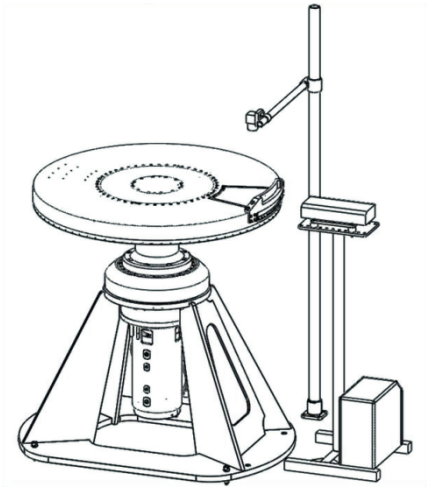
RTFT

THE ROTATING TARGET FLOW TEST FACILITY



4th HPTW. May 3, 2011. Malmö, Sweden

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in collaboration with

OUTLINE

Background

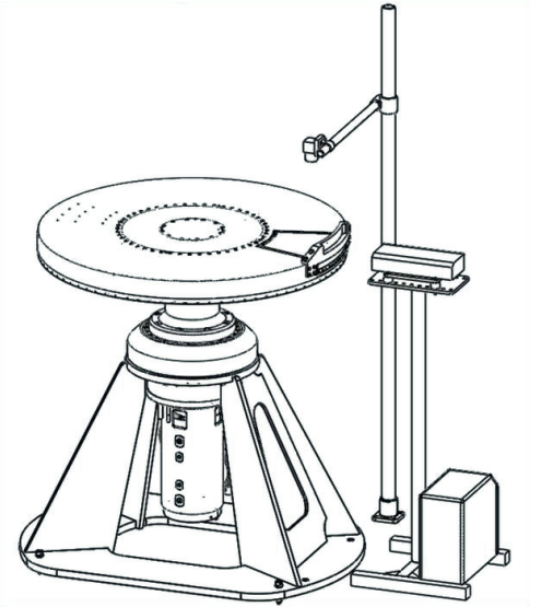
The RTFT

The SNS STS RT Mockup

RTFT Start Up

Summary

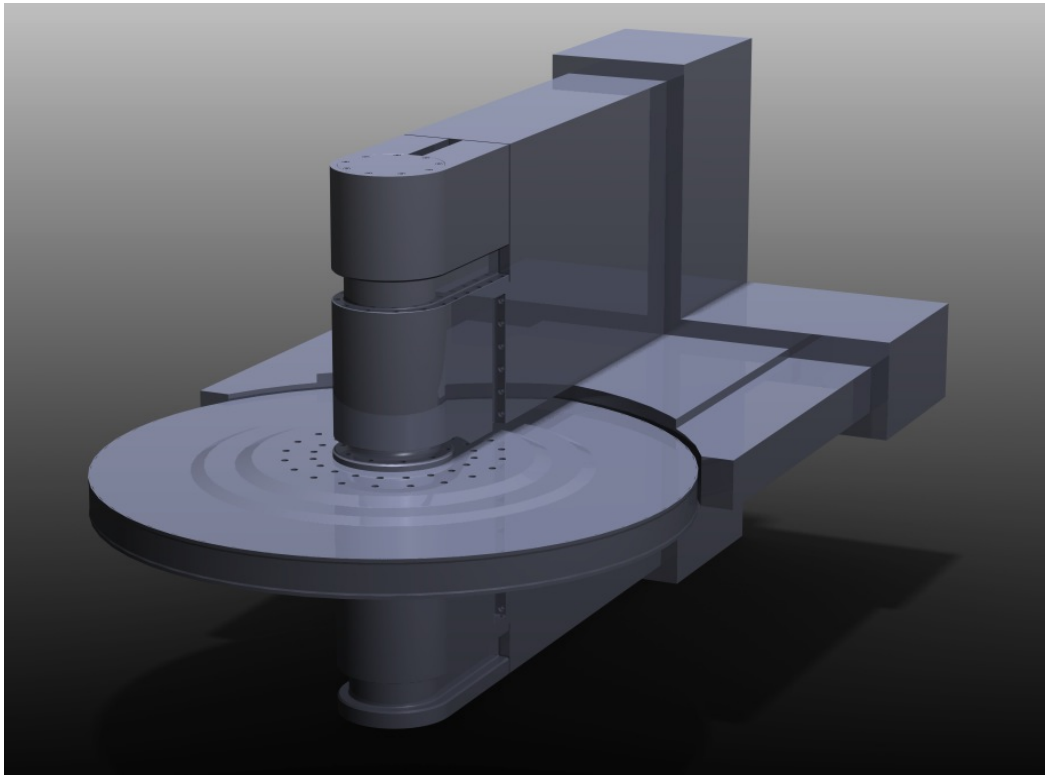
BACKGROUND

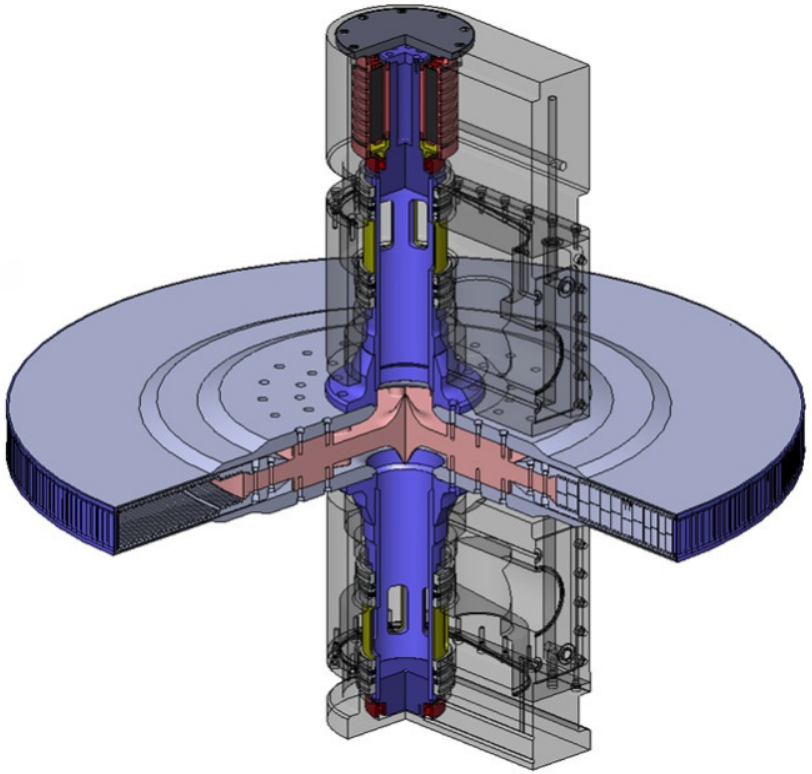


BACKGROUND

Design Study of a Rotating Target for ESS

- In 2009 ESS Bilbao worked out a preliminary design for a rotating target for ESS.
- Disc formed by un-clad tungsten bricks cooled by cold-plates and arranged in a horizontal trolley.
- General design and underlying concepts presented at ICANS 2010. Summary of preliminary assessment presented.





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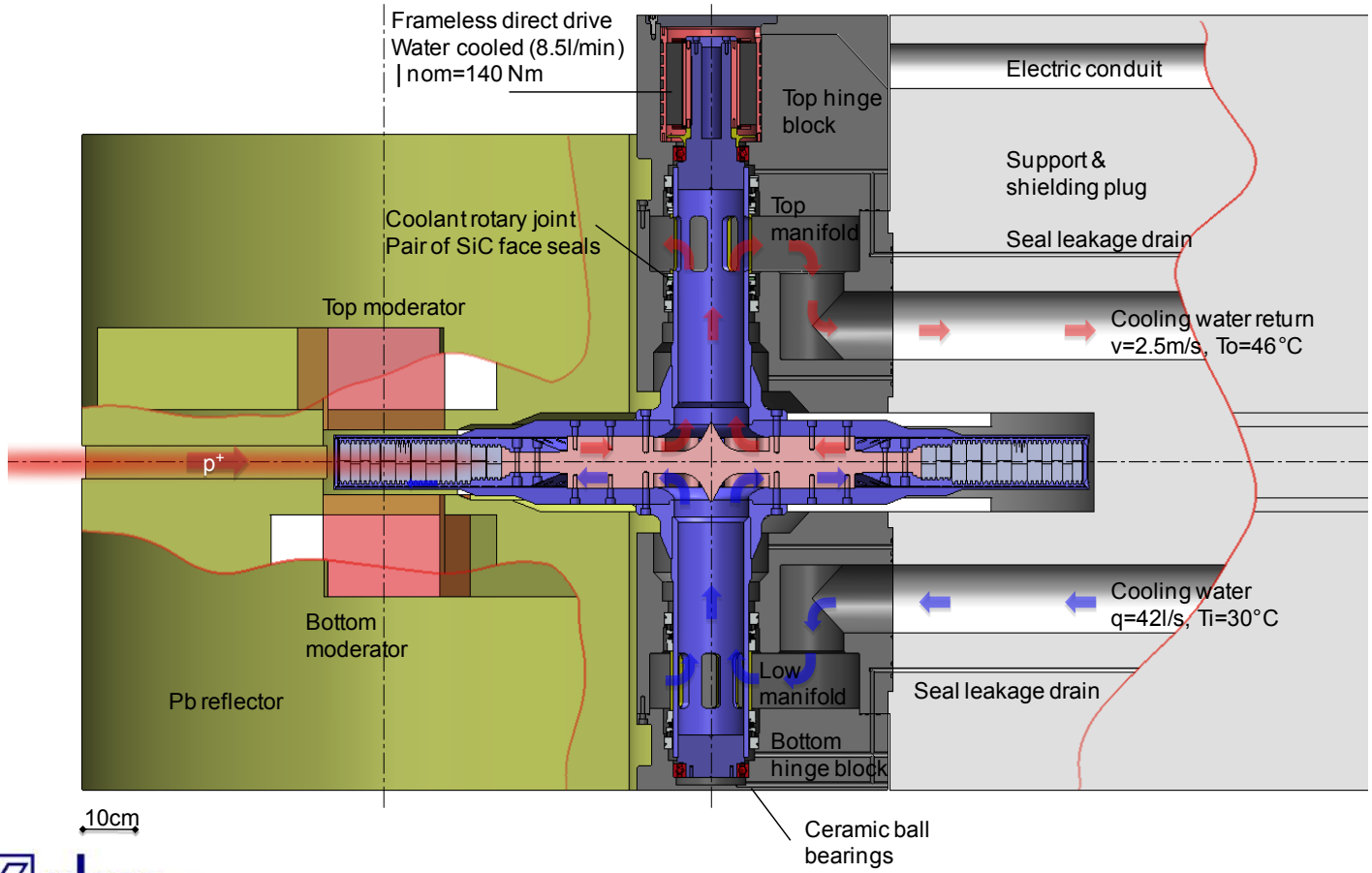
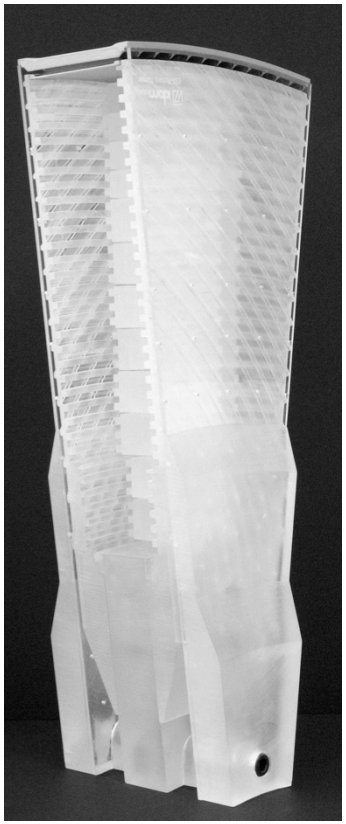
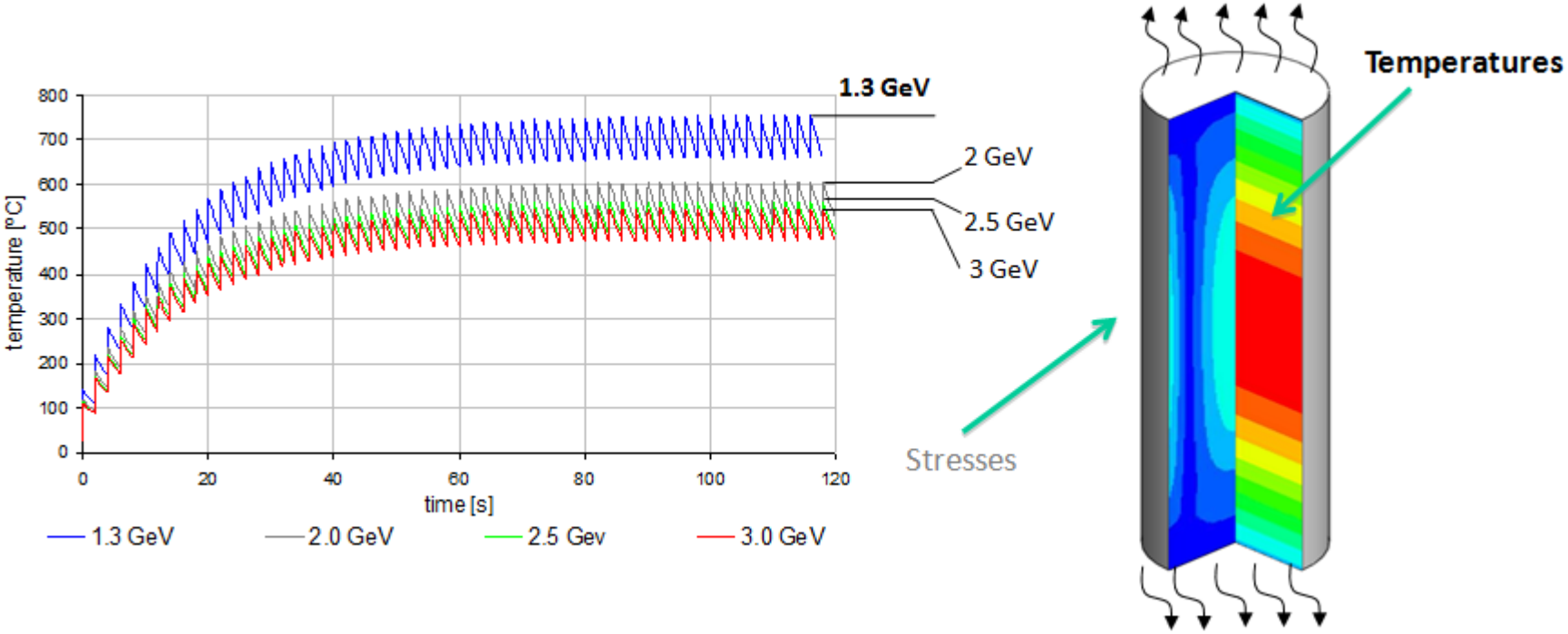




