3MIS:
a Magnetic Measurement Management and Information System

Eleni Tournaki

on behalf of

the TE-MSC-MM Team

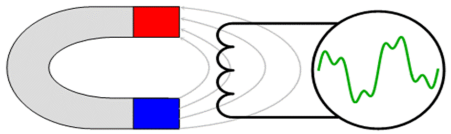
Structure of Presentation

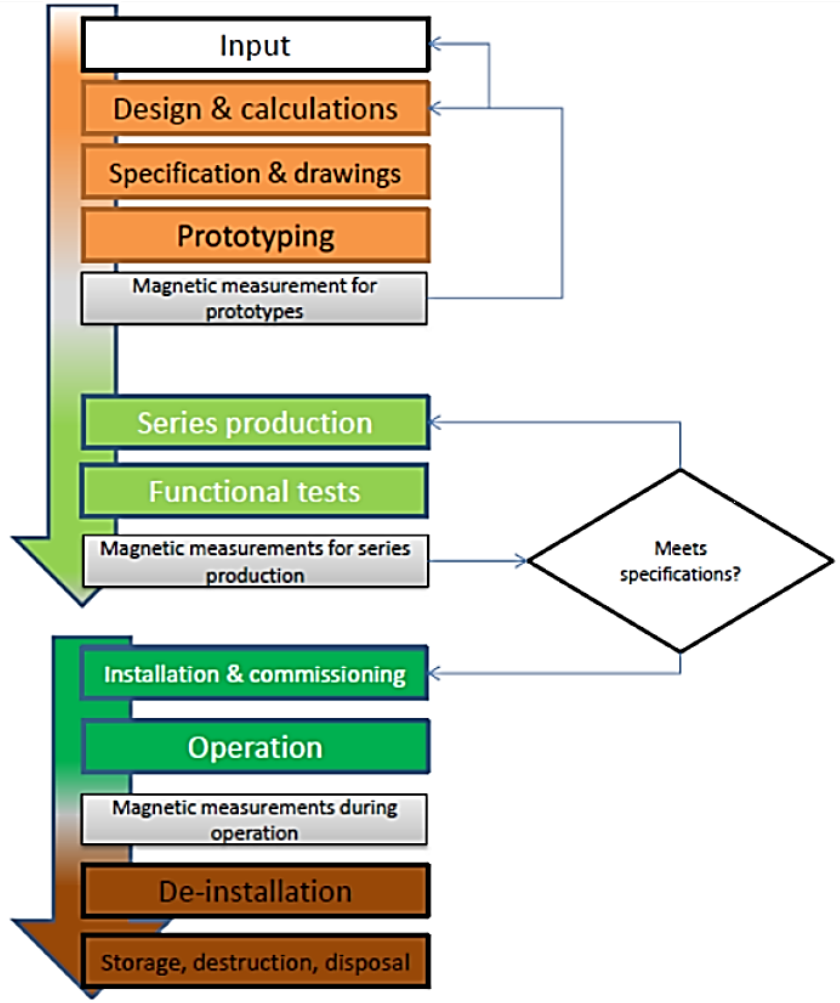
1. Introduction
2. Project Description
3. Implemented Solution: Architecture & Features
4. Benefits
5. Future Road-Map
6. Conclusions

Introduction

Magnetic Measurements (MM) Section:

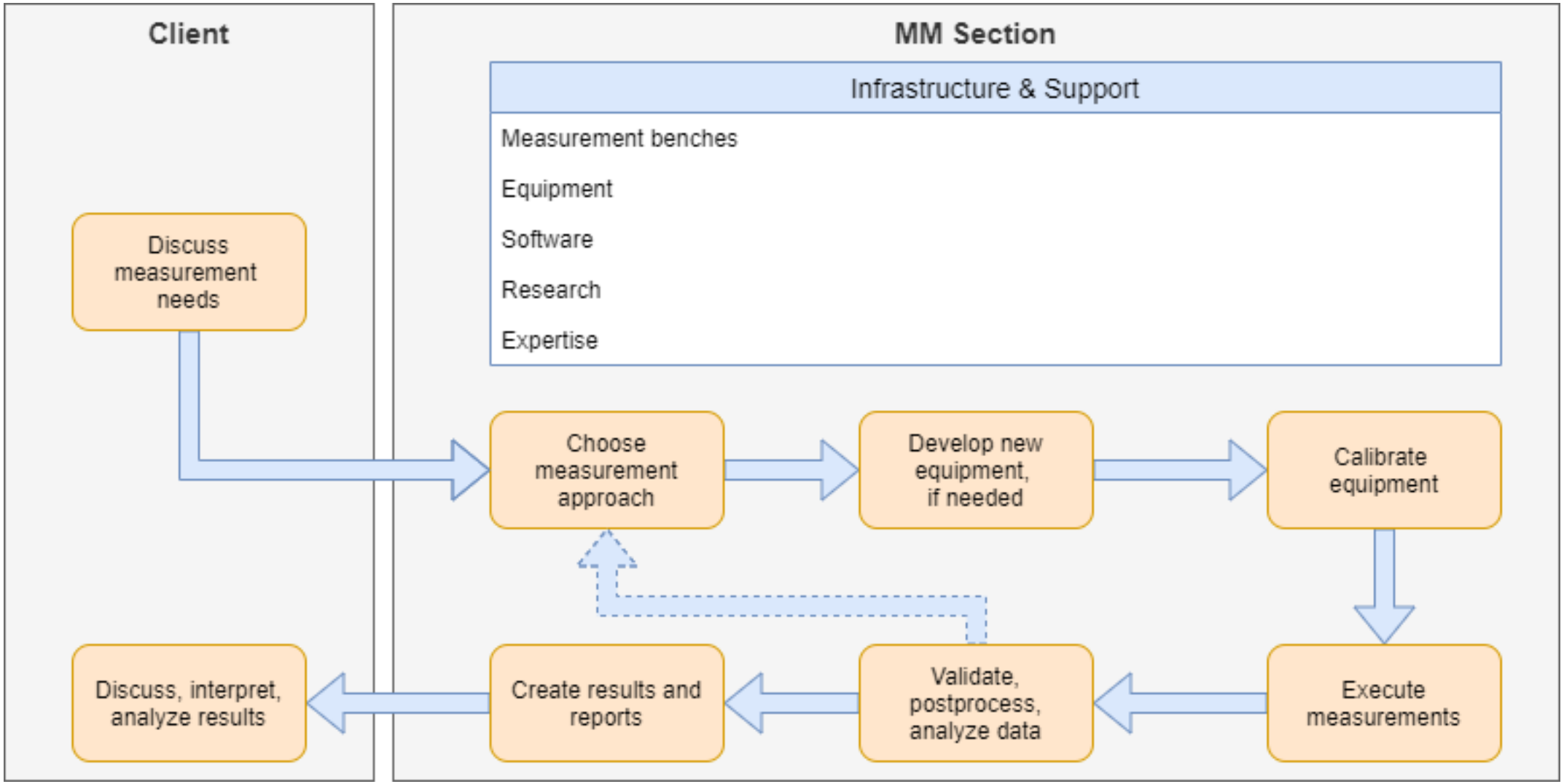
- Responsible for carrying out MMs to assure the correct performance of various accelerator magnets
- Critical for the success of the accelerators operation at CERN





Source: Golluccio, G. (2012). High-Performance Measurement Systems for Characterizing and Monitoring Particle Accelerator Magnets. PhD thesis, Università del Sannio, Benevento.

The TE-MSC-MM Value Shop Model



Source: Bonora, M. (2020). An Integrated Software Framework for Magnetic Measurements - From Raw Data to Assets. TE-MSC Seminar, CERN, Geneva.

Project Description

Problem

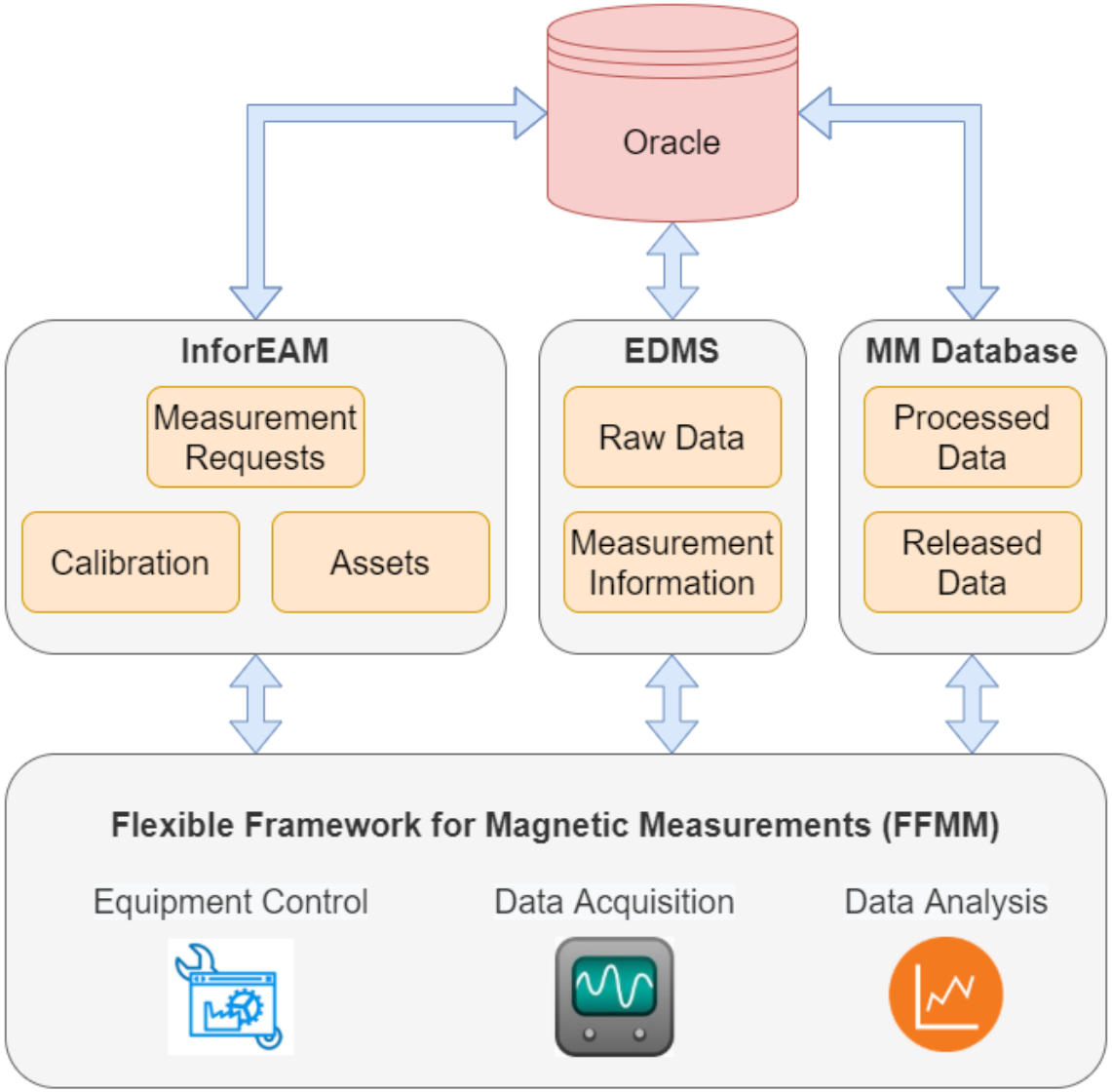
Use of various tools, that do not exchange information

- Lack of centralised database
- Information not accessible easily
- Manual entry/retrieval of data

Solution

3MIS: **M**agnetic **M**easurement **M**anagement & **I**nformation **S**ystem

Architecture of Solution



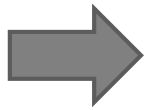
Source: Bonora, M. (2020). An Integrated Software Framework for Magnetic Measurements - From Raw Data to Assets. TE-MSC Seminar, CERN, Geneva.

