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TITLE: OPERATING EXPERIENCE AND CESIUM RECYCLING ON THE LASL POLARIZED TRITON SOURCE

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OPERATING EXPERIENCE AND CESIUM RECYCLING ON THE LASL POLARIZED TRITON SOURCE*

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At the time of the 4th Polarization Conference, the LASL polarized triton source had been in operation for only a few months. A contribution[1] to that conference described the overall operation of the source and the special handling techniques for the tritium gas. The source has accumulated over 3000 hours of operation in the last 5 years and has produced beams for over 40 experiments. Almost 12 liters of tritium (31,000 Ci) have been used.

Of particular interest to other Lamb-shift polarized source developers has been our experience with aspects of operation that are not unique to tritium handling. This paper will briefly discuss these systems, amplifying Ref. 1 to which the reader is referred for a complete source schematic and Ref. 2 which also discusses the calibration of the beam polarization.

A short version of the original[3] spin-filter was designed to minimize the overall length and increase the beam solid angle intercepted at the argon cell (see Fig. 1). The field is constant to within 0.2 Gauss over the 7.5 cm active region of the rf cavity. In addition to the main coil, which is only 20.3 cm long, there are end coils, trim coils and argon coil, all external to the vacuum system and powered by a single, highly stable 100V, 10A dc power supply. A control chassis, linked by fiber optics to pushbutton panels and computer CAMAC control, provides for field reversal, spin-state selection, and dc- and rf-field step functions useful for quench-ratio measurements. The rf field control is shown schematically in Fig. 2. Power into the cavity, provided by a 200 mw solid state oscillator, is controlled by a modulator which derives its control current from a rf power meter connected to a pickup loop. The whole rf system, except for the frequency counter which is needed only for initial setup, can be assembled for less than $2000. Fig. 3 shows the rf cavity and deflection plate assembly, mounted on a support structure that fits in the vacuum

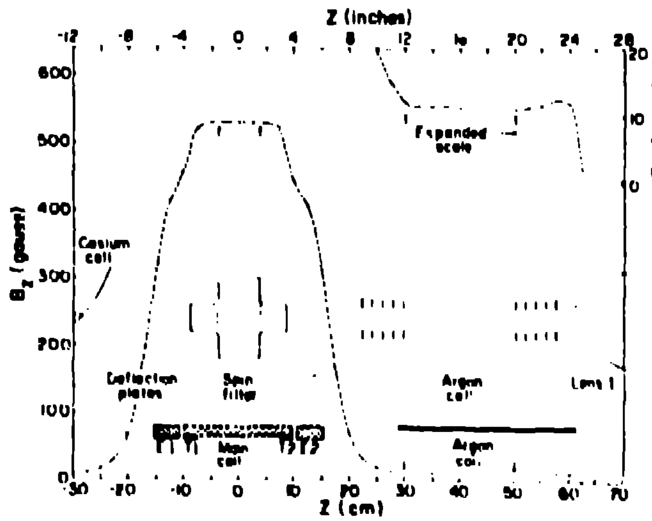

Fig. 1. Location of spin filter and magnetic fields in relation to other components.

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housing within the magnetic coils.

The only vacuum system operating in the spin filter and ionization region is the 20°K surface at either end of the argon canal. A 1 watt helium-cycle refrigerator is sufficient to cryo-pump 2.5 cc/min argon flow and maintain pressure at 2×10^{-5} Torr for operating periods of several weeks. Unfortunately, tritium gas escaping into this region from the ion source contributes a significant amount to this pressure and dilutes the charge exchange selectivity of the ionization process for the metastable state. This problem would be easily solved for a proton/deuteron source by adding a small auxiliary pump in this region. The net effect for polarized tritons is to reduce the polarization to 0.75 – 0.80, and we operate at only 800V atomic beam energy (instead of a calculated optimum of 1500V) in order to attain this performance, thus reducing source output to about 260 nA.

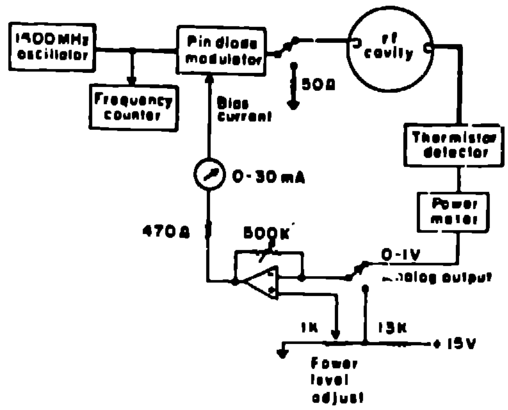

Fig. 2. Spin filter rf control circuit.

