



Mid-Term Review

European Commission, Brussels, Belgium

Presented by: Jean-François Croteau (ESR 9, WP 3), 10 December 2018

ESR 9, WP 3 - Background

University studies:

B.A.Sc. Mechanical Engineering with Option
in Management (2012-2017)



uOttawa

M. Eng Mining and Materials Engineering
(2017-2018) (early termination to start PhD)



McGill

Work experience:

Research in mechanical and materials engineering

Project management on a construction site

Software engineering for the fabrication of aircraft simulators



Public Works and
Government Services
Canada

Travaux publics et
Services gouvernementaux
Canada

ESR 9, WP 3 – Current ESR Position

PhD Title: High velocity forming of superconducting structures with bulk Nb and Cu substrate

Contract start date: 01 March, 2018

Host institute: I-Cube Research, Toulouse, France

EASITrain industry supervisor: Elisa Cantergiani



PhD University: ENSTA Bretagne, Brest, France

EASITrain university supervisor: Nicolas Jacques



ESR 9, WP 3 - Secondments

1. Michigan State University and Arizona State University

Mechanical characterization of niobium single crystals

Early 2019, 2-4 weeks



2. Politecnico di Torino

Mechanical characterization of copper at high strain rates

Mid 2019, 2 to 3 weeks



3. CERN

Characterization of Cu after deformations at high strain rate

Mid to late 2019, up to 1 month



4. Istituto Nazionale di Fisica Nucleare (INFN) LNL

Surface preparation and RF performance measurements of 6 GHz cavities

2020, up to 1 month



Role in the Project & Objectives

Role

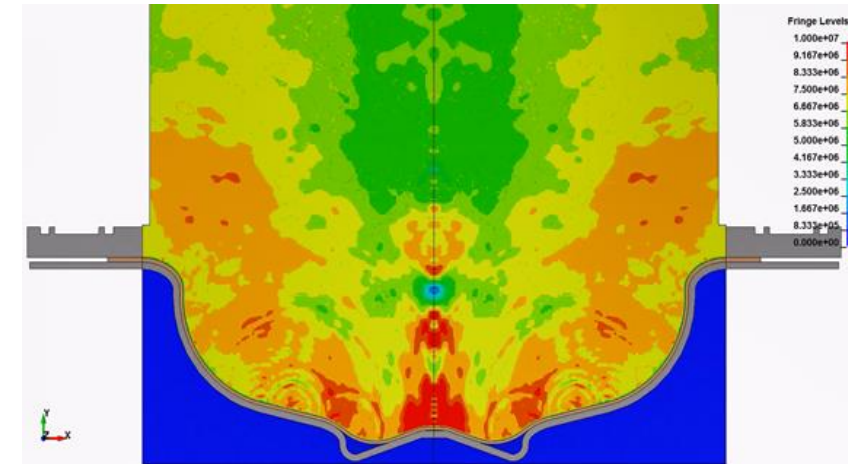
- Forming of substrate in copper and niobium with a novel technique, electrohydraulic forming, and characterization of the microstructural properties of both materials
- Fabrication of seamless cavities in copper

Objectives

- Successfully complete the abovementioned tasks
- Completion of my PhD in the 3-year timeframe of the grant agreement
- Develop non-technical and transferable skills, mostly in management related fields, for my future career

Methodology

1. Characterization of the mechanical properties of copper and niobium at low and high strain rates
2. Use properties for numerical modelling to propose a forming methodology for seamless cavities
3. Build setup to form seamless cavities
4. Analyse the microstructure of copper and niobium following high strain rate deformation to identify the dominant deformation mechanisms

