The FAIR Secondary Beam Targets
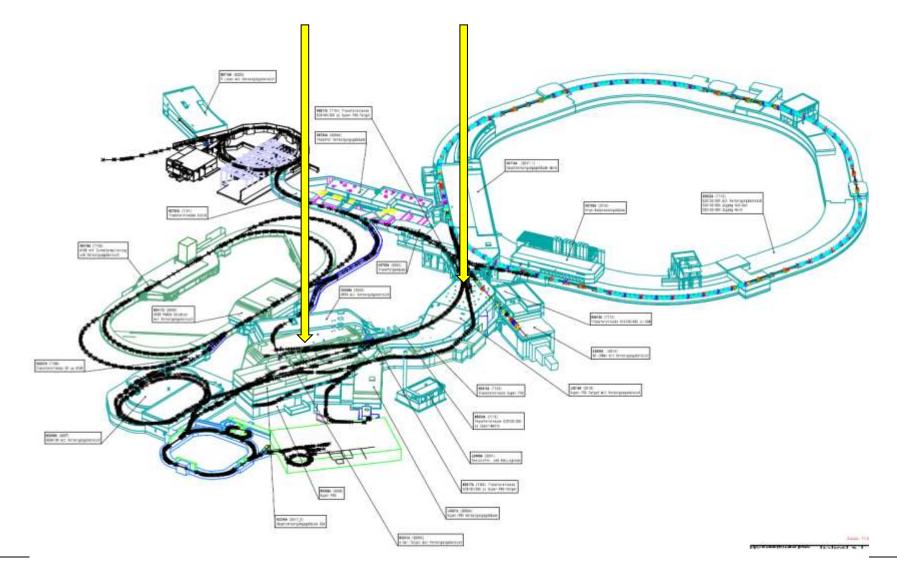
K. Knie

GSI

The target buildings

The FAIR Secondary Beam Targets

Super FRS

- High-Z primary beam (up to U)

- High dE/dx:
  Rotating target
  Target in vacuum

- Target in shielded trench (nearly 6000 t iron!) in large hall
  similar to PSI Target E or Fermilab pbar target

- Fragmentation of primary beam particles

- Huge variety of fragments:
  complex separator

pbar

Primary proton beam

Low dE/dx:
  Fixed target
  Target in air

Target station in shielded tunnel
(7 m thick walls)
  similar to CERN North area target station

Creation of a particle-antiparticle-pair
  Very wide angular distribution: magnetic horn

negative particles: pbar, π-, K-
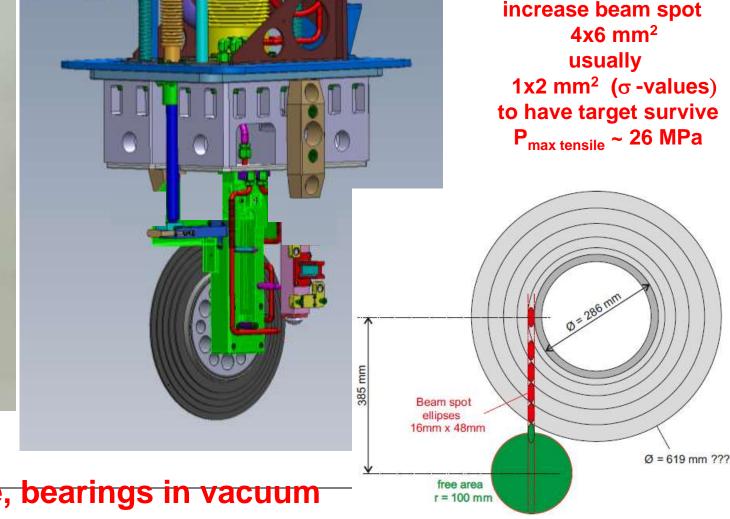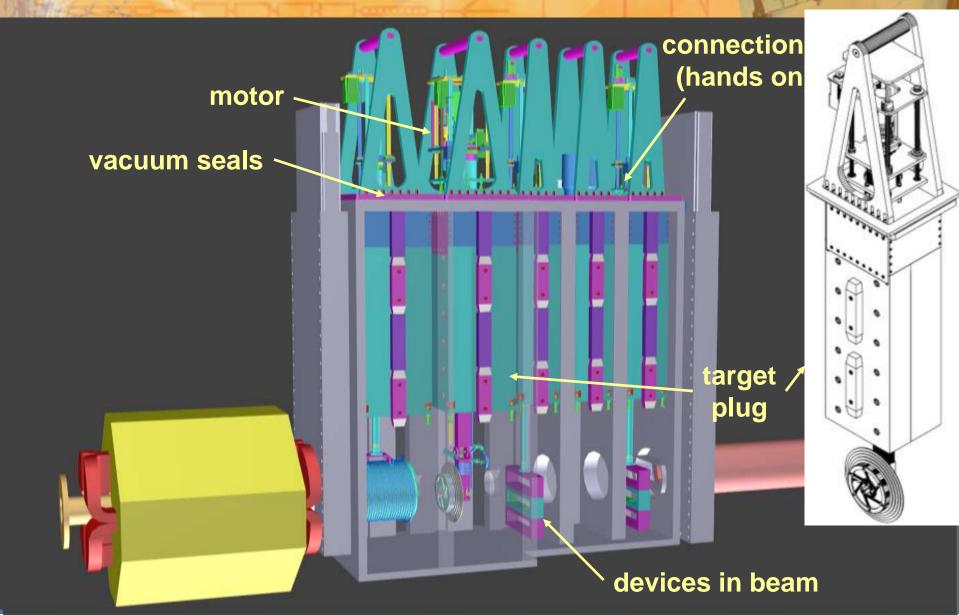 *„simple" separator, optimized for high acceptance*
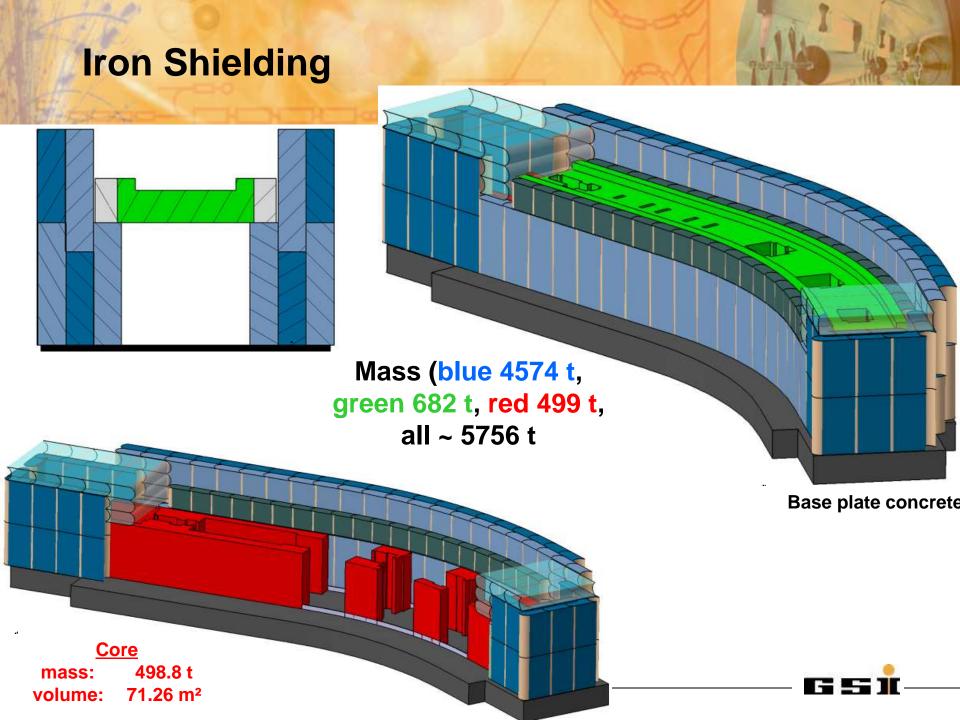
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Super FRS Target Wheel

