T-REX instrument Project: Report of activities in preparation of the STAP meeting in October 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 October 2020.
During the second and third Quarter of 2020 the instrument team worked at the preparation of procurements of various components: detector vessel, fast choppers, neutron guide. The design of various components have been further developed and integrated in the instrument model: detectors integration box, in-bunker components, fast choppers, the latest Bunker Wall Insert, radial collimator, detector vessel design, access to the cave and to the sample area.

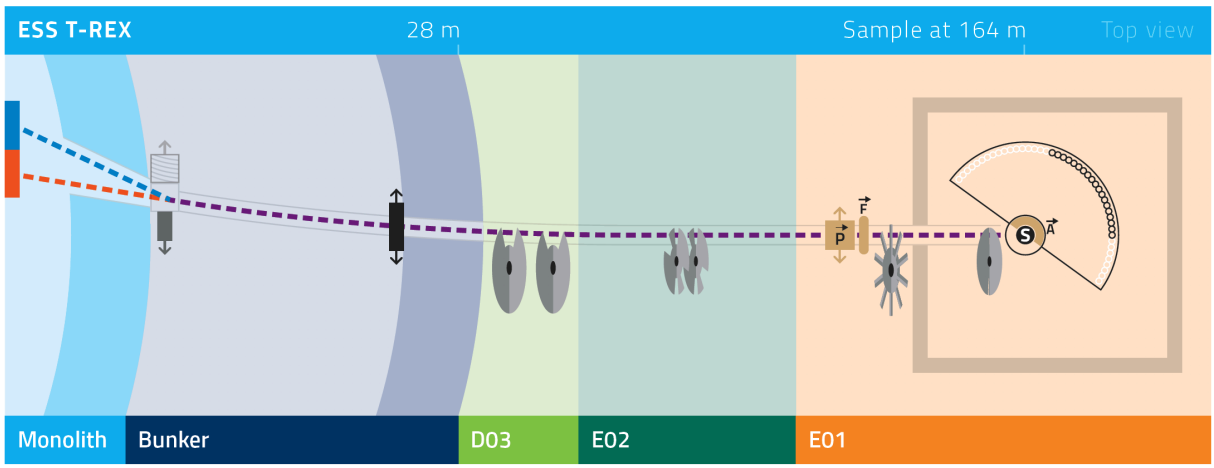


Figure 1. T-REX layout overview.

2. NEUTRON GUIDE

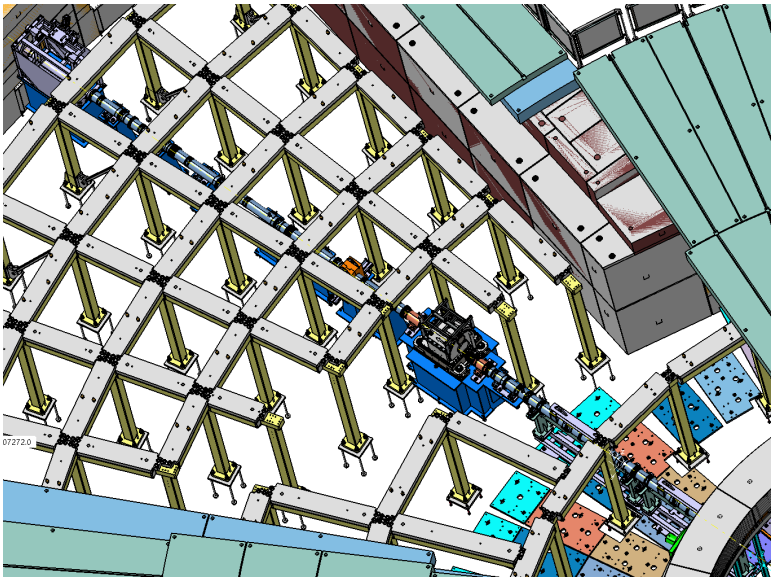


Figure 2. Overview of the in-bunker components.

a) 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. The team is currently waiting the formal approval of the procurement specifications for the In-Bunker guide, the bunker wall feedthrough and the out of bunker guide.
In the meantime we initiated first discussions with the neutron guide suppliers in order to have them informed about the basic principles of our project in advance.
The guide suppliers are fully booked on the medium-term. They indicated that they can start with the construction in the beginning of 2021 and with the production in the beginning of 2022. We plan site delivery for the BBGOA for Q2 of 2022. Maybe we are able to accelerate this, since it is a rather small component. Our expectation for the site delivery for the BWI is Q2/Q3 of 2022 and the in-bunker guide end of Q4 2022 / beginning of Q1 2023.
Regarding the out of bunker guide we plan with the arrival in Lund in Q2/Q3 of 2023. In order to keep this schedule we are aiming to have contracts signed by the end of this year to procure the complete neutron guide from BBGOA to sample.

