Thermal Fatigue Tests in 26-IDA

ME-ASD Group

3/16/05

Argonne National Laboratory
Operated by The University of Chicago
for the U.S. Department of Energy

Office of Science
U.S. Department of Energy

Background

- All SR x-ray absorbers (right) were designed for 300 mA.
- Front-end and beamline components were designed for various current limits between 100 to 300 mA. Thermal analysis documentation is not readily available for many components.
- High current runs are on hold.
- Present design criteria are too conservative.

C2

W2

Beam Dump

TR5

EA3

RF Taper

IEA6

Scraper

Background (contd.)

Advanced Photon Source

December 9, 2003

To: R. E. Gerig — Division Director, ASD
E. Gluskin — Division Director, XFD

From: W. G. Ruzicka WGR — Division Director, AOD

Subject: **Request for Engineering Support**

AOD has been assigned the responsibility of the oversight of the compliance of critical components for safe operation of all the beamlines and front ends. Towards this end we would like to clearly define and document the operating envelop for all critical components of the beamlines and the front ends.

We would like to establish for every beamline and front end an envelope for safe operations based on the following criterion:

- Thermal limitations;
- Radiation limitations;
- Alignment requirements;
- Utility requirements; and
- Mechanical support requirements.

Of all the criteria listed above, we are currently focusing on the thermal limitations of critical components (shutters and masks). At this time we would like to start addressing the insertion device beamlines and front ends. Once we have a clear understanding on the insertion device beamline and front ends, we would subsequently address the bending magnet beamlines and front ends.

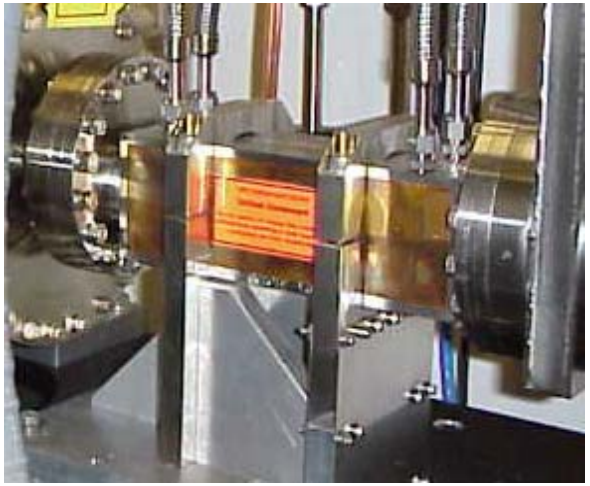
This memo was discussed in an Ops-Directorate meeting and it was decided to pursue two goals simultaneously.

Background (contd.)

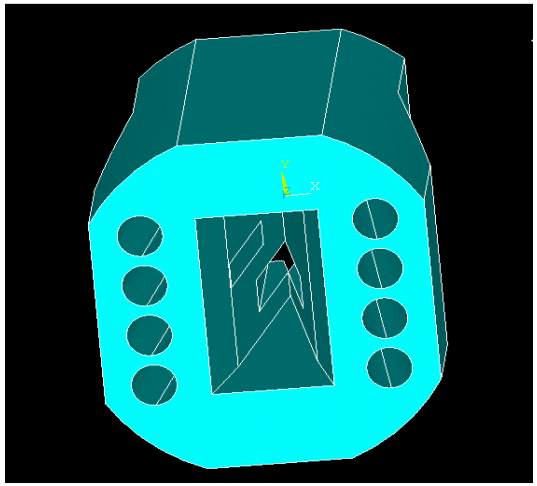
- Goal I: Perform linear elastic finite element (FE) analyses using existing (highly conservative) design criteria to obtain upper limit on beam current.

- Goal II: Establish more realistic design criteria based on fatigue tests and nonlinear elastic-plastic finite element analyses.

