Meson Production Targets at PSI

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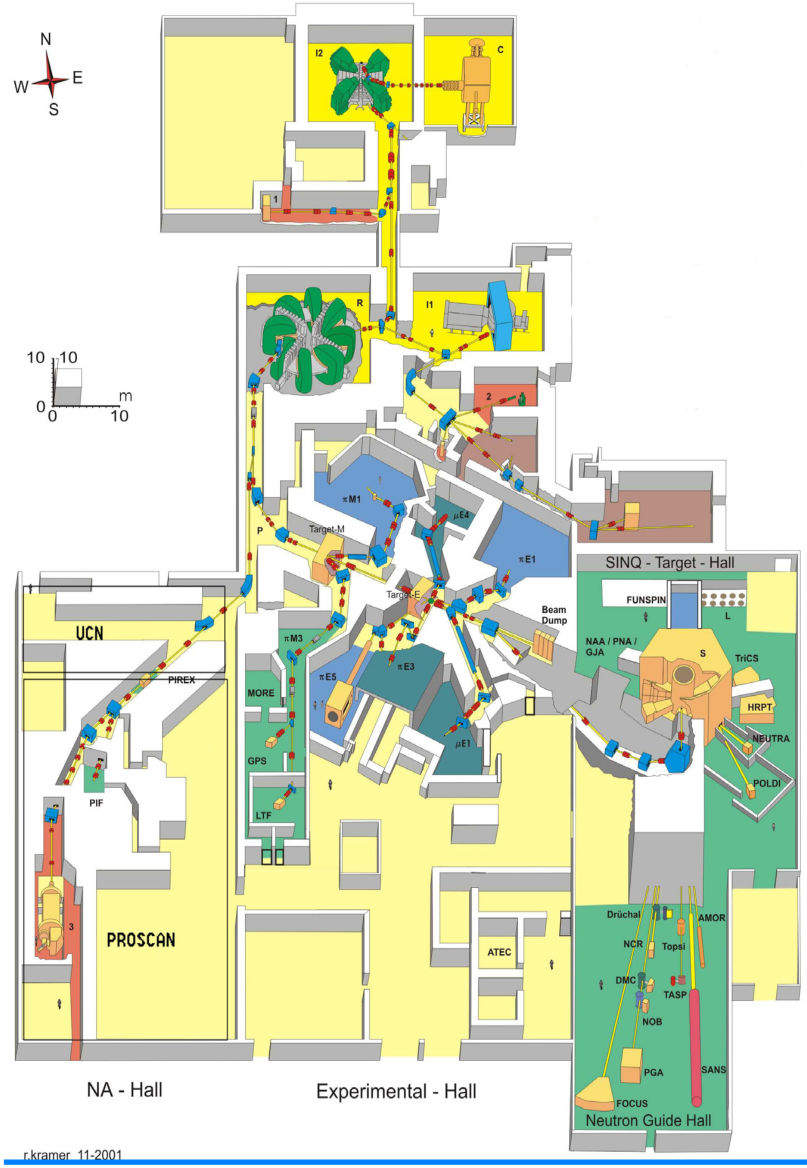
Accelerator Facilities at PSI



- P-beam: 590 MeV, 1.8 mA (1 MW DC)
- 2 meson production targets:
  - Target “M“ (5 mm graphite)
  - Target “E“ (40 or 60 mm graphite)
- Spallation neutron source SINQ
- Proton therapy
- Two new project under construction
  - Ultra Cold Spallation Neutron Source UCN
  - PROSCAN (250 MeV cyclotron for proton therapy)

PAUL SCHERRER INSTITUT PSI

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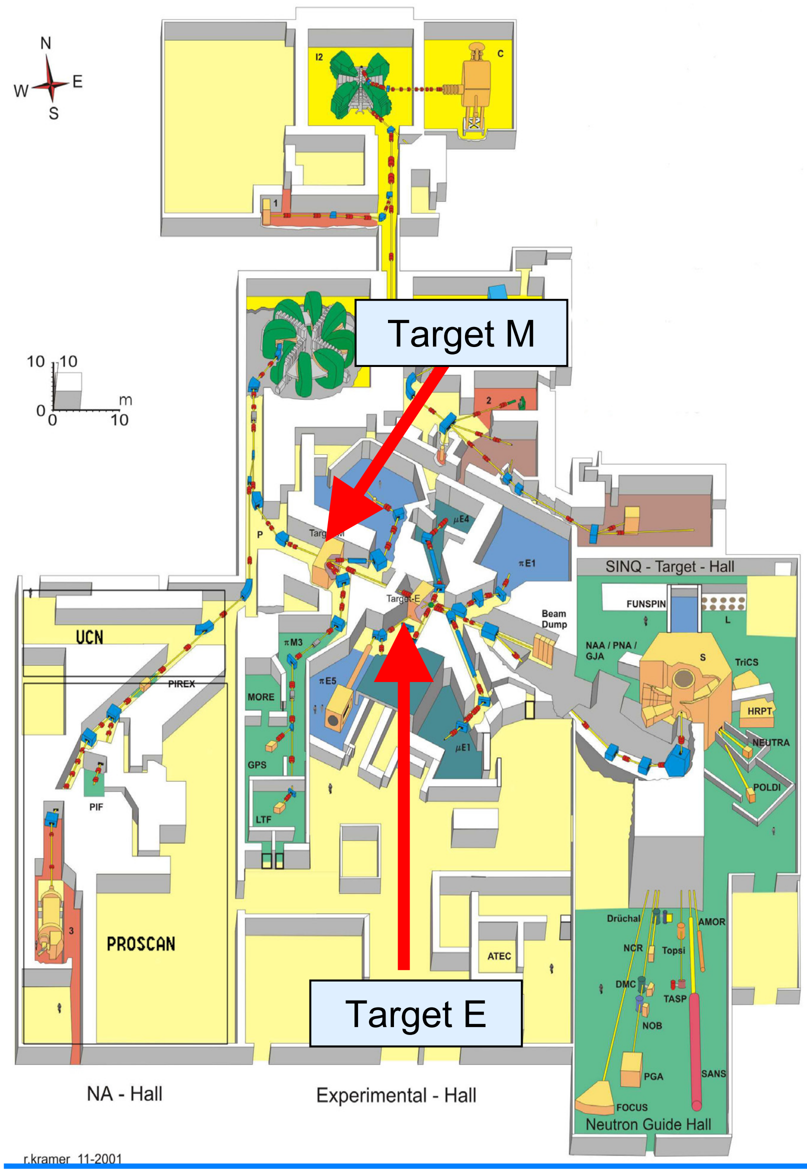

