



WP1: FE-FRT

Industrial review kick-off meeting

30.10.25

A. Neumann for WP1 team

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WP1: FE-FRT (Official overview)

HZB, CERN, CNRS, Uni.Lancaster

Convener: Axel Neumann (HZB), deputy Alick Macpherson (CERN)

Main contacts with other partners: Alick Macpherson (CERN), Walid Kaabi (CNRS),

Graeme Burt (Uni.Lanc.), industry: Alexei Kanareykin (Euclid Techlabs)

Task 1.1: Coordination of R&D on FE-FRT – M1-M48 (HZB)

- General coordination by HZB as described above.

Task 1.2: FE-FRT for *Transient Beam Loading* – M1-M40 (CERN)

- Design a full FE-FRT-based 400 MHz tuner, applicable to *LHC transient detuning* scenarios.
- Perform full RF, mechanical and cryogenic evaluation of the FE-FRT-equipped . LHC cryo-module.
- Use design lessons learned to design a tuner for transient detuning of FCC 800 MHz multi-cell cavities.

Task 1.3: FE-FRT for *Microphonics* – M1-M48 (HZB)

- Establish characteristics and performance of FE-FRT ferroelectric material at frequencies ≥ 1300 MHz.
- Design, fabricate and validate an FE-FRT for *microphonics suppression* on a single-cell 1.3 GHz cavity.
- Design, fabricate and validate an FE-FRT for *multi-cell cavity at 1300 MHz*, in a cryomodule-like setup.

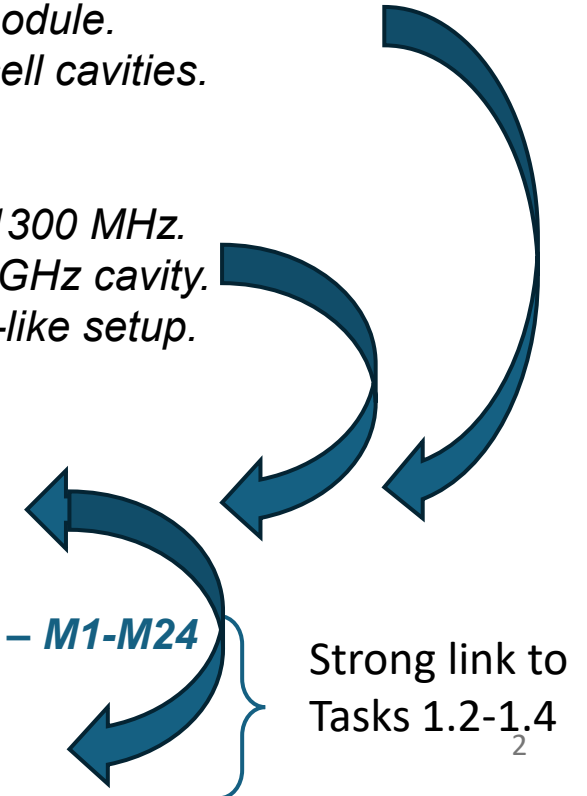
Task 1.4: FE-FRT in Energy-Recovery LINAC (ERL) mode – M1-M48 (CNRS)

- End-group design study for integration into ERL-type cavity, study *HOM+BBU* properties.
- FE-FRT design study for *RF and mechanical integration into upgraded ERL* cavity.

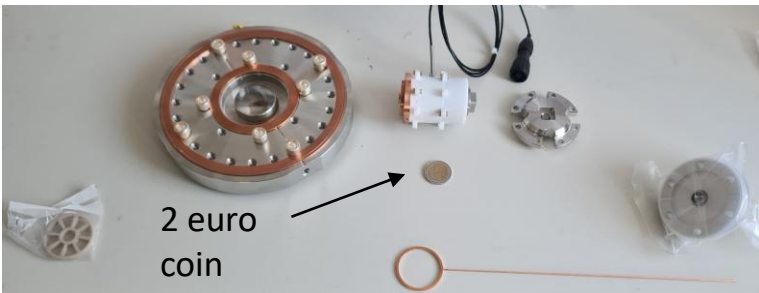
Task 6.2: Retrofitting Fast Reactive Tuners into existing cryomodules HL-LHC oriented – M1-M24

- Study of frequency domain multiplexor-based HOM coupler
- Study the effect of *HOMs on FE-FRT* operation to define max leakage
- Study the heating due to high fundamental power in the coupler

- Task 2.4 **Integrated LLRF control using FE-FRT**
- Task 3.3 **RF tunability**, FE-FRT for Nb3SN coated cavities?



