



4th STEAM Collaboration Meeting - Intro

B. Auchmann, 21.09.2017



TECHNISCHE
UNIVERSITÄT
DARMSTADT



TAMPERE
UNIVERSITY OF
TECHNOLOGY



Previous STEAM Meetings

1. (COMPUMAG 2013, Budapest)
2. 18. -19. Aug. 2014 @ TEMF
3. 13.-14. Jan. 2016 @ CERN
4. 29.-30. Nov. 2016 @ PSI
5. 21.-22. Sep. 2017 @ TEMF



TECHNISCHE
UNIVERSITÄT
DARMSTADT

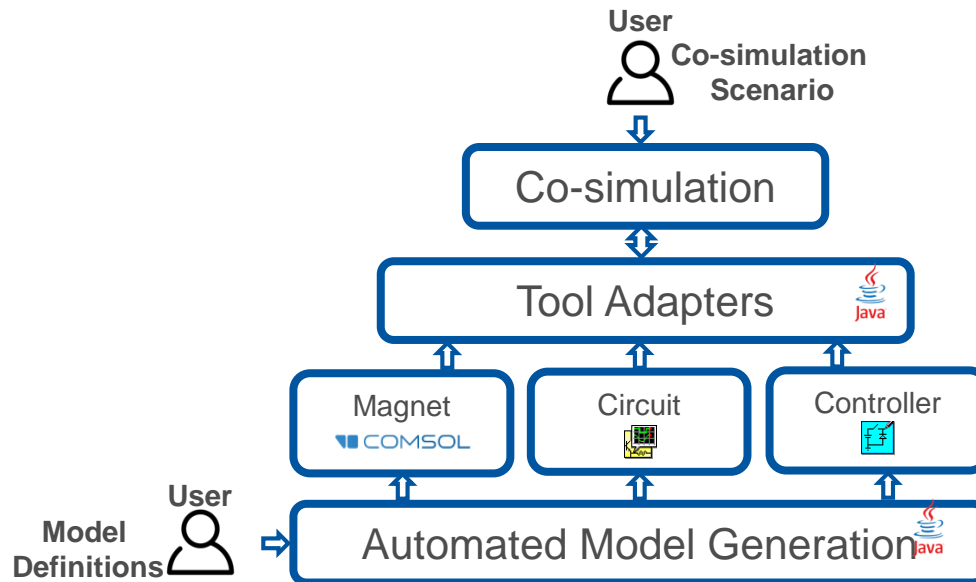


TAMPERE
UNIVERSITY OF
TECHNOLOGY



What is STEAM?

- The **STEAM** project is driven by accelerator-specific needs.
- We harness the power of co-simulation with waveform relaxation to provide a new level of flexibility in tackling complex interdependent problems.
- The framework is used in the analysis of LHC operation data, the design of the HL-LHC upgrade, and the Future Circular Collider study.



What is the goal of STEAM?

Be among the world-wide Top-3 in quench simulation after 2 years (HdG, collab. mtg., Jan. '16)

Show that the invested resources pay off by attracting users in- and outside CERN (A. Siemko @ MT-25 '17)

Multi- (rate, scale, physics, domain) coupling for the accelerator community (BA @ COMPUMAG '17)

Enable ourselves to fulfill our mission, i.e., analyzing the LHC circuit behavior and future helping to design future projects (HL-LHC, FCC) (BA @ CERN '13)