BACKGROUND

Analysis of ESS target performance for different beam parameters

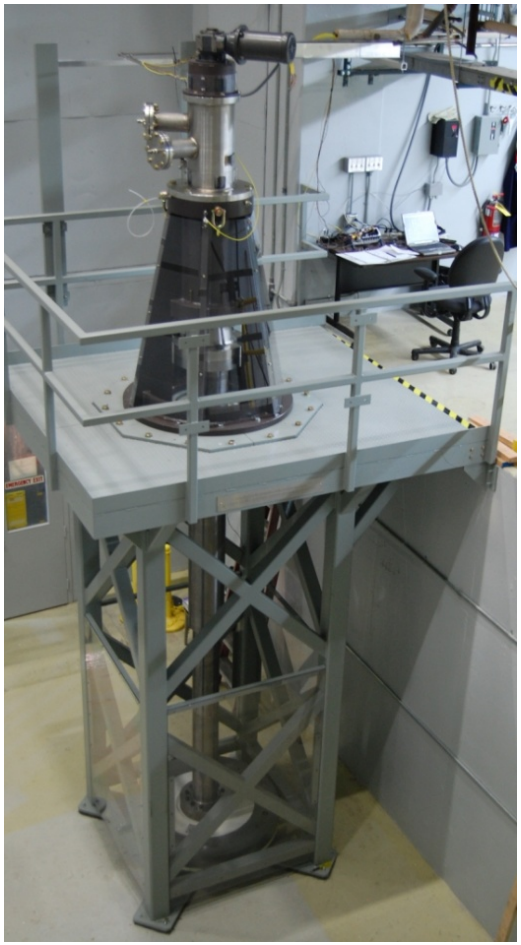
- Analysis of the impact of variations in beam parameters (energy, pulse length and repetition rate) on target disc thermohydraulics and neutron performance.
- Analysis carried out on the rotating target designed by Idom – ESS Bilbao, with the SNS-STS Target-Moderator-Reflector Assembly (TMRA).
- See ICANS 2010 proceedings



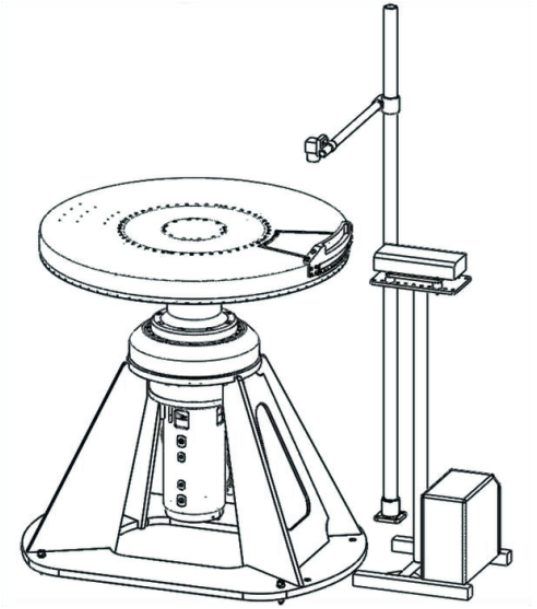
BACKGROUND

Prototype and Testing of SNS STS Rotating Target Design

- Full-scale extended vertical shaft, rotating target, based on a conceptual design for a 1-3 MW spallation target.
- ESS Bilbao in charge of the detail design, manufacturing and assembly of the target module.
- Successful operation for 5400h, with no indication of performance deterioration and no need for maintenance or refurbishment, confirmed overall mechanical feasibility (leak-free, alignment, stability, drive component performance) .
- Presented at ICANS 2010 and AccApp'11



THE RTFT



MOTIVATION

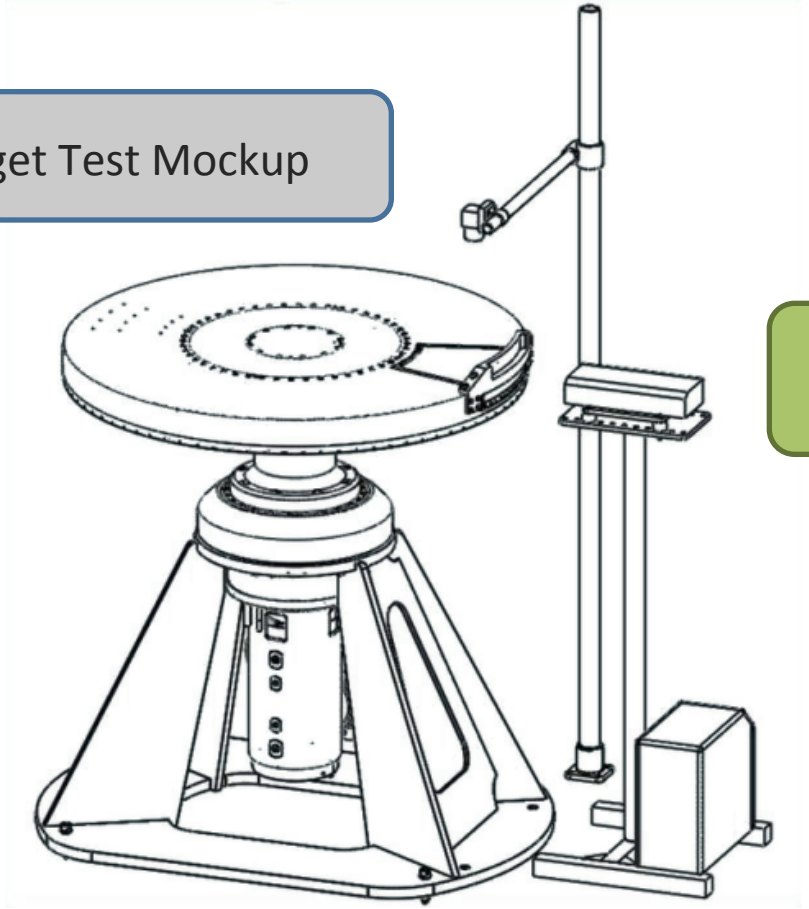
Motivation.

- Efficient cooling of the target material is an important issue in the design of a spallation target.
- The aim of the **R**otating **T**arget **F**low **T**est **F**acility is the characterization of coolant flow in rotating targets.
- First prototype to be tested: SNS design of a RT for 1.5 MW with upper, front and lower cooling

- The RTFT will be used to:
  - Study potential flow instabilities and other adverse effects (e.g. flow stagnation and/or recirculation)
  - Benchmark calculations and simulation models
  - Assess final target designs

MAIN COMPONENTS

Target Test Mockup



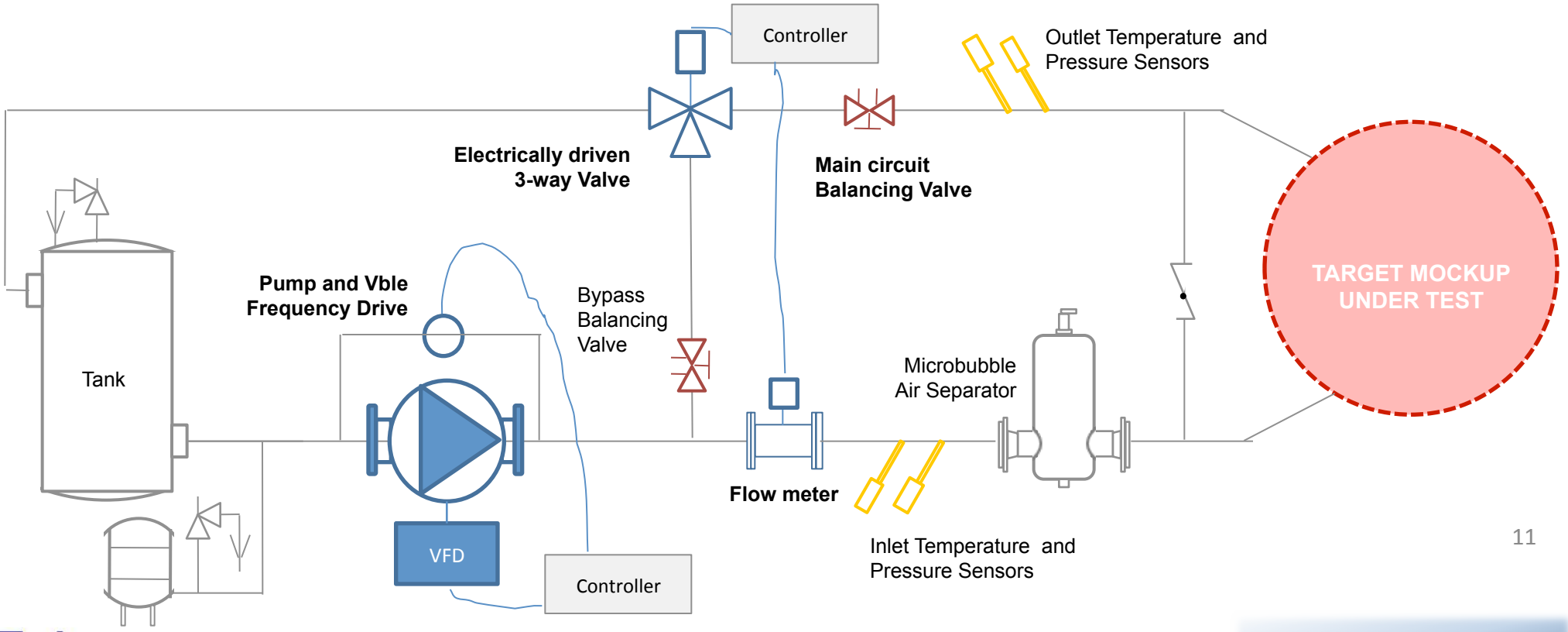
PIV System

Water Loop

Support & Drive System

WATER LOOP

- The water circuit provides **flow rates of up to 30 l/s at pressures up to 7 bar**.
  - Single pump controlled by a variable frequency drive (VFD).
  - 3-way valve commanded by a precision flow-meter for precise control of the flow rate.
  - Balancing valve in main circuit to set the test pressure.
- Micro-bubble air separator to remove air bubbles.
- Pressure and temperature sensors at inlet and outlet pipes