- **Which companies are you collaborating with outside iSAS?**
 - Two tasks within iSAS WP1 are currently developing a product:
 - Task 1.2 FE-FRT to compensate transient beam-loading effects and Task 1.3 FE-FRT to compensate microphonics
 - In Task 1.2 CERN mostly manufactures components within the CERN workshop or mid-size business on contract/order basis
 - In Task 1.3 HZB very similar: Components and tasks are given to small or mid-size companies on an order basis



- Main issue is the ceramics: Exclusively manufactured and delivered by Euclid Techlabs (also including pretreatment)
- Treatment of ceramics, e.g. waterjet cutting, eventually magnetron sputtering done within labs or again on contract basis



CERN polished ring



HZB ring after waterjet cutting



HZB's polishing setup



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- **Some companies might have an interest in iSAS and which ones?**
 - Currently we do not have any company beyond Euclid Techlabs being interested being part of iSAS
 - The iFAST follow-up program (EPITA) comes with two FE-FRT related projects:
 - FE-FRT for transient beam-loading compensation for smaller storage rings (lightsources)
Here, Vitave Tech (Czech Republic) is joining to develop fast switching HV sources
 - FE-FRT to stabilize magnetrons as RF amplifiers: Some companies might have interest
 - There needs to be a larger market for FE-FRT related work and products, before more companies might join, i.e. an higher TRL is required

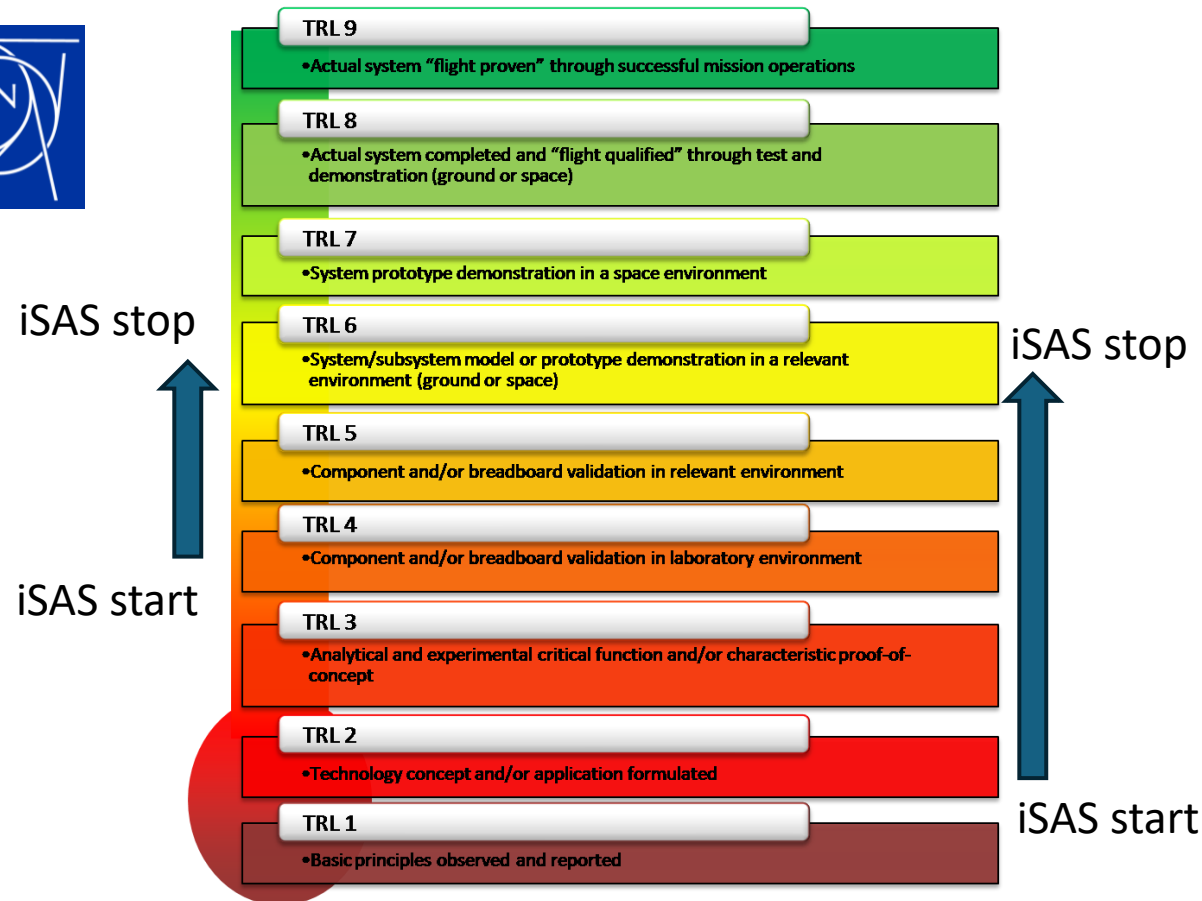


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- Please identify at least 3 points in the development you are facing where you think you need support from industry
 - Discuss integration of FE-FRT within cryo-modules, once an high enough TRL is reached e.g. aiming for $TRL \geq 6$ (beyond iSAS)
 - Survey of other suitable material as ferroelectrics for FRTs
 - Applications beyond iSAS: Faster switching HV sources
 - Treatment, machining, cutting, polishing, coating of FE ceramics (already on-going with Euclid, CERN, local companies)

- How do you estimate your current TRL and so you foresee a reduction from your planned TRL?

CERN



HZB Helmholtz Zentrum Berlin

iSAS stop

New concepts



iSAS start