Target Development for the SINQ high-power Neutron Spallation Source

presented by

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Outline:

The SINQ neutron spallation source:

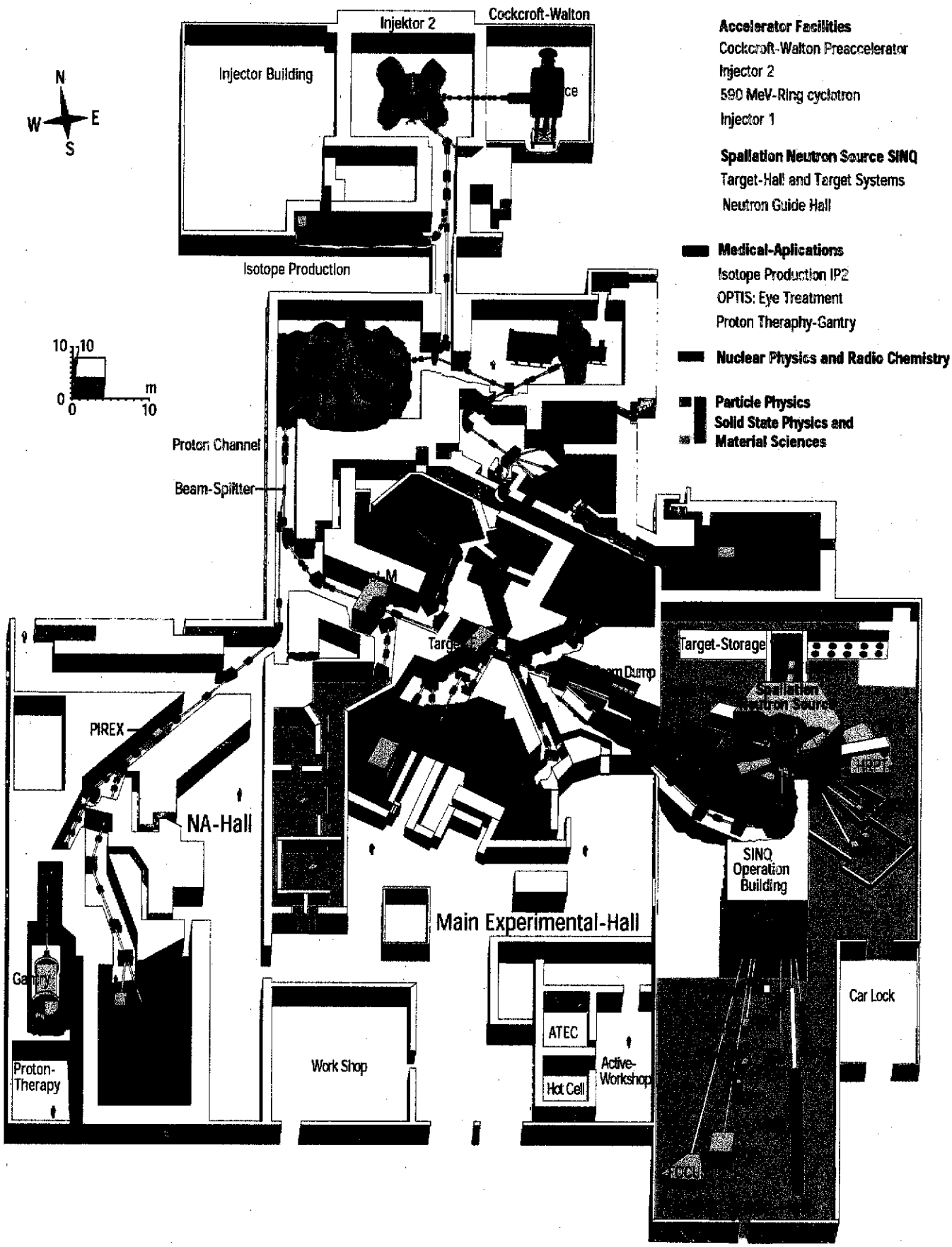
- **Layout, Operation, Applications**

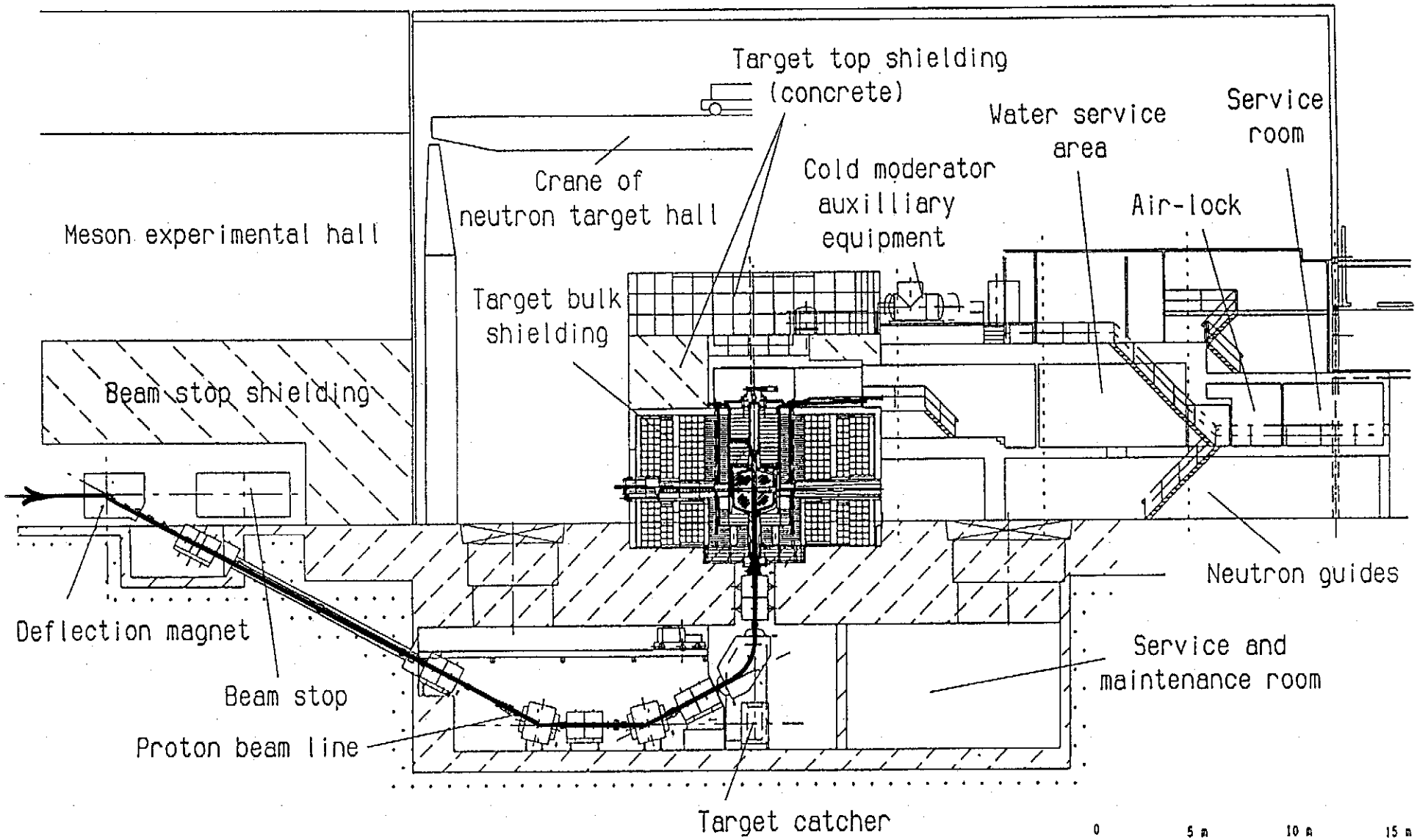
R&D for higher power:

The target development program

- **STIP:** SINQ Target Irradiation Program
- **LiSoR:** Liquid-metal Solid-metal Reactions
- **MEGAPIE:** Megawatt Pilot target Experiment

