ACTIVITY REPORT OF THE TEX FACILITY

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1 Introduction

TEX ("TEst stand for X-band") is a facility based on a high-power test stand that has been created in preparation to the activities of the EuPRAXIA@SPARC_LAB project [1, 2] and the LATINO (Laboratory in Advanced Technologies for INnOvation) Initiative [3]. The purpose of the facility is to test X-band accelerating structure prototypes for the EuPRAXIA and CLIC projects, RF components and sub-systems. For the rest of the time the facility is accessible to external users, including national and international laboratories and companies. The open-access to TEX is one of the services offered by INFN to the external community through LATINO, a project approved and funded by the government of "Regione Lazio" aimed at promoting and increasing the technology transfer between research centres of excellence and the surrounding economic framework. By the end of 2021 the building hosting the facility has been completely refurbished and in the 2022 the installation and commissioning of the RF power source and of all the sub-systems.

2 The X-band RF Power station

The area to host the new test stand within the LNF has been identified in the building 7 of the laboratories and it is being refurbished to provide all the required services to the facility. A new control room with a rack room have been realized into the building next to the testing area, see Fig. 1. The concrete bunker, shielding the accessible area from the radiation produced by the structures under test, is also being designed and constructed in 2021.

Figure 1: *TEX Concrete bunker entrance (left) and top view of the control room and the bunker (right).*

Table 1: *Main Parameters of the RF source.*

Parameter	Units	Value
Frequency	GHz	11.994
RF Peak power	MW	50
Gain	dB	48
Modulator Peak Power	MW	140
Cathode peak voltage	kV	430
Beam Current	A	325
Repetition Rate	Hz	50
RF Pulse length	μs	1.5
Pulse Flatness	%	$< \pm$ 1.5
Pulse to pulse stability	ppm	14

The power source is based on a pulsed solid state modulator feeding an X-band klystron tube. The input RF pulse is generated by a Low Level RF system and amplified by a commercial solid state driver amplifier realized by Microwave Amps to a power of more than 800 W. The power source will produce up to 50 MW RF pulses of 1500 ns pulse width and 50 Hz repetition rate. The klystron that has been installed is a CPI VKX8311A provided to us by CERN and is powered by a ScandiNova k400 solid state modulator. In Fig. 2 the picture of the entire RF source is reported. The solid state technology allows to reach a high stability of the output pulse, required for the EuPRAXIA@SPARC_LAB project with an high compactness of the overall system. The power generated by the source is transported into the bunker by a WR90 rectangular waveguide network. In a secondary phase a X-band BOC type pulse compressor will be installed increasing the output power available. The waveguide layout is then completed by directional couplers for RF diagnostics connected to the LLRF system. The installation on site of all these components took place between the end of 2021 and the beginning of 2022 and the site acceptance test of the modulator has been completed in March 2022. Before the SAT the modulator interface has been integrated in the EPICS control system framework and the Libera LLRF system with the Up/Down converter have been installed. More information about the TEX control system, its commissioning and the implementation of an automatic algorithm for the conditioning can be found in [6] and [7]. The SAT of the source has been performed with the waveguide system terminated on two RF loads, details of the source commissioning can be found in [4, 5]. In Table 1 the main parameters of the power source are reported.

Before the end of the SAT, the stability and flatness of the modulator pulse were accurately measured. The measured pulse flatness was about $\pm$1.5% and the pulsed to pulse stability was 14 ppm. Some preliminary measurements in terms of amplitude and phase jitter of the klystron forward output has been performed trough the LLRF System, measuring 0.04% and 20.7fs respectively A detailed description of the TEX LLRF and these first results are reported in [8, 9].

3 List of Conference Talks by LNF Authors in Year 2022

Include a list of conference talks by LNF authors.

1. F. Cardelli, X-band activities at INFN-LNF, International Workshop on Breakdown Science and High Gradient Technology (HG2022), virtual conference, 16th May 2022.

2. F. Cardelli, INFN-LNF update on the X-band activities, 43° CLIC Project Meeting, 7th December 2022.

Figure 2: *X-band RF power source at TEX.*

References

1. M. Ferrario et al., *"EuPRAXIA@SPARC_LAB Design study towards a compact FEL facility at LNF"*, Nuclear Instruments and Methods in Physics Research Section A: Accelerators, Spectrometers, Detectors and Associated Equipment, 909, pp. 134-138, (2018).

2. D. Alesini et al., *"EuPRAXIA@SPARC_LAB Conceptual Design Report"*, INFN-18-03/LNF, (2018).

3. L. Sabbatini et al., *"The LATINO Project-An Italian Perspective on Connecting SMEs with Research Infrastructures"*, in Proc. 10th Int. Particle Accelerator Conf. IPAC'19, Melbourne, Australia, (2019).

4. S. Pioli et al., *"TEX - an X-Band Test Facility at INFN-LNF"* in Proc. 12th Int. Particle Accelerator Conf. IPAC'21, Campinas, Brazil, (2021).

5. F. Cardelli et al., *"Status and commissioning of the first X-band RF source of the Tex Facility"* in Proc. 13th Int. Particle Accelerator Conf. IPAC'22, Bangkok, Thailand, (2022).

6. S. Pioli, et al., *"Control and Functional Safety Systems Design for Real-Time Conditioning of RF Structures at TEX"* in Proc. 13th Int. Particle Accelerator Conf. IPAC'22, Bangkok, Thailand, (2022).

7. D. Moriggi, et al., *"EPICS-Based Telegram Integration for Control and Alarm Handling at TEX Facility"* in Proc. 13th Int. Particle Accelerator Conf. IPAC'22, Bangkok, Thailand, (2022).

8. L. Piersanti et al., *"Design of an X-Band LLRF System for TEX Test Facility at LNF-INFN"* in Proc. 12th Int. Particle Accelerator Conf. IPAC'21, Campinas, Brazil, (2021)

9. L. Piersanti et al., *"Commissioning and first results of an x-band LLRF system for TEX test facility at LNF-INFN2* in Journal of Physics: Conference Series, volume 2420, number 1, (2023)