Report from the
1st Meeting of the Muon-Technical Advisory Committee(M-TAC) for the Japan-Proton Accelerator Research Complex (J-PARC)

December 13-15, 2004
KEK
Tsukub, Japan.

February 22, 2005

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ii) Executive summary:

This was the first meeting of the Muon-Technical Advisory Committee (M-TAC) of the J-PARC facility. Over two days of presentations and a site visit to the Tokai-Jeari laboratory from the 13^{th} to 15^{Th} of December 04, a committee of experts(see appendix B) reviewed the concepts and designs of the components under the responsibility of the Muon Science Group at J-PARC . Particular attention was paid to those items for which imminent decisions must be taken. The development of a reliable production target is of paramount importance both for the muon and the neutron users. The committee evaluated the two options currently considered, a fixed edge cooled graphite target or a large graphite rotating disc. Both options have advantages and disadvantages. The committee recommends a strategy to continue the development of a fixed target while retaining the option of switching to a rotating target if show –stopper events are encountered in the R/D of such a graphite target. The target vessel is being designed with such a strategy in mind.

The proton beam transport has been developed and a reference design exists. Such an optical design should now be evaluated in the context of operation. First one should try and minimize the dose involved in key beamline elements and for personel during maintenance and emergency repairs . Secondly, a realistic tuning scenario, a protection interlock system should now also be considered in the final lay out of the beam line elements.

Mechanically, considerations of maintenance and remote handling have to be brought to the attention of the designers at this stage. This should continue and a careful assessment of the requirements for documentation, spare parts and disposal will ensure that the lifetime of the facility will not be compromised.

1) Introduction:

This was the first meeting of the newly formed M-TAC (Muon Technical advisory committee) committee established to advise and report on technical issues regarding the J-PARC Muon Facility. This is a sub-committee of the Muon Science Advisory committee (MUSAC) itself reporting the J-PARC International Advisory Committee (IAC).

The meeting was held at KEK on December 13-15Th 2004:

The group was asked to focus on the muon production target and engineering issues associated with the harsh environment predicted for the elements in the proton beam tunnel between the muon and neutron production targets, for which critical decisions must be taken in the near future.

The committee first heard presentations from J-PARC management (Project-Director S.Nagamiya), from the Materials and Life Science Experimental Facility group leader (Y.Ikeda) and an overview of the Muon Science facility by its group leader Dr.Y.Miyake. It is clear that the J-PARC project is an ambitious one and that rapid progress is being made on all fronts. Budgetary cash flow may affect the timetable for completion of the accelerator but every effort is made to deliver a first beam by FY07.

The committee then heard detailed technical presentations on all sub-systems associated with the muon facility. An enormous amount of work is being done by a small team which must account for tight boundary conditions in terms of costs and timeline yet has to deliver a reliable and safe facility.

The committee wants to acknowledge the careful preparation for this meeting for which copies of the presentations were made available ahead of the meeting. A frank exchange of information was carried out through two days of presentations and two open sessions. This allowed for a dynamic interaction between committee members and key physicists and engineers responsible for the Muon facility at J-PARC in an atmosphere of trust and competence. The committee is very appreciative of the openness of the discussions which led to a friendly yet effective meeting.

The committee had a chance to visit the J-PARC complex and the Materials and Life Science Laboratory in particular which provided a real taste of the scope of the challenges but also the opportunities ahead.

This report is first outlining the committee's findings and recommendations on the proton beam transport system in section 2-1), then deals with issues relating to the production target and its associated vaccum chamber in section 2-2) . Secondary channels and radiation hard magnets are considered in section 2-3) . An evaluation of engineering issues dealing with alignment, remote handling and maintenance of the components is described in section 3.

Our recommendations are outlined at the end of each sections and brought back to overall summary at the end in section 4.

2) Review of the Muon Facility:

The muon group is responsible for the section of proton beam transport which includes the last two quadrupoles magnets in front of the muon target station, the muon production target itself and the transport of the beam between the muon target and the neutron facility, as well as the four secondary muon channels viewing the production target. It is anticipated that in the future another muon production source could be located up stream of the present one.

