AGREEMENT FOR EXPERIMENT T-766
MEASUREMENTS OF THE NEUTRON SPECTRUM IN THE TEVATRON TUNNEL
WITH APPLICATION TO THE SSC

This is an agreement between (Fermilab and the experimenters to carry out an experiment to determine the radiation background in the Tevatron tunnel. The goal will be to determine the spectrum of neutrons in the tunnel while the Tevatron is operating (while gating all effects of the Main Ring "out") and for the Main Ring plus Tevatron (no gating). The detectors will also give information on the flux of charged particles near the Tevatron. The purpose is to obtain information on radiation fields in the tunnel in order to estimate possible radiation effects on equipment in such an environment. These data will be useful in designing the SSC tunnel and in assessing detector backgrounds. A preliminary description of the experiment is given in a memorandum from J.B. McCaslin to M. Tigner, dated July 11, 1985, which is attached as Appendix I.

Spokesman:
J.B. McCaslin
Lawrence Berkeley Laboratory
Building 75B-111
Berkeley, CA 94720
Tel: FTS 451-5251

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A. MANPOWER

Lawrence Berkeley Laboratory and SSC Central Design Group:

Joseph B. McCaslin
William P. Swanson
Donald E. Groon

Fermi National Accelerator Laboratory:

John Elias
William S. Freeman
Alexander Elwyn
Peder Yurista

Joe McCaslin is the spokesman for the experiment. Tel: FTS 451-5251.

The presently assigned liaison physicist for Fermilab is Peder Yurista.

B. BEAM, TARGET AND EQUIPMENT

1. Locations

The linear array of counters should be placed approximately at Tevatron beam height (10.5 inches or 26.7 cm from floor), along the tunnel wall opposite from the accelerator. Approximate depth and height of the array are 50 cm x 50 cm (see sketch). Length is about 10 m. The ideal location would be downstream (proton sense) of a short warm straight section with a quiet arc e.g. A48. Measurements made upstream of B0 could be correlated with CDF measurements.

a. Location 1.

A. Far Position:
Initially the array would be positioned far across the tunnel, to avoid obstructing the passage. This would be the "standard" position for checkout and for primary data taking.

B. Near Position:
If time and circumstances permit, a second position closer to the ring would be desirable (see sketch).

b. Location 2.

If time and circumstances permit, steps 1A and 1B should be repeated at a different location in a quiet arc.

2. Beam Conditions:

Primary interest is in the particle fluences during periods which simulate "normal" SSC running. For the Tevatron this means a period during the "flattop" at the highest Tevatron energy. Fluences generated by the various types of Main Ring cycles will be gated out for some of the measurements.

It is intended to run almost entirely parastically. However, depending on count rates, we may request that the stored beam be held briefly (a few minutes) at reduced current, if this does not occur in the normal course of operation.

3. Vacuum

We request that the pressure in the vacuum vessel in the upstream nearby warm straight section be allowed to rise for short periods (a few minutes) when beam conditions are stable, in order to study radiation as a function of gas pressure. This could be done by shutting off the Vacion pump at adjacent point.

4. Access Required

It is intended to install all equipment in the tunnel during the shutdown of the week of September 9. After checkout and data taking in Location 1 (FAR), one access would be desirable to move to Location 1 (NEAR). (Time required for this access: 10 minutes in the tunnel).

After sufficient data at Location 1, it would be desirable to move to Location 2. (Time required: 2 hours for removal; 4 hours for re-installation; 1 hour transport. Total time = 8 hours.)

C. EXPERIMENT-ACCELERATOR PROTOCOL

1. No magnetic elements will be used.

2. Equipment described above may at time partially obstruct movement of the magnet vehicle (but not personnel) in the tunnel. The detectors are light and can be moved aside by one person if circumstances require. See F.2.

3. All cables will be controlled by the Experiments Support Department (ESD). This includes authorization of types, routing, labeling and installation. Basic labeling will be provided by LBL/CDG, but FNAL may add labeling at their descretion. No other utilities underground are required.

