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SPS West Area - Dismantling of 200 GeV Layout - Installation of 450 GeV Layout — Activities of the Radiation Protection Services*

Abstract

This report summarizes the twelve months of radiation protection work necessitated by changing the energy of the protons feeding the West Area secondary beams from 200 to 450 GeV. The scheduled work-plan for this changeover was essentially respected and the new beam lines were ready to receive particles on the 14th of July 1983. The new radiation-detector system was installed before the final dead-line.

The objectives of dose-limitation plans were achieved.

* Translation of CERN TIS-RP/TM/83-54 from the French original by J.C. Gaborit and H. Schoenbacher.

1. Introduction

The "big" shut-down of the West-Area, due to changing the proton energy to 450 GeV, started on the 25th June 1982. It was evident from the outset that the planned work was so large in scope that it would need coordination at all times, both in the preparation phase and during the installation itself.

Figures 1 and 2 show the beam layouts before and after the transformation of the area.

2. Preparation and control

Eight meetings concerning "work progress" were held between March and June 1982 in order to plan firstly for the smooth dismantling of all beam line elements and a part of the hall infrastructure, and then for the re-installation of the 450 GeV project. The points discussed at these meetings mainly concerned: work planning, installation plans, vacuum, mechanical supports, etc., shielding, magnetic elements and zone preparation. For most of these points, these discussions with the persons actually involved allowed the clarification of details to facilitate the work while reassuring personnel concerning the hazards of radioactivity. For example, self-adhesive labels (see Fig. 3) were devised for use on each magnet and on which were displayed a reference number, the magnet's destination (storage or modification) and radiation level, allowing the radiation risk of the element to be assessed at a glance. This helped to reduce dose accumulation due to lack of information.

Twenty-five meetings called "West-Area (450 GeV) Installation", held between June 1982 and June 1983, were necessary to follow the evolution of the work and check on how it followed the established schedule. Two sectors were considered

1. The underground areas i.e., the transfer tunnels.

2. The surface areas i.e., the experimental halls and TT5.

These meetings allowed a regular check on the situation to be made and to take any measures necessitated by unforeseen circumstances. They also helped coordination between the different work groups.

3. Summary of work - Radiation Protection Activities

A summary of the radiation protection activities during the periods of dismantling and re-installation is presented in Table 1. The remarks made allow one to understand the problems and the manner in which they were overcome.

The dose rate from induced radioactivity for each of the 270 magnets in the TT60-TT4-TT5-EHW1, 2 and 3 complex was measured before dismantling the area.

The dismantling work had the additional constraints of neutrino beam operation for the "Beam Dump" experiment until 21st September 1982 and $p\bar{p}$ operation from then until December. Figure 4 shows the temporary shielding which was installed in TCC6 in order to allow work as close as possible to the operating beam lines with a maximum of security. A polarity inversion on two magnets situated within this iron gave rise to significant does rates (0.7 m Sv/h at several meters from the shield). TLD measurements indicate a particularly high hot-spot-of mention (1.25 Sv/h); this is compatible with a loss of 2.5×10^{10} protons per pulse behind 80 cm of iron at a distance of 3 m from the loss point on the beam axis. This loss point was located by a measurement of dose rate from induced radioactivity (1.5 mSv/h after only several hours of beam). This example shows the well-founded basis for the shield which avoided an accidental irradiation of personnel.

Measurements of specific activity from the concrete survey pillars in TT3-TT4 are given in Table 2a. One can see that these activities were greater than 2 Bq/g; the debris from the destruction of these pillars and from certain other unit engineering activities was treated as radioactive waste.

Table 2b shows the specific activities in the steel piping installed in TT4. These measurements allowed precautions to be taken during cutting and milling operations to avoid the spread of radioactive contamination.

The installation of the radiation monitoring system was achieved within the planned schedule and could be tested before beam start-up.

4. Evaluation of personal doses

Each person involved was issued with a pen-dosimeter which was regularly checked by the supervisor or the RP technician. The latter person also collected the readings made by the different supervisors. According to the place and type of work bleeping dose-rate devices were issued when necessary.

