



# Status and update from TUT: Quench protection

*What is done, what is ongoing, and the  
plans for the future*

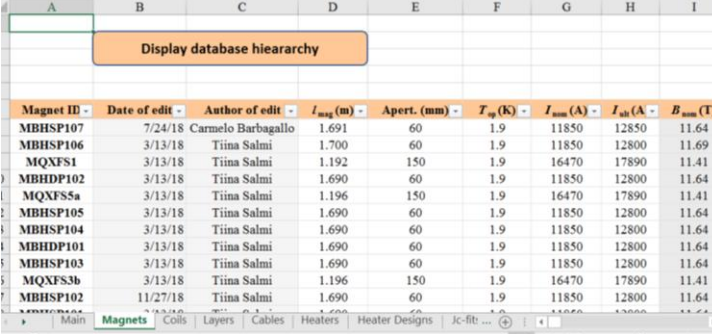
Tiina Salmi, Antti Stenvall

US-EuroCirCol/European meeting 3.12.2018



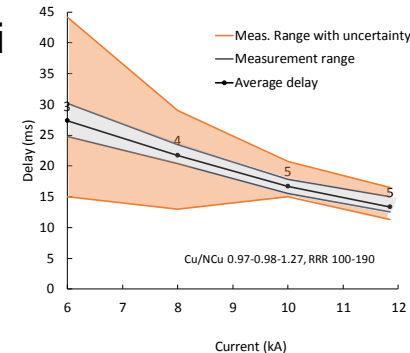
# Ongoing

- **Quench Protection Database (QPDB) project with CERN 2017-2018** (contact person Susana Izquierdo-Bermudez)
- Goals:
  - Development of DB for storage of experimental results
  - Analysis of heater delays and current decays and comparison with simulations
- Status: DB developed together with Timo Tarhasaari (was with TUT), and filled with results from several MQXFS and 11 T models
- Ongoing: Analysis of heater delays: Summaries, general trends, uncertainties



Magnet ID	Date of edit	Author of edit	$I_{mag}$ (m)	Apert. (mm)	$T_{op}$ (K)	$I_{nom}$ (A)	$I_{sh}$ (A)	$B_{nom}$ (T)
MBHSP107	7/24/18	Carmelo Barbagallo	1.691	60	1.9	11850	12850	11.64
MBHSP106	3/13/18	Tiina Salmi	1.700	60	1.9	11850	12800	11.69
MQXFS1	3/13/18	Tiina Salmi	1.192	150	1.9	16470	17890	11.41
MBHDP102	3/13/18	Tiina Salmi	1.690	60	1.9	11850	12800	11.64
MQXFSa	3/13/18	Tiina Salmi	1.196	150	1.9	16470	17890	11.41
MBHSP105	3/13/18	Tiina Salmi	1.690	60	1.9	11850	12800	11.64
MBHSP104	3/13/18	Tiina Salmi	1.690	60	1.9	11850	12800	11.64
MBHDP101	3/13/18	Tiina Salmi	1.690	60	1.9	11850	12800	11.64
MBHSP103	3/13/18	Tiina Salmi	1.690	60	1.9	11850	12800	11.64
MQXFSb	3/13/18	Tiina Salmi	1.196	150	1.9	16470	17890	11.41
MBHSP102	11/27/18	Tiina Salmi	1.690	60	1.9	11850	12800	11.64

*Relational DB built with MS EXCEL, allowing storage of magnet parameters, test set-ups, and test results such as heater delays and current decays. Internal computation of coil Jc, MIITs, and several other parameters.*



*Example of heater delays in 11 T MBHSP105 and MBHSP106 with experimental uncertainty ranges.*

# Plans for future

- January 2019: Quench protection sections for each magnet for FCC CDR
- Tiina: applied 5-year national fellow funding for continuing quench studies of future high field magnets. Willing to collaborate regarding the FCC demo magnets! (Result of the application in May, Let's discuss more)
- Antti: preparing proposal for cloud based database of materials used in superconductor applications (national and EU-level)



# Manufacturing cost modeling approach for 16T dipole arc magnets

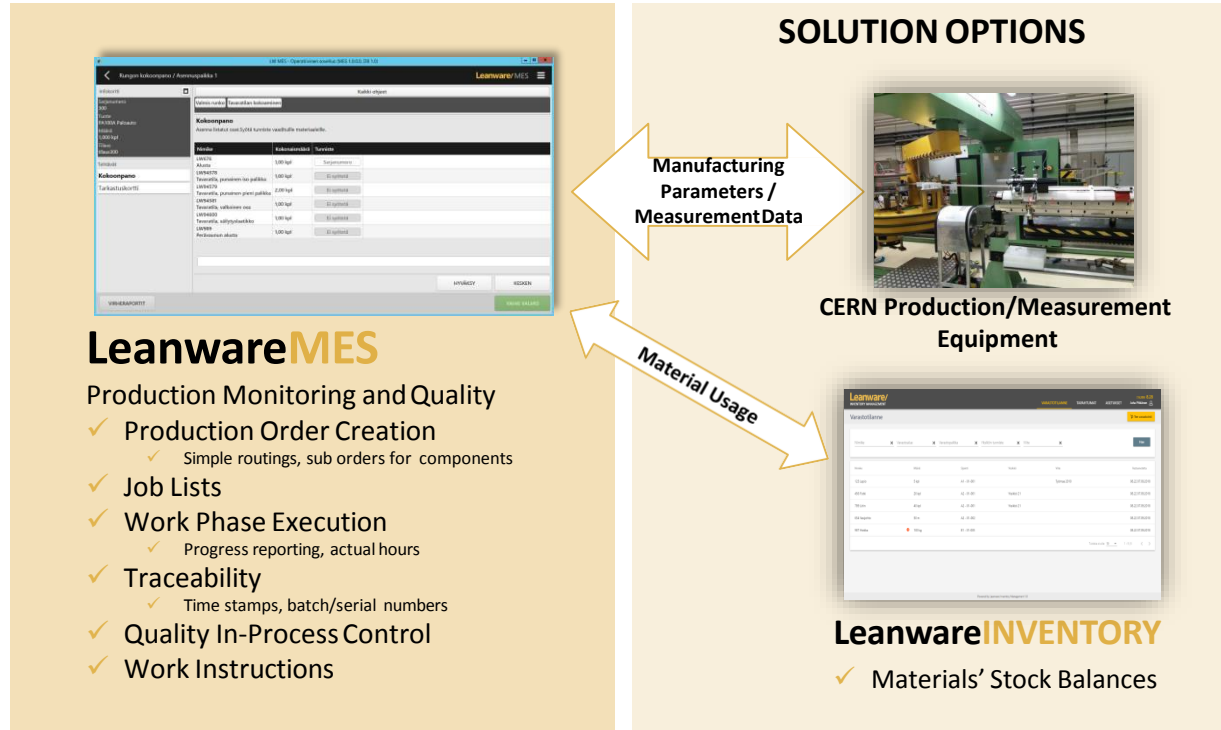
Ananda Chakraborti<sup>[1]</sup>, Suraj Panicker<sup>[1]</sup>, Kari Lyytikäinen<sup>[1]</sup>,  
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# Cost Modeling and Production monitoring Methodology