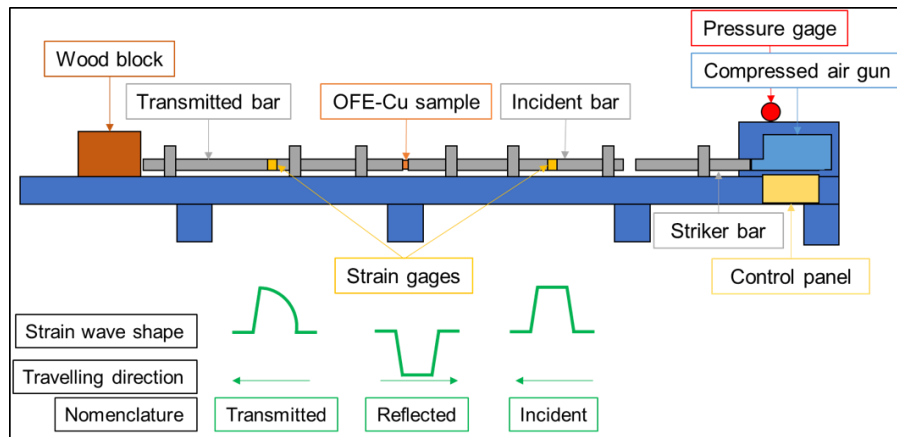


Finite element analysis model used to determine the forming procedure of half-cells



Results

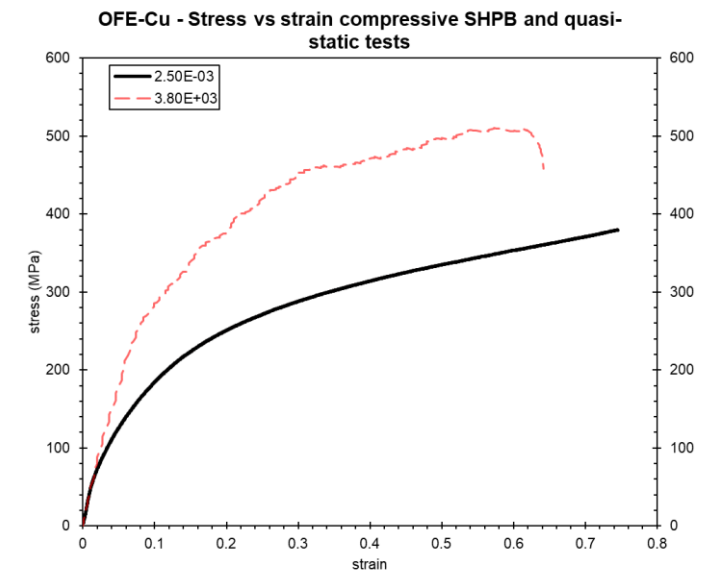
- Characterization of copper at low and high strain rates in compression



Schematic of the split Hopkinson compression system used for tests at high strain rates



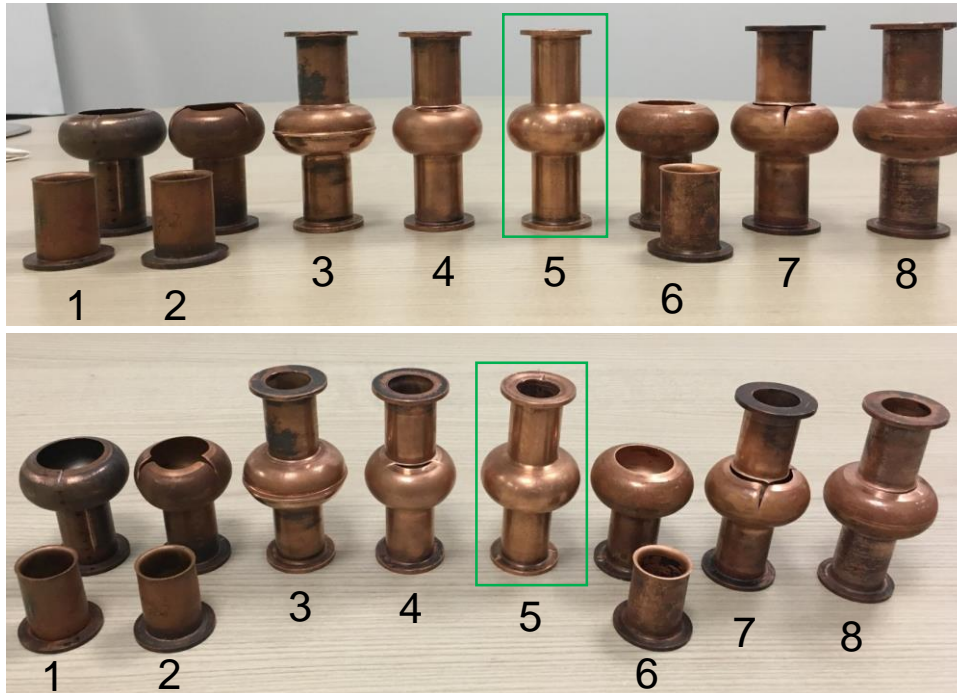
Picture of the instrument used for the quasi-static compression tests (note that the specimen holders were different)



