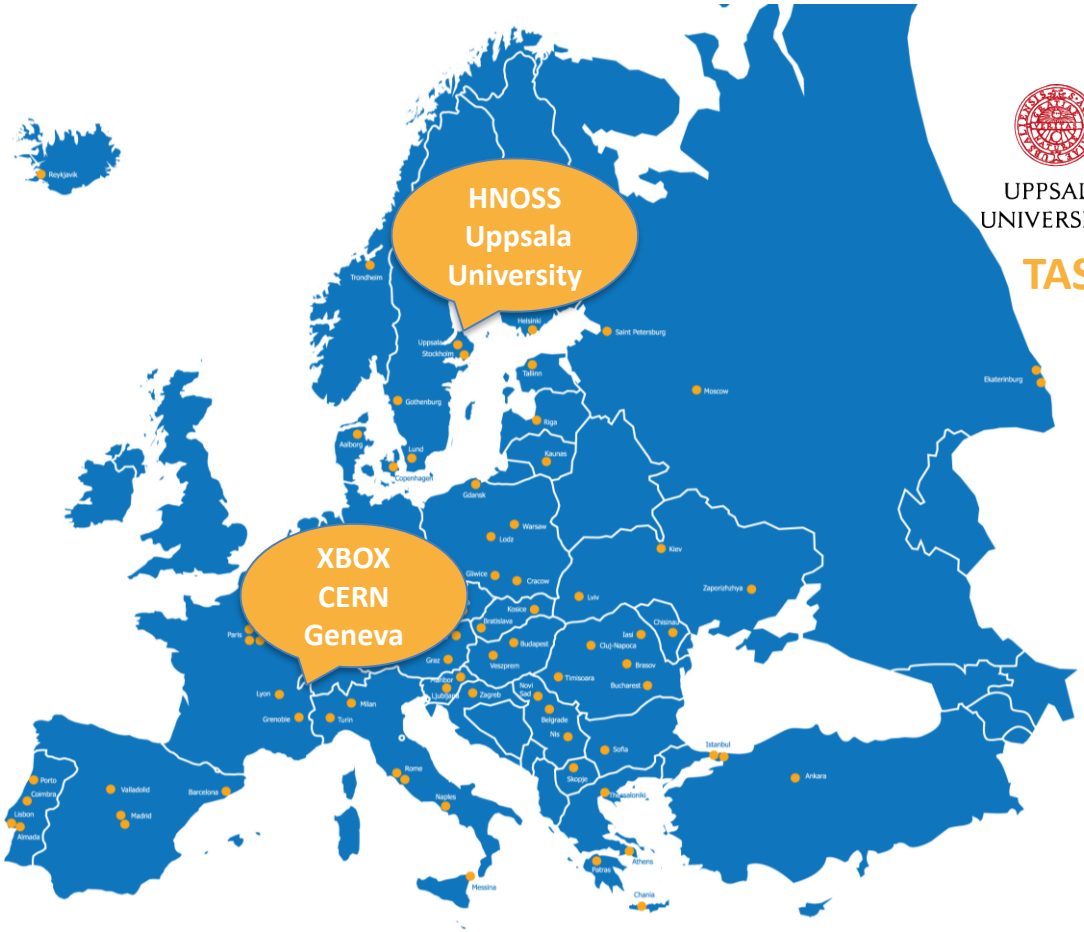
This project has received funding from the European Union's Horizon 2020 Research and Innovation programme under Grant Agreement No 730871.

Testing of Advanced RF Structures
TNA WP12 RF Test Stands

2nd Annual Meeting, Budapest, 8-12 April 2019

Roger Ruber (Uppsala University)
Walter Wuensch (CERN)