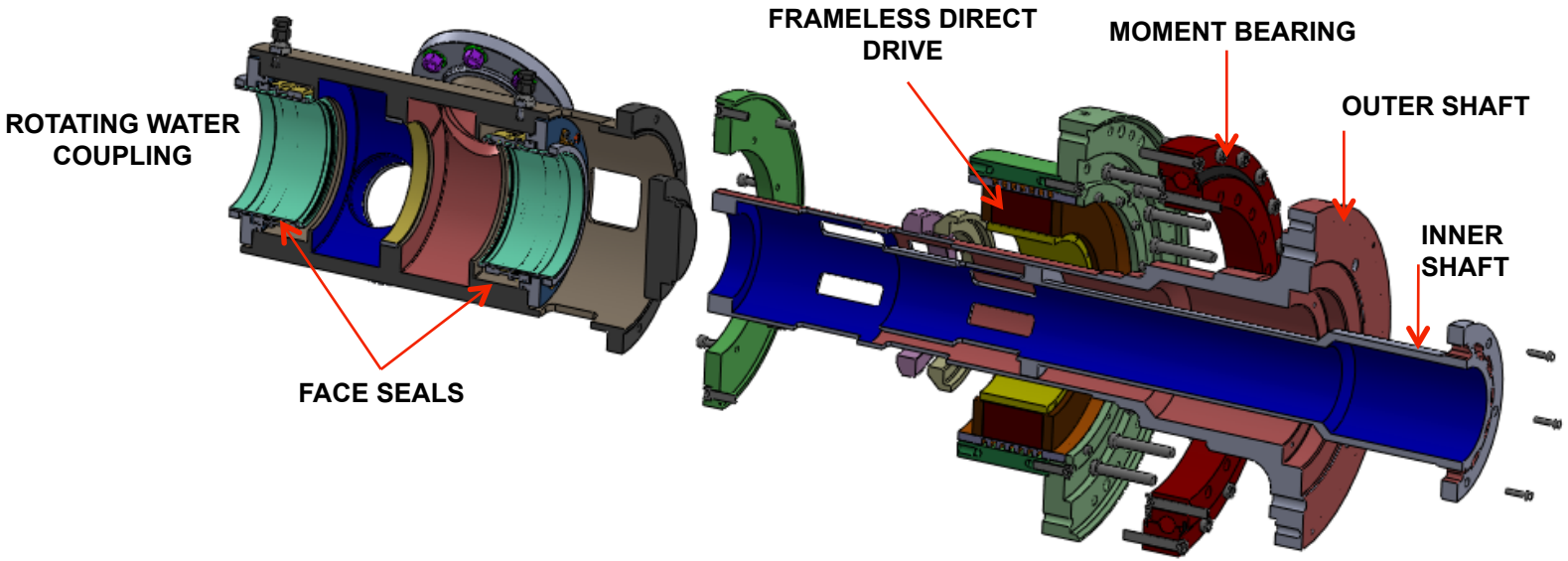


WATER LOOP

- Piping and tanks in stainless steel. A water filter ensures further cleanliness.
- Dedicated control system communicates with general RTFT control system via an OPC server

SUPPORT & DRIVE

- The RTFT features a **compact mechanical system** for the rotation of the targets being tested
  - Inlet and outlet water channels formed by two concentric stainless steel shafts
  - Face seals installed in the rotary water coupling
  - Single moment bearing
  - Direct drive with a servo drive.
- Mechanical components as these are particularly **suitable for real target systems**.
- The system can rotate at **speeds up to 60rpm**.

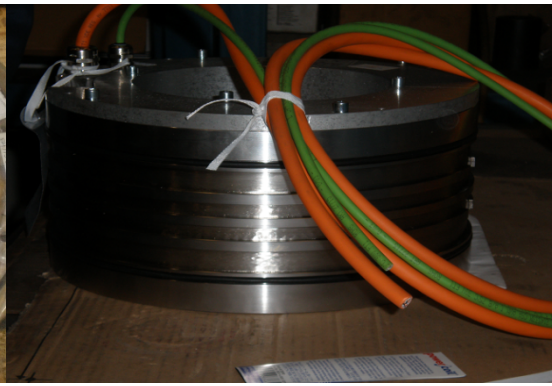


SUPPORT & DRIVE

- Component manufacturing / provision took place from July to October 2010

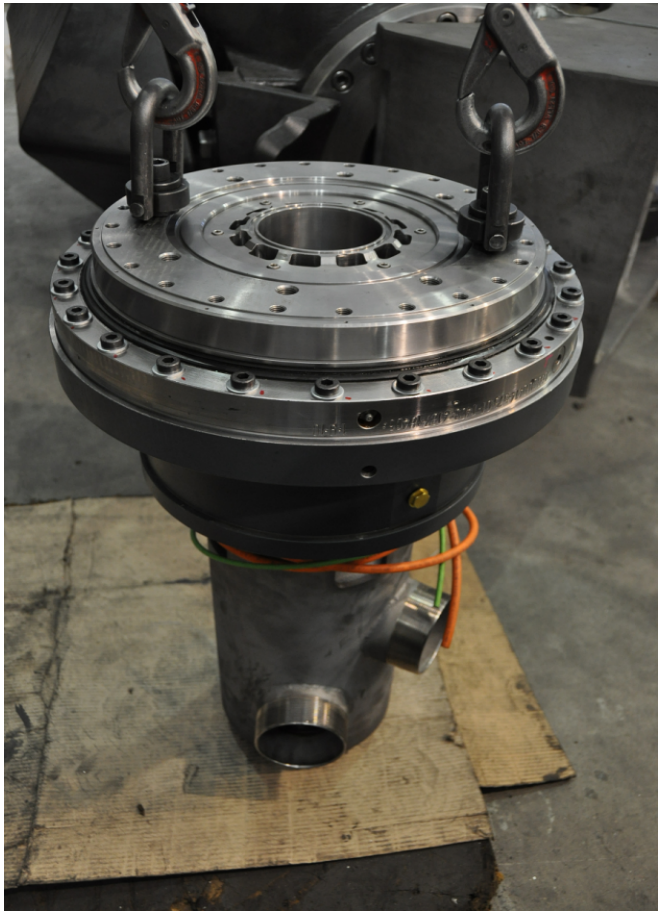
MECHANICAL SYSTEM COMPONENTS	
Motor	VUES ROL – 300442 – 400 VAC
Drive	SERVOSTAR 606 – 9 kW – 44 poles
Bearing	Rothe Erde 060.20.0414
Seals	John Crane R33 – 145 mm

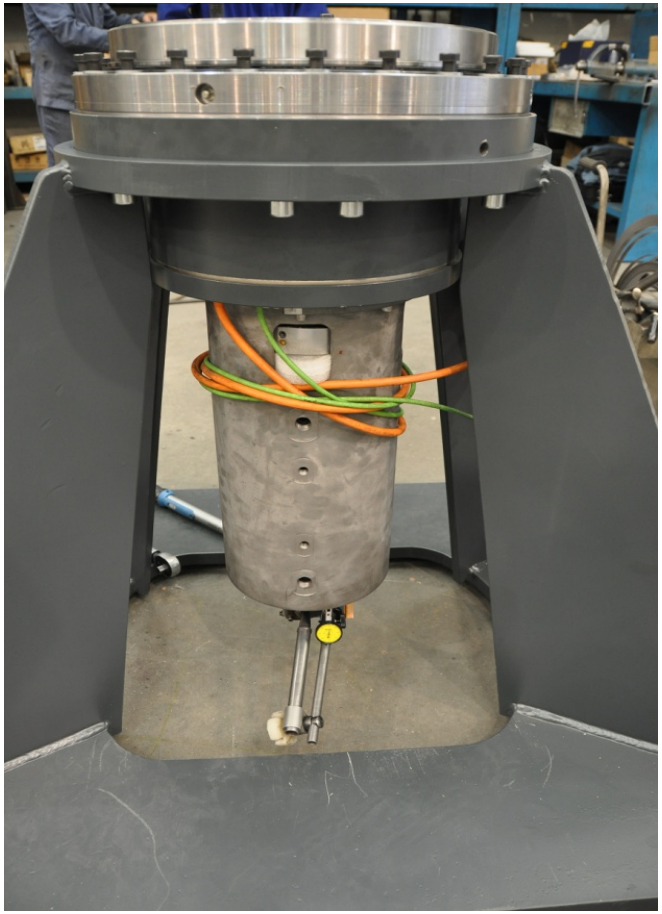





SUPPORT & DRIVE

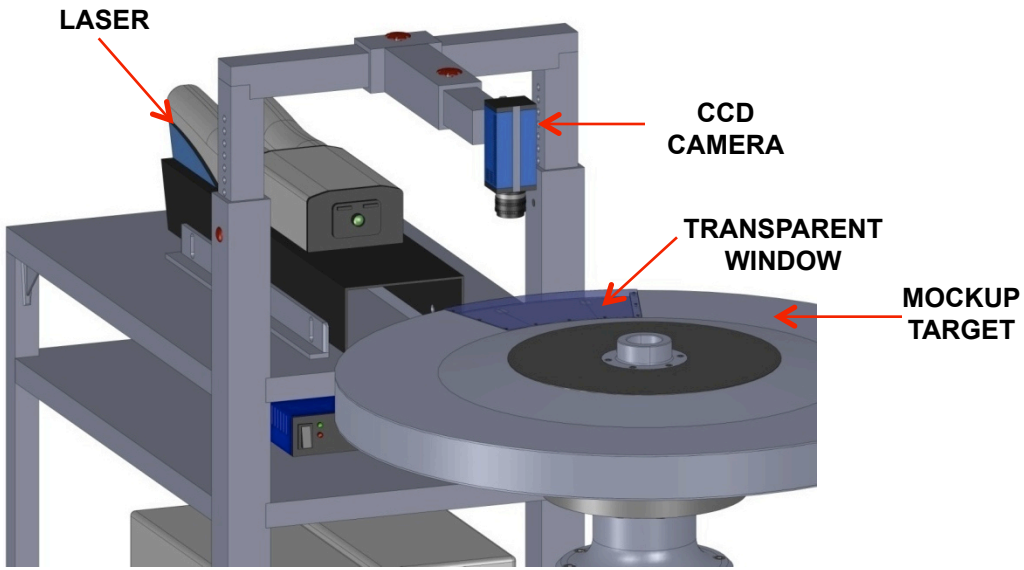
- Assembly and FAT performed in October-November 2010





