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DESIGN STUDY FOR A BEAM INTERCEPTOR IN S.S. 21

The purpose of this study is to get an idea of the feasibility and safety of the construction on one hand, and of the costs on the other hand. In other words, the study is of a general nature, the details have been studied thoroughly only where they were influencing the feasibility or the price.

The beam interceptor, located in s.s. 21, shall allow, in co-operation with a fast kicker in s.s. 18, to dump the proton beam at any energy between 10 GeV/c and 28 GeV/c.

A. SPECIFICATION

The specification is based on Memo MPS/SR/72-104 (Prel. spec. for beam dumping device) from 5.12.1972 and on discussions with Messrs G. Plass, R. Gouiran and Ch. Steinbach.

1. Absorber block

1.1 Copper block 150* 70* 1000, water-cooled (10 kW max.)

1.2 Vertical movement :

a) Stroke

zero position : 26 mm above orbit
dumping position : anything between 16 and 8 mm above orbit.
The stroke is remote controlled.

b) Timing

start of movement	:	within ± 0,05 sec
stroke "in"	:	0,250 sec
time "in" position	:	anything between 0 and 0,6 sec
stroke "out"	:	∿ 0,3 sec
repetition rate	:	anything between 0,72 and 2 sec

c) Life-time : several years. About $3 \cdot 10^6$ cycles/year.

d) Accuracy of positioning :

longitudinal angle : ± 0,1 mrad

vertical position : ± 0,5 mm

from pulse to pulse : ± 0,3 mm.

2. Shielding and supports

The reciprocating absorber block and its tank are surrounded by a stainless steel or/and lead shielding (600 x 700 x 2000).

The support structure must allow an accurate alignment and stability of the mechanism within ± 0,1 mm.

B. PROPOSED SOLUTION

A commercial hydraulic linear actuator (1.1, see Fig. 1) working in phase with the PS, is connected to the reciprocating, water-cooled copper block (1.2) with its arm and guiding system (1.3). The actuator with its support is quickly dismountable, as its height interfers with the PS magnet surveyor sighting lines.

The mobile mass, tank (3.2) and part of the shielding (3.1) form a unit (Fig. 3) and can be taken out of the ring with a minimum of radiation danger. It is replaceable by an identical spare unit.

This unit is supported as a whole on concrete blocks (1.4). An adjustment allows to position the unit, which is itself already aligned (lab.)

Two stainless steel side-plates (2.1, see Fig. 2) and two lead blocks (2.2) hanging on the main shielding block (3.1) complete the shielding of the exchange unit.

The down-stream hippodrome shaped (52 mm high, 146 mm wide, 4 mm thick) chamber (1.5) with a 400 l/sec ionic pump (1.6) is supported and adjusted on the lower shielding structure (2.3), which itself is resting on the concrete support. The chamber is covered with the upper shielding structure (2.4). The shieldings consist of rigid frames filled with lead bricks.

The up-stream chamber (1.7), provided with an elbow and an oberservation window, has its own support and shielding (2.5) resting on the concrete blocks.

The tank has two SI-type connections (1.8), each one having its U-shaped shielding block (1.9).

A 200 l/sec ionic pump mounted on the manifold MU 20 and a 400 l/sec ionic pump (1.6) connected to the down-stream chamber will take care of the increased degassing rate of the bombarded absorber.

The hydraulic and electronic equipment for the actuator (both in the PS ring and the MCR) will be very similar to that of the fast kickers in s.s. 13 and s.s. 97.

A TV-camera with its monitoring system is placed up-stream in front of the elbow-chamber (1.7).

C. CONCLUSIONS

The general philosophy about beam-dumps in accelerators - whether to keep the dumps out of the ring or to accept them in the ring - shall not be discussed here. Even a carefully designed beam interceptor will always present a certain risk for the PS machine.

1. Feasibility of the system

1.1 The requirements on the movement have very heavy implications on the actuator, which shall work in phase with the PS.