WP12 RF Testing Facilities



UPPSALA UNIVERSITET

FREIA

TASK 12.1 HNOSS

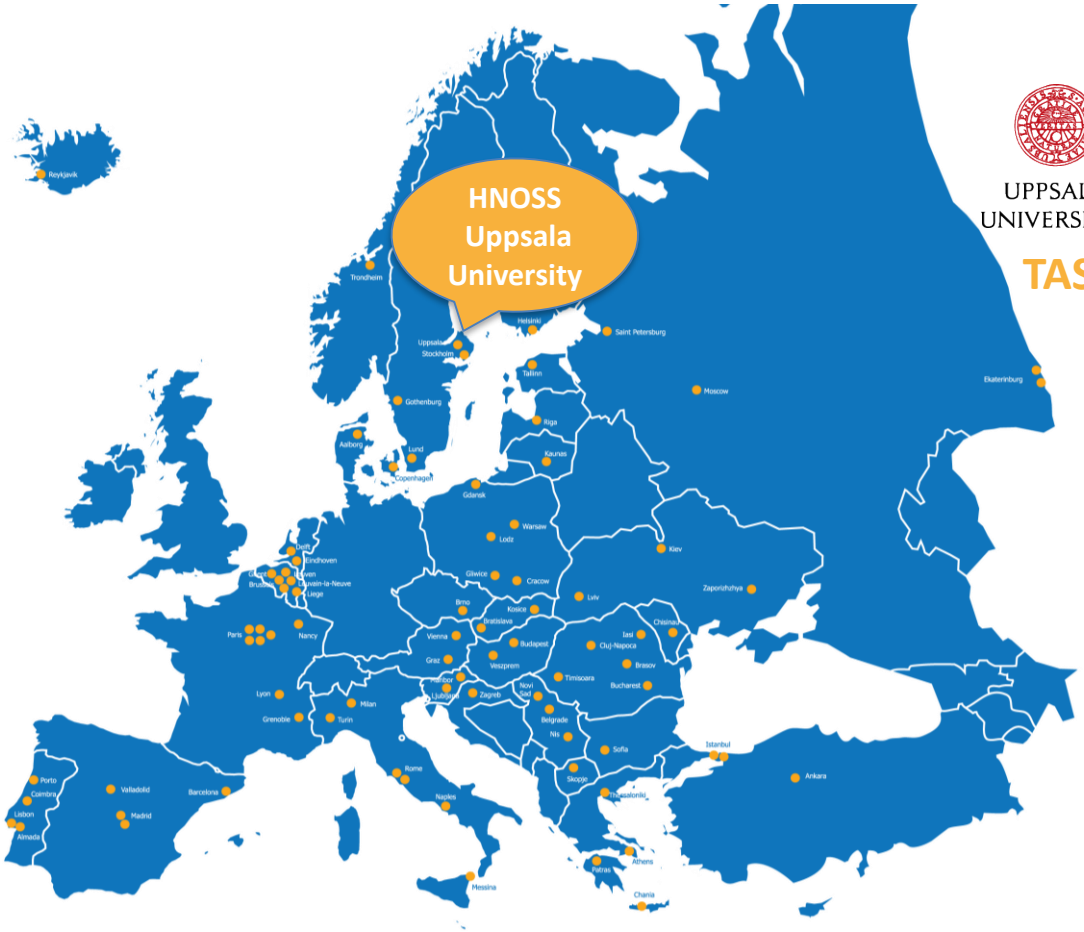
CERN

TASK 12.2 XBOX

The TNA within WP12 groups **TWO** facilities devoted to testing of superconducting RF cavities and normal conducting RF cavities.