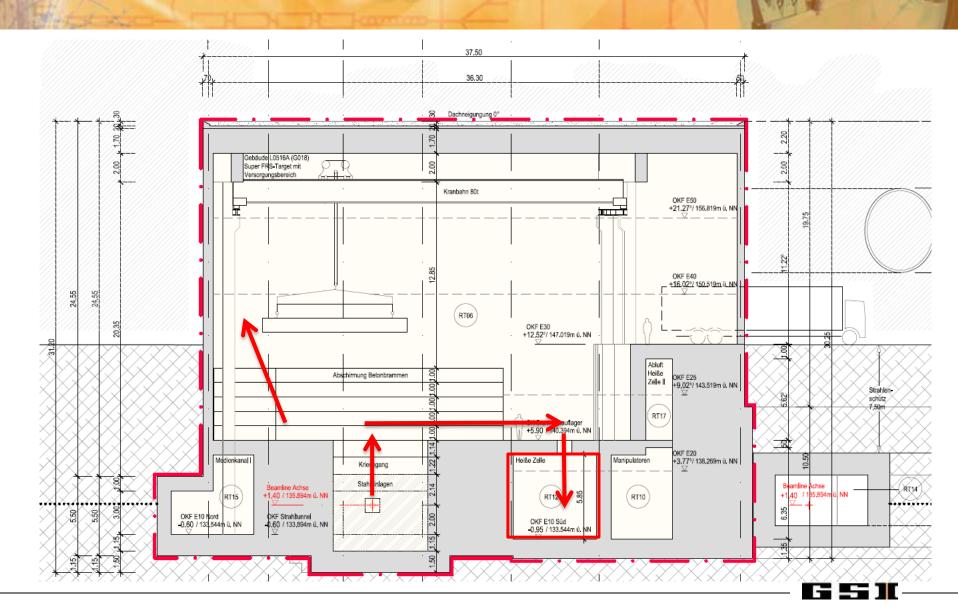**New design planned:**
Larger wheel without transverse motion

increase beam spot
4x6 mm²
usually
1x2 mm² (σ -values)
to have target survive
$P_{max\ tensile}$ ~ 26 MPa

d = 450mm (old)

$\varnothing$ = 286 mm

385 mm

Beam spot
ellipses
16mm x 48mm

$\varnothing$ = 619 mm ???