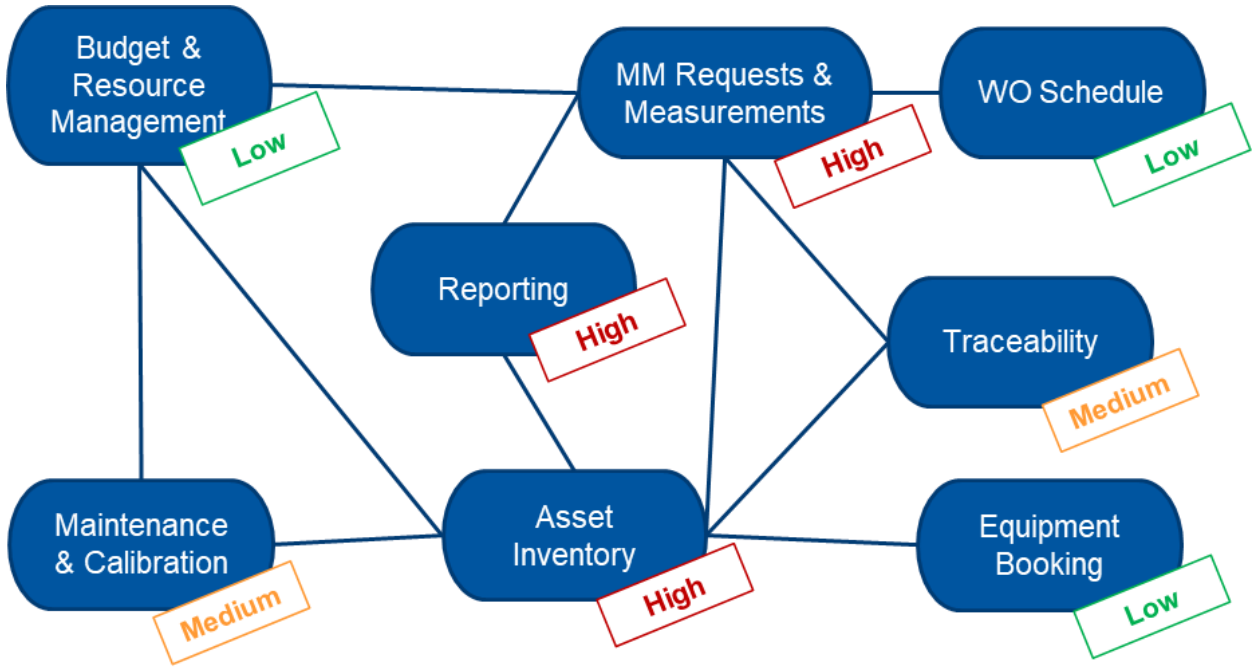
Why Infor EAM and EDMS?

- ✓ Used throughout CERN
- ✓ Service, maintenance & support provided by dedicated Sections at CERN
- ✓ Available solutions for common problems
- ✓ Already integrated with each other and with other CERN systems & applications *(GIS, MTF, TREC, etc.)*
- ✓ Can be integrated with other systems *(web-services)*
- ✓ No extra costs implied
- ✓ Quickly and easily customisable, but with some restrictions & limitations

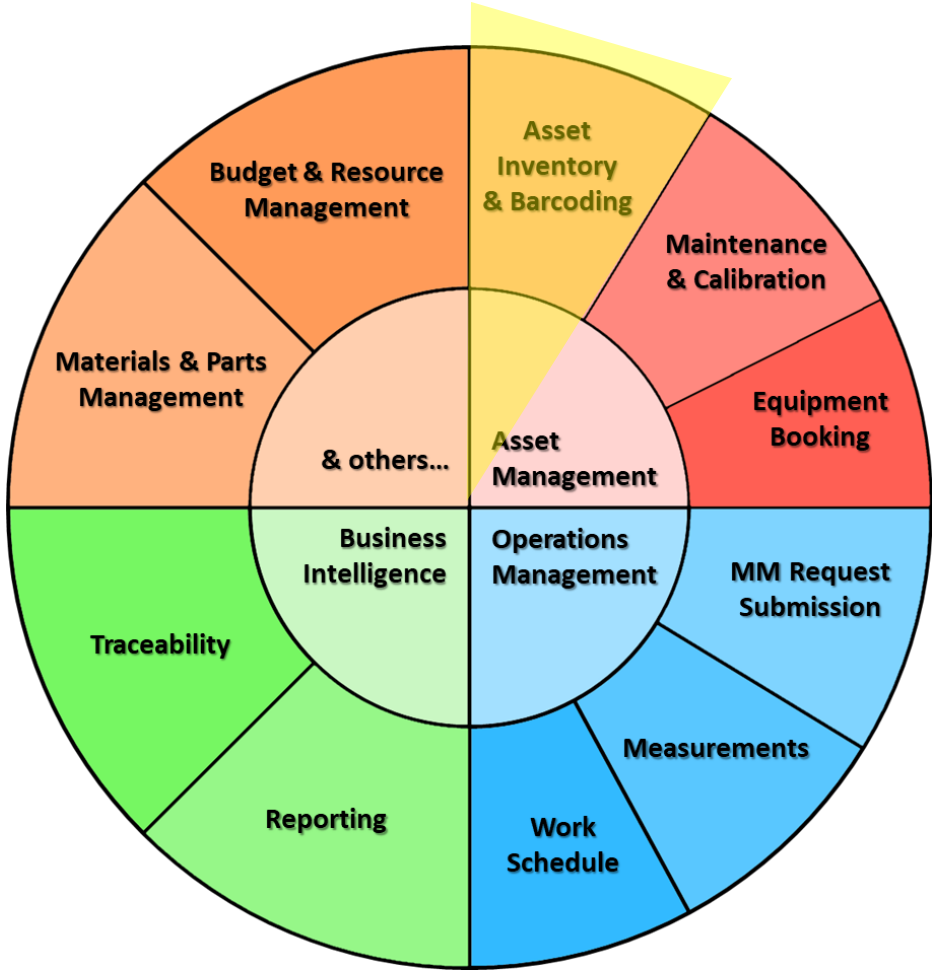
Source: Steenstrup, K., Foust, N. (2019, October 14). Gartner's Magic Quadrant for Enterprise Asset Management Software. Retrieved from www.infor.com

Prioritization of Work





Asset Inventory & Barcoding



Criteria to Register an Asset in the Database

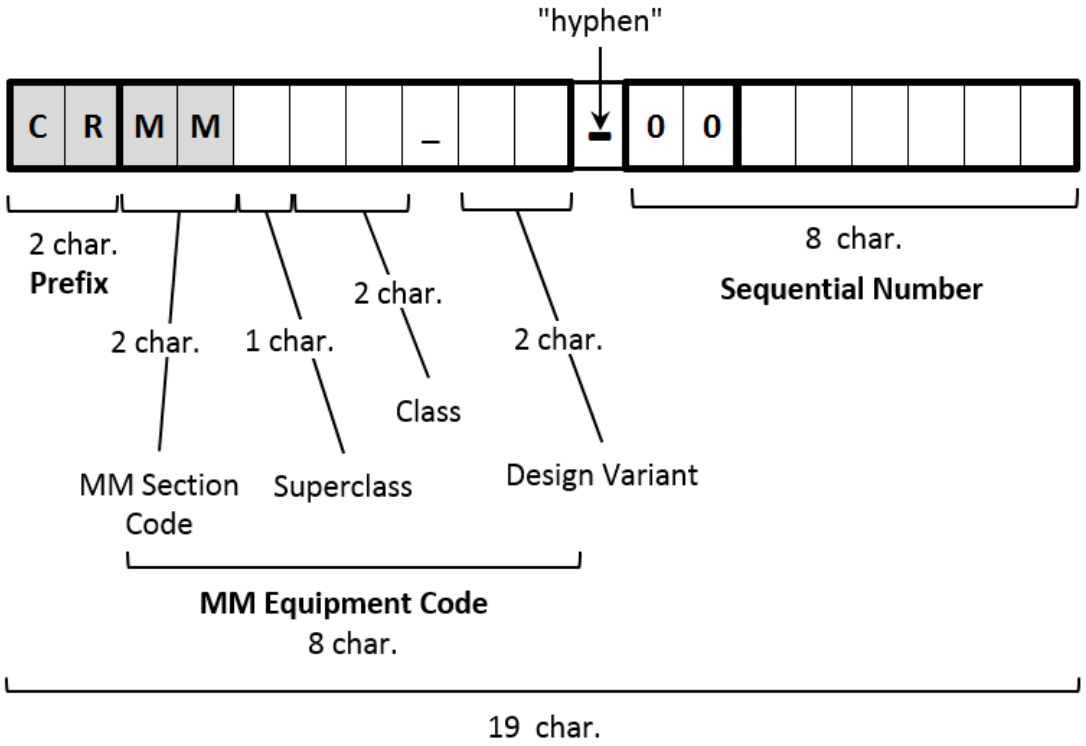
Asset Inventory & Barcoding

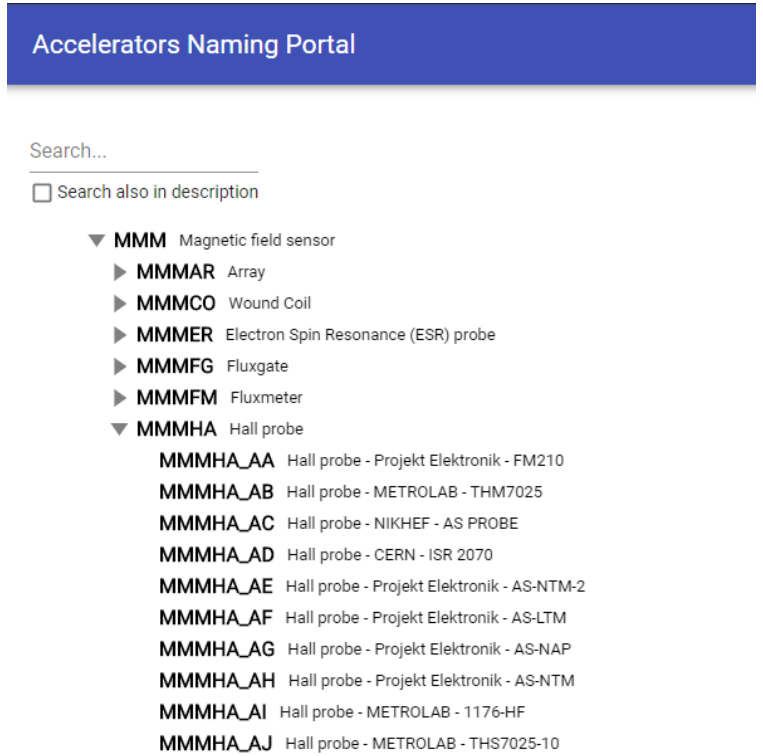
A piece of equipment:

- ✓ Relevant or crucial for magnetic measurement **OR**
- ✓ Holds/pushes data required in FFMM **OR**
- ✓ Requires regular maintenance, calibration, checks **OR**
- ✓ Exceeds a defined financial value **OR**
- ✓ Unique & frequently used