2-1) Proton Beam transport systems:

Beam Properties

The beam transport line from Rapid Cycling Synchrotron(RCS) to the Muon target and beyond that to the Neutron target is one of the most essential part of the facility. The length of the line is approximately 320m and includes approximately 100 magnets. The beam spot at the neutron target must be 15cm wide and 6cm high in order to minimize the pitting problem at the neutron target. This implies that the beam spot size at the muon target can not be as small as that of other muon facilities. On the positive side, this relatively wide beam spot size reduced the seriousness of the target material deterioration due to the radiation damage. The beam optics designed for targeting purpose looks good and magnets designed for the beam line are under preparation. Field measurement is on progress. Therefore the committee recommends that the construction team proceed to the next step, i.e. establishing the tuning procedures of the beam and the development of the beam monitors. Some beam monitors were presented at the review. At this stage, the preparation status of the beam monitoring scheme is lacking behind compared to the preparation status of magnets etc.

Beam profile monitors:

Three kinds of proton beam monitors have been developed.

(1) Beam Profile Monitor
(X-Y type, 23 wires x 23 wires, 6 mm pitch)

(2) Beam Charge Monitor
(Current transformer)

(3) Beam Loss Monitor (Beam Halo Monitor)
(Simple annular plate or gas counter)

Their designs have been proven to work and the R&D has been well performed. .The vacuum chamber design and the installation procedure have been well examined.

The scenario for replacing these monitors and the associated remote handling equipment has been well considered. However, their performance and lifetime under high radiation fields remain to be tested. Their locations and functions in the primary proton beam line have been considered but the detailed proton beam tuning process seems to be undefined yet. Similarly, the interlock functioning diagram for the proton beam line is not available. The interlock function using these monitors is to be further investigated as it may place reliability constraints in their design.

The beam loss monitor using a gas counter seems to need further design work, R&D work and the performance test.

The beam profile monitors discussed above can not work at the full 1MW beam power. Consequently, the fine tuning of quadrupole's and dipole's currents can only be done at low beam intensity with those profile monitors. High intensity beam operation will be a somewhat "blind" operation. Other monitors such as CTs, Halo monitors, loss monitors, which can be operated in full intensity conditions, should be used as "error" detectors and/or "change" monitors. Calibration and continuous record of the outputs from these monitors should provide an essential diagnostic tool.

Beam Collimation:

The primary proton beam optics has been calculated, and the proton beam loss around the production target has been estimated. In the transport section prior to the muon production target, the estimated proton beam loss is less than 1 W/m.

Beyond the target, the beam loss has been obtained assuming a single collimator at the downstream end of the production target and taking into account plausible distortion of proton beam optics. In the worst case, the estimated proton beam loss is about 1 kW/m. Further design works should be continued to reduce the proton beam loss at the downstream of the muon production target.

The residual radiation activity around the production target is not shown in the committee.

The scraper (collimator) design is to be further optimized to minimize the proton beam loss at the downstream of the production target area.

A star-shaped (or square-shaped) vacuum vessel in the quadrupole-magnets is worth investigating to minimize the proton beam loss at the downstream of the production target.

Recommendations:

1, Establish the beam tuning procedure outlining the functions of each beam monitor.
2, define a credible interlock scheme in order to protect beam line elements from mis-operation.
3, Development of profile monitor which can work at 1MW should be an important future long-range home work.
4, Prepare a more detailed study of potential residual radiation level at the beam line based on the beam optics and actual sizes of magnets and beam ducts in order to check the possibility of the hands on maintenance.

Magnets for the High Radiation Areas:

Dr. Kawamura presented a description of the Magnets in the M2 tunnel. Estimates of the radiation dose on a number of magnets were shown. Given the limited funding, only magnets receiving more than 400 MGy will use Mineral Insulated Cable [MIC]. The other magnets will use polyimide insulation. He described the other materials used, and the magnetic design process. A number of the magnets have been field mapped, confirming the design. All magnets will be field mapped before installation.

The decision to use Mineral Insulated Cable [MIC] only in the magnets expected to exceed 400 Mgy and using polyimide insulation for the other magnets is probably a reasonable decision given the cost premium for MIC magnets.

Magnet accessories that could need maintenance, such as temperature switches, should be mounted in the maintenance area, rather than down below. If there is a strong desire to mount these items near the beam, then a separate set should be mounted high above beam level.

Spare magnets will not be purchased. Perhaps JPARC/MLF should consider what must be done if any one of the proton beamline magnets fails. Temporary measures that maintain beam delivery at some level should be investigated. JPARC/MLF should also consider purchasing enough spare MIC cable to be able to quickly manufacture a replacement magnet.

