Discussion groups

- Objective:
  - State-of-the-art?
  - What is missing/needed in the short term?
  - Which benchmarks would help in stimulating this?
  - etc.

Discussion groups

- Group 1: Fundamental aspects/physics (A. Campbell/A. Sanchez)
  - 3D, cross-field effects, etc.
- Group 2: Tapes, cables and coils (F. Gömöry)
  - Multi-filamentary tapes and coils, etc.
- Group 3: Multiphysics and multiscale (P. Masson)
  - Magnets, quench, thermo-mechanical, etc.
- Group 4: Mathematical and software tools (F. Sirois)
  - Vision for near future developments
  - Formulations/numerical methods

Group 1

- Fundamental aspects/physics (A. Campbell/A. Sanchez)

Discussion group “Fundamentals”
HTS Modelling, Bologna, 17 June 2016

7 participants; discussion led by A. Campbell and summarized by A. Sanchez

Few problems were identified as open questions related to fundamental problems. They are briefly described in the following slides

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3D critical state cross-field effects, etc

- The problem when **E** is not parallel to **J** is still open in general.
- Some attempts such as the double critical-state do not seem to be a valid solution.
- It would be worth to explore approaches such as that of Badia and Lopez.
- Experiments like that performed by John Durrell and colleagues on SC films with in-plane magnetic field seem to be a good way to explore the problem

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Need to explore deeply the connections between Josephson Junction (JJ) and CSM communities

- A question was asked as if chaotic solutions could occur in CSM approximation, as happen in JJAs. It was commented that probably, things are smeared up on CSM, and thus prevent chaos.

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Time dependence of the remanent magnetization in SC bulks

- The experimental finding of a plateau appearing for few minutes after magnetizating a SC bulk need to be explained by theory.

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Relation between Ginzburg-Landau and CSM approximations

- It would be interesting to do calculations based on G-L formalism to try to recover the CSM limit, for the case of a certain number of flux lines.

Group 2

- Tapes, cables and coils (F. Gömöry)

Discussion group “Tapes, Cables, Coils”
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~10 participants

topics discussed:

- computation speed
- data on material properties
- exchange of codes
- benchmark

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computation speed:
not a big issue in a general purpose modelling
recommended to look for the remedies developed

- effective turns instead of real turns
- modified aspect ratio for CC tapes (e.g. 10 μm SC)
- simultaneous computations (instead of parallel programming)

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data on materials properties:
big issue in the practical use of modelling
would be nice to have a materials properties database
- not easy also because standard procedures for e.g. I_c determination still missing
- some labs have lot of data, maybe before starting a measurement ask colleagues if they would provide it for free

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exchange of codes:
not exploited enough
- should be easy with free codes
- should be even easier between users of the same commercial code

benchmark:
could be the magnetization of 10-tapes stack

Group 3

- Multiphysics and multiscale (P. Masson)

Summary to come

Group 4

- Mathematical and software tools (F. Sirois)

State-of-the-art

- Approaches/methods
  - Analytical
    - New formula once in a while
    - Hard to push this further for complex problems
  - FEM/BEM
    - Trend to move towards open-source software
      - Although more and more possibilities exist in commercial softwares
    - Much work done to reduce computational load (homogenization, 2.5-D, etc.)
    - Should move towards modern formulations? (cohomology, etc.)
    - PGD/POD?
    - Better use adaptivity (space and time)

State-of-the-art

- Approaches/methods
  - Integral
    - Traditional way not scalable
    - Fast multi-pole methods
    - New approaches: re-cast as circuit equations (face elements, generalized PEEC)
  - Variational method/integral
    - Should become more widely available / open source or integration in commercial codes
    - Mixed formulations (solve for both J and E for better control on error)
  - Circuit equations
    - Could be interesting (see integral methods)
  - Mesh-less methods? Not much explored

State-of-the-art

- Things to always keep in mind:
  - Follow evolution of hardware
  - Parallelization/hardware acceleration
  - Methods should allow easy coupling with other physics
    - Too specialized tools are quickly limited
  - Compatible with 3-D problems
  - Better documentation of open-source codes?
  - Must be able to take into account statistical fluctuations in materials properties
  - Better coupling with experts in numerical analysis

Benchmark?

- Not enough time to identify something