MM Equipment Codes

Asset Inventory & Barcoding

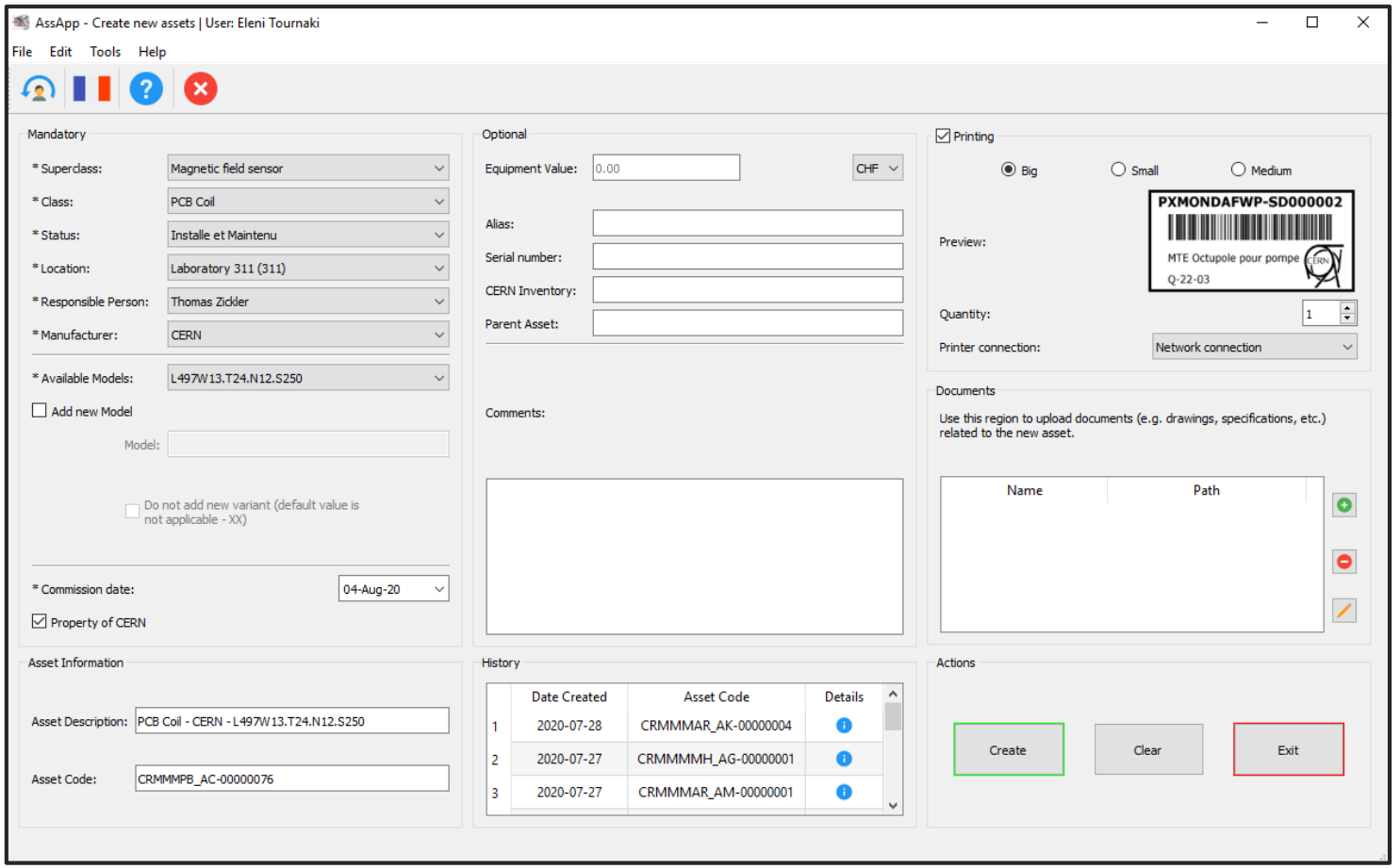




- ✓ MM Section's Equipment Naming Convention Report published in EDMS
- ✓ MM Equipment Codes published on the Accelerators Naming Portal

MM Assets Creation & Printing Application

Asset Inventory & Barcoding



Courtesy: R. Martinez Estebanez, S. Gutzeit, M. Bonora

Progress of Inventory Process

First Campaign (Q3, 2017)

