**Profile LFR-57**

**IPUL**

**LATVIA**

## GENERAL INFORMATION

| | |
|---|---|
| NAME OF THE FACILITY | Experimental lead – bismuth loop |
| ACRONYM | - |
| COOLANT(S) OF THE FACILITY | Lead – bismuth eutectics |
| LOCATION (address): | Institute of Physics University of Latvia (IPUL), Salaspils, Latvia ,LV-2169 |
| OPERATOR | IPUL |
| CONTACT PERSON (name, address, institute, function, telephone, email): | Ernests Platacis, IPUL, Miera 32, Salaspils, Latvia LV-2169 Head of Hydro-mechanic Laboratory, Tel. +371 2651 3424, erik@sal.lv |

| | |
|---|---|
| **STATUS OF THE FACILITY** | In operation |
| Start of operation (date): | **2013** |

**MAIN RESEARCH FIELD(S)**

- ☐ Zero power facility for V&V and licensing purposes
- ☐ Design Basis Accidents (DBA) and Design Extended Conditions (DEC)
- x Thermal-hydraulics
- ☐ Coolant chemistry
- x Materials
- x Systems and components
- x Instrumentation & ISI&R

## TECHNICAL DESCRIPTION

### Description of the facility

The facility is foreseen for operating with liquid lead –bismuth eutectics (PbBi).
The liquid metal circulates inside a closed loop made of stainless steel. The main components of the loop are: an induction pump on permanent magnets, a heat exchanger, an expansion tank and

a storage tank. The loop is designed to operate at a pressure of up to 10 bars and a flow rate up to 20 L/s. Characteristic of the piping: diameter – DN - 100mm, length –12m, inventory of PbBi – 100 L. The operating temperatures of the facility correspond to the range 200… 500°C. In the case necessity the PbBi inventory of the loop can easily be substituted by lead- lithium PbLi (operation in the range 300…500°C). The temperature status of the loop is monitored by thermocouples. The flow rate is measured by a Venturi tube and an electromagnetic flow meter. The pressure drops are fixed by high temperature pressure sensors with a direct electric output. A special heat exchanger is installed with a high -temperature oil as intermediate medium between the hot lead-bismuth and the cooling water. The cooling power can be flexibly controlled by changing the filling height of the oil.

Attention should be paid to the newly introduced (typically for heavy metals) induction pumps on permanent magnets. These machines can be considered as one the most interesting developments of IPUL. Approx. 50 examples have been produced. In one of the machines the pressure reached 13 bars, in another case high was the flow rate of Hg, up to 20 L/s.

In all the presented illustrations in the test section of the facility a prototypic module of the liquid metal spallation target is installed developed in accordance with the program of the European Neutron Spallation Source ESS.