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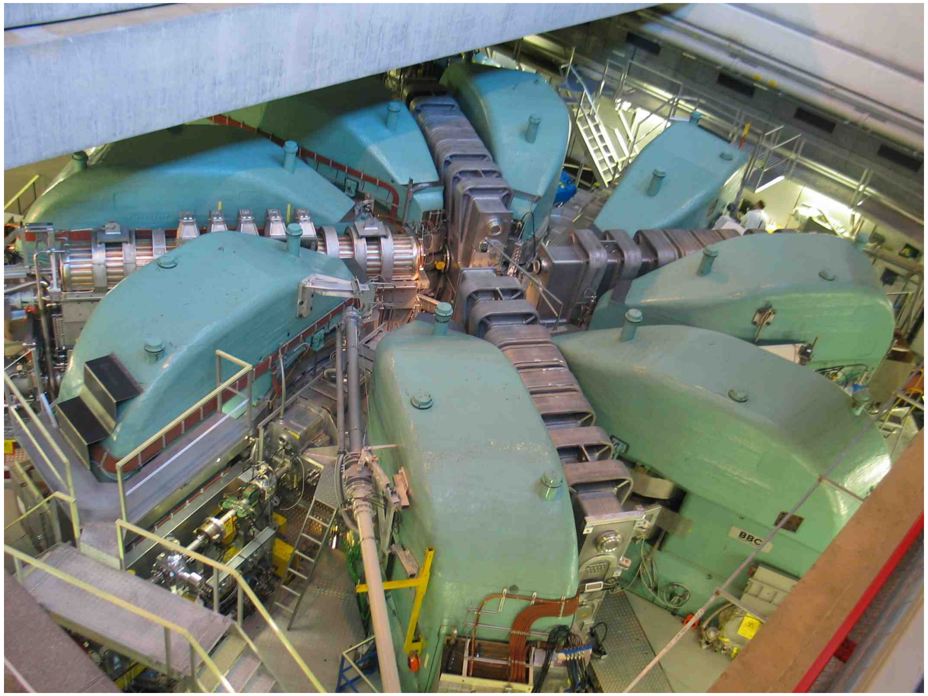
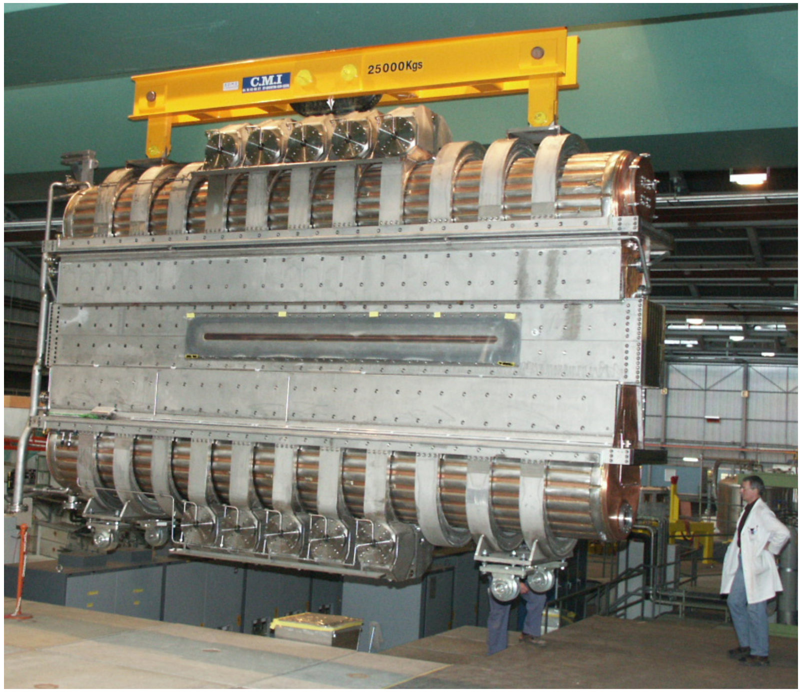
590 MeV Ring Cyclotron



New copper RF-cavities will allow a beam current of up to 3 mA in future

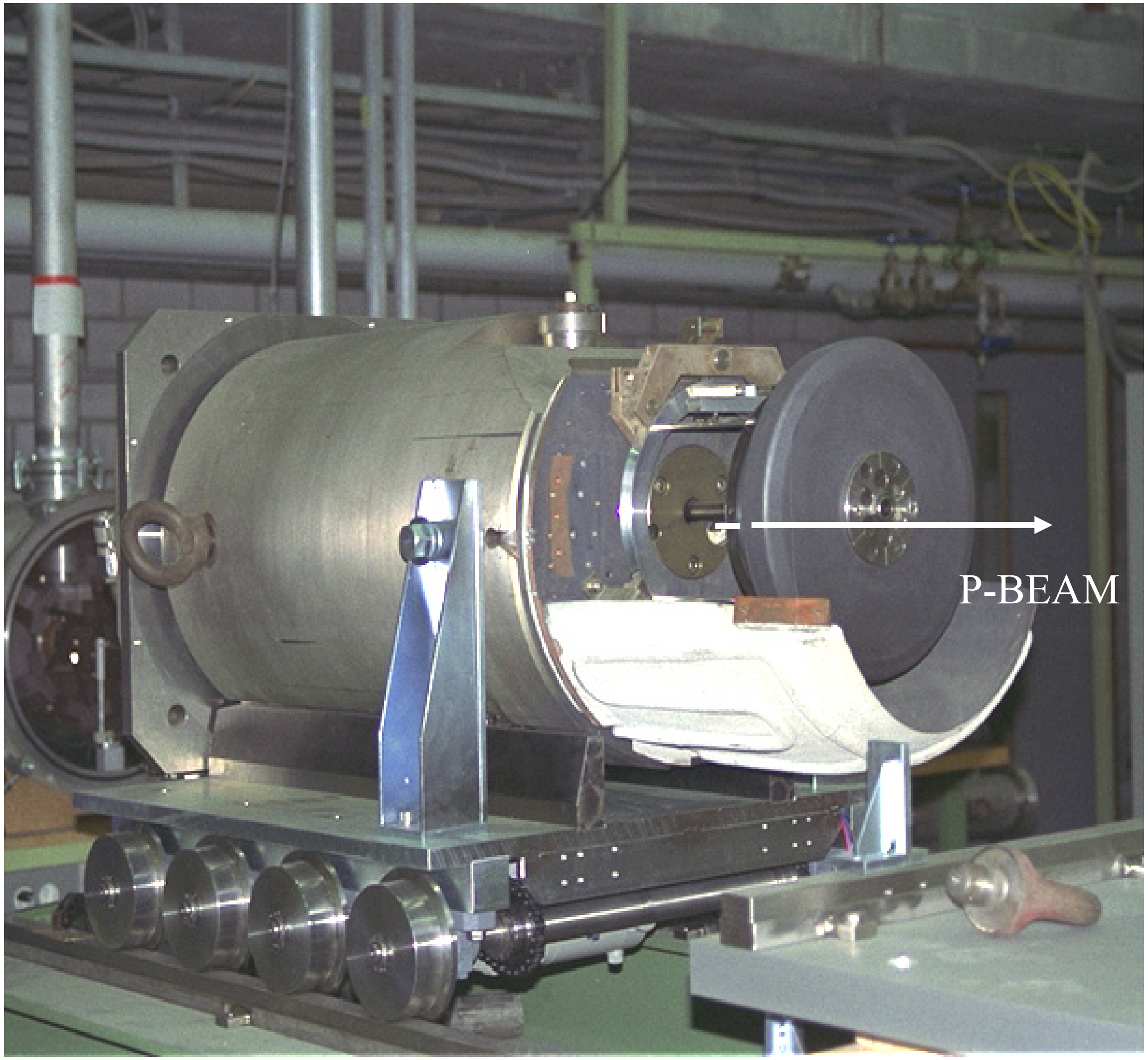


Meson production targets used at PSI

		Target M	Target E
1974-80	< 100 μA	**Be, Graphite *)** ∅ 190 mm 0.9 g/cm²	**Be, Graphite *)** ∅ 190 mm 22 g/cm² **Pyrolitic graphite**)** 22 g/cm²
1980-89	250 μA	**Graphite *)** ∅ 320 mm 0.9 g/cm²	**Graphite *)** ∅ 280 mm 18 g/cm²
since 1990	0.5 - 2 mA	**Graphite *)** ∅ 320 mm 0.9 g/cm²	**Graphite *)** ∅ 450 mm 10 g/cm² (60 mm) or 7 g/cm² (40 mm)

