Title
CONCERNING THE ABSOLUTE CALIBRATION OF THE BERKELEY SYNCHROTRON BEAM

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CONCERNING THE ABSOLUTE CALIBRATION OF THE BERKELEY SYNCHROTRON BEAM

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April 15, 1953

This paper arose from information gained during a recent experiment (UCRL-2159) which measured an absolute meson cross section. The accuracy of the calibration of the beam monitor, needed for an absolute measurement, had begun to be in doubt, and investigation revealed some instructive information.

The monitoring method in common use at the present time consists of an ionization chamber in the synchrotron beam just after the beam leaves the electron orbit and before the beam is collimated. Charge from this ionization chamber collects on a condenser which is automatically discharged after reaching a given value. The number of discharges (called the number of "nunans" after one of the original designers) is used as a relative measure of amount of beam that goes through the chamber. The number and kind of photons that pass through an experimental set-up depends on the size collimator and the energy of electrons used to make the beam. The following discussion will assume a one inch collimator and a full energy beam (322 Mev electrons). This beam will also be assumed to be the "long beam", a beam of several thousand microseconds made by letting the rf oscillator die off slowly. This beam will have a slightly different energy spectrum than a beam with a slump rf cut-off due to the slight variation in the electron energies.

The nunan, the unit of the discharge of the beam monitor, has been calibrated by the method of Blocker, Kenney and Panofsky.[1] The first calibration used as the standard was made in 1950 by Blocker and Kenney (hereafter known as B. and K.) and was 14.7×10^{-8} equivalent quanta/nunan.

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1. Blocker, Kenney, and Panofsky, Phys. Rev. 79, 419 (1950).

The number of equivalent quanta (Q.) is defined as the total energy in the beam divided by the maximum energy of photon (in our case 322 Mev). Recent measurements by the crew, and by the author have been quite different from this old measurement used as a standard for most of the absolute experiments done on the synchrotron since that time. These results are shown in Fig. 1. This figure shows another effect than just a macroscopic change between the old and new calibrations. Evidently, the value of the calibration, which should be a constant for various beam strengths, varies roughly as the ratio of the background to the beam. The intensities of the beam and of the background are measured in arbitrary units by rate ionization chambers, one in the beam and one in the corner of the room.

The other measurements on Fig. 1 are victoreen thimble measurements (the thimble enclosed in 1/8 inch of lead) of the intensity in the center of the beam relative to the nunan, made by A. C. Helmholz. These also verify the jump in the value of the calibration from 1950 to the present. The ordinate for the victoreen measurements is arbitrary.

The variation in the calibration with the ratio of beam to background could reasonably be explained by the following: the chamber is quite close to the synchrotron. Extra background flooding into the chamber would give the nunan a faster rate for a given beam level and lower the value of the calibration, which does appear to be the case.

R. M. Littauer of Cornell University late in the summer of 1952 made a calibration measurement of the beam of the Berkeley Synchrotron with equipment used to calibrate the beam of the Cornell Synchrotron. The Cornell machine has been calibrated by using both an ionization chamber and pair spectrometer, and the two methods agree. Littauer found that the Cornell calibration was about 25 percent lower than that of the Berkeley Synchrotron using the old 1950 standard. Inspection of Fig. 1 will clearly show that the recent Berkeley calibrations are in much better agreement with Cornell.

The above discussion leads us to the following conclusions:

1. A new monitoring system should be developed. One method would be the use of a second "background" chamber sitting next to the regular chamber to automatically subtract off the effect of the background. Another would be to put the chamber behind the collimator. Possibly, completely different methods (pair spectrometer, etc.) could be developed. Work is now in progress on this probelm at the synchrotron.

2. The rf system at the synchrotron should be stabilized and standardized so that the shape of the beam pulse in time and energy and its affect on the calibration would be accurately known.

3. Some internal parameter in the monitoring system has probably changed since 1950. The values of the condensers have been checked and have not changed. Experiments done since 1950 measuring absolute values could well be re-examined to see in what way this change could have affected them.

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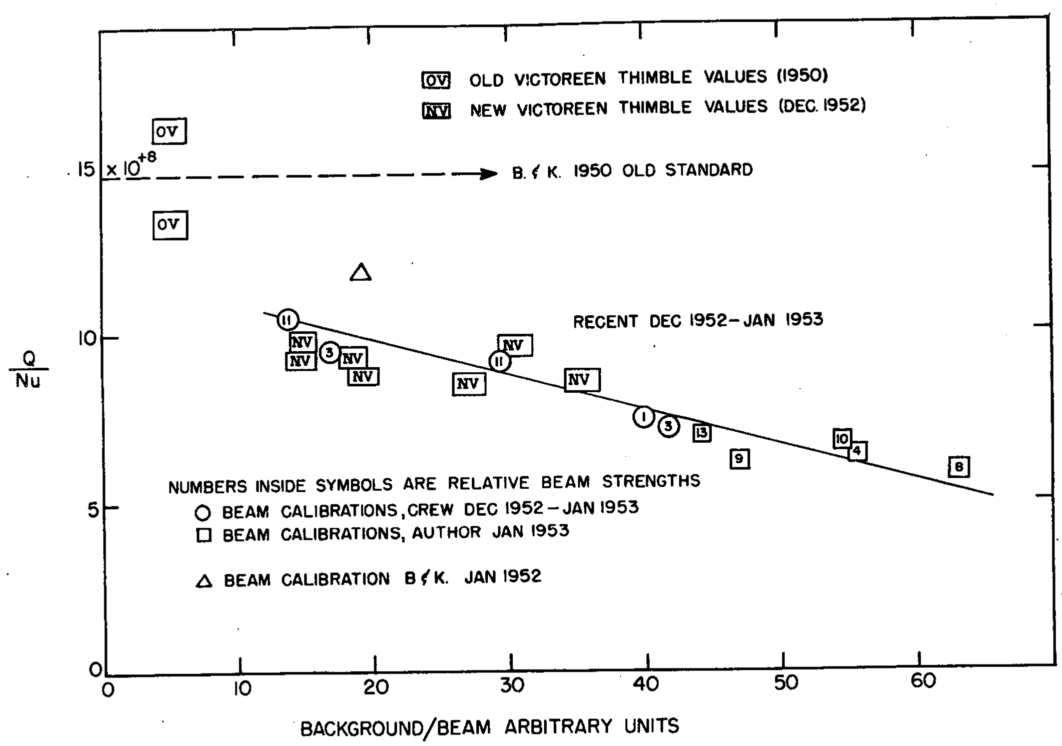

OV OLD VICTOREEN THIMBLE VALUES (1950)
NV NEW VICTOREEN THIMBLE VALUES (DEC. 1952)
15 x 10+8
B. & K. 1950 OLD STANDARD
RECENT DEC 1952–JAN 1953
Q/Nu
NUMBERS INSIDE SYMBOLS ARE RELATIVE BEAM STRENGTHS
○ BEAM CALIBRATIONS, CREW DEC 1952 – JAN 1953
□ BEAM CALIBRATIONS, AUTHOR JAN 1953
△ BEAM CALIBRATION B & K. JAN 1952
BACKGROUND/BEAM ARBITRARY UNITS

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