

Conceptual Design Review of CE-78

On February 4, 2000 a conceptual design for IUCF Cooler experiment CE-78 was reviewed by a committee consisting of Gary East (IUCF), Roy Holt (University of Illinois), Dave Hutcheon (TRIUMF, chair), Will Jacobs (IUCF), Bob Pollock (Indiana University) and Barbara von Przewoski (IUCF). The committee heard 10 presentations by collaboration members, followed by an open discussion session.

The reaction $dd \rightarrow \alpha\pi^0$ is forbidden by Charge Symmetry and its observation would be a direct and striking demonstration of Charge Symmetry Breaking (CSB). Models of CSB have yielded estimates for the total $dd \rightarrow \alpha\pi^0$ cross section at 231.4 MeV from 2 pb to several 100's of pb. An unavoidable background reaction is $dd \rightarrow \alpha\gamma\gamma$, which a recent publication estimates to be 3.6 pb/MeV/c² at 236 MeV. A characteristic of the $dd \rightarrow \alpha\pi^0$ reaction at threshold is that its analyzing power T_{20} is constrained to its maximum positive value, $1/\sqrt{2}$.

The conceptual design proposed creation of a 6m-long magnetic channel for detection of the α 's and two walls containing more than 200 lead-glass scintillators to detect both γ 's from decay of the π^0 . A polarized beam would provide data on T_{20} in addition to the cross section. The timetable called for design, installation, commissioning, and up to 60 days of production running before the end of the nuclear physics program on the Cooler in October 2002.

This committee concurs with the PAC's view that $dd \rightarrow \alpha\pi^0$ is an important experiment, and supports the proposal to measure tensor analyzing power as a confirmation that the reaction was observed. The goal of the experiment should be a sensitivity for $dd \rightarrow \alpha\pi^0$ at the 1-pb level, in the presence of a possible $dd \rightarrow \alpha\gamma\gamma$ background of several pb/MeV/c².

Considering the magnitude of the task and the tight timeframe, the committee concludes that the collaboration is seriously understaffed and needs the addition of key people, especially a technical coordinator and collaborators with previous experience on the Cooler. This is a serious threat to the success of the experiment and a plan to address it must be put in place within the next 4 months, by the time of a June 2000 PAC meeting.

An immediate need is to develop, in cooperation with IUCF management, a detailed list of tasks and to identify people to carry them out, so that manpower conflicts with other projects are known. This, together with a budget and a timetable with key milestones, should be submitted to the laboratory management before March 1, 2000.

The committee strongly urges that the following be completed within the next 4 months as a minimum step towards meeting the very tight timelines for CE-78:

- septum magnet out to bid
- test of rates from an accelerated d beam on a d gas jet in a plastic scintillator stack and 12 lead-glass scintillators
- analysis of test runs and an estimate of the α PID efficiency of the plastic scintillators
- design of the target box

Extensive technical support by the Laboratory will be essential. Tests with a deuteron

beam in the Cooler should be scheduled for Spring 2000, and a polarized deuteron beam of intensity $> 10^{10}$ after acceleration must be developed by the time CE-78 production runs begin. Space will be required for assembly and testing of detector arrays.

The committee has the following observations on technical aspects of the Conceptual Design:

- detection of both γ rays in coincidence with the α should be an effective, and possibly necessary, way to suppress backgrounds other than $dd \rightarrow \alpha\gamma\gamma$.
- the projected counting rate of 0.7 events/day is the minimum that is viable for this experiment. Higher rates should be sought by optimizing the luminosity, decreasing the dead-time of the data acquisition system, and designing the detectors to have high-rate capabilities.
- the collaboration is to be commended for the good progress in design of the magnetic channel and the testing/simulation of the lead-glass blocks.
- a single commissioning run is unlikely to be enough for a measurement of this degree of difficulty. Every effort should be made to advance the date of the first commissioning run for the full system into the first half of 2001. Tests of the apparatus at yields between the design sensitivity (pb) and the $pd \rightarrow {}^3\text{He}\pi^0$ cross section (μb) should be planned.
- provision of a polarimeter to measure deuteron tensor polarization at 231 MeV will be a major task. The CE-78 group should work closely with other groups having similar needs, to avoid duplication of effort.
- the experience of groups which have already built and used monitors of luminosity and gas jet location should be sought
- the lack of a simulation program is preventing informed decision-making on MWPC wire spacing, scintillator thickness, and other design parameters. Realistic simulation is essential for understanding and improving the missing-mass resolution of the experiment.
- CE-78 will have a serious impact on tagger experiments after the year 2000. Estimated switch-over times of 8–10 weeks will severely constrain the scheduling options in the Cooler. Where feasible, apparatus should be designed to simplify switch-over.
- responsibilities must be assigned and plans developed for:
 - installation and commissioning of the α channel and detectors
 - installation and calibration of the arrays of lead-glass counters
 - installation and commissioning of the target chamber, gas target, and luminosity monitor
 - data acquisition, including selection of monitor event streams
 - data analysis