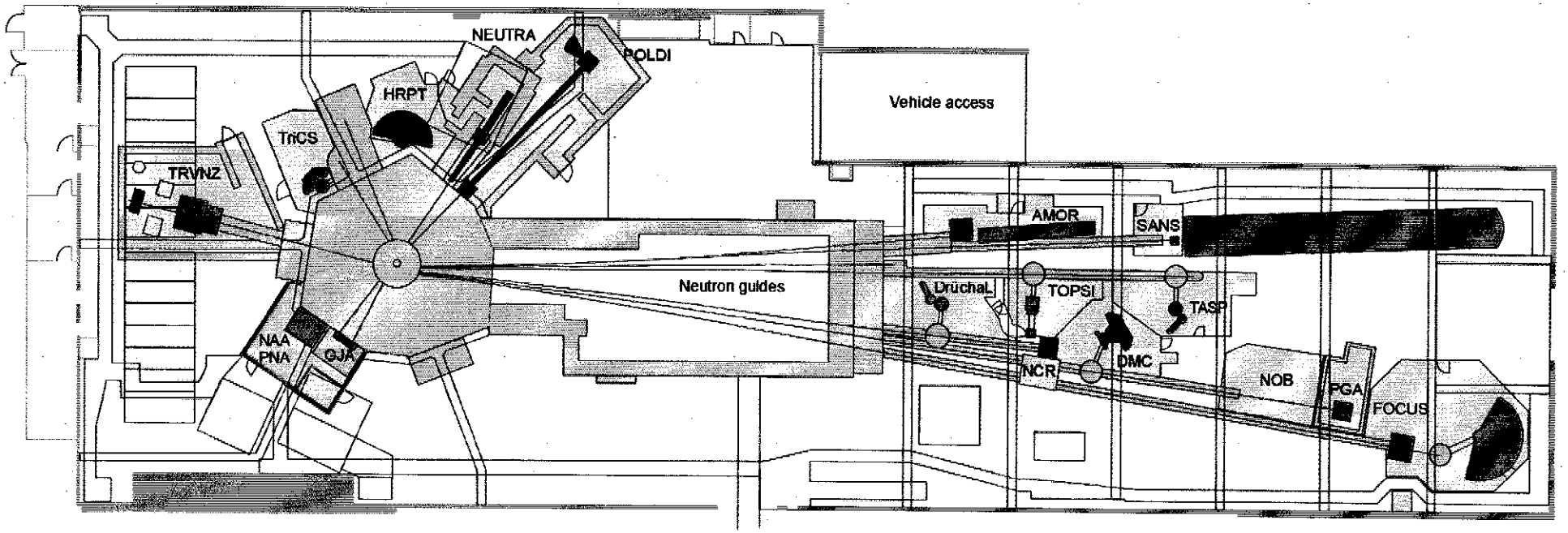
Proton Accelerator Facilities of the Paul Scherrer Institute





The SINQ facility

Floor plan of the SINQ halls with shielding layout (blue), footprints of experiments (green) and instrument layout (red)