The details of the guides used to install the magnets where not available for review. The base plate, alignment plate system appeared well thought-out, although the re-alignment of the components (magnets, targets, & monitors) to compensate for future building settlement may be a problem.

Recommendations:

More thorough testing of the pillow seal system should be conducted in a mock up of the real environment.

JPARC/MLF should give some attention to diagnosing water and vacuum leaks. This may involve a minor re-design of the pillow seal with the addition of a remote Helium leak-test line.

Shielding and radiation issues:

Dr. Kawamura presented the current effort in quantifying the radiation environment of the muon production facility and its associated beam transport system.

The muon production target area and the beam transport system downstream account for a 5% loss of the 3 Gev 333μamps proton beam. Detailed simulations of beam losses and estimation of the shielding requirements to meet the limits established at J-PARC for controlled and open areas were carried out using the MCNPX code. A fairly realistic model of the geometry of the main components is used. Shielding requirement have been established with a safety margin of a factor 2. Through cooperation with JEARI's safety group, the estimates have been confirmed and initial installation of iron slabs in critical area has proceeded.

More detailed simulation of the losses and heath generation is required for evaluating the radiation dose and heat distribution in beamline elements. This task is an integral part of the design process and must be validated before engineering of components can proceed. This is a critical and demanding task and good progress is being made in understanding the challenges which are to be faced. Cross checks of

some of the results with existing facility's experience (like PSI) are very important.

The most critical component will be the quadrupole magnet immediately downstream of the M target and its scrapers for which special materials and dedicated maintenance facilities will be required.

Recommendation:

The committee would like to see a targeted effort to estimate the suitability of the assumptions made in MCNPX for a 3 Gev proton beam energy. (Energy dependence of the cross sections) . A check with other hadronic packages (like MARS and Fluka) in a simple test configuration would be desirable to establish a level of confidence for these calculations.

Alignment and Delayed installation issues:

Settling of the building floor has been anticipated and may be serious due to the weight of the neutron target and the huge volume of radiation shielding. Steering magnets placed in the beam line can correct a 3 mrad change in the beam direction to the neutron target. During the first few years of operation, the magnet/beam line alignment should be monitored frequently. In case of a larger than 3mrad shift, it is anticipated that a spacer plate between the magnet base (alignment) plate and the magnet, i.e. at the bottom of the magnet will be inserted. The thickness of the spacer plate can be tuned later in order to correct the magnet/beam line height. The committee debated whether this procedure is sufficient to accommodate a large sinking of the experimental floor as was experienced at the US SNS. One possible solution is to place the magnets on jacks remotely operated from the top of the magnet. However such a solution will increase the magnet cost and may not be applicable to 20-40 tons of elements for 3GeV beam transport. A possible scenario is to replace the spacer plate at the bottom of the magnets . Such eventuality should be designed in from the beginning by providing magnetic lifting of the spacer plates from the bottom of the beam line.

Recommendation:

Design a mechanism for adding or removing alignment shims which could be used after initial operation has started.

Temporary iron shield blocks will be used for the two future beam line caves and should be removed later. Those blocks are oriented at 45 and 120 degrees to the proton beam axis. It is proposed to reinsert them into the primary beam line shield for the extra radiation shield. A rotation scheme for heavy and "hot" components lifted by the crane will be necessary and should be defined before building these blocks.

Recommendation:

Design a system for remotely rotating heavy and" hot" elements while hanging form the main crane.

2-2) Muon production Target:

Overall Assessment:

The committee appreciates the chosen approach permitting either a fixed or a rotating graphite target to be installed in the facility. Experience gained at other facilities e.g ISIS, LAMPF and PSI indicates that the fixed target should have a useful lifetime on the JPARC Muon Facility, particularly at lower beam currents. At the highest beam currents, the lifetime of the fixed target may be limited by radiation damage effects and the PSI style rotating target appears a more attractive solution.

The two targets offer complementary technologies. The lifetime of either target is likely to be limited in different ways by radiation damage effects which are difficult to quantify and solve. In the case of the fixed target, lifetime is expected to be limited by the radiation damage of the graphite itself, whereas for the rotating target experience at PSI indicates lifetime will be determined by that of the bearings. If one technology proves to restrict the operation of the facility the other may provide a more successful solution. Designing the facility to accommodate both solutions increases the operational safety of the facility. Attention should be paid to the different requirements of the two targets in the design of the target chamber.

