PSI

# Grooved Slanted Target E and Target H for IMPACT/HIMB

## Bridge Japan

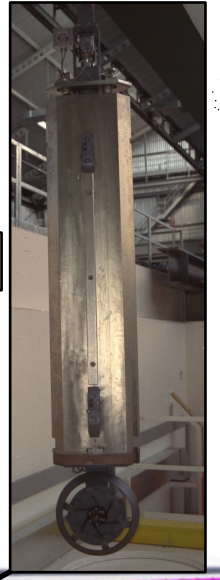
Daniel Laube
20.10.2025

# Content

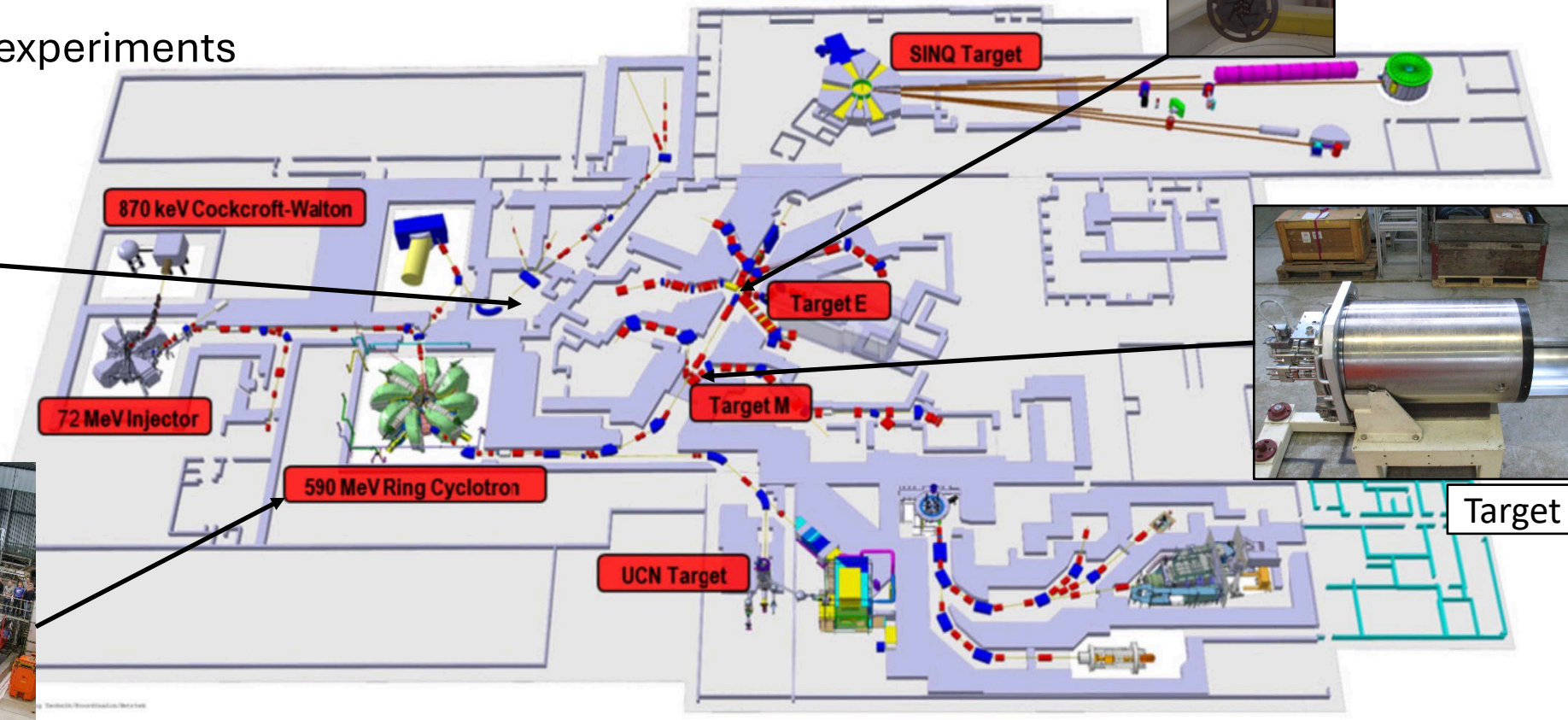
1. Protonbeamline at PSI
2. Introduction about target E
3. Slanted target E grooves and shims
4. HIMB target H

# Protonbeamline at PSI

- Proton beam with the world's highest continuous intensity
- 1.3 MW beam power
- 5 targets
- > 30 simultaneous experiments

Target E



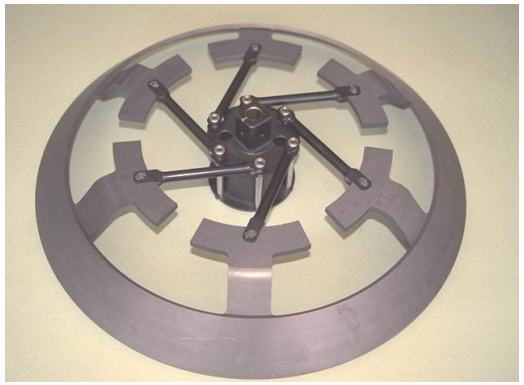



Target M

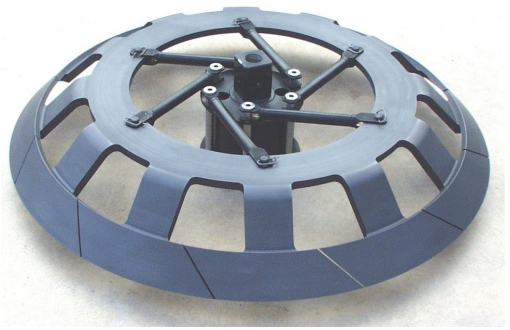
# Introduction about target E

- The upgrade to target E took place in 1990.
- Since then, the design has changed and improved.

1. Slotted in the center, solid ring on the outside, until 2001



2. Slotted on the outside of the ring, since 2001



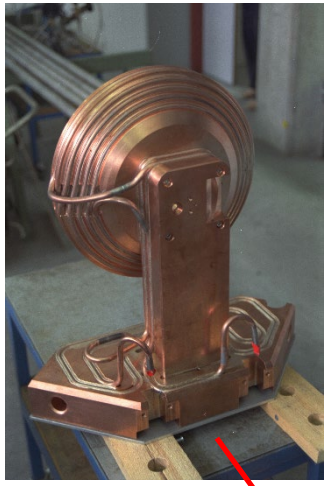
3. Slotted on the outside of the ring with diagnostic grooves, in 2020

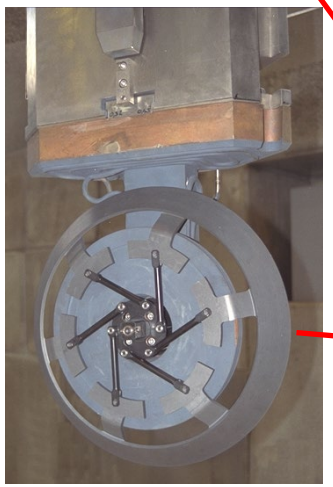
4. Slanted 8°, slotted outside on ring, since 2019