**Acceptance of radioactive material**

No

**Scheme/diagram**

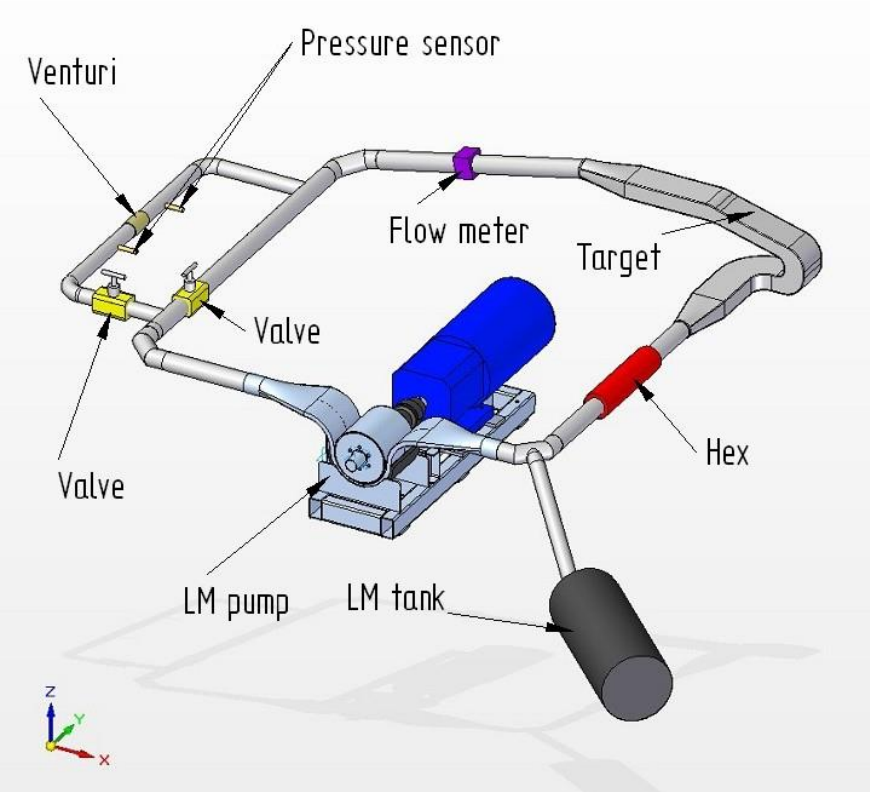

*FIG. 1. Principle scheme of the IPUL lead – bismuth loop*

## 3D drawing/photo

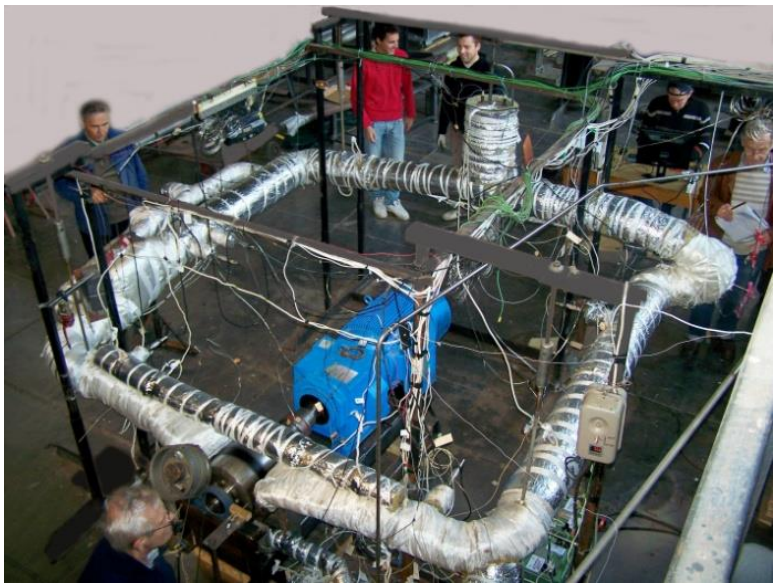

*FIG. 2. View of the IPUL lead – bismuth loop*

**PbLI**
**( Q = 12 L/s, p = 3bar )**

**Hg**
**( Q = 18L/s, p = 5 bar )**

*FIG. 3. Induction pumps on permanent magnets*

**Parameters table**

| | |
|---|---|
| Coolant inventory | Liquid lead- bismuth eutectic – 100 L |
| Power | Hydraulic power (p x Q) 20kW |
| Test sections | |
| TS 1 | *Characteristic dimensions*<br>Length of the test module (distance between the inlet/outlet flanges) - up to 2 m. The module can be installed straight in line with the main loop, second version - in the corner (for a better accessibility, see illustrations) |
| | *Static/dynamic experiment*<br>Both static and dynamic experiments foreseen |
| | *Temperature range in the test section (Delta T)*<br>$450^0$ C |
| | *Operating pressure and design pressure*<br>Op. Pres. – 3bar; design pres. – 10bar. |
| | *Flow range (mass, velocity, etc.)*<br>Flow rate up to 18 L/s; velocity in the test section up to 5 m/s |
| Coolant chemistry measurement and control (active or not, measured parameters) | Coolant chemistry not controlled |
| Instrumentation | Thermocouples, pressure transducers with a direct electric output, Venturi tube, home- made electromagnetic flow meters of different type, ultrasound Doppler velocimeter (UDV) tested, complex measurements by vibrometer performed, an inductive heater for localized introduction of power installed |

## COMPLETED EXPERIMENTAL CAMPAIGNS: MAIN RESULTS AND ACHIEVEMENTS

Thermo – hydraulic testing of the META:LIC mock-up in accordance with the WP6 of the ESS programme

- Measuring techniques in PbBi loop tested (electromagnetic induction flow meter, high temperature Doppler velocimeter sensors, vibrometer sensors).

- Techniques for localized introduction of power developed and compared – by a free flame and by an inductive heater.

- Downstream development of the temperature field investigated; applicability of the computational codes confirmed.

- Adaptable measurements of PbBi flow distribution in the target body started using high temperature Doppler sensors; corresponding dynamics codes validated.

**PLANNED EXPERIMENTS (including time schedule)**

On the existing PbBi loop specific features of heavy metal systems will be investigated.

- Introduction of means for investigation of vibrations/instabilities in heavy liquid metal loops. Performance of corresponding experiments taking into account the potentially increasing role of inertial forces and the expressed space limitations typical to a part heavy liquid metals applications.

- Detailed investigation of the stability of different kinds of electromagnetic pumps on permanent magnets.

- Tests of diverse materials in flowing liquid lead – bismuth at temperature up to $500^0$C. Corrosion and erosion attack of structural materials by PbBi at temperature up to $500^0$C

**TRAINING ACTIVITIES**

Training activities should be agreed with IPUL for the operation of the experimental facility under the supervision of IPUL qualified staff.

**REFERENCES (*specification of availability and language*)**

1. PLATACIS E., POZNAKS A., ROMANCHUKS A., NIKOLUSKINS R., BULIGINS L. "Metalic concept thermo-hydrodynamics testing facility at the Institute of Physics of the University of Latvia "Fundamental and Applied MHD, Thermo Acoustic and Space Technology, ( 9th International Pamir Conference, Riga) Volume 1; pp. 95-99, 2014.