Due to the complementary nature of the fixed and rotating targets, it is suggested that the KEK Mechanical Engineering Centre be involved in the development of both target designs and manufacturing techniques. To assist with the design of the rotating target it is recommended that the engineers responsible visit PSI to study aspects of the design and operation.

Fixed Target:

The committee commends the progress made on the fixed target solution to date. It was noted that the design has been developed allowing for the deterioration in thermal conductivity of graphite indicated in neutron irradiation data. The insertion of a titanium layer is an ingenious approach to mitigate the effect of thermal contraction mismatch between the copper and graphite during manufacture and operation. This joint is critical in maintaining the heat transfer path to the surrounding cooling block and may limit the target lifetime. Graphite shrinkage within the beam spot region is also likely to limit the target lifetime. The committee suggests the investigation of radial stress relieving slits in the graphite in the beam region in order to minimize both shrinkage stresses and thermal stresses during operation.

For bonding graphite directly to copper, ISIS has developed a diffusion bonding technique using an aluminium foil as an intermediate layer. This may offer an alternative to the silver brazing technique for the graphite/titanium/copper joint developed for the JPARC muon target.

The JPARC beam current will reach 333 μA compared with 200 μA at ISIS, and will have a similar beam size at the muon target. The power density is consequently expected to be around 50% greater than that for the ISIS graphite target. The ISIS target uses a carbon-carbon composite block diffusion bonded into a copper base. Two or more such targets could be arranged with a small gap between them in order to split the beam power deposited in each.

Recommendations:

The Muon Target design team may like to consider the following suggestions for further evolution of the fixed target:
(i) Use of the irradiation facility at BNL to test the resistance of the graphite/Ti/Cu joint to radiation damage, although the lifetime of this joint is likely to be influenced just as much by thermal cycling etc;
(ii) The use of alternative codes (e.g. MARS, FLUKA) to validate the heat deposition results generated by MCMPX;
(iii) The cooling water flow can be safely increased to increase the heat transfer coefficient in the forced convection regime.

Rotating Target:

The attractions of a rotating target include (a) the reduction of the graphite operating temperatures, (b) distribution of irradiation damage effects over a greater volume. The proposed design also has an excellent track record at PSI.

The rotating target radiates all the power deposited to the target chamber, consequently this requires a high emissivity and sufficient cooling of the target chamber walls. At PSI sufficient emissivity of the chamber inner surface is achieved with a plasma sprayed mixture of titanium oxide / aluminium oxide powder.

Detailed calculations should be performed of the power deposited in the bearings by secondary particles generated in the target. It is also necessary to minimise the thermal conduction path between the target and the bearings; the ball bearings must have sufficient clearance at the operating temperature. Estimates of the temperatures should be compared with PSI experience to assess the anticipated lifetime of the bearings

It is recommended, for operational safety, to have two independent cooling loops so in the event that one of the loops develops a leak, sufficient cooling is maintained by the remaining loop.

Recommendations:

Improve effectiveness and provide redundancy of the cooling loops of the target chamber and increase the emissivity of the chamber inner wall.. Develop a more detailed modeling of the heat transfer to the ball bearing assembly.

Remote handling of Muon targets:

S. Makimura described the concepts and some details of the maintenance and remote handling envisaged for the key highly activated muon target and associated components.

When the Muon target needs to be changed, the target assembly will be disconnected and lifted into a 150 mm thick transfer cask. This will allow the target assembly to be transferred to a temporary storage pod enabling a complete replacement target assembly to be installed and beam operation to continue. This procedure will require the beam to be switched off for 10-14 days. The water connections, stepper motor and vacuum bellows at the top of the target shield plug can be connected/disconnected by hand. The detailed design should pay close attention to the details of replacement of vacuum seals.

The transfer cask will also be used to transport the target assembly to the hot cell (which can be done with proton beam on). The hot cell will be used to remove the target rod and cut it up for disposal. A new target rod can then be fitted into the shield plug.

A similar procedure is envisaged to replace the beam profile monitor or a pillow seal if necessary. A larger transfer cask is available to replace the scraper assembly.

It is recommended that a dedicated transfer flask be used for the activated target transport in order to minimise scheduling conflicts with the neutron target operation. Collaboration with the neutron group is being actively pursued with a view to using a common hot cell for handling both the muon and neutron targets and associated components.