4. Experimental apparatus to be interfaced with the AD control system will be coordinated with the Head of the AD Controls Group (Dixon Bogert) so that standard modules can be used.

5. All access to accelerator tunnel experimental areas will be strictly controlled by the Accelerator Division via a protocol which is to be developed by the ESD.

6. All experimenters must attend the safety training courses defined by the AD head. These courses presently include ODH, Accelerator New Employee Radiation and Accelerator Controlled Access.

7. It is understood that successful operation of the basic accelerator functions has priority over experiments.

D. EQUIPMENT AND SERVICES

1. Fermilab Accelerator Division will provide:

a. Detector area (see Sketch 1), a "homogeneous" length of tunnel in a quiet arc.

b. A counting area near the selected detector area (the adjacent service building would be satisfactory). A 8-ft of rack space should be provided. Also one table with chairs.

c. NIM module which provides at least: a gate which is "on" when the Tevatron is at flattop and the Main Ring is not ramping. The contemplated module actually does more than this (see Memorandum to Dixon Bogert et al. from Dave Beechy, dated 8 August 1985, attached as Appendix II).

d. Key to chosen service building.

e. Communication between tunnel and service building for checkout.

2. Fermilab Safety Section will provide:

a. One 50-MHz oscilloscope.

b. Capability of spectrum unfolding, via program SWIFT.

c. One or more "Chipmunk" ion chamber detectors, capable of being gated, with 1-sec time constant.

d. Isolation transformers, if needed, with 1.5 kW minimum capacity.

3. Lawrence Berkeley Laboratory and SCC Central Design Group will provide:

a. All required cables (power, HV and signal) to all tunnel equipment except for that supplied by FNAL Radiation Physics. (The cables will be 300 ft long and generally consist of sheathed bundles of HV, preamp power and 1 or 2 signal cables. Estimated weight per bundle: 55 lbs.)

b. All neutron counters, including: Bonner Spectrometer (8 counters), Moderated BF-3 counter, Thorium-fission counter and Bismuth-fission counter.

c. All pulse-height analysis equipment required for the neutron detectors.

d. Spectrum unfolding capability via program LOUHI.

E. <u>TIME TABLE</u>

MILESTONE	COMPLETION DATE
Fabrication of 300 ft cables at LBL	Done
Fabrication of NIM module by D. Beechy	Aug. 30
Sheathing of 300 ft cables at LBL	Aug. 30
Air shipment of cables & detectors from LBL	Aug. 30
Arrival of shipment at FNAL	Sept. 3
Above-ground setup and checkout	Sept. 4-8
Installation of cables & counters in tunnel	Sept. 9-13

Checkout with beam and data taking	Sept. 16-30
Removal of detectors from tunnel (approx.)	Oct. 4-7

F. SPECIAL CONSIDERATIONS

1. This experiment must be completed during the running period beginning about 16 September and ending about 30 September 1985.

2. As detectors may sometimes obstruct movement of the magnet move, and may need to be moved, we request that the liaison physicist be advised, if practical, to assist such removal.

3. The experimenters agree to familiarize themselves with Fermilab safety policies and adhere to them.

4. Users are reminded that they not bring to Fermilab, or take from Fermilab, radioactive material or sources without first receiving advance written agreement to do so for each source from the Head of the Fermilab Safety Section. Further, sources must be kept locked and properly marked. Application for such written agreement has been made to the Safety Department for one small neutron source which will be provided by LBL.

5. Apart from the NIM module built by Dave Beechy (Appendix II), LBL will be responsible for maintaining and repairing the electronics and computing hardware supplied by them for the experiment.

6. At the conclusion of the experiment, the experimenters agree to remove from the Fermilab site all equipment the Laboratory request them to remove, expeditiously and carefully.

7. Upon publication, six copies of all preprints and publications for this experiment will be sent, by the scientific spokesman, to the Director of Fermilab. One copy of each of these results for this experiment shall be sent to the Fermilab library. Five copies of any major conference report including a Fermilab author will be sent to the Fermilab Technical Information Office.