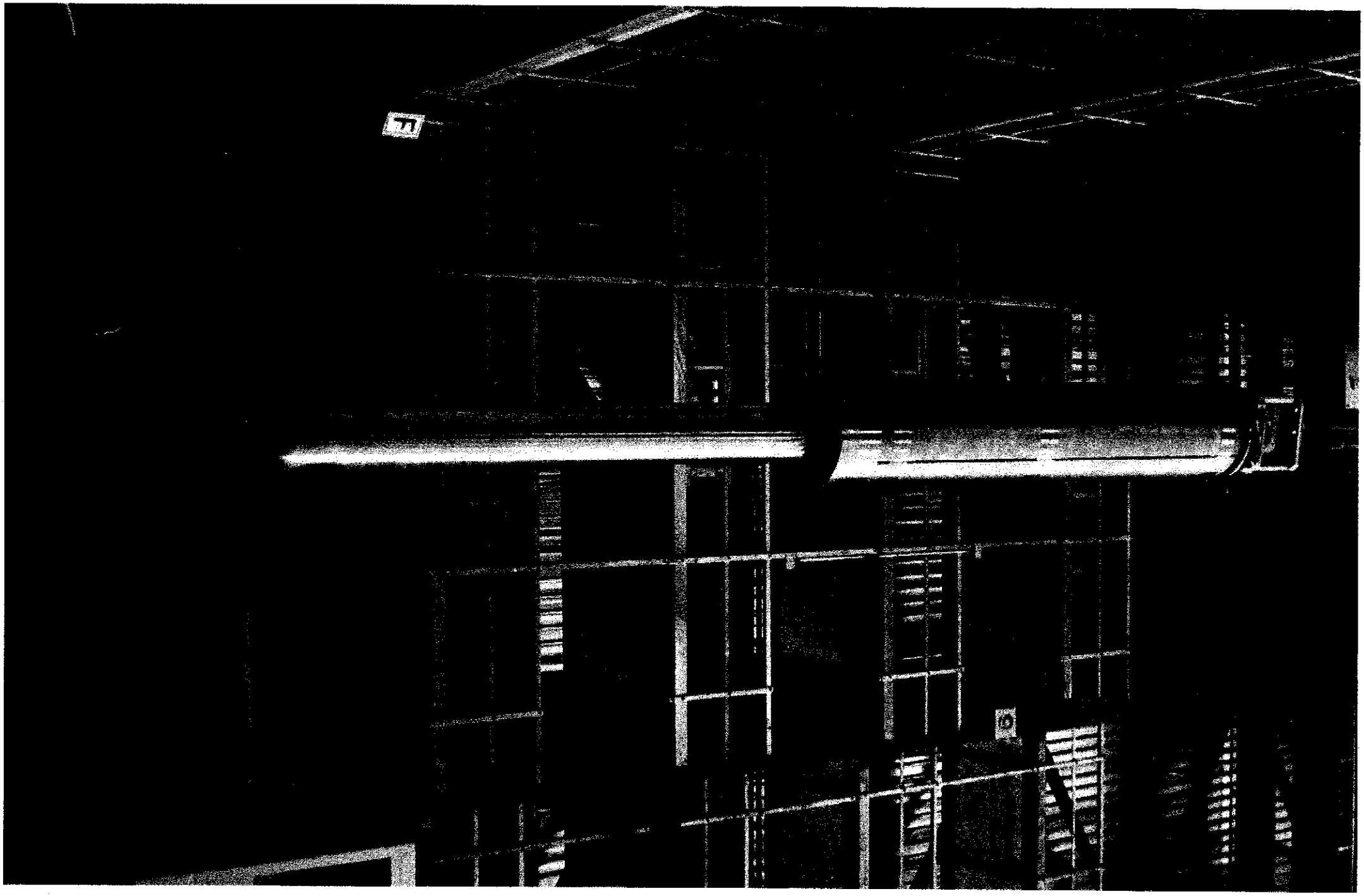


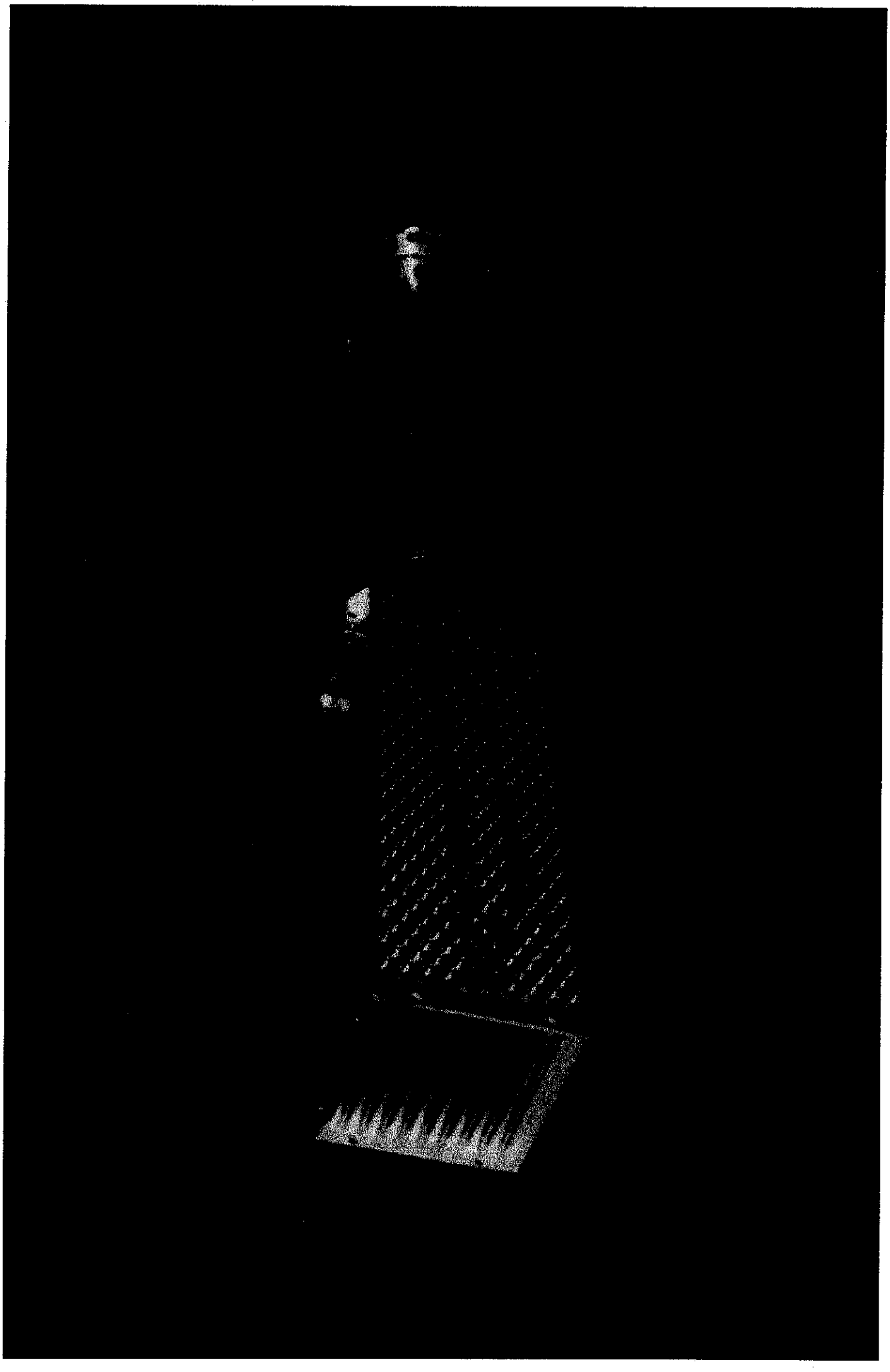
0 1 2 3 4 5 6 7 8 9 10m

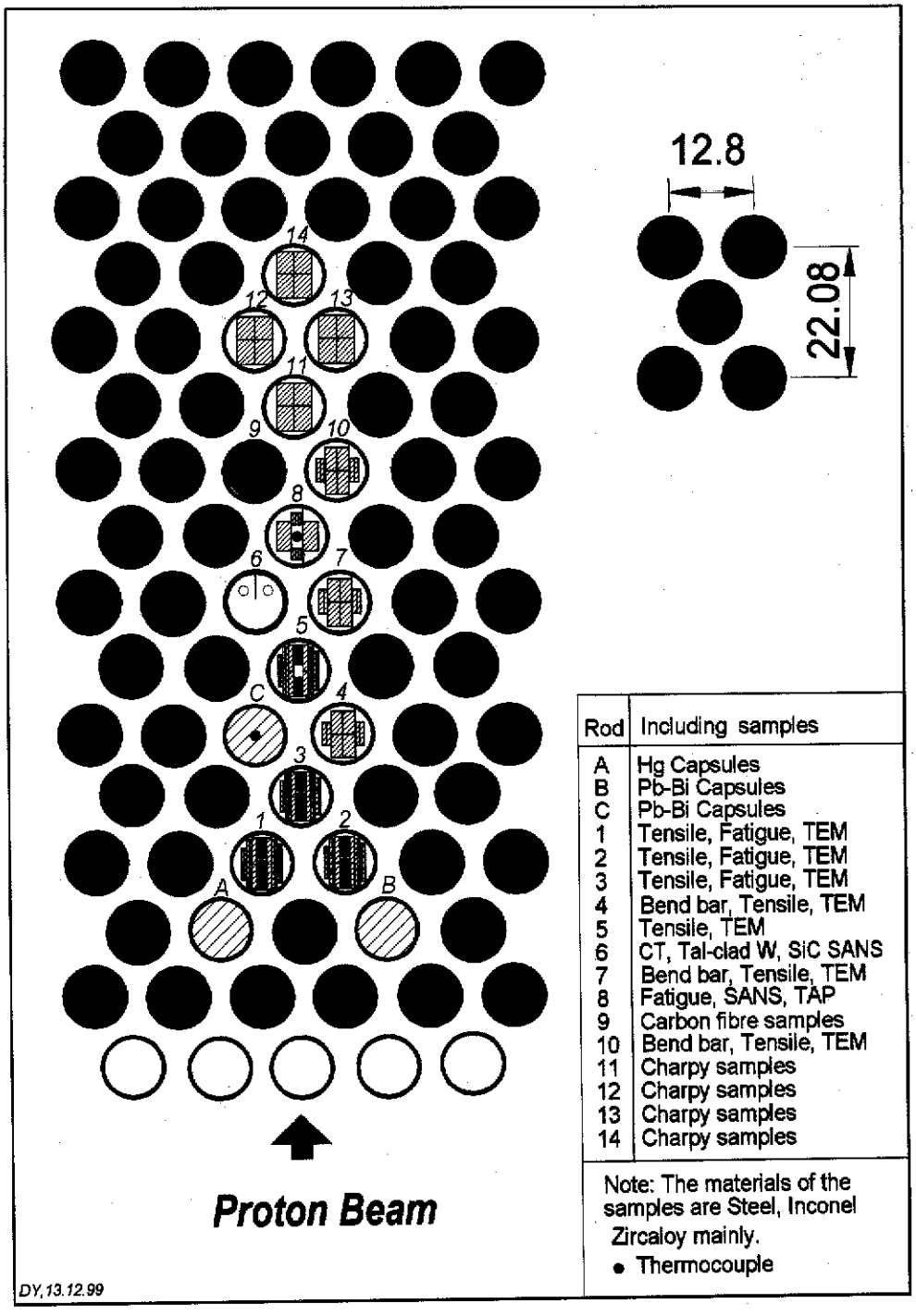
SINQ - HALL

N

K. Geissmann 22.3.99



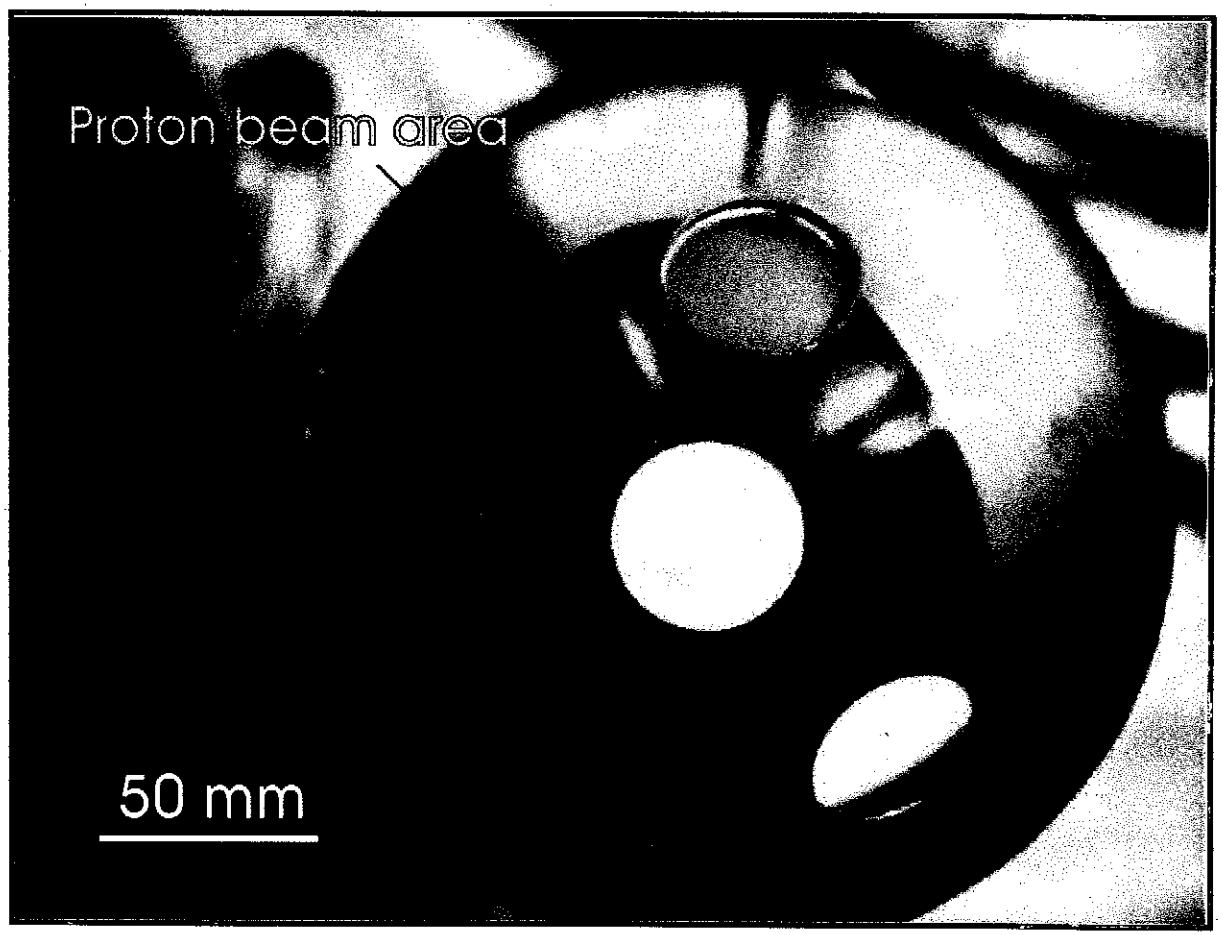




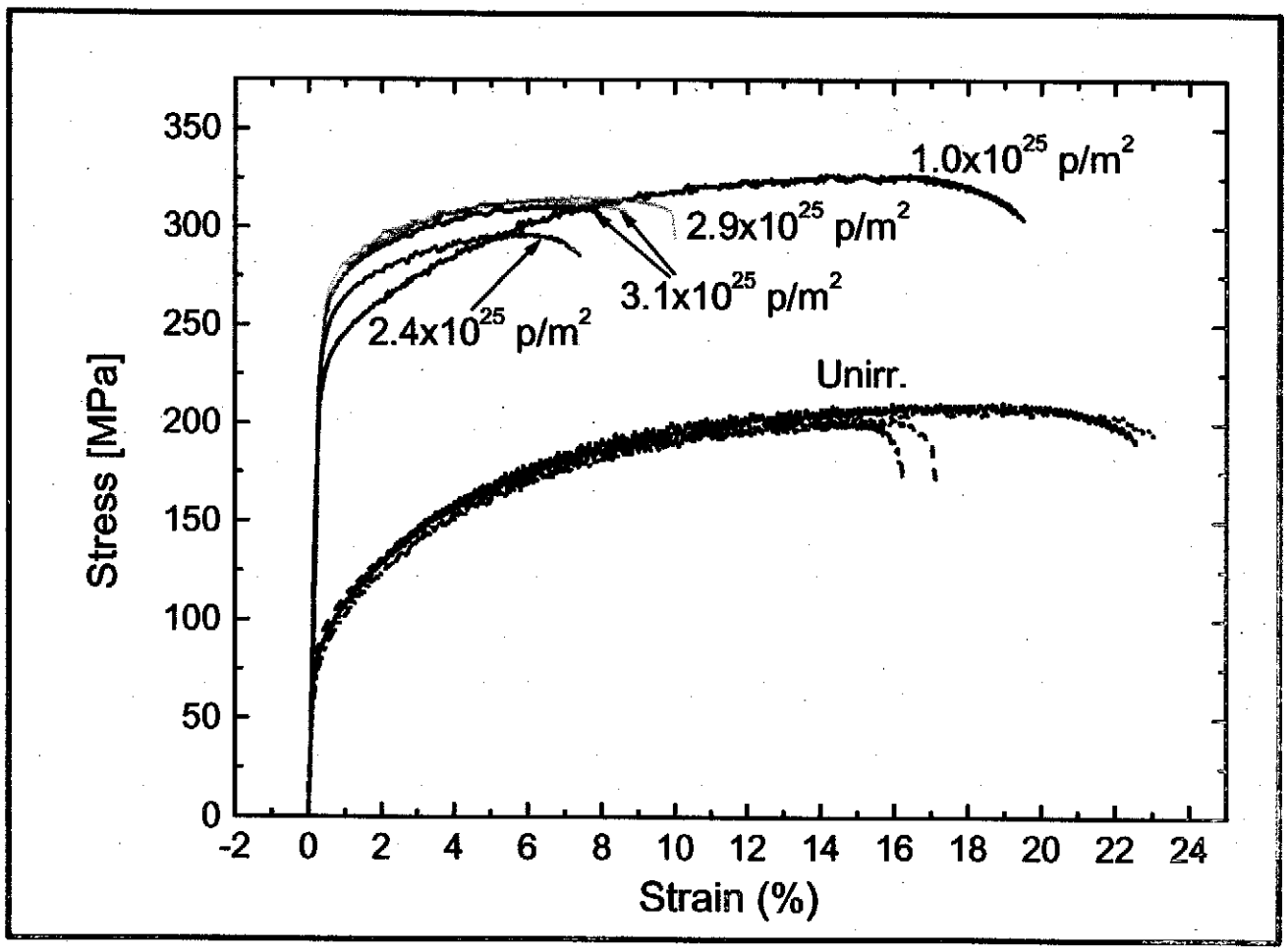
Rod	Including samples
A	Hg Capsules
B	Pb-Bi Capsules
C	Pb-Bi Capsules
1	Tensile, Fatigue, TEM
2	Tensile, Fatigue, TEM
3	Tensile, Fatigue, TEM
4	Bend bar, Tensile, TEM
5	Tensile, TEM
6	CT, Tal-clad W, SiC SANS
7	Bend bar, Tensile, TEM