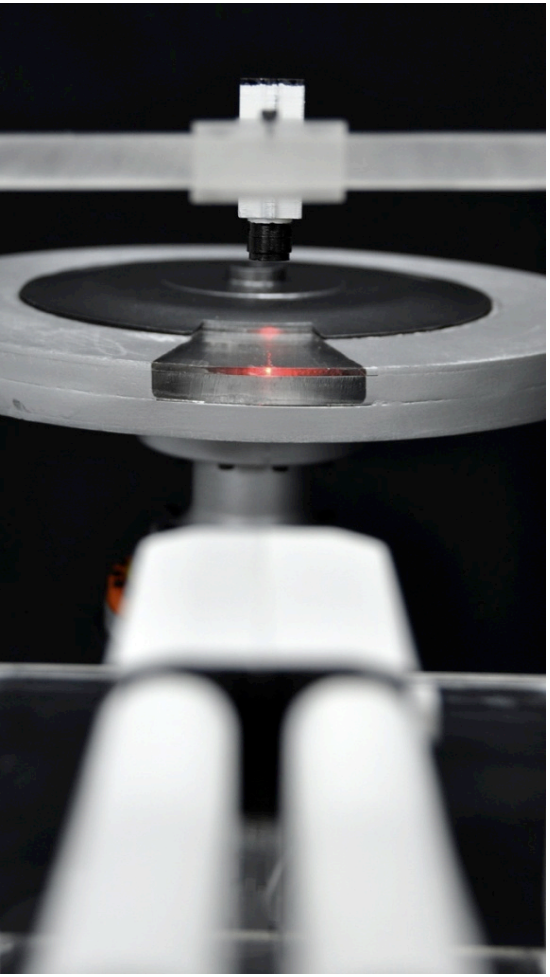
FLOW CHARACTERIZATION

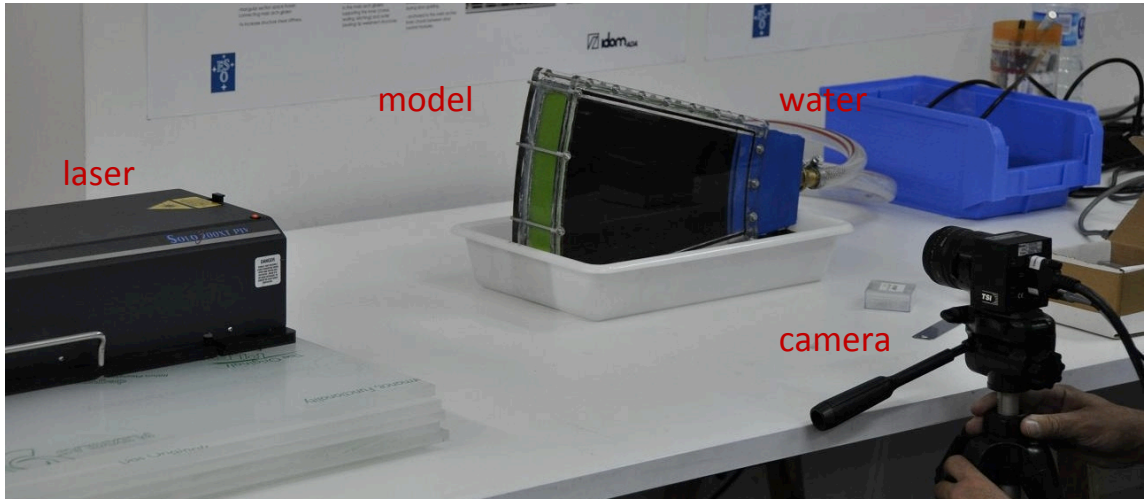
- Flow velocity along the cooling channels will be obtained with **PIV (Particle Image Velocimetry)** techniques



- A high power laser illuminates a planar sheet in rapid successive pulses.
- Small tracer particles that follow the flow, scatter the light.
- A CCD camera, optimized for PIV use, collects the light and records one image for each laser pulse.
- Particle displacements are then processed by comparing two consecutive images and applying spatial cross-correlation techniques.
- **Velocity** is obtained by dividing displacements by the time between pulses.

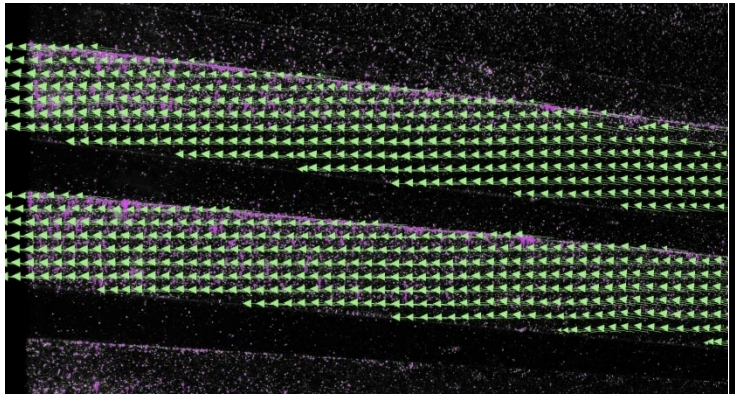
FLOW CHARACTERIZATION

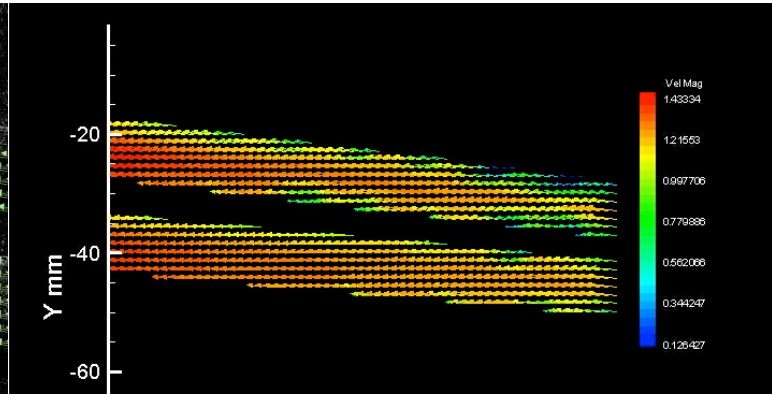




PIV system trial test on a disc sector.
Disc model at 1:1 scale, with prototypic cooling channels.
Static test.

Results plots.





INSTALLATION

INSTALLATION

- The support & drive system was taken to the ESS Bilbao R&D Center in November 2010
- The Water Circuit was put on place in January 2011.
- The PIV system was received in December 2010.
- The Mockup Target was connected to the RTFT in March 2011.

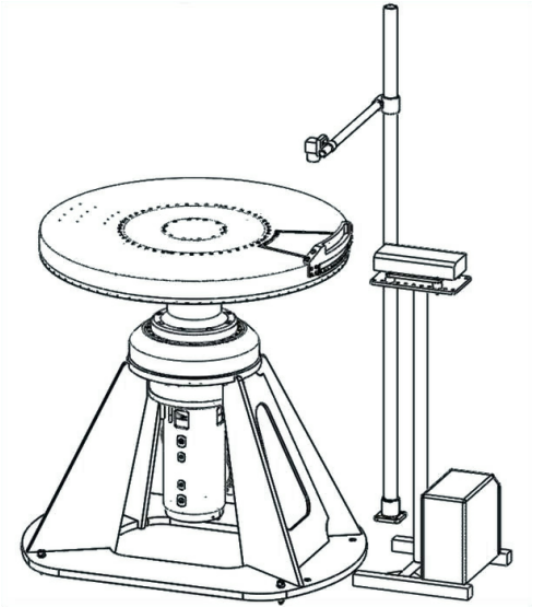
COMMISSIONING

- Commissioning of the Water Circuit was successfully completed in March 2011.
- Tests and commissioning of the PIV system were carried out in April 2011.
- Partial tests on the global control system are being carried out
- Final tests and commissioning of the drive system will be performed in May 2011.
- Final commissioning of the control system is planned for May 2011.

ESS BILBAO R&D CENTER
Bizkaia Technology Park
Zamudio, SPAIN

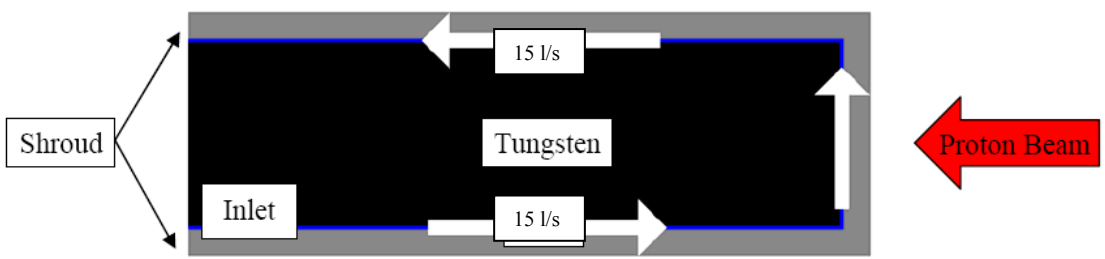
INSTALLATION

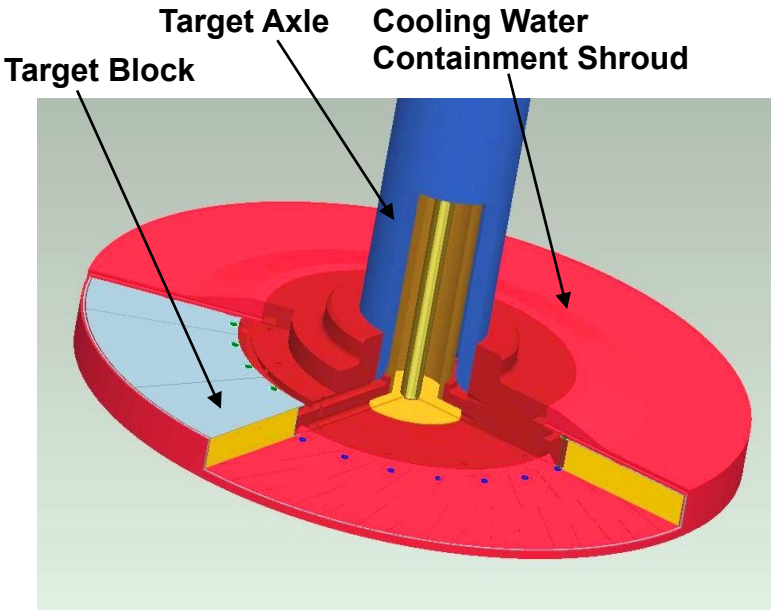
SNS STS RT MOCKUP



REFERENCE DESIGN

- SNS design of a rotating target for 1.5 MW
- 1200mm diameter tungsten disc, with top, window and bottom cooling
- Formed by 12 blocks, channels drilled on shroud inner faces to improve coolant flow guidance





