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# Cryogenic and thermal properties of superconducting magnet coils

COMMISSARIAT À L'ÉNERGIE ATOMIQUE (CEA - DACM)

UNIVERSITÉ PARIS-SACLAY

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ESR3 – WP4 Cryogenics

**EASITrain - FCC Week 2018**



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# Outline

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1. Research topic description

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  2. Work plan

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  3. Challenges

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  4. Status

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Research  
topic  
description

- **Title:** Cryogenic and thermal properties of superconducting magnet coils

Work plan

- **Main objectives:**

1. Understanding the thermal phenomena in superfluid helium in micro-channels
2. Achieving improved cryogenic design of magnet coils

Challenges

- **Task:** Study of heat and mass transfer in superfluid helium in confined geometries

Status



# 1. Heat transfer in accelerators magnets

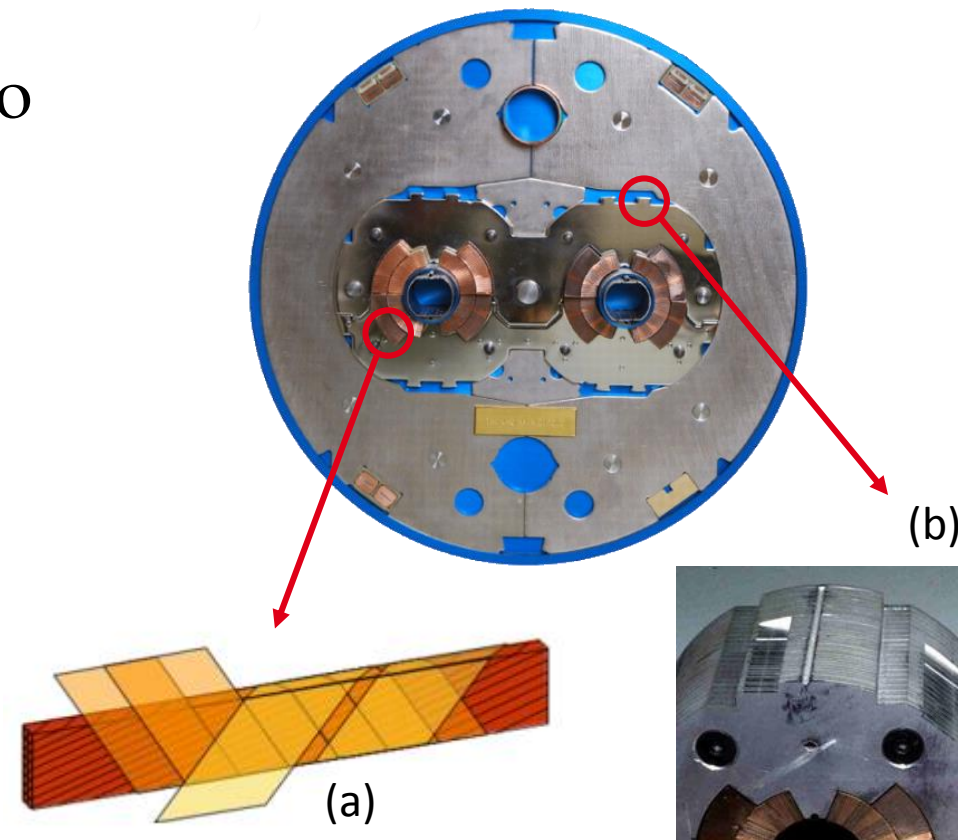
Research  
topic  
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Work plan

Challenges

Status

- Magnet cooling is ensured by **He II** to maintain the SC state against generated or deposited heat loads
- Confined geometries constitutes the highest thermal barrier for cooling:
  - Cable electrical **insulation** (a)
  - Space between steel **collars** (b)



