n_TOF target #3 Production readiness review – Final mechanical design

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M. Timmins & V. Maire n_TOF target #3 PRR 29-05-2019
Outline

• Mechanical design overview
• Target core and anti-creep structure
• Target vessel and moderators
• Carrier frame
• Target piping work
• Instrumentation
• Design vs Safety requirements
• Conclusions
Mechanical design overview

- Nitrogen circuit
- Demineralized water circuit
- Borated water circuit
- Beam

- Cover (St Steel 316L Low cobalt <0.1%)
- Lead wedge (Pur lead 99.99%)
- Moderator support (Aluminium 6082)
- Cradle assembly (Aluminium 6082+ Pur lead 99.99%)
- Vessel (St Steel 316L)
- Moderators (Aluminium 5083)

Total weight: 1900 Kg
Target core and anti-creep structure

- Lead slice Th.150 mm
- Anticreep plate (7x) (Aluminium 6082)
- Tie rod (4x) (St Steel 316L)
- Lead slice Th.49 mm (5x)
- Cradle (Aluminium 6082)
- Stiffeners (12x) Aluminium 6082

Weight 1550 Kg
Downstream arteries closing plate
N2 cooling
Target core and anti-creep structure

Core

Total: 1440kg

550kg

178kg
Target core and anti-creep structure

Anti-creep structure

Restricted area
Target core and anti-creep structure

Anti creep plate

New design with respect to what was shown in IEDR in May 2018.

- More cooling efficient (direct contact of N2 on Pb).
- Easier to produce (Only one part, no extrusion, predicted less deformation thanks to symmetric design. See prototype in next talk.)

IEDR 2018

PRR 2019
Target core and anti-creep structure

Anti-creep structure

schematic diagram (half top view) for slice TH. 48.9 mm

Lead block

Anticreep plate

Tie rod

Stiffener

48.9 +/- 0.1

9.86 +/- 0.05

4

Anticreep plate

Anticreep plate

If lead block centered:
0.045 mm < Gap < 0.195 mm on each side

Thickness: 10 g6 mm
Thickness: 9.86 mm
Thickness: 4 mm

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Target vessel and moderators

**H.** Moderator with bi-metallic transition
**V.** Moderator without Bi-metallic transition

Bi-metallic transition not abandoned for the H. moderator as suggested by panel in IEDR 2018

Gap 2.5mm
Gap 1 mm
St steel support Th.4 mm

Vertical moderator (EAR2)
Horizontal moderator (EAR1)
EB weld vertical moderator to avoid humidity and corrosion
EB weld horizontal moderator to close the vessel

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Target vessel and moderators

Vessel

- Upstream part – Closing plate
- Central part - Vessel
- Downstream part – Multilayer plate

Vertical moderator support

- N2 outlet (DN80)
- End stopper / cradle fixe point
- Foot

Front view (without cover)
Target vessel and moderators

Bimetallic transition

![Diagram of bimetallic transition]

- Titanium Gr1
- Aluminium 1060
- Aluminium 5083
- St Steel 316L

(12) - Aluminium 5083
(2) - Titanium Grade 1
(2) - Aluminium 1060
(12) - St Steel 316 L

EN AW-5083
EN AW-1050
Titanium Grade 1
AISI 316L
Target vessel and moderators

H. moderator

- Withstand 2.5 barg (see Laurene’s talk)
- Limited deformations <1 mm (see Laurene’s talk)
- Limited Al. seen by the beam (no more than current target)
- Limit number of welds to increase robustness (Insert machined from a bulk)
Target vessel and moderators

H. moderator – Inlet/outlet nozzle

- Bimetallic transitions Aluminium / St steel
- Nozzles (Aluminium)
- Groove to avoid bubbles

1. EB weld
2. EB weld
3. TIG weld
Target vessel and moderators

V. moderator
Target vessel and moderators

Lead wedge

Pb wedge

V moderator

Moderator cup

Pb 47kg

Closing weld (no pressure)

Wall thickness 4mm

Gap 2.5mm

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Carrier frame

830 mm

626 mm

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Carrier frame

Lifting hoist

Lifting bar

Grip hooks for lifting bar

Survey target
Carrier frame

Gap: 30 mm

Gap: 15 mm

Existing positioning pins

Pool

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Target piping work

Flexible pipes

In Situ welding

Disconnection area

Flexible pipes

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Instrumentation

2x3 thermo-couples type K.

Feedthrough

Probe tips

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Design vs Safety requirements

N2 Vessel <= 0.5barg (out of scope)  
Water in moderators = 2.5barg (CAT. SEP)

However

**Category 1** recommendations will be applied due to a highly radioactive environment, with difficult access.

1. Design: All welded joints are checked against pressure vessel standards *(See Laurene’s talk)*
2. Manufacturing: Material certificates, raw material inspection, weld book (certified process + certified welders)
3. Inspection: 100% visual & PT, 100% x-ray wherever possible. *(See Marc’s talk)*
4. Leak & pressure tests *(See Marc’s talk)*
5. Full tractability record
Conclusions

• Functional design completed.
• 80% of 2D drawings completed.
• Fine tuning production processes.
• Prototypes and tests completed or launched.
• Challenging manufacturing operations, but no showstoppers.
Thankyou for your attention
Questions ?
Back-up slide

N_TOF target 2 (current)