free area
r = 100 mm

biggest issue, bearings in vacuum

Super FRSTarget Chamber

connection
(hands on

motor

vacuum seals

target
plug

devices in beam

Iron Shielding

Mass (blue 4574 t,
green 682 t, red 499 t,
all ~ 5756 t

Base plate concrete

Core
mass: 498.8 t
volume: 71.26 m²

GSI
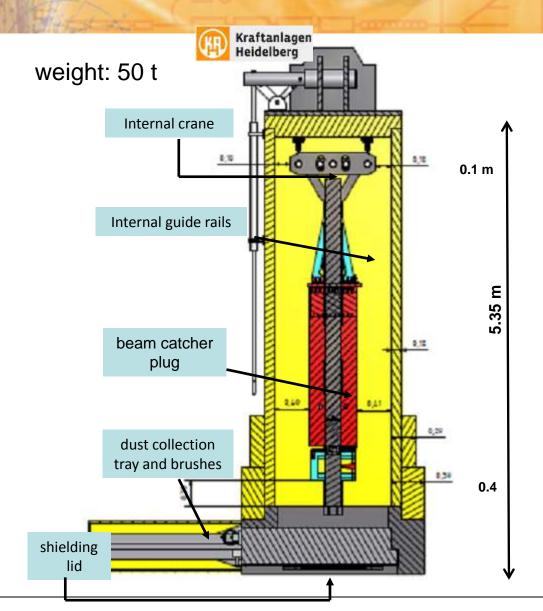
Hot cell in SuperFRS building

Hot cell in SuperFRS building

weight: 50 t

Internal crane

Internal guide rails

beam catcher plug

dust collection tray and brushes

shielding lid

0.1 m

5.35 m

0.4

Kraftanlagen Heidelberg
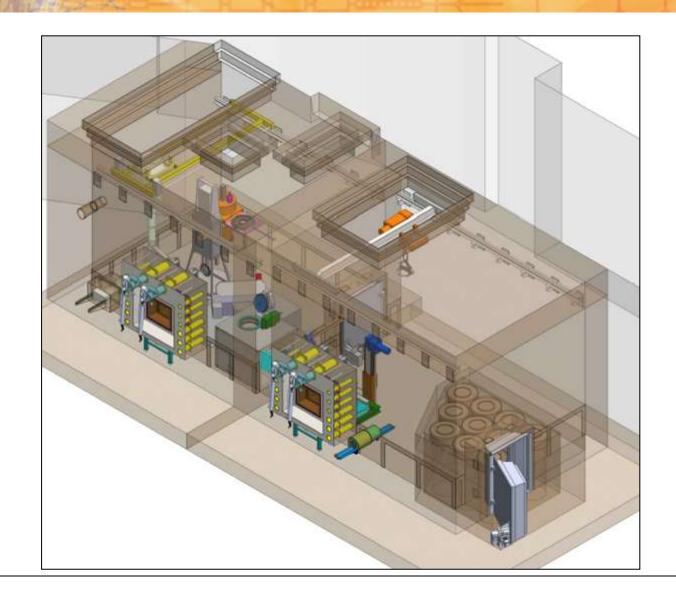
Target exchange at the Paul-Scherrer-Institut

GSI
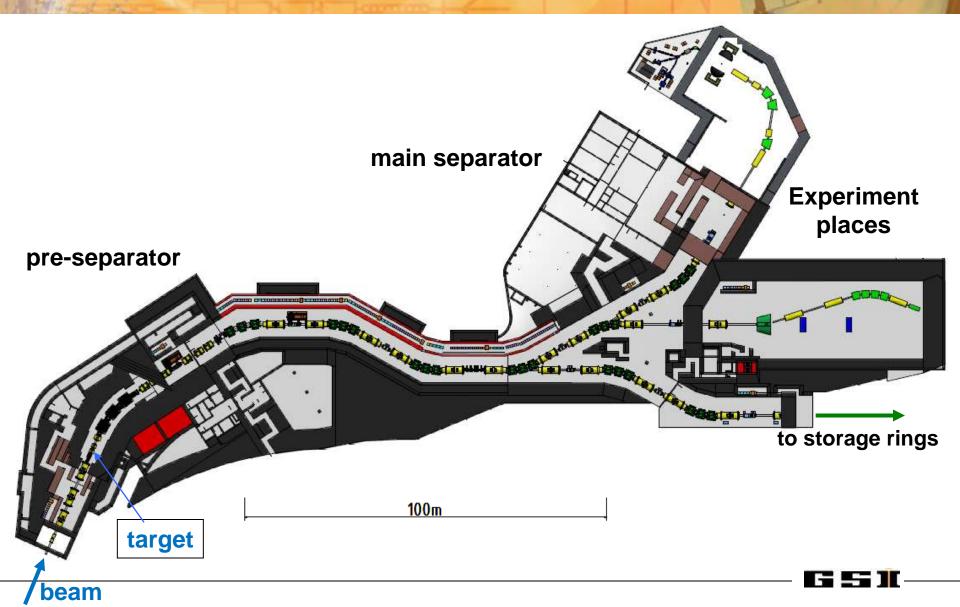
Hot cell in Super FRS building

Super-FRS (Overview)