DOI: 10.1098/rsta.2011.0453

# 2. Magnet quench and phase transition

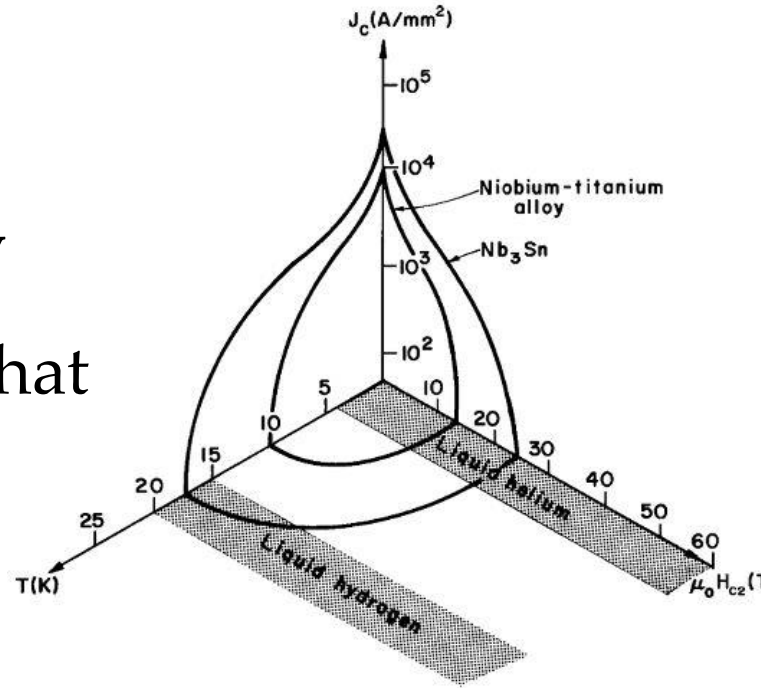
Research topic description

Work plan

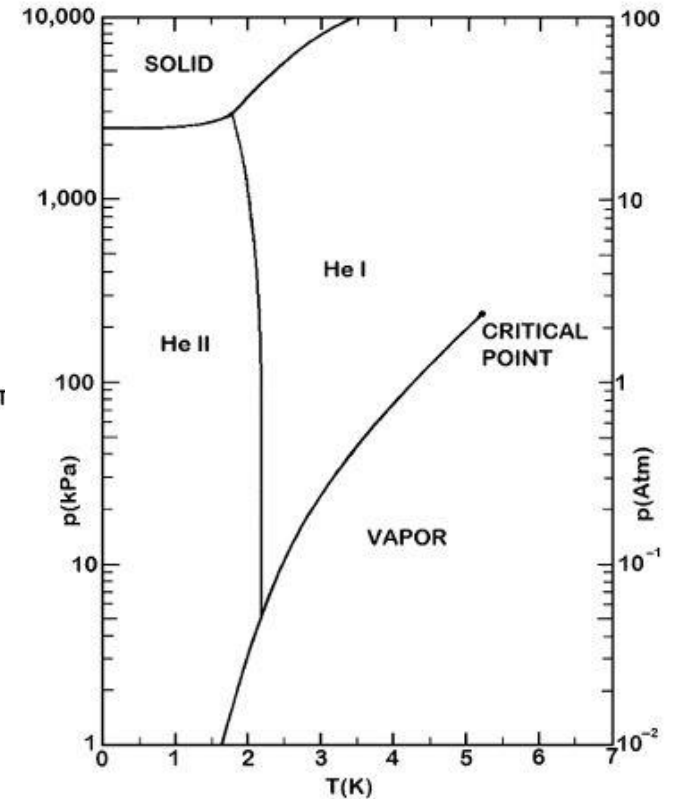
Challenges

Status

- During magnet quenches the **energy dissipation** is such that helium undergoes phase transitions
- Diverse transient phenomena arise under He phase change



DOI: 10.1007/978-1-4419-9979-5



# Experimental work

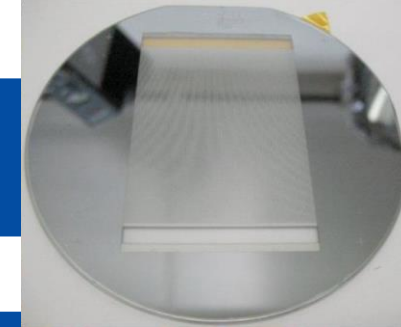
Research  
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Work plan