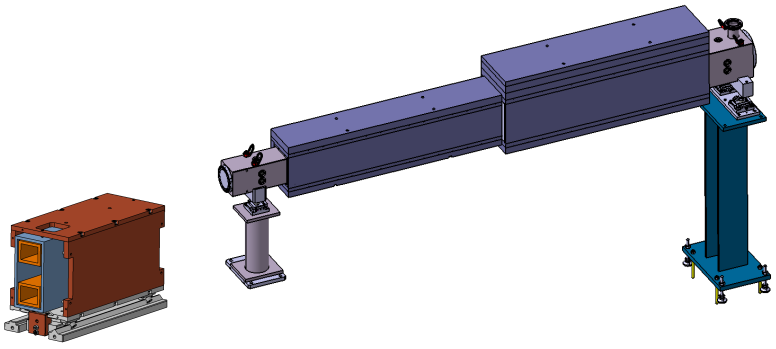


Figure 3 Left: The BBGOA. Right: the BWI.

b) The T-REX **NBOA** is currently in production at SD-H.
The coating is completed and the alignment features are being manufactured. The reference measurements of reflectivity are delayed due to the COVID-19 outbreak. S-DH requested beamtime @ PSI for the purpose of high m-value measurements.

3. MULTIGRID DETECTOR INTEGRATION BOX

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.

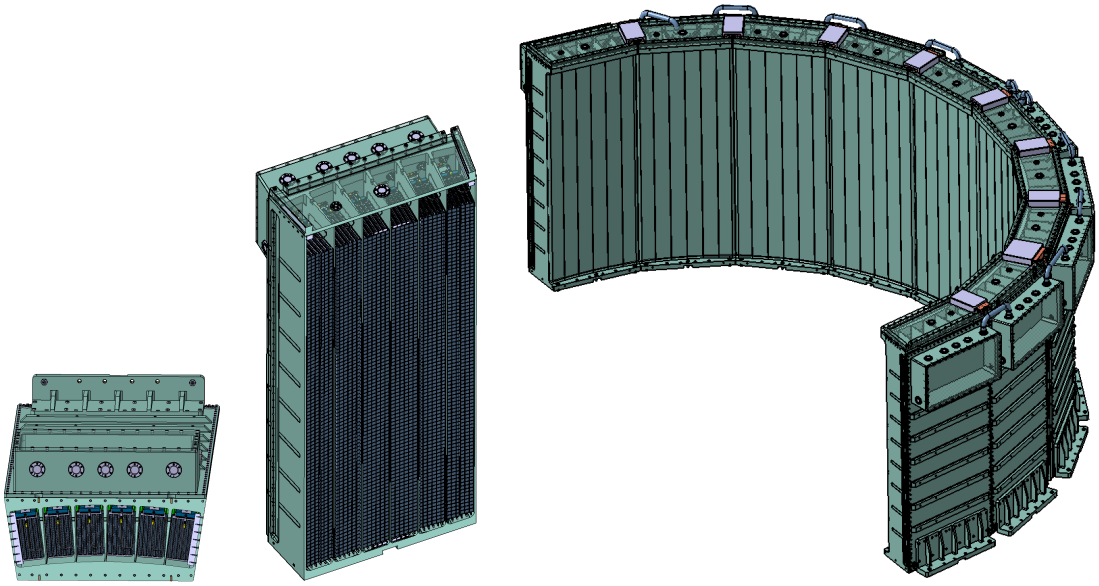


Figure 4. Multi-GRID Detector integration system. Left: top view of the integration box. Center: the integration box. Right: The whole integration system represented as to cover the entire detector area.

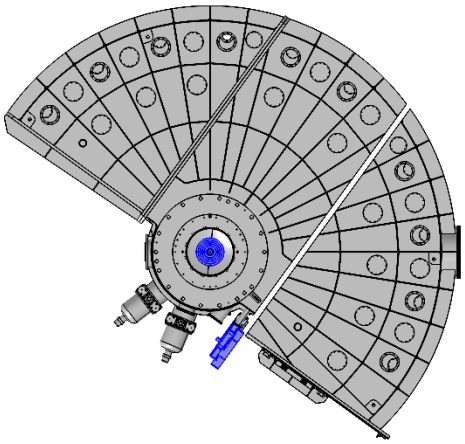
4. FAST CHOPPERS.

The Procurement process for the fast choppers of T-REX has been initiated.