Table 3 shows the distribution of collective and average personal doses as well as the total dose for the duration of the work for CERN and Contractors' personnel (79.5 mSv and 223.2 mSv respectively).

Figure 5 shows a graphical representation of the monthly mean of the doses received by the personnel. Two peaks can be seen, one in July and one in the following January. The first is explained by the dismantling work which had to take place soon after the beam operation stopped; the induced activity levels were still high in certain regions. The January peak is due to the installation of radioactive magnets, the special mobile shield trolleys and

the target assembly in TCC6. The low doses from October to January are due to a transient phase in the installation of the infrastructure, the most active magnets not being ready for re-installation.

5. Comments

a) Good preparation before the start of the operation and regular checks as work proceeded led to a successful "450 GeV" project from the Radiation Protection viewpoint. A wide variety of problems were encountered, but these were often quickly resolved by the sympathetic understanding of the persons involved.

b) The installation of a sensitive radiation monitor at the Meyrin exit point of the road passage-way between the two sites "sensitized" personnel who took away radioactive material without control.

c) The greatest difficulties appeared during the re-installation near the end of the work when the radiation protection recommendations were not respected by persons working in zones that had become radiation areas by the re-installation of active magnets.

d) The frequent movement of equipment waiting to be re-installed posed a problem in maintaining the temporary fencing around provisional radioactive-storage areas.

e) The follow-up of doses accumulated by the personal was indispensable, especially at the beginning of the dismantling and when the most active magnetic elements were re-installed. The sharing of the most active work amongst a number of persons achieved it's objective, i.e., an individual weekly average of less than 0.2 mSv.

Table 1

Activities	Comments
July-August 1982 (Survey Report 82-05)	
a) Tunnels	
- Survey of induced activity	- 20 mSv/h close to TCSA - 2 mSv/h ambient close to cable trays
- Disconnection of electrical and vacuum connections to magnets	- about 70 magnets dismantled and transferred to EHWI - then to the Prevessin site depending on dose rate and work to be done.
- Neutron films required for those persons working in TT60.	- Neutrion beam dump experiment continued until Sept. with consequent risk of beam losses in the switchyard
- Installation of an alarm monitor in TT60 at the access grid.	
- Control of material leaving the tunnels	- wilting and sorting of cables into containers and of tubes into palettes before transport to radioactive waste area.
- Recommendations for cutting-up radioactive tubes	- flame-cutting rather than sawing to reduce contamination risks
- Sundry measurements of specific activity	
b) Halls	
- Survey of induced activity: about 100 magnets measured	- for each magnet dose rate was marked on special ticket which also contained other relevant information.
c) Miscellaneous	
- Check on persons working in active areas: about a dozen people without films.	- Complaint to contractors.
- Discovery of active material leaving hall un-checked	- efficacity of detector installed at tunnel site exit: guards had instructions to send persons back who did not have the special yellow transfer slip.

Table 1 (continued)

Activities	Comments
- Transfer of iron shielding blocks for the neutrino-oscillation experiment.	
d) Collective dose - July - 43 mSv August - 26 mSv	- The majority of the work in radio-active areas was completed during these two months.
September 1982 (Survey Report 82-06)	
- Neutrino beam-dump operation until 21st Sept.	- Access to lower part of TT61 & TCC6 forbidden.
- Survey of induced activity in TCC6.	
- Dismantling of largest stations	- Collective dose 4.5 mSv.
- From 21st Sept: installation of provisional shielding in TCC6.	- to allow antiproton operation via TT70 while giving access to as large a part of TCC6 as possible.
- Dismantling of all beam line elements in TCC6 except those of the neutrino lines	
- for convenience, access to TCC6 authorized via BA7	- guard placed at BA7 entry to control access.
- storage of magnets in EHW3	- no space available on the Prevessin site; shielded zone created in EHW3 for the most active magnets.
- CERN Open Day (!) Temporary barriers placed around the storage area between BDW and EHW3	- maximum dose rate at the barriers 2μSv/h
- Collective dose, 24 mSv	
October 1982 (Survey Report 82-07	
- Installation of two alarm monitors and TLD dosimeters in TCC6	- alarm of 20 μSv/h for the monitor placed in the accessible work area
- Start up of antiproton operation; dose rates > 0.7 mSv/h close to shield	- polarity inversion in two magnets during proton tests. After correction dose rates < 50 μSv/h.

