Workshop summary on computational techniques and shielding

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The target station workshop session on Thursday afternoon was in two parts: the first part was entitled "Computational Techniques and Shielding" and the second, which was chaired by Tim Broome, "Practical Concerns". As things turned out, a strict distinction between the two parts was not maintained and I am going to report about the first part which, by the end of the allotted time, had made the transition to practical concerns. Although the full text of the contributions should be included elsewhere in these proceedings, the summaries, as made at the Friday morning session, have been retained in this written version.

Before getting to the actual work discussed, I would like to make a couple of comments about the role of the calculator in source design. Calculations contributed in different ways at four principal stages of the project:

1. To sell a project to your management.
2. To allow the management to sell the project for funding.

I will skip over these.

3. To allow detailed design:

At this stage, the detailed calculations start. By their very nature these are principally theoretical, although they can be backed-up with results from other (running) facilities or an experimental program. There would seem to be three main goals:

3a. To produce the best system possible. This is principally neutronic optimization but carries with it the study of the other major concerns: heating, damage, activation, and radiation safety.

3b. To give/justify particular dimensions in the system. This is where the actual work lies: design engineers want exact numbers; normally the best we can do (not necessarily being engineers) is to say things like "make it as small as possible", or "as thin as possible."

3c. To restrain the design engineers. This is rather obvious and mainly involves neutronic considerations, e.g., trying to divert the engineers from neutronically bad materials.

4. <u>To improve an existing system.</u>

Stage 4 calculations are rather different. Normally you have an operational source and real problems to solve (i.e., something has been measured that is unsatisfactory and must be fixed). The huge advantage is that the calculations can be backed up with measurements (compared to those at stage 3, where the measurements will be made after the calculations).

We started the session with an unscheduled but welcome "one-foil" presentation (Fig. 1) from Bruce Brown, to record the successful completion of mounting the IPNS Booster-target. This needs no summary!

The first presentation *"Design for a New PSR and LAMPF"* was given by Eugene Colton and described the motivation and design for a second generation proton storage ring at LAMPF.

The motivation comes from what he called the "Bauer" report and is to use the full potential of an upgraded LAMPF for production of spallation neutrons and neutrinos. The basis of the design is a pair of compressor rings for 1.6-GeV protons with an average current of 1.2 mA and a repetition frequency of 48 Hz. This will require that the present linac be upgraded by the addition of another 800 MeV of acceleration and the current from the ion-source be increased by a factor of two. The neutron and neutrino facilities are to have separate target stations, and each will receive alternate pulses (i.e., each facility will operate at 24 Hz). The aim is to provide pulses of length < 2 μs each containing 1.5×10^{14} protons. A major design goal is to keep losses very low (< 100 nA) so that "hands-on" maintenance can be done. In operation, the two rings are to be filled with 7.5×10^{13} protons, which are fast-extracted in a single turn to either one of the transfer lines. The two pulses are sent in box-car fashion to the source target(s) to give a 1.7-μs-long pulse consisting of two 750-ns lumps of protons separated by 200 ns. The machine looks feasible on the basis that 4×10^{13} protons per pulse have been stored in the PSR and other basic ideas put forward in the design have been tested. There do remain many open questions and specific details; in particular, to achieve the low beam-losses required.

The second presentation *"Some Neutronic Calculations for KENS-II"* was by Masatoshi Arai and concerned the neutronic optimization of KENS-II. This work is typical of stage 3 calculations (see above) and also typifies the lot of the calculator, namely the huge amount of effort that has to be put in to settle comparatively few parameters. He presented the results of a calculational "tour-de-force" to allow selection of target material and dimensions and positions for the moderators: these calculations were based on use of moderated neutron intensity (i.e., usable flux) as figure-of-merit. He also studied the effect of different beam energies when the total beam power (product of beam energy and current) is kept constant. Summarizing, his results show that the increased incident energy (0.8 to 2 GeV) does give increased moderator flux, but when the reduced current (for equal power) is taken into account, the best flux is obtained with 0.8 GeV, i.e., beam current dominates.

The last four presentations:

"Neutron Beam-Line Shield Calculations"
"LANSCE Neutron Beam-Line FP-1 and FP-5 Shield Designs"
"Bulk Shield/Neutron Instrument Shield Interface"
"LANSCE Neutron Beam-Line Dose Measurements"

were taken together and led by Gary Russell: these gave a good mixture of presentation and discussion. The main theme was how to shield the instrument-flight-path section outside the bulk shield at LANSCE (a good example of a stage 4 calculation). There are two simultaneous considerations: (i) external dose rate plus background at other instruments; and (ii) reflection back from the shielding to the flight path causing background problems at the instrument whose flight-path is being shielded. Gary presented the results of a wide survey for the performance of various laminated shields. Many of the results of the calculations have been confirmed by measurements.

We talked about the bulk-shield/instrument-flight-path interface. We came to the conclusion that this needs a lot of care, in particular the design of the outer layer of the bulk-shield should include recesses to allow stepping-in to join with the flight-path shield so that streaming paths are eliminated.

Noburu Watanabe pointed out the rather large size difference between beam-catchers at ISIS, IPNS, and LANSCE. I don't think we actually resolved the issue. One point that came out of the discussion was that the sizes are not necessarily only based on neutronic considerations. When you, for instance, have iron blacks in stock with rather larger dimensions than you really need, you use them (they are in some sense "free"): hence, part of the answer of the size-difference question comes from practical concerns.

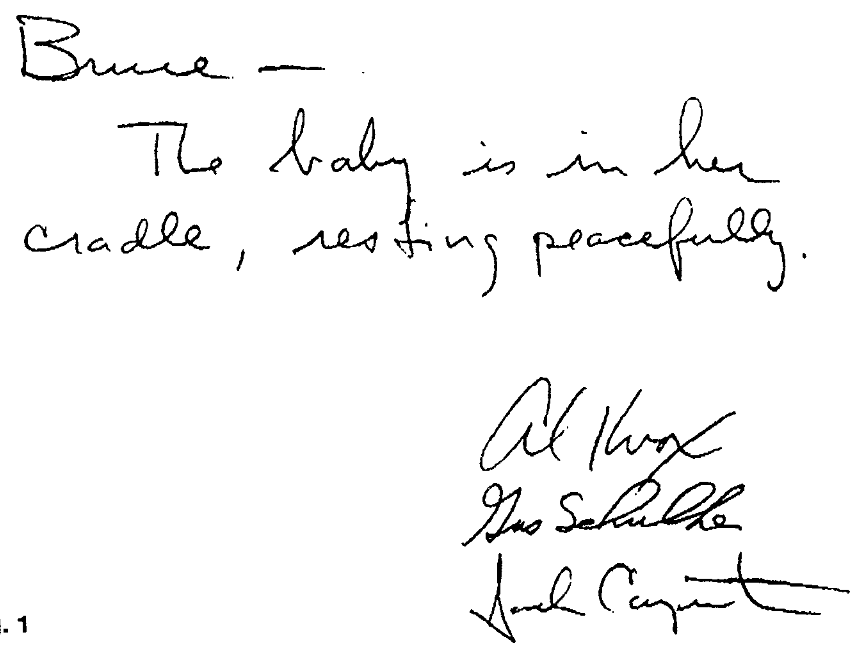

Fig. 1