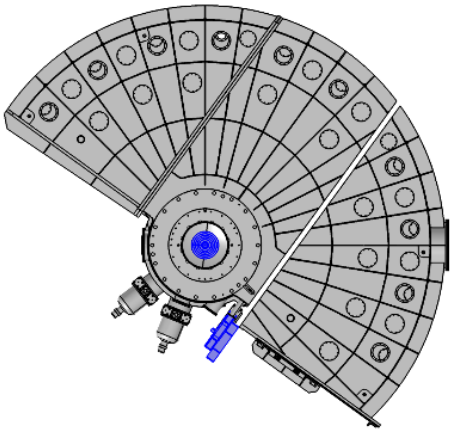
There is no substantial change of the choppers functions and the design choices (from the scientific view point) has been confirmed so far.

5. 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 has propose a solution with a linear drive that seems to meet all requirements. The polarization team of the ESS performed simulations to estimate what the field gradient at the position of the drive would be in the case a 15T magnet should be placed at the sample position. This helped the team define position of the drive and specifications. At the same time there is the feeling that a test phase is necessary to validate the installation. During the pre-installation phase in FZJ, the team aims to complete these integration tests.



Linear drive positions: as in the drawing and displaced radially 150mm



Linear drive positions: as in the drawing and displaced radially 200mm

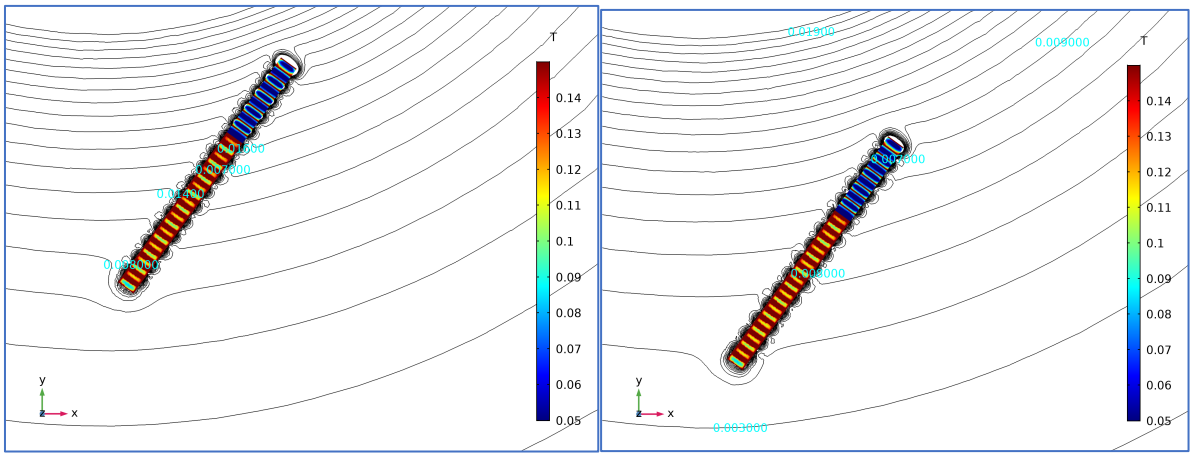


Figure 5. Results of the simulations performed by the Polarisation team of the ESS. The two top pictures show the Detector Vessel and the linear drive (in blue). The two bottom pictures shoe the linear drive in the field generated by a 15T magnet at the sample position.

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

The Italian CNR started working at the design of the experimental cave, starting from the conceptual design developed at FZJ.

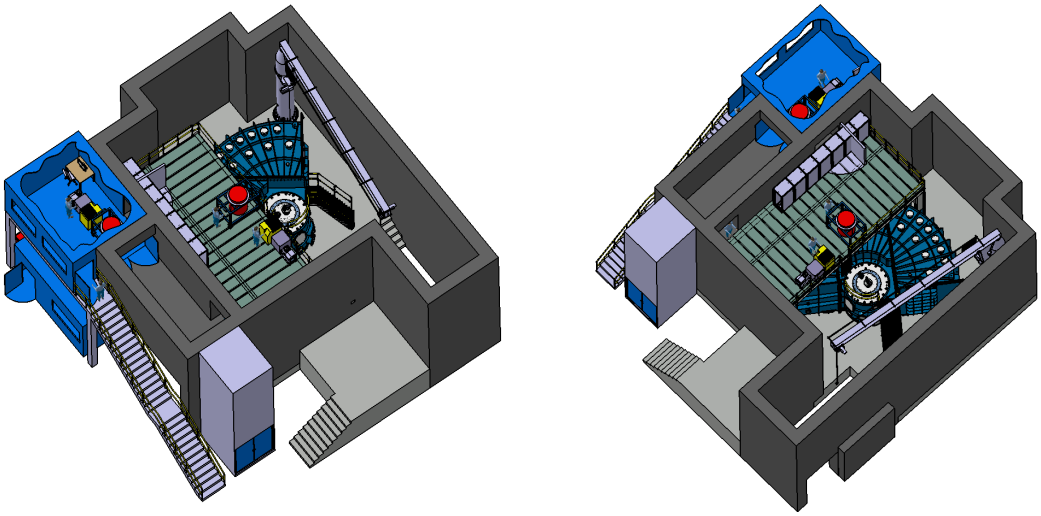


Figure 6. Two different views of the experimental cave.