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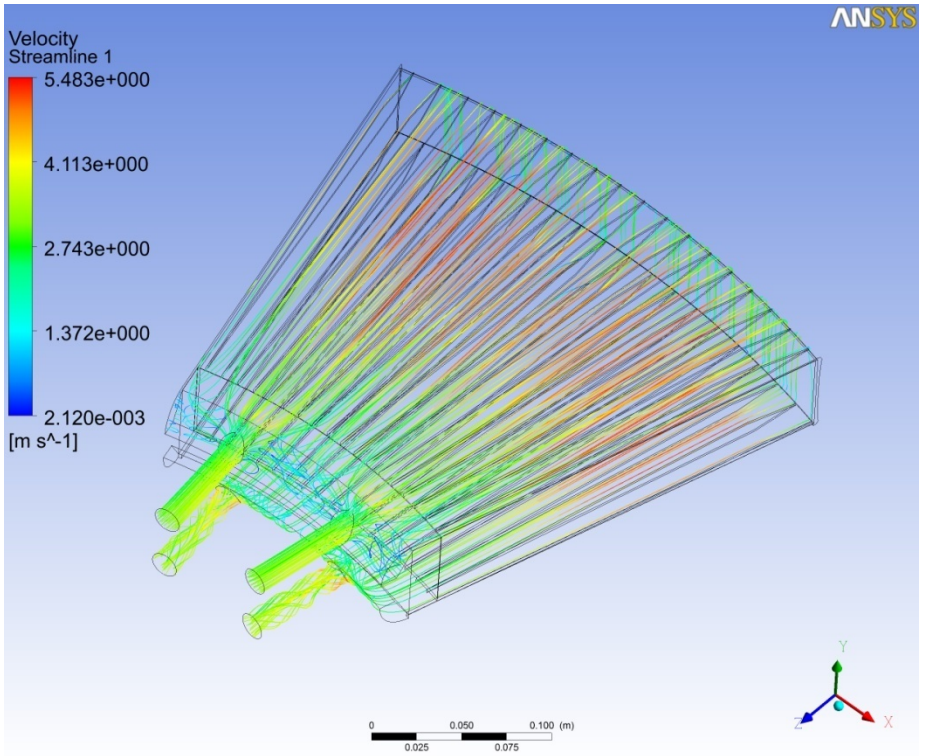
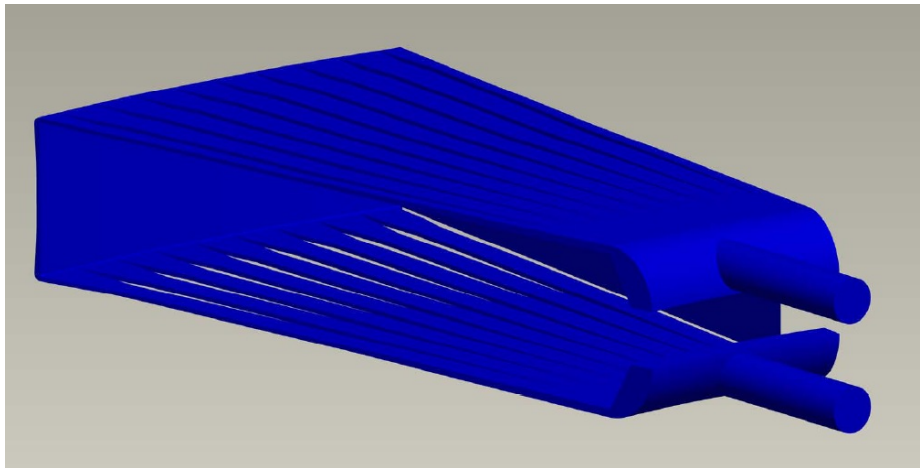
Jim Janney ,
Patrick Geoghegan,
SNS, April 2010.

Flow streamlines around a segment.

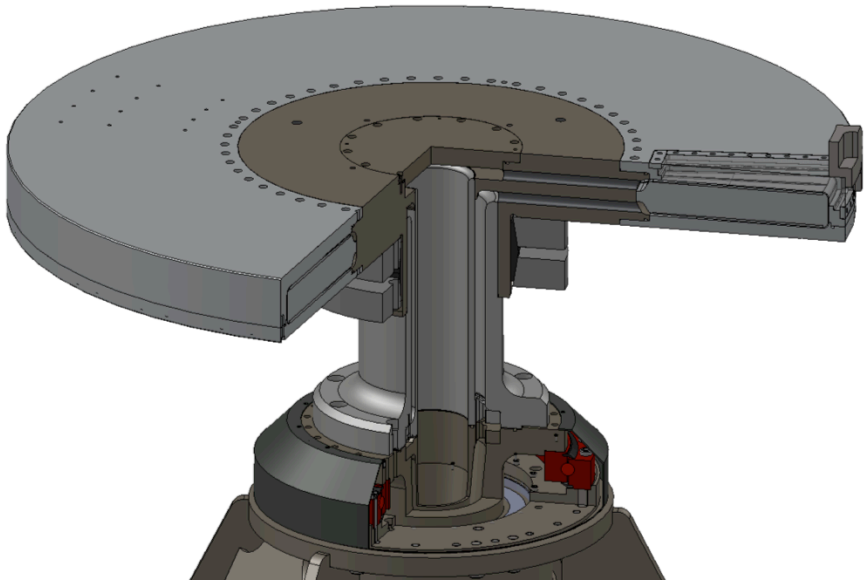


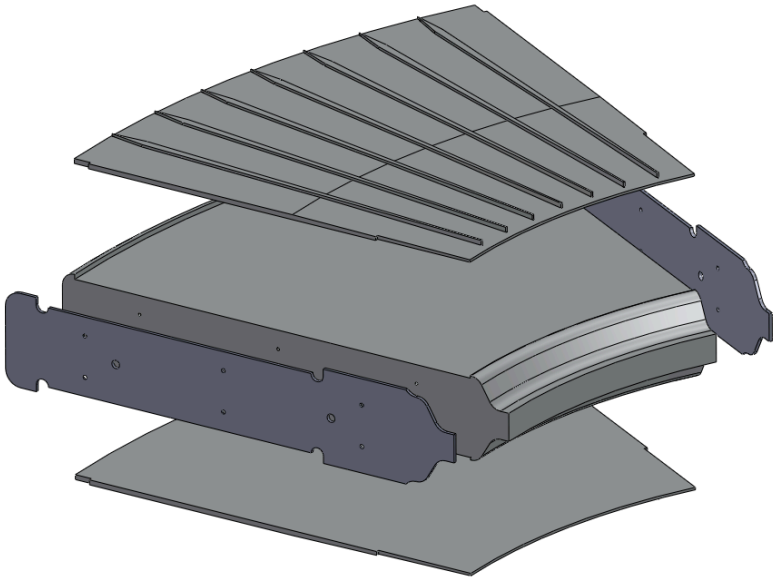
Water volume around half a segment . Radial channels.



MOCKUP DESIGN

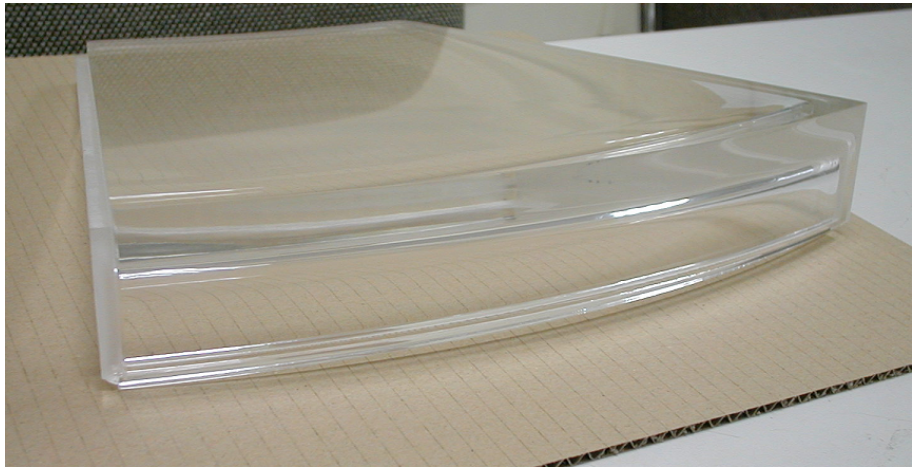
- Water channels geometry (hub manifolds, blocks and shroud inner geometry) as specified in the design, except for radial vertical gaps between blocks.
- Channels milled in thin plates attached to the blocks, instead of in shroud inner faces.
- Shroud and hub made of stainless steel; Blocks made of aluminium.
- Flange bolted connection to the support and drive system
- Shrink disc bolted connection to the shaft. Compatible with SNS full-scale long shaft mockup.