*) rotating wheel target **) static target

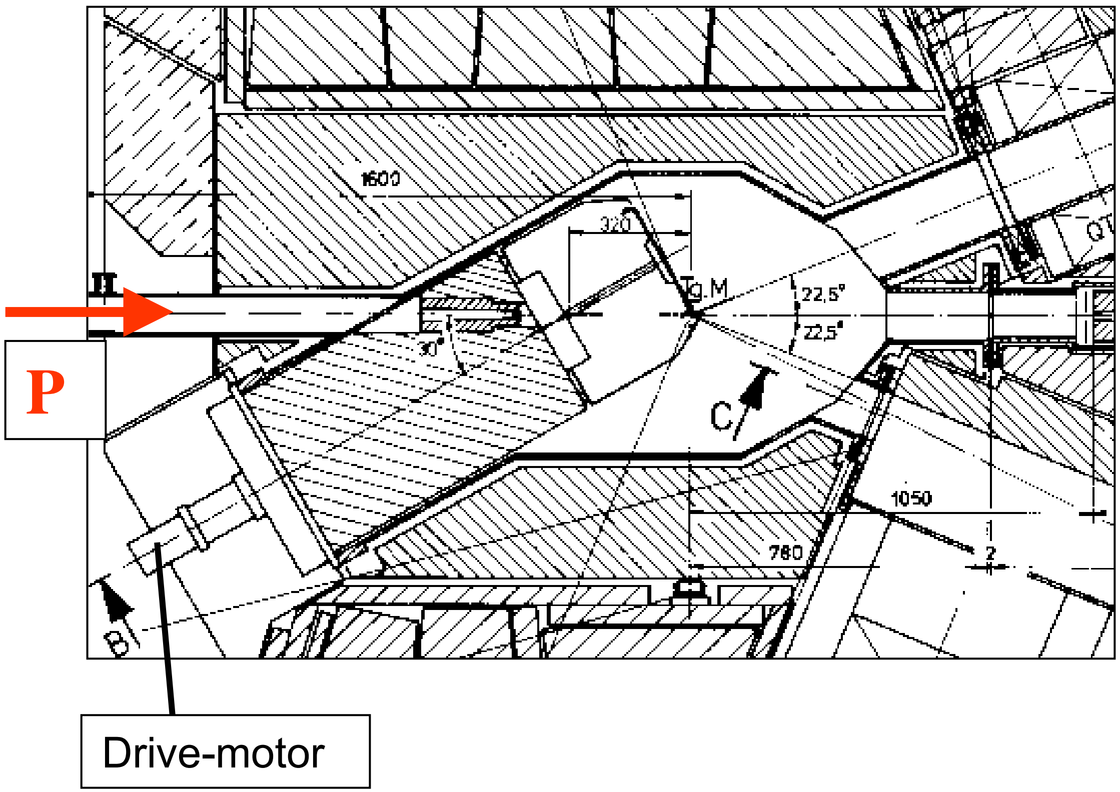
Target-M design



Target M:

Mean diameter:	320 mm
Target thickness:	5.2 mm
Target width:	20 mm
Graphite density:	1.8 g/cm^3
Beam loss:	1.6 %
Power deposition:	2.4 kW/mA
Operating Temperature:	1100 K
Irradiation damage rate:	0.12 dpa/Ah
Rotational Speed:	1 Turn/s

Target-M design



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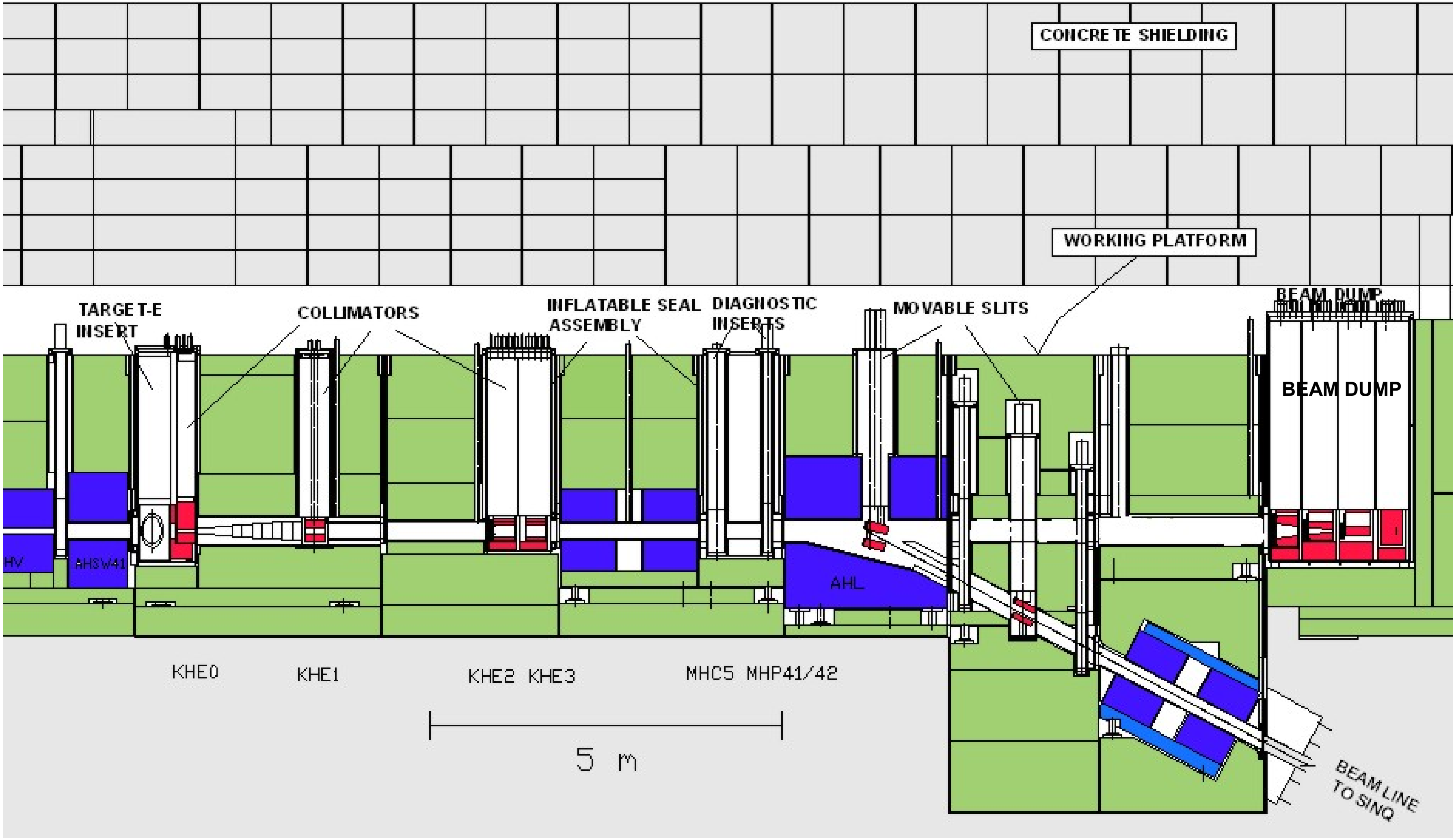
Exchange of Target-M

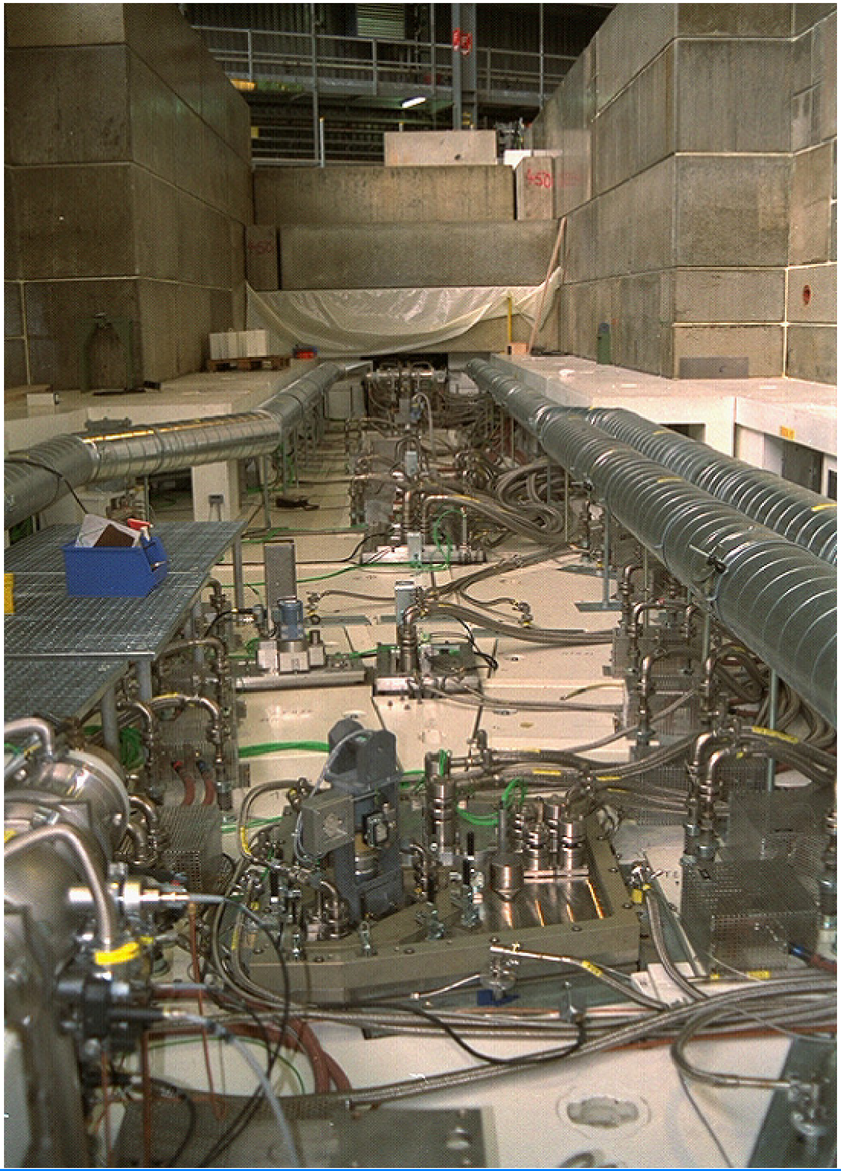
Operation of the remotely controlled shielded flask