G. ACCEPTANCE

This agreement is mutually acceptable to both the experimenters and to Fermilab. Circumstances and needs will change as the design of the experiment and plans for the experimental program develop. This agreement will be amended when necessary by mutual consent.

For Fermi National Accelerator Laboratory

Joseph B. McCaslin
Spokesman for the Experiment

Appendix I

LAWRENCE BERKELEY LABORATORY
Bldg.: B75B Room: 123 Ext.: 5251

July 11, 1985 451-5251
JBMcC:236:85

LBL 451-4000
FTS

MEMO

TO: Maurey Tigner

FROM: Joe McCaslin/Bill Swanson

SUBJECT: Proposed Neutron Energy Spectrum Measurements in Tevatron Tunnel - Application to SSC

In order to estimate radiation damage effects in materials placed in the tunnel it is advisable to measure the neutron fluence and its energy distribution. Measurements should be made both in a "warm" region near gas interaction areas, and also in a region where gas interactions are minimal but where beam particles which have been previously displaced from stable orbit may be lost. Conditions must be such that the data can be applied to SSC operation. (Beam intensity, lifetime and loss pattern, etc.)

Because it appears necessary to exclude non-Tevatron related activity from the measurements, only active gateable detectors will be used instead of threshold activation detectors. Bonner spheres are the primary detectors. Eight detectors, each with 1/2-inch X 1/2-inch LiI scintillators, and with spherical moderators up to 18 inches in diameter can be used simultaneously. The data from the measurement are subsequently processed in the unfolding code, LOUHI. Calculated response functions extend to 400 MeV beyond which we assume that they are constant.

In practice, this low resolution neutron spectrometer is used and operates well outside of shielding where flux densities are relatively low and where interference from pileup of prompt beam-target photons and neutron-capture photons is minimal. Whether operation of these counters within the Tevatron tunnel is possible at normal beam intensity has yet to be determined.

In addition to the Bonner spectrometer, it is strongly recommended that the following three detectors also be used:

Detector	Response
1. Moderated BF_3 counter	20 BeV - 20 MeV
2. Thorium fission counter	>2 MeV
3. Bismuth fission counter	>50 MeV

All three counters are very reliable, stable, and have excellent discrimination against photon pileup.

All detectors and associated electronics can be supplied by the LBL Radiation Physics Group with the exception of cables, a variable delay gate generator, and 50 MH_3 oscilloscope. We would need assistance in the following areas:

1. Selection of detector locations within the tunnel

2. Fabrication, installation of cables

3. Timing and gating signals

4. Coordination with accelerator operations staff in order to correlate detector data with machine conditions

5. Assistance form FNAL Health Physics (via Bill Freeman) at a level not yet fully determined, but which will probably require his active participation, along with ours, in setup, measurement and coordination activities.

The following table lists the cables which will be required.

Detector	Cables		
	HV	Signal	P.A. Power
Bonner Spectrometer	8 (<1KV)	16	8 (3 conductor shielded)
BF_3	1 (3KV)	2	1 (5 conductor shielded)
Thorium	1 (<1KV)	2	1 (5 conductor shielded)
Bismuth Fission	1 (<1KV)	2	1 (5 conductor shielded)

Consideration might be given to proceeding in two stages: (1) setup and evaluation, and (2) data collection.

If it is decided to make the measurements, it would be helpful if you would discuss our plans with Bill Freeman and Larry Coulson, the head of Radiation Physics at FNAL.

JBMcC:rbt

cc: Jim Sanford

TO: Dixon Bogert, Ale·· Elwyn, Bill Freeman — 8 August 85
From: Dave Beechy

Re: Neutron Energy Spectrum Measurement in Tev Tunnel

Appendix II

After talking to several persons, I propose to build the following NIM module for use with the above mentioned experiment.

INPUT: Tevatron Clock

OUTPUT: Single digital signal (0 or +4 volts) to be used for gating counting equipment. +4 volts will allow counts to accumulate.