Difference in mechanical properties at low and high strain rates

Results

- Fabrication of seamless cavities with a first methodology at low strain rate

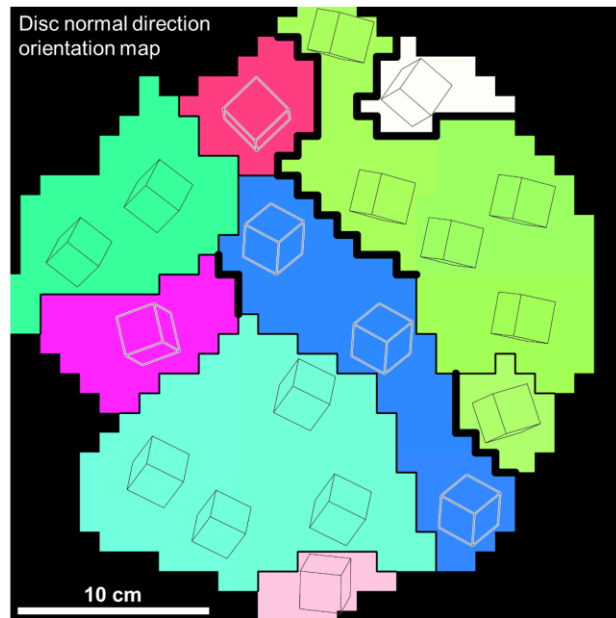


Fabrication of a 6 GHz seamless cavity using a low strain rate methodology that can be adapted to include an electrohydraulic forming step

