n_TOF External Panel Review

14-15 June 2007

1 Participants

1.1 External Experts

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2 Program

2.1 Thursday 14 June 2007

http://indico.cern.ch/conferenceDisplay.py?confId=17459

14:00 → 18:20		*n_TOF External Panel Review*		
Session 1		**Introduction to n_TOF, Present Status**		
14:00	3.1	Welcome	10'	*Jos Engelen*
14:10		Introduction to the Review	10'	*Steve Myers*
14:20	3.2	Introduction to n_TOF physics: Original choice of the target and facility design	20'	*Vasilis Vlachoudis*
14:40		Visit of the n_TOF Facility (for the external reviewers	1h40'	
16:20		*Coffee break*	15'	
16:35	3.3	The n_TOF Facility today: Technical issues; Minor actinide targets, Operation resources	30'	*Paolo Cennini*
17:05	3.4	Radiation Protection Issues and Radioactive Waste Disposal	30'	*Thomas Otto*
17:35	3.5	Future Physics and Detectors at n_TOF	30'	*Alberto Mengoni*
18:05		*End of Meeting*		

2.2 Friday 15 June 2007

08:45 → 15:00		*n_TOF External Panel Review*		
Session 2		**Studies and Options**		
08:45	4.1	Target Engineering Design: Studies and Options (including W Target Study)	50'	*Yacine Kadi*
09:35	4.2	Dose Rates, Radio Isotope Inventories and Air Activation	40'	*Markus Brugger*
10:15		*Coffee break*	15'	
10:30	4.3	Technical Design Resources	15'	*Pierre Bourquin*
10:45	4.4	New Crane	15'	Ingo Ruehl
11:00	4.5	Cooling System and Ventilation	30'	Joaquin Inigo-Golfin
11:15	4.6	Corrosion Modeling	20'	*Enrique Gonzalez*
11:35	4.7	General Discussion	10'	*-all-*
11:45	4.8	Conclusion	15'	*Steve Myers*
12:00		*LUNCH*	2h00'	
14:00	5	CLOSED SESSION With External Experts	20'	P. Cennini, J. Lettry, S. Myers V. Vlachoudis

3 Session 1 *Thursday 14 June 2007*

Introduction to n_TOF, Present Status

3.1 Welcome *Jos Engelen*

[3.1.1] Jos Engelen welcomed the panel of external experts and the participants. He stressed the importance of the n_TOF facility and he pointed out that the outcome of this review would be to define the resources needed for bringing up the facility up to operation respecting the safety requirements. This is important in order to pursue the experimental program which is already approved by the ISOLDE and n_TOF scientific committee (INTC).

3.2 Introduction to n_TOF physics: Original choice of the target and facility design *Vasilis Vlachoudis*

[3.2.1] No questions

3.3 The n_TOF Facility today: Technical issues; Minor actinide targets, Operation resources *Paolo Cennini*

[3.3.1] MERIT interference to n_TOF Beam time is estimated to be: 1-2 weeks 100 pulses during operation. The PS beam must be stopped during the work needed to remove MERIT and to reinstall the n_TOF proton beam line

[3.3.2] Paolo mentioned that the cooling pipes close to the target are made with Aluminum, and Stainless steel elsewhere.

[3.3.3] The cooling water was never replaced nor added. There was no indication up to now of a possible leak, as can be seen from the level indicator as well with the no presence in the water retention tanks.

[3.3.4] The temperature hotspot in the spallation target is located at 5-7cm depth from the point of impact of the proton beam.

[3.3.5] The safety file includes the risk analysis for the target handling but could include for every other part. During the investigation of the pool, the Al window will also have to be inspected

[3.3.6] The existing thermocouples in the lead target used during the commissioning are no longer functional. It is very difficult to re-install and connect new thermocouples on the new target.

[3.3.7] A question was raised on the ratio of Anions/Cations in the resine filter? For the moment this information does not exist.

[3.3.8] The collaboration was asking, if in the case that the results of the analysis are "positive" should we repeat the design of the existing spallation target that proved to work for 4 years until the moment we flushed the cooling circuit with air? J.Lettry pointed that we have a contamination case on the cooling water with the present target, therefore repeating the design the same contamination cannot be excluded.

3.4 Radiation Protection Issues and Radioactive Waste Disposal

Thomas Otto

[3.4.1] RP is concerned if the LE (exemption limit) of the cooling water due to the contamination with long lived spallation products becomes higher than 100LE. On a possible leak of the cooling system this contamination will be released to the environment which is against the rules. The heat exchanger and the target water container are protected against possible water leaks leaving only the cooling pipes as a possible weak point.

[3.4.2] Enrique Gonzalez pointed that is important to understand the mechanism of the "problem" of the contamination. A possible lead oxide layer will have 100-1000 times higher solubility (~10^{-4} moles/l) than plain lead (~10^{-6} – 10^{-7} moles/l) strongly enhancing the release of spallation products. These conditions could be cleaned in order to avoid repetition of the problem. Thomas Otto stated that CERN can not accept having contaminated water with activity higher than 100 LE in the pool again.

