Date: February 26, 2019

To: RSC, M. Palmer, C. Cullen, K. Kusche

From: K. Yip

Subject: RSC Review of Study for X-Rays Near Test Sphere at ATF

Present: Mark Palmer, Ed Lessard, Lee Hammons, Peter Cirnigliaro, Pat Sullivan (BHSO), Igor Pogorelsky, Marcus Babzien, Chris Cullen, Karl Kusche, Sidra Zia, Chuck Schaefer, Mohamed Benmerrouche and Kin Yip

Summary of M. Palmer’s presentation and discussion on Feb. 26, 2018

Mark Palmer gave a presentation 1 of “Safety Studies for the ATF CO₂ Laser System”. Various issues have been raised and discussed among the Committee members and the ATF group. One may find the technical details from the presentation. C. Cullen has also provided us some powerpoint graphics 2 to illustrate the angles of the holes on the test sphere which people inquired about during the meeting. The main points of discussions are provided below.

1. This experiment/test using a test sphere was designed to test the radiation conditions exceeding what the current CO₂ Laser system is capable of. The laser intensity in this study is $2.7 \times 10^{17}$ W/cm² compared to their current maximum operating laser intensity of $5.4 \times 10^{15}$ W/cm².3

2. M. Benmerrouche mentioned the possibility of putting a TLD even closer to the beam to see whether we could have even higher radiation. Mark replied that they have placed the TLD reasonably close to the beam and it should have given us an idea of the peak radiation in the right order of magnitude, even if it is not the absolute maximum. (And it is also quite expensive to run this test).

3. Mark told us that they will place permanent shielding at both ends of the vacuum chamber. The only opening is the view port which is currently a type of steel glass. People asked whether lead glass can be used. Mark said that it is only a few mm thick and lead or steel may not make a big difference and using lead glass would make it a special design that

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3 With the appropriate change of equipment and configuration, ATF is technically capable of delivering a laser intensity higher than $5.4 \times 10^{15}$ W/cm². But such a request would undergo a full review by the Experimental Safety Review Committee and corresponding review by the Radiation Safety Committee before it could be implemented.
would cost more and take more effort to maintain. It is and will be an operating procedure to cap the view port before the beam operation starts.

4. I. Pogorelsky told us that the shutter system would be checked routinely and replaced when there is any sign of deterioration or leak. This may happen as frequently as weekly.

5. P. Sullivan raised concern about the configuration control. Mark told us that the ATF configuration control is within the configuration control system of C-AD as ATF is a C-AD managed facility. It will be documented in the “Safety Assessment Document” (SAD) and “Accelerator Safety Envelopes” (ASEs). Drawings cannot be changed without a “Unreviewed Safety Issue” (USI) analysis.

6. Near the end of the presentation, Mark informed us that they would like to double the current diameter (~0.6”) of entrance hole for the YAG laser to allow easier alignment. In this case, the radiation dose at 1 foot from the hole in a fault would be increased from 3 µrad (in Mark’s presentation) to 12 µrad. This amount of dose and that of the first approach with a steel shell described in Mark’s presentation (<25 µrad) are all well below the limit of 20 mrem per fault at an accelerator facility allowed in the Laboratory’s “LESHC Procedure (the 2nd last row of the table on p.10)” and therefore it is acceptable.

Action Items:

1. Place the shielding at both ends of the vacuum chamber and provide drawings (K. Kusche and C. Cullen).

2. Checkoff list needs to mention that the shielding exists for the operation and the written operating procedure needs to include the step to cover view port before the beam operation starts (M. Palmer).

3. Add the description and analysis of the “Safety Studies” as a USI to the ASE (M. Palmer and E. Lessard).

D. Passarello will post the Action Items in Family ATS. All Action Items should be closed by June 30, 2019.

Copy to:

T. Roser
D. Passarello
C. Hoffman
P. Sullivan (BHSO)

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4 Since it is photon, the radiation weighting factor to convert rad to rem is 1.
Date: 06/20/95

To: S. Musolino

From: A.J. Stevens

Subj: Magnet Access Penetration at 12 O'clock: Required Exit Shield Block

This memorandum documents a CASIM calculation for the shielding needed to block the ends of the magnet access penetrations at 12 o'clock. These penetrations are tunnels of 5 ft. radius (centered about 14" below the beam line elevation) which make an angle of about 20° with respect to the beam line. The tunnel opening near the collider ring has a full view of the D0 and Q1 magnets. Since D0 is now believed to be a limiting aperture the fault potential is the full beam. The length of the tunnel is about 55m from the beam line.