main separator

Experiment places

pre-separator

target

beam

100m

to storage rings

GSI
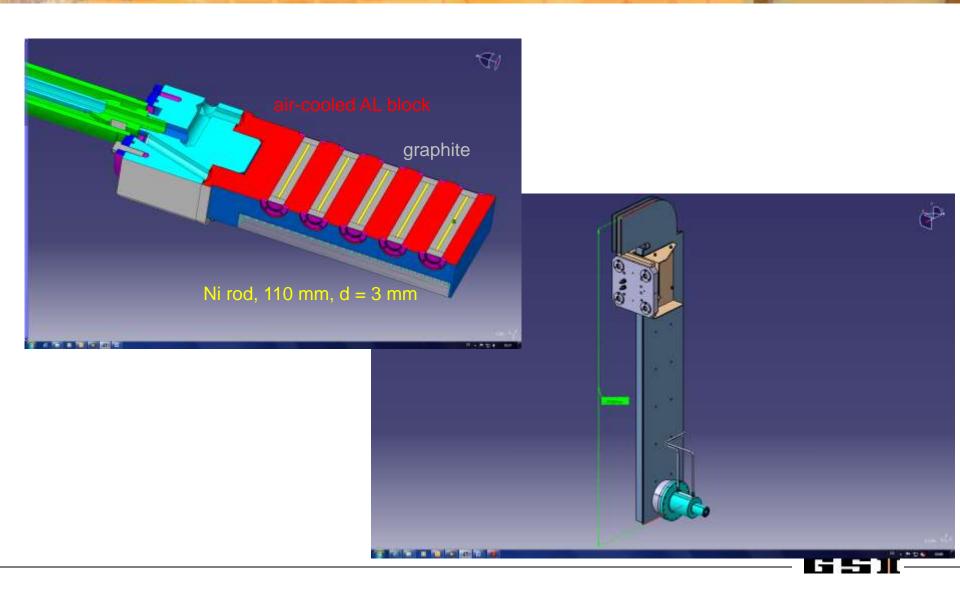
FAIR / CERN / FNAL pbar Sources
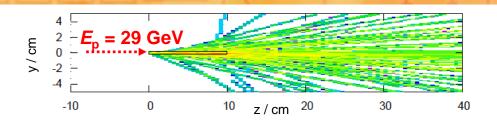
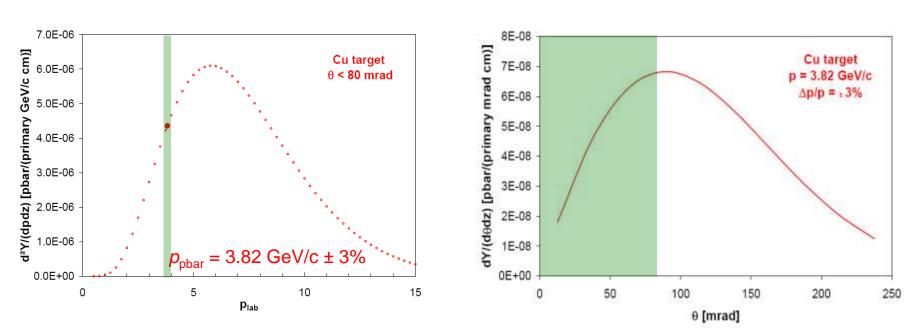|	FAIR	CERN (AC+AA)	FNAL
E(p), E(pbar)	29 GeV, 3 GeV	25 GeV, 2.7 GeV	120 GeV, 8 GeV
acceptance	240 π mm mrad	200 π mm mrad	$\approx$ 30 π mm mrad
protons / pulse	2.5×10^{13}	$1 - 2 \times 10^{13}$	$\geq 5 \times 10^{12}$
pulse length	single bunch (50 ns)	5 bunches in 400 ns	single bunch 1.6 µs
cycle time	10 s (5 s after upgrade)	4.8 s	1.5 s

pbar Target and Magnetic Horn

air-cooled AL block

graphite

Ni rod, 110 mm, d = 3 mm

pbar Distribution After the Target

E_p = 29 GeV

Cu target
$\theta < 80$ mrad

p_{pbar} = 3.82 GeV/c ± 3%
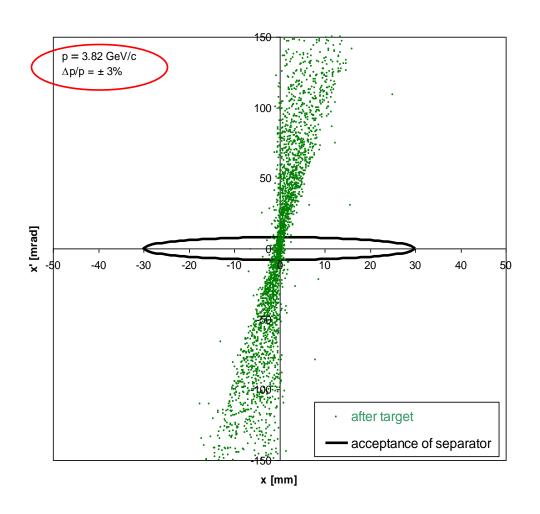
Cu target
p = 3.82 GeV/c
$\Delta p/p = \pm 3\%$