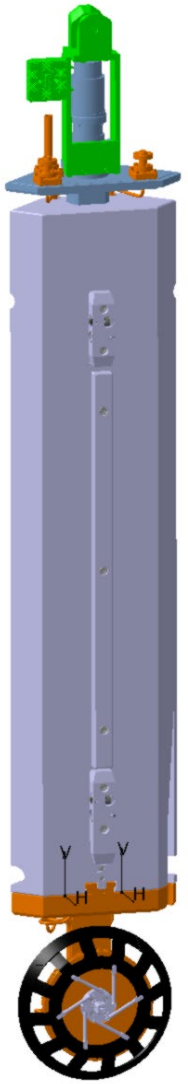
5. Slanted 8°, slotted on the outside of the ring, with diagnostic grooves and shims, since 2021

# Introduction about target E

- Design of the target E-insert
- Remained unchanged since 1990

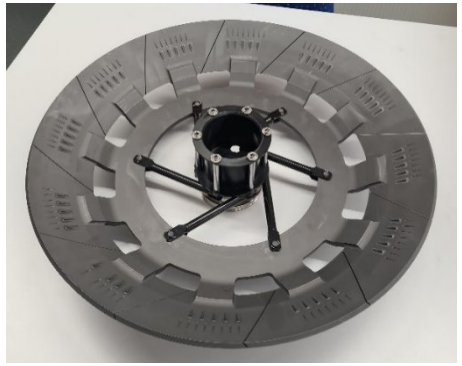


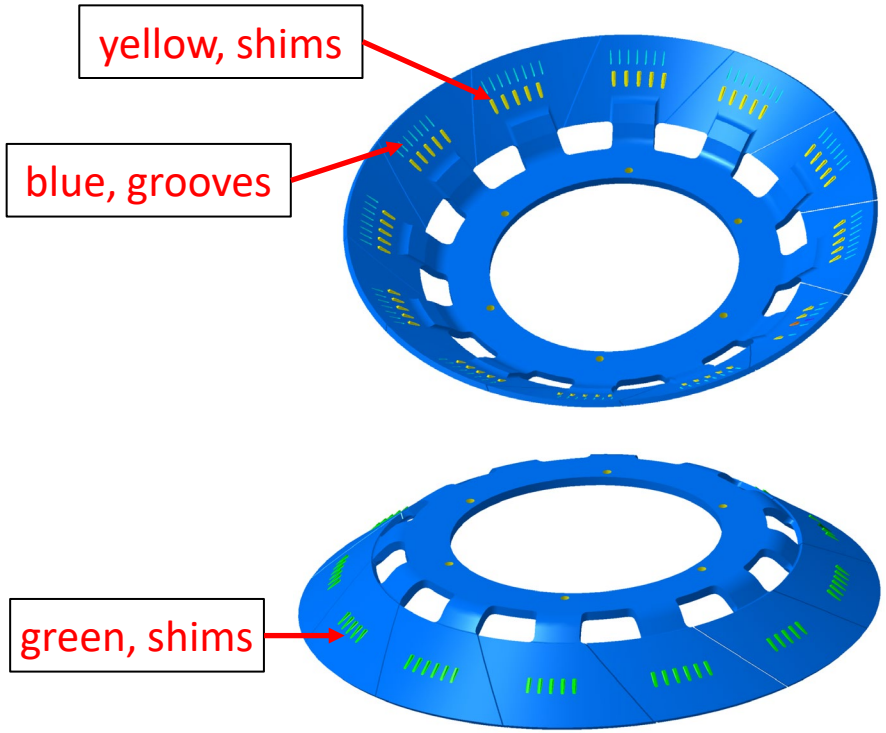


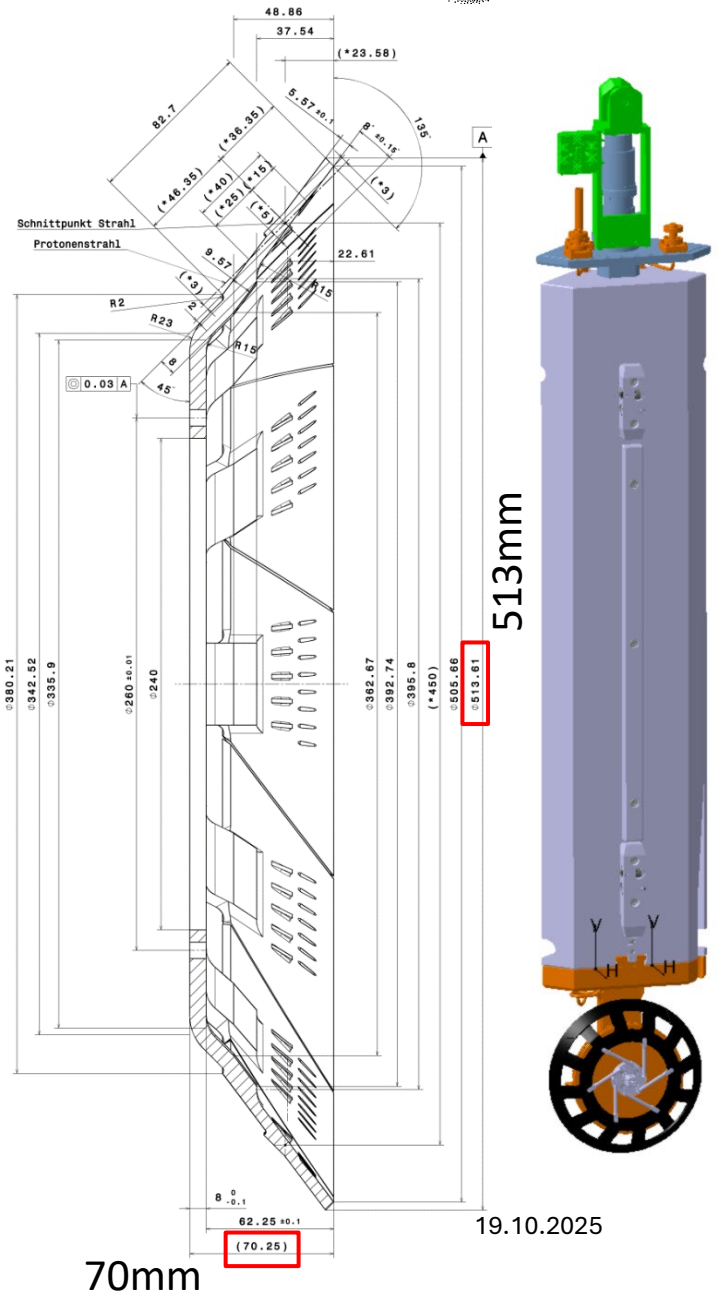


# Slanted target E grooves and shims

- Current slanted target E with grooves and shims
- Additional beam diagnostic, for beam position
- More surface muons
- More difficult to miss the target