TECHNISCHE
UNIVERSITÄT
DARMSTADT



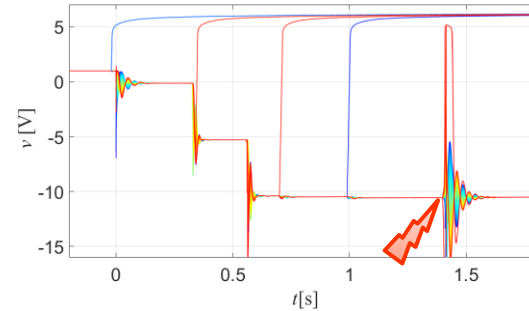
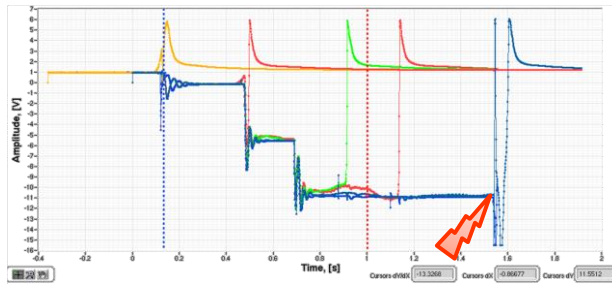
TAMPERE
UNIVERSITY OF
TECHNOLOGY



What STEAM has been used for so far ...

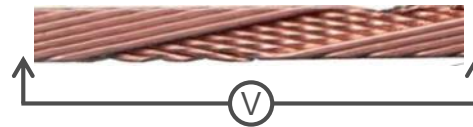
1. Transient simulations by a single tool

Ground fault localization in LHC MB circuit. Use of Spice model generator. See M. Prioli talk.

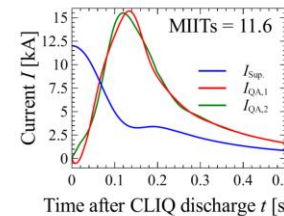
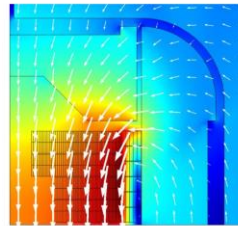
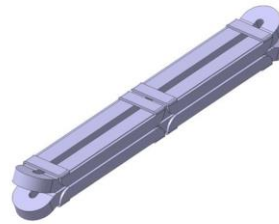


LHC

Busbar protection by means of 1-D COMSOL electro-thermal model. A. Fernandez.



Quench absorption coils, use of COMSOL model generator. See M. Mentink talk.



What STEAM has been used for so far ...

1. Transient simulations by a single tool

FCC magnet protection: electro-thermal & mechanical coupling in COMSOL.
Use of COMSOL model generator. See T. Salmi's talk.

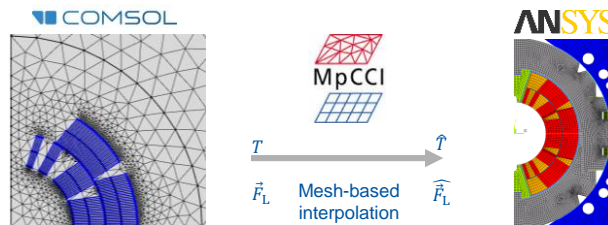


HL-LHC beam-screen design: magnetic & mechanical in COMSOL.
Use of COMSOL model generator. S-Team.



2. Sequential coupling

HL-LHC 11-T magnet: Mesh-based coupling with MpCCI, see M. Maciejewski talk.



Effects of spurious heater- or CLIQ-firing on the beam. COMSOL-MAD-X coupling via field maps.

LHC



What STEAM has been used for so far ...

3. Controller / Circuit Coupling

11-T in RB circuit; power-converter controller design verification by means of PSim – PSpice cosimulation.



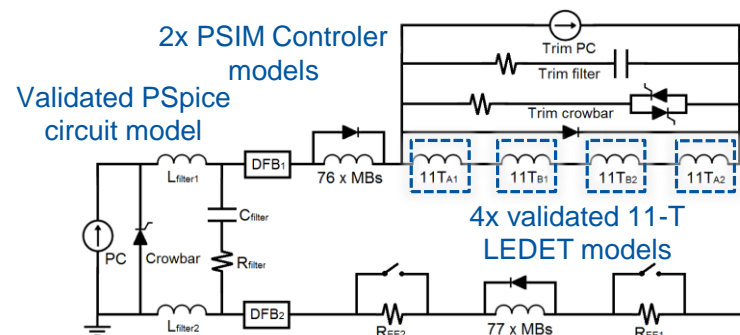
4. Field / Circuit Coupling

CLIQ simulations for FCC, PSpice – LEDET / COMSOL cosimulation. See M. Prioli and T. Salmi talks.



