Source capsules for intense 22-Na sources

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- Requirements for source capsule
- Realization as full Ti version
- Diagnostics of empty and filled capsule

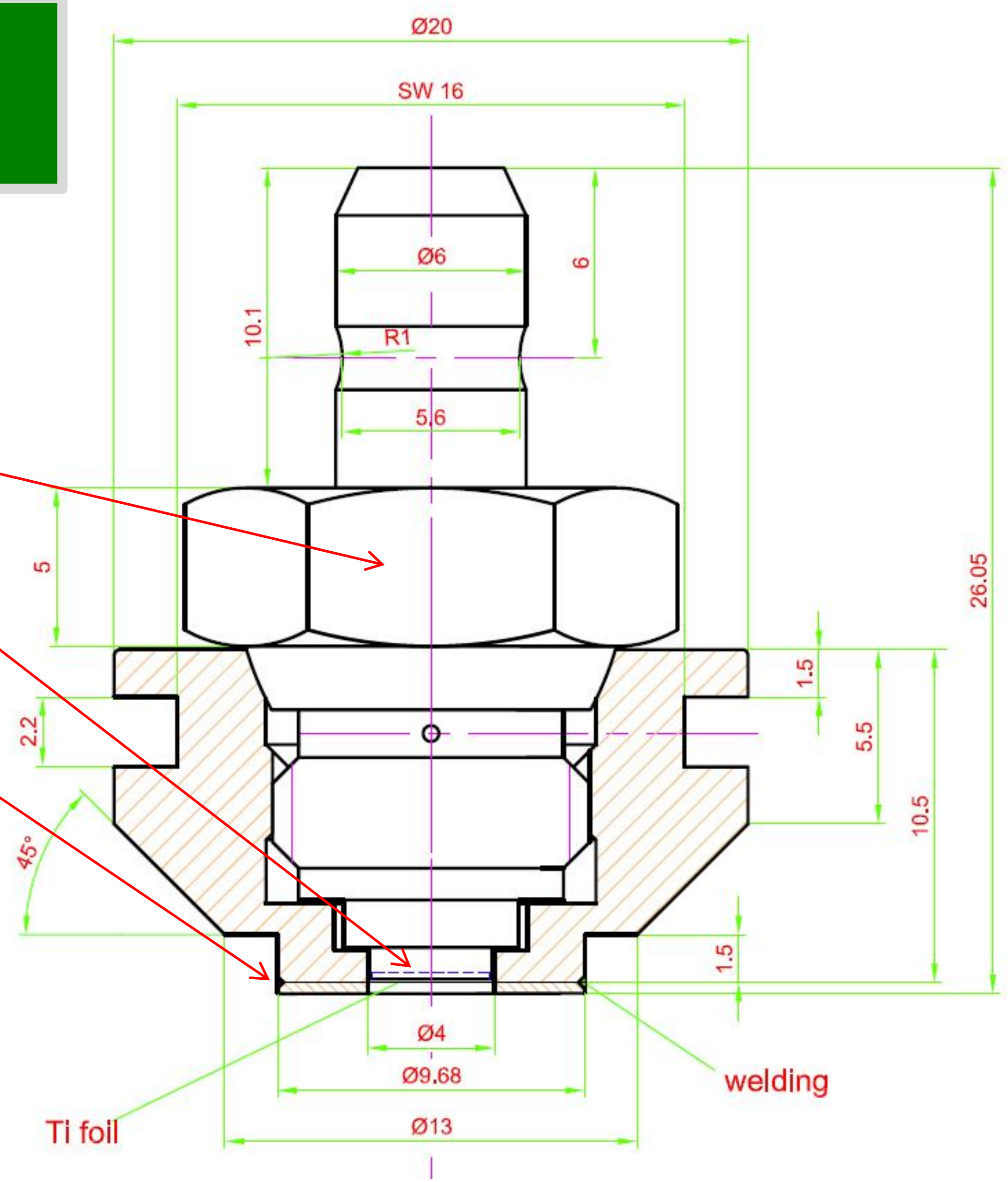
Requirements of the source capsule

- the capsule has to fulfill the following conditions
  - fully UHV-compatible (individual He leak test for each capsule)
  - bakeable up to 200°C
  - operation at 4 K for solid rare-gas moderators
  - many cycles from RT to 4K possible
  - Version for mechanical compatibility to former NEN-source
  - internal volume for generated Ne gas; volume large enough for overpressure