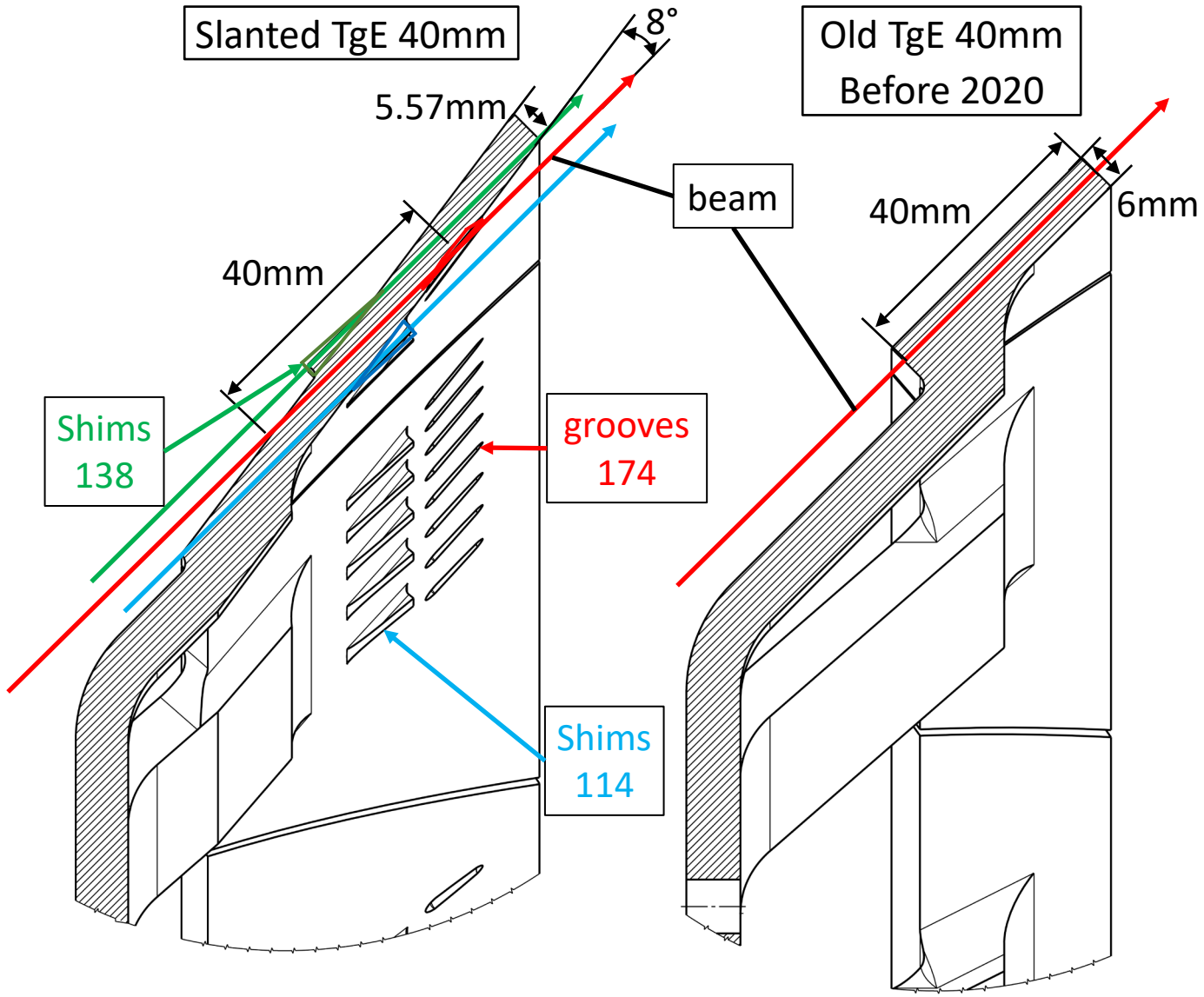
# Slanted target E grooves and shims

Old target E 40mm before 2020

- The beam penetrates a 40 mm ring

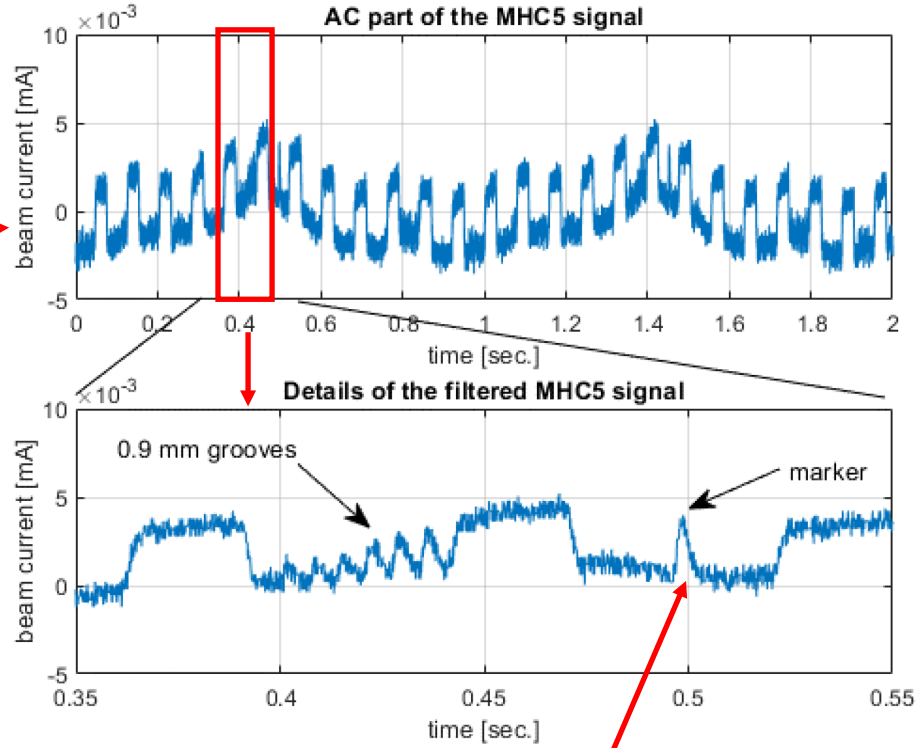
Slanted target E 40mm

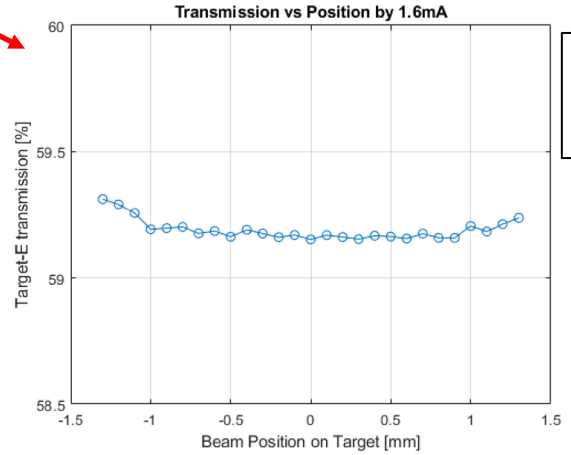
- Beam in middle position (red arrow)
  Beam passes through 174 grooves
- Beam in left position (green arrow)
  Beam passes through 138 shims on the outside
- Beam in right position (blue arrow)
  Beam passes through 114 shims on the inside



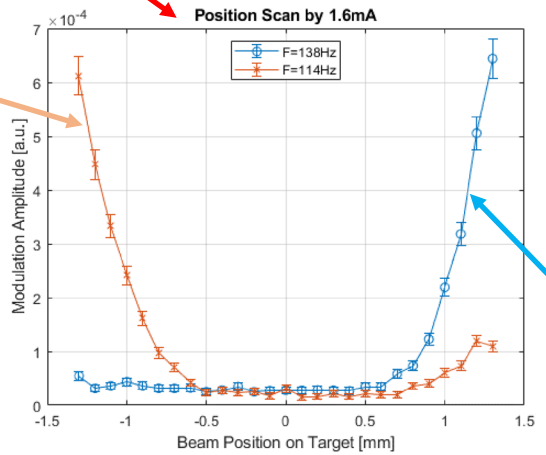
# Slanted target E grooves and shims

- The MHC5 current monitor, located downstream of Target E, delivers the following signals. Rotation 60 $min^{-1}$ (1Hz). The Wheel ring is divided into 12 wings.
- Some shims and grooves are missing on one wing as a reference.
- The number of shims and grooves can be used with Fourier transformation to convert the signal into a diagram showing the position of the beam in relation to the target.
- The results are clearer than with transmission.