8	Fatigue, SANS, TAP
9	Carbon fibre samples
10	Bend bar, Tensile, TEM
11	Charpy samples
12	Charpy samples
13	Charpy samples
14	Charpy samples

Note: The materials of the samples are Steel, Inconel Zircaloy mainly.
• Thermocouple

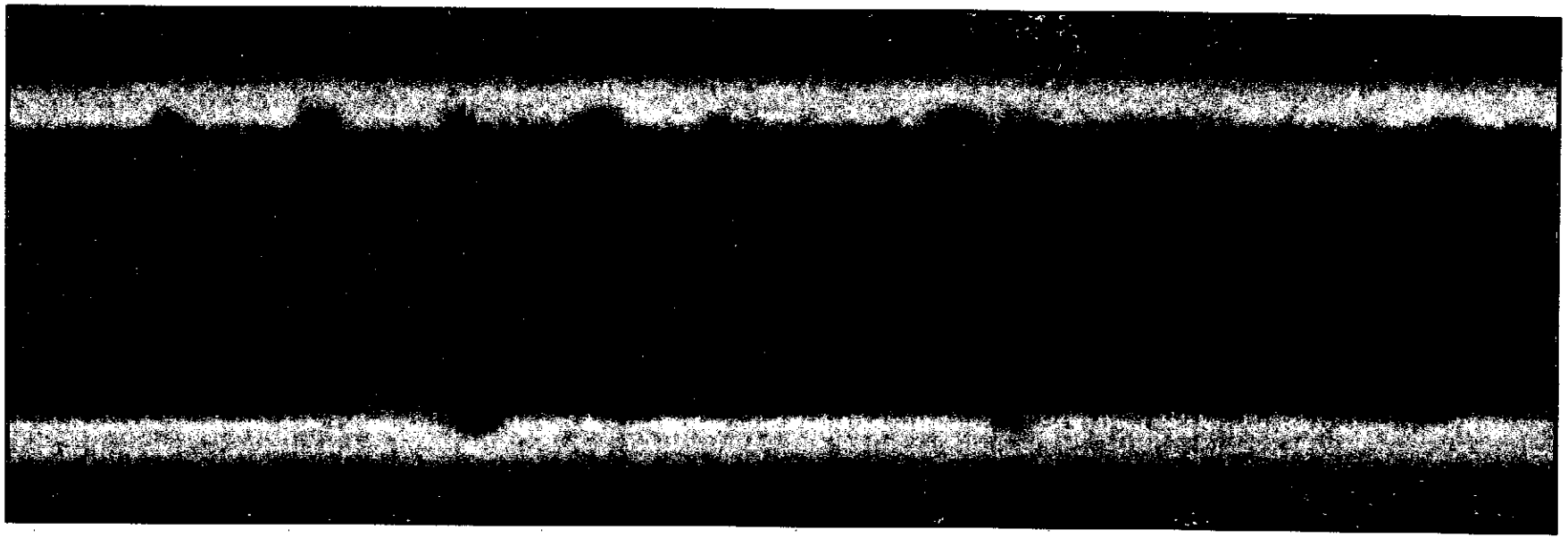
A sketch illustrating the arrangement of the 17 specimen rods in the target Mark-3. Temperatures during irradiation are monitored with a total of 10 thermocouples



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.