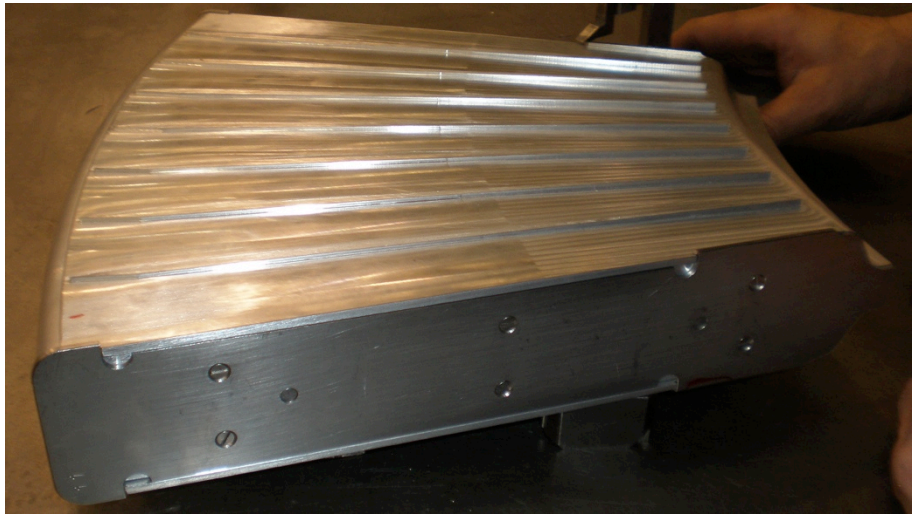


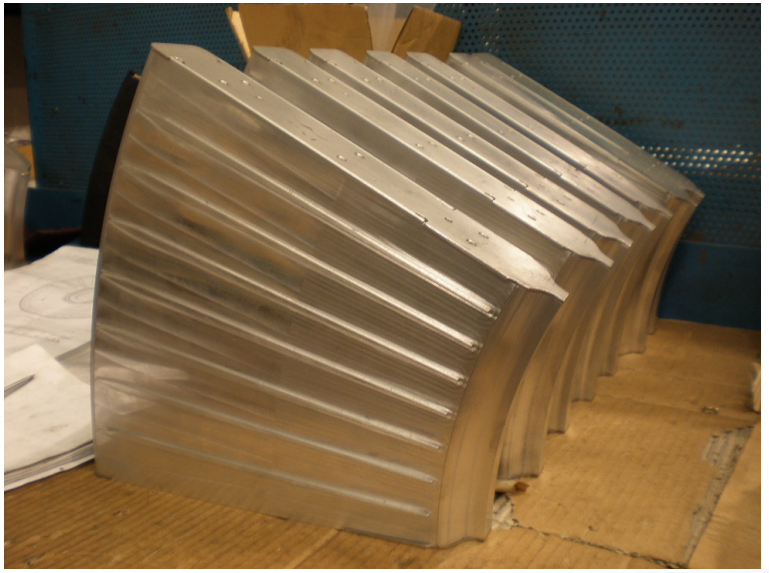


FABRICATION

- Mockup manufacturing and assembly spanned from December 2010 to March 2011







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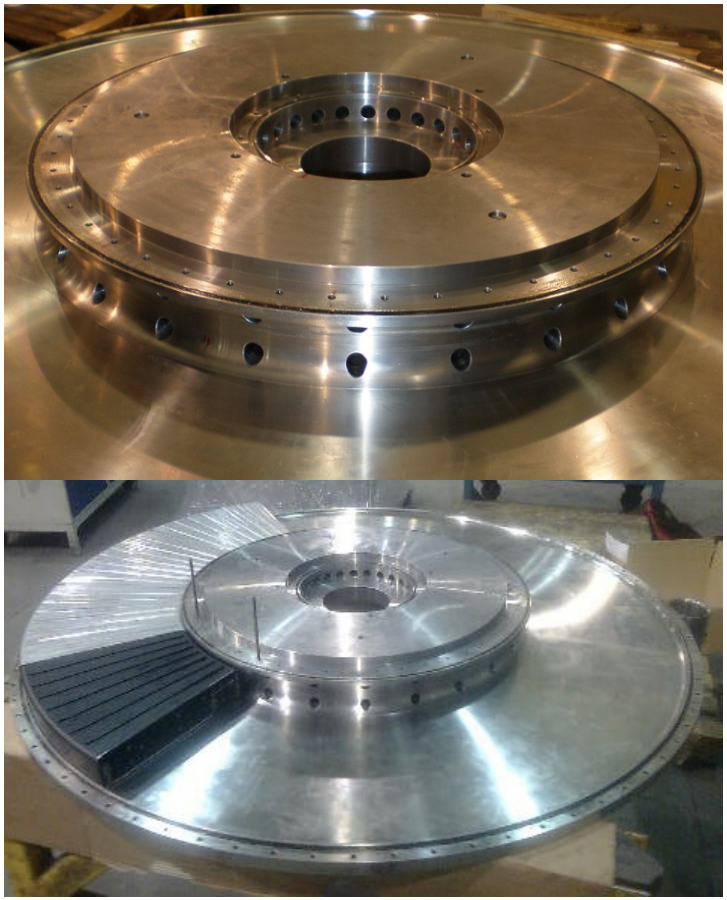
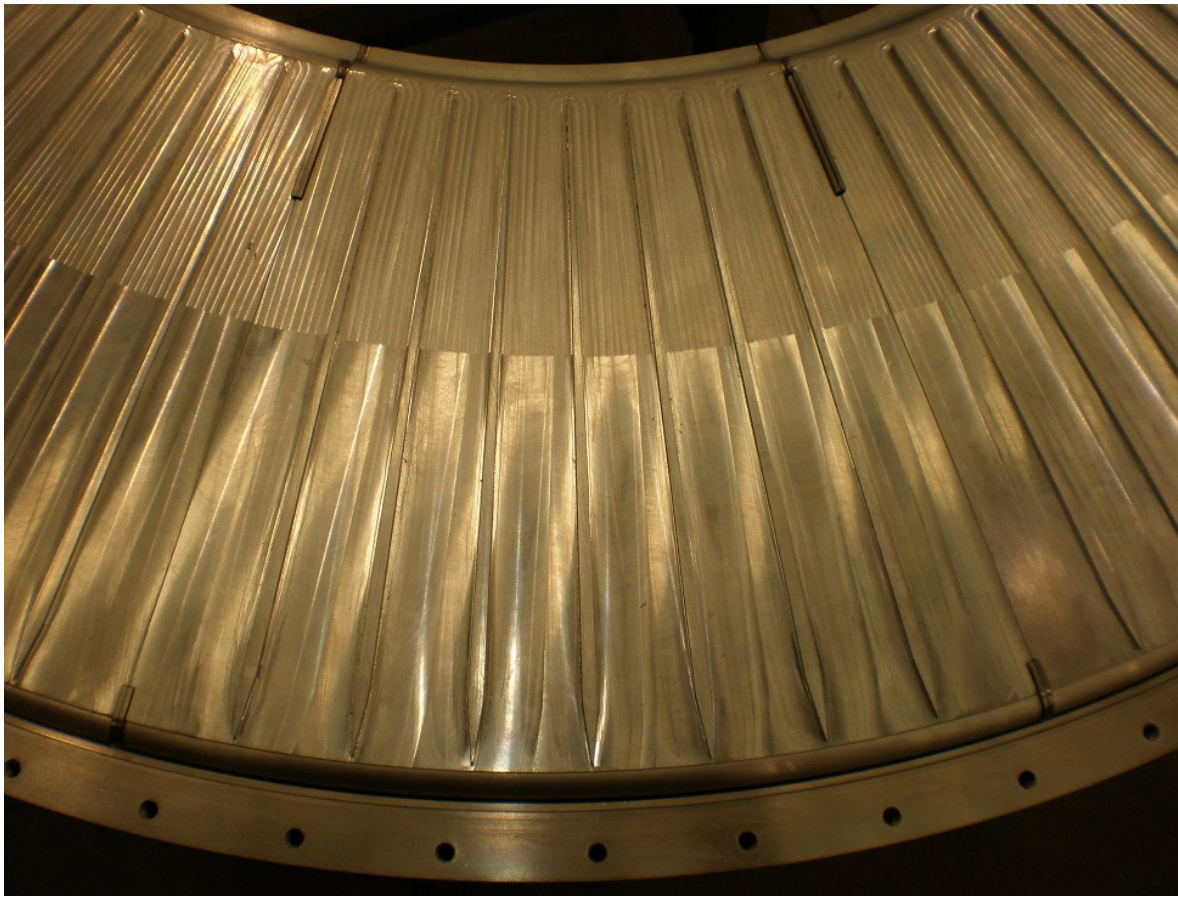
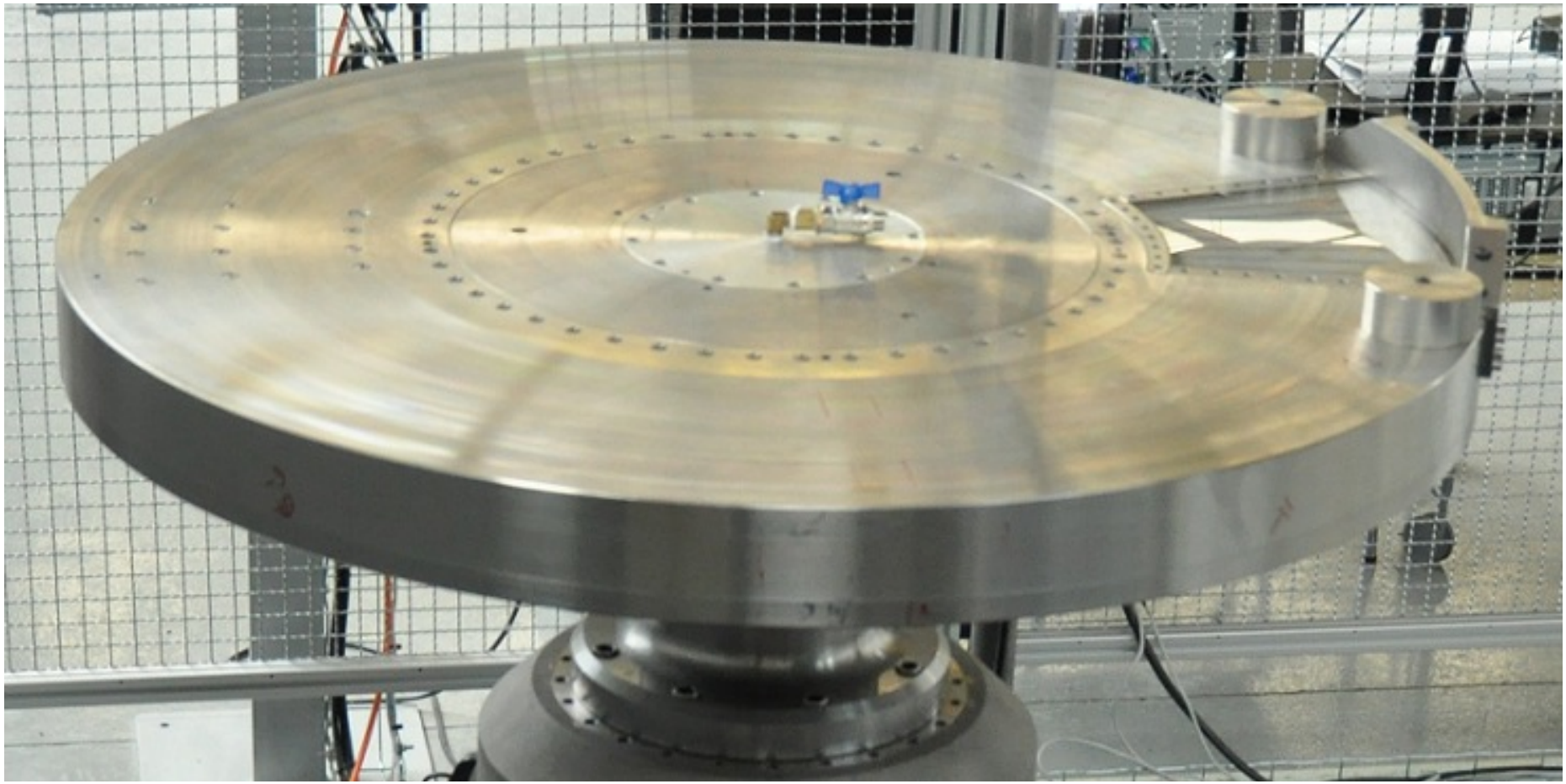