A pneumatic drive was eliminated because of life-time and timing-precision problems (compressibility of air). Ordinary electromotors cannot be used because of the flexibility of timing demanded. The commercial stepping motors are not powerful enough to satisfy the requirements. A three-stage commercial hydraulic linear actuator, similar in service and feasibility to the one in s.s. 13, will be flexible and precise enough.

For the oil supply, either the prolongation of the existing fast kicker line, or an independent small commercial pumping unit (2 l/min) placed close to s.s. 21, can be envisaged, depending on the future of the kicker lines.

1.2 The positional stability requirements need a very careful study :

a) the copper absorber block will be cooled by two parallel water circuits, the majority of the temperature gradients being more or less in the horizontal plane to avoid a deformation. Nevertheless, due to the dynamic forces and the heating up of the block, its deformation will be close to 0,1 mm;

b) the guiding of the mechanism requires necessarily some play. This play transmitted to the absorber block will give some 0,2 mrad angular movement;

c) to keep the long-term stability in the horizontal plane of the support structure within ± 0,1 mm requires a very heavy and elaborate construction (concrete block with embedded steel plates for the base).

As the stainless steel shielding of the mechanism represents a very big and compact structure, it is used as upper supporting element of the mechanism and the tank.

The same reasoning can be used for the down-stream vacuum-chamber: the proposed structures (upper and lower), filled with lead bricks, could be replaced by solid stainless steel blocks (for a somewhat higher price).

1.3 Handling, radiation

The actuator and its mounting form a constructional unit which can be easily separated from the mechanism without effecting the alignment. This is necessary for inspection and repair of the actuator on one hand and the deblocking of the surveyor sighting lines on the other hand.

If any faults appear during operation of the beam interceptor (waterleak, damage to the guiding, vacuum-leak on bellows or tank, broken screen in front of block etc.), the whole unit (Fig. 3), consisting of mechanism, tank and part of the shielding, is replaced by an identical spare unit, already aligned and tested. The philosophy applied here is to have a minimum of intervention time under maximum protection against radiation.

1.4 Further points

In this study the problem of life-time tests, which will be necessary before installation, have been treated very briefly. It should be stressed that this part of the development is rather time and money consuming, based on past experience with the fast kickers.

The height of the vacuum-chamber in MU 20 cannot be enlarged (70 mm) as required, unless one would consider specially constructed flat pole-face windings.

2. Prices

2.1	Mechanism, block, guiding, tank, membrane, support	Frs.	50.000.-
2.2	Actuator with support	"	21.000.-
2.3	Vacuum-chambers, ionic pump	"	26.000.-
2.4	Hydraulic and electric installations and instrumentation on the ring and the MCR	"	90.000.-
2.5	Shieldings and supports	"	66.000.-
2.6	Spare unit and spare actuator (pos. 2.1 and 2.2)	"	71.000.-
2.7	Assembly work	"	12.000.-
	Total	Frs.	336.000.-
2.8	Tests (approximation)	Frs.	80.000.-

3. Assembly times in the PS

First assembly in the s.s. with alignment and tests	4 days (12 man days)
Replacement of eventually damaged interceptor for spare unit	4 hours (10 man hours)
Replacement of the faulty actuator by a spare one	1 hour (2 man hours)

The design effort will be around 40 man weeks. The production time will take about 6 months.