An elevated access to the inside of the cave has been included in the current design that will enable faster handover of the sample environment through a platform inside the cave, which will enable access for the users to exchange the sample stick. For major installation work and maintenance the cave will feature a wider entrance. It could be used also for installation of more complex sample environments.

7. THE DETECTOR VACUUM VESSEL

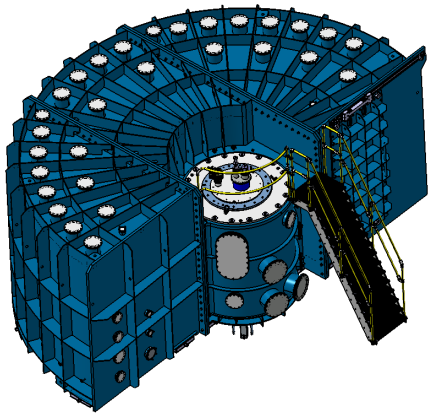


Figure 7. Detector Vessel 3D view.

The tender procedure for the T-REX vacuum vessel failed for formal reasons and it has been closed on September the 28th of 2020. We will have to repeat it as soon as possible or we will have to consider the option of internal manufacturing at FZJ. The impact on the overall project schedule is still under evaluation.

8. PROJECT PROGRESS TRACKING

In the following table we summarize the Milestones agreed with the ESS and their current progress state. The delays on the NBOA are due to the Covid-19 pandemic (see the relative paragraph).

Milestone	Description 1	Description 2	Date	Doc. Submitted	Expected Date	Approved	Status
WP08.1	Detector Vessel	Design Reviewed (IDR/CTV)	Jul 18	06.06.18	06.07.18	05.08.18	Complete
WP01.1	NBOA	Design Reviewed (CTV)	Jul 18	26.07.18	26.07.18	26.08.18	Complete
WP01.2	NBOA	Procured	Mar 19	15.03.19	01.03.19	22.03.19	Complete
WP08.2	Detector Vessel	Design Accepted/Sub-TG3.1	Apr 19	01.04.19	01.04.19	15.01.20	Complete
WP09.1	Neutron Detector	Protoype Detector Box Design Reviewed (IDR)	Apr 19	04.04.19	01.04.20	05.04.19	Complete
WP01.3	NBOA	Design Accepted/Sub-TG3.0	Aug 19	01.08.19		08.05.20	Complete
WP02.1	In Bunker Components	Design Reviewed (IDR/CTV)	Oct 19	01.10.19	15.07.20		In progress
WP06.1	Fast Choppers	Design Reviewed (CTV)	Oct 19	01.10.19	15.07.20	27.05.20	Complete
WP04.1	Beamline Shielding	Design start	Feb 20	01.02.20	15.04.20		Delayed
WP01.4	NBOA	Manufactured	Feb 20	15.02.20	01.09.20		Delayed
WP01.5	NBOA	FAT	Mar 20		15.09.20		Delayed
WP03.1	Neutron Guide Outside Bunker	Design Reviewed (CTV)	Apr 20	27.05.20	30.09.20		In progress
WP06.2	Fast Choppers	Procured	Apr 20		30.08.20		In progress
WP09.2	Neutron Detector	Protoype Detector Design Accepted	Apr 20		30.04.20	22.05.20	Complete
WP01.6	NBOA	Delivered (ESS)	May 20		No information available		Delayed
WP01.7	NBOA	Installed	Jul 20		No informatio		Delayed

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WP04.2	Beamline Shielding	Design Reviewed (IDR)	Sep 20		01.09.20		Delayed
WP02.2	In Bunker Components	Procured	Oct 20		01.02.21		Delayed
WP06.3	Fast Choppers	Design Accepted/Sub-TG3.2	Oct 20		01.02.21		Delayed
WP08.3	Detector Vessel	Procured	Oct 20	25.06.20	01.12.20		In progress

At the moment we don't have in place a method to track the level of completion, so we can't report this as requested by the STAP.s