From ~ 2.5×10^{-4} pbar / (p cm target) ~ 5×10^{-6} (or 2 %) are "collectable"
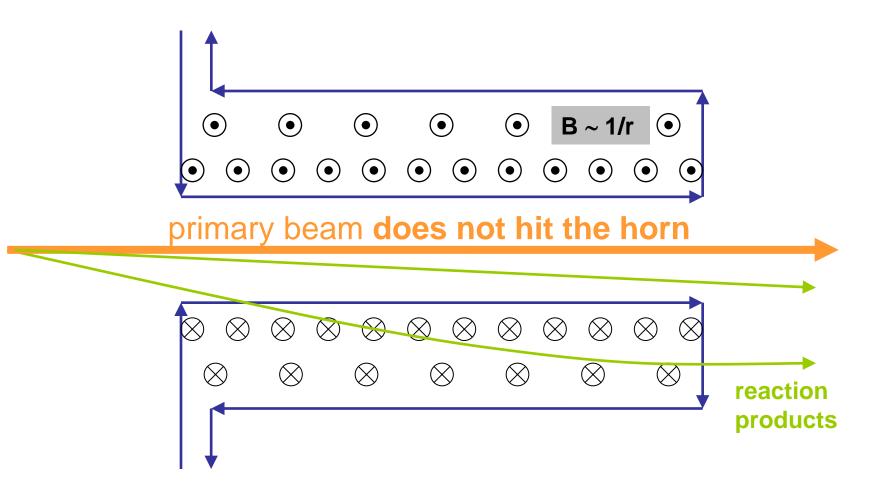
R.P. Duperray et al., Phys. Rev. **D 68**, 094017 (2003)
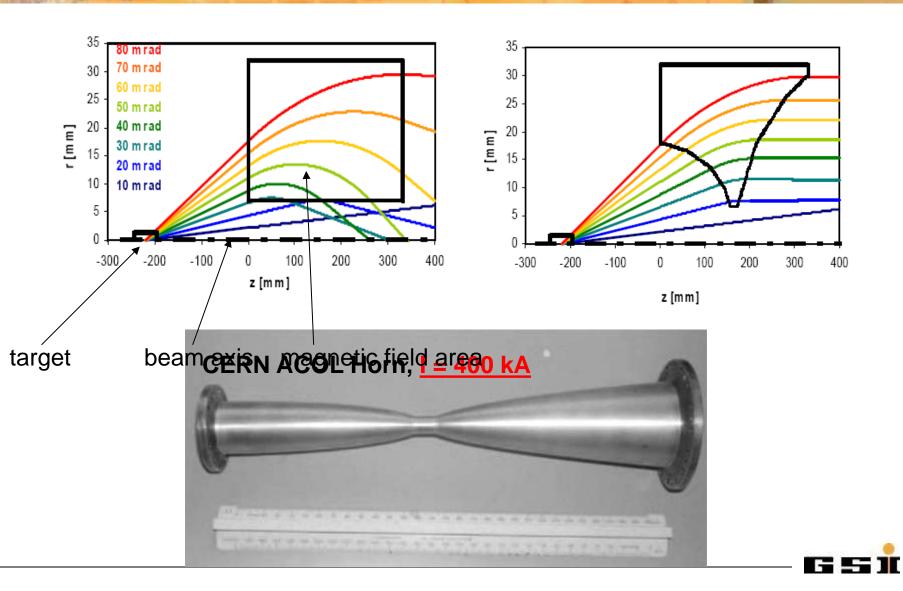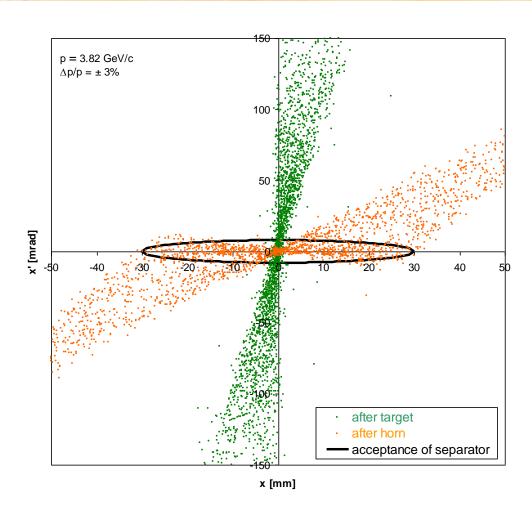
MARS Simulation of the pbar Yields

Collecting pbars: Magnetic Horn

B ~ 1/r

primary beam **does not hit the horn**

reaction products

Collecting pbars: Magnetic Horn

target   beam axis   magnetic field area

CERN ACOL Horn, I = 400 kA

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MARS Simulation of the pbar Yields

p = 3.82 GeV/c
Δp/p = ± 3%

x' [mrad]

x [mm]

Legend:
- after target
- after horn
- acceptance of separator
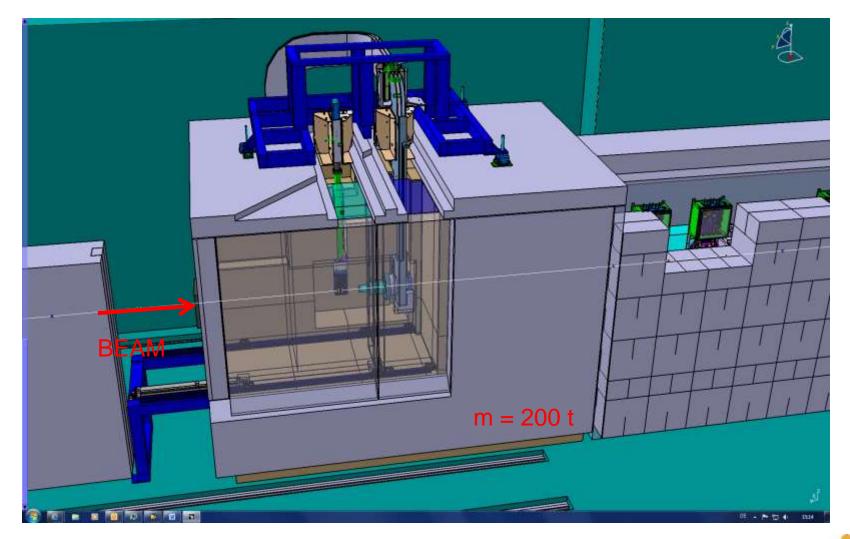
$$\text{yield} = \frac{\text{pbars in the ellipse}}{\text{primary protons}}$$