ARIES

WP12 RF Testing Facilities



UPPSALA UNIVERSITET

FREIA

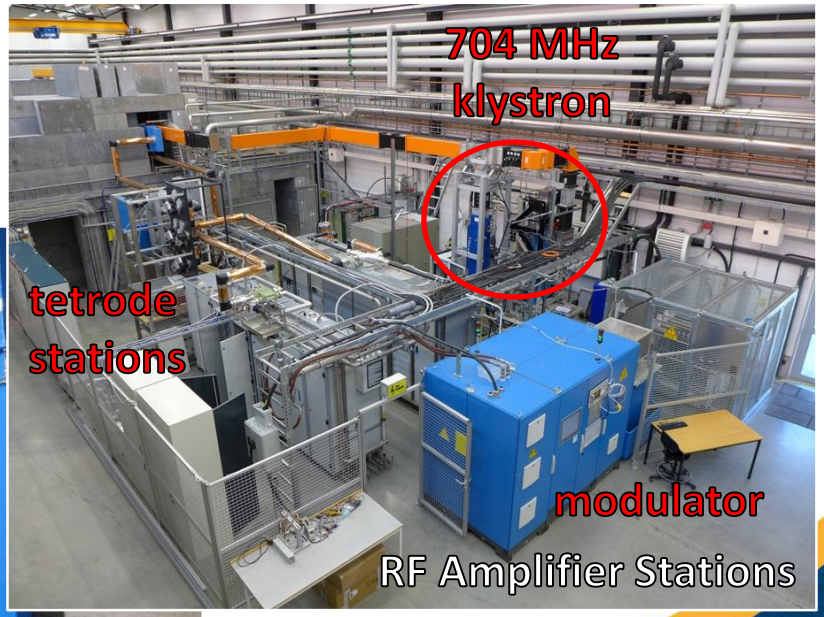
TASK 12.1 HNOSS

The **HNOSS** facility at the FREIA Laboratory, Uppsala University, Sweden, is available for testing of superconducting RF cavities with integrated helium tank.

ARIES

WP12.1 The HNOSS TNA

- Located at Uppsala University, the HNOSS test stand is used to test and characterize superconducting cavities
- There are 4 RF high power RF sources available, two at 352 MHz at 400 kW_{pulsed}, one at either 352 or 400 MHz at 50 kW_{CW}, and one at 704 MHz at 1.5 MW_{pulsed}, extensive instrumentation and support infrastructure (radiation shielding, SHe & water cooling, vacuum, etc).
- The user community spans
  - High-power proton accelerators
  - High-power electron accelerators



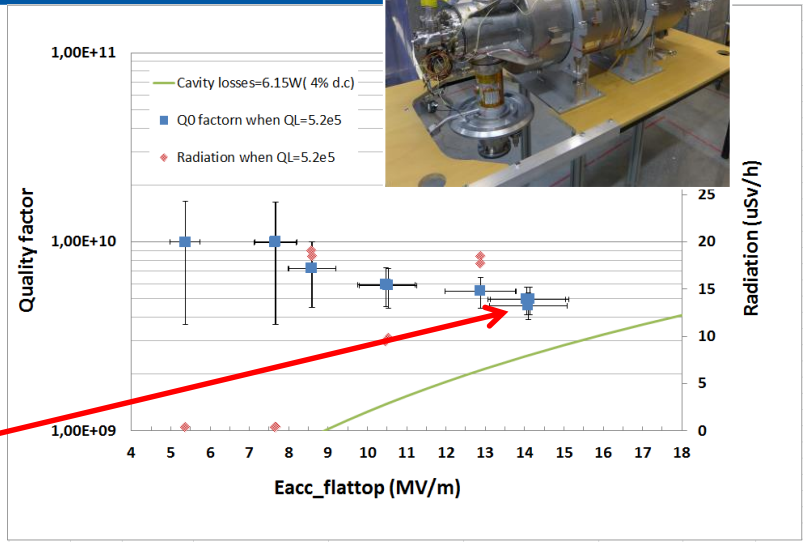
WP12.1 HNOSS - User Projects

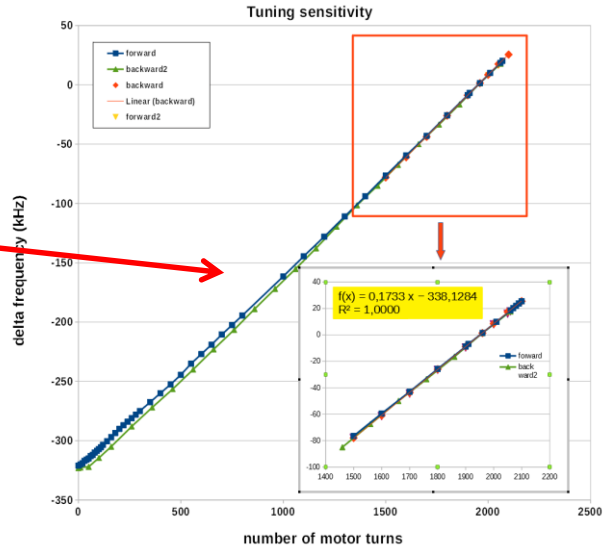
- Four user projects
  - one completed, one ongoing, one under discussion
  - 1330 (46%) out of 2880 access units