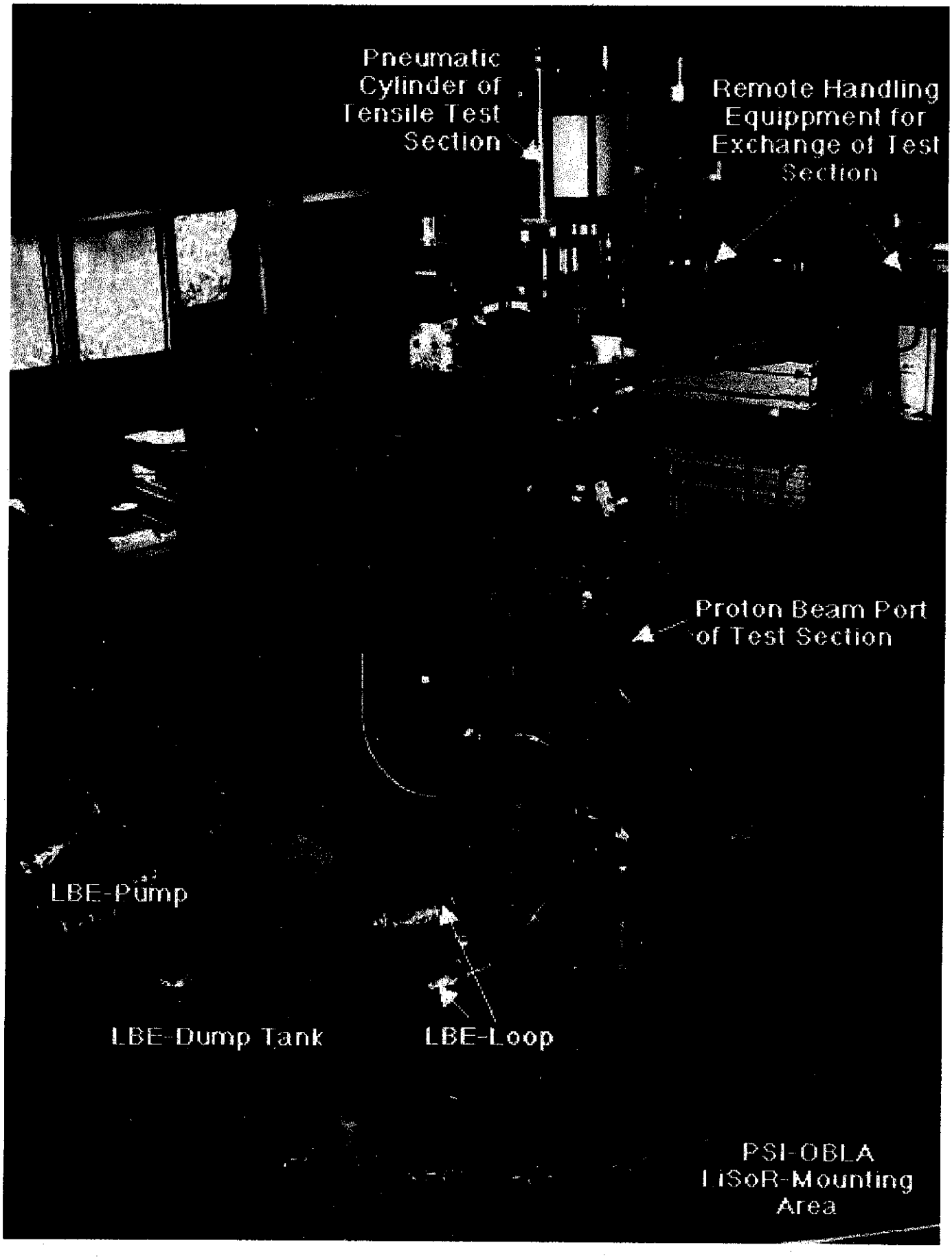


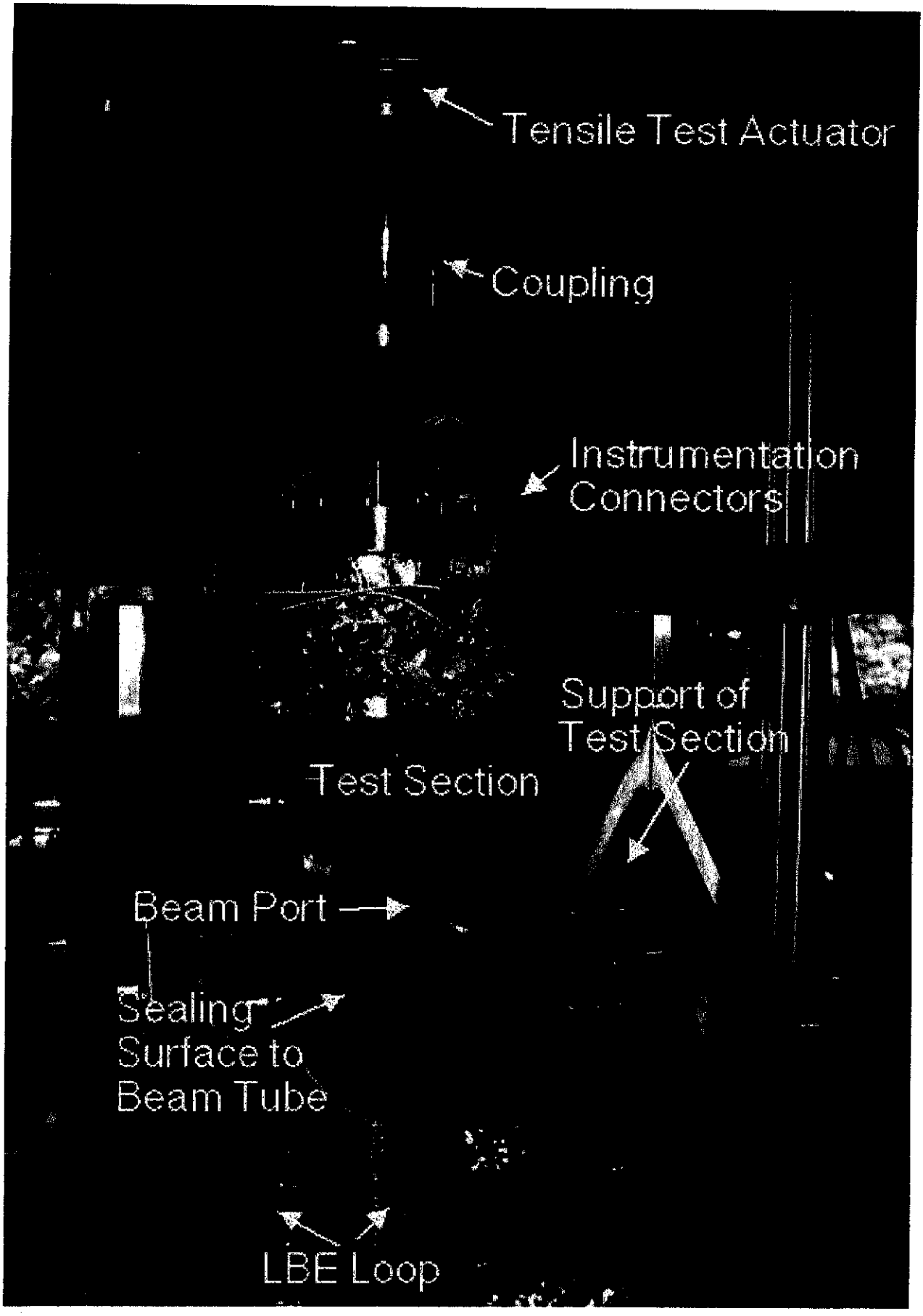
A picture of neutron radiography showing the middle part of a zircaloy clad martensitic steel (F82H) sample. The black spots are believed as hydrides formed in zircaloy cladding.

LiSoR:

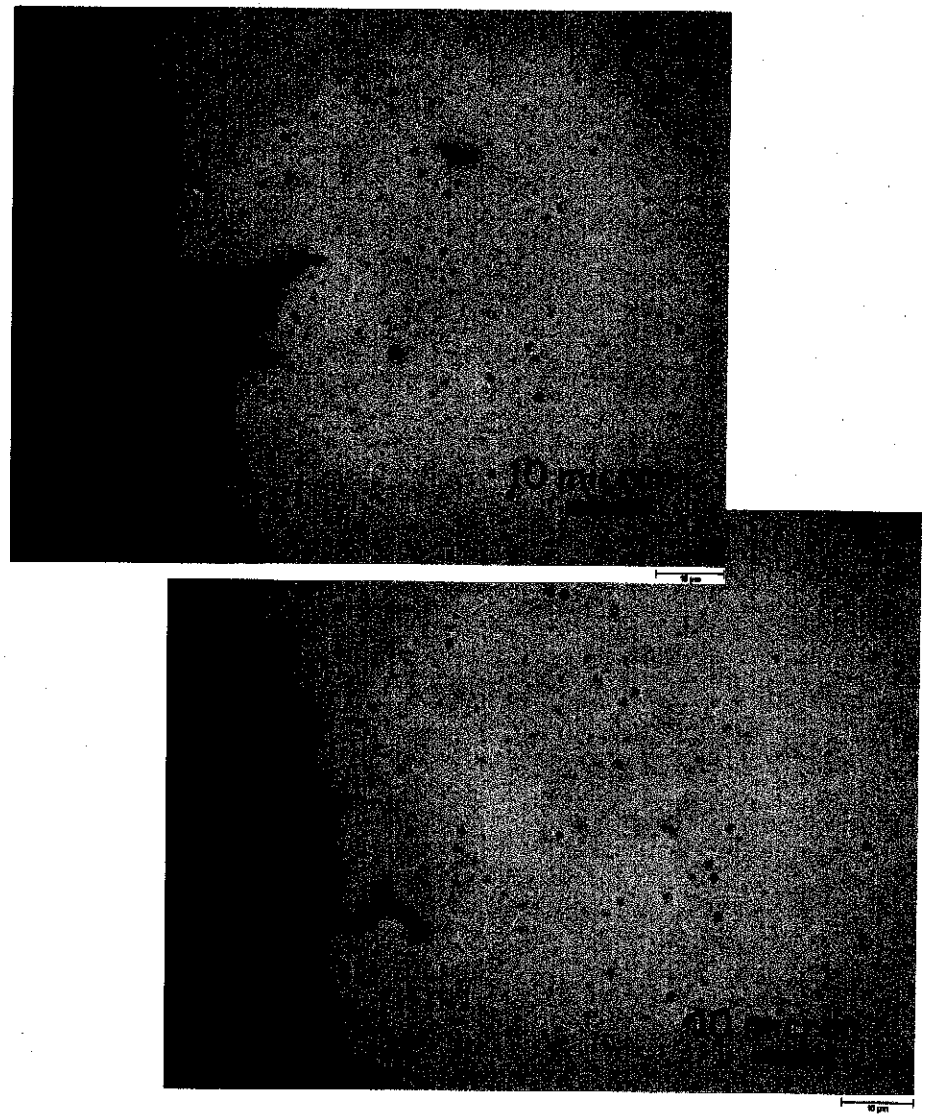
Experiment on Liquid-metal Solid-metal Reactions

