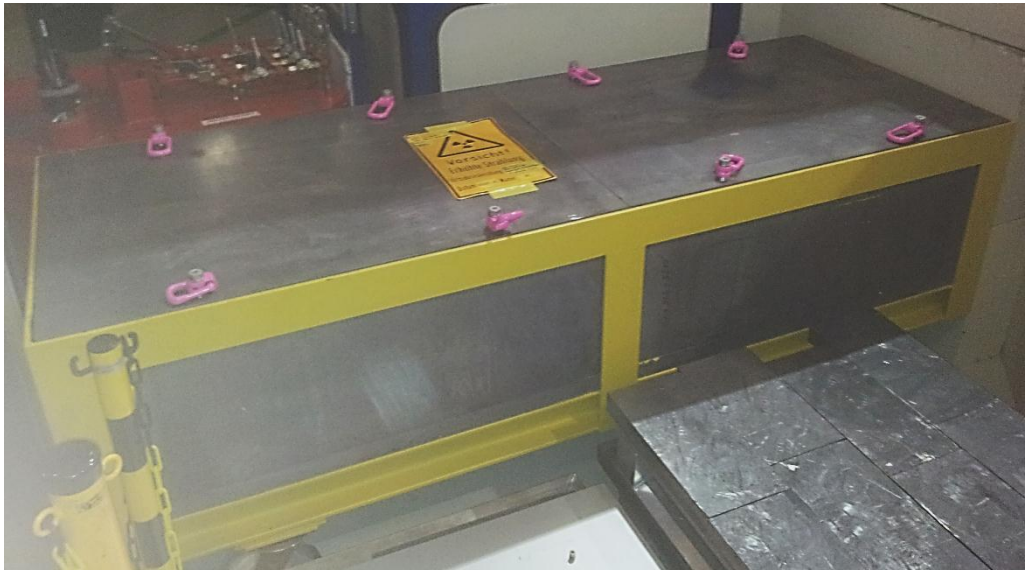
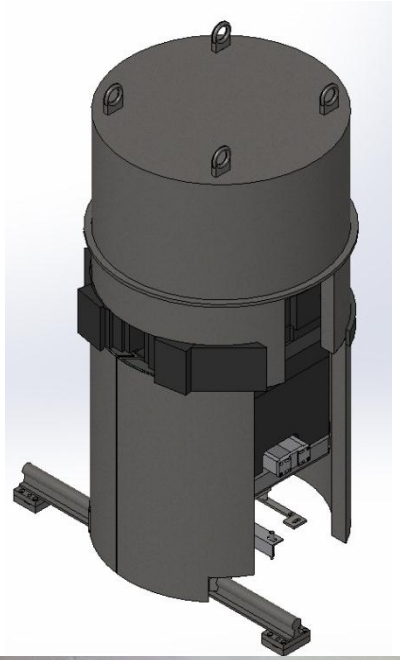
Using Lead as construction material

Andreas Ofner



Exemplary Pb shielding for the TREFF monochromator

Steel formwork filled with pure lead



Disadvantages experienced:

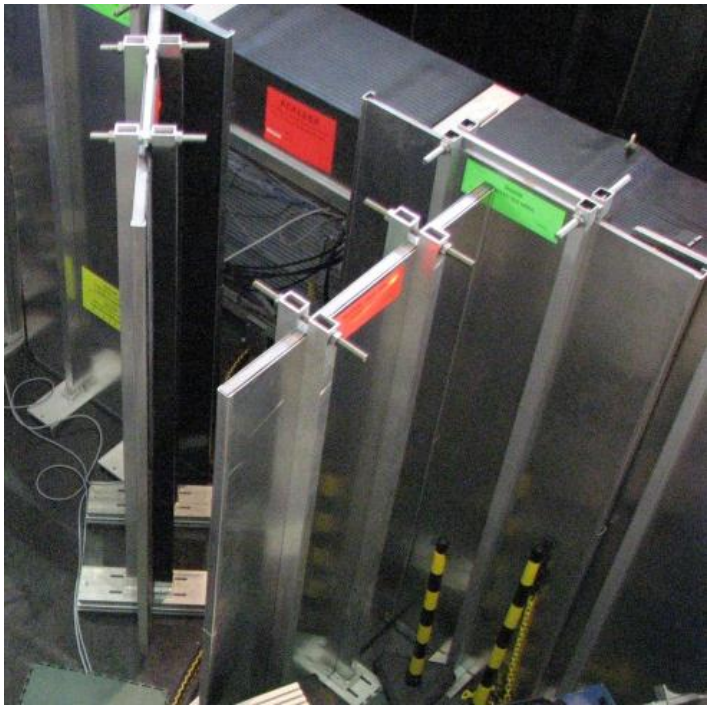
- complicated design
- it is complicated to improve when shielding is too thin
- chicanes are difficult to implement
- there are air bubbles without shielding
- the disposal is difficult

