

T-REX instrument Project: Report of activities in preparation of the STAP meeting in April 2020.

1. INSTRUMENT PROJECT OVERVIEW

The T-REX instrument project is a collaboration between the German JCNS (75%) and the Italian CNR (25%), with a total agreed value of 16.85 M€. The project passed officially TG2 in August 2017. The Technical Annex has been signed and endorsed in January 2020.

The project of T-REX is expected to achieve completion in June 2025. The access dates to ESS buildings for installation are foreseen for the end of 2022 in building E01 (first access) and in 2024 for the bunker area.

The agreed scope includes the delivery of a world class DGCS, capable to perform INS experiments for a broad user community spanning from magnetism to functional materials and functional soft matter, including the option of using polarized neutron for x-y-z neutron spin analysis. In the first-day, T-REX will be equipped with about 40% of detector area, equivalent to 0.8 sr. The instrument specific SE will be a dedicated cryostat.

At present, the instrument team is actively engaged in several activities, which are running in parallel and involve various instrument team members. We here provide a brief overview, for the use of STAP members only, in preparation of the next STAP meeting in April 2020.

During the last Quarter of 2019 and the first quarter of 2020 the instrument team worked at the preparation of TG3 project phases of: Detectors integration box, in-bunker components, fast choppers. The design of various components have been further developed and integrated in the instrument model: the latest Bunker Wall Insert, radial collimator, detector vessel design, access to the cave and to the sample area.

2. EXPERIMENTAL CAVE

The instrument team acknowledges the suggestion emerging from the previous STAP meetings, to improve the design of the experimental cave. We would like to remind, as already stressed during the STAP meetings in 2019, that the work package is assigned to the CNR and that so far there is no fulltime personnel dedicated to the engineering work. So far, the work has been taken over by FZJ and it has been dedicated to further improve the previously developed conceptual design, necessary to advance with the design of the secondary spectrometer and enable a preliminary safety assessment by shielding calculations. Following this method of work, we applied some changes that we consider improvements in the direction of improving the ‘user experience’. However, this is not yet at a level of detailed design.

3. MULTI-GRID DESIGN AND VACUUM INTEGRATION

The instrument team completed the design of a prototype of the vacuum integration box for the multi-GRID of T-REX. The team is currently discussing with the Detector Group of ESS to verify that the current design of Multi-GRID has a clear interface with the integration box, so that the manufacturing can start. The requirements of (a) small gap between neighbour GRID columns, and (b) a small Al window in the neutron beam brought us to a challenging design from the point of view of mechanical stress and deformation, so we consider the construction of a prototype a necessary step to limit the technical risk associated with this engineering development. Moreover, the interfaces with electronics and supply have been analysed along with the requirements of maintenance and access to electronics with a minimum work. In these regards, the lack of a solution for the electronics has been a complication and we would acknowledge any progress on this side from the Detector Group of ESS. The design solution for mechanical integration of the boxes has been developed, and the needs for safe installation and maintenance activities have been considered.

4. IN-BUNKER COMPONENTS.

In the past months the team addressed the comments emerged during the review of the conceptual design of the in-bunker components. Here is the [link](#) to the confluence page that captures the current status of this discussion. At the moment all comments from the reviewers have been addressed and the team is waiting for formal approval to proceed with the procurements.

5. FAST CHOPPERS.

The Call for Tender Verification for the fast choppers of T-REX has been initiated. The iterations on the engineering requirements have been done over the past months and the revised version of the documentation is expected to be approved in April 2020, so that the procurement can start immediately after approval.

There is no substantial change of the choppers functions and the design choices (from the scientific view point) has been confirmed so far.

6. RADIAL COLLIMATOR.

A substantial effort has been put into the design of the drives for the collimator: the engineering requirements are quite challenging in this case, due to the interface with the vacuum vessel and

the magnetic requirements imposed by the need to use T-REX with polarization, while still being able to run also measurements with magnetic fields at the sample area. The team is going to propose a solution with a linear drive that seems to meet all requirements, while at the same time there is the feeling that a test phase is necessary to confirm that. During the pre-installation phase in FZJ, the team aims to complete these integration tests.

7. ACCESS TO THE CAVE AND TO THE SAMPLE AREA.

A second access to the cave has been included in the current design.

The inner cave has been enriched with a platform inside the cave that will enable access for the users to exchange the sample stick and for fast access to the secondary spectrometer, while keeping a wider entrance to the cave for maintenance and other kind of operations, including exchange of sample environment.

8. MONITORS.

The outcome of the relative T-REX team meeting has been captured in the annex to the present report. We'd acknowledge any feedback from the STAP about this.

Annex: BEAM MONITORS for T-REX.

Preliminary until design review.

The T-REX project budget provides for the design, manufacturing and installation of **three beamline monitors**:

- 1) just downstream the BWC2 assembly
- 2) just downstream the PC assembly
- 3) upstream the sample position, downstream all the other components in the primary spectrometer

After the TG2, the ESS updated the facility requirements for monitors to be used for diagnostics purpose and requested all instrument teams to include the provision of a monitor in the bunker, just outside the monolith.

The costs of this additional monitor are not covered with a corresponding increase of instrument budget, therefore on Wed 1st of April the T-REX team had a meeting to discuss and define:

- Positions of the monitors (where should the monitors be located)
- Scientific and technical priorities. (which monitors are more necessary to guarantee the instrumental functionalities)

Here is the order of scientific and technical priority (from the instrument team viewpoint):

1. Monitor upstream the sample position. It's mandatory from the scientific and technical viewpoint to enable data normalization.
2. Monitor just downstream the Pulse Shaping Chopper assembly. It's considered necessary from the scientific and technical perspective, to the definition of incident neutron wavelengths. We envisage that measurements of flux peaks and time of flight from this monitor to the monitor upstream the sample will clearly identify the neutron wavelengths.
3. Transmission monitor after the sample, in front of the beam-stop. It would enable verification of sample illumination and beam shape. From the engineering perspective, it could be relatively easy to have space reservation and provision of later installation as part of an upgrade, provided that some design considerations need to be already evaluated for a proper provisions.
4. Monitor just downstream the BWC2 assembly. It will provide relevant diagnostics and flux monitoring outside the bunker and might provide a redundant information on the T0, which could be used for determination of wavelengths.

Monitor outside the monolith. From the instrument team perspective, this monitor provides the less relevant information about the status of the neutron optics, since the in-monolith optics cannot be re-aligned unless fully replaced, it doesn't add useful diagnostics for the operation and maintenance of the beamline.

Given the facts that:

- The monitor outside the monolith is required by the ESS,
- The increased scope of the monitors project comes without a relative increase of budget,

the way forward proposed by the team is to anticipate the need to move at least one monitor to the upgrade phase, therefore considering the above priority order as metrics to evaluate which monitors should be designed and procured first.

Position of the monitor upstream the sample:

One of the points the team discussed, is the position of the last monitor. Should it be as close as possible to the sample or should it be close to the M-chopper pit. For the majority of the user program, we envisage the use of thermal neutrons, for which the neutron optics provides already the required collimation, without the need for further collimation. Measuring the neutron flux at M-chopper seems to be a good choice, which will provide less scattering due to the monitors windows.

For a relatively smaller fraction of experiments, (with cold neutrons and the need to detect neutrons at small angles), it would be advantageous, but not necessary to know the flux after collimation, but placing the monitor after the collimator, would increase the background due to scattering from the monitor windows. We consider not worth the risk to compromise the quality of the majority of experiments.