Dose rate ~10 mSv/h

Design of the proton channel between target-E and the beam dump

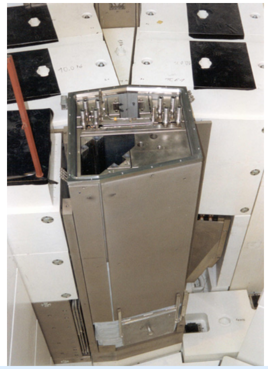


Working platform / Operation of the remotely controlled shielded flask

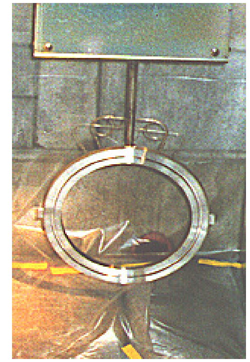


Design of Target station E

BACKWARD SHIELDING

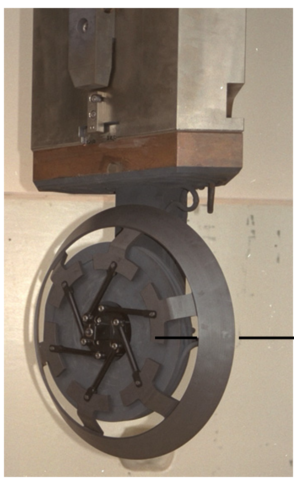


TARGET CHAMBER



INFLATABLE ALL-METAL SEAL

COLLIMATOR 2 & 3
Beam losses: 22/18 %



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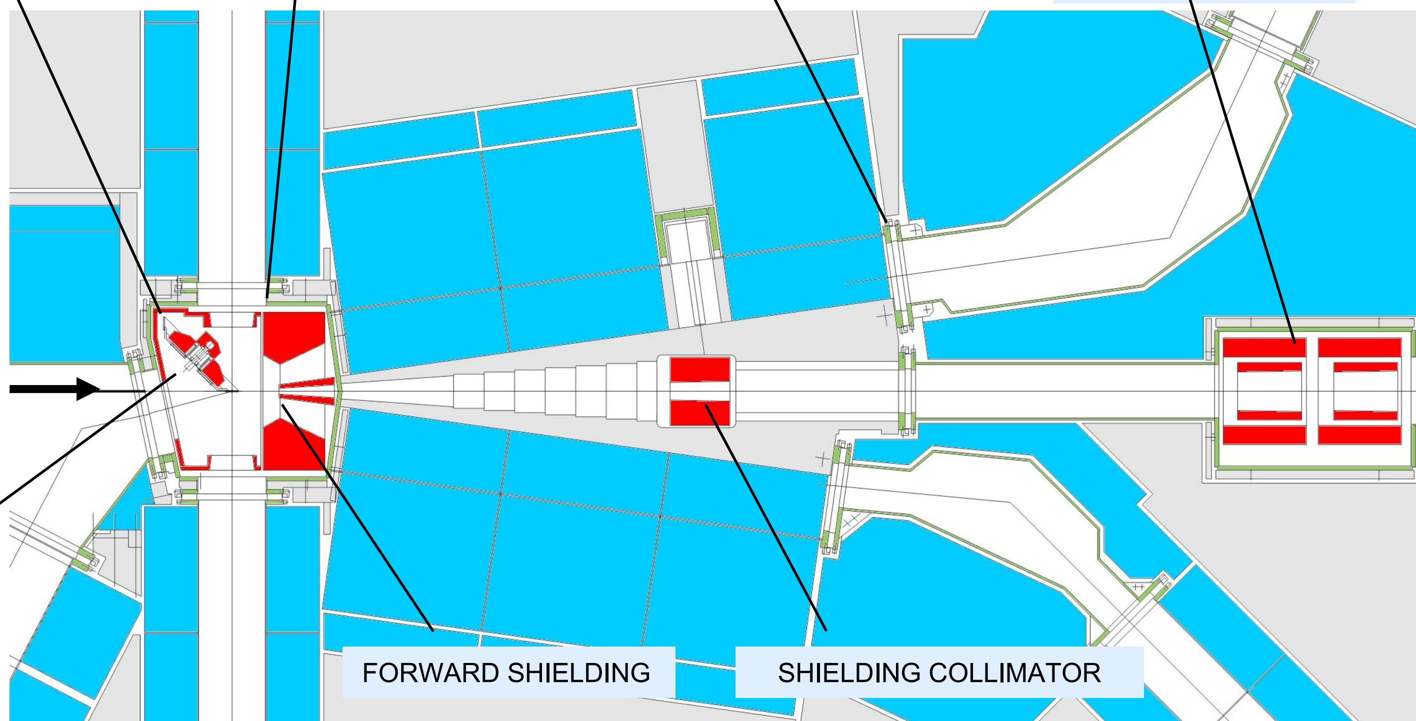
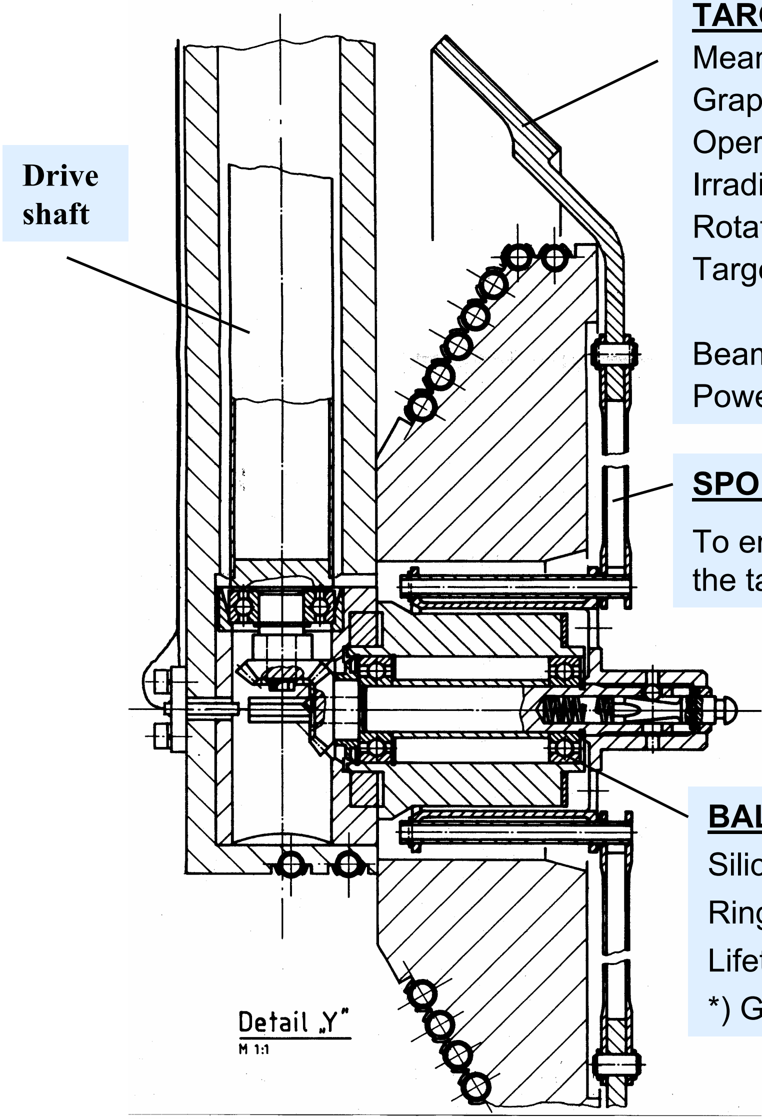
TARGET E: 6/4cm
Beam losses: 18/12 %