- Overpressure after complete decay of source
  - 50 mCi -> 2.2×10^{17} Ne atoms -> volume for 1 bar = 9.1 mm^3
  - opening in capsule: 77 mm^3 -> maximum extra pressure 0.12 bar
  - capsule is tested to stand 6 bar overpressure

Realization as full Ti capsule

- the capsule consists of 3 parts:
  - back part with stand and gas volume inside
  - high-Z Ta reflection plate
  - front part with welded-in 5µm Ti front foil (e^+ absorption 8%)
- stud can also have different metric or inch threads
- after filling, the capsule is closed by a torque spanner with defined torque
- radiation safety measures: see talk of Clive Naidoo



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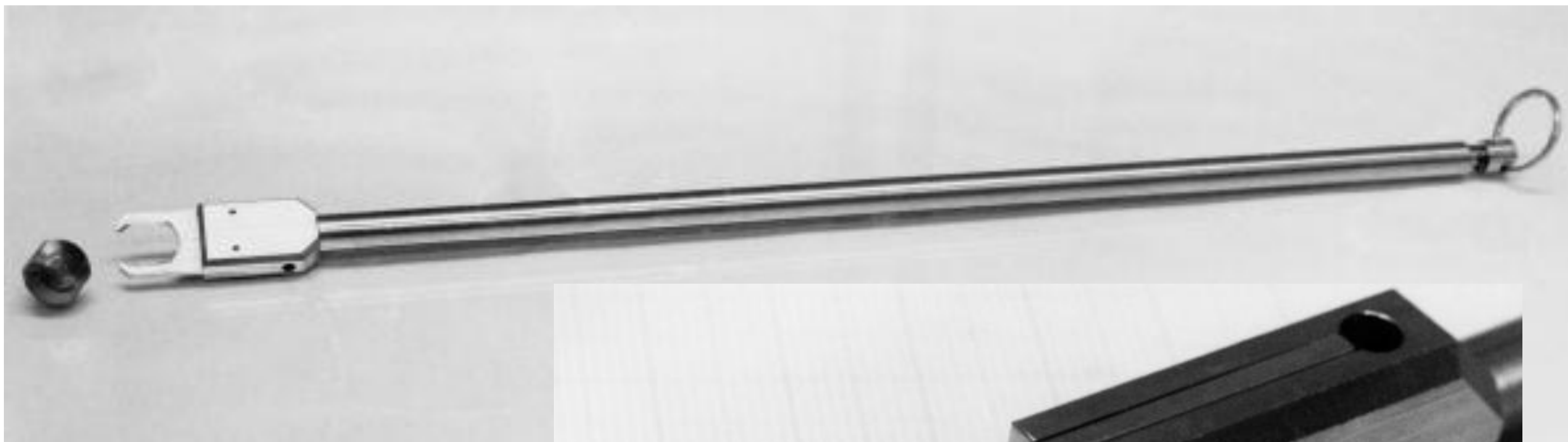
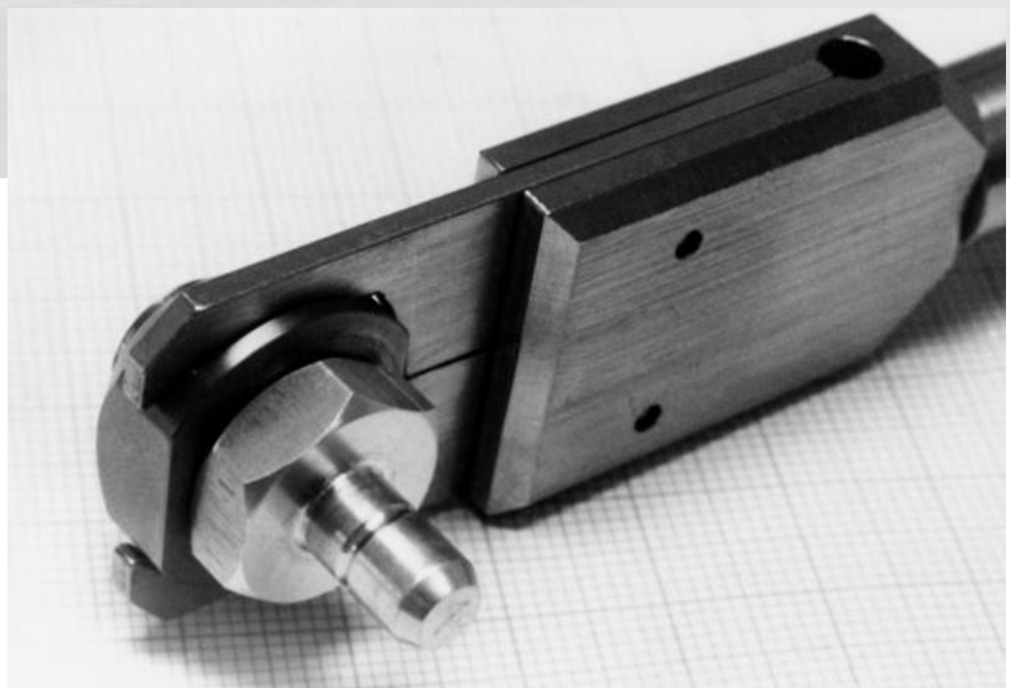
Manipulator exist for large version of source capsule