Why did one choose this solution?

- Pure lead is a soft material and deforms over time.
- Lead should be protected from unnecessary contact with skin.

Other solution:

- Lead alloy with antimony (PbSb4)
  2m high lead walls are stable
- Surfaces protection with aluminum or paint



Reasons not to use antimony in lead

- Antimony is activated by neutrons, therefore do not use it in direct neutron beam.

  This argument is irrelevant in many shielding containers
  (they are in general not hit by the direct neutron beam)

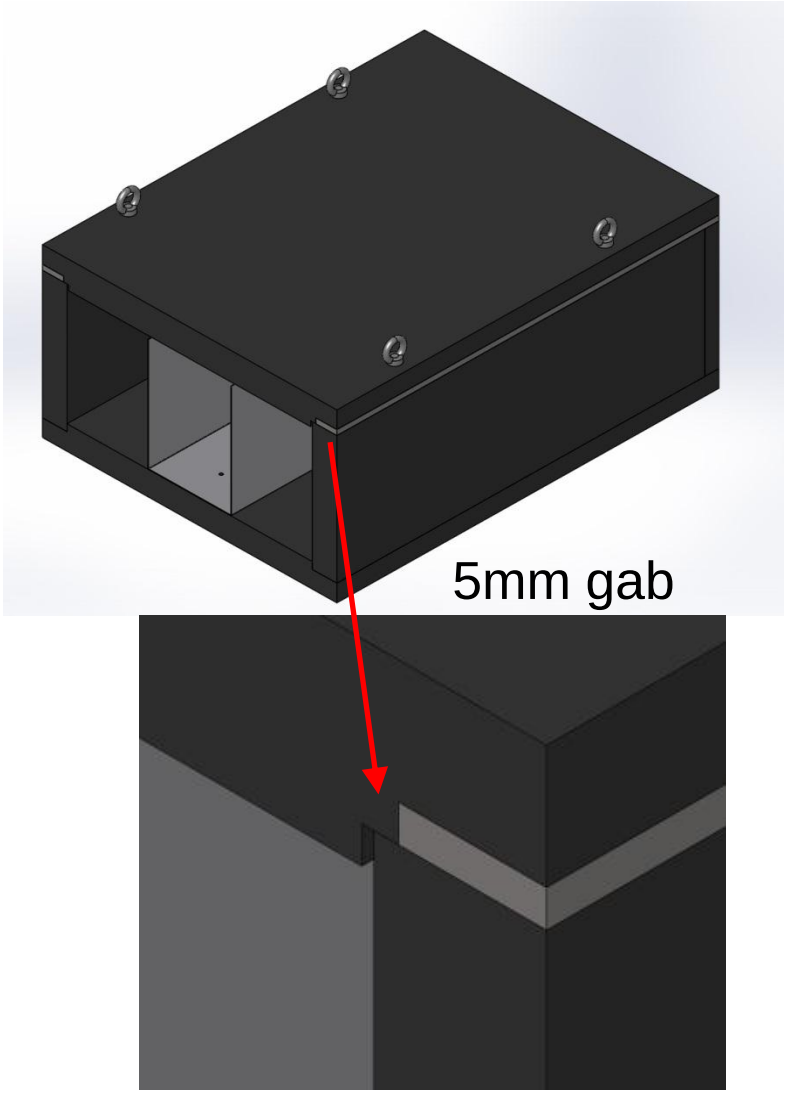
  Reminder: Cobalt in stainless steel has a higher and longer lasting activation level by neutrons.

