Machine Protection Review Day – New Projects
14th December 2010, 13:45 - 15:30

Minutes B. Todd – 6th January 2011

Agenda:

- Machine Interlock Systems Upgrades [CM – TE/MPE/MI]
- Group Involvement in the HiRadMat Project [JB – TE/MPE/PE]
- Compact Linear Collider: Machine Protection and Interlock Systems [MJ – TE/MPE/PE]
- Large Size Micromegas and Gas Electron Multiplier Detectors [RDO – TE/MPE/EM]
- B-867 Project - Workshop for the Repair of Irradiated Modules [BM – TE/MPE/EM]
- B-107 Project - [RB – TE/MPE/EM]

1. Machine Interlock Systems Upgrades [CM – TE/MPE/MI]

C. Martin made a presentation describing the upcoming work which is required for the maintenance, consolidation and upgrading of key interlock systems. Several new card developments were outlined:

- **CIST** – VME Manchester transmitter for Safe Machine Parameters**.**
- **CISV** – VME Safe Machine Parameter receiver
- **CIBV** – Beam Interlock System connection to the post-mortem system.

In addition **C. Martin** outlined that several elements will need to be upgraded, to accommodate design changes, and component obsolescence:

- **CIBM** – VME based Beam Interlock Controller Manager board**.**
- **CISV** – VME based Test and Monitor board for the Beam Interlock Controller.

Following this, **C. Martin** explained that two designs need to be studied to accommodate higher-than-expected levels of radiation in the machine environment:

- **CIBUR** – A radiation tolerant User Interface for the Beam Interlock System**.**
- **CIBF** – A radiation tolerant Fibre-Extended User Interface for the Beam Interlock System.

All of the items listed above will require the physical production of an electronic circuit (**SCH**, **PCB**), corresponding firmware (**VHDL**) and most will require software controls (**FESA**, **JAVA**).

Finally, **C. Martin** explained that the controls group are releasing a new VME standard chassis and standard power-pc type controller board. This would have an effect on existing systems. *Linux* will be used instead of *LynxOS*, requiring drivers to be rebuilt. The *VME-bus master* card will have a new method of bus access, requiring firmware upgrades in the corresponding Beam Interlock and Safe Machine Parameter Systems. In addition the *mechanics* will change, meaning the current solution of patch panel and redundant power supplies may need to be updated.

In closing, **C. Martin** outlined that there are significant hardware developments planned and scheduled for the SMP and BIS systems. Both systems are well prepared in their current states for the years ahead; nevertheless, the interlocks section is preparation for possible radiation issues, the improvement of existing designs, and the obsolescence of components.

A. Siemko and **R. Schmidt** questioned why the controls group changes would depend so heavily on the supplied VME chassis. **B. Todd** explained that the solution chosen several years ago depended heavily on the mechanical solution provided by the particular VME supplier, in this case Wiener. **F. Formenti** added that some years ago similar problems were observed due to the integration of the VME solutions with the experiments. **B. Puccio** agreed that it was an open issue, confirming that a test system has been purchased, and that more information will be provided at the end of 2011 concerning the impact of this chassis change on the machine interlocks section.

1: key elements of the BIS and SMP to be updated [MI & EM]
2: development to accommodate new VME crate [MI]

2. Group Involvement in the HiRadMat Project [JBS – TE/MPE/PE]

J. Blanco made a presentation outlining the involvement of the machine protection group in the high radiation to materials (**HiRadMat**) Project. A new infrastructure is being constructed in the Beam-1 transfer line and extraction area of the SPS, in the old West Area Neutrino Facility (**WANF**). The area is to be commissioned in September 2011, with the first experiments scheduled to be carried out in October 2011.

J. Blanco continued to explain some of the key parameters of the beams to be used:

Beam Type	Energy	Bunch Intensity	# Bunches	Pulse Energy	Pulse Length	Bunch Spacing
Protons:	440 GeV	3.0e9 – 1.7e11	up to 288	3.5 MJ	7.2 us	25 ns
Lead Ions	173.5 GeV/A	3.0e7 – 7.0e7	up to 52	21 kJ	5.2 us	100 ns

All with a nominal beam sigma of 0.1 to 2.0 mm.

J. Blanco then presented a list of users, intending to exploit the new experimental area, of which the MPE group was mentioned as a user for damage experiments.

J. Blanco the continued to explain the current state of simulations, which are modelling the physical processes of *energy deposition (FLUKA)*, and *hydrodynamic motion (BIG2)*. As these processes are coupled, simulations are executed in iterative steps, combining FLUKA and BIG2 at each step. These new combined simulations have revealed a tunnelling effect, which is hypothesised as an explanation for previous simulations having an incorrect estimation of proton penetration range. **J. Blanco** went on to explain that this hypothesis is to be tested by a physical experiment, to compare the simulations with observed events, in the HiRadMat experimental area, which will become a state-of-the-art experimental area.