FORWARD SHIELDING

SHIELDING COLLIMATOR

Target-E design



TARGET CONE

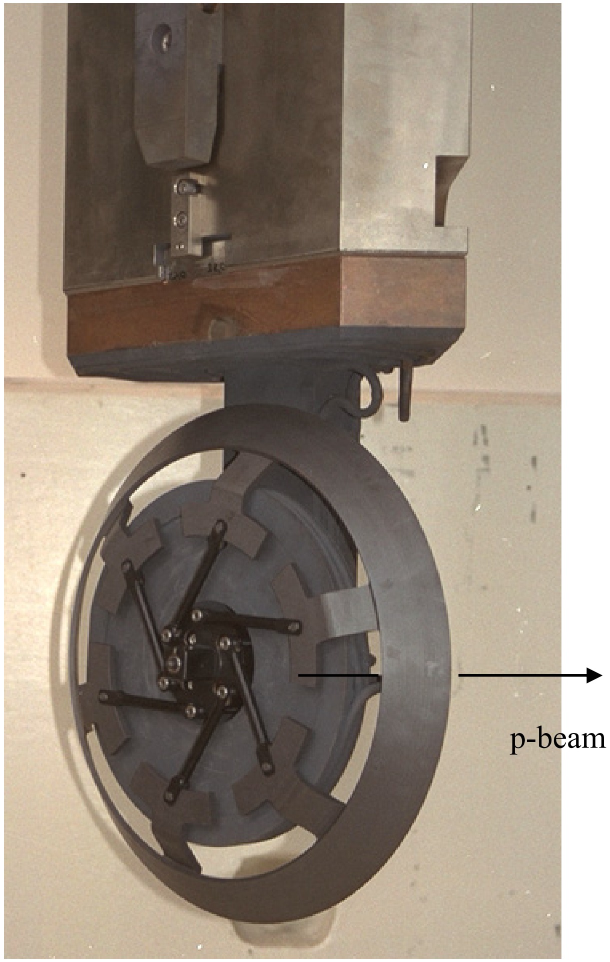
Mean diameter: 450 mm
Graphite density: 1.8 g/cm^3
Operating Temperature: 1700 K
Irradiation damage rate: 0.1 dpa/Ah
Rotational Speed: 1 Turn/s
Target thickness: 60 / 40 mm
10 / 7 g/cm^2
Beam loss: 18 / 12 %
Power deposition: 30 / 20 kW/mA

SPOKES

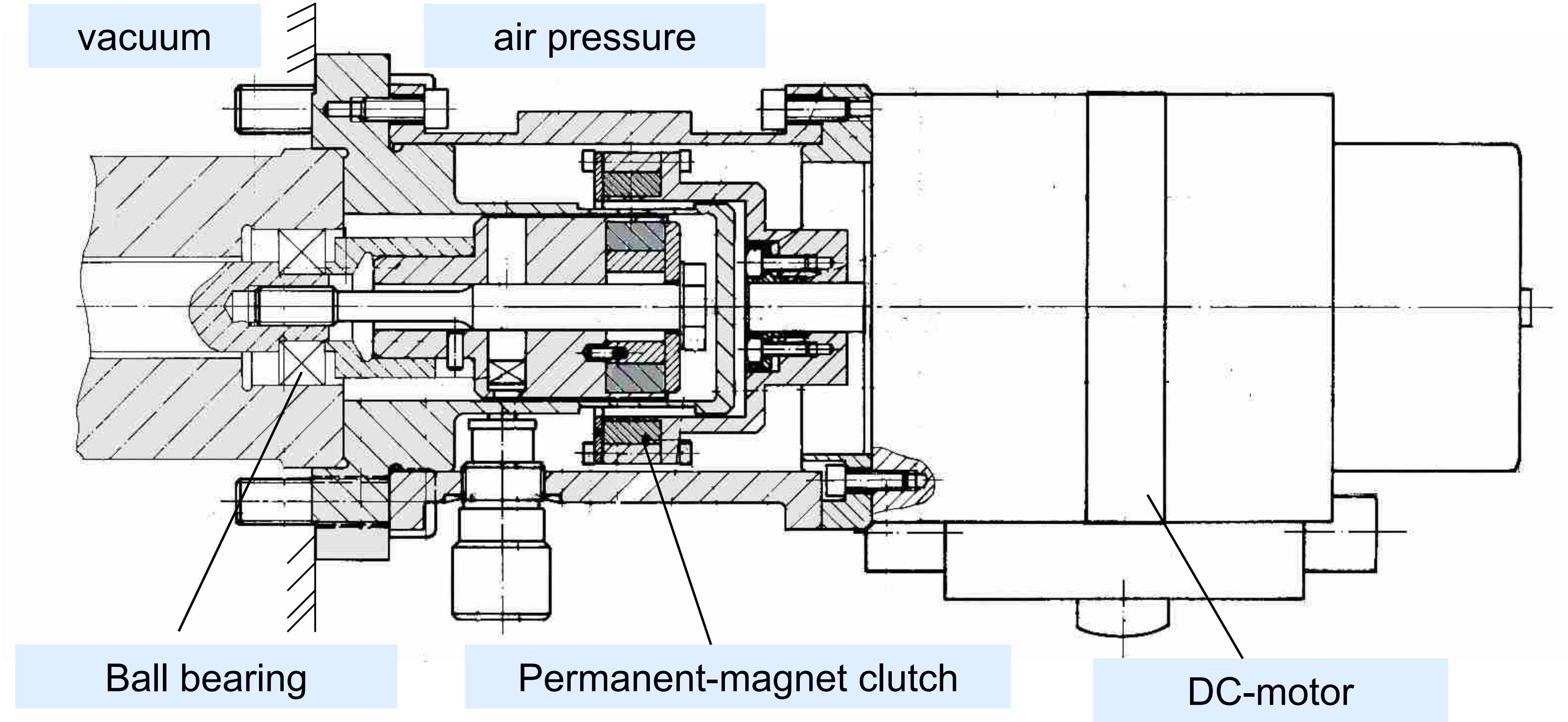
To enable the thermal expansion of the target cone

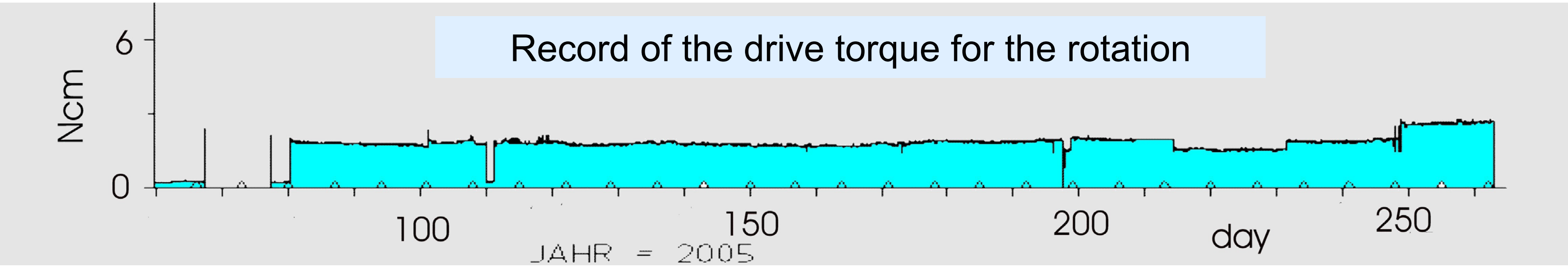
BALL BEARINGS *)