FABRICATION & ASSEMBLY



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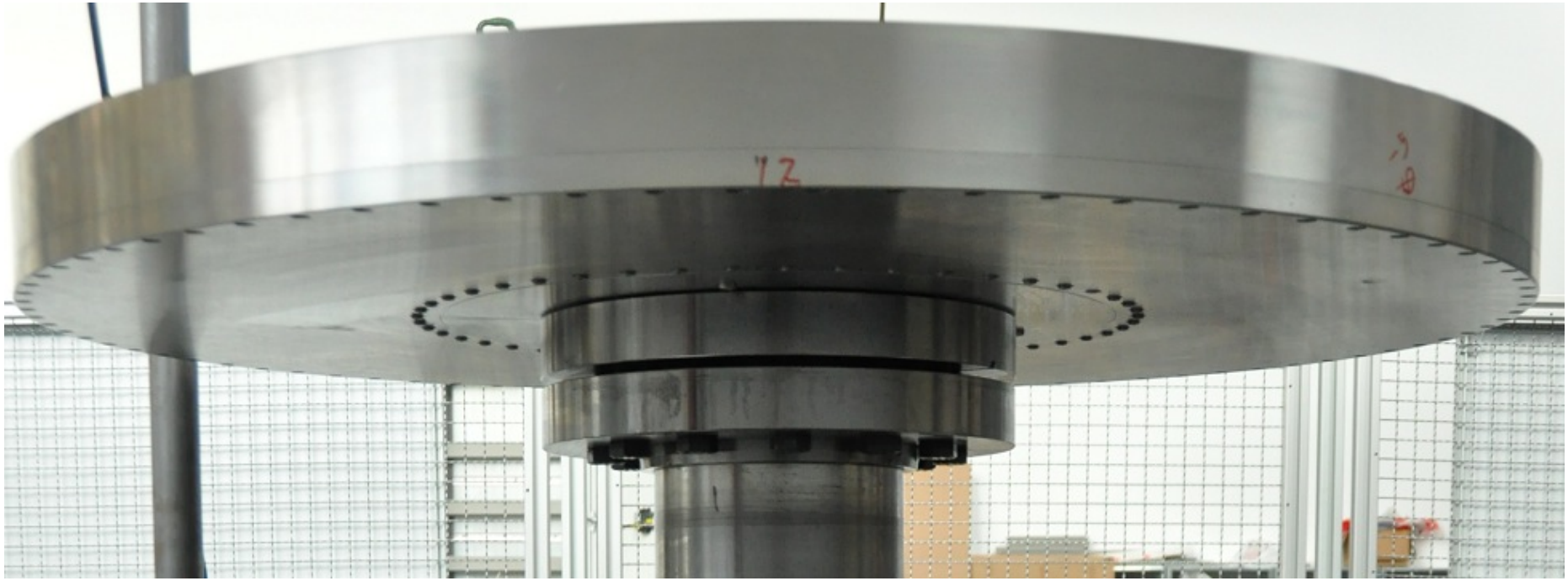
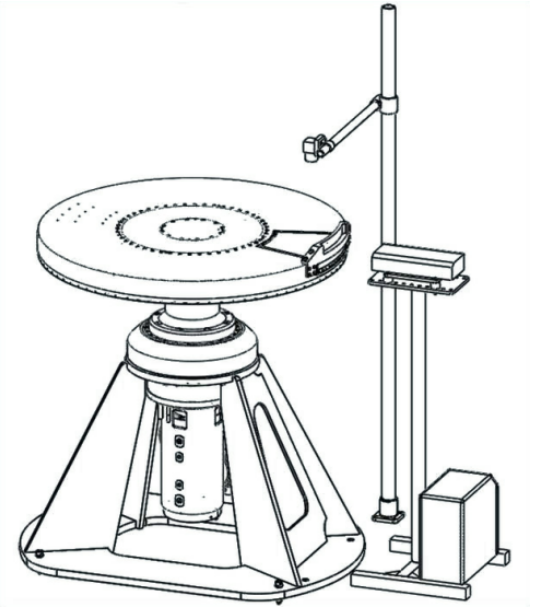
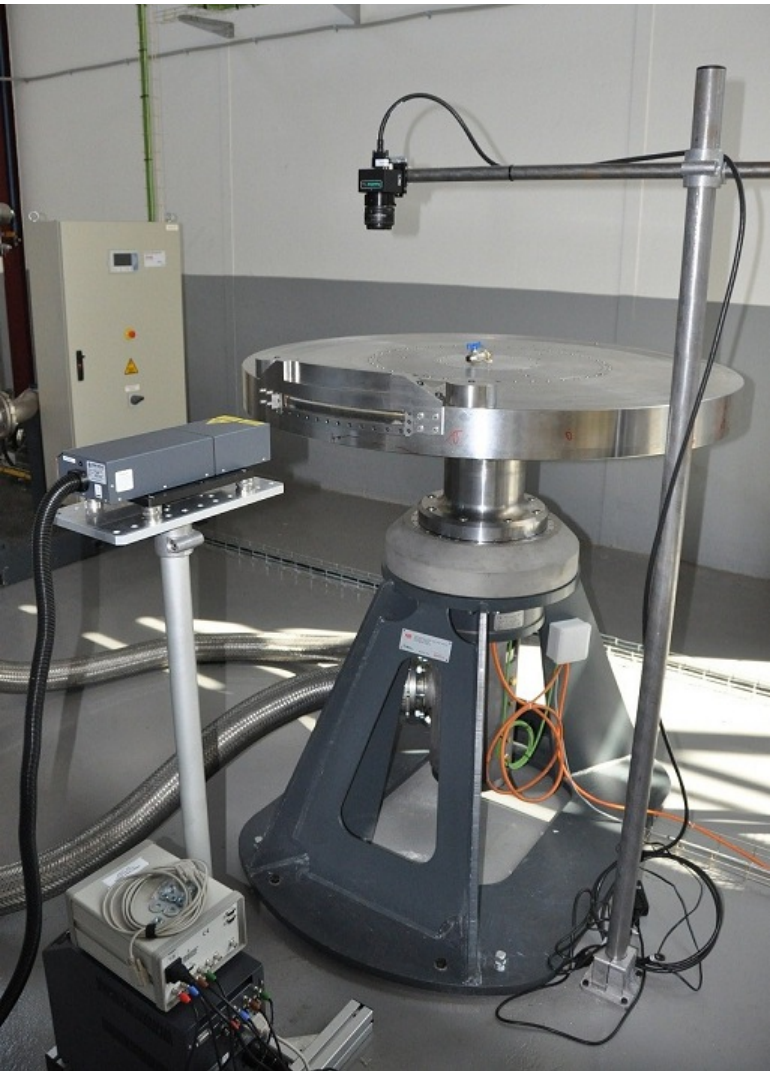
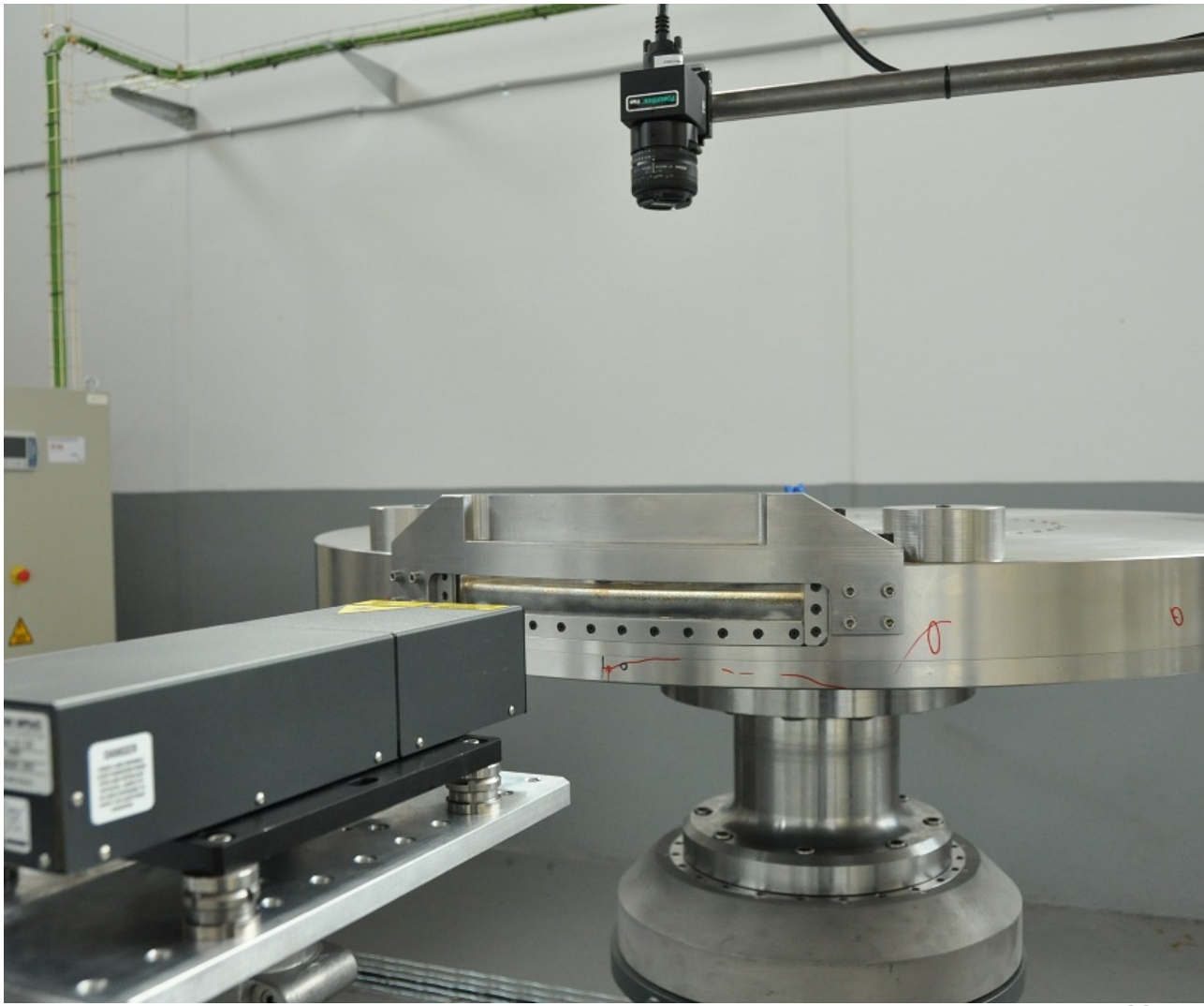


