The Munich Fission Fragment Accelerator

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After submitting a proposal for a fission fragment accelerator at the new Munich high flux reactor FRM-II in September 1997 the instrumentation committee of the reactor has recommended it and expressed its support in November.

During the last year several important steps have been achieved by the project management of the FRM-II:

- During the first partial approval of the reactor openings in the outside wall of the reactor have been introduced to allow later for a beam tube which transfers the radioactive ions to an outside experimental hall. Furthermore the concrete walls close to the reactor vessel have been shifted to allow for sufficient space in the area of the ion source.
- significant payments have been done for additional changes of the beam tube design in the reactor vessel.
- The second partial approval of the reactor included the through-going zircaloy beam tube.

However, the second partial approval for the reactor the beam tube of the fission fragment accelerator included only an operation mode with a helium filling at 1.2 bar, while the essential option to operate it under vacuum was skipped. We work now on a modified approval including vacuum inside the beam tube. This requires major changes in the beam tube design. For evacuated beam tubes the special safety considerations with potential water shock waves have to be considered. In these shock waves equivalent pressures of about 200 bar occur, which have to be absorbed to prevent a loss of cooling water of the reactor. For gasfilled beam tubes an initial shock wave is completely damped by the gas cushion. We work out a special design of the beam tube, where a leak will indicate a potential successive break in order to avoid the problems with the water shock wave. On the other hand the additional precautions to confine the water shock wave within a second barrier are technically feasible and we will include them in our plannings to reduce the final risks.

Besides making a design which excrludes all possible dangers for the reactor, a second area of considerations is the safe handling of the hot radioactive ion source. For all accelerators with intense radioactive beams the control of gaseous radioactivities represents one of the main limitations. We want to freeze out these radioactivities on cryo panels close to the ion source, reducing the outside gaseous activity by more than 10^4. The adsorbed short-lived activities convert quickly into non-volatile elements. In commissioning the accelerator we want to increase the radioactivity in the source in a stepwise procedure, proving the safe operation at low activities. In contrast to the PIAFE project [1] we thus have designed an ion source which does not only rely on internal heating by fission but also on external heating and heat shields (fig.1).

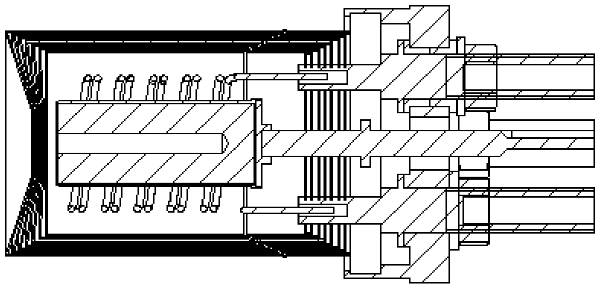

Fig. 1: The fission target-ion source of the Munich FRM-II reactor. The inner UC-cylinder is shown together with the external heating coil, the surrounding heat shields and parts of the mounting structure. Overall length: 168 mm.

Furthermore we designed an experimental hall for the fission fragment accelerator east of the reactor which houses also experiments on neutron tomography and fundamental physics with cold neutrons (fig.2). It is important that such a layout is considered in the early phase when the suroundings of the reactor are still under design, preventing later expensive modifications.

The concepts, safety considerations and system descriptions which we develop in collaboration with the TÜV Bavaria are also important to obtain realistic cost estimates for the project.

Furthermore we started to study many detailed questions related to the fission fragment accelerator:

- We are setting up a test stand to explore the long term behavior of the fission target when heating it to high temperatures [2].
- We develop optimized ion sources for surface ionisation, laser ionisation and plasma discharge [3].
- We designed a variable neutron flux absorber surrounding the beam tube in the target region. Filling the vessel with boron acid of 5% concentration it is possible to vary the local neutron flux by 45% [4].
- Detailed studies have been performed to evaluate the design parameters for the individual components of the fission fragment LINAC [5].
- One of the experimental key topics will be the production of very heavy elements. In collaboration with GSI (Darmstadt) we will build up a system for efficient collection, cooling, mass separation and mass measurement of very heavy nuclei consisting of a buffer gas cell, a quadrupole ion guide and a (double) Penning trap. This system will first be used at GSI (SHIPTRAP) before being installed at the fission fragment accelerator. Test setups at the Tandem accelerator are in progress [6].

