BNL-105746-2014-TECH

EP&S No. 30;BNL-105746-2014-IR

Operation and security requirements for the neutral beam port at 0¿ from target station A

T. E. Toohig

June 1969

Collider Accelerator Department

Brookhaven National Laboratory

U.S. Department of Energy

USDOE Office of Science (SC)

DISCLAIMER

Accelerator Department
BROOKHAVEN NATIONAL LABORATORY
Associated Universities, Inc.
Upton, L.I., N.Y.

EP & S DIVISION TECHNICAL NOTE

No. 30

June 17, 1969

OPERATION AND SECURITY REQUIREMENTS FOR THE NEUTRAL BEAM PORT AT 0^{o} FROM TARGET STATION A

T.E. Toohig

During the current shutdown a neutral beam port is to be provided at 0^{o} in the beam dump downstream of target station A of the SEB. Longo proposes that this be a 2-inch sleeve into which inserts would be placed to provide an aperture of about 1-inch. With the beam dump shield beefed up to provide thirty feet of steel along the beam direction, the distance from target station A to the 1-inch defining aperture at the downstream end of the shield wall is 144 feet (1728 inches). The solid angle subtended by the port is then

$$\Delta\Omega = 1/4^{\pi}/(1728)^2 \approx .08\ \mu\text{ster}.$$

If we look at Longo's earlier data (Phys. Rev. Letters 20, 468 (1968)) and assume that with 10^6 neutrons/pulse in his beam as advertised there then the 1-inch port may be an overestimate. In the previous experiment the solid angle, at 1^{o} to the incident beam direction was

$$\Delta\Omega = 1/4^{\pi}/(1380)^2 \approx .13\ \mu\text{ster}.$$

5×10^{10} protons/pulse on a Be target yielded the quoted 10^6 neutrons/pulse in the beam.

Assuming that the neutron production spectrum in the target is similar to the inelastic proton spectrum and using the CKP curves for estimating, the neutron flux at 0^{o} should be comparable to that at 1^{o}. With $\sim 10^{12}$ protons/pulse on the target the neutron flux on these assumptions would be more like $10^7 - 10^8$ neutrons/pulse in the beam. The 1-inch aperture proposed by Longo would, then, be an upper limit, imposed by detector rate limitations, on the aperture in the shield wall.

Radiation security must be provided for the neutron beam cave which is consistent with personnel safety and the reasonable operation of the neutron experiments plus the experiments set up simultaneously on target station A. Additionally a backstop must be provided to absorb the neutron beam and also provide radiation protection against the possibility of the primary proton beam accidentally impinging on the 0^{o} port.

Radiation Conditions:

1. No neutral port experiment, target station A running. Neutral port is plugged with rods, no special security.

2. Neutral port experiment, extracted beam to T-85 or Target Station C. Minimal radiation plug upstream of port. Plug length, material will be determined by more severe conditions below.

3. Neutral port experiment, target station A running, neutral experiment not running. Radiation security is required against the possibility of D1, D2 losing power. We postulate a 3-foot x 3-inch x 3-inch failsafe tungsten plug similar to the radiation plug for the Lindenbaum port.

The solid angle on target A, assuming a 2-inch beam envelope at the quadrupole just upstream of target station A is:

$$\Delta\Omega \approx 3 \times 10^{-4} \text{ ster.}$$

The relative flux against the face of the plug is

$$R \approx \frac{.1 \times 10^{-7} \text{ ster.}}{3 \times 10^{-4} \text{ ster.}} \approx 3 \times 10^{-5}$$

assuming no scattering in the target and no nuclear interactions (worst case)

$$\Delta N \approx 3 \times 10^{-5} \times 10^{13} \text{ ppp}$$

$$\boxed{\Delta N \approx 3 \times 10^{8} \text{ ppp}}$$

$$\text{Attenuation} \approx \frac{36 \text{ in.} \times 254 - 7.8}{1.3 \times 7.8} \approx 8.25\ \lambda$$

$$\text{Att} \approx 3 \times 10^{-4}$$

$$\text{Flux} \approx 3 \times 10^{8} \times 3 \times 10^{-4}$$

$$\approx 10^{5} \text{ particles/pulse}$$

$$\boxed{\text{DE} \approx 10 \text{ mrem/pulse}}$$

We assume as usual the presence of a radiation monitor that will shut off the SEB within one pulse if the radiation levels go above tolerance. In addition this flux is well-collimated by the port so levels in regions outside the line of sight of the beam port will be much lower.

4. Neutral port open, beam operating

In view of the neutron and possible proton levels calculated above the neutral beam cave should be fitted with health physics locks similar to the gate arrangement for Beam 10 the 0^{o} charged particle beam. A single cave and gate system would suffice for both experiments. This would be desirable also in view of the small lateral separation between the two experiments in the region of the downstream end of the shielding wall.

The Neutral Beam Backstop

The calculations above indicate that the beam offers no particular problem, even viewing the target at 0^{o}. Even allowing for 10^{10} protons/pulse in the event of D1, D2 failure 6 feet of steel and four feet of concrete should be sufficient to reduce the particle flux well below 10^{5} particles/cm^{2} pulse, a tolerable limit.

Distr:

EP & S Div. Staff
Administrative Group
C. Distenfeld
W. Gefers