- Project #1 - FREIA-HNOSS 2017-01
  - ESS High-beta Elliptical Cavity
  - Franck Peauger (CEA, France)
  - 1330 access units
- Project #2 - FREIA-HNOSS 2018-01
  - Validation of a prototype double spoke cavity cryomodule
  - Guillaume Olry (IPN Orsay, France)
  - Access: in progress
- Project #3 (to be submitted & approved by USP)
  - RF and piezo actuators study on spoke cavities
  - Wojciech Cichalewski (Lodz)

WP12.1 HNOSS - Project #1

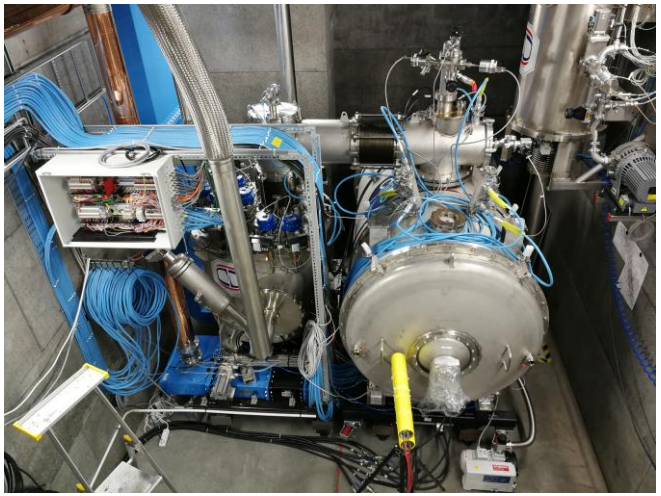
- High-beta elliptical cavity package
  - from CEA Saclay, prototype for ESS,
  - experiment run in June and August 2018,
    - start-up delay due to technical issues with high power klystron and RF-load
  - cold tuner problem
    - → warm-up and fix
- Results
  - Q_0 >10^9
    - not much multipacting,
  - Lorenz force detuning, cavity tuning sensitivity ok
    - lost some motor steps during 1st movement, others ok
    - test of new electronics for cold tuner system
  - full report
    - presented at SLHiPP-8 (12 June 2018)
    - published: urn:nbn:se:uu:diva-371627