Table 1 (continued)

Activities	Comments
- Installation of rails for the mobile shield of the MTR. Excavation of concrete (specific activity 925 Bq/kg)	- active concrete placed in same containers as non-active. All concrete considered as active and stored in PS center ring area
- Holes drilled in wall between TT61 and neutrino area	
- Removal of iron collimator from TCX and TDX	- Collective dose 1.5 mSv.
- Making order in TT3 storage area	- Collective dose 1.6 mSv.
- Collective dose: CERN 7.5 mSv, Contractors 1.7 mSv.	
<u>November 1982</u> (Survey Report 82-08)	
- Removal of gantry crane in TT5 and transport to Prevessin Site (5 μSv/h)	
- Survey of iron blocks for use in BA5	- maximum allowed dose rate: 50 μSv/h at 10 cm from the block surface
- 35 iron blocks (TDX shield) transferred to PS center storage area	- up to 2 mSv/h on some faces
- transport of remaining magnets from EHW3 for modification on the Prevessin site Collective dose: 20 mSv	- shielding needed for some magnets
<u>December 1982</u> (Survey Report 82-09)	
- $p\bar{p}$ operation stopped, survey of induced activity along the anti-proton line	- the TLD dosimeters placed in the exclusion area showed high neutron doses due to the incident at start-up
- dismantling of provisional shielding at TCC6	- the iron blocks remained in the area for use in the MTR shield.
- start of re-installation of magnets	- about 70 magnets put into position in the E1/H1 and X7 lines.
- Collective dose: 19 mSv.	

Table 1 (continued)

Activities	Comments
January 1983 (Survey Report 83-01)	
- Installation of magnets in TCC6 and TT61	- survey of magnets as installation proceeded.
- Installation of target station T1	
- Installation of special trolley for the MTR's of TCC6	- many spectators. It was regrettable that certain persons, whose presence was neither necessary or justified, ironically allowed themselves to be seen without dosimeters.
- frequent movements of material arriving or just waiting to be installed.	- significant problems of maintaining a correct-delimitation of temporary radioactive storage areas.
- the December film dosimeter of Mr. Coppel (H. Reinier) showed a high dose	- enquiry in progress; the pen dosimeter only indicated 1.75 mSv.
- a radioactive iron block (2.5 mSv/h hot spot on one face) was found in the detector pit of Hall 181(ISR)	- enquiry in progress: the block was in any case found in a Controlled Radiation Area. However, it had not been checked by an RP tech. neither when leaving the storage area nor on arrival at the pit and no requests for a block from the radioactive storage area had been received by the RP services.
Collective dose Contractors - 33.3 mSv CERN - 21.2 mSv (10.4 mSv attributed to one person - Mr. Roiron)	
February 1983 (Survey Report 83-02)	
- mainly checking material coming back form the Prevessin site.	- magnets and vacuum equipment.
- 100 iron blocks checked and sorted for reuse in the ISR, BA5 and the neutrino-oscillation filter close to BEBC	- limit of 1-2 μSv/h as maximum dose rate acceptable for blocks to be installed close to physics detectors

Table 1 (continued)

Activities	Comments
	- 2 μSv/h on the ground near to the BEBC filter; 5 μSv/h on the platform of the outside staircase.
- several iron beams acting as roof supports for under-beam passageways were exchanged	- contact dose ratio of 0.1 mSv/h giving rise to 20 μSv/h in the passage ways.
Collective dose Contractors - 28 mSv CERN - 7.4 mSv	
March 1983 (Survey Report 83-03)	
- alarm monitor plus recorder installed for ejection tests at 450 GeV and $p\bar{p}$ operation.	- access forbidden from 15-23 March in TCC6 and the bottom part of TT61. Beam stopped at the TED during ejection tests.
- welds radiographed on the Cryogenics platform in EHW1; 30-40 μSv/h at 20 m from the x-ray generator.	- in spite of installed warning signs (including one flashing alarm with an acoustic indicator) a number of persons removed security barriers to avoid making detours. They also refused to accept the remarks of the RP technician concerning their non-respect of warning signs.
Collective dose: Contractions 18.6 mSv CERN 8.4 mSv	
April-June 1983 (Survey Report 83-04)	
- Continuation of re-installation of magnets in the halls	- new lists established of magnets per beam and zone.
- Removal of material from temporary radioactive stores by BDW & EHW3	- mainly cables, cable trays & vacuum pieces
- Check of iron blocks for re-use in the hall	- about 10% of the blocks could be re-used in the open hall areas. A few blocks with dose rates > 1 m Sv/h were transferred to the radioactive storage.