The storage pod should have the facility to be evacuated while a rotating target assembly is installed in order to protect the bearings from humidity and oxidation. It should also be possible to operate the rotation mechanism of spare targets periodically while in storage.

Access to the maintenance area at the top of the target assembly currently requires removal of the ceiling shields to a temporary storage space, a procedure which takes 2 days. It is recommended that an interlocked labyrinth + door be incorporated into the beamline shielding to permit easier access for personnel to investigate minor leaks etc.

The target handling concepts all appear to be well thought out and the committee is satisfied that there is sufficient provision to develop these further as resources become available.

Recommendations:

The committee recommends to develop a transfer flask dedicated to the muon facility.

A storage vessel for spare targets should be designed to permit storage under vacuum and regular operation of the target rotation systems.

The committee recommends that a quick access be provided to the maintenance level above the primary beamline for quick evaluation of faults or failures.

2-3) Secondary Beamlines :

Dr. Shimomura presented a description of the secondary beamlines. There will be four secondary channels imaging the M target. One channel will be a conventional decay/surface muon channel using the existing KEK superconducting solenoid. The second channel will be a surface muon channel using magnets that exist at KEK-MSL. The third channel will be a high intensity muon channel using new concepts for large solid angle acceptance. The fourth channel will be a high momentum muon channel. Work on the design of the conventional and surface muon channels is well advanced and much of the hardware is available for installation before start-up. The design of the high intensity and high momentum channels is not as far along due to funding constraints. These two beamlines will be installed some years after beam start-up.

The transfer of existing equipment, both beam and experimental hardware, from KEK to JPARC is useful way to jump-start the experimental program.

The committee was concerned that the thick copper support ring of the fixed graphite target would compromise the view of the target from the secondary beamlines or generate undesirable contamination in the muon beam. We were shown that this had been checked and there were no problems.

The beam heating of the superconducting solenoid was questioned. This radiation heating in the proposed JPARC location should be very similar to that in its present KEK location and therefore should not be a problem.

The two large solid angle beamlines leave big holes in the shielding aimed at the experimental areas. We were assured that the radiation fields had been calculated and were OK.

The delayed installation of two secondary channels is required due to the current funding profile. JPARC/MLF may wish to give the some priority to installing the front-ends before the target area becomes too radioactive.

3) Mechanical considerations:

Target Chamber Assembly:

Mr. Makimura presented the design of the target chamber. The design of the target chamber has been modified so that it can accept either the fixed target or the rotating target. The target chamber contains the target rod, and two scrapers. The target rod supports the target and a profile monitor. It is mounted on a linear bearing. The rod may be lifted into three positions: target in, profile monitor in, and empty. In the empty position the proton beam travels unimpeded to the neutron target.

Recommendations:

The maintenance procedures for the radioactive parts and the skills needed should be identified, and step-by-step procedures written. The designers and operators of the J-PARC/MLF hot cells should then review these procedures. These reviews will likely identify improvements needed in the designs. It may be necessary to make and test mock-ups.

Pillow Seal:

Dr. Ueno presented the design of the pillow seal. The pillow seal is a radiation hard, remotely handleable, sealing system first developed at PSI. KEK has adapted the Swiss design to match the J-PARC requirements: longer stroke, better vacuum, and different diameters. A partial prototype has been manufactured and successfully tested. The full system including the shield plug and guides should be tested. These tests should include insertion using a crane, sealing, leak testing, and removal. Perhaps the tests could include tilted guides, miss-aligned flanges, different surface finishes and damaged flanges. Repeated tests would be useful. Operation with and without the pantograph could be tested.

Based on experience at PSI, the pillow seal is a good design choice.

Recommendation:

Develop a comprehensive testing program for this critical component of the beamline.

Maintenance:

The high radiation fields and radioactive parts will make maintenance difficult, slow, and costly. The detail design of the systems should be reviewed by the people and groups involved in their maintenance. The design of the systems could then be improved. A review of the designs could be made to identify short lifetime and fragile parts. A list of spare parts needed should be generated; the parts purchased and stored.

As components are designed, the design documents (reports, calculations, and drawings) should be retained by J-PARC/MLF and stored in a central place.

Recommendation:

Establish a comprehensive documentation system for all components and parts. A sparing philosophy and a maintenance scheme for highly radioactive componentst should be established.