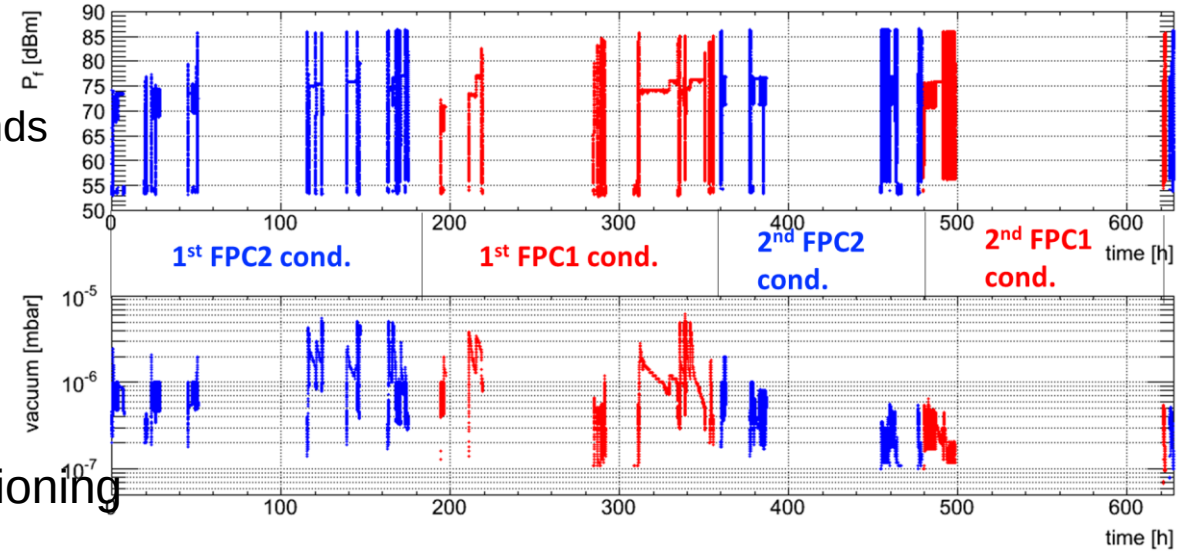




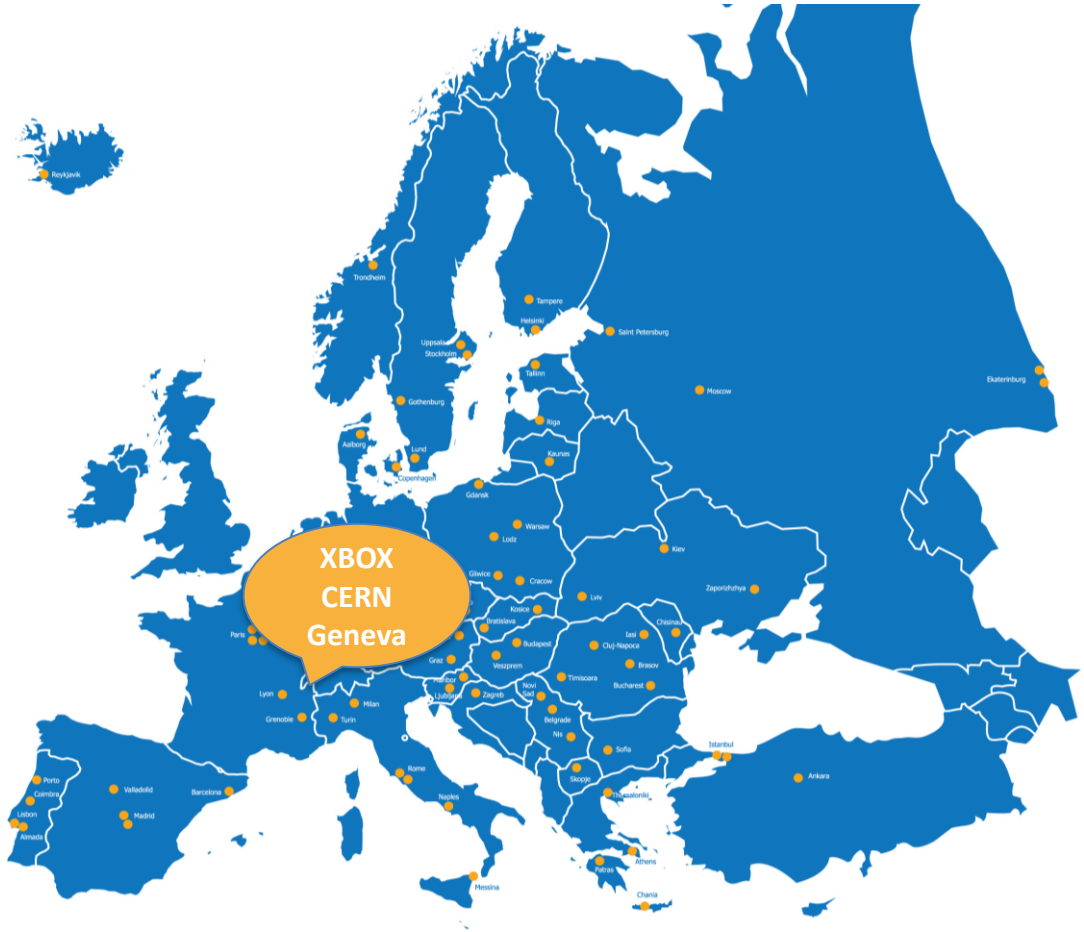
WP12.1 HNOSS - Project #2

- Double-spoke cavity cryomodule & valve box
  - from IPN Orsay, prototype for ESS
  - validation valve box in Dec. 2018 & Jan. 2019
    - use simulator to validate operation
    - thermo-acoustic (Taconis) oscillations
      - → installed RLC circuit
  - cryomodule run just started
- Results
  - warm RF conditioning
    - several multipacting bands
      - strength depends on pulse length, 1st/2nd conditioning…
  - cold RF conditioning
    - no multipacting
  - this week: cavity conditioning





WP12 RF Testing Facilities



TASK 12.2 XBOX

The **XBox** facility at CERN, Switzerland, is available for testing of normal conducting RF cavities/structures at X-band frequency.

