ARIES TRANSNATIONAL ACCESS APPLICATION FORM

Before completing this form please contact the relevant facility coordinator for a preliminary discussion about the technical feasibility of your proposal.

Contact details can be found here.

For each item refer to **Guidelines for Applications (Annex 1).**

I. Description of the project/experiment/test

Project Title	**Dark and breakdown currents studies with Uppsala/CLIC X-band Spectrometer**
Project TA Identifier	*To be allocated by the ARIES project office*
Project Duration	**2017-2018**

Please select the facility to which you apply for Transnational access

Type of facility	**Access provider**	**Infrastructure**	
Magnet testing	CERN	MagNet	☐
	UU	FREIA	☐
Material testing	CERN	HiRadMat	☐
	GSI	UNILAC	☐
Electron and proton beam testing	KIT	ANKA	☐
	KIT	FLUTE	☐
	CEA	IPHI	☐
	DESY	SINBAD	☐
	STFC	VELA	☐
Radiofrequency testing	UU	FREIA	☐
	CERN	Xbox	☒
Plasma beam testing	CNRS	LULI	☐
	CEA	LIDyL	☐
	ULUND	LULAL	☐

Project abstract (please write a short summary of the project and its objectives in the box below)

During RF breakdown plasma forms inside the cavity which is followed by the ejection of a significant amount of electrons and positively charged ions. These phenomena will influence the electron beam properties considerably and need to be studied. A general-purpose system for detection and measurements of the dark and breakdown currents during conditioning of new prototype accelerating structures for CLIC has been installed and commissioned at CERN Xbox2 test stand. We would like to use the spectrometer in order to collect long-term measurements of dark and breakdown currents for the installed RF cavity and complement the setup with an additional CCD camera and optical line to enable separate measurement of the dark current.

Project description (1-1,5 page) including:

- **Research or experimental work planned**
- **How the project/experiment/test will benefit from the access to this facility**
- **If relevant, tentative schedule of the use of the facility**

A spectrometer for detection of the dark and breakdown currents during conditioning of new accelerating structures for CLIC is installed at Xbox2, one of the 12 GHz stand-alone test-stands at CERN. The spectrometer consists of a dipole magnet, a variable collimator, and a fluorescent screen read out by a fast camera. Built for high repetition rate operation it can measure the spatial and energy distributions of the electrons emitted from the acceleration structure during a single RF pulse.

CLIC structures operate very close to the gradient limit that is set by appearance of the vacuum breakdowns. The particles escaping the structure provide useful information about the physics of the vacuum breakdown e.g. the evolution of the surface under RF pulses or the underlying trigger mechanism. Together with the information from the measured RF powers we obtain with the new setup a more complete picture of the vacuum breakdown phenomenon that can help in achieving higher reliability and long life-time for the structures.

Plans for the project:

1) **Following the conditioning process**. It is important to continuously operate the spectrometer to follow the conditioning of the cavity. It is theorized that the changes in dark current level can reveal information about the physics of the RF breakdowns; especially long-time trends can carry information about surface hardening process and perhaps could be used to foresee the formation of the breakdown. In addition the spectrometer provides useful information for the conditioning operation like the transverse position of the source of the electrons emitted from the structure or the energies of the electrons escaping the structure. Long term operations can be monitored remotely, but regular visits to the Xbox test stand are still necessary to make changes and maintain the setup. During the access we will check magnetic field map values and degaussing procedure, check and recalibrate the linear actuators as well as commission new software updates. During access we would also perform dark current scans with respect to incident RF power and pulse length which requires assistance of the CERN RF group. We foresee one week visit during installation of a new cavity and restart of the Xbox and three, one-week long visits to maintain the system during conditioning process.
2) **Transfer**. Recently the Xbox1 test stand resumed its operation in the CTF2 experimental hall that was originally planned to house the spectrometer. It is very likely that the setup will be transferred to the new, more suitable location and a visit to CERN will be required to ensure successful transfer. We estimate that two-week access is necessary to complete the transfer, re-cabling and commissioning of the system.
3) **Upgrades**. The spectrometer is equipped with a single camera observing light emitted from the fluorescent screen by impinging electrons. During operation we are able to observe both the breakdown currents (triggered by breakdown events) and dark current (during regular RF pulses). As mentioned before, the dark current is believed to be a precursor of a breakdown and often is used as an input to many theoretical models that may someday be used to predict an approaching breakdown. As the same time it is responsible for the power loss and radiation at

