European XFEL-linac Feed and End Cap dimensional tolerance validation

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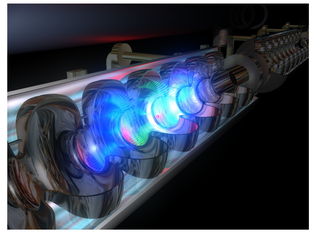
European XFEL-linac

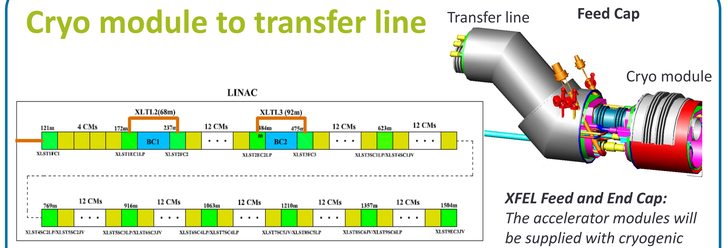
Using the X-ray flashes, scientists will be able to map the atomic details of viruses, decipher the molecular composition of cells, take three-dimensional images of the nanoworld, film chemical reactions, and study processes such as those occurring deep inside planets.

Location
The European XFEL will be located mainly in underground tunnels which can be accessed on three different sites. The 3.4-kilometre-long facility will run from DESY in Hamburg to the town of Schenefeld



Acceleration in a resonator
Electromagnetic fields accelerate the electrons in superconducting resonators

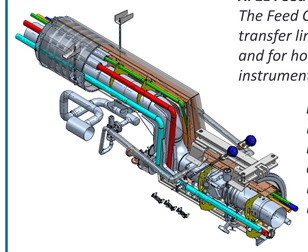
Cryo module to transfer line



Linac accelerator modules:
The accelerator modules arranged in strings consisting each of 12 modules will be installed in the XFEL linear accelerator

XFEL Feed and End Cap:
The accelerator modules will be supplied with cryogenic fluids from the transfer lines. A cryogenic box called the XFEL Feed & End Cap is required

Demaco – XFEL Feed and End Cap



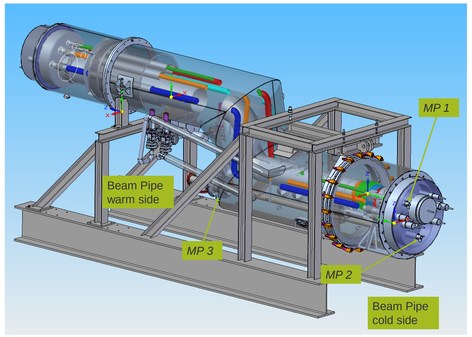
XFEL Feed and End Cap:
The Feed Cap will serve for vacuum separation between the transfer line and the concerned string of the accelerator modules, and for holding armatures and instrumentation.

Demaco:
Design, manufacture, inspection, transport and tests for 3 XFEL Feed Caps and 3 XFEL End Caps

Test & Measurement setup for Feed and End caps

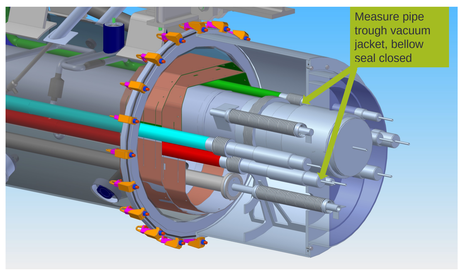
Verification of movement during pressure loading and during thermal cycling of the Beam Pipe, at warm and cold side

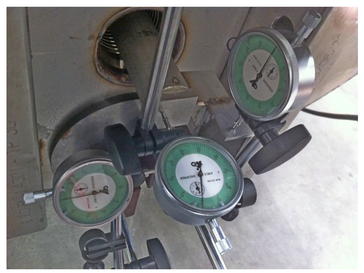
The test cap on the Cryo Module side will be equipped with a beam pipe adapter. Bellow closed feed throughs enable measurement of the actual Beam Pipe movement relative to the interface flange of the Vacuum Jacket



Measurement setup
Feed and End Cap installed in stiff support frame with Transfer line and Cryo Module side closed with test caps. The measurement locations are MP1 (DN300), MP2 (Beam Pipe – cold side), MP3 (Beam Pipe – warm side)

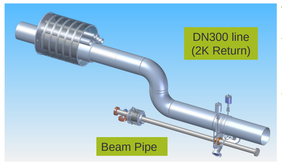
Cryo Module side test cap
To measure the Beam pipe and DN300 line, which acts as the Beam Pipe backbone, pipes are fed through the vacuum jacket





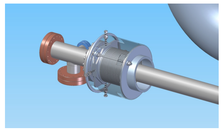
Measuring dial gauge setup
Dial gauges for measure the X and Y displacements during pressure load and cryogenic thermal cycle test

Beam Pipe position

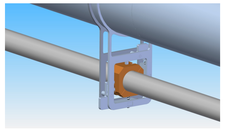


The position of the Beam Pipe must be accurate to 0.5 mm in operation conditions

Beam Pipe supports
The Beam Pipe is supported in the Feed and End caps at two locations: at the warm side and at the Cryo Module cold side. At the warm side, the BP is connected straight to the vacuum jacket; at the cold Cryo Module side the BP is connected to the DN300 line



Beam Pipe adjustable support at the warm side

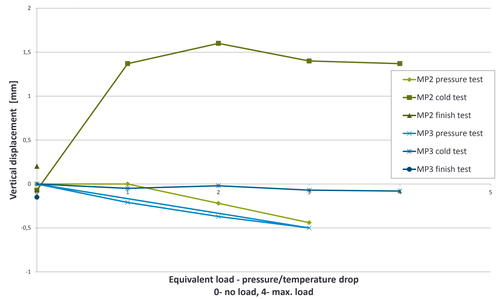


Beam Pipe adjustable support at the cold side

Beam Pipe position: measurements

Important observations are:

- The Beam Pipe penetration of the Vacuum Jacket is quite stable with max. 0.5 mm displacement
- The upward displacement at the cold side of max. 1.5 mm is smaller than the expected displacement of 2 mm. Likely cause:
  - the DN300 support is not cooled completely and thermal equilibrium has not been achieved

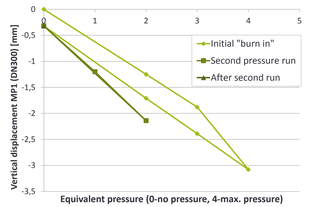


Displacement of the Beam Pipe vertical position at the cold side (MP2) and the warm side (MP3) during pressure and cold testing with LN2

Burn-in procedure

The pressure test is also a 'burn-in' procedure:

- Piping and supports face max. life time loading
- No plastic deformation expected after 'burn-in'
- Measurements confirm that displacements are reproducible after 'burn-in'
- Beam Pipe position during operation can be predicted and adjusted accordingly



Displacement of the DN300 vertical position (MP1) during the 'burn-in' procedure and the following pressure cycle

Concluding remarks

- The displacements of the Beam Pipe and the DN300 are repeatable after the initial 'burn-in' test
- The Beam Pipe position during operation can be predicted and the Beam Pipe can be adjusted accordingly during installation

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