Silicon nitride balls
Rings and cage silver coated
Lifetime 2 y
*) GMN, Nürnberg, Germany



Drive motor & permanent-magnet clutch

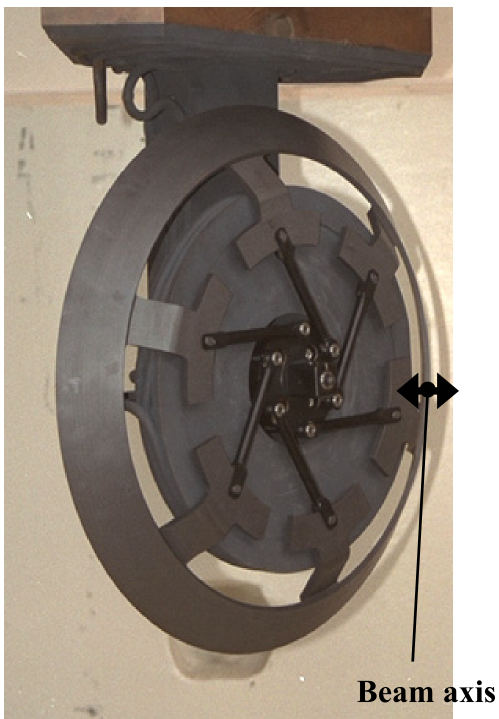


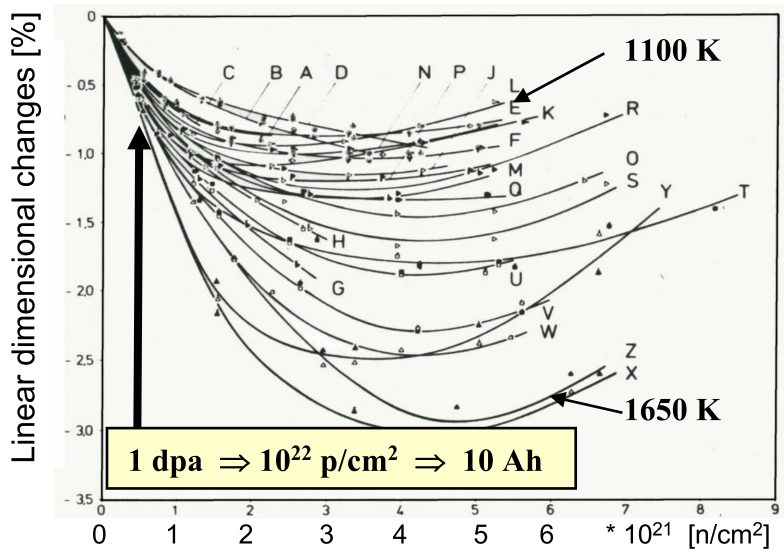


Lifetime of the rotating polycristalline graphite target cones due to irradiation-induced dimensional changes

The design of the spokes allow the **isotropic shrinkage** of the graphite.

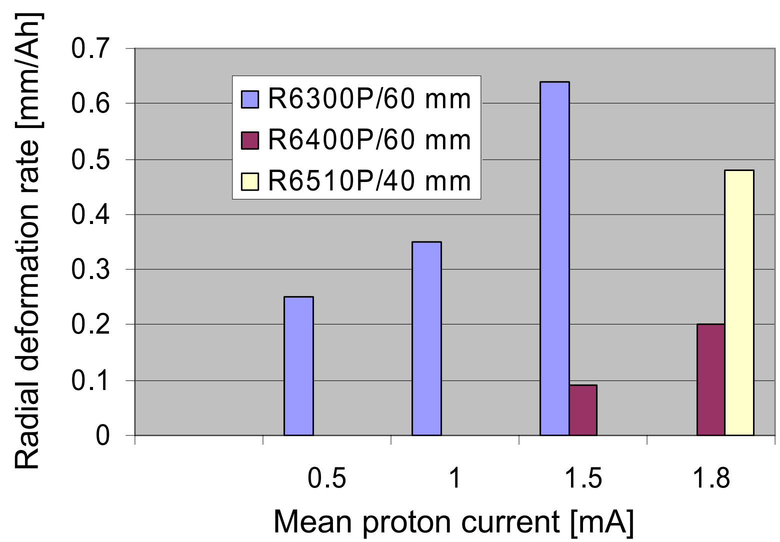
Anisotropic dimensional changes causes deformation of the shape and hence leads to a radial wobble.





Irradiation induced isotropic shrinkage of polycristalline graphite as a function of neutron fluence and temperature.

W. Delle, Juelich 1980



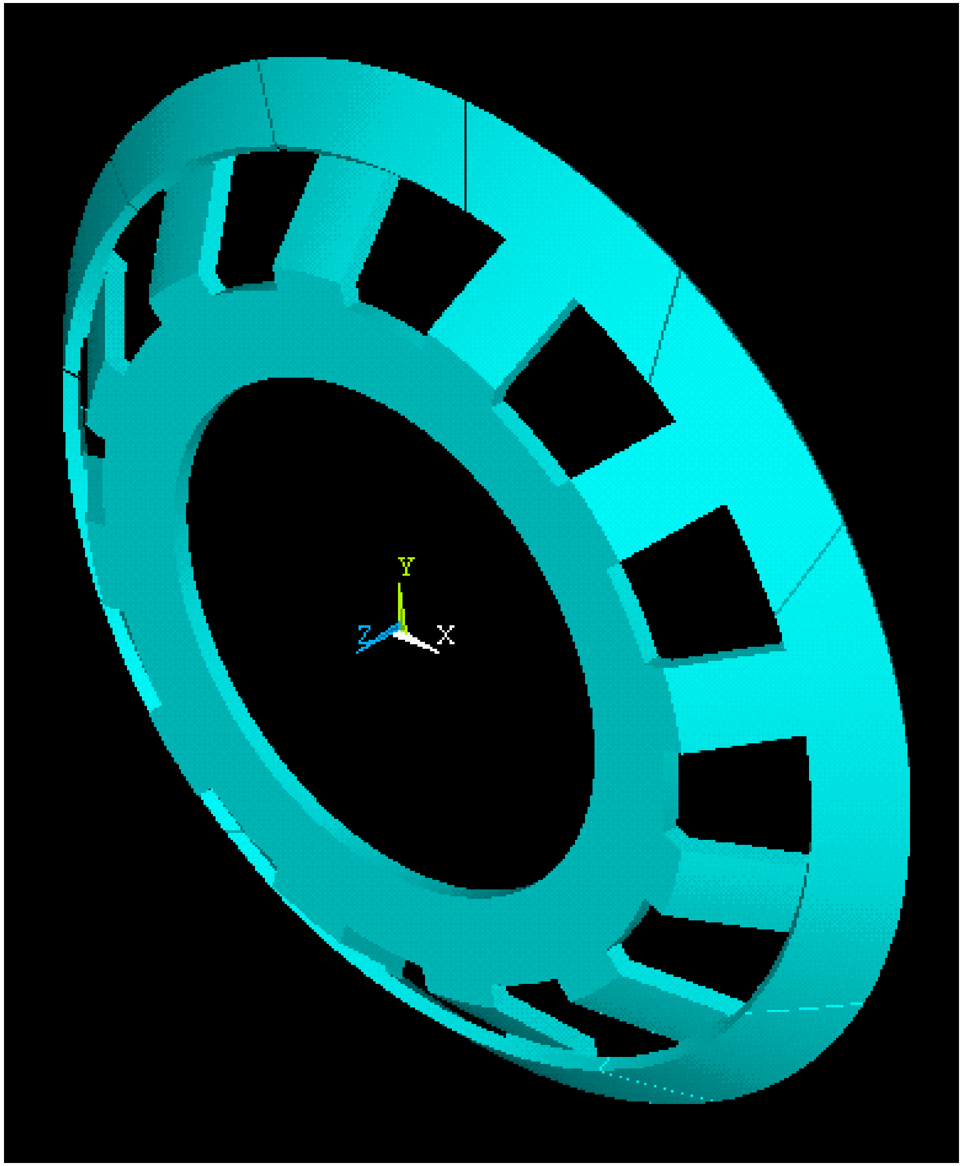
Radial deformation rates of the graphite cones as a function of proton current for different graphite grades *).