Shims 138

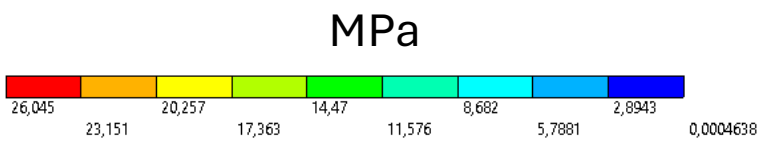



Shims 114

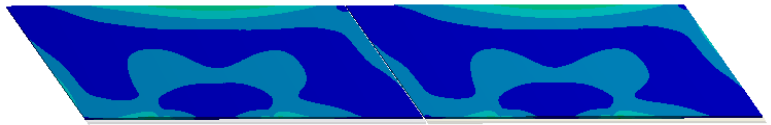
Reference, missing shim and groove

# Slanted target E grooves and shims

- Result old target E versus slanted,
- Simplified geometries for calculation
- Max allowed stress 69MPa

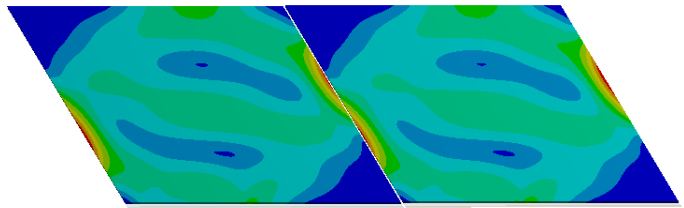


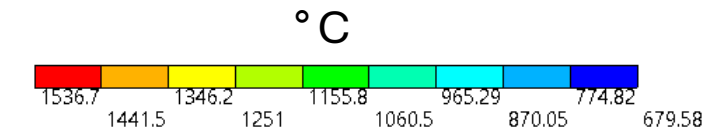

**Old target E** Second max. ~ 13 MPa



**Slanted target E**

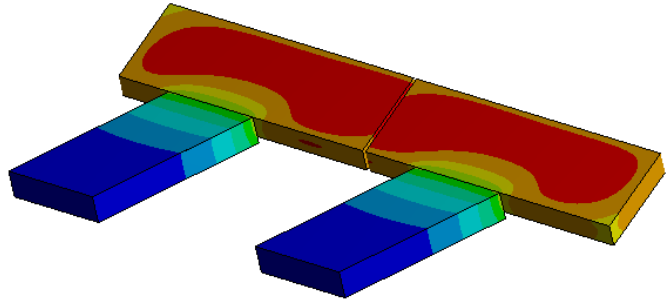
beam entry angle 8°, Second max. ~ 26 MPa





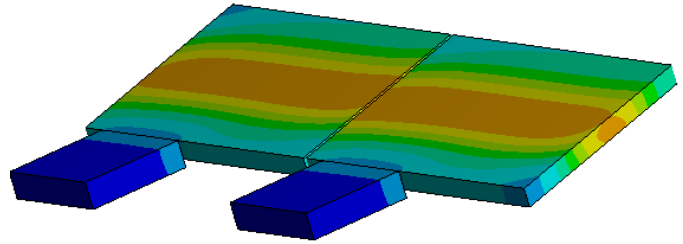

**Old target E**

**Max. 1536** °C Min. 679 °C



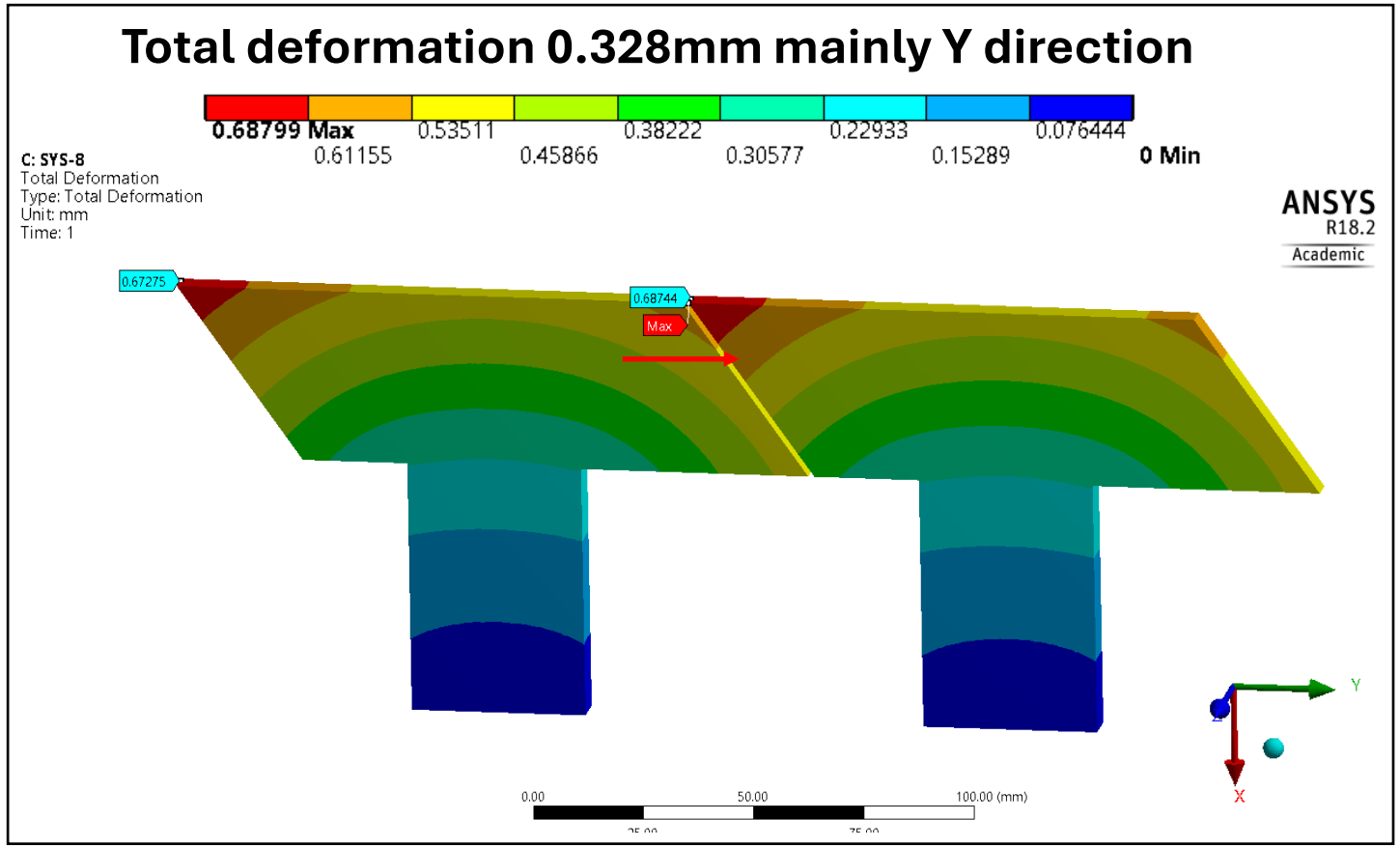
**Slanted target E**

beam entry angle 8°, **Max. 1459** °C Min. 703 °C



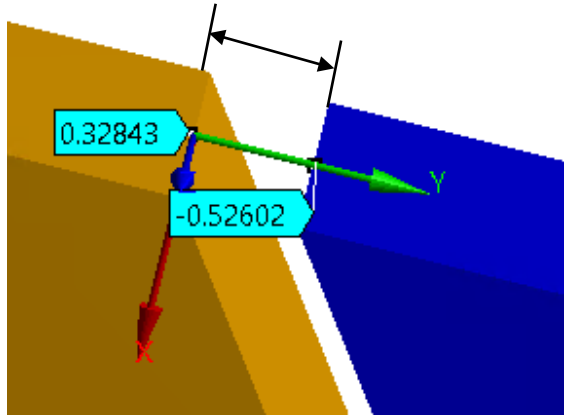
# HIMB target H

- Old target 40mm
- Simulation results of temperature and deformation at 3mA beam