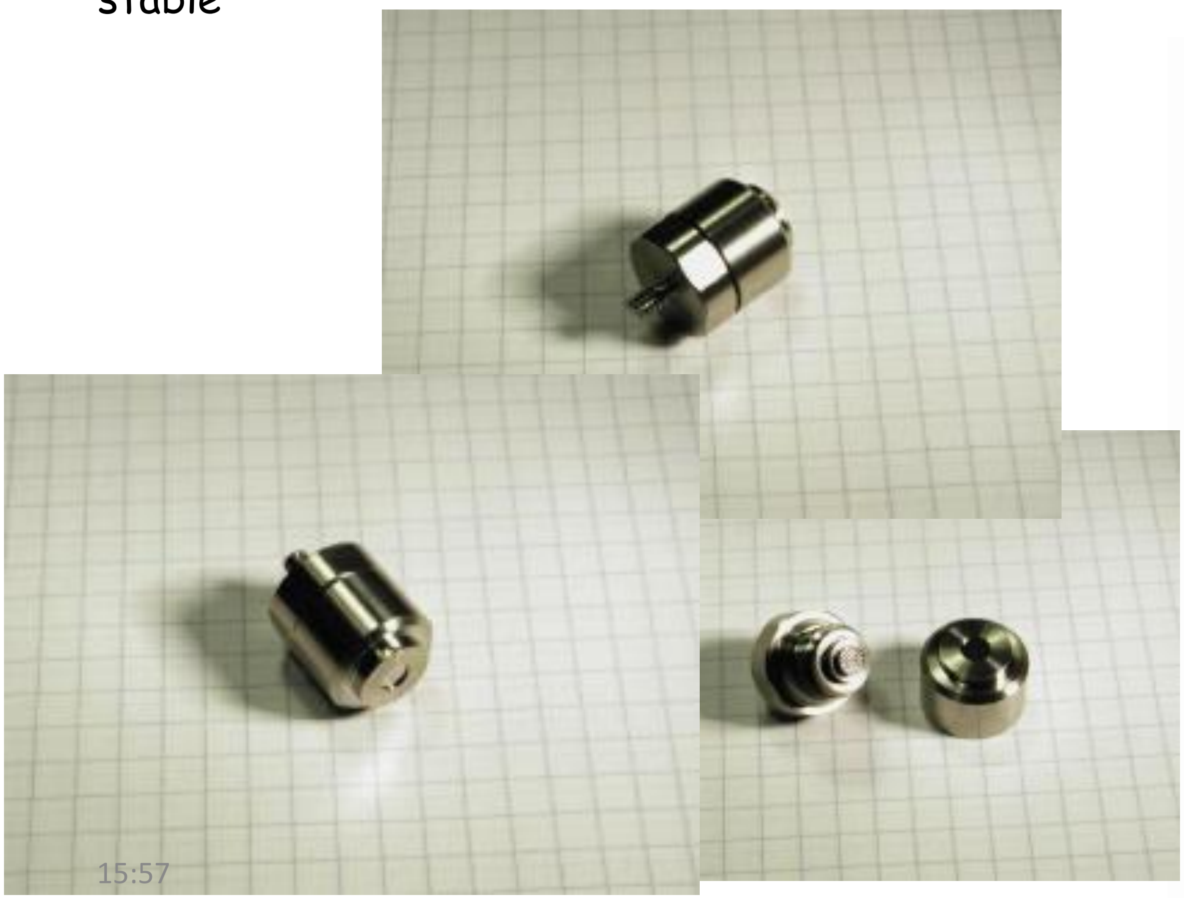
- AutoCad drawings (made by Munich colleagues) exist on our home page: http://positron.physik.uni-halle.de/source.html