M. Jonker asked whether cutting the material in slices effect the simulation, **J. Blanco** and **R. Schmidt** agreed, saying this kind of study was one of the interesting hypotheses of the study.

A. Siemko said that seeing the lack of documentation provided a good opportunity for this kind of work to improve models such as BIG2, **J. Blanco** agreed.

3: ongoing work to improve models [PE]

3. **Compact Linear Collider: Machine Protection and Interlock Systems [MJ – TE/MPE/PE]**

M. Jonker made a presentation outlining the principles of the Compact Linear Collider (**CLIC**), beginning by describing the basic principles: CLIC is intended to precisely study new phenomena which are expected to be uncovered by the LHC, such as Super Symmetry (**SUSY**) and the Higgs particle. To do this it uses electron positron collisions, giving cleaner collisions. To complement the LHC, the energy range required for collisions is around 1.5 TeV per beam.

M. Jonker continued by explaining that a circular collider would need to be twice the diameter of the earth to realise the requirements, thus a linear collider is the only solution. The final length of a machine would be around 48km, considering that accelerating gradients could be made ten times the current state of the art.

M. Jonker then explained that for each of the beams, a system has been proposed that consists of a two beam acceleration scheme, a high-intensity low-energy drive beam, which has its energy extracted to accelerate a low-intensity high-energy main beam. The stored energy in each drive beam is around 70 MW, and in each main beam it's 14 MW. Due to the small size of the beam, the energy density is four orders of magnitude higher than the damage limits of the materials involved.

M. Jonker said that the plan was to have a conceptual design report completed by 2016, **A. Siemko** asked whether the expected time scale was expected to be maintained, **M. Jonker** said that this would be clarified by the beginning of the year.

M. Jonker then outlined the implications of CLIC on the machine protection group in two domains:

1. Machine Protection
    - Conceptual design of CLIC MP system and operational scenario
    - Failure simulation and risk analysis
    - Interlocks and post pulse analysis
    - Static protection
    - Quench protection system
    - Real time protection, emergency dumps.
2. Electronics
    - Radiation hard electronic developments
    - 200k electronic cards to build

M. Jonker continued to explain that current studies are considering the different *failure simulations*, estimating the potential damage, and the potential frequency of these failures. That a new *post pulse analysis* system, behaving like an enhanced interlock and Post-Mortem system, determining go, no-go in some eighty milliseconds, a new doctoral student has been hired for this.

M. Jonker continued to explain that masks will need to be made for CLIC, showing a possible synergy with the work outlined by **J. Blanco** earlier. Once the technical design report is completed, dumps should be studied. In addition, CLIC will require a Quench Protection System, The QPS team have already commented on the proposed designs.

M. Jonker finished by saying some 200k electronics boards would be required, **R. Schmidt** questioned whether this price included cables, **M. Jonker** clarified that multi-wire-cables are to be used to minimise the costs associated with cabling.

A. Siemko asked whether protecting the drive beam or the main beam was more critical, **M. Jonker** explained that the charge density is the important factor, in both cases the beams are dangerous, just the length of the holes drilled would be longer, in both cases it is destructive for the machine, so rfom the protection point of view, there is no big difference.

F. Formenti asked whether VME is to be excluded, **M. Jonker** said that a new study was underway to determine the appropriate method to use for controls hardware, the density is several hundred channels every two meters.

4: identification of synergies with existing machine protection [MI & QPS & PE]
5: possible development of high density electronic chassis [EM]

4. Large Size Micromegas and Gas Electron Multiplier Detectors [RDO – TE/MPE/EM]

R. de Oliviera made a presentation outlining the new projects involving Micro Pattern Gas Detector (**MPGD**) principles, namely Gas Electron Multiplier (**GEM**) detectors and Micro Mesh Gaseous Structure detectors (**Micromegas**).

R. de Oliviera began by explaining the principles of these detection methods: Particles passing through these detectors pass successive layers of prepared material, having holes for electrons to pass through, causing an avalanche of charges, finally giving a signal strong enough to be detected by electronics.

R. de Oliviera then explained that two experiments have upgrades planned, to take advantage of the new technologies being developed by CERN. CMS and ATLAS have projects in development to replace certain detector electronics with MPGD, which will be faster, and more radiation tolerant.

R. de Oliviera then continued to describe the timing of these two projects:

CMS	2010	2 prototypes built
	2011	Two further prototypes for test beams
	2012	80 detectors produced by CERN
	>2012	Large volume production in industry
ATLAS	2010	Prototype built in Normal Bulk
	2011	Large protected bulk prototypes
	2012	Installation of prototypes in ATLAS
	>2012	Large volume production with industry

In order to manage these developments, an investment of 785 kCHF has been made in 2010-11, to prepare CERN's workshops, including: development, copper-etching, stripping and exposure machines; A laminator, drier, oven, a continuous Kapton etching machine and potentially, an electro-chemical copper etching line. All of which should be ready for mid 2011.