6 labs

20 days

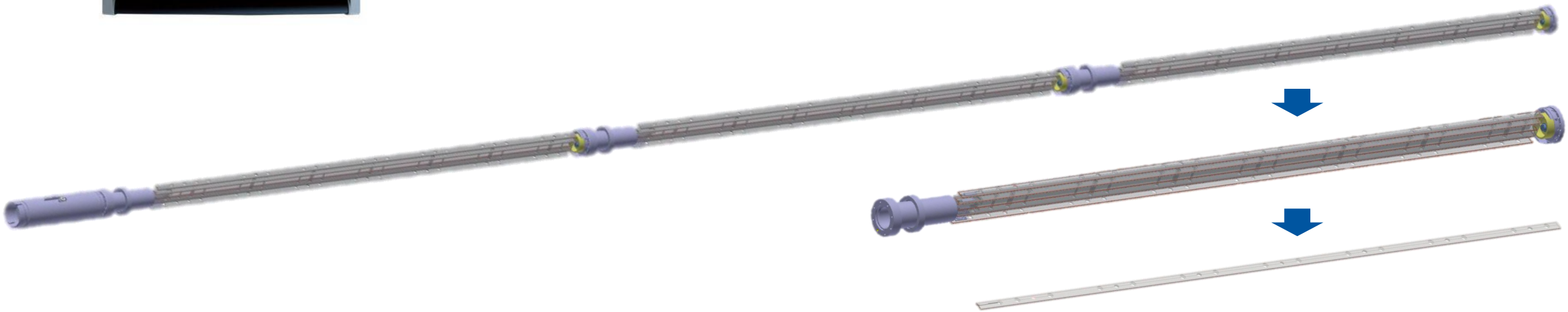
1.197 Assets

Now

~2.300 Assets

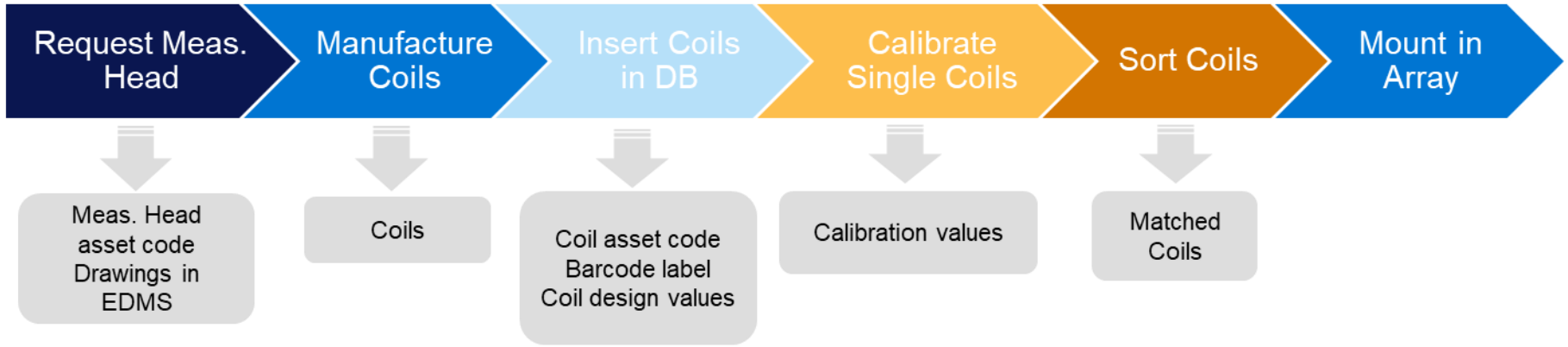
Examples of MM Assets

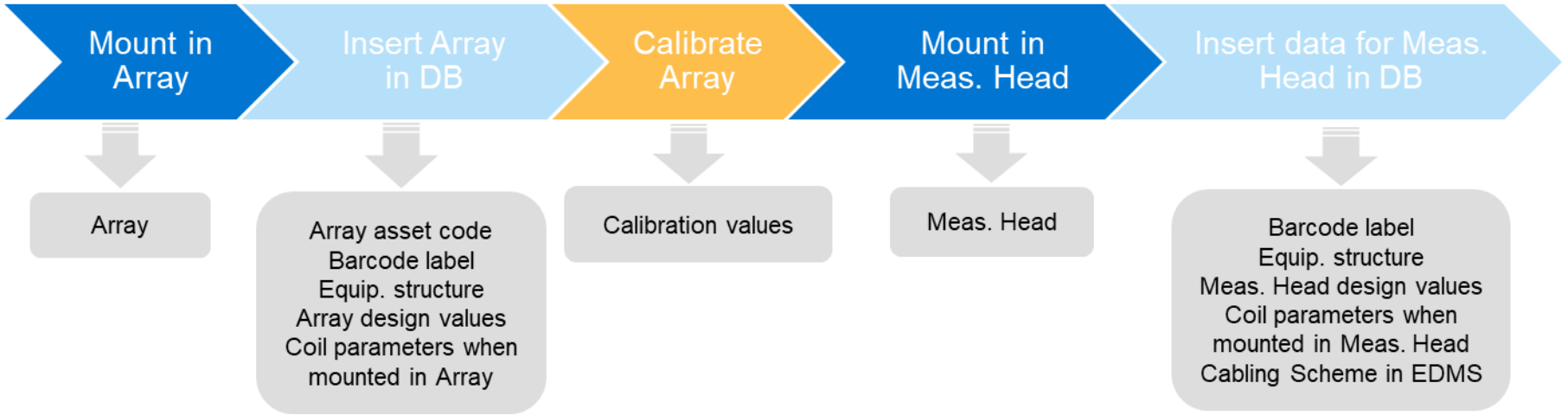
Asset Inventory & Barcoding

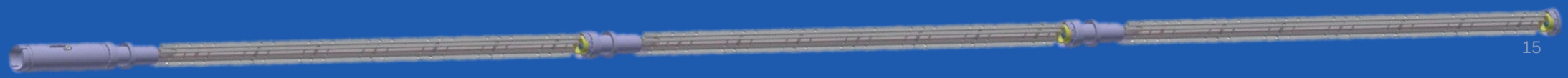


MM Low-Level Equipment

Asset Inventory & Barcoding







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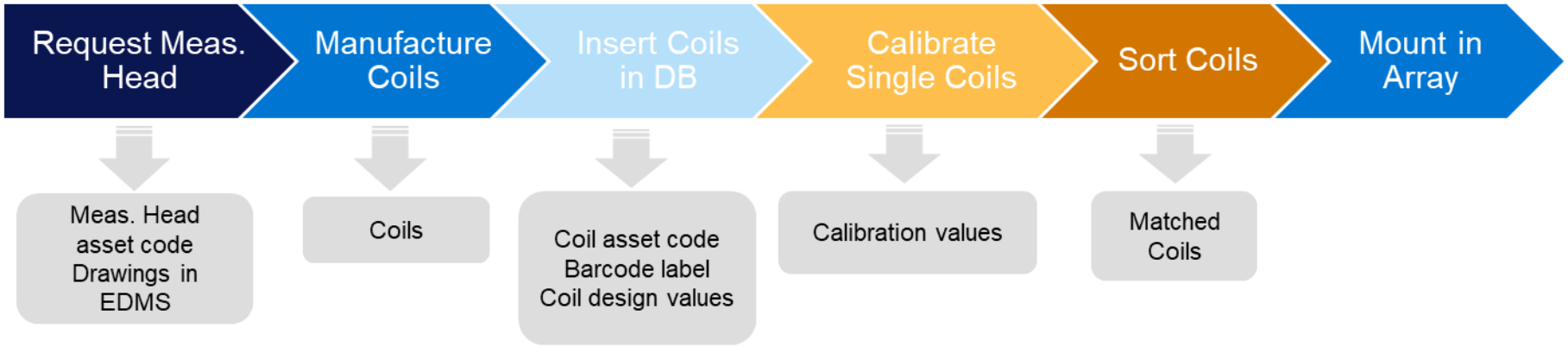
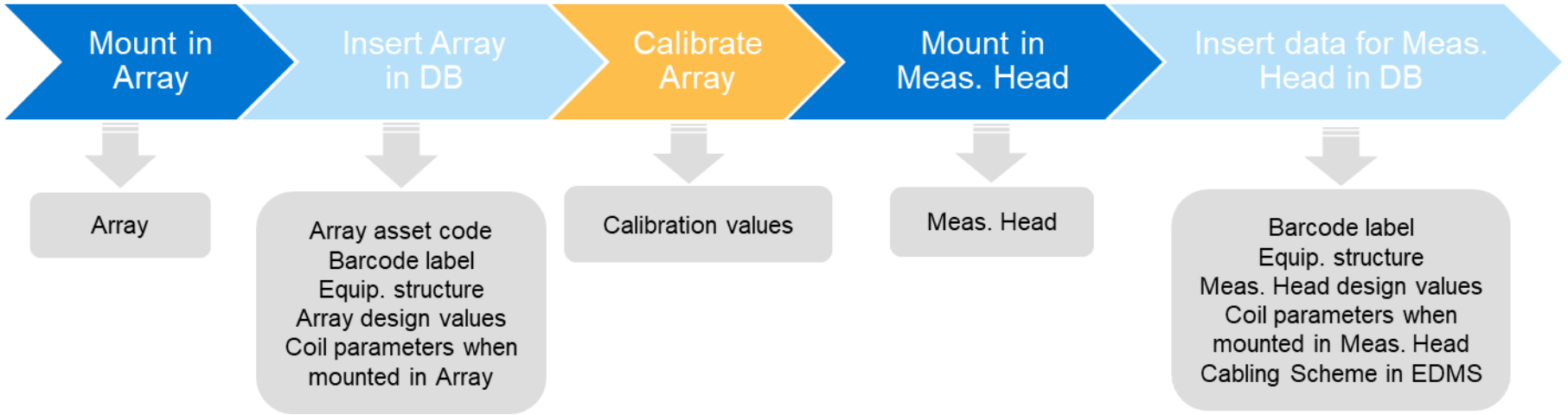
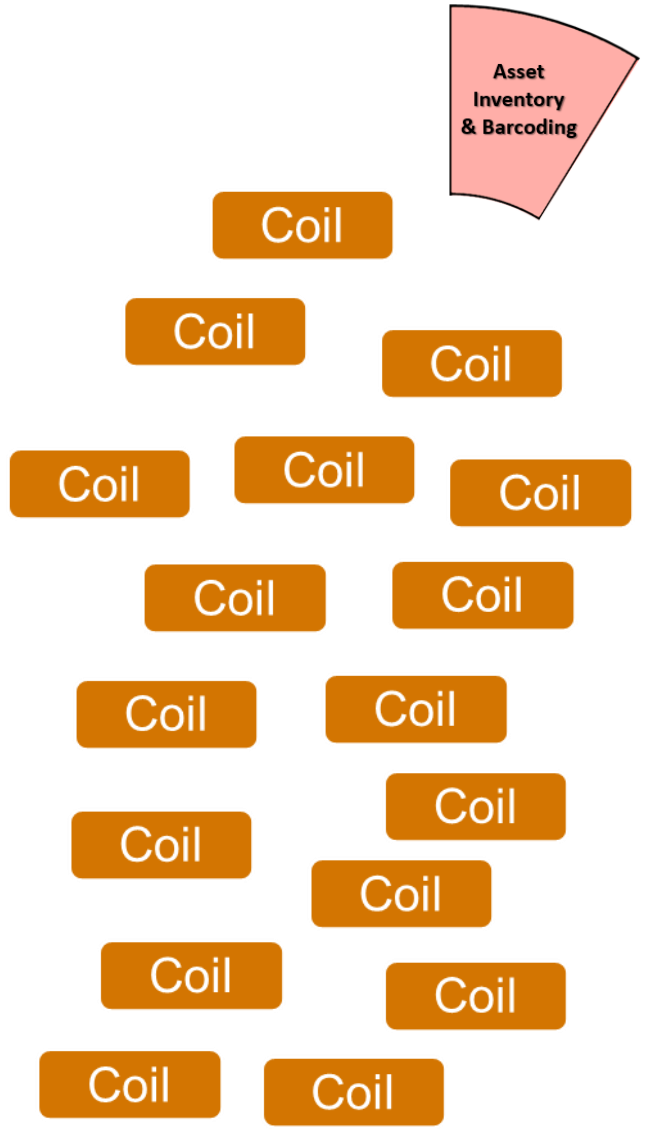






MM Low-Level Equipment

Coil

Asset Inventory & Barcoding

Request Meas. Head → Manufacture Coils → Insert Coils in DB → Calibrate Single Coils → Sort Coils → Mount in Array

- Meas. Head asset code Drawings in EDMS
- Coils
- Coil asset code Barcode label Coil design values
- Calibration values
- Matched Coils

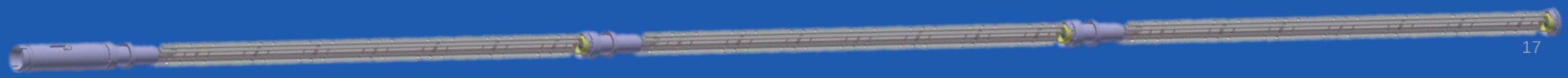
Coil Coil Coil Coil Coil Coil Coil Coil Coil Coil

Mount in Array → Insert Array in DB → Calibrate Array → Mount in Meas. Head → Insert data for Meas. Head in DB

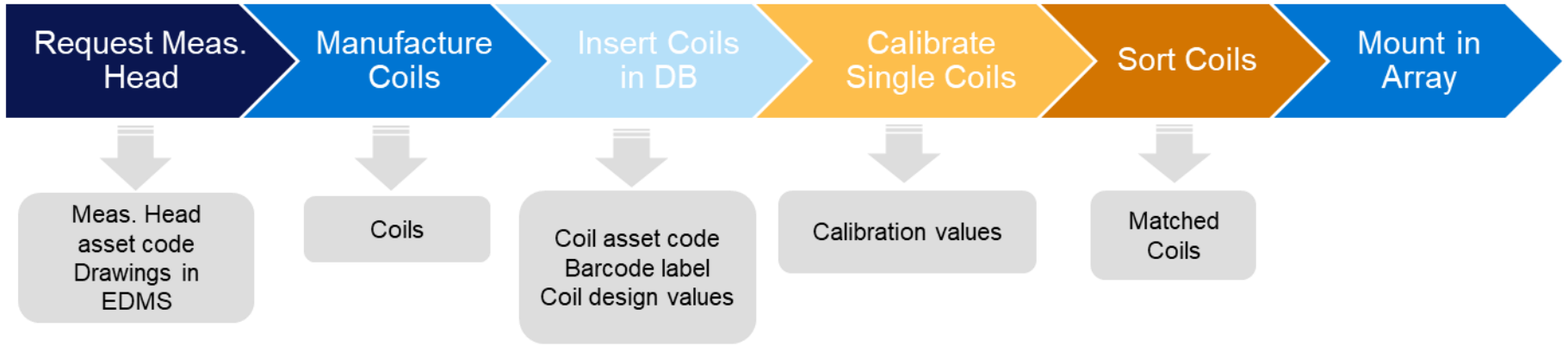
- Array
- Array asset code Barcode label Equip. structure Array design values Coil parameters when mounted in Array
- Calibration values
- Meas. Head
- Barcode label Equip. structure Meas. Head design values Coil parameters when mounted in Meas. Head Cabling Scheme in EDMS