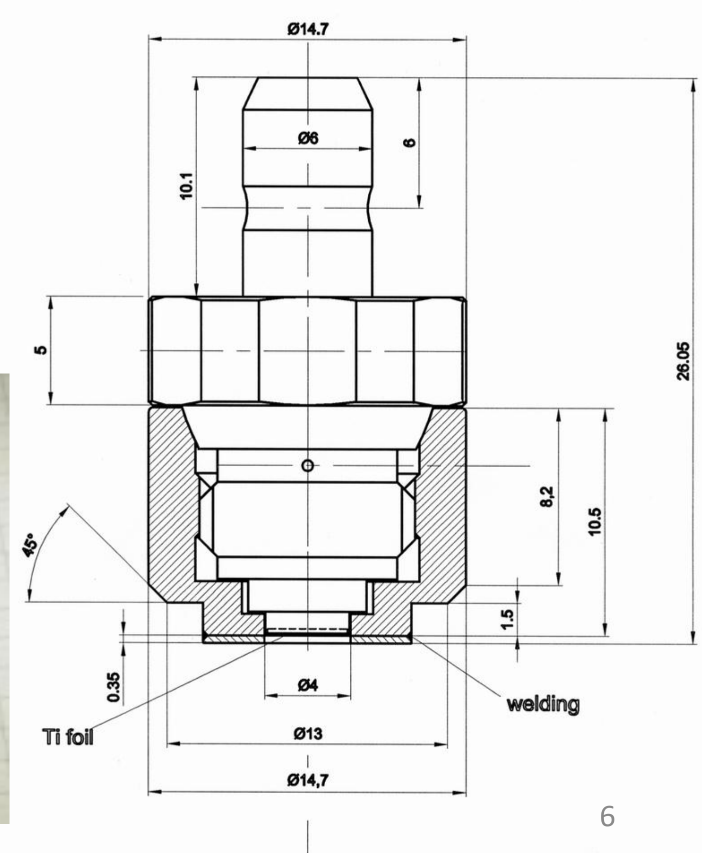




Small version exist: compatible to earlier NEN source

- it is the same source: just peeled of the larger version of the source
- diameter 14.7 mm according to the old source made by NEN
- my suggestion for new projects: use the large version; it is better to handle and more stable