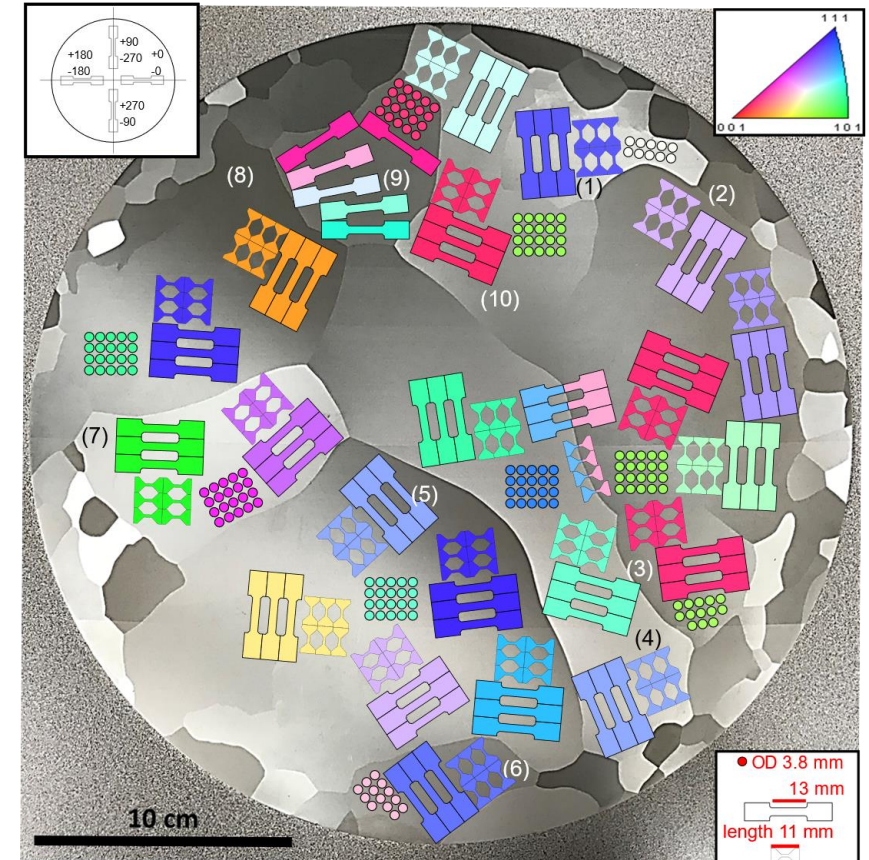
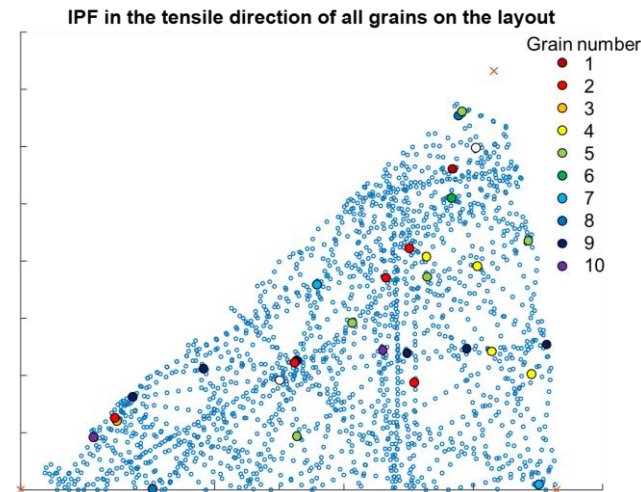


Results

- Characterization of the orientations of single crystals in a niobium disk and preparation of a layout with tensile orientations of interest for mechanical tests



Measurement of the crystal orientation in each grain



Proposed layouts for tensile tests at low and high strain rates to be performed in 2019 during a secondment at Michigan State University and Arizona State University.





Next Steps

- Characterization of copper at high strain rates in tension (early 2019)
- Characterization of niobium at high strain rate in compression and tension (early 2019)
- Experimental and numerical work on forming limit diagrams (FLD) for Cu and Nb (mid 2019)
- Propose a second forming approach to form seamless cavities at high strain rates (end of 2019)
- Collaboration with the INFN LNL for coating and performance measurement of seamless cavity formed at I-Cube (2020)



General Trainings

- Media training at Terra Mater in Vienna during the EASISchool 1
- Multiple health and safety trainings regarding working with high voltage, working with hydrofluoric acid and general practices in a laboratory

Scientific Training

- Numerical modeling of electromagnetic, solid and fluids using the LS-DYNA software



Group photo at the Terra Mater studio following the media training

Workshops

- The 8th International Workshop on Thin Films and New Ideas for Pushing the Limits of RF Superconductivity, Legnaro Italy, October 2018

Attended EASITrain events

- CERN initial training, Geneva Switzerland, March 2018
- EASISchool 1, Vienna Austria, September 2018