Table 1 (continued)

Activities	Comments
- Radiography of welds in BEBC	
April Collective doses: Contractors 6.2 mSv CERN 3.2 mSv	
- installation of radiation monitor system	- only possible at this stage, after all magnets, cables and pipe-work had been installed.
- a few more radiographs of welds	
- routine surveys	- vacuum elements, dump supports, etc.
May collective dose: Contractors 8.8 mSv CERN 4.6 mSv	

Table 2a

	Isotope T ½	^{7}Be 53d	^{22}Na 2,6y	^{46}Sc 84d	^{54}Mn 280d	^{60}Co 5,2y	^{152}Eu 13y	^{134}Cs 2,2y	Total Specific Activity Bq/g
Pillar 1/TT4		1,04 39,4%	1,16 43,6%	0,056 2,1%	0,173 6,5%	0,045 1,7%	0,151 5,7%	0,026 1%	2,651
Pillar 2/TT4		0,991 44,4%	0,656 29,6%	0,134 6%	0,101 4,6%	0,096 4,3%	0,181 8,1%	0,067 3%	2,226
Pillar TT3		0,706 36,4%	0,734 37,8%	0,057 3%	0,109 5,6%	0,082 4,2%	0,200 10,3%	0,053 2,7%	1,941
Floor TCC6		6,78 22%	17,3 56,3%	0,66 2,15%	1,87 6,1%	1,21 3,9%	2,18 7,1%	0,74 2,4%	30,74

Table 2b

	Isotope T ½	^{57}Co 270d	^{51}Cr 28d	^{58}Co 71d	^{54}Mn 280d	^{60}Co 5,2y	Total Specific Activity Bq/g
Stainless Steel Pipes TT4		3,85 1,3%	120,2 40,6%	5,80 1,9%	24,90 8,4%	141,2 47,7%	295,9

Specific activities are given in Bq/g

TABLE 3

Monthly Collective Dose

Month	Dose of CERN Personnel (μSv)	No. of Persons & Mean Dose (μSv)	Dose of Contractors' Personnel (μSv)	No. of persons & Mean dose (μSv)	Total dose (mSv)	Total No. of Persons
July	5,4	30 - 180 μSv	38,7	62 - 624 μSv	44,1	92
August	7	32 - 218	18,9	62 - 304	25,9	94
September	7,5	33 - 227	16,7	65 - 257	24,2	98
October	3,4	30 - 113	11,8	60 - 196	15,2	90
November	3,1	29 - 106	17,4	79 - 220	20,5	108
December	2,5	29 - 86	16,4 *	78 - 210	18,9	107
January	21,2	38 - 557	33,3	78 - 427	54,5	116
February	7,4	39 - 189	28	74 - 378	35,4	113
March	8,4	33 - 254	18,6	47 - 395	27	80
April	3,2	32 - 100	6,2	29 - 213	9,4	61
May	4,6	18 - 255	8,8	28 - 314	13,4	46
June	5,8	20 - 290	8,4	28 - 300	14,2	48
TOTAL	79,5		223,2		302,7	

* For the month of December the dose of M. Coppel (H. Reinier) viz 54 mSv (film) was not added to the total - the dose of 1.8 mSv as read by the pen dosimeter being more realistic (comparison with his colleagues). This was determined after a formal inquiry.