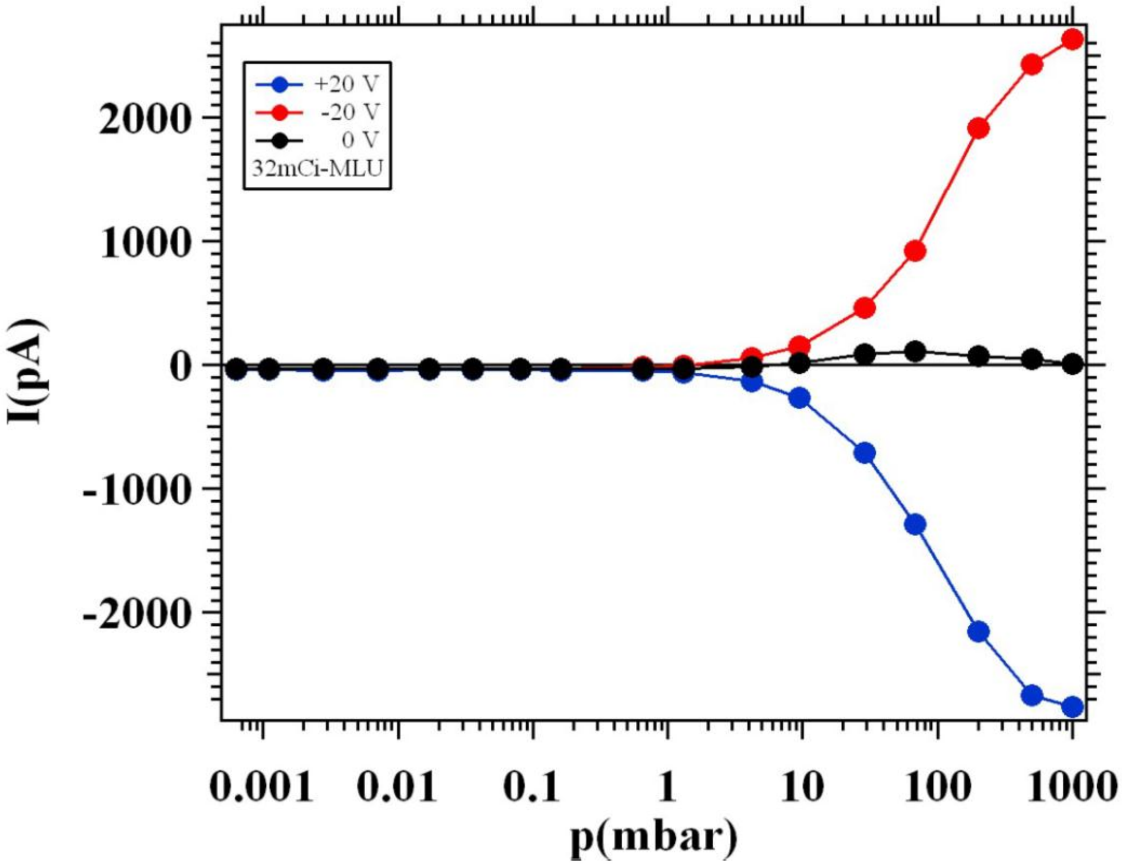


Diagnostics: current measurements to determine the beta activity

- Idea: electrical current from the source to the wall of the vacuum chamber
- (for my knowledge) first realized at TU Helsinki
- problem: generation of carriers by positrons and gammas at chamber walls (secondary electrons)
- vacuum necessary to avoid charging of rest gas ($< 10^{-2}$ mbar)

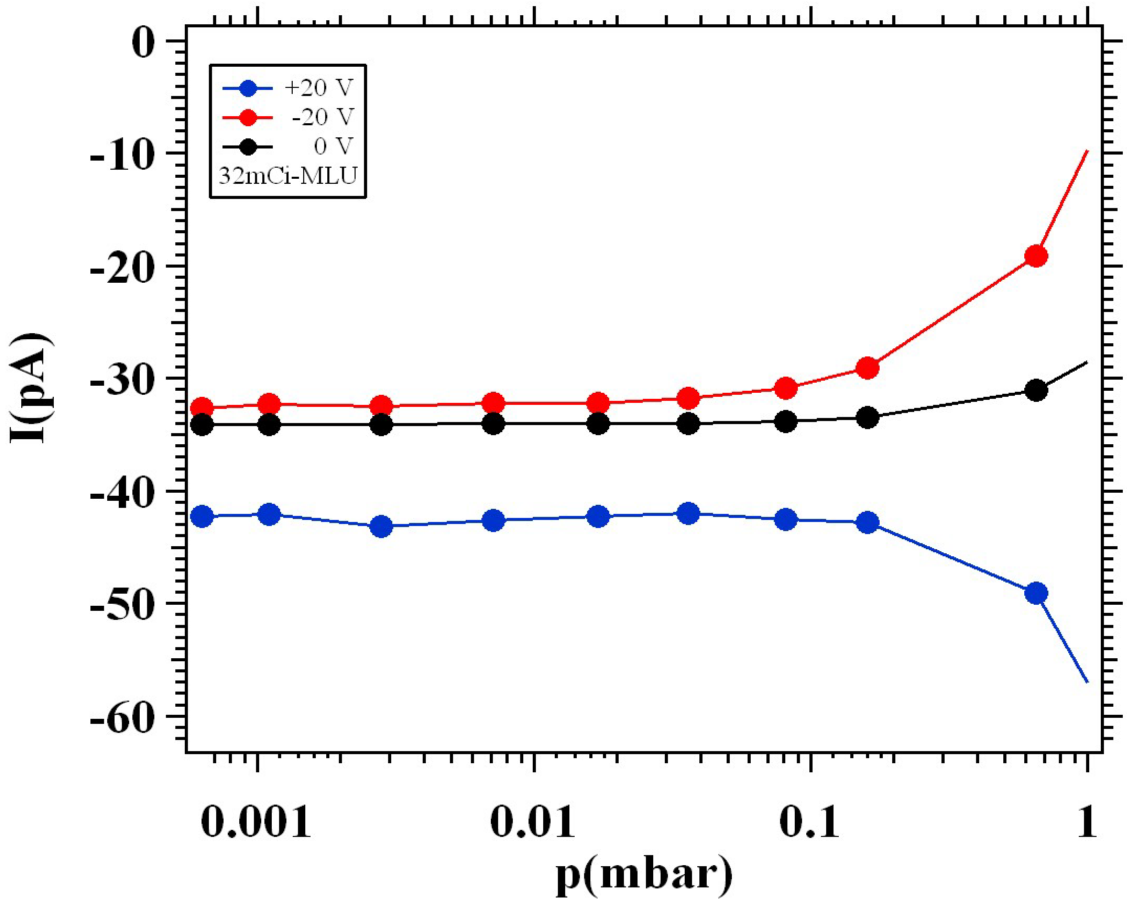
Diagnostics: current measurements to determine the beta activity