CONTROL: Front panel mode selector to choose 1 of 4 possible operating modes.

DISPLAY: "On Time" accumulator to show amount of time output has been at +4 volts; resolution=1 second; maximum count=large.

Front panel leds:
- a) Output active (+4 volts)
- b) Main Ring ramping
- c) Tevatron at flattop
- d) Operating mode selected

OPERATION: (MR=Main Ring ramping; TEVFT=Tevatron at flattop; OUT=output of module)

Mode 1) Normal Mode IF (.NOT.MR.AND.TEVFT) OUT=.TRUE.
Counting takes place if the Main Ring is not ramping and the Tevatron is at flattop.

Mode 2) IF (.NOT.MR) OUT=.TRUE.
Couting takes place whenever the Main Ring is not ramping, irregardless of the Tevatron.

Mode 3) IF (TEVFT) OUT=.TRUE.
Counting takes place whenever the Tevatron is at flattop, irregardless of the Main Ring.

Mode 4) OUT=.TRUE.
Counting takes place at all times.

CLOCK EVENTS:

Start of Main Ring Ramp (beam in main ring)
$20, $21, $29, $2A, $2B, $2D, $2E

Main Ring Abort Cleanup (no beam in main ring)
$27, $2F

Start of Tevatron Flattop (indicates starts of storage mode operation)
$45

End of Tevatron Flattop (end of store)
$46

To: Rich Orr
From: Dixon B.
I propose that we do this for the SSC neutron spectrum task as CDG requested.
cc. F Nezrick, P. Koehler, H. Edwards, R. Lundy

, Reznick

Fermilab

Fermi National Accelerator Laboratory
P.O. Box 500 • Batavia, Illinois • 60510

Appendix 3

July 17, 1985

Maury Tigner
SSC Design Center
M.S. 90-4040
LBL
Berkeley, CA 94720

Dear Maury,

Regarding the memo to you from Joe McCaslin and Bill Swanson dated July 11, 1985, I agree that high quality neutron spectrum measurements in the Main Ring Tunnel would be useful and desireable.

A few complications come immediately to mind. There may be others. Some points to consider are:

1. Installation Schedule - We have a two day maintenance period in July (30,31). We will have another 4-5 day period the first week of September. That's it. We have 57 keys to the tunnel. There are usually demands for twice that number. Each person in the tunnel must have a key and an escort (also with a key) if he is not qualified by physical exam and lectures to work in an Oxygen Deficient Hazard (ODH) environment. This means that the installation may have to be done on the night shift. Access is controlled and coordinated by the Operations Group.

2. Gating - While the Tevatron is going through its cycle the Main Ring is busily supplying 120 GeV beam interspersed with squirts of 8 GeV beam for Anti-proton Source tests. There are about 7 clock events associated with Main Ring activity and another 7 or so with Booster activity. An interface with the controls system will be necessary to sort out what is going on.

3. Intensity - The Tevatron beam intensity information will have to be made available through the Control system for normalization purposes. Incidentally, much of the September collider run will probably be at reduced average intensity.

4. Location - This will have to take into account the possibility of repair teams passing through the tunnel with magnet changing vehicles, golf carts, welding carts, tool carts and other implements of destruction.

5. Conditions - I would oppose changing the running conditions (e.g. cycle time, intensity, etc.) for the purposes of this measurement. We have a very tight schedule and little or no maneuvering room.

As you can see, this will take some knowledgeable coordination. Frank Nezrick, Peter Koehler's deputy for the Accelerator Division Experiments Support Department, has agreed to do this task. His phone number is FTS 370-4604.

Sincerely,

J. R. Orr

cc: D. Bogert w/enclosure
H. Casebolt "
L. Coulson "
H. Edwards "
P. Koehler "
L. Lederman "
B. Mau "
M. May "
F. Nezrick "
M. Palmer "
J. Peoples "
D. Edwards "
D. Lundy "