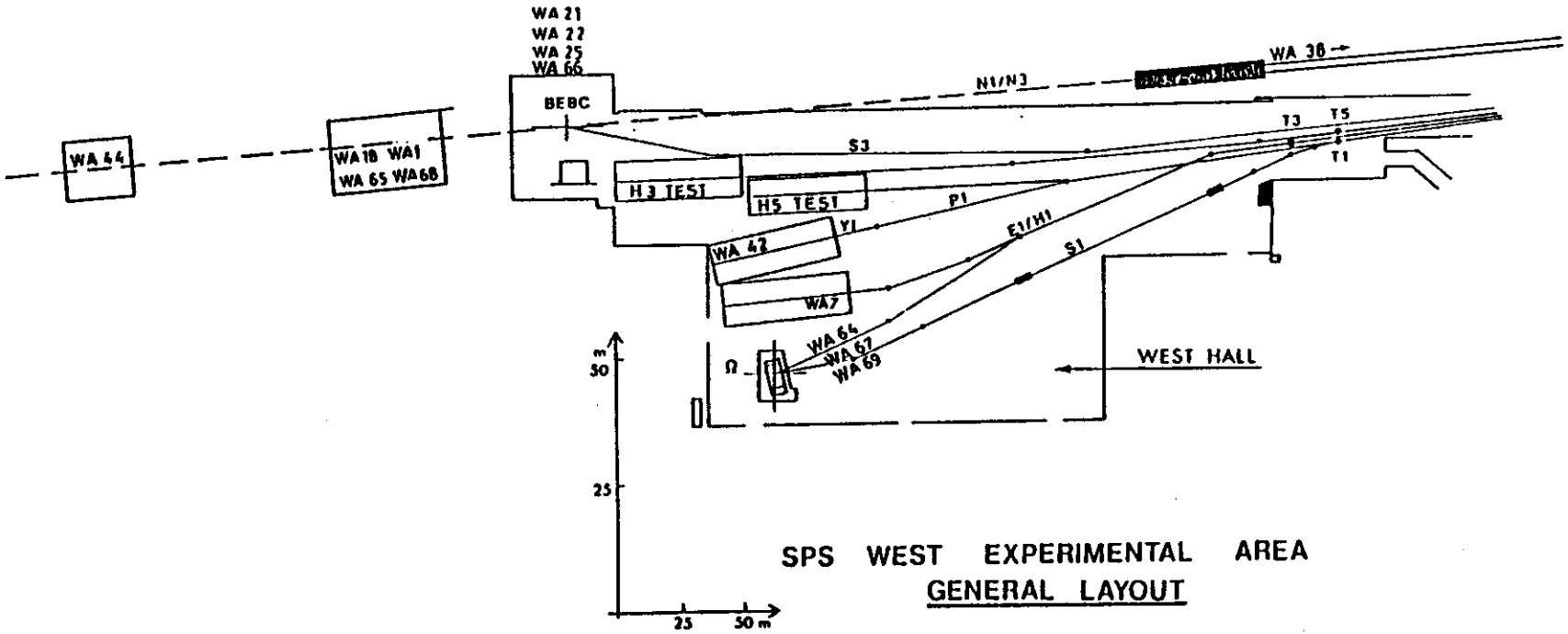


Fig. 1 Beam layout for 200 GeV.