the test stand. Unfortunately the intensity of the two currents can differ by the order of magnitude and the setup with the single camera cannot cope well with that. A valuable upgrade would be to add another optical line entirely dedicated to dark current. A technical design and fabrication of the line will be prepared in advance; however the installation would require two visits at the test stand as it would involve first the mechanical installation including a dedicated lead shielding and then integration into the DAQ system with various software tests when system is running.

II. 2-3 relevant publications of the user group leader

1. M. Jacewicz, V. Ziemann, T. Ekelöf, A. Dubrovskiy, R. Ruber, *Spectrometers for RF breakdown studies for CLIC,* Nucl. Inst. and Methods A 828 (2016) 63.
2. A. Palaia, M. Jacewicz et al. (5 authors), *Effects of rf breakdown on the beam in the Compact Linear Collider prototype accelerator structure,* Physical Review Special Topics - Accelerators and Beams, 16, 081004 (2013).
3.

III. Access requested under the TNA programme of ARIES

User group leader	Home institution (Name, Country)	Researcher status[1]	Total no. of days	No. of visits
Marek Jacewicz	Uppsala University, Sweden	EXP	60	8

List in the following table all users part of the team including those who will not be physically present (remote access users, for these users number of days and number of visits will be 0)

Researchers	Home institution (Name, Country)	Researcher status	Total no. of days	No. of visits
Volker Ziemann	Uppsala University, Sweden	EXP	0	0
Jim Ögren	Uppsala University, Sweden	PGR	0	0

4) Comments

[1] UND=Undergraduate; PGR=Post graduate researcher; PDOC=Post-doc researcher; TEC=Technician; EXP=Experienced researcher.

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☒ **We acknowledge the requirements to publish the results (except for SMEs) from the TNA of ARIES in a journal or conference paper or ARIES note**

☒ **We are aware that all technical aspects of the project/experiment/test including safety and risk hasards need to be discussed with the technical coordinator of the facility concerned**

Date
2017-06-19
……..

User Group Leader Name
Marek Jacewicz
……

Signature


Annex. 1

Guidelines for Application

The Transnational Access programme poses certain restrictions upon the eligibility of users, defined in Article 16.1 of the Horizon 2020 Grant Agreement.

1) **Experiment**
Indicate the title of the experiment.
The project TA identifier will be assigned to you by ARIES-TA@cern.ch, after the project has been approved.
(e.g. ARIES-MAGNET-2017-01).

Description of the project (max. 1 page)
Describe the scientific and technical aspects of the project. Underline the goal of your project and the specific relevance of your proposal. Add references if necessary.

2) **Include a list of 2-3 relevant publications of the user group leader.**

3) **Access requested under TA Programme**
Indicate the researcher's name, the number of days that he/she will spend at the facility and the number of visits to the facility. For remote users, please specify "remote user" in the table.

4) **Comments**
Add any additional comments you think might be helpful to the User Selection Panel (USP) for the evaluation of your proposal.

For any further information or questions, please contact ARIES-TA@cern.ch

! Note to users:

- The user group leader needs to sign a confirmation of beamtime/irradiation time, at the end of each visit.
- The user group leader needs to complete a TA summary report.
- The user group needs to disseminate the results generated under the project. All publications should include the following acknowledgement:

This project has received funding from the European Union's Horizon 2020 Research and Innovation programme under Grant Agreement No 730871