- 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

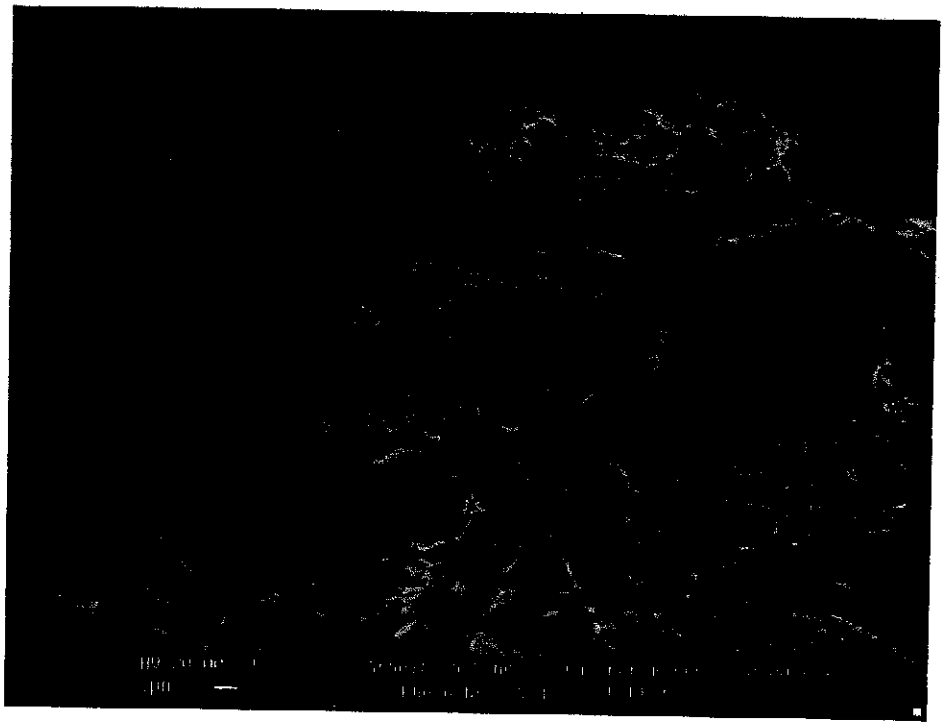

Pneumatic Cylinder of Tensile Test Section
Remote Handling Equippment for Exchange of Test Section
Proton Beam Port of Test Section
LBE-Pump
LBE-Dump Tank
LBE-Loop
PSI-OBLA LiSoR-Mounting Area


Tensile Test Actuator
Coupling
Instrumentation Connectors
Support of Test Section
Test Section
Beam Port
Sealing Surface to Beam Tube
LBE Loop

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

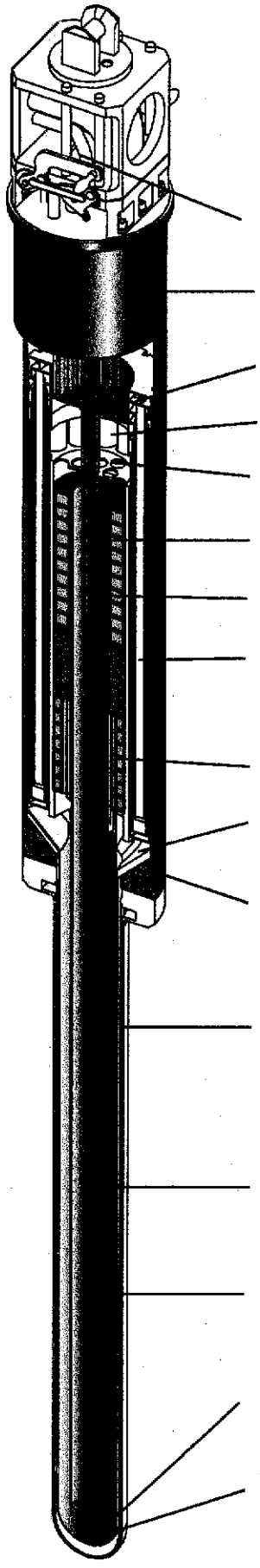
- **demonstrate the feasibility for future ADS development**
- **increase neutron flux for SINQ**

Project Partners:

Korea Atomic Energy Research Institute

Department of Energy

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)