- at pressures over 1 mbar: charged particles of the rest gas dominates
- charging by beta particles and gammas



Diagnostics: current measurements to determine the beta activity

- at pressures < 0.01 mbar: no effect of gas any more
- positrons produce secondary electrons when hitting the wall of the chamber
- negative bias voltage at the source suppresses this effect
- from the current I one can obtain the beta efficiency



Diagnostics: current measurements to determine the beta activity

The gamma activity of the source can be calculated from the gamma dose rate at a distance r:

$$A_\gamma = \frac{\dot{H} \cdot r^2}{\Gamma_H} \quad \text{mit } \dot{H} \text{ ... } \gamma\text{-dose rate; } r \text{ ... distance source-detector}$$

$$\Gamma_H \text{... gamma constant for } {}^{22}\text{Na} = 322 \frac{\mu Sv \cdot m^2}{h \cdot GBq} \quad .$$

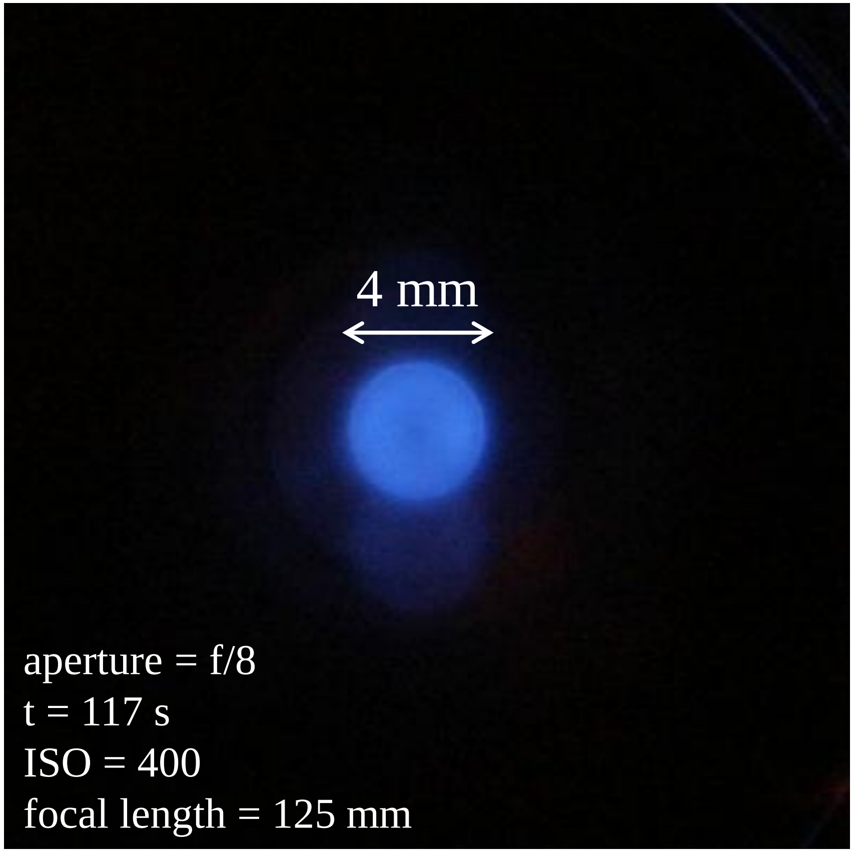
the beta efficiency is then: $\eta_\beta = \frac{N_\beta}{A_\gamma \cdot 0.905}$ N_β ... number of positrons leaving the front window