[3.4.3] It was suggested to make a chemical analysis on the water samples. PSI could be a possible laboratory to perform the analysis.

[3.4.4] Daniel Cano Ott stated that sealed sources could be built for both capture and fission, which could cover a many years of experimental program.

[3.4.5] In the case of a target reduced in size, it will result in higher activity (no self shielding) therefore an extra container should be used. Paolo Cennini mentions that for the target disposal the contact of Al and concrete is forbidden, while over packaging is allowed. Another solution could be to remove the cladding before the final disposal. The elimination of the filter should be added also in the disposal cost. One possible scenario for the new target is to use one filter over a long period of time.

[3.4.6] J.Lettry mentioned that the goal is to dispose the present target and construct a new target that will be used for the life span of the n_TOF Phase 2 experiment.

[3.4.7] Paolo Cennini mentioned that the option of using heavy water both as neutron moderator and cooling is abandoned. What still remains, is the idea to have a small vessel in front of the spallation target to be used as a moderator.

3.5 Future Physics and Detectors at n_TOF ***Alberto Mengoni***

[3.5.1] The collaboration has tight commitments to their funding agencies as well the European programs. According to the EUROTRANS program the ^{243}Am should be measured by the end of 2008

[3.5.2] Paul Wright was asking if the RP stopped the facility with view to restart or to stop completely? Alberto Mengoni pointed out that the facility was not stopped during the measurements, the experimental campaign finished normally with the PS shutdown, and after that the RP didn't give anymore the green light for restart

[3.5.3] Enrique Gonzales stressed again the importance of investigation of the target it self and understanding the origin of the problem. He mentioned that specialized radio-chemist on such issues, claimed that the scenario was predictable, and even with minimal information he was able to predict the scenario. This discussion was stopped because Thomas Otto was absent.

[3.5.4] An alternative scenario would require a “similar” target like the present one, using a commissioning filter for the startup and shutdown and one filter for the normal operation.

4 Session 2 ***Friday 15 June 2007***

Studies and Options

4.1 Target Engineering Design: Studies and Options (including W Target Study) ***Yacine Kadi***

[4.1.1] The water flux is horizontal driven by 4 pipes for entry and 2 for exit.

[4.1.2] For the calculation the gap between lead and cladding was assumed to be vacuum (as a worst case) applying zero pressure to the cladding

[4.1.3] The strong stresses in the core of lead will result in a failure of the lead target or on the aluminum cladding. Presently we have no means to make a fatigue analysis of many pulses to fully understand the problem. Enrique requested for a clearer clarification on the word “failure”, since eventual generation of cracks does not affect at all the neutron fluence and/or the physics program, while it could have an influence on the container.

[4.1.4] The visual inspection program will include also endoscopy and extract samples for further analysis. There is a need to develop a program.

[4.1.5] For the moment radiation damage from gas production is not a concern for the engineering calculations. Over long period possible swelling from Helium gas production will increase the stresses. In the mini-pool the production of hydrogen gas bubbles is not checked. As well the water chemistry is not checked.

[4.1.6] Question was raised on where another liquid could be used in the place of water.

[4.1.7] Daniel Cano Ott stated that the present lead target with water cooling, in comparison with the presented solutions seems to be the best solution, apart from the problem that appeared in the last year of operation. Yacine pointed out that indeed from the physics point of view the present target has the best properties, and is important to understand the problem of the contamination of the cooling circuit.

4.2 Dose Rates, Radio Isotope Inventories and Air Activation ***Markus Brugger***

No questions

4.3 Technical Design Resources ***Pierre Bourquin***

No questions

4.4 New Crane *Ingo Ruehl*

[4.4.1] Ingo is asking for 4 weeks to add extra shielding on the exit of the shaft for additional protection in case the hoist breaks and we have half target in the shaft and half out.

[4.4.2] Trial lift could was performed when the shielding was removed. The present crane has no redundant system. Also the new design whether it will be for 2 tons or 4t changes a lot the requirements

4.5 Cooling System and Ventilation *Joaquin Inigo-Golfin*

[4.5.1] It was mentioned that countries have ISO standards for non-reactor nuclear facilities, which it would be useful to refer to that. The recirculation is needed (instead of driving directly to the extraction point) in order to reduce the dose before release.

[4.5.2] Using acid to decontaminate the cooling circuit is a very bad idea, it would be more preferable to leave the contamination, but this would depend on the type of the contamination.

[4.5.3] In case we wanted to change the cooling circuit to accept more than 100LE, will have to change the tunnel to make it water tight. For the moment Thomas Otto does not have available the specifications. Thomas stated that for good ventilation a certain under pressure should be imposed and have a controlled air flow.

[4.5.4] Is important to know from where the air comes from, in order to avoid possible corrosion the humidity must be controlled, and air-conditioning is needed. Paul Wright thinks that the issue of corrosion due to humidity in the tunnel, maybe is inflated a bit.

4.6 Corrosion Modeling [Enrique Gonzalez]

[4.6.1] Enrique presented the analysis of the radio-chemist on the possible effect of the lead oxide layer on the solubility of the lead in water. Radiolytical effects are not included in this calculation. The solubility has a dependence on the pH of the cooling water. Therefore the water chemistry has to be very well controlled, protocols can be defined.