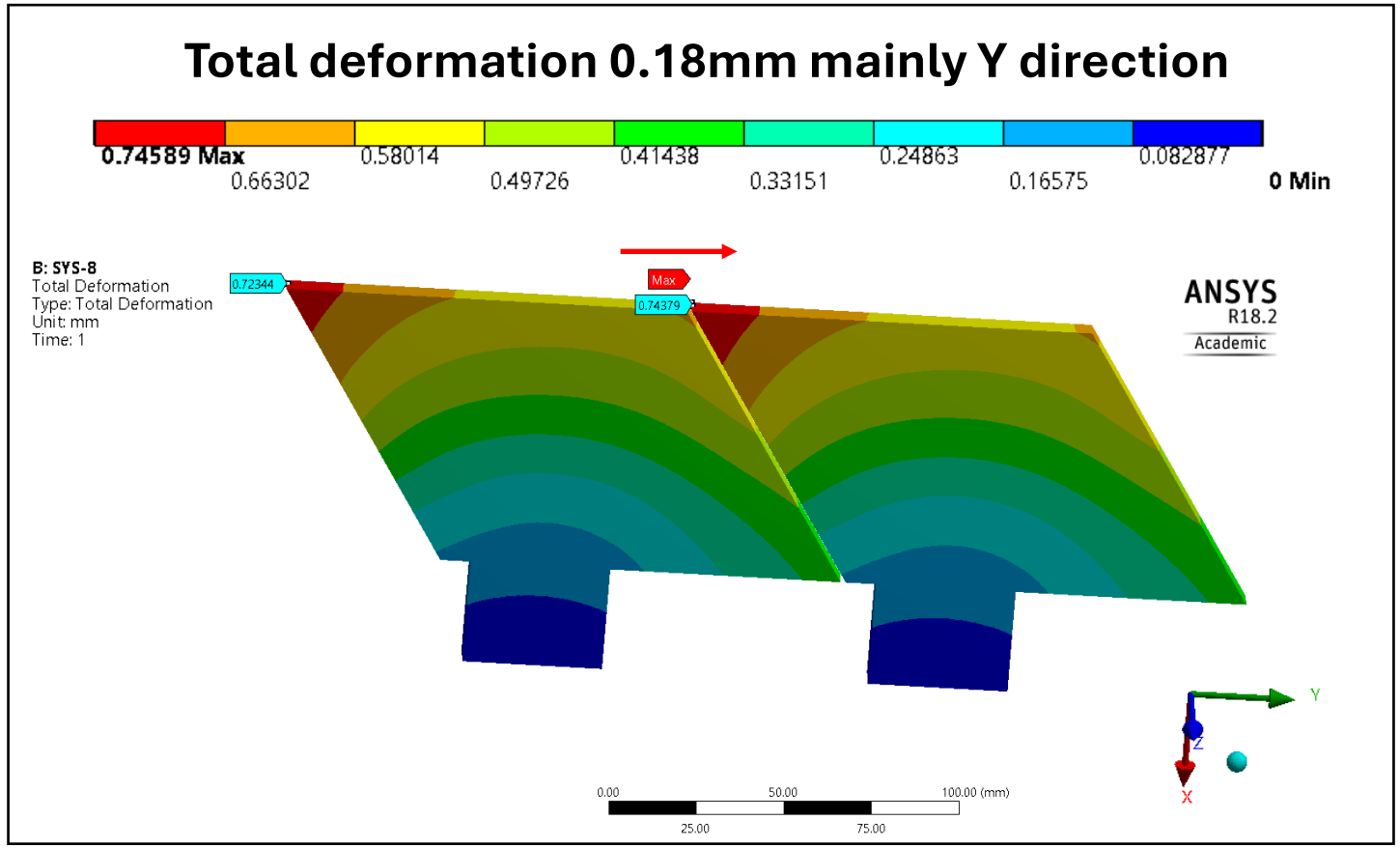

Gap shrinks

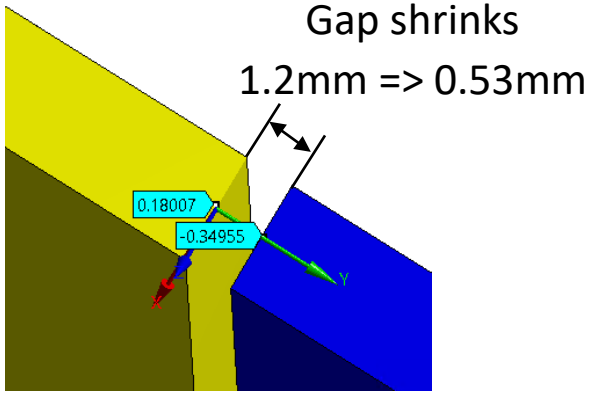
1.15mm => 0.85mm



# Slanted target E grooves and shims

- Slanted target E
- Simulation results of temperature and deformation at 3mA beam

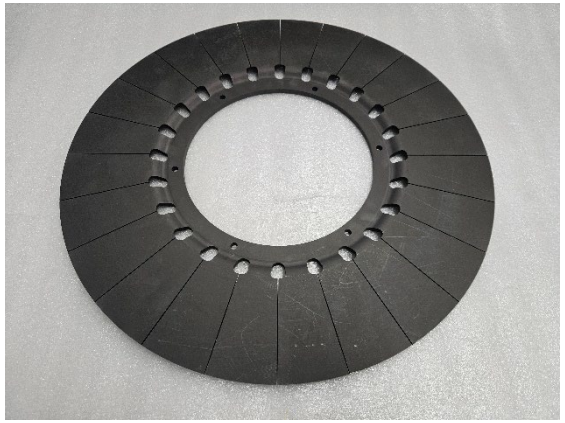


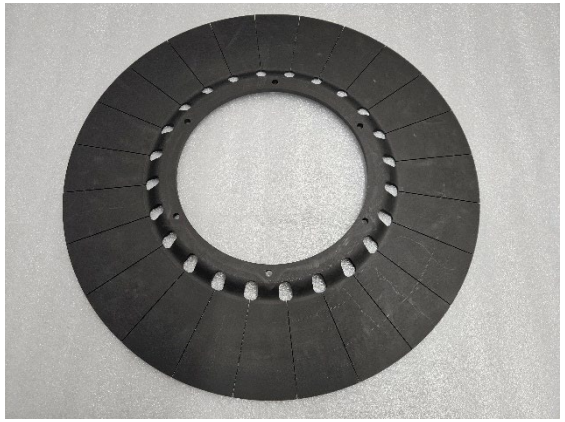



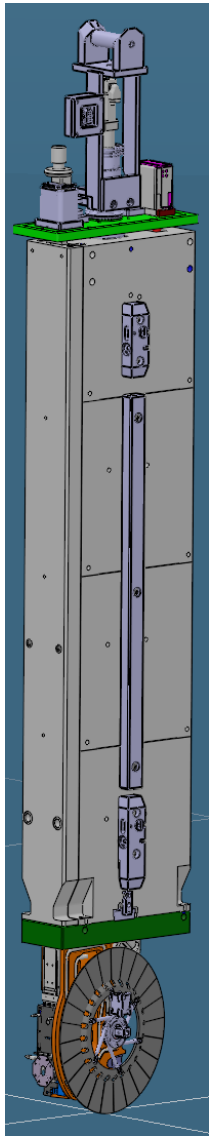
# HIMB target H

- Target H will replace Target M
- Target M: Beam penetrates 5mm
- New target H: Beam penetrates 20mm
  + more surface muons
  + more difficult to miss the target