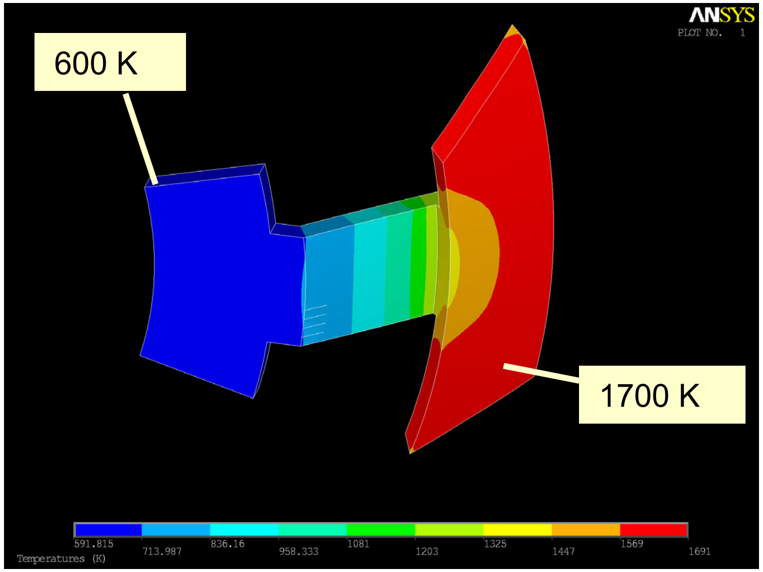
*) SGL Carbon

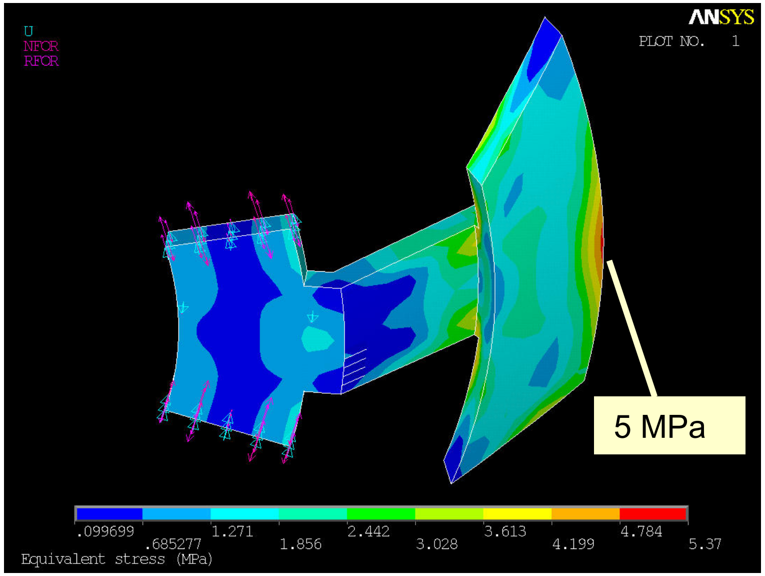
2nd High-Power Targetry Workshop, Oak Ridge, TN, October 10-14, 2005 / G. Heidenreich

A new design of graphite wheel

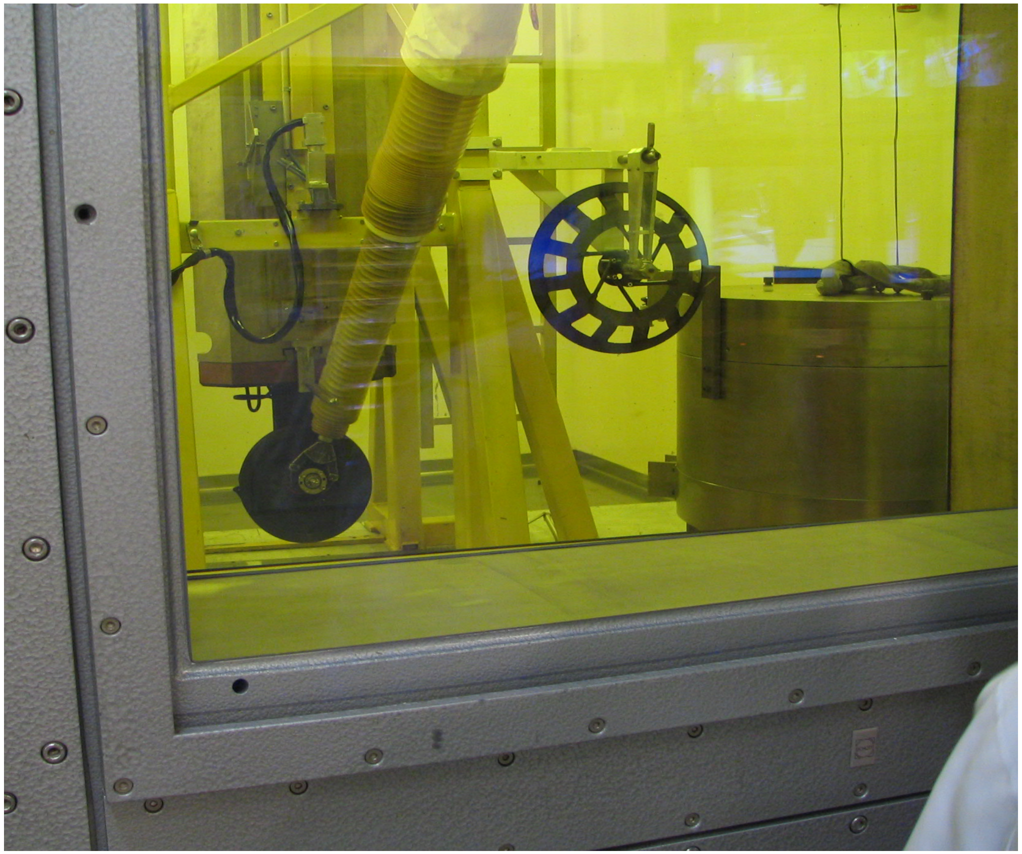
Temperature & stress distribution (2mA, 40 kW)