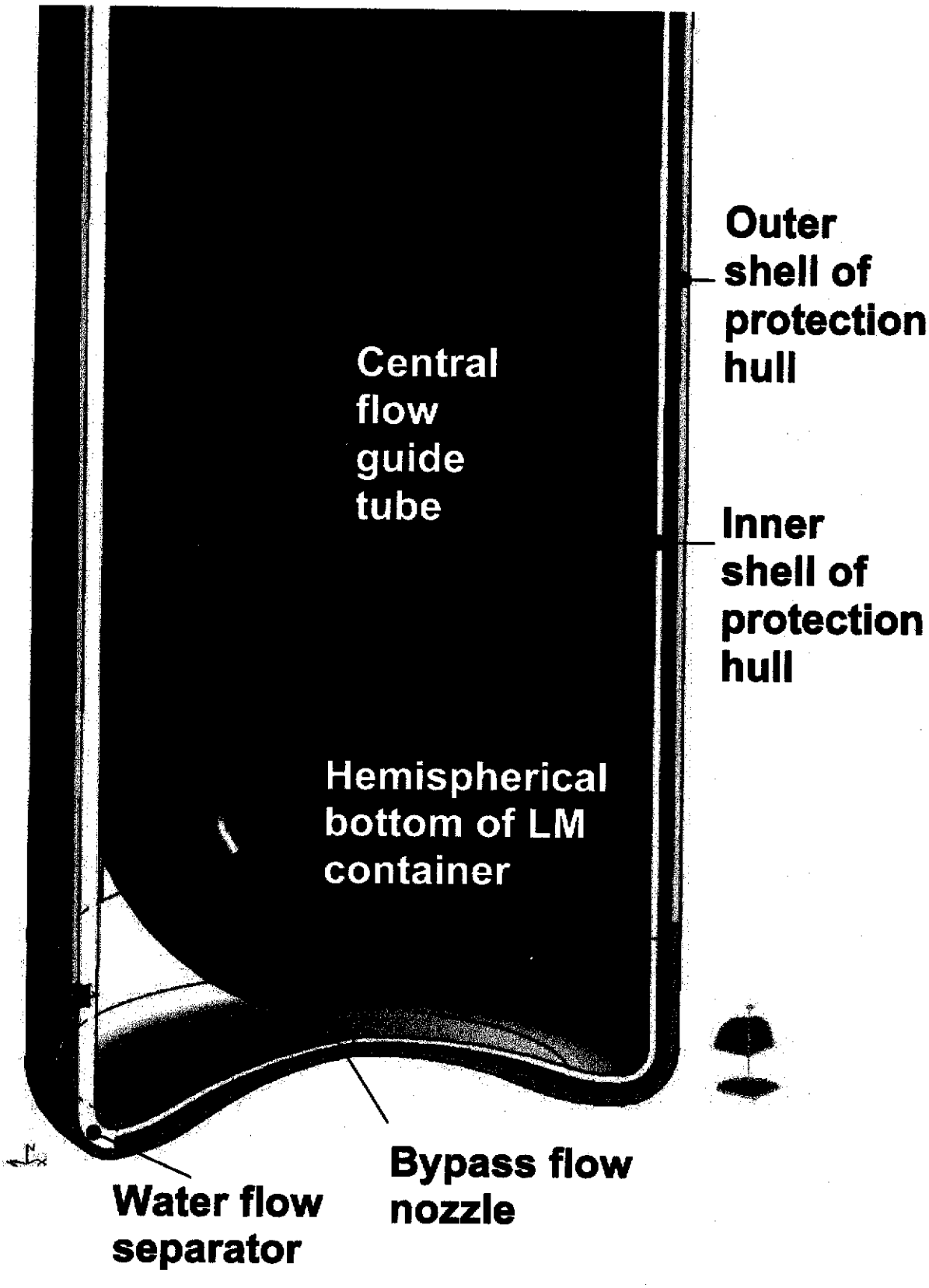
Bypass flow guide tube

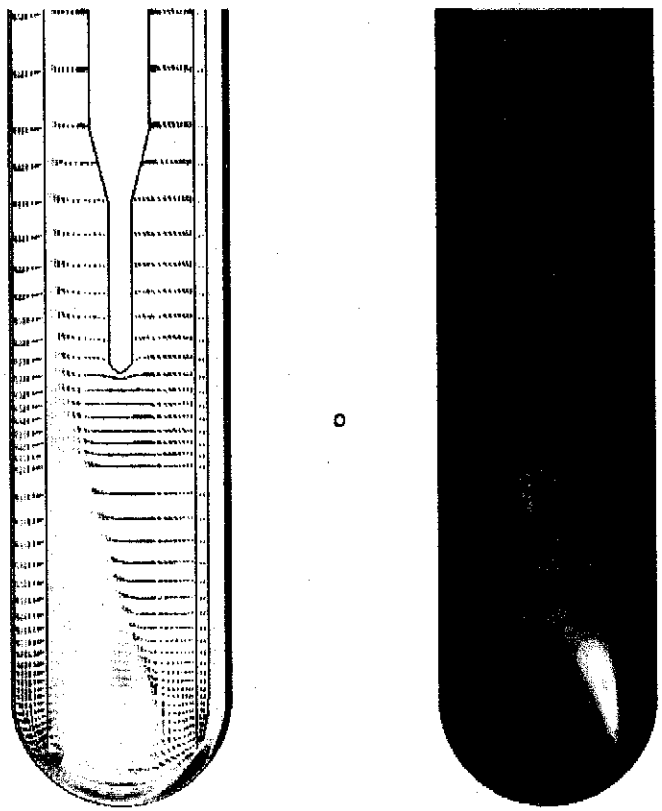
Main flow guide tube (heated)

Inner beam window

Window cooling jet nozzle

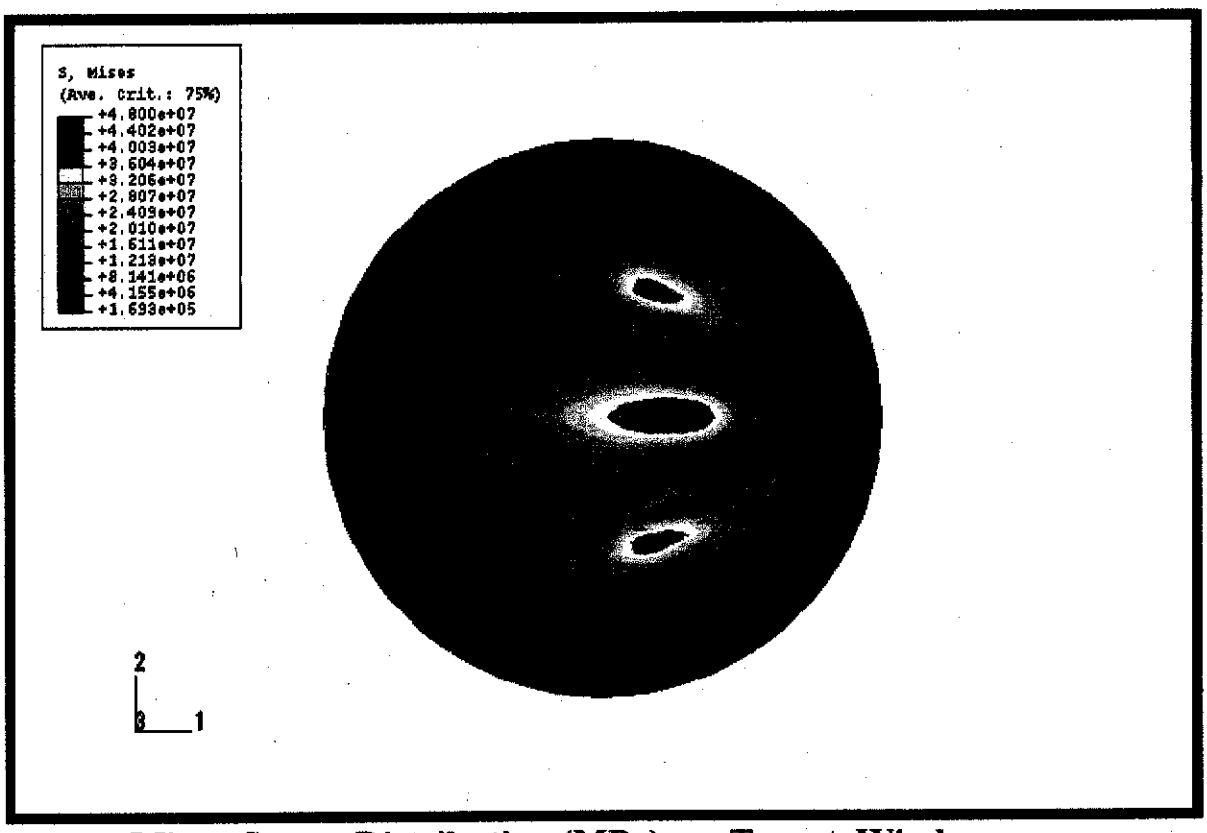
Bottom part of the MEGAPIE target shell with convex-concave protection hull window



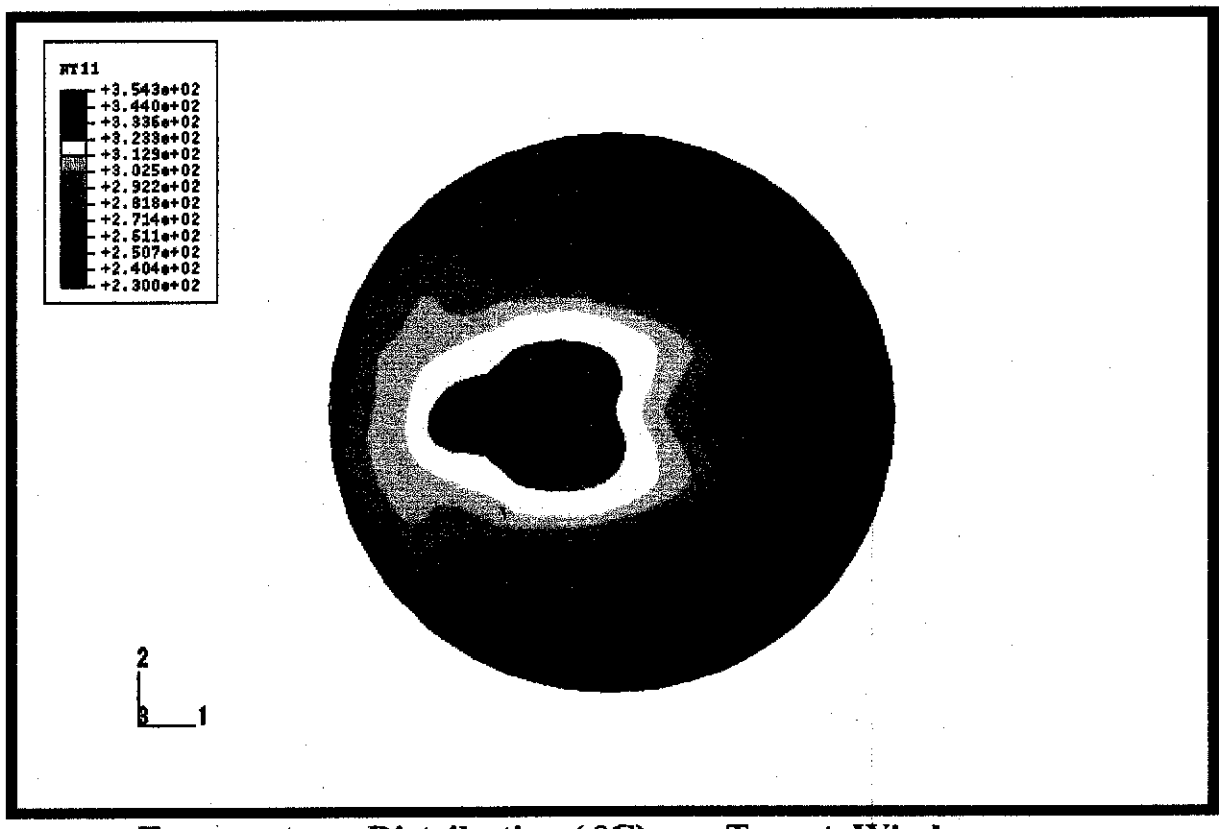


Heat removal and beam window cooling by forced main (4 l/s) and bypass (0.35l/s) flow

