Summary

Within the **Mega**Watt **Pi**lot **E**xperiment (MEGAPIE) to be conducted at the **P**aul-**S**cherrer **I**nstitute (PSI) the feasibility of a lead-bismuth alloy cooled target for spallation purposes will be demonstrated. Such types of liquid metal cooled targets are under consideration for various concepts of **a**ccelerator **d**riven **s**ystems (ADS) aimed to transmute nuclear waste in order to reduce the size of a final repository or to generate fast neutrons for applications like neutron tomography etc. A major component of such targets are the pumps, which are necessary to remove the heat from the highly heat loaded window facing the proton beam generated by the accelarator and transporting the heat through the heat exchangers.

Since the pumps are merely inaccessible for maintenance during operation electro-magnetic pumps without any rotating parts are preferred compared to mechanical devices. Within this report the general performance features of the electro-magnetic tandem pump for the MEGAPIE target being designed and constructed at the Institute of Physics in Riga are reviewed and recalculated using a two-dimensional approach. Additionally the power balance as well as the velocity profile and the operational characteristics are discussed.

The main results of this report are:

a.) Both the main pump as well as the bypass pump will very likely attain the required flow rates. They are in principle capable to reach $27.5m^3/h$ at a pressure head of $0.3bars$ for the main pump and $2.2m^3/h$ at a pressure head of $0.71bars$ for bypass pump. This corresponds to a safety margin of 50%.
b.) The power limiting variable is the input current which should not exceed *37 Amperes* for each pump in order to keep the copper winding temperature within acceptable limits.
c.) The overall pump efficiency is extremely weak. It accounts for the main pump to 1.18% and for the bypass unit to only 0.249%. Both is caused by an initially in the design chosen very high slip ratio s which is far above $s=0.5$. The second major reason leading to this weak efficiency is the improper design of the end regions (of in- and outlet), where most of the input power is only spent as eddy loss currents. A proper design here without any change of the pump channel could lead to an order of magnitude higher efficiencies.
d.) The relatively large gap in the main pump causes a pressure variation through the gap in radial direction leading to a non-uniform magnetic induction, which itself leads to a non-uniform velocity profile. This profile has been calculated for nominal conditions. It should be proofed with a computational fluid dynamics code (CFD) if with this profile at the pump outlet the afterwards connected heat exchanger is capable to remove the desired power.
e.) The time scales being given in the report of Platacis and Freibergs (2002) for heating up the pump before filling it with the PbBi do only account for the wall currents and, hence, they are significantly too long. If they would be conducted in the way proposed the pump will very likely be damaged. A more secure way for controlling the up-heating procedure is to use only about 10% of the nominal power and to wait longer times in order to get a more homogeneous temperature distribution in the pump. Therefore, the minimum amount of control thermocouples for each pump are 7. The exact location is given in this report (c.f. fig. 6.1).
f.) In order to avoid misreadings of the pump temperatures by the existing magnetic field and the appearing temperature gradients Copper-Konstantan thermocouples should by used.
g.) A fixation of the iron sheets by means of a mechanical clamping or welding should be used in order to prevent vibrations.
h.) The calculated spaces for thermal expansions in radial of at least $0.85mm$ and axial of at least $0.2mm$ should be existent both on the inductor side **and** the core side due to the different temperatures within the pump. The drawings show spaces but the distances where not given.
i.) Estimates about the response time of the pump to changes in the supply current show a time delay of about $4.89 seconds$.