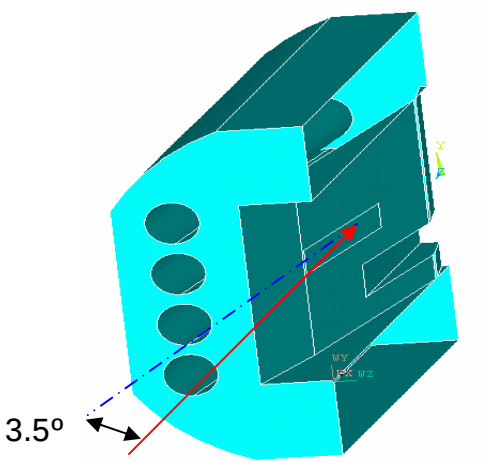
P4-50 Shutter



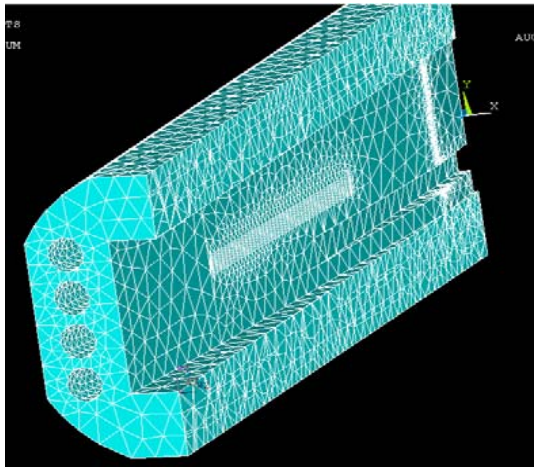
P4-50



P4-50 3-D model

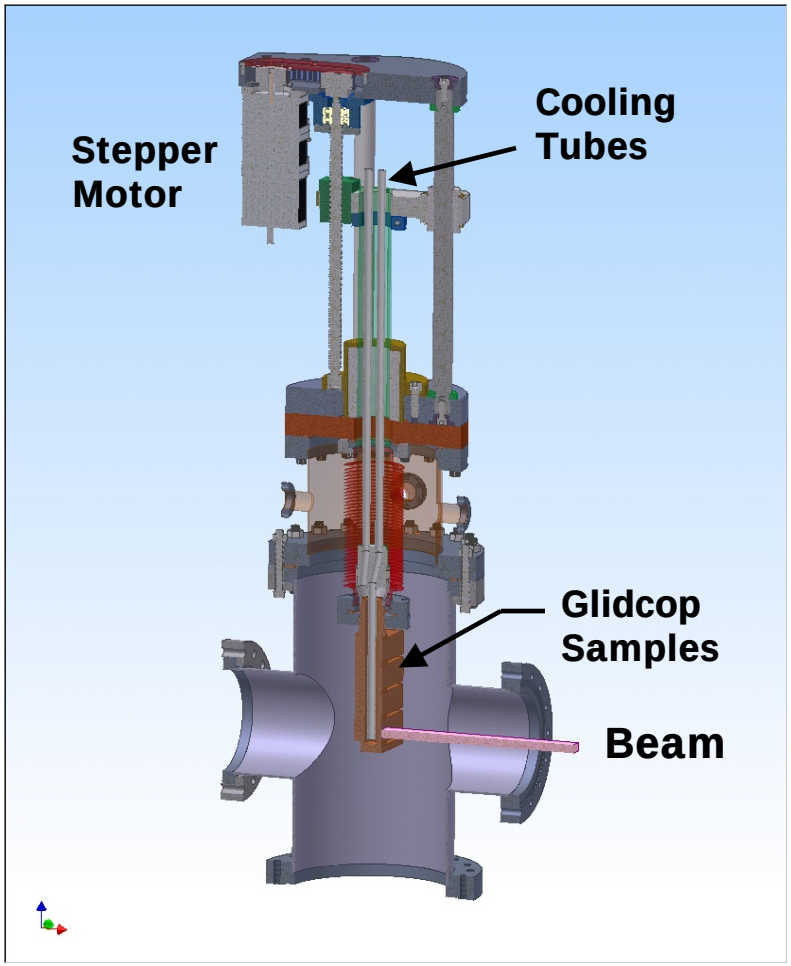


P4-50 Beam orientation



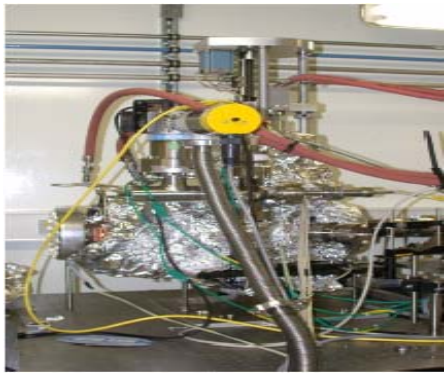
P4-50 FEA mesh

Goal II - Fatigue Tests



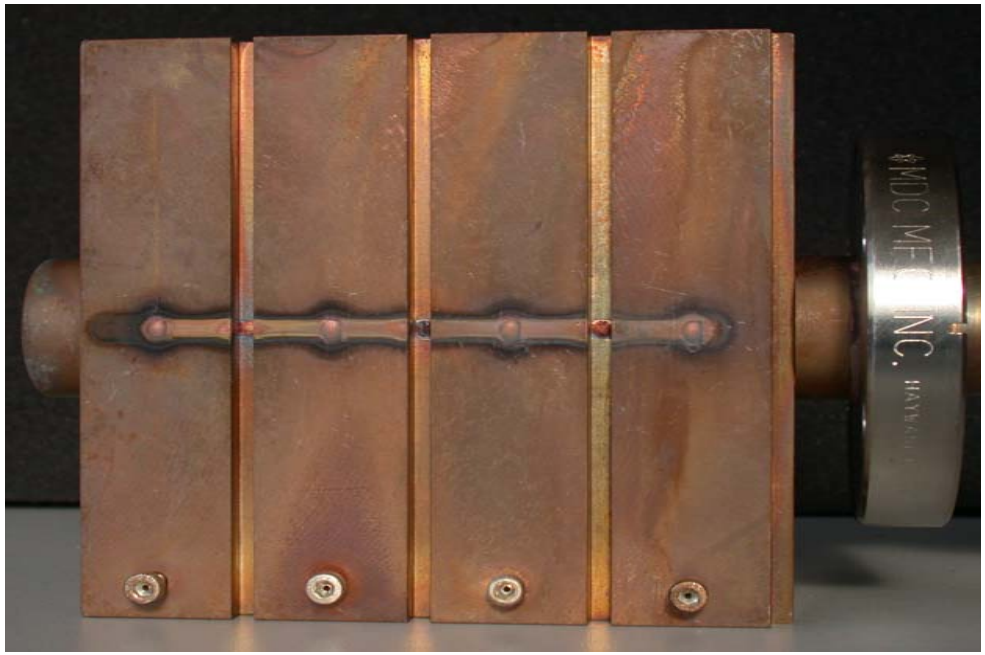