$$= 2 \times 10^{-5}$$

pbar Target station

BEAM

m = 200 t

The pbar separator

pbar separator
240 π mm mrad
p = 3.82 GeV/c
$\Delta p/p = \pm 3\%$

target & collector
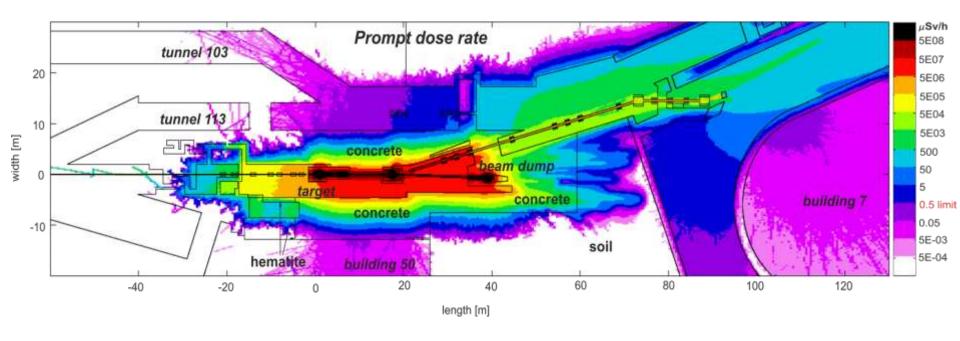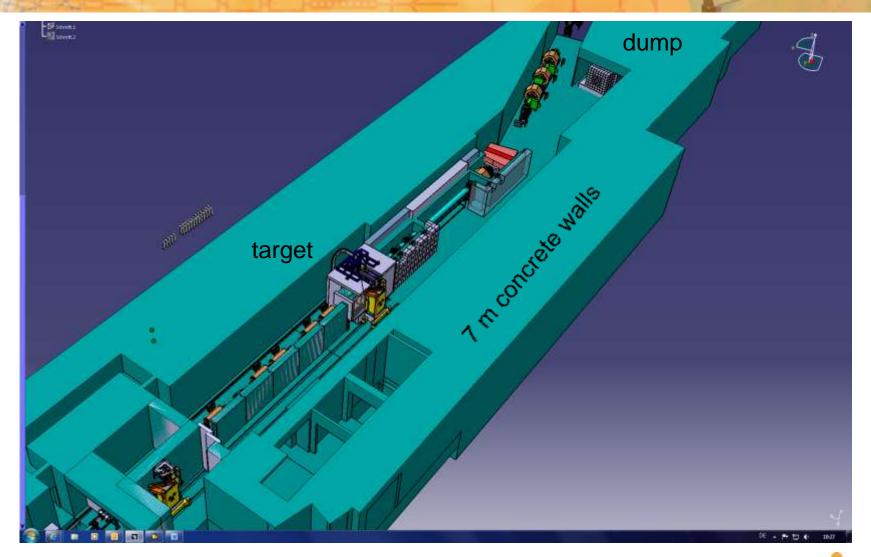
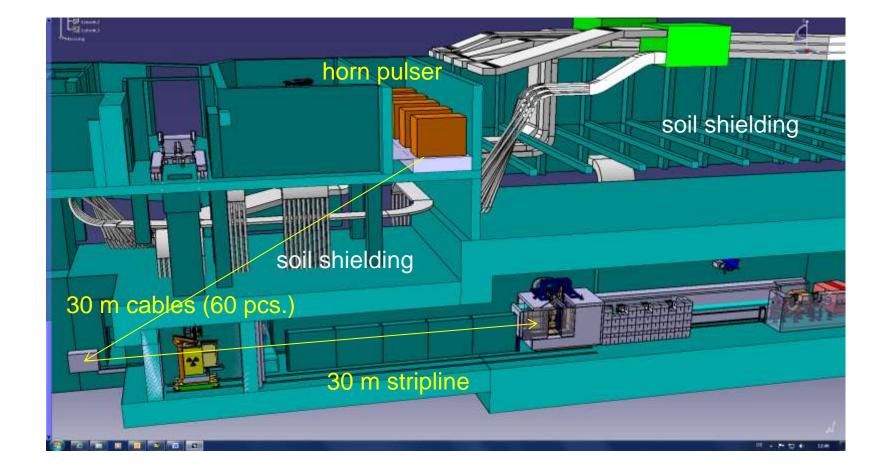**29 GeV p from SIS 100**