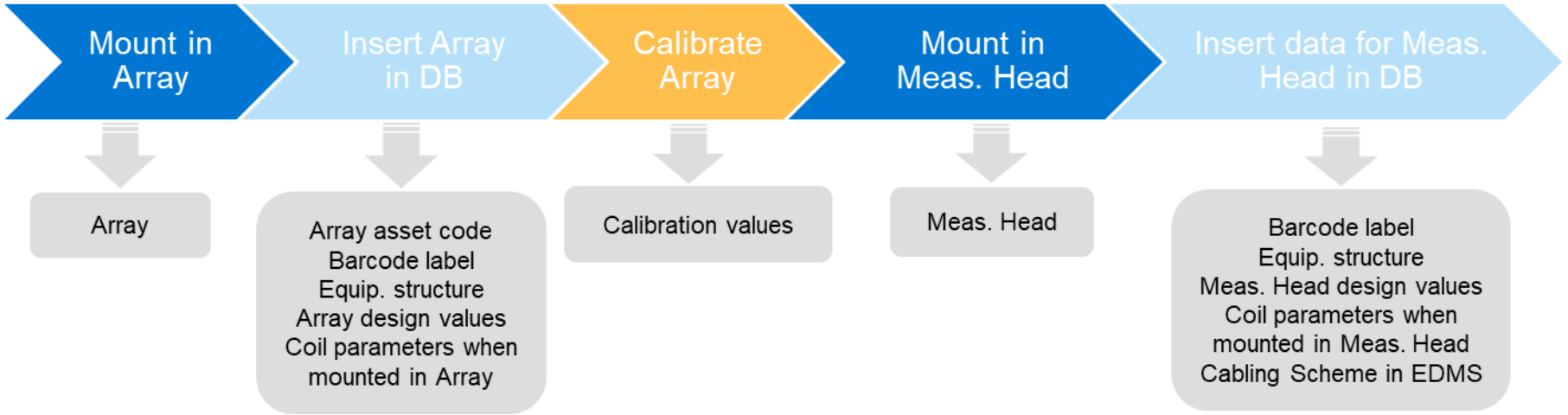
Coil Coil Coil Coil Coil

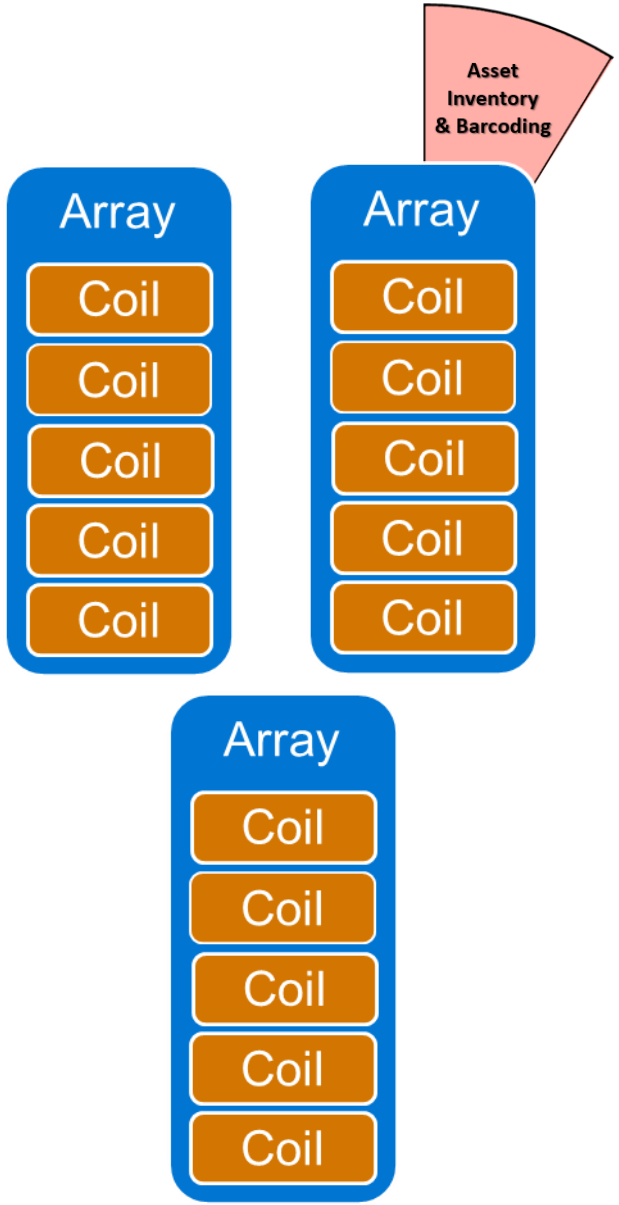
Coil



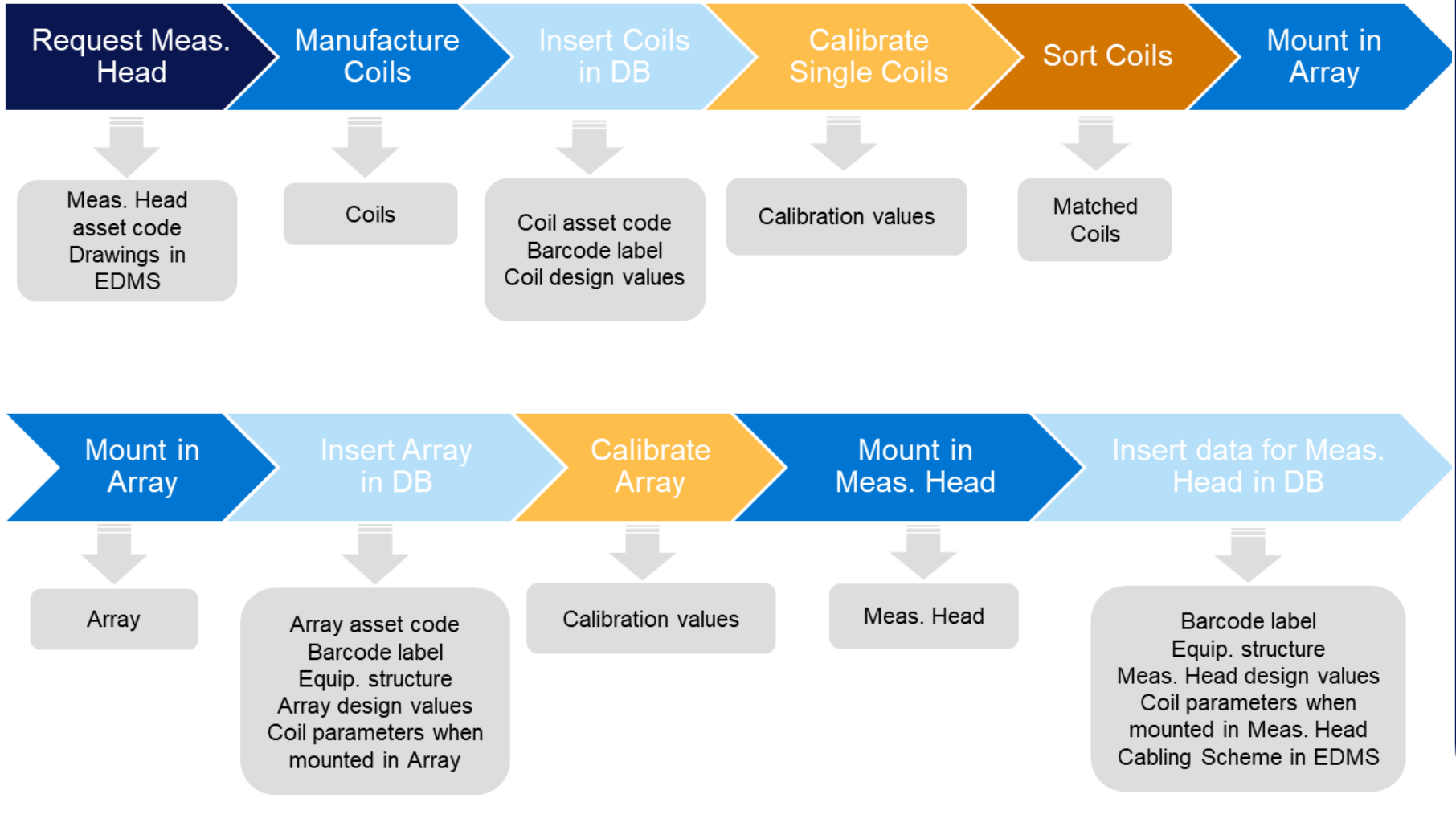
MM Low-Level Equipment

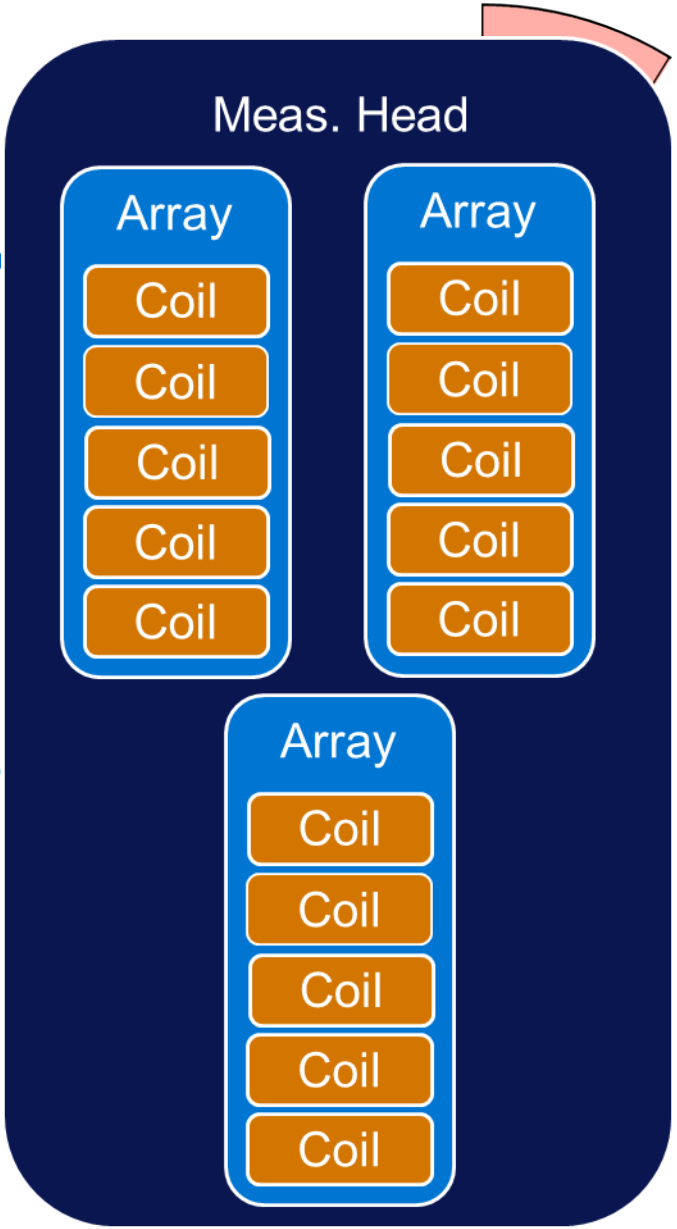






MM Low-Level Equipment

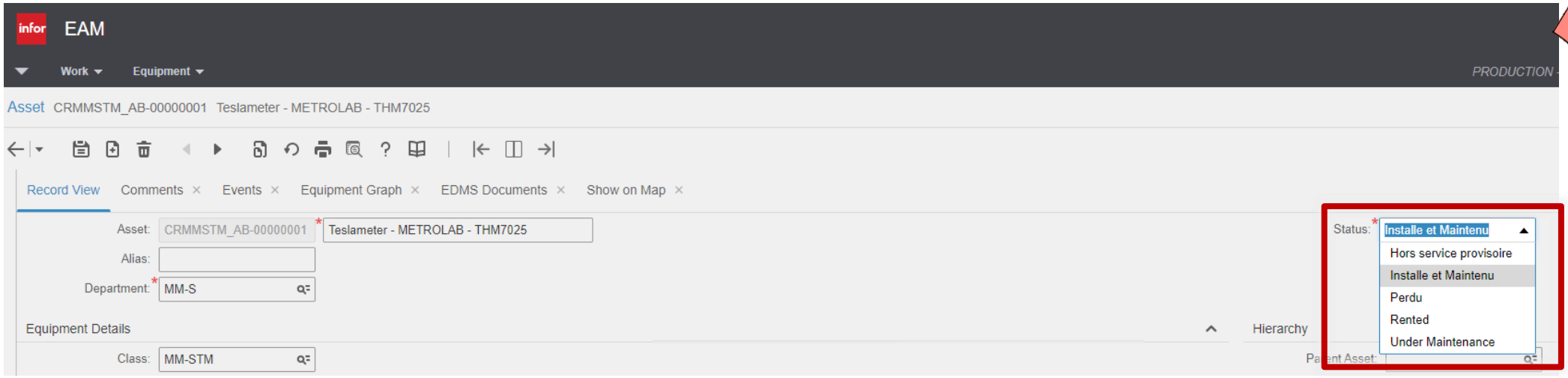


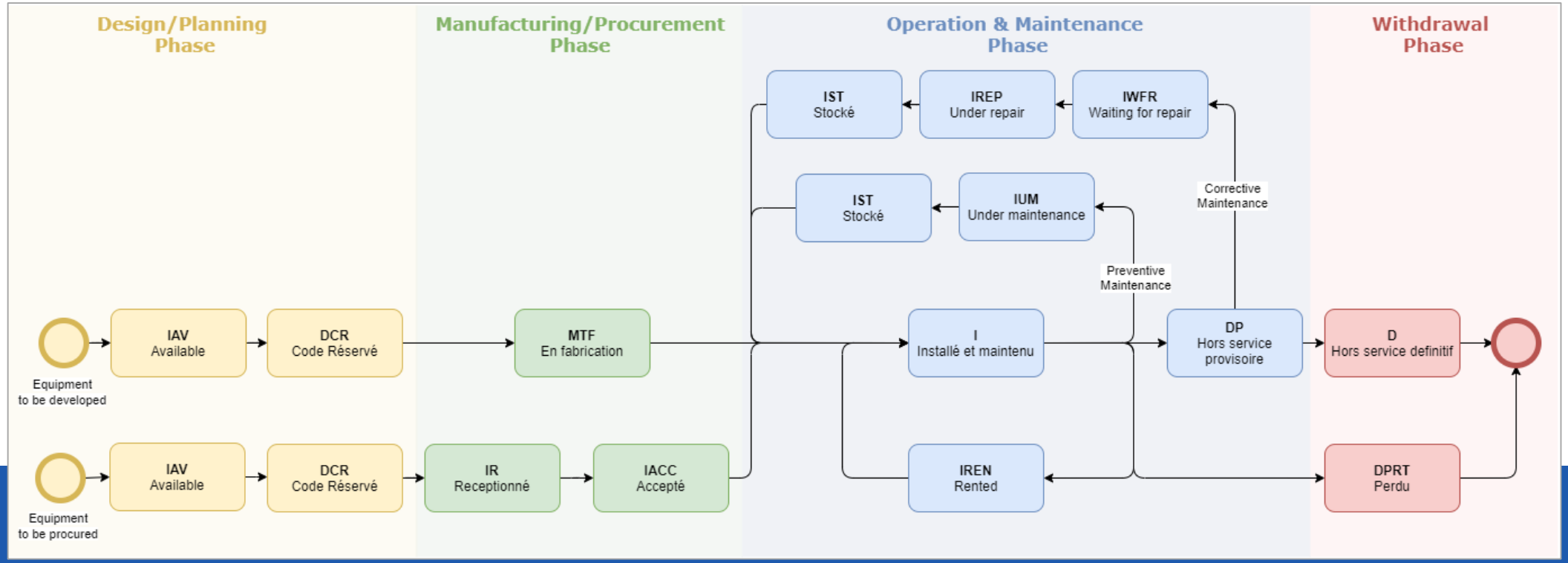


Maintenance & Calibration

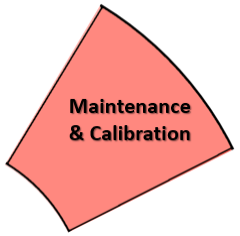
MM Equipment Lifecycle

Maintenance & Calibration





Calibration (1/2)