START UP OF THE RTFT



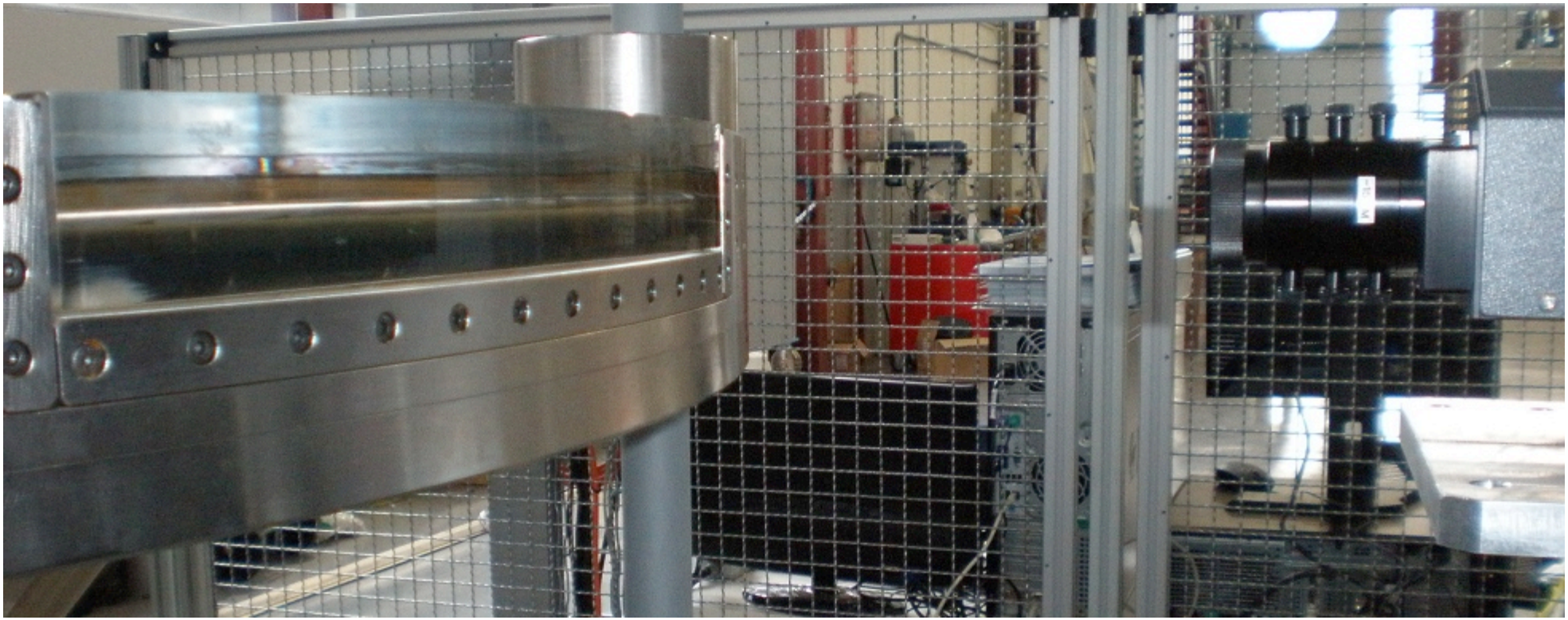
PIV SYSTEM INSTALLATION



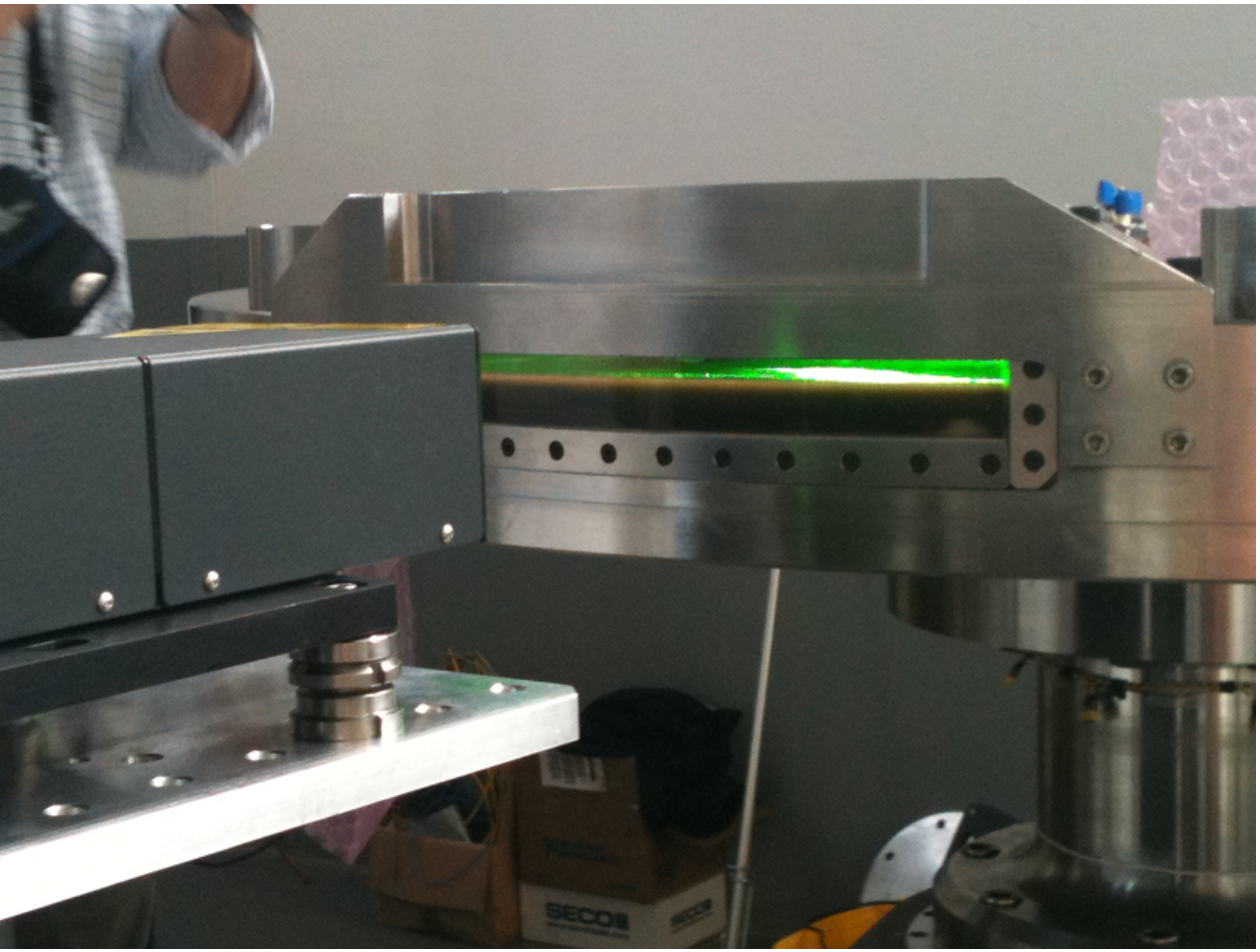


PIV SYSTEM INSTALLATION

- PIV system installation and initial runs were carried out on April 19-20.

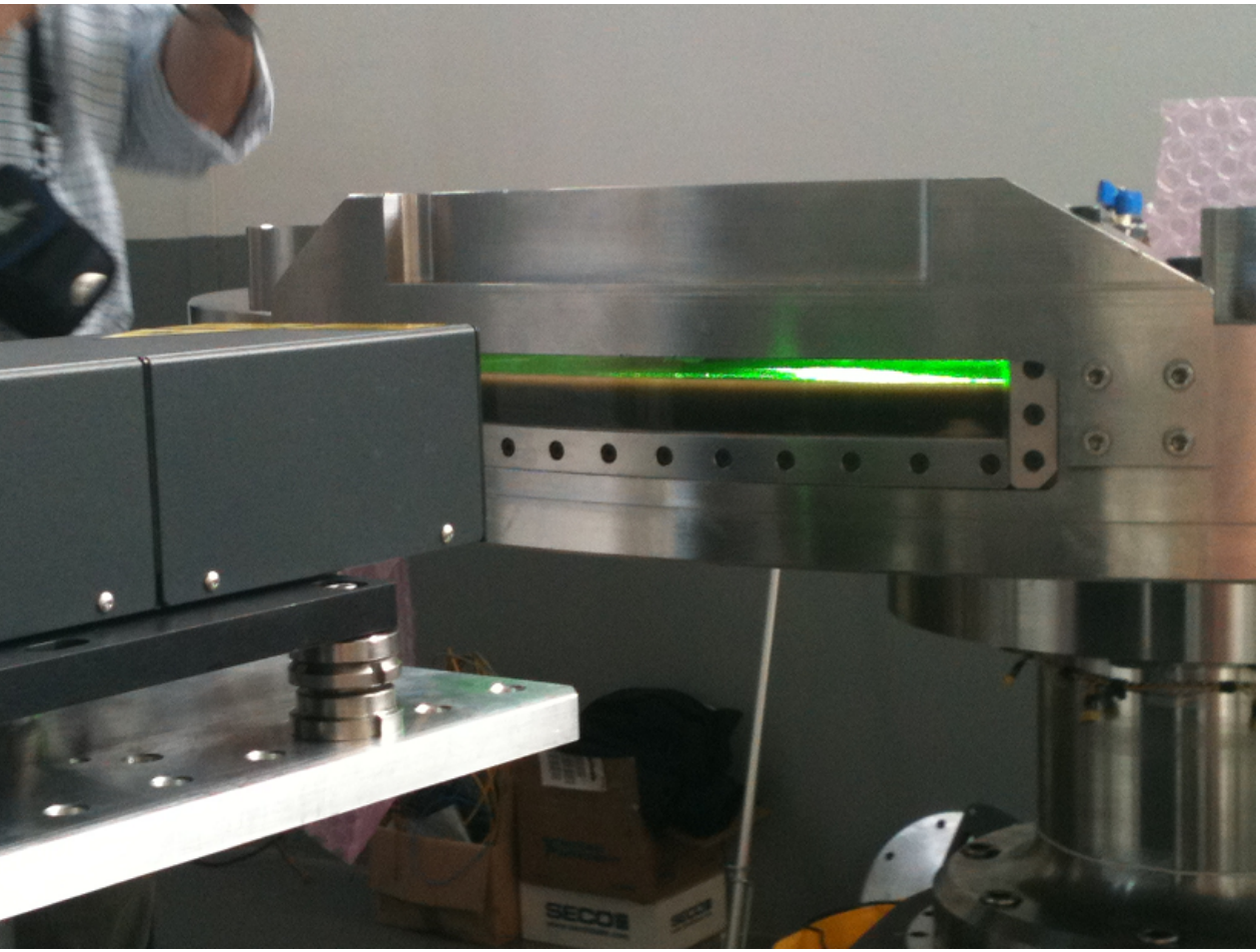


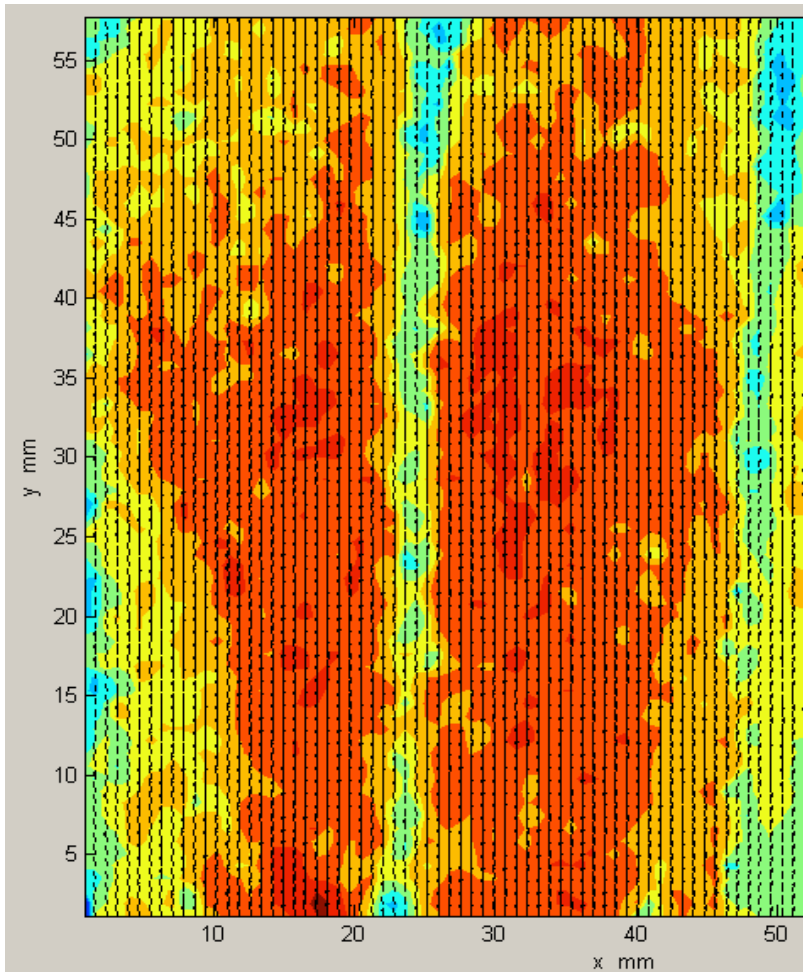
INITIAL PIV RUNS



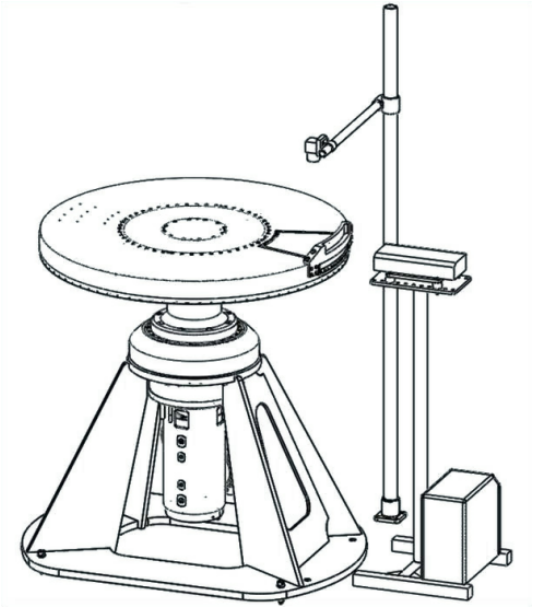
INITIAL PIV RUNS

PRELIMINARY





RTFT - SUMMARY



SUMMARY

- Efficient cooling of the target material is an important issue in the design of a (spallation) target.
- The aim of the RTFT is the **characterization of coolant flow in (rotating) targets**, and will be used to study potential flow instabilities or other adverse effects, to benchmark calculation models and to assess final target designs.
- **PIV (Particle Image Velocimetry) techniques** will be used to obtain flow patterns along the target cooling channels.
- The RTFT design started in early 2010. Fabrication was launched in July and FAT tests were successfully completed in December 2010.

SUMMARY

- The **first prototype to be tested is the SNS design** of a rotating target for the Second Target Station.
- A mockup for these tests has been designed, fabricated and finally assembled in March 2011.
- **The PIV system was installed and first runs were performed** on April 19-20, 2011.
- Next step: calibration of the experiment.
- Tests on the SNS STS design will be performed, first for nominal values of flow rate and rotation speed. After that, higher flow rate and rotation velocity values will be tested.

THANK YOU FOR YOUR ATTENTION

On behalf of the RTFT development team

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