100 m

GSI
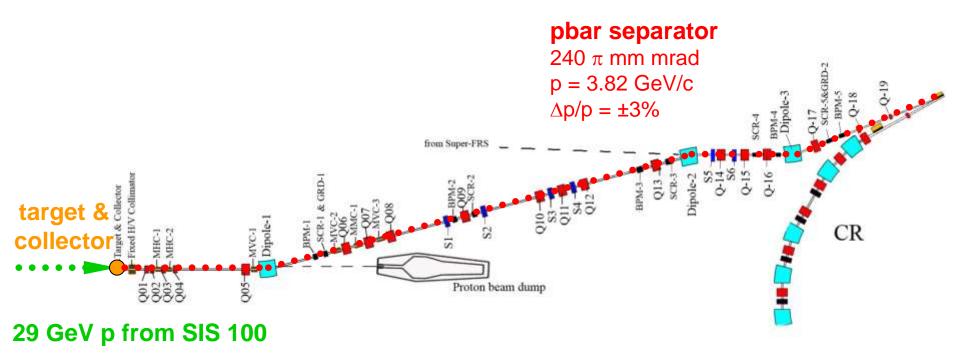
Dose rates during operation

The pbar building
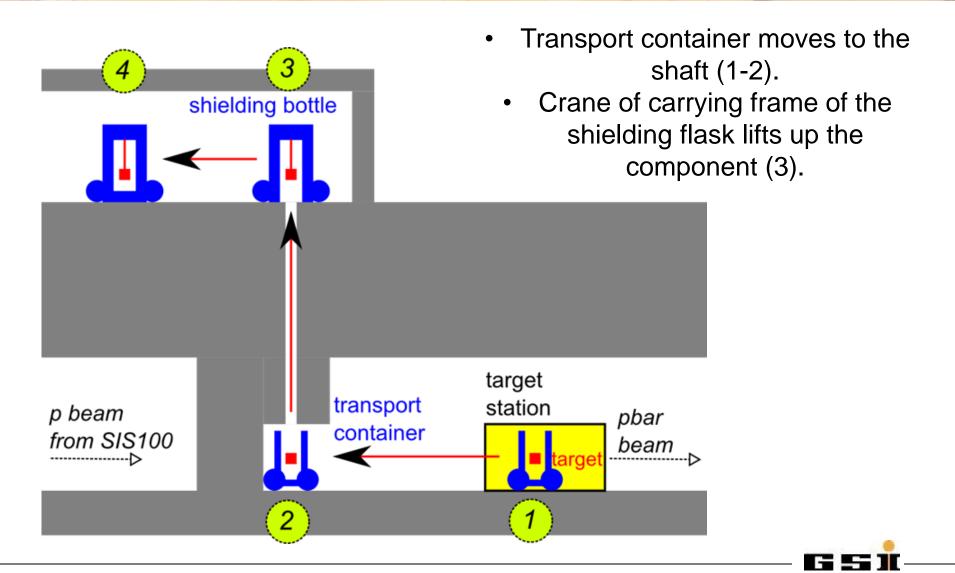
The pbar building
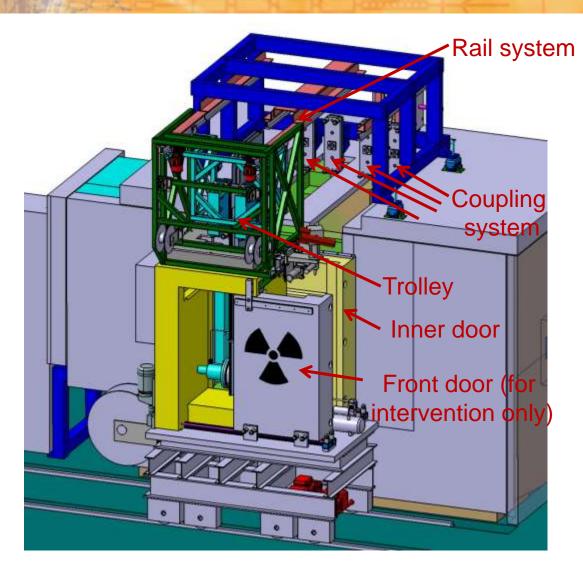
Transport concept in building 6c

- Transport container moves to the shaft (1-2).
- Crane of carrying frame of the shielding flask lifts up the component (3).

Target station and transport container

Rail system

Coupling system

Trolley

Inner door

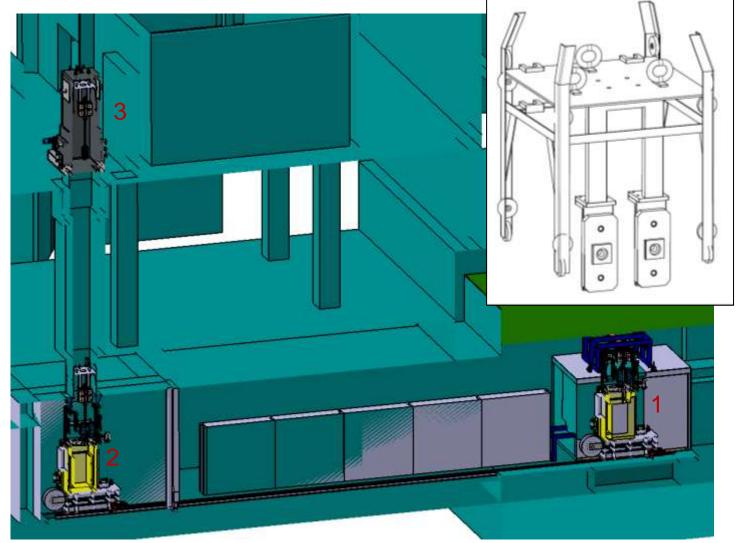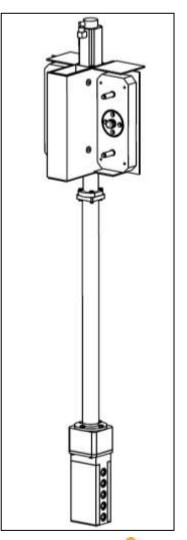Front door (for intervention only)