1. Research is being conducted at Tampere University of Technology to define **performance indicators** for Nb<sub>3</sub>Sn magnet manufacturing and select **key performance indicators** (KPIs) for manufacturing cost and quality
2. Machine learning based techniques are under investigation for selection of KPIs
3. In the following months,
  1. Monitoring of 11T Nb<sub>3</sub>Sn dipole magnet production is planned at Large Magnet Facility in CERN
  2. Production monitoring software known as **Manufacturing Execution System** (MES) will be used for this purpose
  3. MES will provide high degree of visibility of the manufacturing in terms of **tracking and tracing of magnet parts, production scheduling, tracking major tooling and quality management**
4. Tampere University of Technology is working with their industrial partners to prepare a prototype for production monitoring software for 11T Nb<sub>3</sub>Sn dipole magnet production (more dialogue between all parties are needed)

# MES concept for 11T production



# EXAMPLE 1: WORK PHASE EXECUTION

The screenshot displays the 'Assembling / Workstation 1' interface. On the left, a sidebar contains 'Info card', 'Tasks' (with 'ASSEMBLY' selected), and 'Inspection sheet'. The main area shows 'All instructions' with a search bar containing 'Valmis runko' and 'Tavaratilan kokoaminen'. Below this is the 'ASSEMBLY' instruction: 'Assemble listed materials. Insert code for needed materials.' A table lists materials with columns for 'Material', 'Qty', and 'Batch/serial number'. At the bottom, there is a 'Comment' field and buttons for 'ACCEPT TASK', 'UNFINISHED', and 'PHASE READY'. A 'DEFECT REPORTS' button is also visible in the bottom left.

Material	Qty	Batch/serial number
LW676 Alusta	1 kpl	<input type="text" value="Serial number"/>
LW94578 Tavaratila, punainen iso palikka	1 kpl	<input type="button" value="Optional"/>
LW94579 Tavaratila, punainen pieni palikka	2 kpl	<input type="button" value="Optional"/>
LW94581 Tavaratila, valkoinen osa	1 kpl	<input type="button" value="Optional"/>
LW94600 Tavaratila, säilytyslaatikko	1 kpl	<input type="button" value="Optional"/>
LW989 Perävaunun alusta	1 kpl	<input type="button" value="Optional"/>

**Work phase**: Assembling / Workstation 1

**Product and order information**: Serial number AB3456, Product PA100A Paloauto, Quantity 1,000 kpl, Order 123456

**Sub tasks**: ASSEMBLY

**Materials related to the work phase**: LW676 Alusta, LW94578 Tavaratila, punainen iso palikka, LW94579 Tavaratila, punainen pieni palikka, LW94581 Tavaratila, valkoinen osa, LW94600 Tavaratila, säilytyslaatikko, LW989 Perävaunun alusta

**Work instructions**: ASSEMBLY: Assemble listed materials. Insert code for needed materials.

**Batch/serial numbers**: Serial number, Optional

**Progress reporting Actual hours**: PHASE READY



# EXAMPLE 2: TRACEABILITY REPORT

The screenshot shows the Leanware web application interface. The main content area is titled "TRACEABILITY REPORT". A search field contains the batch/serial number "1000456". Below the search field are buttons for "Hae" (Search) and "Tyhjennä" (Clear). A tree view shows the hierarchy: Sarjanro 1000456 (Paloauto) > Eränro 28701 (Tavaralaatikko) > Eränro 453239 (Kans) > Sarjanro 546356 (Hälytysvikku) > Sarjanro 32236 (Paloauton alusta). Below the tree is a table with the following data:

Työvaihe	Tehtävä	Kuitaaja	Aloitettu	Lopetettu
Rungon kokoonpano	Kokoonpano	Leo M	20.12.2016 10:23	20.12.2016 10:30
Rungon kokoonpano	Tarkastuskortti	Leo M	20.12.2016 10:36	20.12.2016 10:45
Varustelu	Kokoonpano	Leo M	20.12.2016 10:36	20.12.2016 10:45
Varustelu	Lopputarkastus	Leo M	20.12.2016 10:36	20.12.2016 10:45

Link to batch/serial no. data in trace batch hierarchy (e.g. 546356)

Time stamps for execution