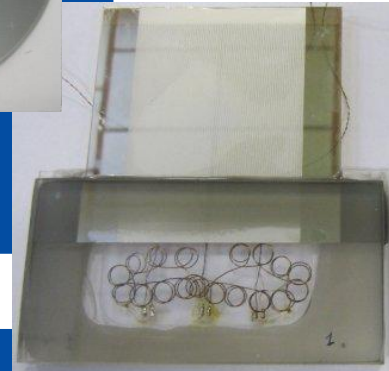
Challenges

Status

1. Identification of required tools



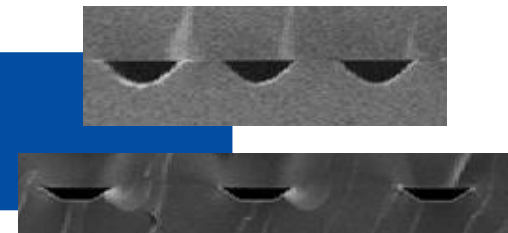
2. Assembly of the experimental setup



3. Thermal measurements in channel geometries

10.1063/1.4706925

4. Development of new micro-size channels



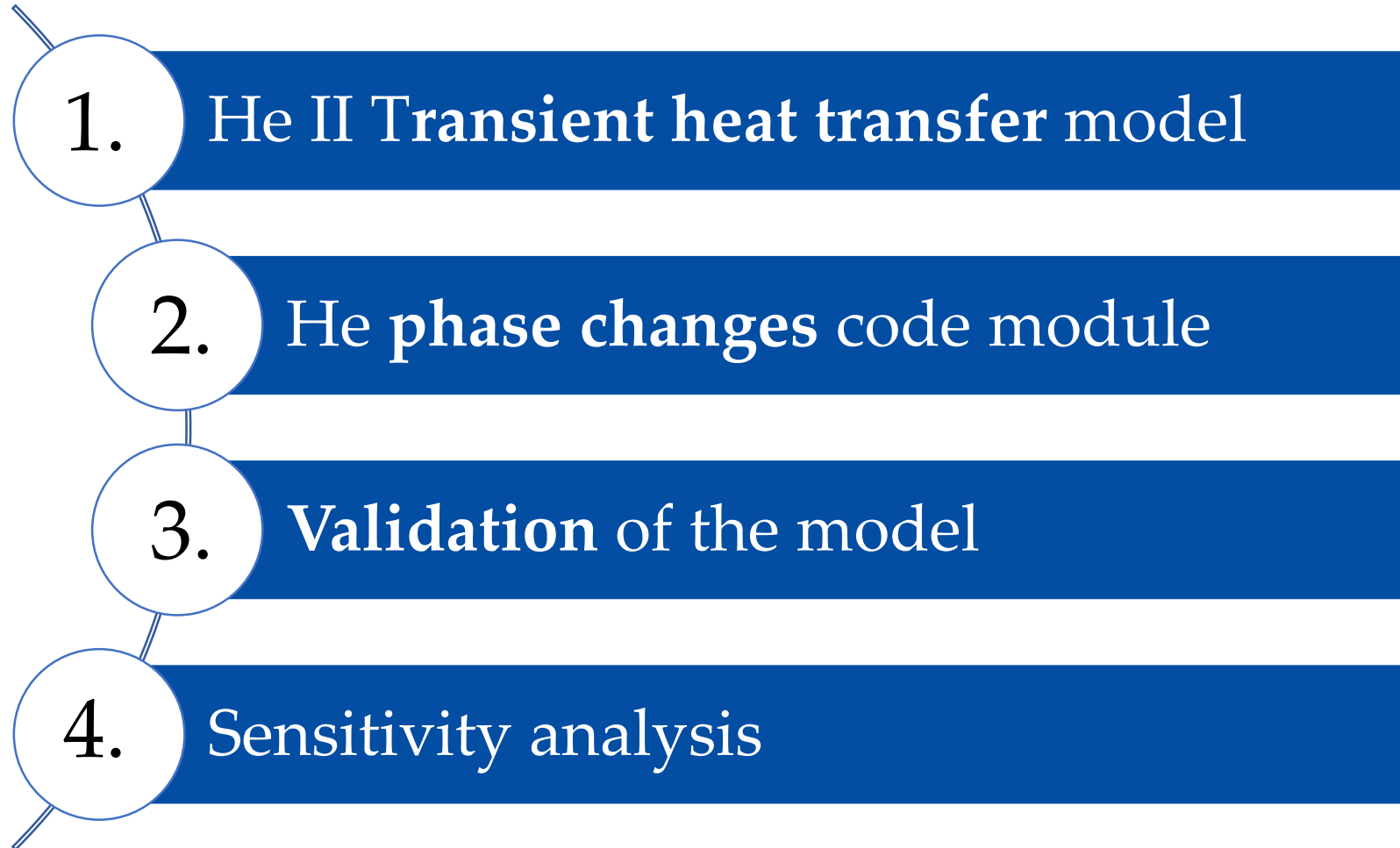
# Numerical work

Research  
topic  
description

Work plan

Challenges

Status



OpenFOAM  
The Open Source CFD Toolbox

ANSYS<sup>®</sup>  
FLUENT<sup>®</sup>

MATLAB<sup>®</sup>



# Challenges

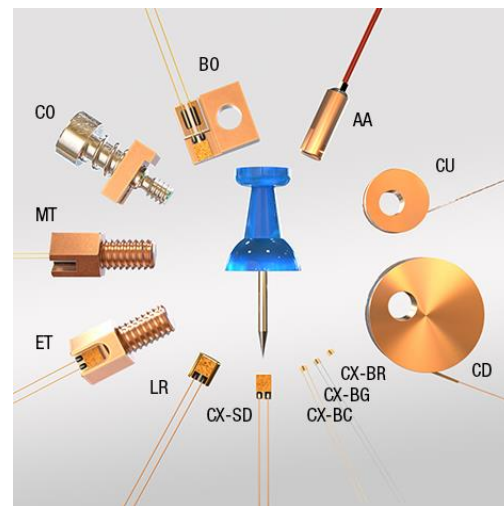
Research topic description

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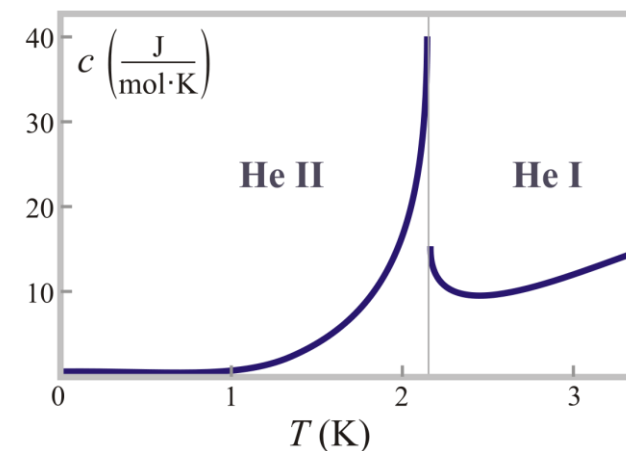