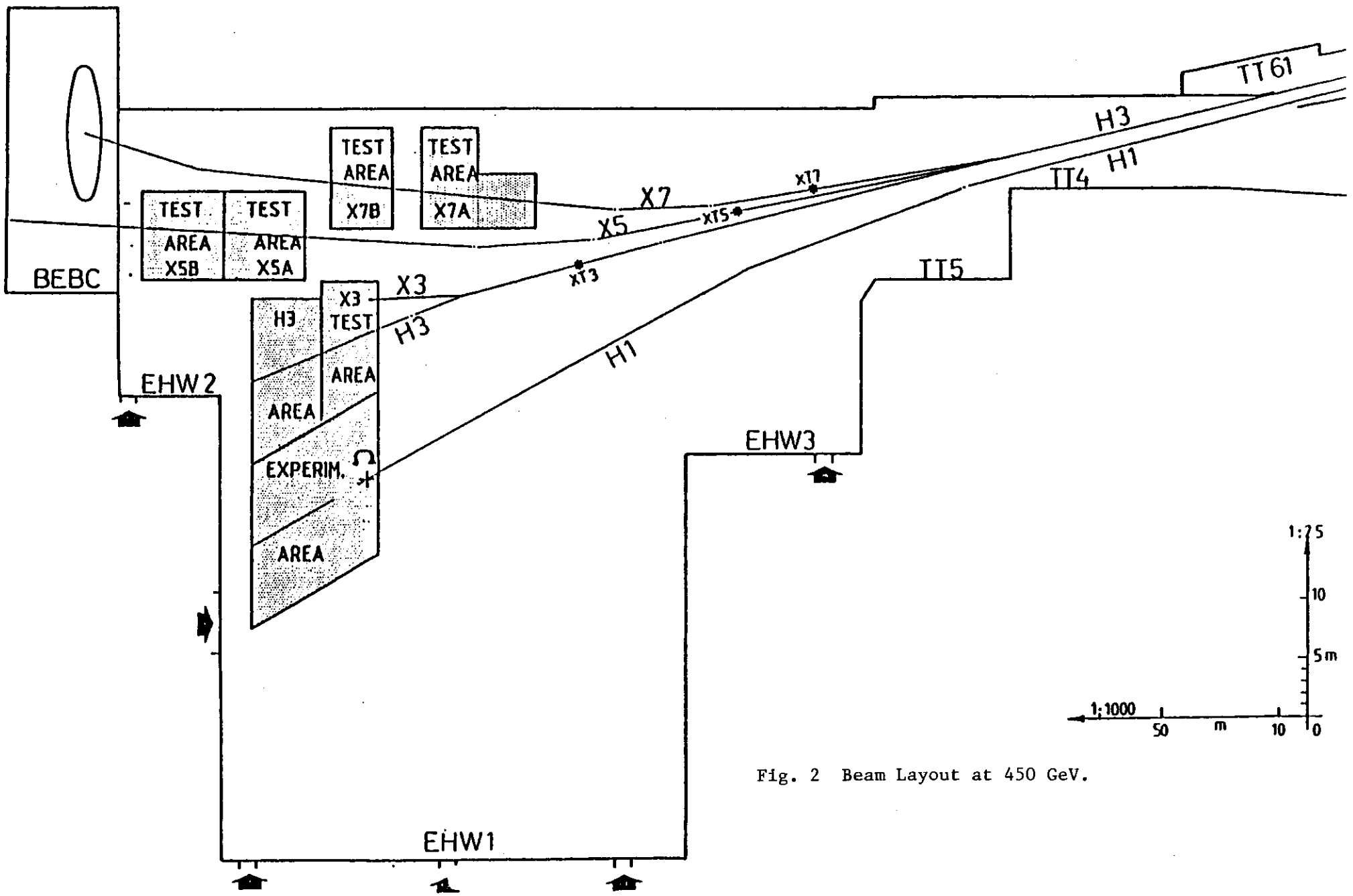