CFD simulations (B. Smith)

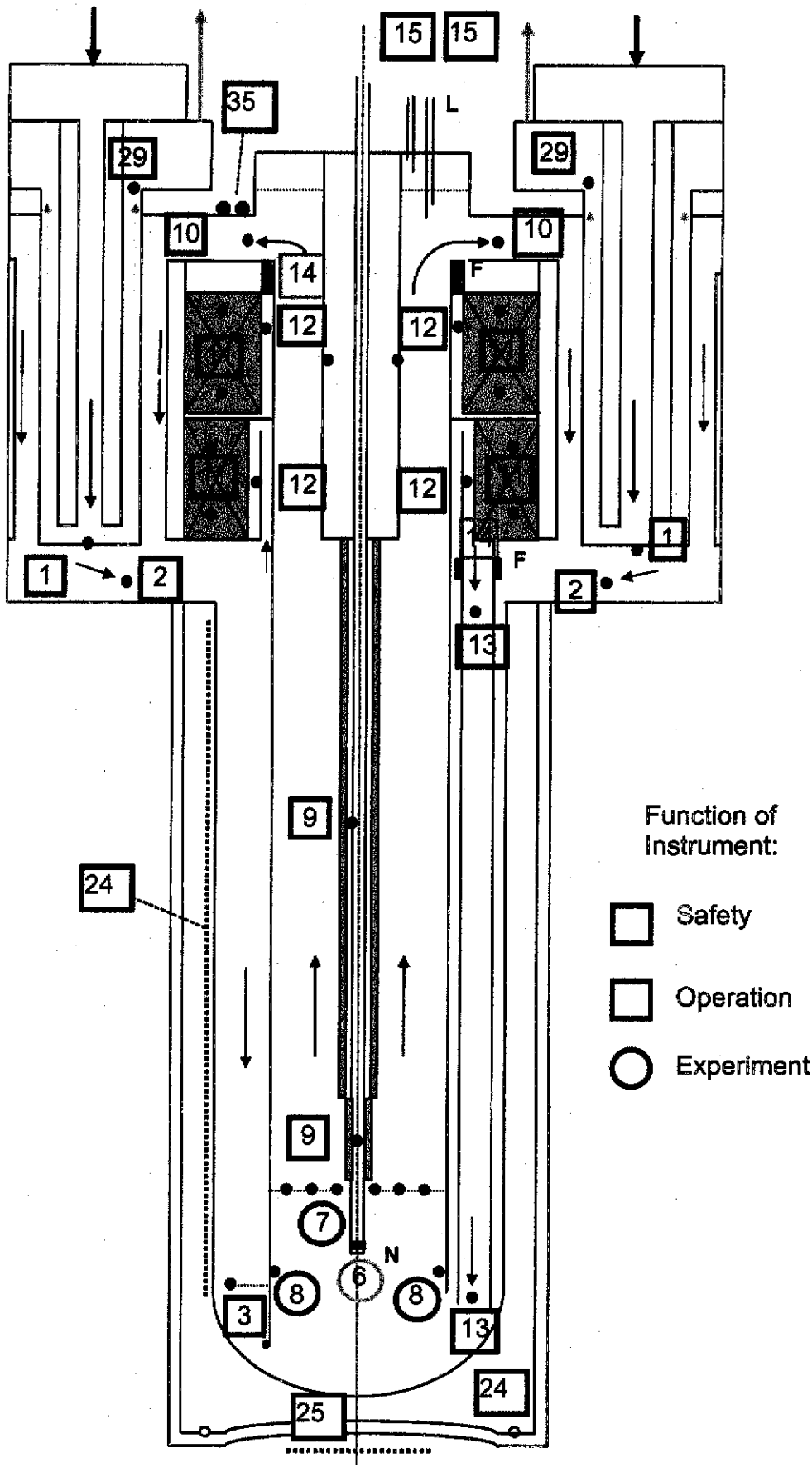


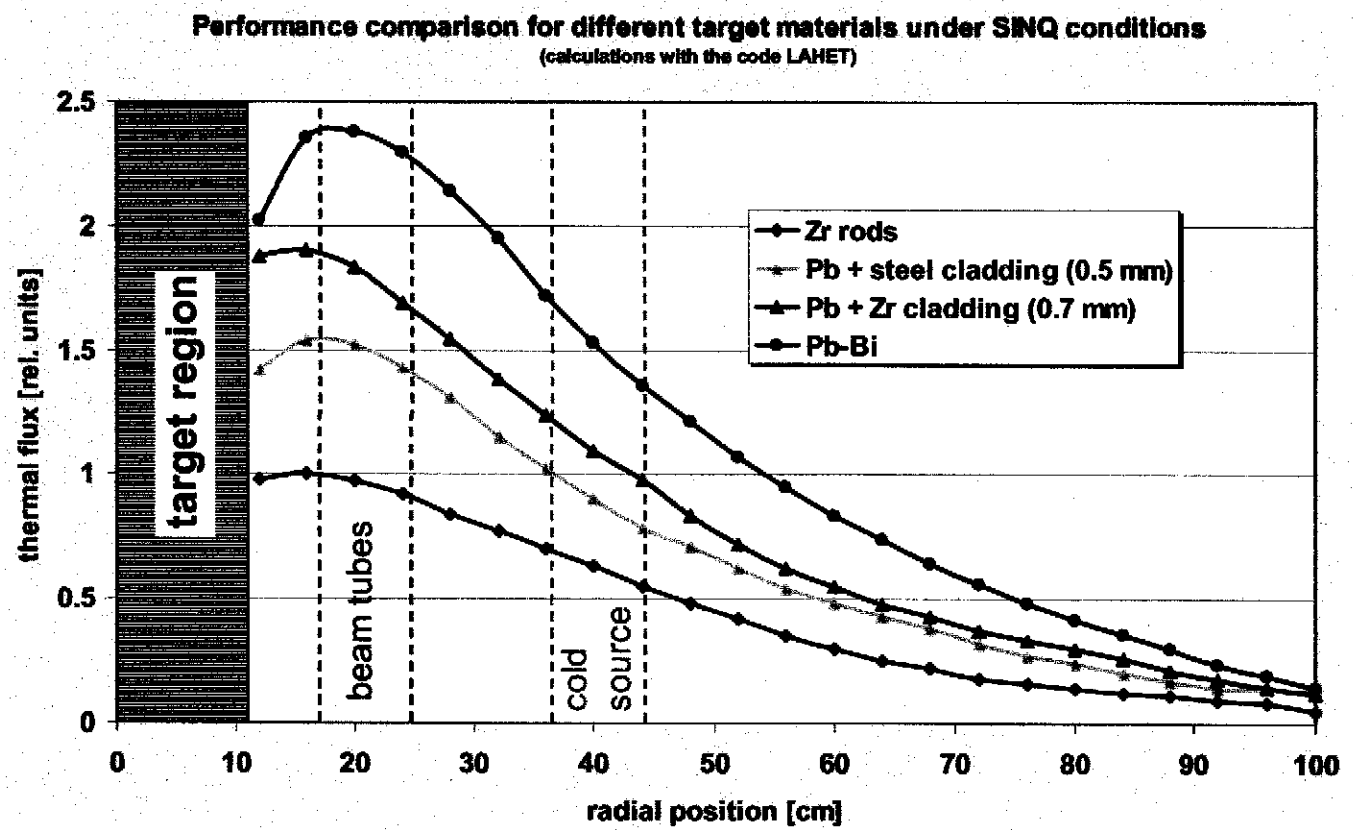
Mises Stress Distribution (MPa) on Target Window
(internal surface)



Temperature Distribution (°C) on Target Window
(internal surface)

Target Instrumentation Schematic





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

Aknowledgement:

Cooperation and participation of

- Friedrich Gröschel
- Yong Dai
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- Liping Ni
- Brian Smith
- E. Lehmann

- Günter Bauer, FZ Jülich, Germany