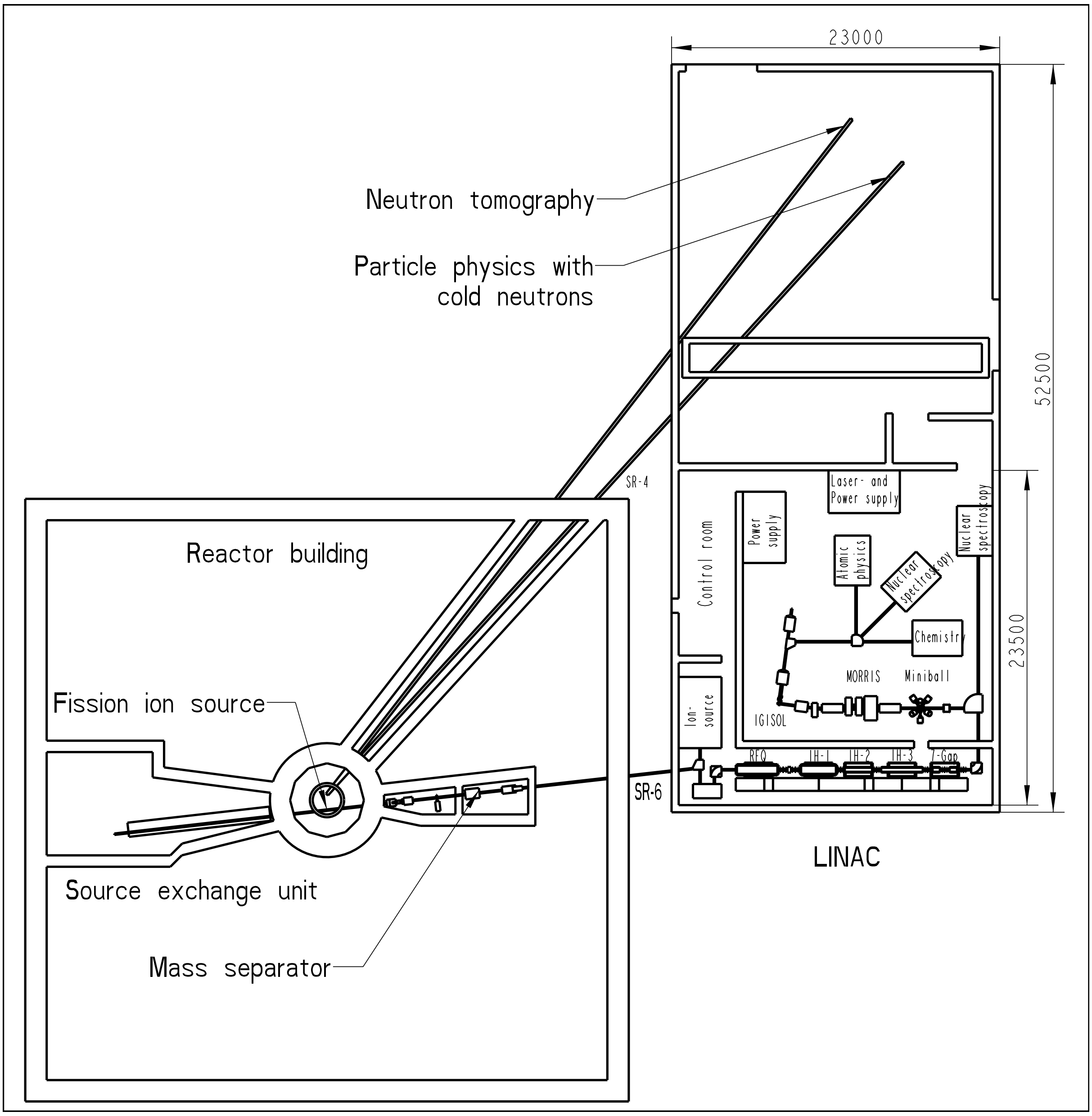

Fig. 2: Layout of the fission fragment accelerator at the FRM-II. The fission source in the reactor vessel is shown together with the beam tube leading into the experimental hall, where the linear accelerator, the mass separator and experimental setups will be positioned.

References

[1] Technical Report of the PIAFE project (1993-1996), ISN 97-52 (1997)
[2] H. J. Maier *et al.*, this report, p. 80
[3] U. Köster *et al.*, this report, p. 101
[4] M. Groß *et al.*, this report, p. 70
[5] O. Kester *et al.*, this report, p. 71
[6] J. Ott *et al.*, this report, p. 99