Old target M → New target H



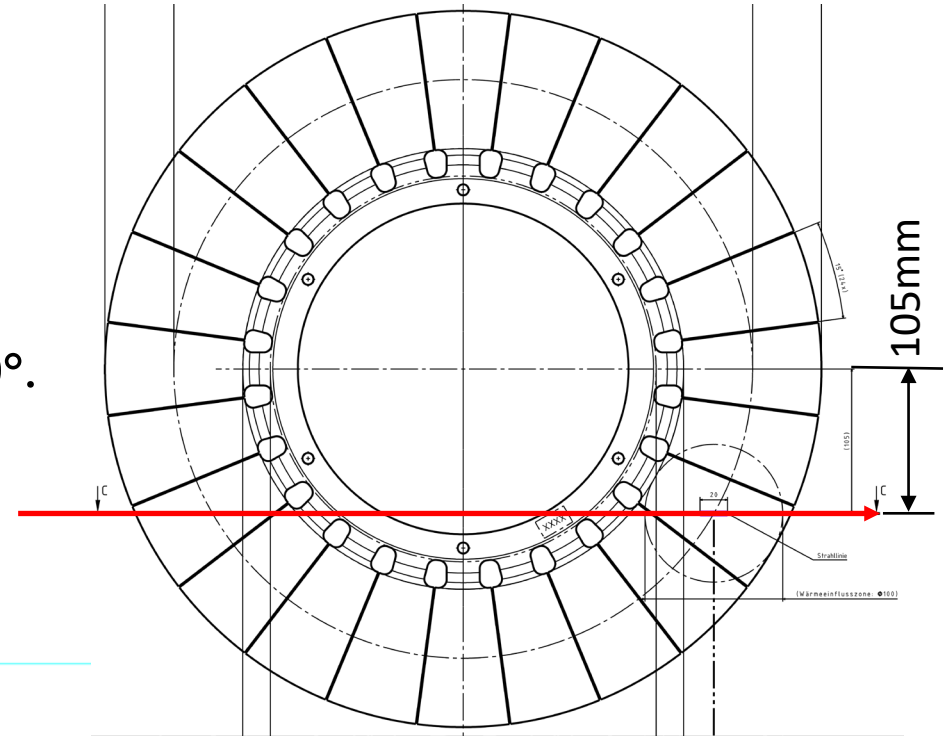


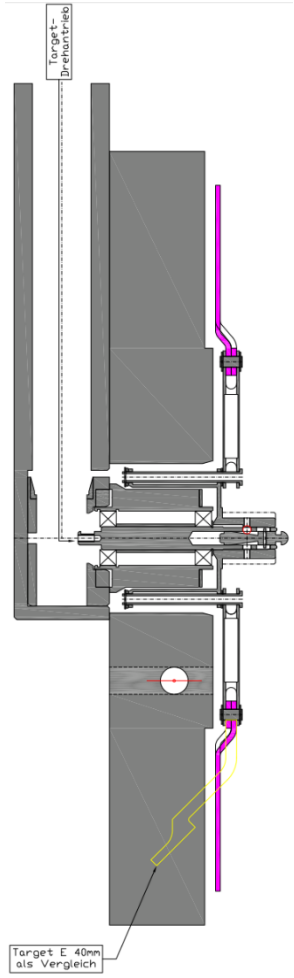


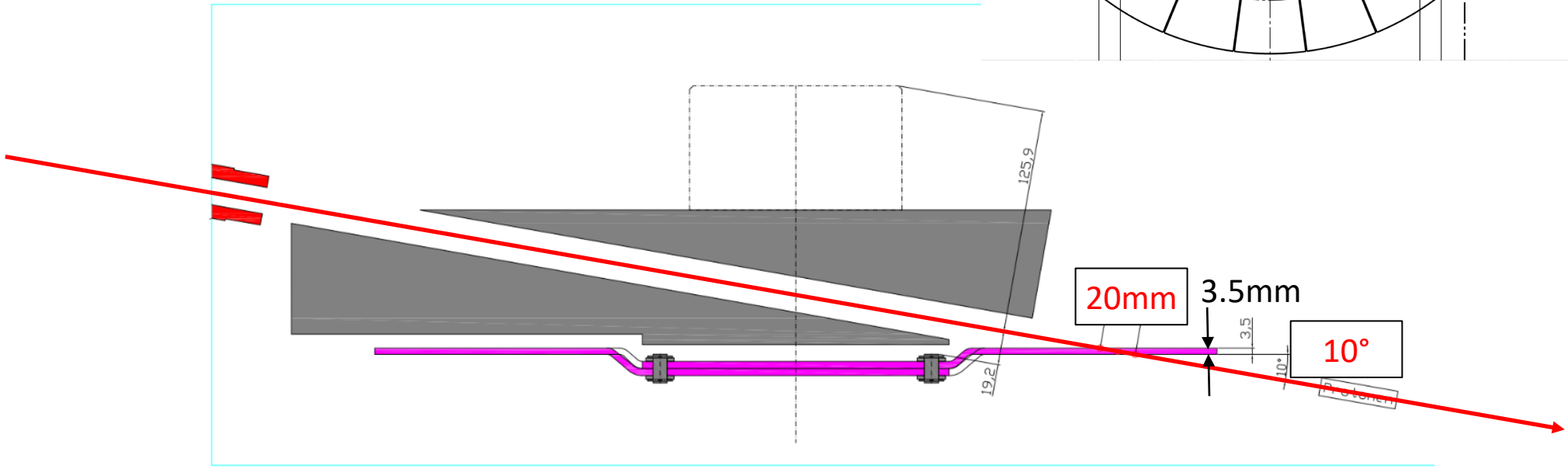
Target M disk, this design is used since 1984

# HIMB target H

- The beam passes through the opening of the protection collimator of the target insert and penetrates 20mm of graphite at an angle of 10°.
- The target is rotating like the target E with 60 $min^{-1}$ (1Hz).
- The disk is divided into 24 wings.





