Target Development
for the SINQ high-power Neutron Spallation Source

presented by

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Outline:

The SINQ neutron spallation source:

- Layout, Operation, Applications

R&D for higher power:

The target development program

- STIP: SINQ Target Irradiation Program
- LiSoR: Liquid-metal Solid-metal Reactions
- MEGAPIE: Megawatt Pilot target Experiment
The SINQ facility
Floor plan of the SINF halls with shielding layout (blue), footprints of experiments (green) and instrument layout (red)
A sketch illustrating the arrangement of the 17 specimen rods in the target Mark-3. Temperatures during irradiation are monitored with a total of 10 thermocouples.
The window of the aluminium safety-hull of target Mark-2 after cutting several discs from it in ATEC.
Tensile test results of samples cut from the centre and edge area of the proton beam and unirradiated material.
A picture of neutron radiography showing the middle part of a zircaloy clad martensitic steel (F82H) sample. The black spots are believed as hydrides formed in zircaloy cladding.
LiSoR:
Experiment on Liquid-metal Solid-metal Reactions

- **Materials:** Martensitic steels MANET and T91
  - Testing in liquid PbBi
  - at elevated temperature: 300°C
  - under constant load (50% of yield stress)
  - under irradiation: 72 MeV proton beam
MANET II Tensile Tests in LiSoR at 300 °C in LBE
MANET II Tensile Tests in LiSoR at 300 °C in LBE
MEGAPIE MEgawatt PIlot Experiment

International collaboration to develop a liquid lead-bismuth spallation target for a beam power level of 1 MW to be operated at SINQ for one year (6000 mAh) in 2005 aiming to

- demonstrate the feasibility for future ADS development
- increase neutron flux for SINQ
The MEGAPIE Target Conceptual Design

- Target head with connectors
- Upper shielding plug
- Heat exchanger water manifold
- Cover gas plenum
- Flow baffle plate
- Main flow EM pump
- Flow monitoring sensors
- Double walled heat exchanger pin with intermediate heat transfer fluid
- Bypass flow EM pump
- Liquid metal container
- Outer target container (vacuum shell)
- Water cooled enclosure hull (double walled)
- Bypass flow guide tube
- Main flow guide tube (heated)
- Inner beam window
- Window cooling jet nozzle
Bottom part of the MEGAPIE target shell with convex-concave protection hull window

- Outer shell of protection hull
- Inner shell of protection hull
- Central flow guide tube
- Hemispherical bottom of LM container
- Water flow separator
- Bypass flow nozzle
Heat removal and beam window cooling by forced main (4 l/s) and bypass (0.35l/s) flow

CFD simulations (B. Smith)
Mises Stress Distribution (MPa) on Target Window (internal surface)

Temperature Distribution (°C) on Target Window (internal surface)
Performance comparison for different target materials under SINQ conditions
(calculations with the code LAHET)

- Zr rods
- Pb + steel cladding (0.5 mm)
- Pb + Zr cladding (0.7 mm)
- Pb-Bi

Expected increase in neutron flux by 50% compared to Mark II target LAHET calculations (A. Dementjev, E. Lehmann)
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