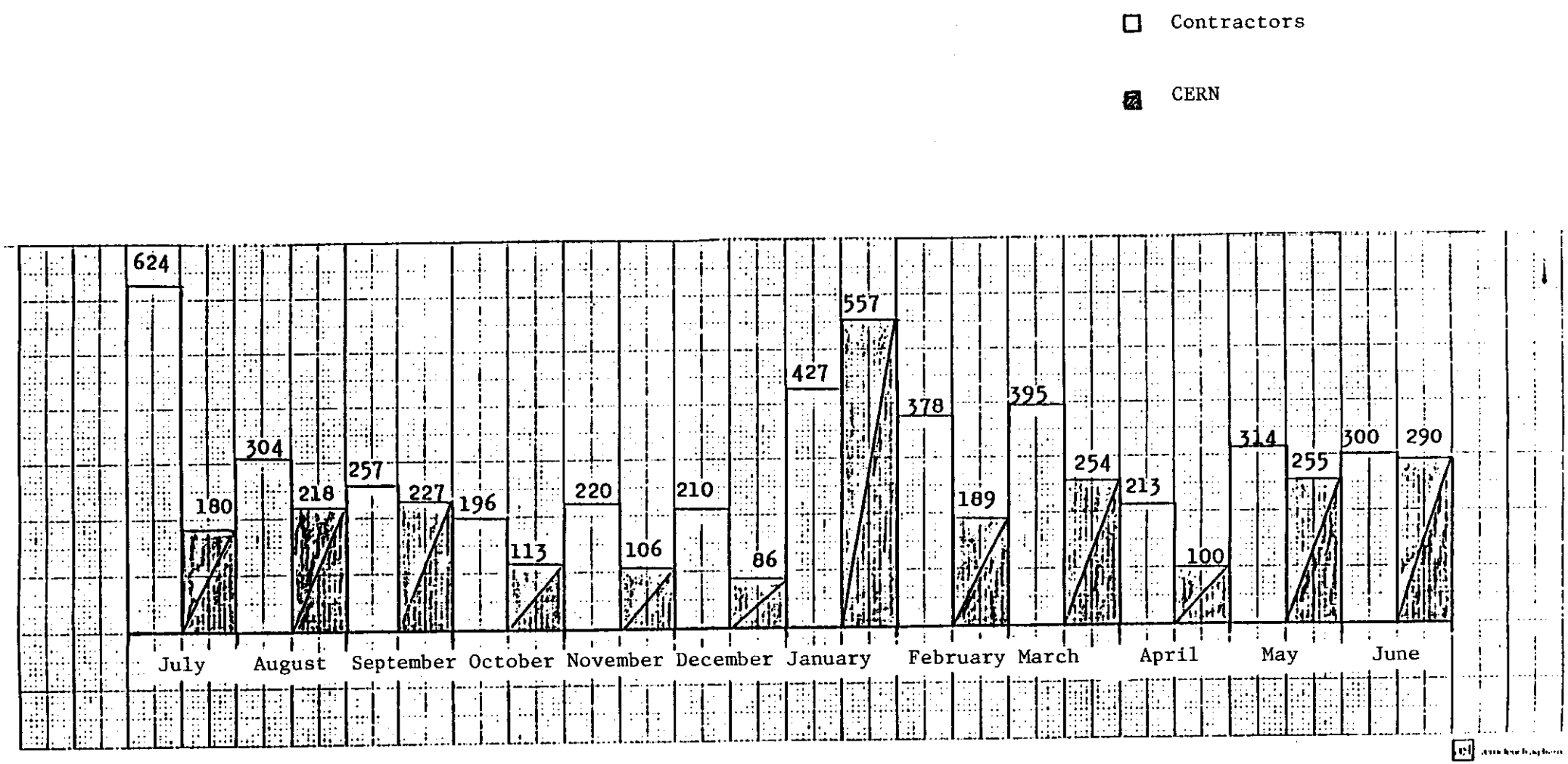