5. Multi-field / Circuit Coupling

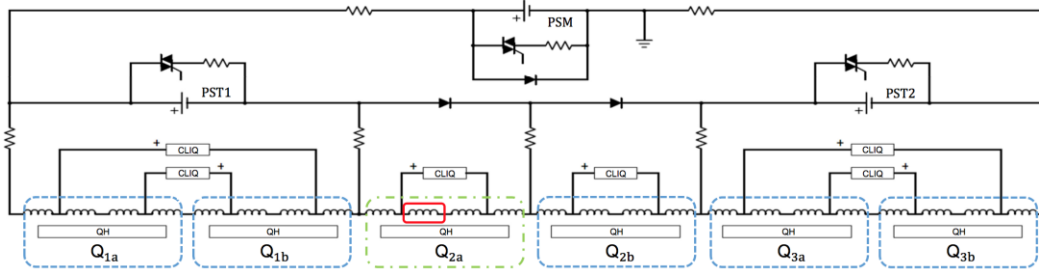
11-T in RB circuit: 4x LEDET in PSpice circuit. A. Fernandez.



What STEAM has been used for so far ...

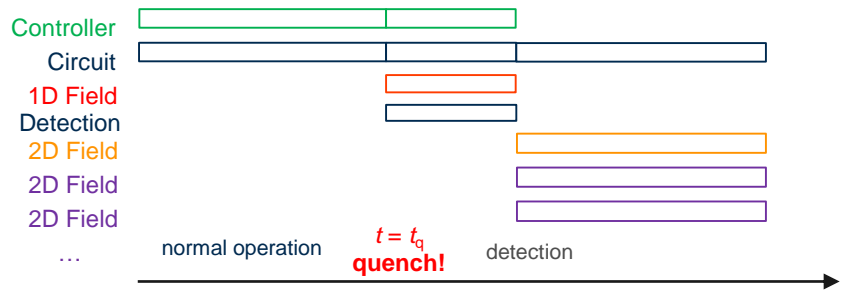
5. Multi-field / Circuit Coupling

HL-LHC triplet circuit, 6x LEDET and PSpice. See M. Mentink talk.



6. Hierarchical Cosimulation Hullabaloo

Presentation at MT-25: *The term 'Hullabaloo' is still used in Indian English to describe a type of public demonstration, involving making a great noise. (Wikipedia)*



Where to go from here ...

- *We harness the power of cosimulation ... to provide a new level of flexibility in tackling complex interdependent problems. This vision has become a reality!*
- We are certainly among the Top-3 in quench simulation, but we can and must improve in numerous areas:
 - **Applications:** new in HL-LHC: electron-lense solenoids, short correctors.
 - **Tools:** add QLasas, release COMSOL 2D and 1D, add ANSYS, GetDP, TUT materials, TUT tools, TEMF electro-thermal FEM, CERN "quench", improved detection, HW in the loop, ...
 - **Model generators:** more numerous tool alternatives call for stream-lined input.
 - **User experience:** GUI for standard workflows, documentation,
 - **Validation:** improve modeling through continuous comparison with measurements.
 - **Performance computing:** parallelization in algorithms, space, time, phys. domains
 - **Theory:** automatic window size, execution order, and coupling algorithm; graphical bond-graph representation, improved hierarchical modeling, enabling in-iteration model switch, in-time-window state change, ...
 - **Users:** extend user base in- and outside CERN (CERN TE-MS, CIEMAT, ...)
 - **Funding:** continue to apply for funding for participating univ. institutes.



TECHNISCHE
UNIVERSITÄT
DARMSTADT



TAMPERE
UNIVERSITY OF
TECHNOLOGY





www.cern.ch