R. de Oliviera continued to explain the expected man-power evolution over the coming three years: in

2011: One staff, one FSU for CMS.
One staff, one fellow for ATLAS.

2012: One staff for technology transfer, and two FSU for large productions for CMS.
One staff for technology transfer.
2013: Two staff members to follow-up subcontracted productions.

A. Siemko, asked what the motivations were for experiments to move towards Micromegas,

R. de Olivera explained that GEM detectors are the current state of the art, Micromegas are quite new, but have the potential to be more reduced in cost, having better characteristics, making them an attractive alternative. The experimental community wants tests to be carried out to validate them as a solution.

M. Koratzinos asked whether this work had a big impact on other groups, **R. de Olivera** confirmed that it is a world-wide collaboration, having some eighty collaborating institutes. **R. Schmidt** commented that the installation date in the experiments would be interesting to know, as it could be related to the general shut-down of the LHC.

6: identify whether developments can be synchronised to the long shut-down [EM]

5. B-867 Project - Workshop for the Repair of Irradiated Modules [BM – TE/MPE/EM]

B. Magnin made a presentation outlining project plans for building 867, which is intended to be a controlled facility for the repair of irradiated material.

B. Magnin began by explaining that in September 2009 a Site Committee Study Group was mandated to give detailed planning and budget requirements for the restructuring of building 867. The study group has delivered, several independent work packages, each staged in time, covering:

● A dismantling plan ● A new layout ● safety arrangements ● A restructuring strategy ● A baseline planning.

Features of the new layout include:

● Easily moveable separations ● No mezzanines in the controlled area ● Changing rooms and lavatories ● Transformers located outside the building.

AMS and CMS will relocate away from building 867.

B. Magnin continued by explaining that the requirements of the individual users are being collected in order to correctly layout the work areas.

B. Magnin concluded with several pending actions: collaboration between different groups, training for staff, ordering equipment for the general purpose area, optimisation of the final layout, all within a budget of around 260k CHF. The workshop is intended to be in operation by Q1 / Q2 2011.

B. Magnin asked whether QPS or MI would need access to repairing of irradiated material,
A. Siemko said that analysis of failures was imperative, in order to determine failure modes.

R. Schmidt asked whether typical QPS boards would require special treatment, **R. Denz** explained that some boards may require destructive testing to determine failures, which would definitely need to be treated specially, in a laboratory such as that provided by 867. **K. Dahlup-Peterson** explained that the QPS team had foreseen to collaborate with EPC, in building 287, but that the workspace will not be ready until sometime in 2012.

R. Schmidt summarised that it is difficult to determine the precise requirements for handling of irradiated components in the future, and who will really be the users, a flexible solution with many work places would be useful for the long term solution. **B. Magnin** agreed, commenting that it is important to consider that equipment cannot be easily brought to and from the workshops.

7: gather and implement all user requirements, especially concerning rad [EM]

6. B-107 Project - [RB – TE/MPE/EM]

R. Berberat made a presentation outlining the plans for building 107. This is intended to regroup all of the members of the Electronic Modules section in one building.

R. Berberat explained that the construction of a new building is necessary for this, in order to conform with safety and environmental regulations, and make new space new machines required for new products, such as the MPGD**. R. de Olivera** explained that whilst the current building was safe, it is not capable of being extended to accommodate new requirements, without significant work, justifying the investment in a new building.

R. Berberat continued to explain that this concerns the surface chemistry and coating section (TE/VSC/SCC) as well as the electronic modules (**EM**) section. This presents an opportunity for the EM section to be regrouped in a single building.

R. Berberat continued to show the proposed layouts for building 107, and explained some interesting characteristics of the building. The floor area is to be around $3200m^2$, the wet process floor area is to have special water collection apparatus, to ensure a connection to the existing waste water treatment plant. For hazardous air extraction and air conditioning, a cooling and ventilation infrastructure is to be installed, linked to the existing 18kV sub-station through a dedicated transformer. The building is to be equipped with UPS and a diesel back-up generator.

R. Berberat outlined the organisation and planning which is foreseen for building 107, using two contracts, one for design and supervision, a second for construction. Giving five phases:

Phase 1 – Preliminary design [April - June 2011]
Phase 2 – Tender design [July - October 2011]
Phase 3 – Construction design [November 2011 - March 2012]
Phase 4 – Site supervision of construction works [April 2012 - November 2013]
Phase 5 – Defects liability period [construction + one year]

A. Siemko asked whether there was any spare surface area foreseen, **R. de Olivera** said that 10% of extra space was available in the building.

8: develop ideas further, is further room for expansion is needed? [EM]