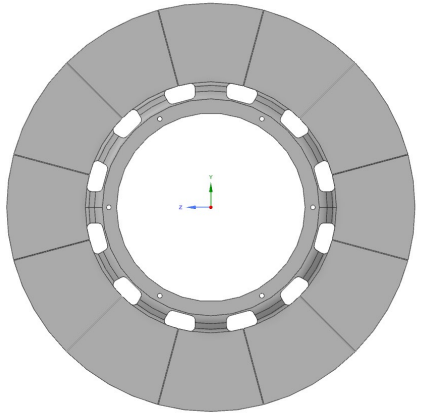
# HIMB target H

- Target H dividing into how much wings?
- Brittle material with uneven strengths

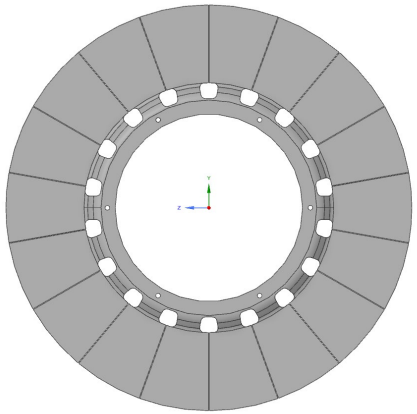
  $\sigma_{tensile\ limit} = 38\ MPa$

  $\sigma_{compressive\ limit} = 130\ MPa$
- The larger the wing, the higher the principal stress