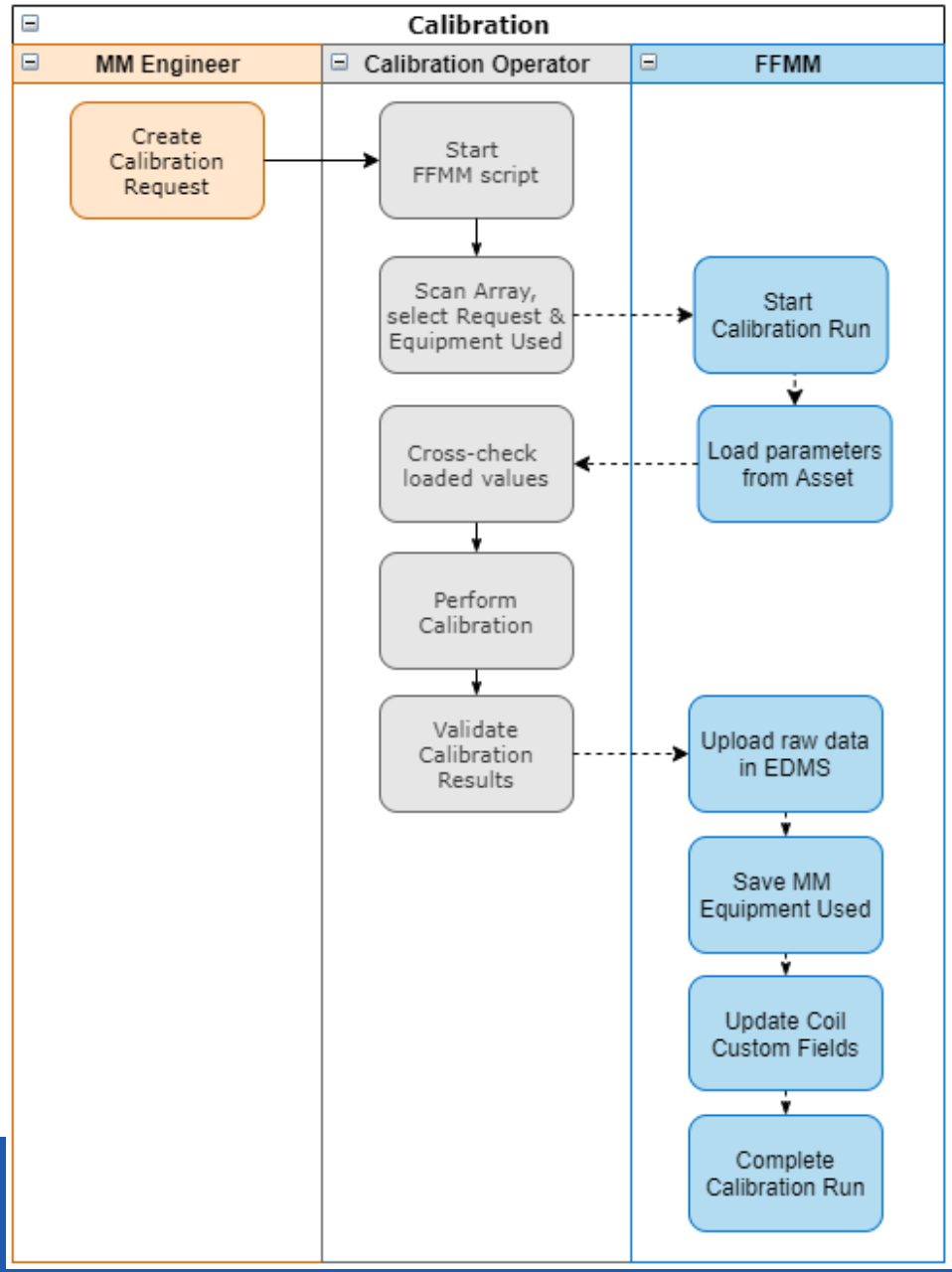


Required for many reasons:

- New instrument
- After an event *(repair/modification, shock)*
- After a specified time period/usage
- Before a critical measurement
- Whenever observations appear questionable
- As specified by a requirement

Calibration (2/2)

Maintenance & Calibration



- ✓ Manual entry of data minimized
- ✓ Automatic retrieval of design values & structure
- ✓ Automatic archiving of results
- ✓ History of calibration values available