Test Setup (ME-ASD)

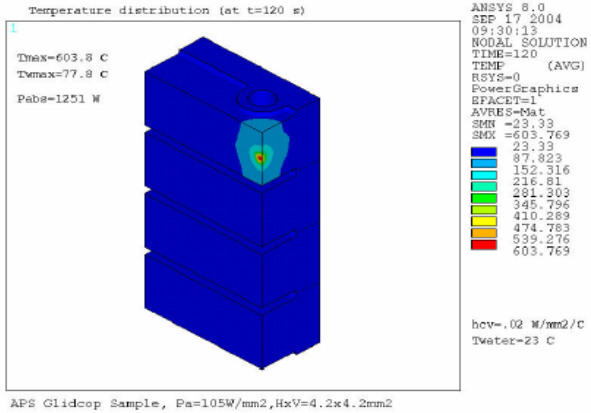
ESRF Beamline Hutch



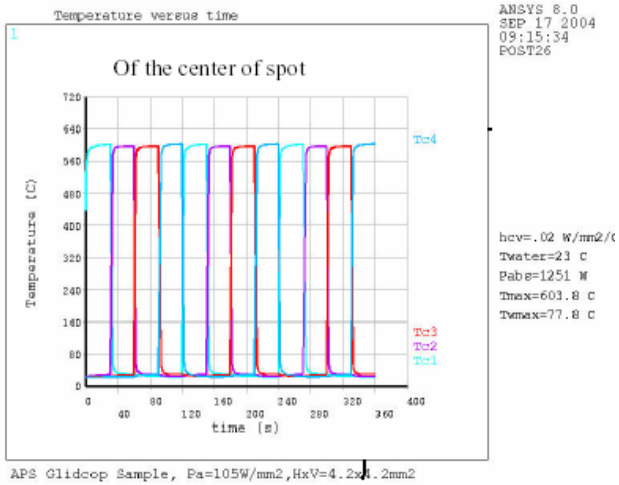
- **Two U42 and one U34 undulators**
- **P = 105 W/mm² (200 mA, 73 % absorption)**
- **Beam size = 4.2mm x 4.2mm**
- **Total absorbed power = 1251 W**
- **Max. Temperature = 604 ⁰C**