B. Szeless

Enclosures : 3 sketches

Distribution

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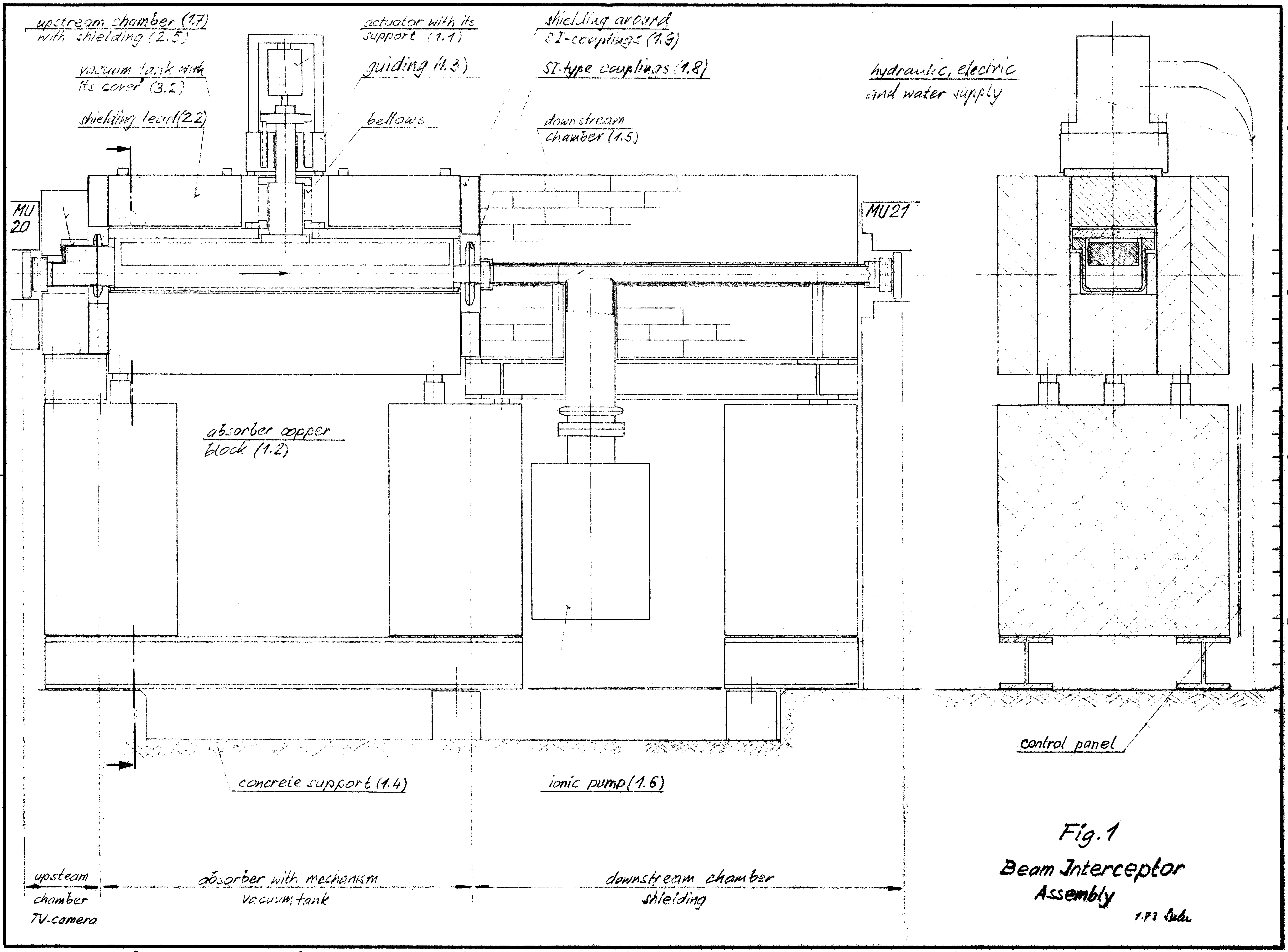