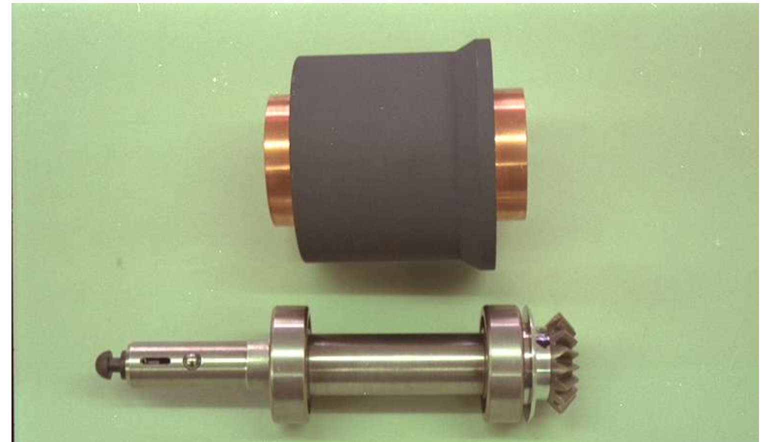




Maintenance of the target-insert in the hot-cell

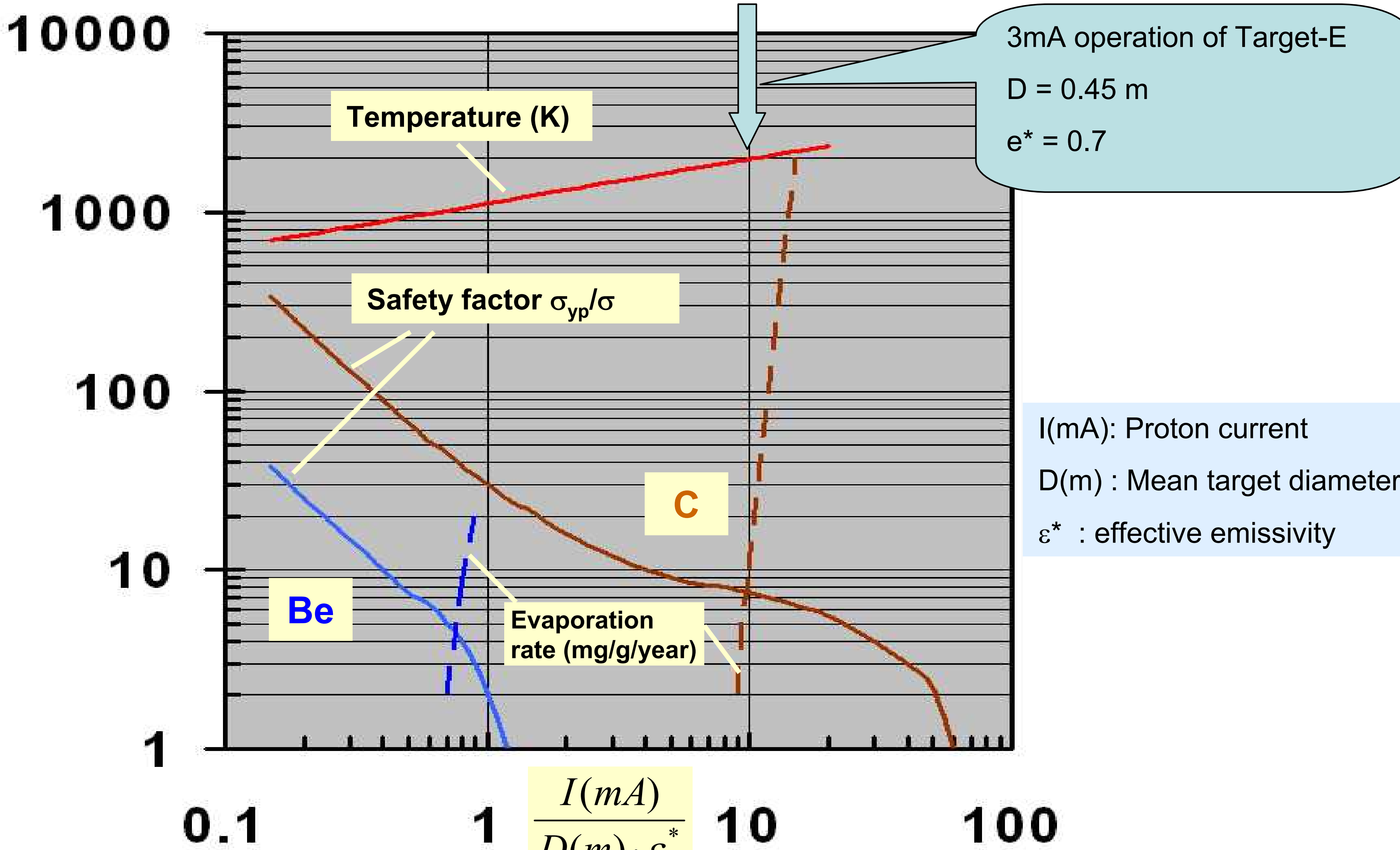


Exchange parts:



horizontal drive shaft

Operational limits of the rotating graphite & beryllium cones for target-E



$$\frac{I(mA)}{D(m)\cdot\varepsilon^*}$$

I(mA): Proton current

D(m) : Mean target diameter

ε^* : effective emissivity

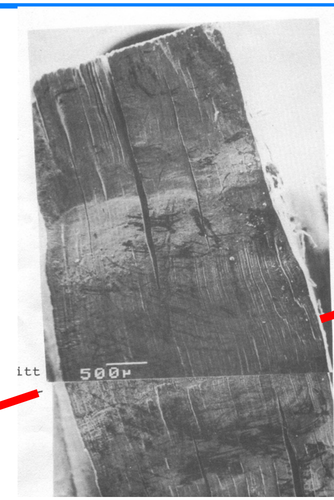
Lifetime of the pyrolitic graphite targets due to irradiation-induced dimensional changes

<u>Operational parameters:</u>

Proton current:	100 μA
Peak current density:	1000 μA/cm²
Peak temperature:	1800 K

<u>Lifetime limits:</u>

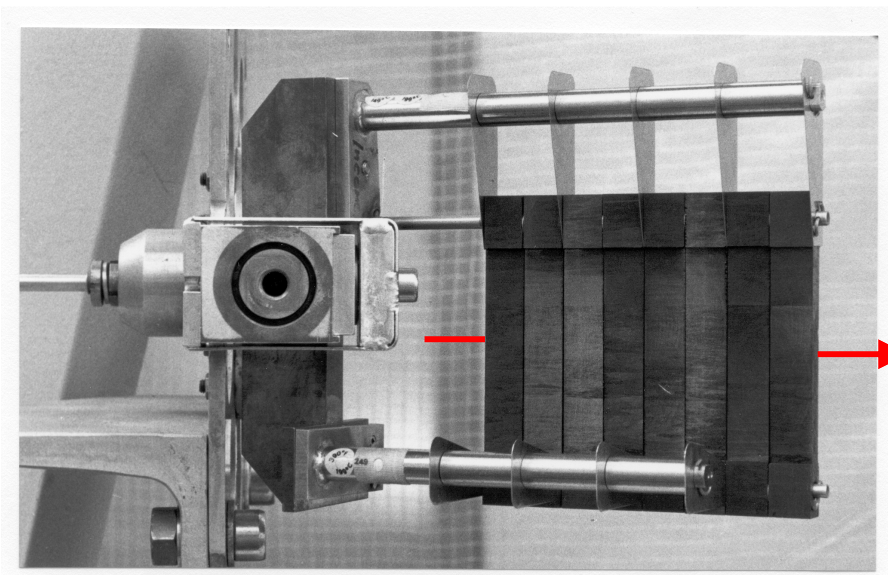
Proton fluence:	10^{22} p/cm²
Integrated beam current:	50 mAh
Irradiation-induced swelling:	~ 10 %
Irradiation damage rate:	~ 1 dpa



Swelling of the target after irradiation

10^{22} p/cm2

p



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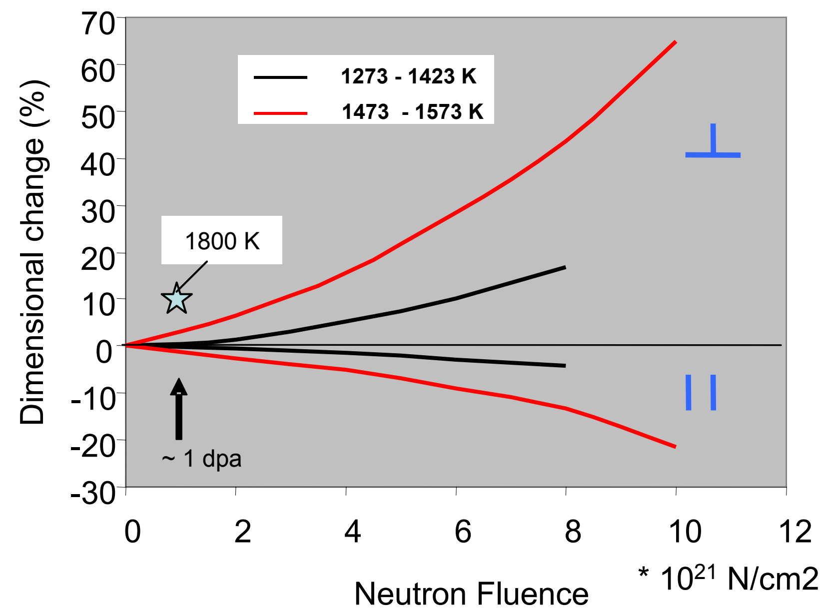

J. Bokros et. al, Carbon 1971,Vol. 9,p. 349

Thank you for your attention !