- Transport container is placed in front of target station.
- Door of target station and transport container are opened.
- Component is gripped by a quick coupling system.
- Trolley moves the component via rail system into the transport container.
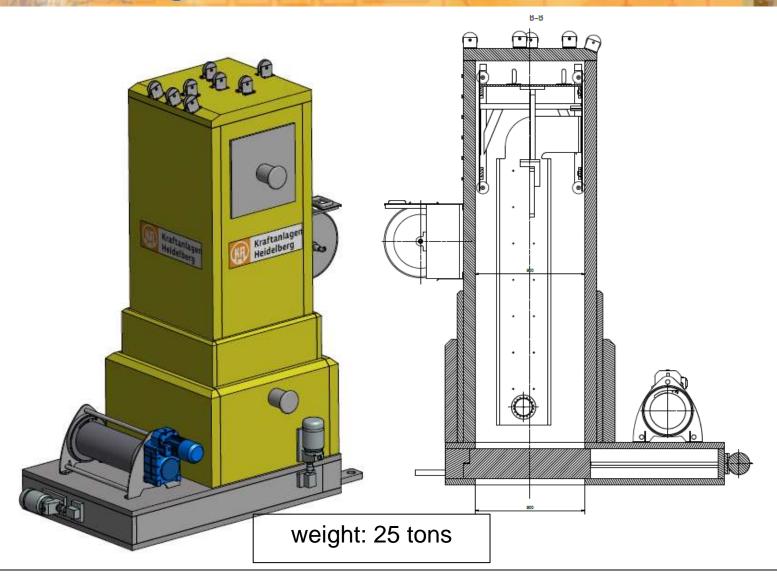- Doors are closed.

pbar shielding flask: technical design
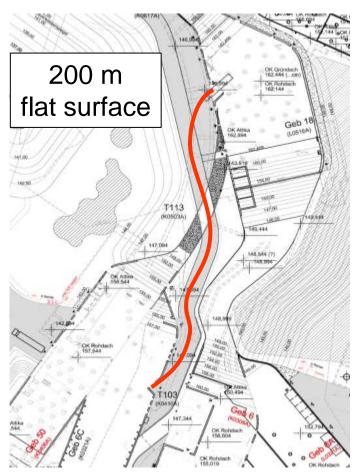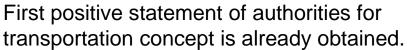

weight: 25 tons
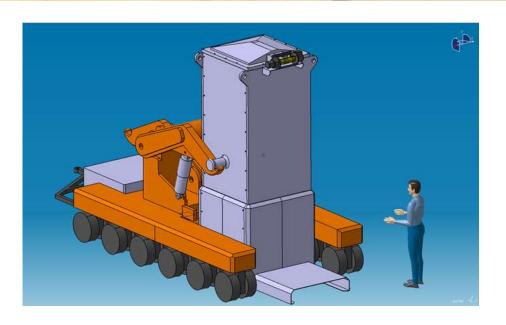
Transport outside of the building

200 m
flat surface

First positive statement of authorities for
transportation concept is already obtained.

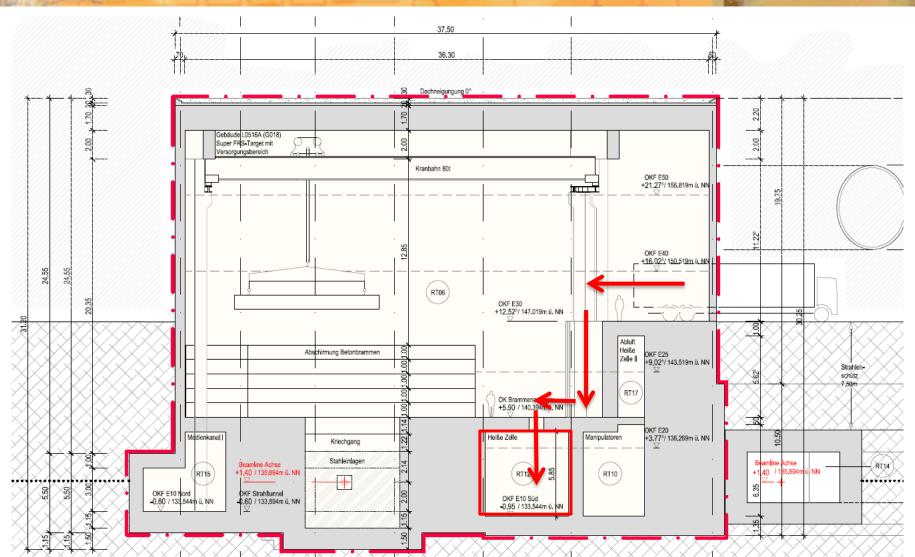Special design for trailer necessary;
no standard vehicle avaliable.

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  Very wide angular distribution: magnetic horn

negative particles: pbar, π-, K-
  „simple" separator, optimized for high acceptance

Thank you Martin Winkler & Helmut Weick for the Super FRS transperencies

GSI