Fig. 1
Beam Interceptor Assembly

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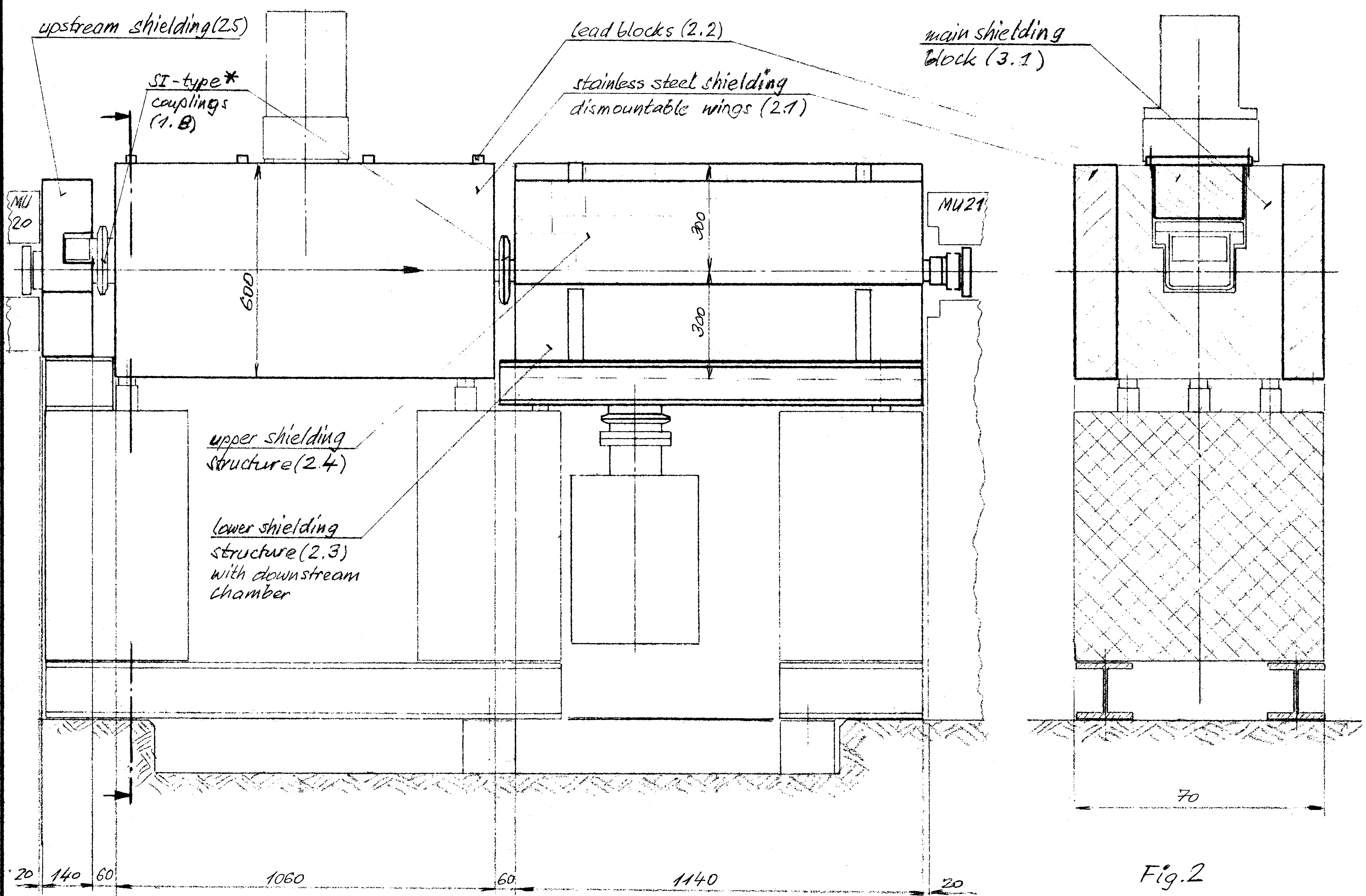
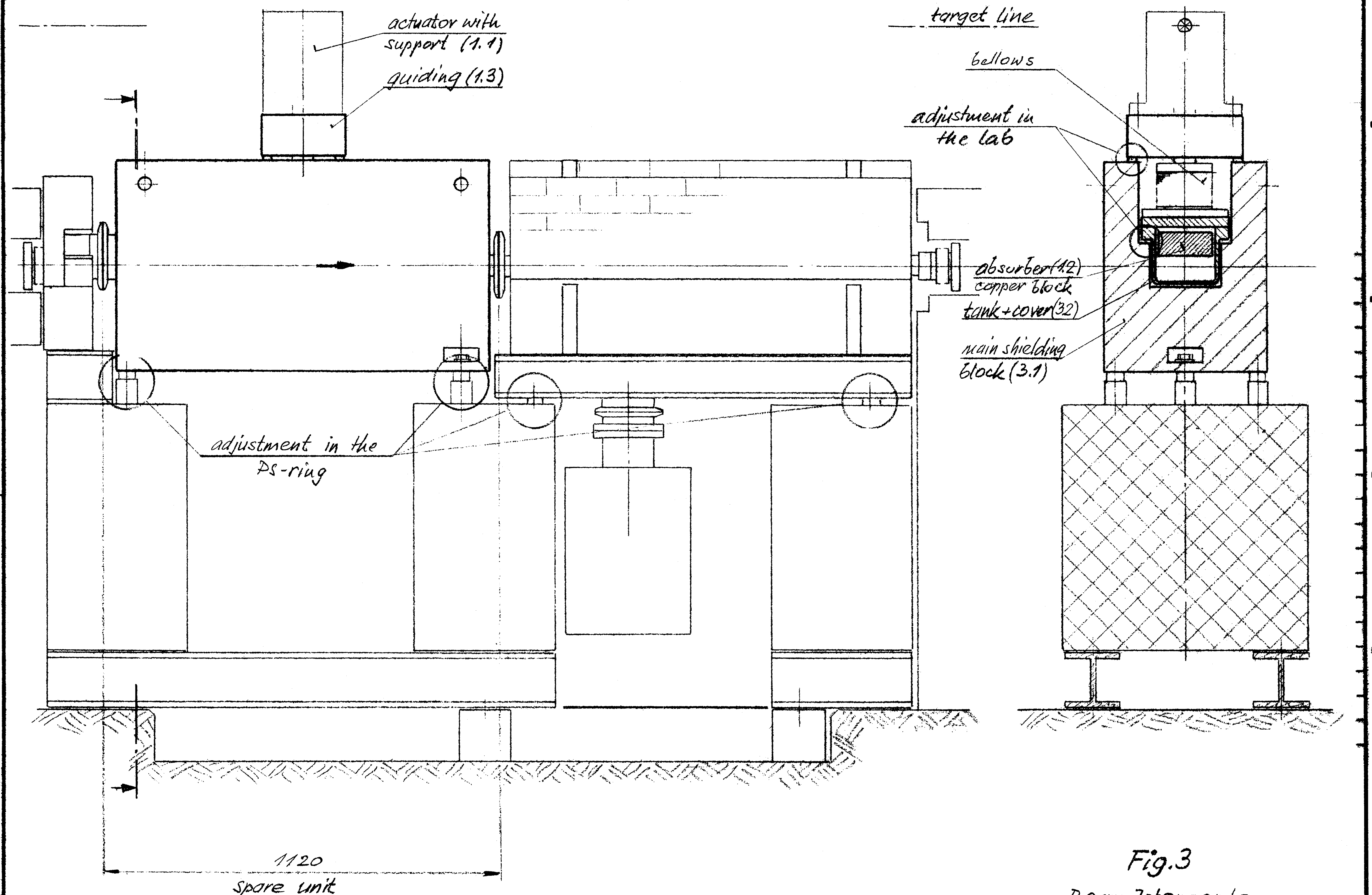


Fig.2

Beam Interceptor
Shielding Units

*Shielding (1.9) around SI-type couplings (1.8) not shown here.



Shielding (1.9) around SI-type couplings, lead blocks (2.2) and shielding wings (2.1), all to be mounted on the unit, are not shown.

Fig.3

Beam Interceptor
Spare Unit

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