4) Conclusions and Recommendations:

The muon facility project has come a long way towards realization and crucial decisions are about to be made on key components. The committee had a good opportunity to evaluate the situation and formulate recommendations to try and help the builders with the decision process. In this section, a summary of the recommendations is presented.

The recommendations fall under five global categories:

- Validation of simulation models used for determining radiation levels, residual activation in components and heat transfer. For those aspects the committee would like to recommend that a careful quantitative comparison be made with similar situations in other laboratories and that confirmation of appropriateness of the input data for a 3 Gev proton beam energy be obtained.

- Realistic Irradiation tests to determine components reliability (target heat transfer join, pillow seals, beam monitors,..) Cooling system improvements and redundancy for target assembly, target chamber and collimators.

- Realistic models for beam tuning and beamline failure diagnostics should be considered in the implementation design of the beamline.

- Realistic assembly and disassembly procedures for target changes, magnet ,beam monitor exchanges, and remote handling of components with the view of establishing a quality assurance program which would oversee the documentation, the specification of installed components including as- built drawings, the stocking of critical spare parts and the estimated dose requirements of foreseen interventions in the beamline. These evaluations should influence the final designs of components.

Within the tight budgetary constraints, the committee found that the team is building a sound facility while minimizing the risks of future downtime in operation.

Appendice A:

Committee's mandate:

The committee's charge is to evaluate the overall beam transport and muon production target under the responsibility of the Muon Facility group. Particular attention will be paid to those elements for which critical decision must be made within a few months. Of crucial importance is the decision of possible high intensity targets. The committee will assess the appropriateness of the R/D effort in this area and recommend a strategy to minimize the risk of muon target failures. The committee will comment of the design of all key components with a focus on requirements for maintenance and reliability.

Appendix B

Committee membership:

Dr. Jean-Michel Poutissou (TRIUMF) Chairman

Dr. Gerd Heidenreich (PSI)

Dr. Chris Densham (ISIS)

Mr. George Clark (TRIUMF)

Dr. Nickolas Simos (BNL)

Dr. K.Ueno (KEK)

Dr. K.Tanaka (KEK)

Dr. T Matsuzaki (RIKEN)

Dr. Y.Miyake (KEK) secretary

Appendix C

Agenda for the first M-TAC meeting:

Date	13-Dec				14-Dec			
Time	Title	Presenter		Time	Title	Presenter		Time
8:30-9:00	*Closed session*	Committee member + Secretary		8:30-9:00	*Closed session*	Committee member + Secretary		8:30-9:00
9:00-9:10	**Welcome Address**	Koma Director	Makimura	9:00-9:30	Secondary Lines	Shimomura	Makimura	9:00-10:20
9:10-9:20	**Greeting**	Nishiyama						
9:20-9:30	**Opening remarks**	Poutissou		9:30-10:00	Development of Pillow Seal	Ueno/Sato		
9:30-10:05	**Status of J-PARC Project**	Nagamiya		10:00-10:30	and Guide			
10:05-10:40	**MLF project overview**	Ikeda			Magnets in M2 Tunnel	Kawamura		
10:40-10:50	Break			10:30-10:40	Break			10:20-10:30
10:50-11:30	Muon Facility Overview	Miyake	Strasser	10:40-11:10	Baseplates and Installation of Magnets etc	Strasser	Kawamura	10:30-11:30
11:30-12:00	Proton Beam Transport	Meigo		11:10-12:00	Remote handling of components in the vicinity of muon target	Makimura		**11:30-12:00**
12:00-13:00	Lunch			12:00-13:00	Lunch			12:00-13:00
13:00-13:30	*Closed session*	Committee member + Secretary		13:00-13:30	*Closed session*	Committee member + Secretary		13::00
13:30-14:30	Radiation Calculation	Kawamura	Strasser	13:30-15:30	***Target Issues for Technical Des***		Strasser	14:30-15:30
14:30-15:30	Edge cooled Graphite Target	Makimura						
15:30-16:00	Break			15:30-16:00	Break			
16:00-16:40	Rotating Graphite target	Beveridge	Shiomomura	15:40-17:40	***All Issues for Technical Design***		Shiomomura	
16:40-17:20	Chamber design including water, interlocks and scrapers	Makimura						
17:20-17:50	Profile Monitor Chamber	Strasser						
18:00				18:00	Get Together			