Challenges

Status

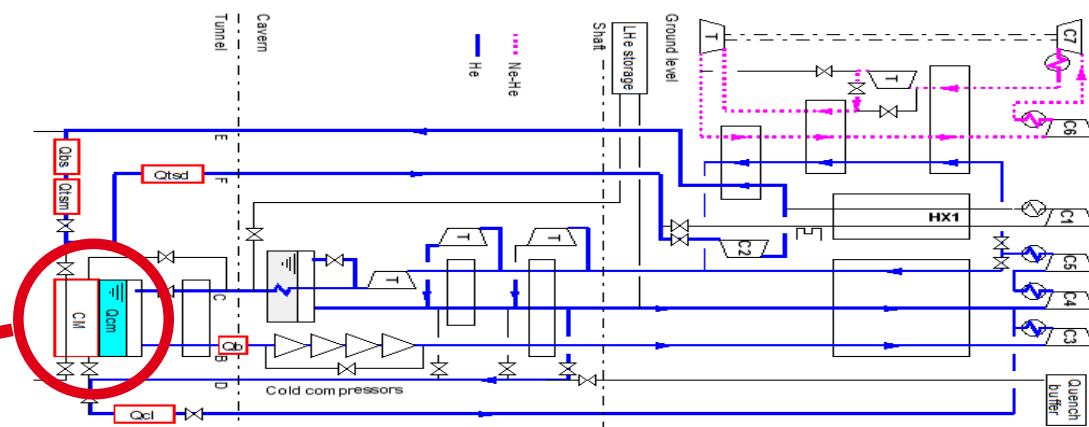
- Experimental challenge: thermal probe accuracy
- Modelling challenge:
  - 2<sup>nd</sup> order phase change
  - integration of the tool with an overall cryogenic system



Cernox®



[https://en.wikipedia.org/wiki/Lambda\\_point](https://en.wikipedia.org/wiki/Lambda_point)



L. Tavian – Cryogenic cycle design

**ESR3**



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Literature review

Experimental apparatus and materials

Numerical software

Work in progress...



# Thank you for your attention



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