Group visit of the MedAustron facility during EASISchool 1



Myself presenting at the workshop hosted by the INFN LNL

Conferences

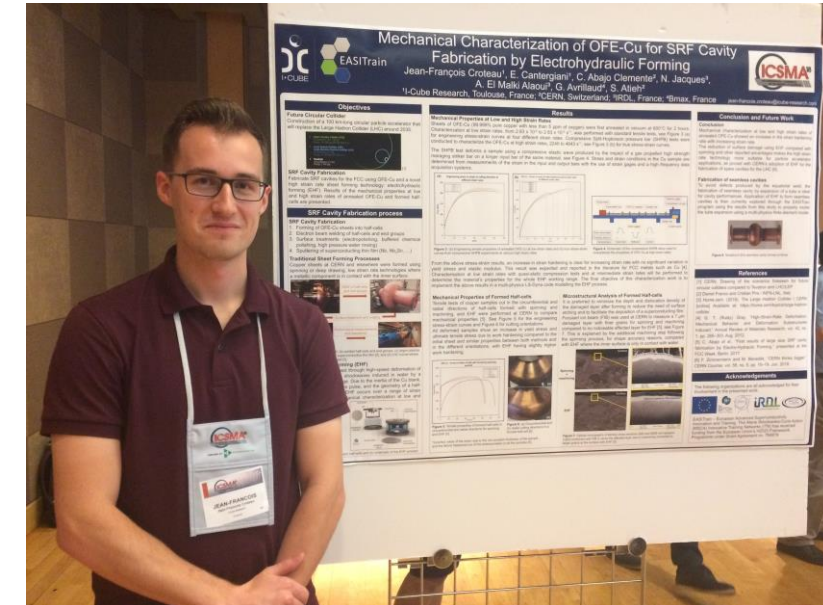
- Future Circular Collider (FCC) Week 2018, Amsterdam Netherlands, April 2018
- EuroScience Open Forum (ESOF) 2018, Toulouse France, July 2018
- International Conference on the Strength of Materials (ICSMA18), Columbus United States, July 2018



Myself presenting at the FCC Week 2018 conference in Amsterdam



Group of panelists at the ESOF 2018 conference in Toulouse



Myself with the poster I presented at the ICSMA18 conference in Columbus

Outreach activities

- ESOF 2018 as a panelist talking about the role of EASITrain in the FCC collaboration to an audience of scientists and non-scientists
- Planning to visit high school physics next year, back in Canada, to present the FCC and most importantly the possibility as future scientists and engineers to work in European projects

Dissemination activities

- **Presentations:** FCC Week 2018 and 8th international thin film workshop at the INFN LNL
- **Poster:** ICSMA18

Networking activities

- Initial training at CERN where I met the manufacturing group with whom I am collaborating
- FCC week to meet researchers in the SRF community from different nations
- ICSMA18 to meet experts in dislocation theories, an essential part of my work for material characterization
- ESOF 2018 where I met colleagues involved in the FCC from research institutes and private companies
- Thin film workshop at the INFN Legnaro to present our technology to the SRF community and to discuss with authors of important work in the field of SRF cavities

- Fabrication of seamless cavities with a new technique that is preferred for the microstructure of the cavities. This could increase the performances of the cavities, which is essential for higher energy collisions
- The society will indirectly benefit by an increased knowledge in EHF which is used for other products, such as lighter and thus more environmentally friendly car components
- Impact on me and my career
 - Exposure to students from different countries and learning from experienced researchers at the various workshops and trainings
 - Opportunity to work in a research environment, inside a private company
 - Participation in different workshops and conferences where I grow my network of researchers and have the chance to present my work

Conclusion

- 9 months completed out of a total of 36 (25%)
 - Technical skills acquired during 2018 to successfully perform multiphysics simulations
 - Few results on the compressive properties of copper at high strain rates
- Most of the work completed this year is in preparation of tests starting next year
- Results of next year's tests will be presented in conferences
- Outreach activity in high-school around 2020

The background is a blurred image of a high-speed train, likely a TGV, moving from left to right. The train is white with blue and red accents. A large, golden, cylindrical object, possibly a particle detector component, is mounted on the side of the train. The background is a clear blue sky.

Thank you for your attention

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