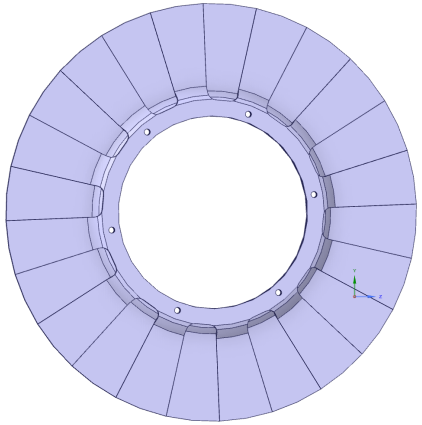
12 wings
40MPa

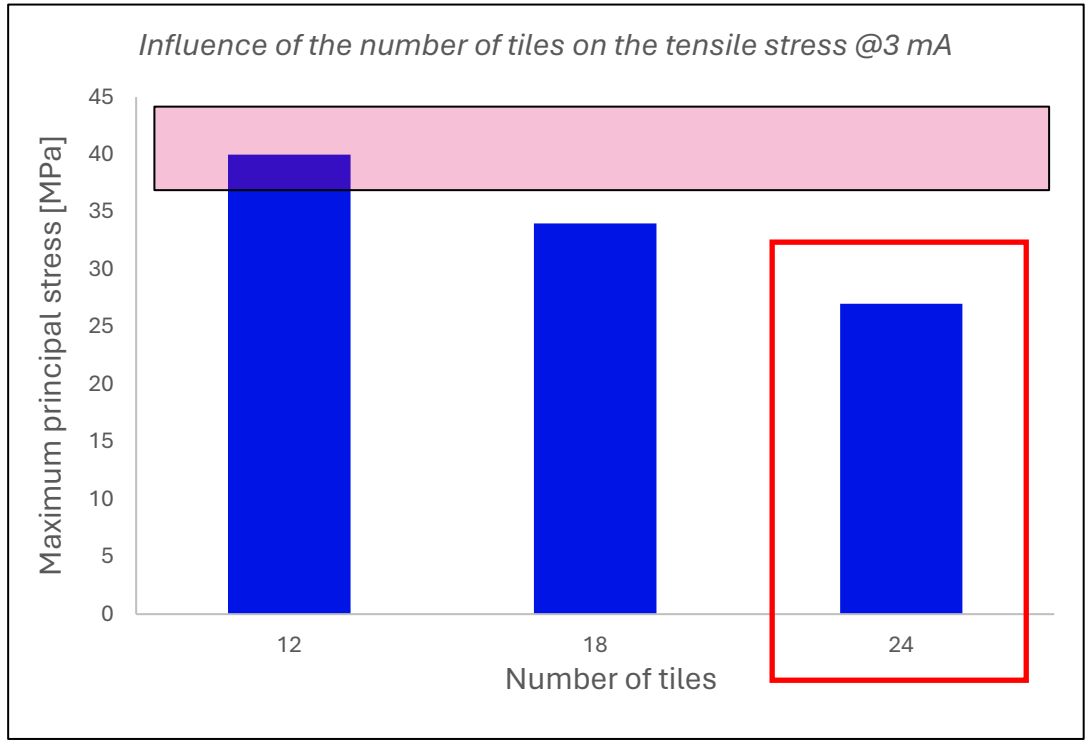


18 wings
34MPa



24 wings
27MPa

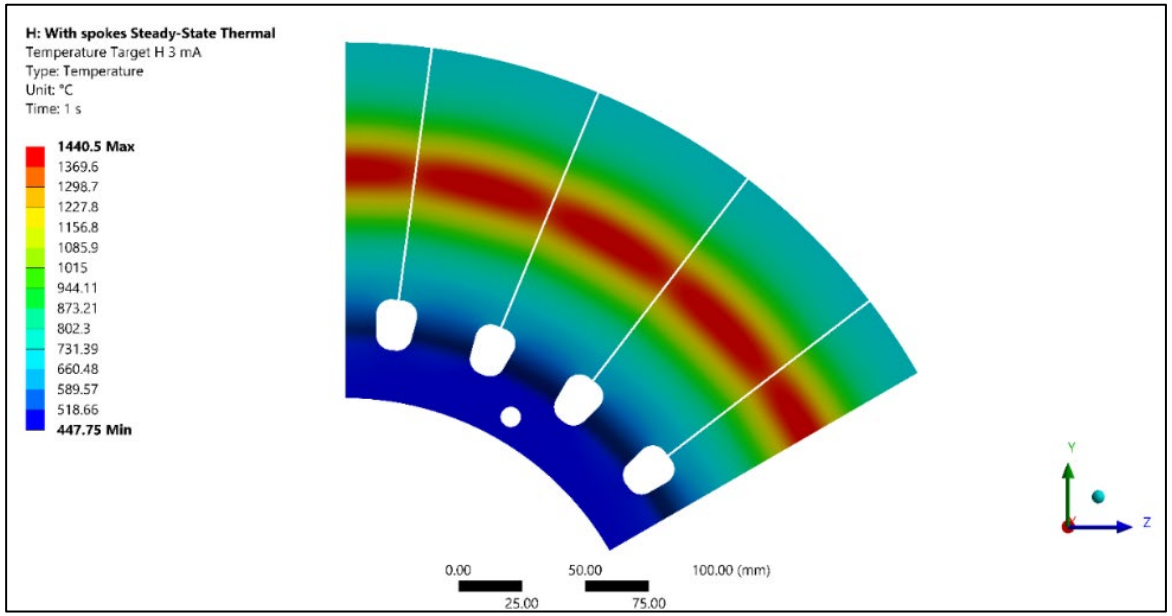




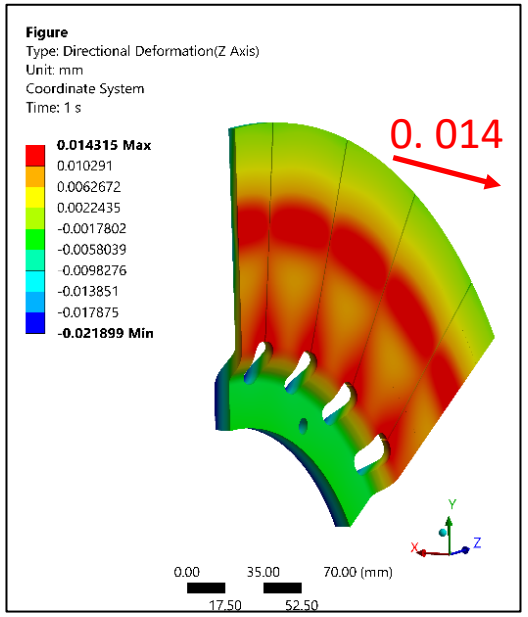
# HIMB target H

- Simulation results of temperature and deformation at 3mA beam

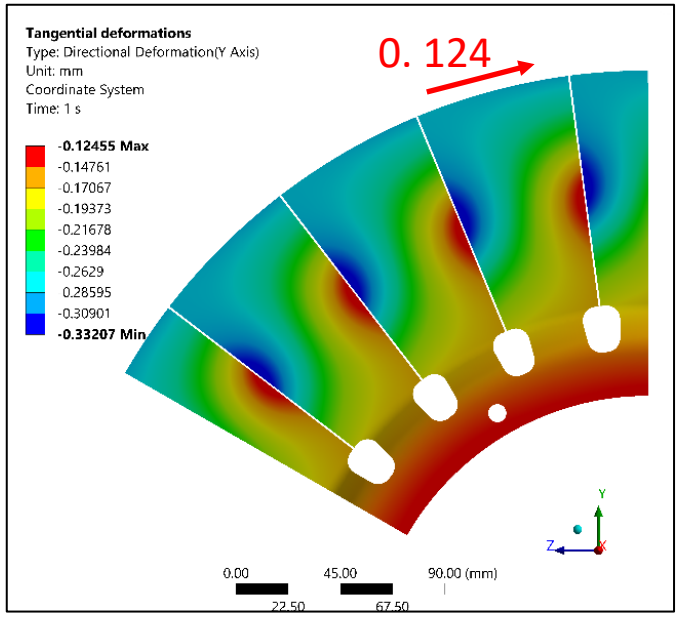
Temperature 1440.5°C




Deformation orthogonal rotation axis 0.0143mm



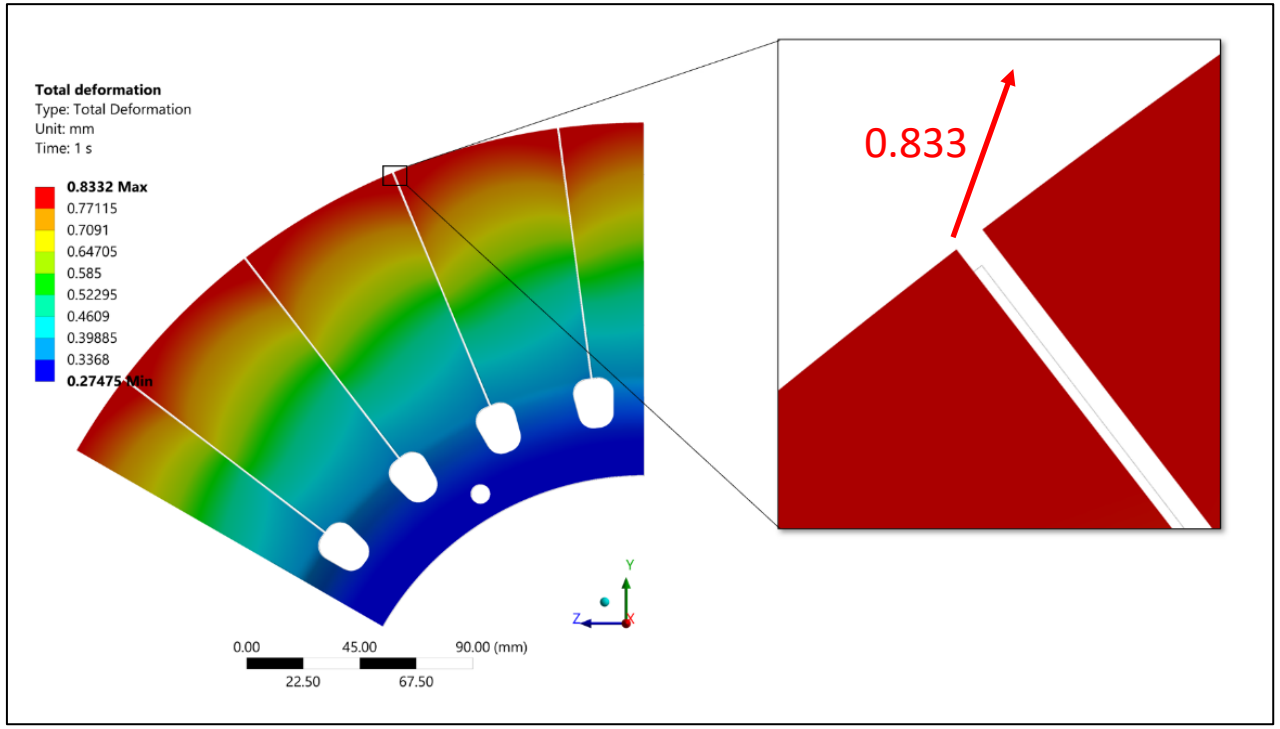

Deformation tangential 0.1245mm



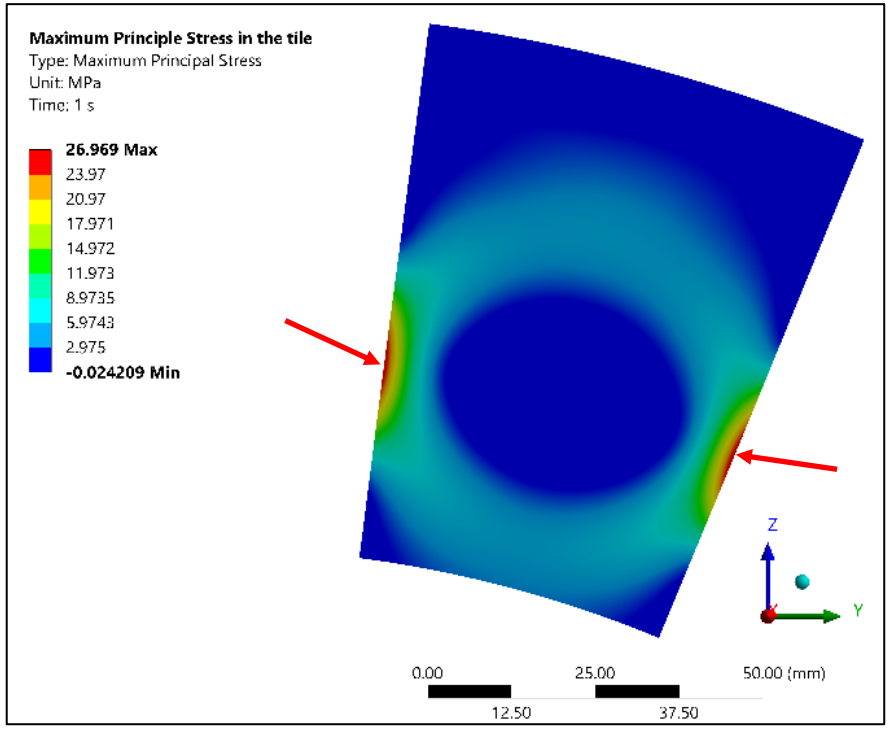
# HIMB target H

- Simulation results of deformation and stress at 3mA beam

Total deformation 0.8332mm mainly radial and tangential




Principal stress 26.969MPa




Thanks to:
Christian Lehmann
Daniela Kiselev
Davide Reggiani
Jochem Snuverink
Pedro Baumann
Pierre-André Duperrex
Rémi Martinie
Raffaello Sobbia
Stefan Joray

# Thank you for your attention