WP12.2 The Xbox TNA

- Located at CERN, and built up by the CLIC collaboration, the Xbox test stands are used to carry out high-gradient accelerator technology development and research into the multiple process which occur at high surface fields.
- There are four independent klystron-based test stands with peak powers in the range of 50-150 MW, extensive instrumentation and support infrastructure (radiation shielding, water cooling, vacuum, etc).
- The user community spans:
  - High-performance normal-conducting electron linacs
  - High-gradient proton linac applications such as medical
  - High-power device users such as satellite communication
  - Material science and plasma physics groups who study high-field dynamics

Xbox-3 klystron-modulator rf power unit

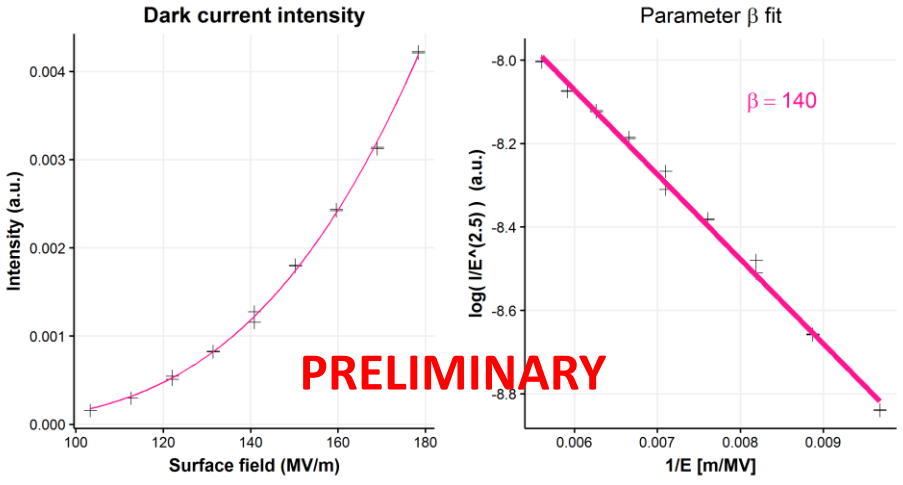
WP12.2 XBox - User Projects

- Four user projects
  - one completed, one ongoing, two under discussion
  - 1680 (28%) out of 6000 access units

- Project #1 - CERN-XBOX 2017-01
  - Dark and breakdown current studies
  - Marek Jacewicz (UU, Sweden)
  - 1680 access units
- Project #2 - CERN-XBOX 2018-01
  - X-band pulse compression chain
  - Riccardo Zennaro (PSI, Switzerland)
  - Access: in progress
- Project #3 (to be submitted & approved by USP)
  - X-band RF deflecting structure testing
  - Graeme Burt (Lancaster, UK)