Steve Myers pointed that it if this hypothesis is correct the solution is very simple to clean the cooling circuit and reuse the old or an equivalent target. Thomas Otto objection is that there we are depending on a very delicate chemistry balance. Probably could be done but CERN has not the competences. Enrique stated that the cooling water was contaminated from day one but to an acceptable level with no chemistry control, and he doesn't propose to change the chemistry but to define a protocol to control it. Visual inspection is the most crucial element to exclude other hypothesis.

4.7 General Discussion *-all-*

4.8 Conclusion ***Steve Myers***

Steve Myers summarized that for him the situation was more complicated before, than what he heard this morning. The most important tasks should be:

- Proper understanding on the mechanism that generated the contamination of the cooling water.
- Inspection of the present target is important to understand the mechanism and check for possible structural damage. This will define what is the impact on safety.
- Crane has progress, and we have to lift the existing target out.
- During the initial construction some safety requirements were waived, but in the new design we have to comply with the safety rules.
- Experimental area needs an upgrade for contamination control. Each target has to have less than 1LA
- There is a men power constraint for the RP side which has to be discussed.
- We will need radio-chemical understanding of the problem

5 CLOSED SESSION

With External Experts

Present: P. Cennini, J .Lettry, V. Vlachoudis, T. Otto, M. Brugger

5.1 Justification

Scientific case is clear and restart of the facility is justified. In any event, further action is required for the cooling plant.

5.2 Optimization

The CERN staff involved have shown considerable effort to develop options and address the problems of: ventilation, containment and radiation hazards

The panel considers that:

[5.2.1] The ventilation needs to be improved, although the concepts presented may not be optimal and further refinement is needed, especially to control dust (which is overlooked) in the tunnel and possibly the humidity. Control for possible corrosion should be performed in order to understand if humidity is really an issue. Running a de-humidifier could result in more effort. Dust is quite important, is the vehicle to ingest the radiation, especially concrete dust. Containment could reduce the dust considerably. The panel was concerned why access is needed during or immediately after operation. In principle the primary area is a zone you don't want access often.

Containment of liquids needs to be improved by having at least 2 levels of containment at all stages of the facility where such liquids exist. Flanges of piping are the most vulnerable parts. This can be done for example by sealing all concrete surfaces, plastic sleeves over pipes and flanges, fully enclosure of the cooling plant, drain tank for the target. . A check manual should be provided for a regular inspection. Everything should be labeled-up with arrows, names and documented.

[5.2.2] Water quality such as pH, conductivity, temperature, flow, pressure, levels of contamination needs greater degree of monitoring or sampled i.e. Add interlock if conductivity goes too high or pH goes too low. The PMI close to the filter should provide enough information and could indicate the safety level when to stop the beam, and intervention should occur.

Flow meters could provide a real indication of problems. When you lose flow it will trigger a lot of action. It could pick up small leaks quite quickly.

[5.2.3] Redundant ion exchange columns are needed with some shielding and heat exchanger: At least two ion exchange columns are needed. In case of incident we could switch to the next column. The existing ion exchanger is too expensive; a cheaper option should be looked.

[5.2.4] Flanges and heat exchanger should all be metal or graphite, especially when drying the system the organic sealing's they shrink.

[5.2.5] Handling of open actinide samples should be discontinued.

[5.2.6] Options for target design have not been fully determined, more analysis is required for both "new" and "old" target options. A comprehensive examination of the existing target should be made. Alternatives to the current target could not be ruled out of having the same or additional problems. Investigating on how to work with the present target, could be a viable solution. Water chemistry and corrosion issues should be addressed by an expert, and then we can continue to work with the present design.

The new target designs increase complexity and chances of having more problems. It is easier to have a simple design that we fully master than a complicated design that might generate more unknown problems. We have to define a clear set of criteria to investigate the present target. We should be able to predict and to prove or disprove the concepts.

5.3 Limitations

n_TOF should comply with all CERN safety requirements

5.4 Mitigation

[5.4.1] A design basis accident (worst case of accident) should be made to facilitate the design so that safety is applicable under reasonably foreseen conditions. This should include a failure mode assessment and contingency plans. An operational safety document should be created, which should be the reference point for any changes to the plan safety and to the modifications. We should have a contingency plan for the accident, in order to limit the effects of such an event.

[5.4.2] As critical handling will be done with the old crane with all precautions, why to make a huge investment (after the operation) for a new crane.

The safety operation should not ask for a heavy investment for one time operation.

[5.4.3] Verify if we could reuse the existing activated target or construct a new lead target. Reusing the present one will avoid the problem of disposal and total mass to be disposed in the end. Carrotage samples of the present lead target could be important to understand the present status of the oxidation and determiner where is possible to reuse or create a new one. A new target could foresee positions for inserting samples, to avoid drilling for any future measurement. As well as new safety instrumentation could be foreseen for the new target for scientific measurements. Clearly define a set of levels on what is acceptable as contamination in the target.

[5.4.4] Check if we comply with the access control IC61508?

[5.4.5] The panel can not judge on the resources but only give directions and recommendations.