of CMS on this option, as well as the amount of resources absorbed by other projects. It is worth noting that the CMS study is correlated with a small part of the large work program of RD51.

*(3) Which resources are you able to inject in that particular project either to reach completion of new requirements or to customise or to integrate? With which time scale?*

The CMS resources involved at present are rather modest. A substantial increase can be envisaged only in the context of a possible future construction project.

*(4) How do you see the long term future (beyond 2011) of this WP ? (e.g. extension, reduction, re-focus, conversion to service, absorption in experiment specific upgrade projects, ...).*

It is certainly important for CERN to maintain the infrastructures developed, and the associated expertise. Substantial investments beyond that should be linked to well-defined projects in the experiments.

*(5) General comments*

The broad and ambitious work program of RD51, structured in its 7 working groups, needs to be seriously confronted with the limited availability of collaboration funds and resources, and with the perspectives of possible construction projects in the experiments.

## WP6: Quality Assurance and Reliability Testing

*(1) How is this WP fitting in your experiment program?*

The facilities procured will be certainly very useful for the upgrade projects of CMS, notably (but not only) the Tracker upgrades.

*(2) Are the deliverables expected end of 2011 meeting your requirements?*

The QA lab that has been setup is an excellent starting point, and will serve well the needs in the short term (probably, in the coming few years).

*(3) Which resources are you able to inject in that particular project either to reach completion of new requirements or to customise or to integrate? With which time scale?*

The upgrade projects are not yet sufficiently advanced to profit from these facilities. When prototypes become available and the qualification process starts, it can be expected that adequate resources will be allocated by the collaboration.

*(4) How do you see the long term future (beyond 2011) of this WP ? (e.g. extension, reduction, re-focus, conversion to service, absorption in experiment specific upgrade projects, ...).*

In the long term, when prototypes of modules and larger assemblies become available, additional needs will most likely arise, and at that point it should be possible to attract additional resources from CMS to further expand the lab and the

equipment. The QA lab should remain as a facility available to the experiments, and be further developed also using experiments' funds, and responding to specific needs.

*(5) General comments*

CERN has played a central role in the quality assurance and reliability testing for the present CMS silicon-based subdetectors (tracker, preshower). Having now collected and expanded expertise and equipment in a QART lab is an excellent initiative, which will facilitate and promote good QART practice in the experiments.

## WP7: Facilities and Component Analysis for Detector R&D

*(1) How is this WP fitting in your experiment program?*

CMS has been profiting of the GIF facility, notably for RPC gas studies; the availability of a facility for this type has been and will remain of crucial importance. For proton irradiations, instead, CMS uses mostly the Karlsruhe facility.

*(2) Are the deliverables expected end of 2011 meeting your requirements?*

It would be important that access to GIF is maintained until the new GIF++ facility becomes available.

*(3) Which resources are you able to inject in that particular project either to reach completion of new requirements or to customise or to integrate? With which time scale?*

Typically CMS people carry out tests involving CMS detectors.

*(4) How do you see the long term future (beyond 2011) of this WP ? (e.g. extension, reduction, re-focus, conversion to service, absorption in experiment specific upgrade projects, ...).*

Investing in this type of facilities is important for CERN and for the collaborations. CERN should focus on creating and supporting facilities which are not available elsewhere, or which are needed very frequently by machine or experiments. A mixed-field irradiation facility would be particularly valuable for the future.

*(5) General comments*

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## WP11: Detector cooling

*(1) How is this WP fitting in your experiment program?*

The work package, although established very recently, includes a large variety of R&D activities. $CO_2$ cooling is the baseline for the "phase-I" pixel upgrade, as well as for the ultimate upgrade of the whole tracker. Although the project will require the participation of several CERN departments and external groups, it is vital that CMX+DT retains technical leadership of the project, not only during the initial R&D phase, but also during the subsequent design and engineering, construction and quality control, integration, commissioning and operation. The realization and

operation of the cooling plant is the main goal; basic process studies are of interest, other side-projects (e.g. portable cooling plant) may be of no use for CMS. Fiber-optic sensors and leak search/repair are also potentially useful, although perhaps the likelihood of remote leak repair is not very high. Micro-channel cooling seems to be unlikely to be usable in large-area tracking detectors (in the time frame presently envisaged). Generic investigations on materials for thermal joints and thermal management are in principle interesting, but have a moderate likelihood to be useful if not focused on a specific design, due to wide phase-space of possible solutions.

*(2) Are the deliverables expected end of 2011 meeting your requirements?*

The work planned on $CO_2$ cooling and fiber optic sensors is well matched to the CMS upgrade plans.

*(3) Which resources are you able to inject in that particular project either to reach completion of new requirements or to customise or to integrate? With which time scale?*

CMX and many other CMS Institutes are actively pursuing $CO_2$ cooling R&D, and the resources allocated (human and financial) are expected to increase in the coming years. At present CMX is also providing technical support for the leak search/repair WP: such support will have to be reviewed according to the priorities of the experiment and the available resources.

*(4) How do you see the long term future (beyond 2011) of this WP ? (e.g. extension, reduction, re-focus, conversion to service, absorption in experiment specific upgrade projects, ...).*

The many activities launched (or planned) have high scientific value and potentially a broad spectrum of possible applications, including technology transfer; they have also the potential for absorbing a vast amount of resources. For CMS the priority is the construction and operation of the $CO_2$ cooling system for the upgraded pixel detector, possibly followed by a bigger system for the ultimate upgrade of the full tracker. Since in these cases the design of the cooling plant is inextricably connected with the design and performance of the detector, the CERN PH Department must retain leadership of these projects, and their subsequent operation. All that will require the allocation of substantial financial and human resources. Other activities have lower priority, as discussed in (1).

*(5) General comments*

There must be clear guidelines for the allocation of resources for the future; it is important to ensure that the $CO_2$ cooling system for the upgraded pixel detector will receive full support from the department, in all phases of the project, from the R&D to the commissioning and operation, and that the many other activities launched will not weaken that project.