Perhaps the most interesting technology, judging from the number of inquiries received, is the cesium containment and recycling process. The original idea for our design came from M. Bacal and W. Reichelt[4], and the reader is referred to that paper for the theory of cesium recycling via capillary action in a wick. Our design differs from theirs not only in details of the supply reservoir and mounting (see Fig. 4), but also in the construction of the canal, shown in Fig. 5. We have found that the fabrication and cleaning procedure is critical to the successful operation of the cell. We start with type 304 ss mesh, 250 wires/ inch with 0.0016 inch wire diameter, a 3 ft stainless steel pipe of 0.625 inch O.D. x 0.035 inch wall thickness, and a 0.50 inch O.D. copper mandrel. The mesh is sonically cleaned in several solvents and then fired to 900°C in a vacuum furnace. After rolling about 6 layers of screen on the mandrel and inserting in the ss pipe, the assembly is swaged to 0.594 inch O.D.,

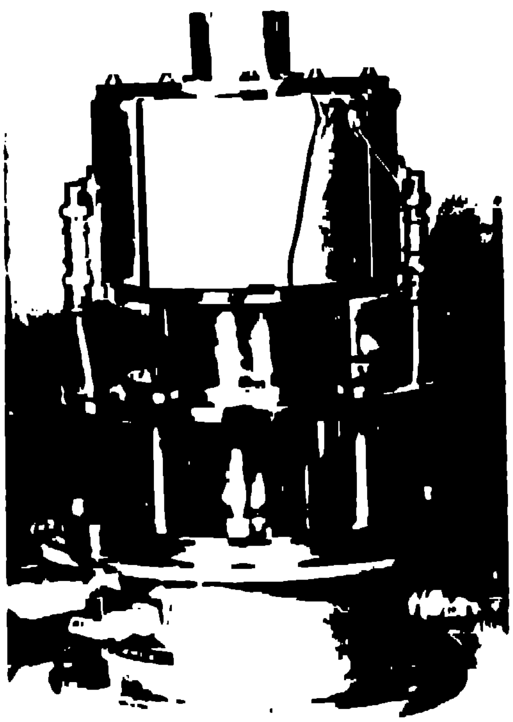

Fig. 3. Photograph of short spin filter and deflection plate assembly. The lower part is the vacuum housing which contains the rf and dc electrical feedthroughs.

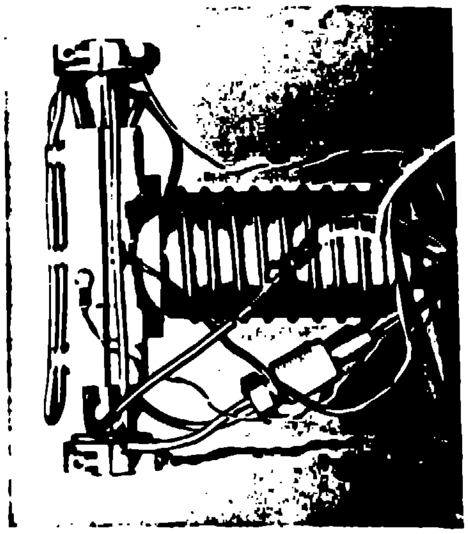

Fig. 4. Cesium reservoir and canal assembly.

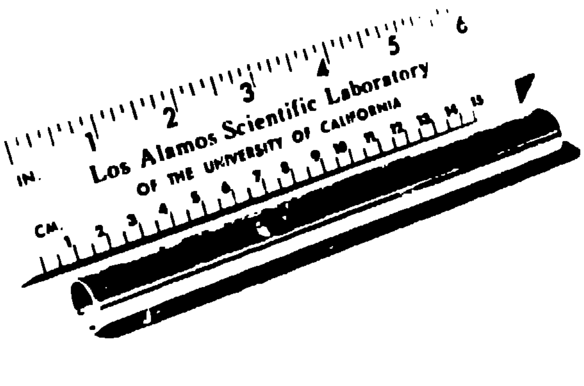

Fig. 5. Cesium canal with internal mesh for wicking cesium via capillary force. Canals are tightly clamped in the copper block on the reservoir, shown in the figure at left.

compressing the mesh against the inside of the tube. We then cut to 6 inch lengths, machine the ends, and drill the cesium entrance hole in the middle. After vacuum firing again at 900°C to set the mesh, the mandrel is etched out with a nitric acid solution and the pipes are again sonically cleaned in solvents. A final firing to 900°C in vacuum completes the process.

In our experience, the best way to put these cells into operation is to heat them to about 150°C after installation in the polarized source. The reservoir valve is then opened and the reservoir heated to somewhat above 150°C until cesium can be seen depositing on surfaces positioned near the ends of the canal. The ends are then cooled to 28°C and the central canal is reduced to operating temperature of about 80°C. In some cases we continue to feed the cell at a high rate for several hours to fully saturate the wick and then shut the reservoir valve completely. We have operated for as long as 4 months with no cesium addition after the initial saturation. At other times, we have lowered the reservoir temperature immediately and fed the canal at a low rate for many hours while the source is operating for experiments. Some cells have failed to wick properly, particularly after the source has been idle for several months, and continuous feed is necessary to maintain cesium density. Even in these cases, however, the cooled ends greatly reduce cesium escape from the canal, and the mesh appears to spread out the condensed cesium and prevent balling up and blockage.

1. R. A. Hardekopf, in Proc. 4th Int. Symp. on Polarization Phenomena in Nuclear Reactions, Zurich, 1975, ed. by W. Gruebler and V. König (Birkhauser, Basel, 1976) p. 865.
2. R. A. Hardekopf, G. G. Ohlsen, R. V. Poore, and Nelson Jarmie, Phys. Rev. C 13, 2127 (1976).
3. J. L. McKibben, G. P. Lawrence, and G. G. Ohlsen, Phys. Rev. Lett. 20, 1180 (1968).
4. M. Bacal and W. Reichelt, Rev. Sci. Instrum. 45, 769 (1974).