Fig. 2 Beam Layout at 450 GeV.

Fig. 5 Mean monthly doses integrated by Personnel (μSv)



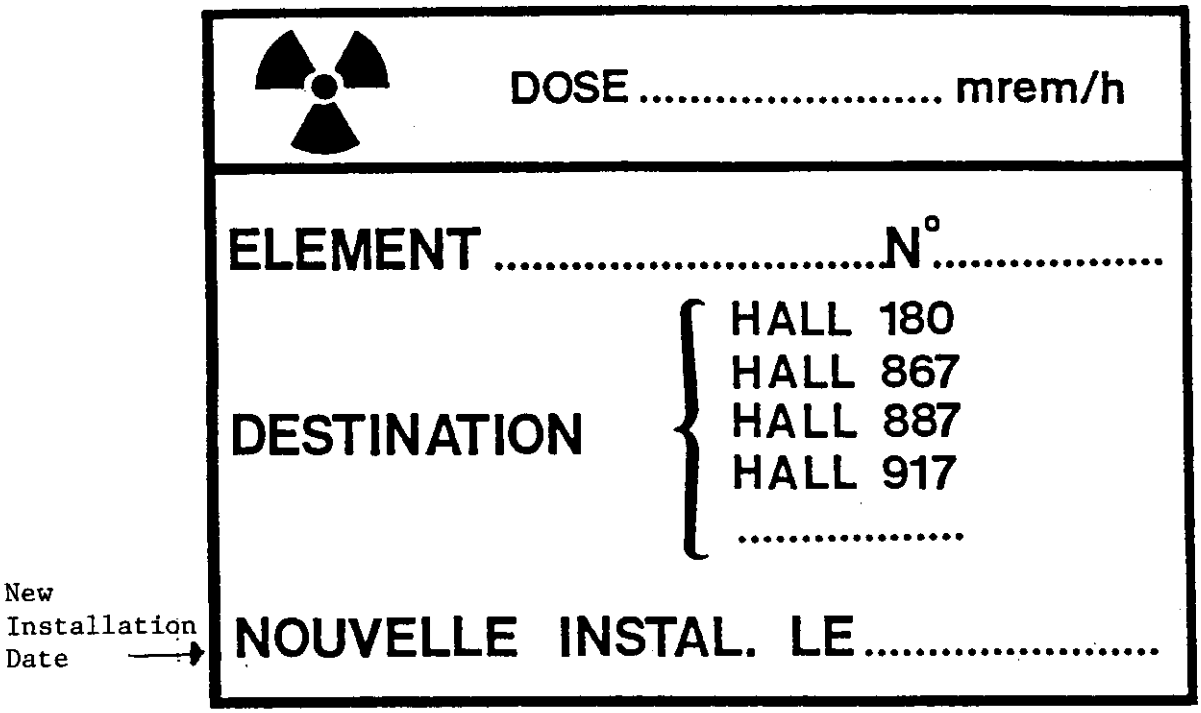


Fig. 3 Identification tag for beam line elements.

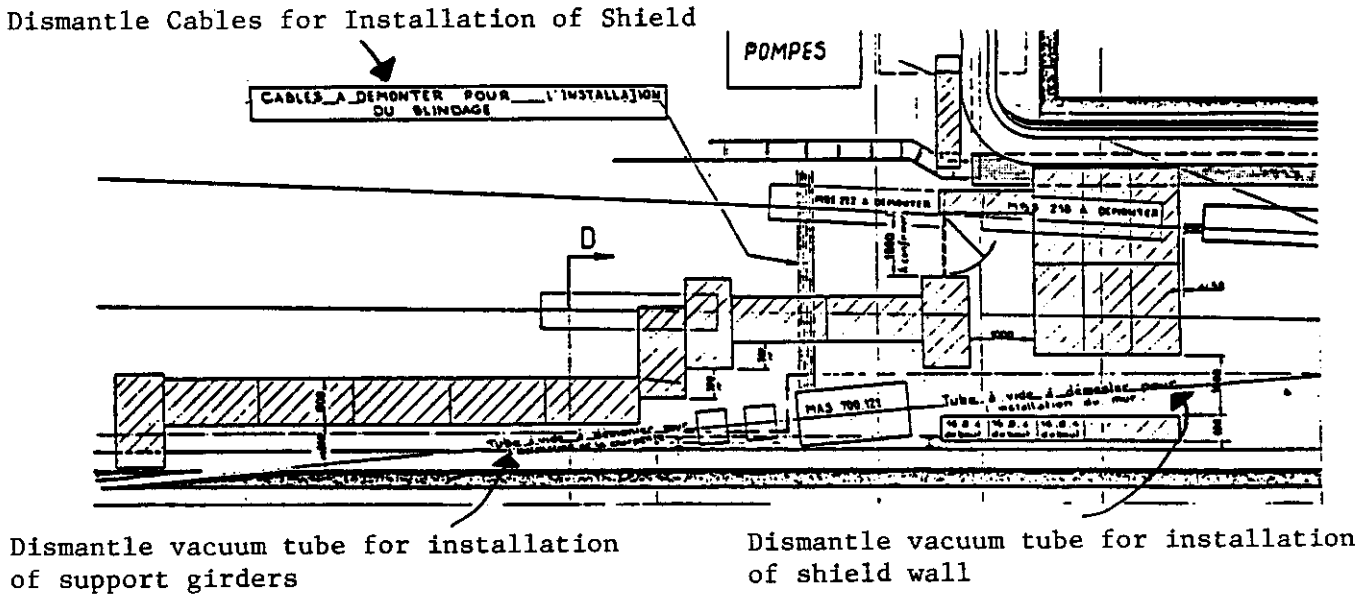


Fig. 4. Provisional shielding in TCC 6.