The calculation, which resembles many others, will not be described in detail. The assumed fault was a 250 GeV/c proton beam scraping on D0. The star density was calculated in a light concrete block assumed to be at the end of the tunnel. The variation across the face of the block was very small. The attached Fig. 1 shows the star density averaged over the face vs. distance in the block. I had expected the star density to scale by 1/R^2 from a recent calculation done for the end wall of 6 o'clock^1 since that geometry also included angles as small as 20°. However, the star density in Fig. 1 is 3 times higher than such scaling would give. The difference was investigated and turns out to have three components. The largest difference is that the side walls of the tunnel considered here have interactions which "feed into" the end wall. Secondly, the assumed D0 source has magnets immediately downstream which "contract" the cascade unlike the 6 o'clock geometry where very little material existed near the beam pipe downstream of the DX source. Finally, the magnetic field configuration is worse in this penetration geometry since the access tunnel is essentially on the midplane.

As mentioned above, this geometry has the fault potential of the full beam. At 4 times the design intensity this is $2.28 \times 10^{13}$ protons. Using the usual design star density to rem conversion of $1.8 \times 10^{-5}$ rem/star-cc, the star density corresponding to 1 rem is determined to be $2.4 \times 10^9$. From Fig. 1, this corresponds to about 256 cm., or 8.5 ft., of light concrete. For completeness the muon dose was checked and found to be less than 5 mrem.

Reference


cc: A. Etkin
    M. Schaeffer

Attachment
Fig. 1 Star Density vs. Length in Light Concrete at the Exit of the Access Tunnel.
The length of each bin is 12.2 cm. The block was a total of 244 cm (8 ft.) long in the calculation.
Brookhaven National Laboratory

MEMORANDUM

Date: 07/19/95

To: S. Musolino

From: A.J. Stevens

Subj.: Magnet Access Penetration at 8 O'clock: Required Exit Shield Block

This memorandum is a follow-up to a previous memorandum\(^1\) which documented a CASIM calculation for the shielding needed to block the ends of the magnet access penetrations at 12 o'clock. The penetrations at 8 o'clock are similar geometrically, but are slightly longer (about 63m vs. 55m) and, more importantly, curve away from the beam line. One of the penetrations is shown in Fig. 1.

Again, the calculation will not be described in detail. Note that the source term (Fig. 1) is D5. Unlike the 12 o'clock situation, which viewed limiting aperture magnets, the design basis fault in this geometry is half the full (4 times design) beam intensity. This translates to a star density requirement of \(1.2 \times 10^{-9}\) stars/cc-p in light concrete for a 1 rem level and \(1.92 \times 10^{-10}\) stars/cc-p for a 160 mrem level.

Fig. 2 shows the star density in the concrete "backstop" vs. depth averaged over the lateral extent of the backstop. The error bars shown are the rms deviations from 3 CASIM runs with 1 million primaries each. Statistical errors did not permit the exploration of the star density variation across the lateral width in what I would judge to be reasonable computer time. For this reason some allowance should be made for possible enhancements that do not appear in the lateral average shown in Fig. 2. I allow a factor of 2 for such possible enhancements and set the criteria for the 160 mrem level (low occupancy, uncontrolled region) at \(10^{-10}\) rather than the \(\sim 2 \times 10^{-10}\) given above. As seen in Fig. 2, this occurs at a depth of about 110 cm. or 3.6 ft. A shield wall of 4 ft. of light concrete is therefore sufficient to reduce the fault dose level outside the access tunnel below 160 mrem.

Reference

1. Memorandum from A.J. Stevens to S. Musolino dated 06/20/95 titled "Magnet Access Penetration at 12 O'clock: Required Exit Shield Block".

cc: A. Etkin
M. Schaeffer

Attachments
Fig. 1. The 8 O'clock Region Showing One of the Access Penetrations
Fig. 2. Star Density vs Depth in a Light Concrete Block at the Exit of the Penetration. The Source is 250 GeV/c Protons Scraping on D5.