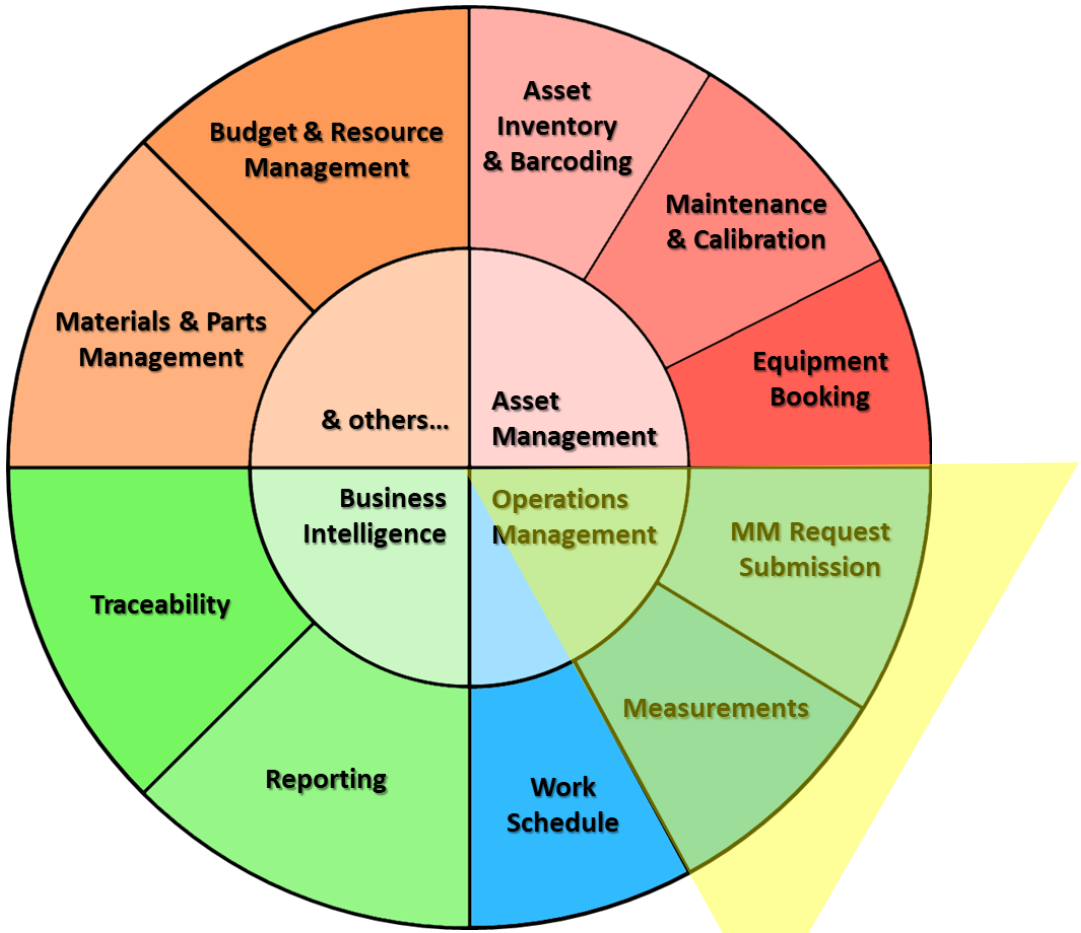
Audit Trail

(default) Edit Date = Run

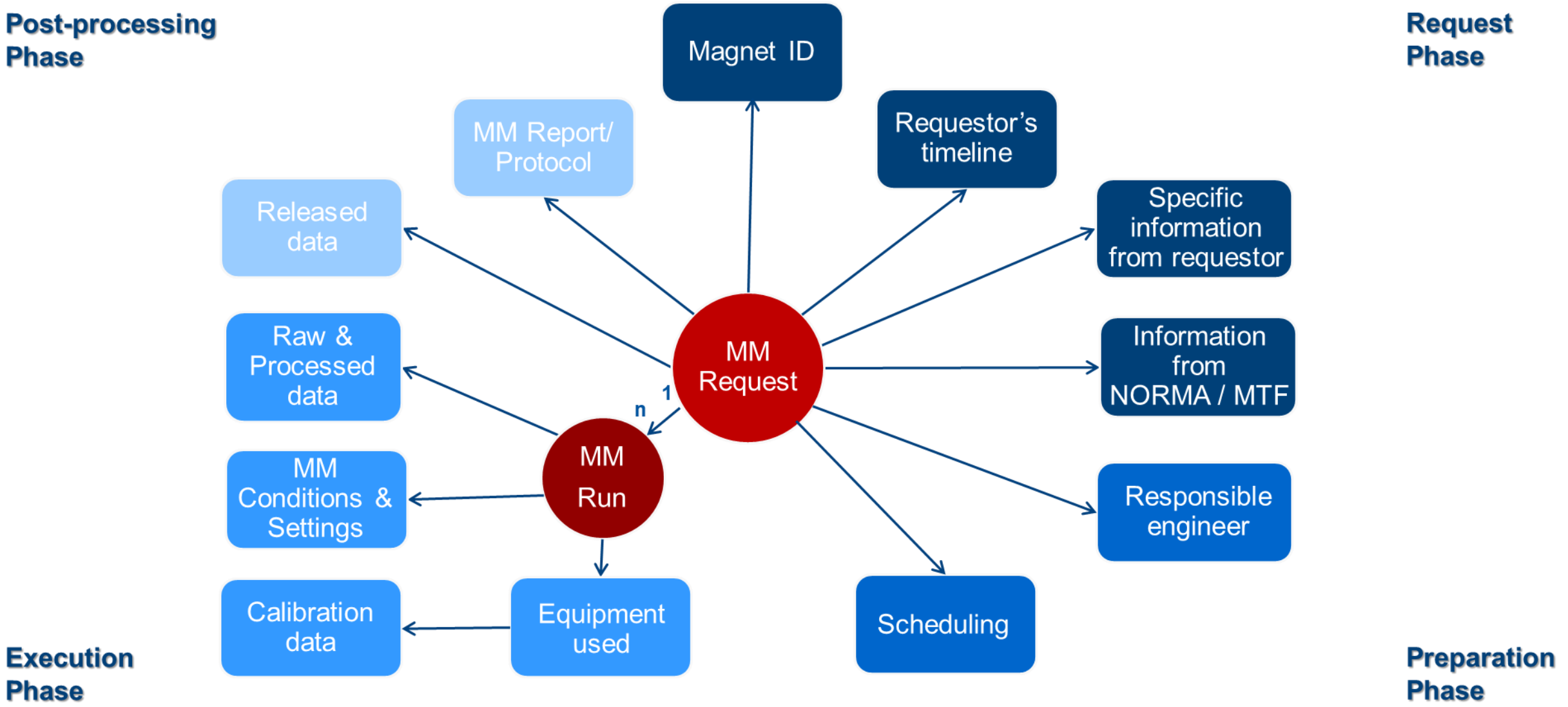
Date	Field	Old Value	New Value	Changed By	Action	Recorded in Mobile	Audit Trail Description
03-JUN-2020 13:37	MM0113		0.178544197916867	MMEASURE	Insert	☐	Efficient Coil Area (single calib.) [m^2]
03-JUN-2020 13:37	MM0114		03-06-2020 13:36	MMEASURE	Insert	☐	Calibration Date (single)
03-JUN-2020 13:37	MM0148		403	MMEASURE	Insert	☐	Impedance [Ohm]
03-JUN-2020 13:43	MM0113	0.17854419791...	0.178536608396261	MMEASURE	Update	☐	Efficient Coil Area (single calib.) [m^2]
03-JUN-2020 13:43	MM0114	03-06-2020 13:36	03-06-2020 13:41	MMEASURE	Update	☐	Calibration Date (single)

Show Filter Row:

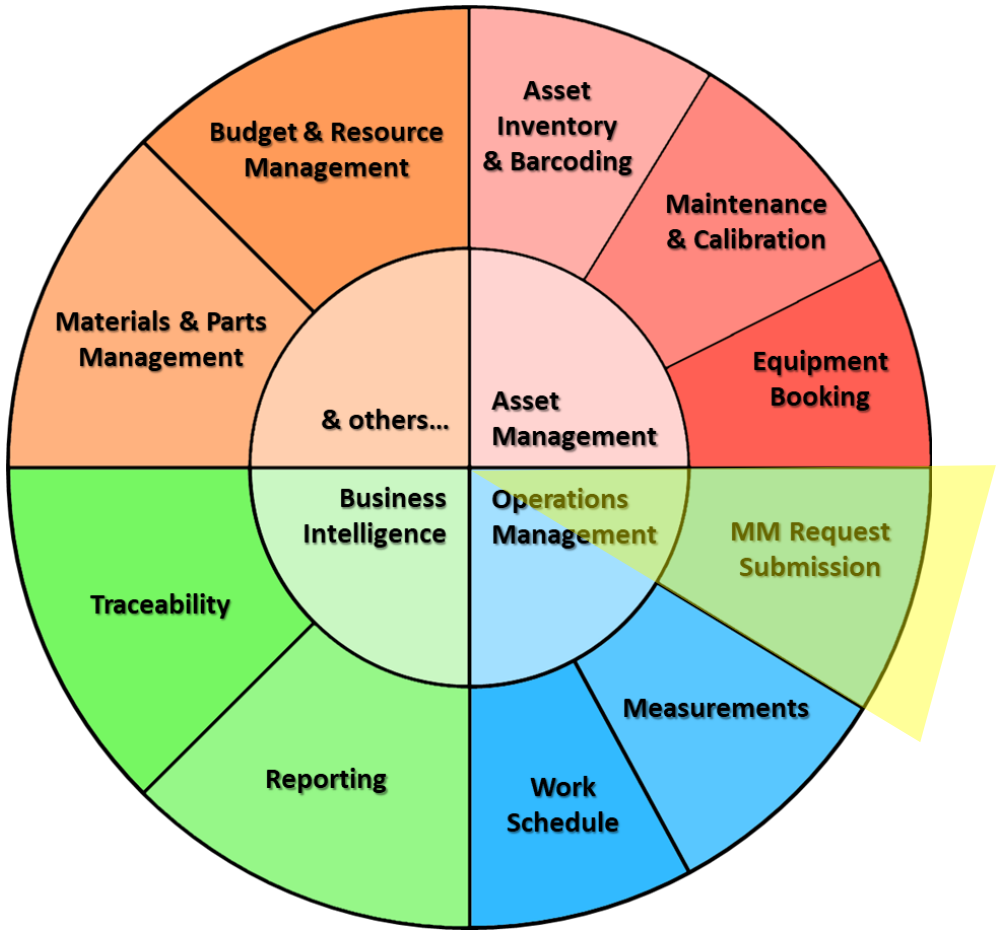
Operations Management



MM Requests: the Central Point of our New IS

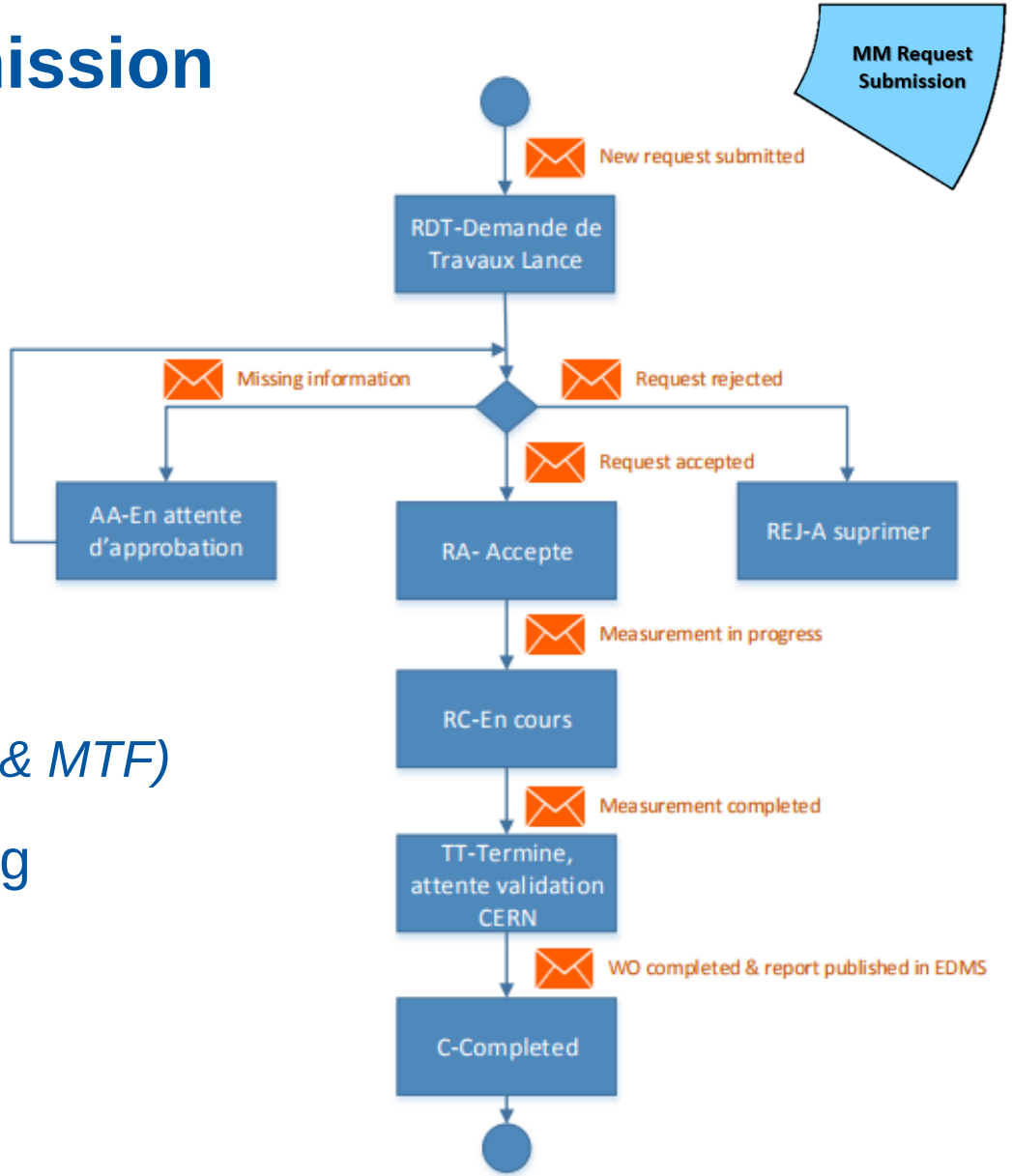


MM Request Submission



MM Request Submission

- ✓ Requests created by the MM Clients:
  - Need for clear, simple & easy way to request information
- ✓ Change in philosophy wrt the past:
  - Less information required *(integration with EDMS & MTF)*
  - Request acts as trigger for discussion & planning
- ✓ Real-time notifications to MM Clients



MM Request Submission Interface

MM Request Submission

EAM Light

TESTTOUR

Work Order 26356708 | SAVE | NEW | DELETE

WSJB29

DETAILS

Description
MM Request Form for Normal-conducting/Permanent Magnets

Equipment *
PXMQSAAIAP-00000123 — PXMQSAAIAP - Quadrupole magnet, skew, type 404

Status
RDT - Demande de Travaux Lance

Class
MME01 — Normal-Conducting/Permanent MM Request - MM Section

SCHEDULING

Reported By
145295 — TOURNAKI ELENI 64631

Assigned To

Req. Start Date *
12-Apr-2019

Req. End Date *
13-Apr-2019

Sched. Start Date
12-Apr-2019

Sched. End Date
19-Apr-2019

Date Completed

EDMS DOCUMENTS

ID	Title	Status

No documents

Per page 5 0-0 of 0

COMMENTS

TE Enter new comment here

CHECKLISTS

Activity

1 — Please provide general information here: CREATE FOLLOW-UP WO

TESTP — TEST POSITION

Project (Root Project)