Fatigue Tests at ESRF



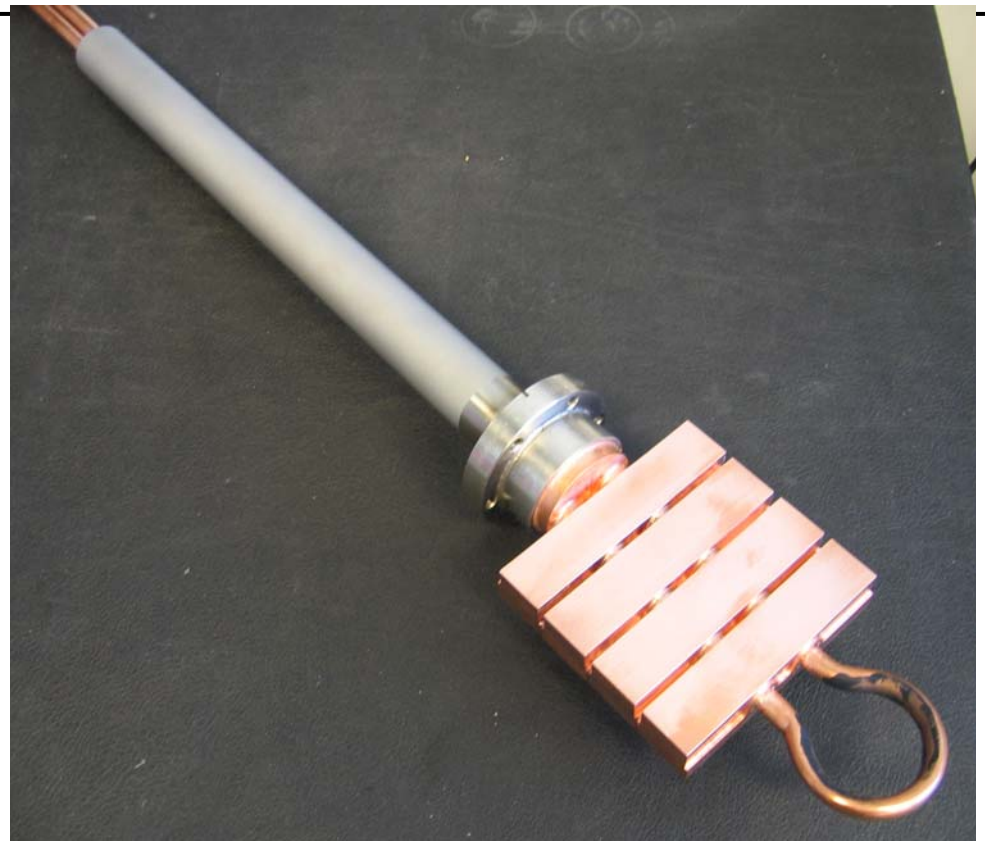


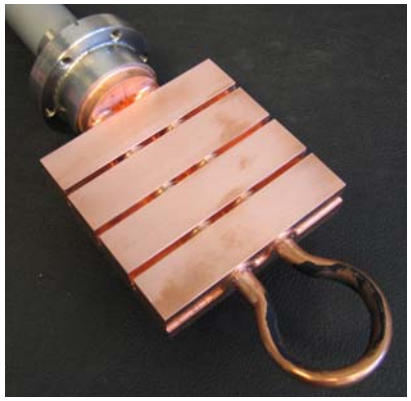
Thermal Analysis



Numerous cracks in all samples after ~ 14000 cycles at 600 deg C