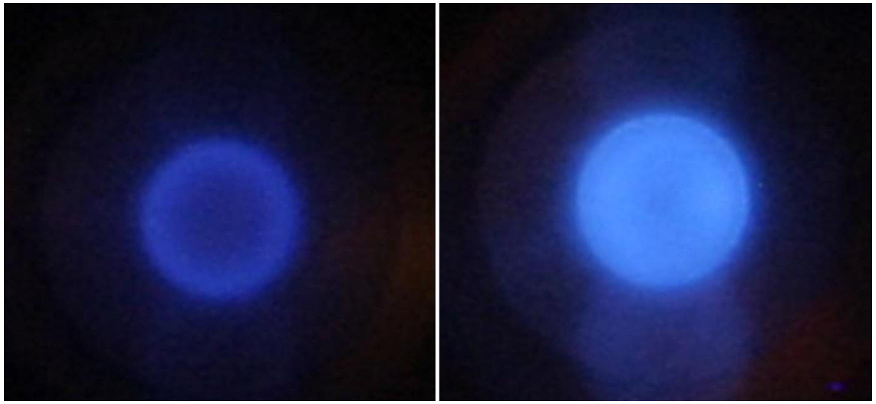
$$N_\beta = \frac{I}{1.602 \cdot 10^{-19} As} \quad \text{thus} \quad \eta_\beta = \frac{I}{A_\gamma \cdot 0.905 \cdot 1.602 \cdot 10^{-19} As}$$

the current I is in the order of 10…30 pA. Care must be taken to **avoid hiss and earth loops**. We used batteries in a shielded box for the source capsule bias. The obtained beta efficiency was found for several capsules to be 18…28%. One might expect 45…50% (8 % absorption in the Ti Window, but use of Ta reflection plate).

Diagnostics: lateral resolution of beta source using a thin plastic scintillator

- A thin plastic scintillator (0.3 mm) is placed directly on top of the source capsule
- photos can be done from a tripod using long-time exposure