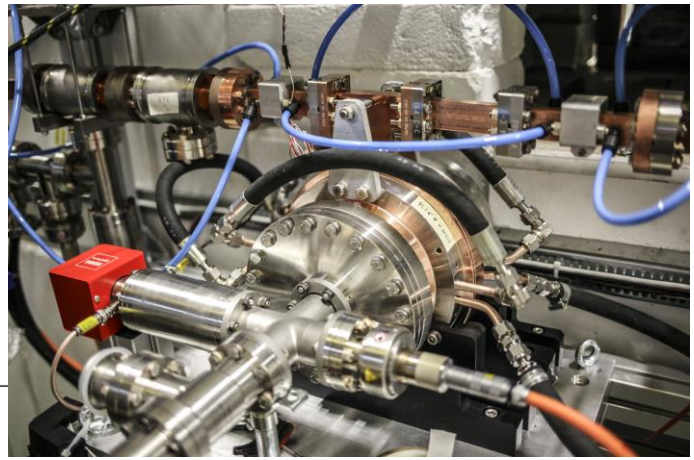
WP12.2 Xbox - User Project #1

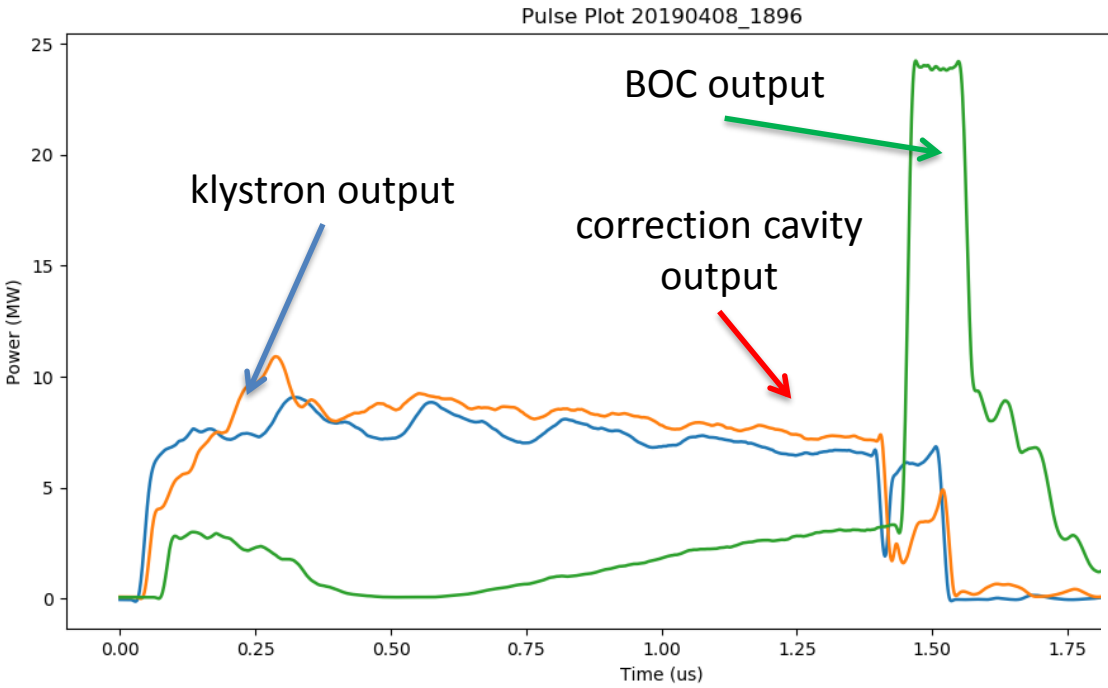
- Dark and breakdown currents studies during high field effects
  - can give information about changes inside the structure during conditioning:
    - use the spectrometer to look at the changes,
      both spatially on the screen and by measuring the energy spectrum
  - two visits with dedicated access February and April 2018
  - remote access during April through June 2018
- Results
  - Enhancement factor β accounts for the increase in a local (microscopic) field value E_{local} from the ideal surface field E
    - $E_{local} = \beta * E$
  - scans with respect to incident RF power and pulse length
  - **Good agreement with underlying theory of field emission**
  - full report under preparation

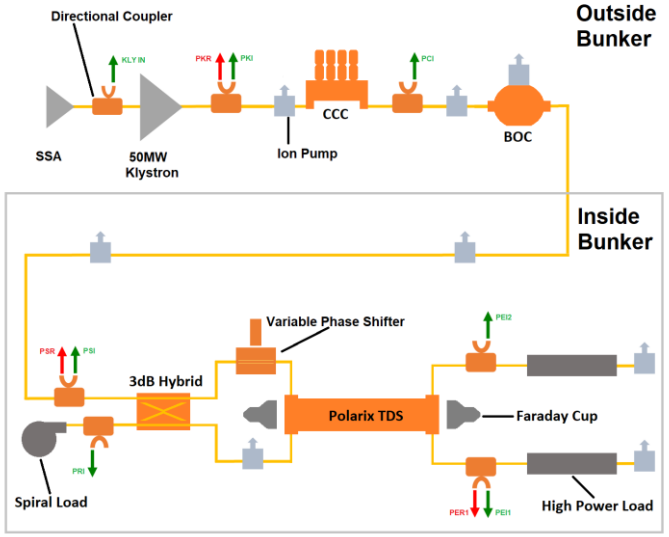


WP12.2 XBox - Project #2

- Validation of the high power performance of a new pulse compressor cavity (BOC) and correction cavity chain (CCC) for X-band operation







WP12 HNOSS and Xbox TNA - Outlook

- A typical User Project is quite complex, often requires some form of approval at the level of the proposing institutes, so lead times are long.

- Discussions are underway with various groups for future User Projects.
  - HNOSS:
    - might not reach the promised 4 user project, but full use of access units
  - XBox
    - expect to fulfil the promise of 4 user projects and all access units.