Modified Glidcop Samples

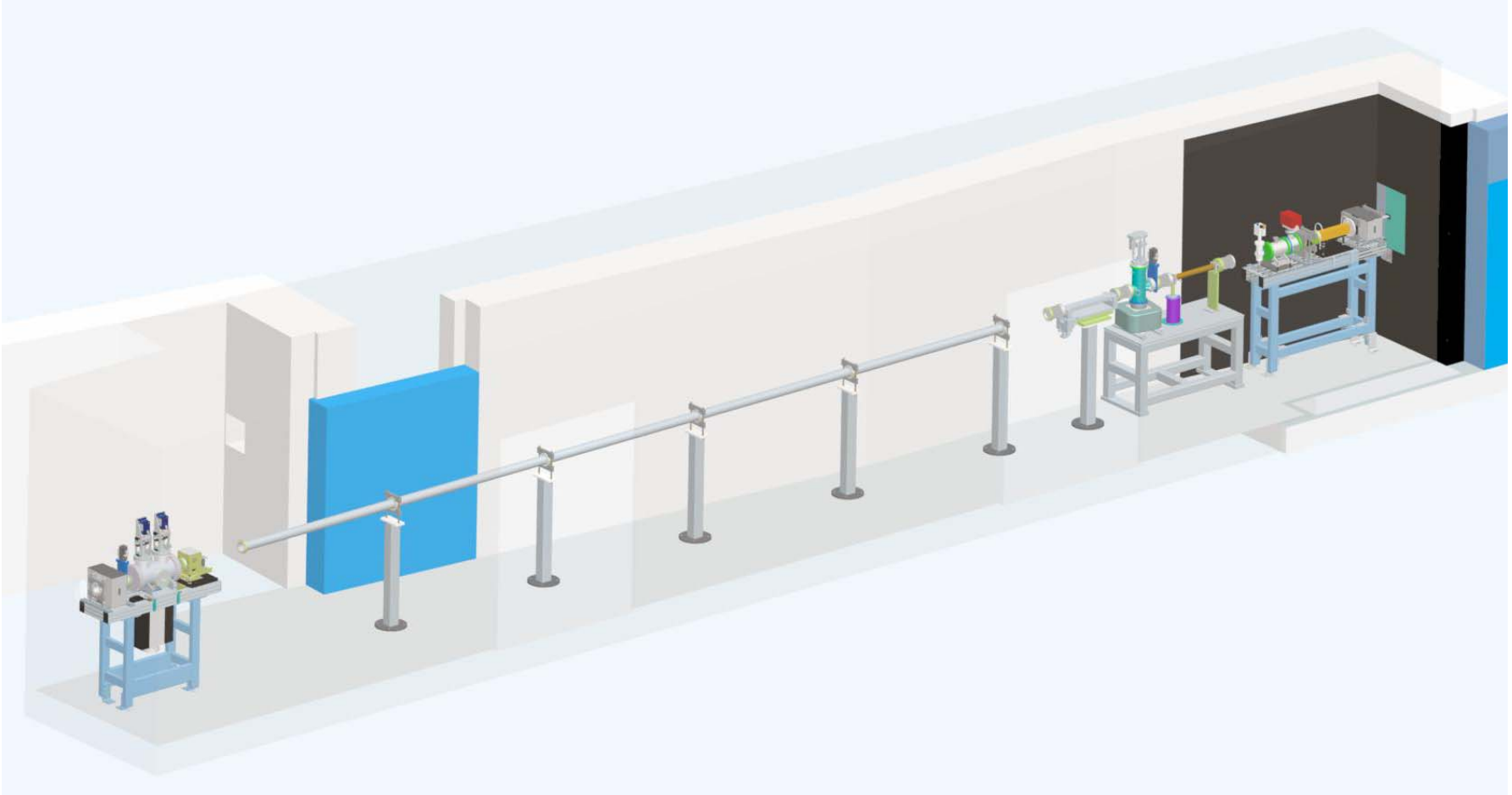




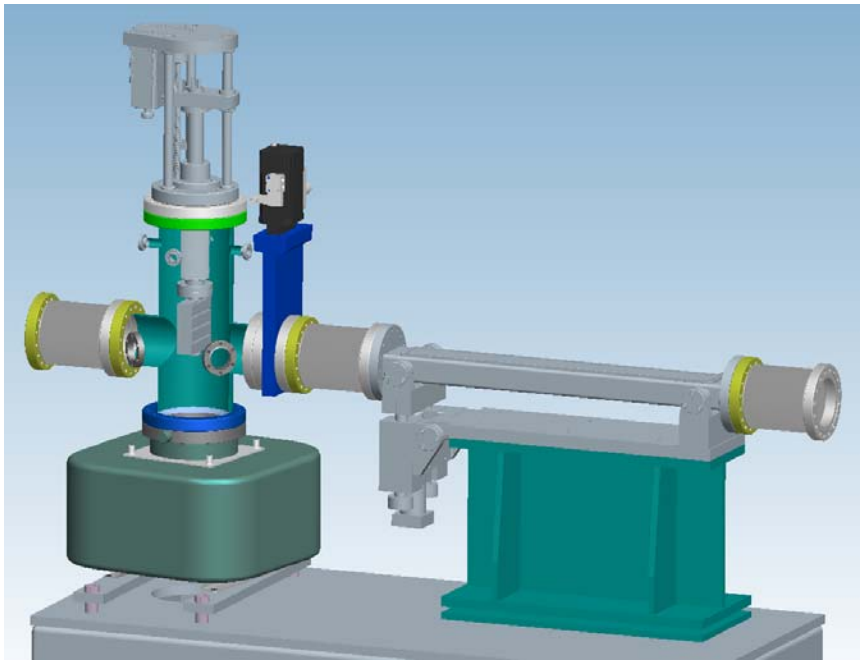
A copper tube is brazed to the Glidcop samples:

- No water to vacuum joint
- Cracks will not propagate to water channels

26-IDA Layout for Fatigue Tests

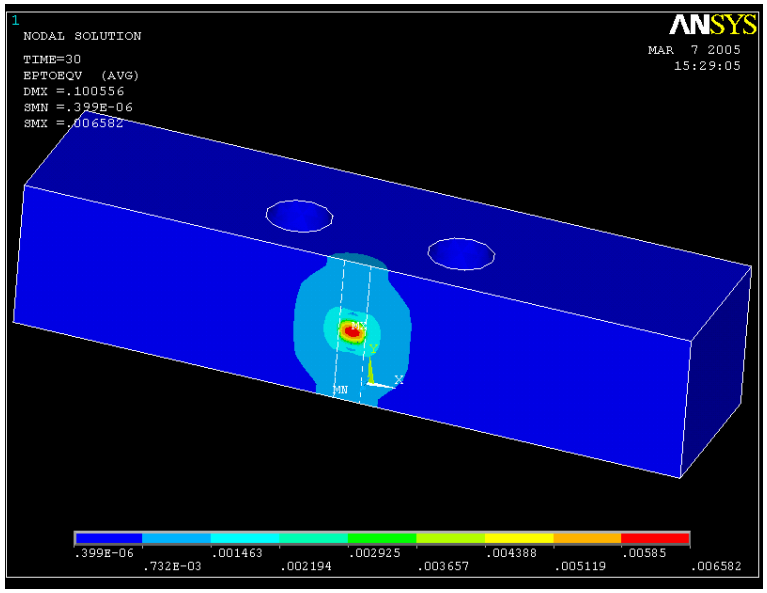


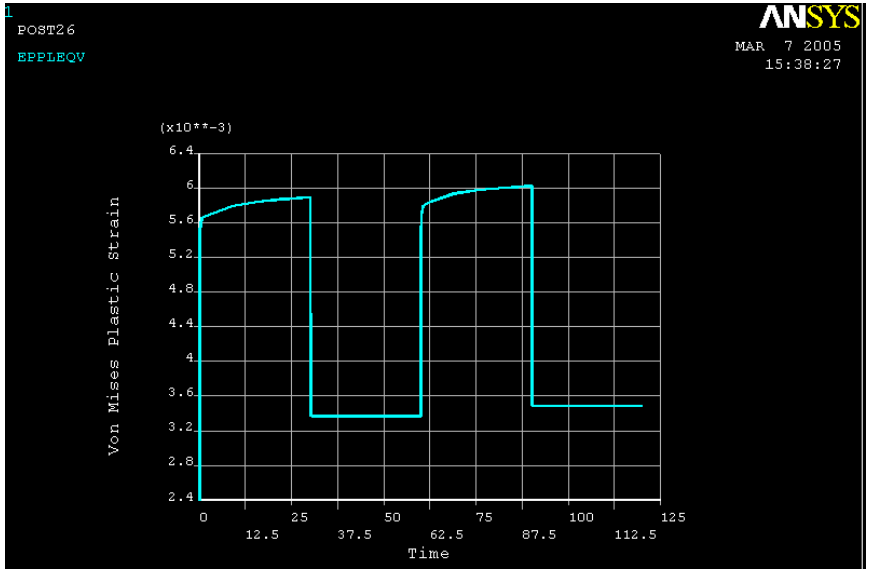
Proposed Test Configuration



Available Test Components

Thermal Analysis





FE Analysis Results

Fatigue Tests Requirements:

- At least a month's beam time, preferably during late summer
- Beam stop at the end of beamline
- Assistance in accessing the hutch for test setup
- Assistance in opening undulator gap