- The density decreases with increasing antimony content

- The price goes up with the antimony content

Rules to obey designing with lead

- Larger tolerances are needed. For example a lid on a lead shielding requires a 5mm gap.
- Use for frequently used lifting points iron deposits
- In lead no thread should be cut
  Using thread inserts
- Avoid lead on lead friction, use a thin aluminum sheet as plain bearing!



Material properties of lead antimony alloys

- linear expansion:

Sb [%]	**0**	**1**	**2**	**4**
1/K	29,1*10E-6	28,8*10E-6	28,4*10E-6	27,8*10E-6

- tensile strength :

Sb [%]	**0**	**1**	**2**	**4**
kp/mm²	1,25	1,5 – 3	----	2,5 - 5

- density:

Sb [%]	**0**	**1**	**2**	**4**
kg/dm³	11,34	11,30	11,25	11,16

Considerations for the usage of threaded inserts in lead:

During mechanical design and assembly:

- Choose a sufficiently large dimension of the threaded insert
- Select the correct kind of threaded insert
- Install it in a correct way
- Design lifting points at appropriate places (3 points, consider center of gravity, load triangle)

Considerations for the usage of threaded inserts in lead:

In use:

- Check for damage prior to usage
- Avoid long distance transport with the crane

What threaded inserts we use:

We tested different threaded inserts for screws M12 and M16 in **PbSb4**

Typ A

Typ ES

Typ SKD

We tested a straight clamping and with 15° tilt

Results for 0°

threaded inserts	Typ A		Typ ES		Typ SKD	
	M12	M16	M12	M16	M12	M16
Extraction force in kN	18,81	20,58	7,84	10,17	12,78	17,25

Results for 15° tilt on type A

Threaded inserts	Typ A	
	M12	M16
0°	18,81	20,58
15°	17,09	17,97

Already moderate tilt results in about 10-15% reduced load capacity !

Summary of the threaded inserts test

Loads with 3x safety :

- threaded inserts M12 5,0 kN
- threaded inserts M16 6,5 kN

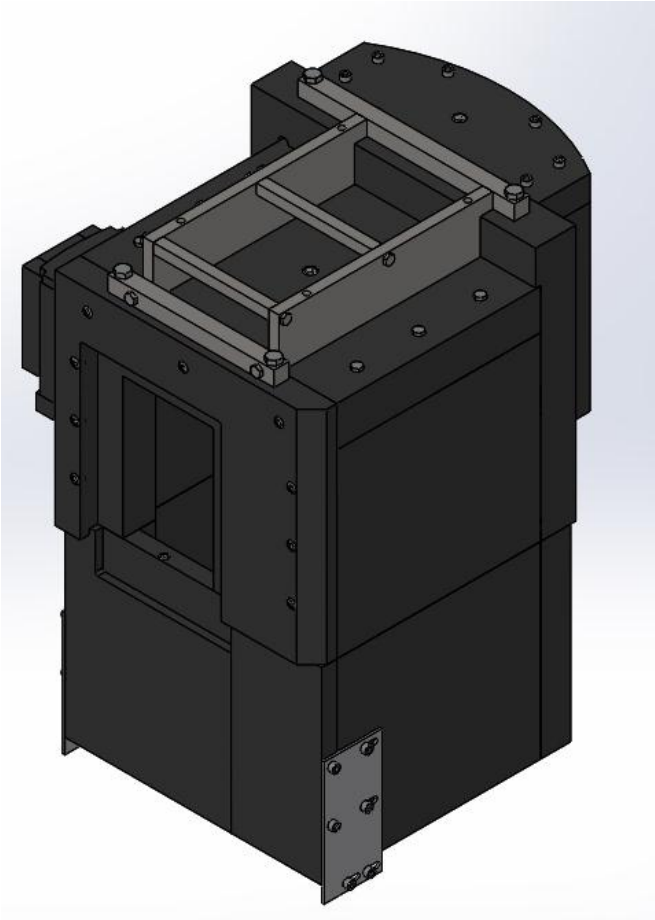
Drill hole diameter:

- threaded inserts M12 18,5 mm
- threaded inserts M16 21,5 mm

Rampa Typ A 22 x 25 M12 (Nr. 001225)
Rampa Typ A 25 x 25 M16 (Nr. 001651)

www.rampa.com

Exemplary monochromator shielding on TREFF



Exemplary compact neutron guide shielding at FRM2