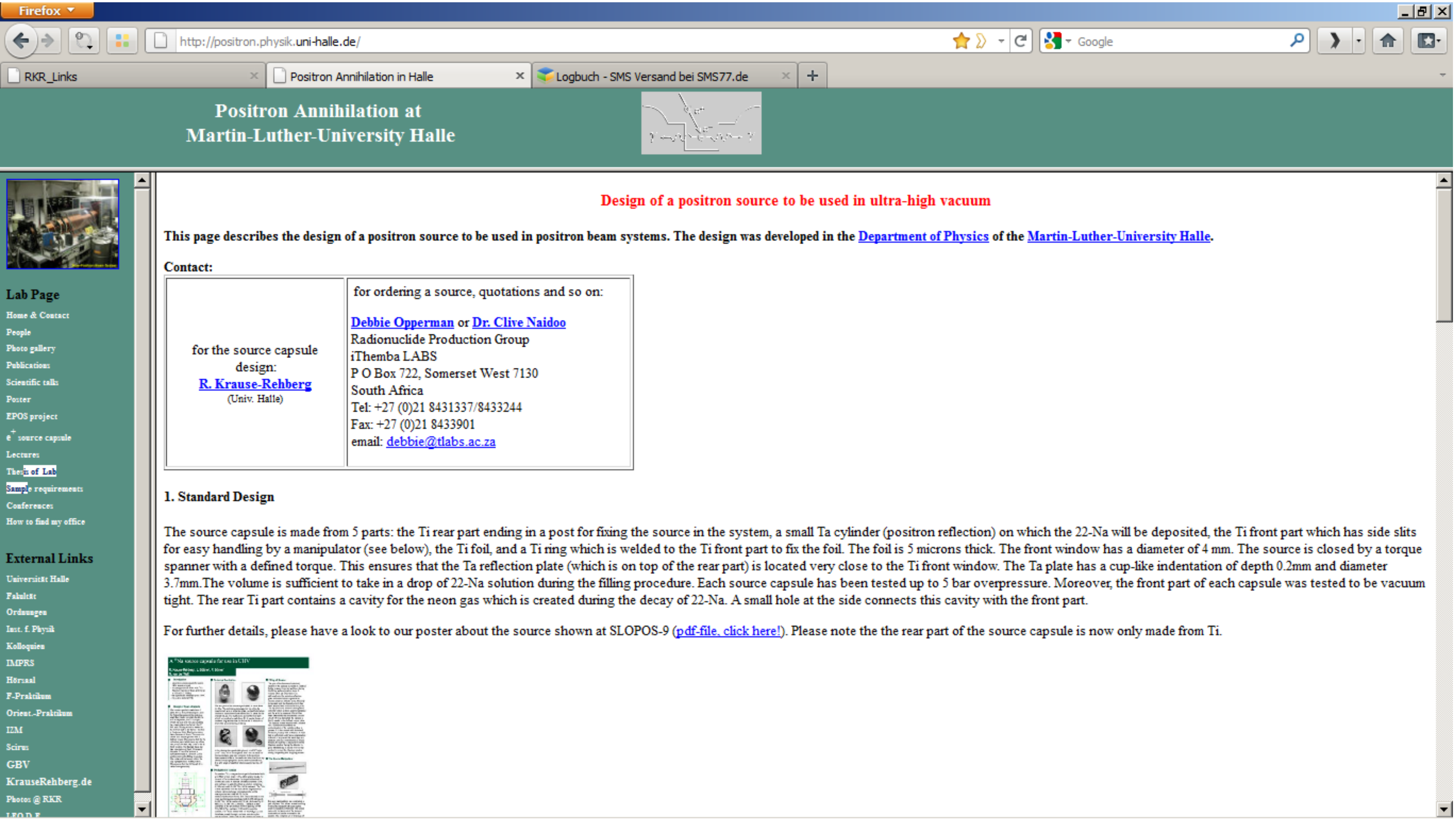


Comparison of two sources

Talk available at http://positron.physik.uni-halle.de

Information on source capsule at http://positron.physik.uni-halle.de

- just google "Positron"



Firefox

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Design of a positron source to be used in ultra-high vacuum

This page describes the design of a positron source to be used in positron beam systems. The design was developed in the Department of Physics of the Martin-Luther-University Halle.

Contact:

for the source capsule design:	for ordering a source, quotations and so on:
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1. Standard Design

The source capsule is made from 5 parts: the Ti rear part ending in a post for fixing the source in the system, a small Ta cylinder (positron reflection) on which the 22-Na will be deposited, the Ti front part which has side slits for easy handling by a manipulator (see below), the Ti foil, and a Ti ring which is welded to the Ti front part to fix the foil. The foil is 5 microns thick. The front window has a diameter of 4 mm. The source is closed by a torque spanner with a defined torque. This ensures that the Ta reflection plate (which is on top of the rear part) is located very close to the Ti front window. The Ta plate has a cup-like indentation of depth 0.2mm and diameter 3.7mm.The volume is sufficient to take in a drop of 22-Na solution during the filling procedure. Each source capsule has been tested up to 5 bar overpressure. Moreover, the front part of each capsule was tested to be vacuum tight. The rear Ti part contains a cavity for the neon gas which is created during the decay of 22-Na. A small hole at the side connects this cavity with the front part.

For further details, please have a look to our poster about the source shown at SLOPOS-9 (pdf-file, click here!). Please note the the rear part of the source capsule is now only made from Ti.