Measurement Scope

Is the magnet radioactive? Yes No

Does the magnet have a Thermal Interlock? Yes No

Does the magnet follow the LHC Polarity Convention? Yes No

Measurements

Measurement Bench

Bench setup

- Hardware
- Software
- Meas. Settings

Data Acquisition

- Raw data

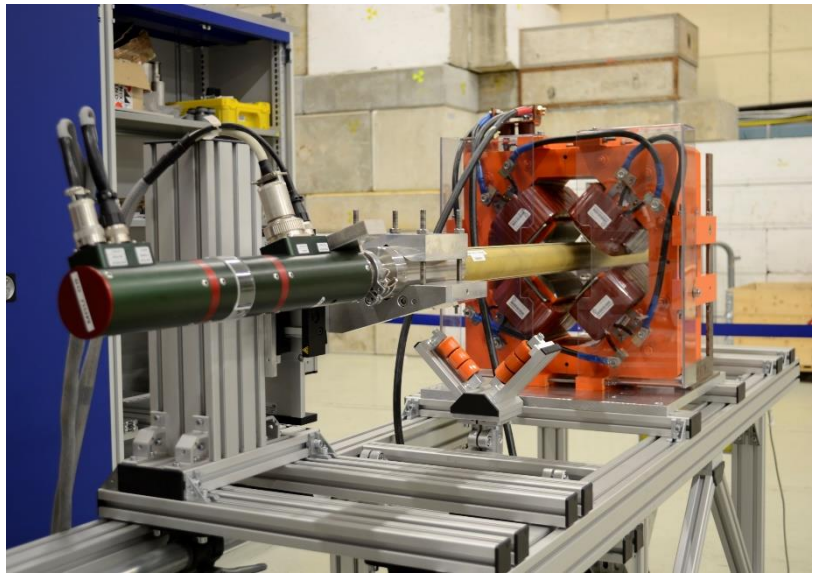
Data Processing

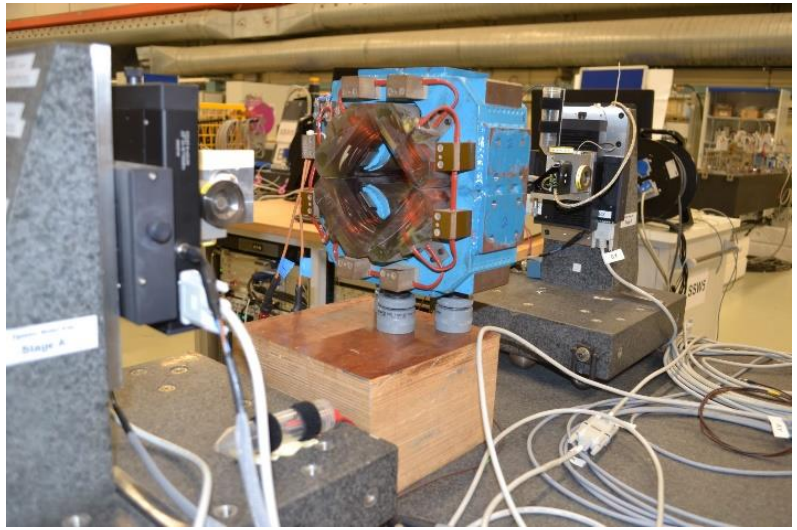
- Processed data

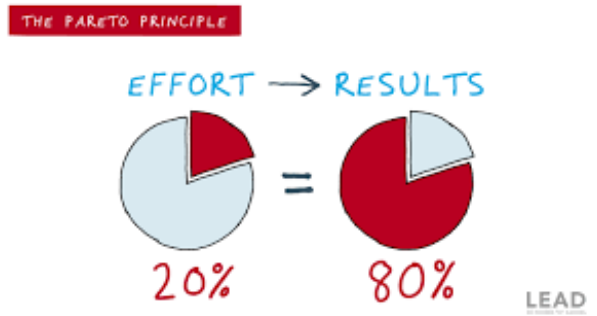
Analysis

- Released data
- MM Reports

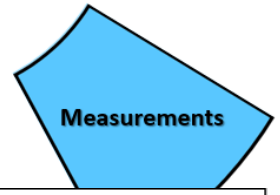
Measurement Systems





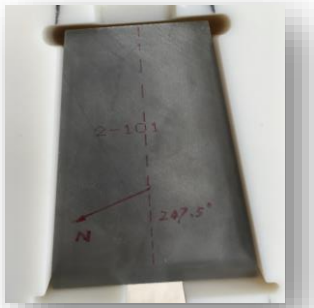


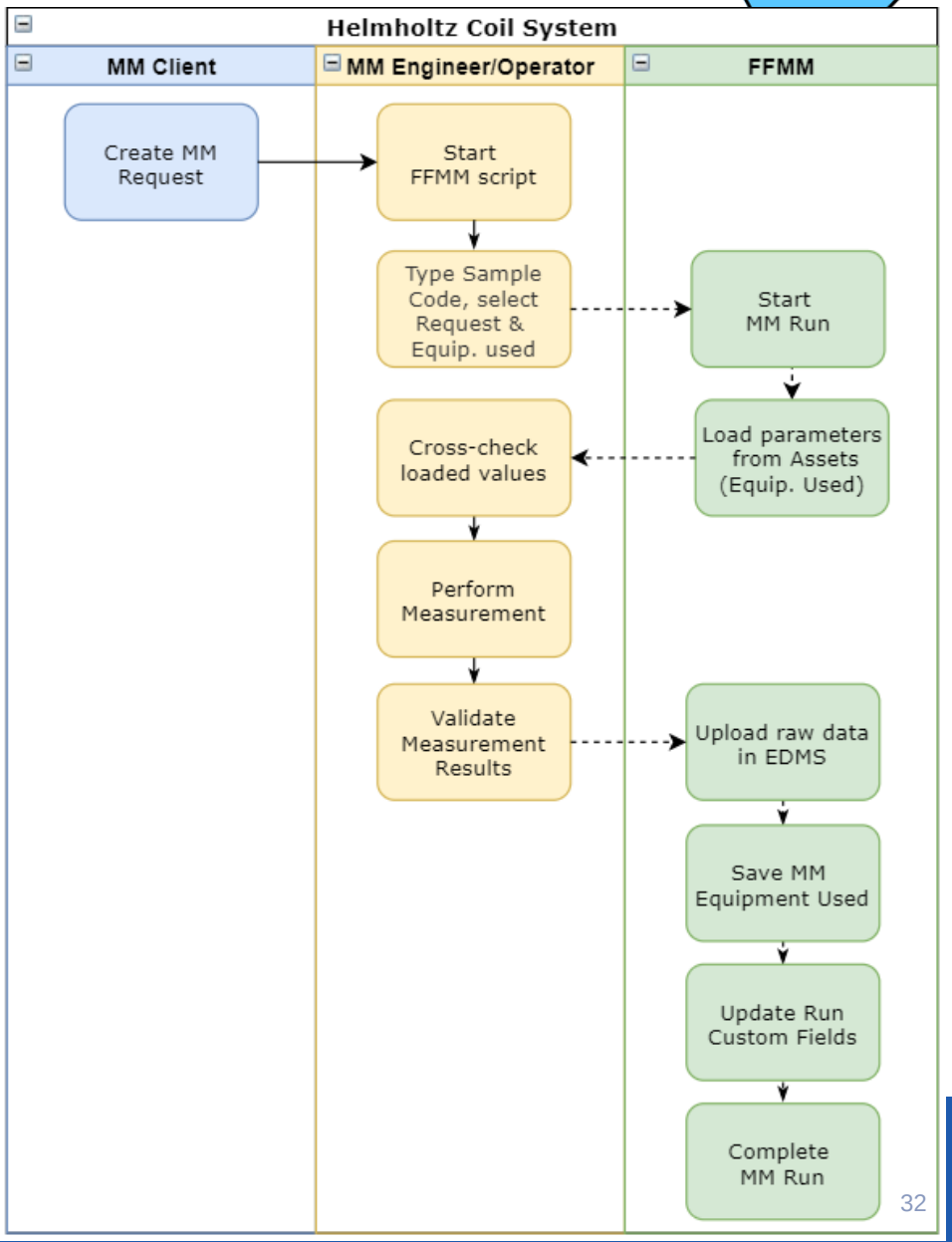
Measurements: Helmholtz Coil System



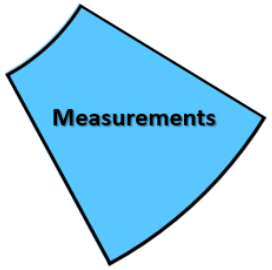
- ✓ MM Campaign for FASER Project

  (690 permanent magnet blocks)
- ✓ Good candidate as a pilot project *(simple & quick MM)*
- ✓ Workflow similar to calibration
- ✓ Instructions & feedback provided to the operator
- ✓ Results available immediately & with one click





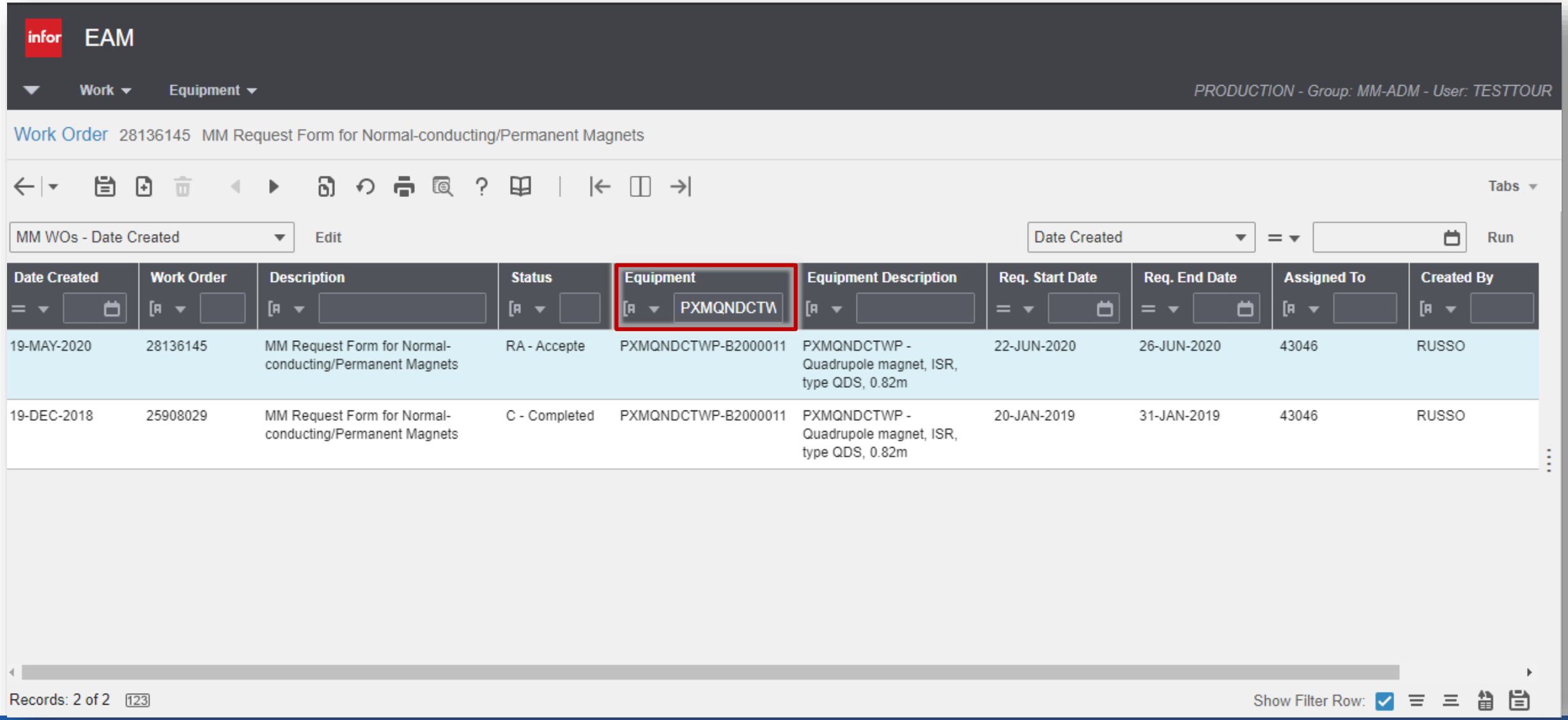
Measurements: Rotating Coil System



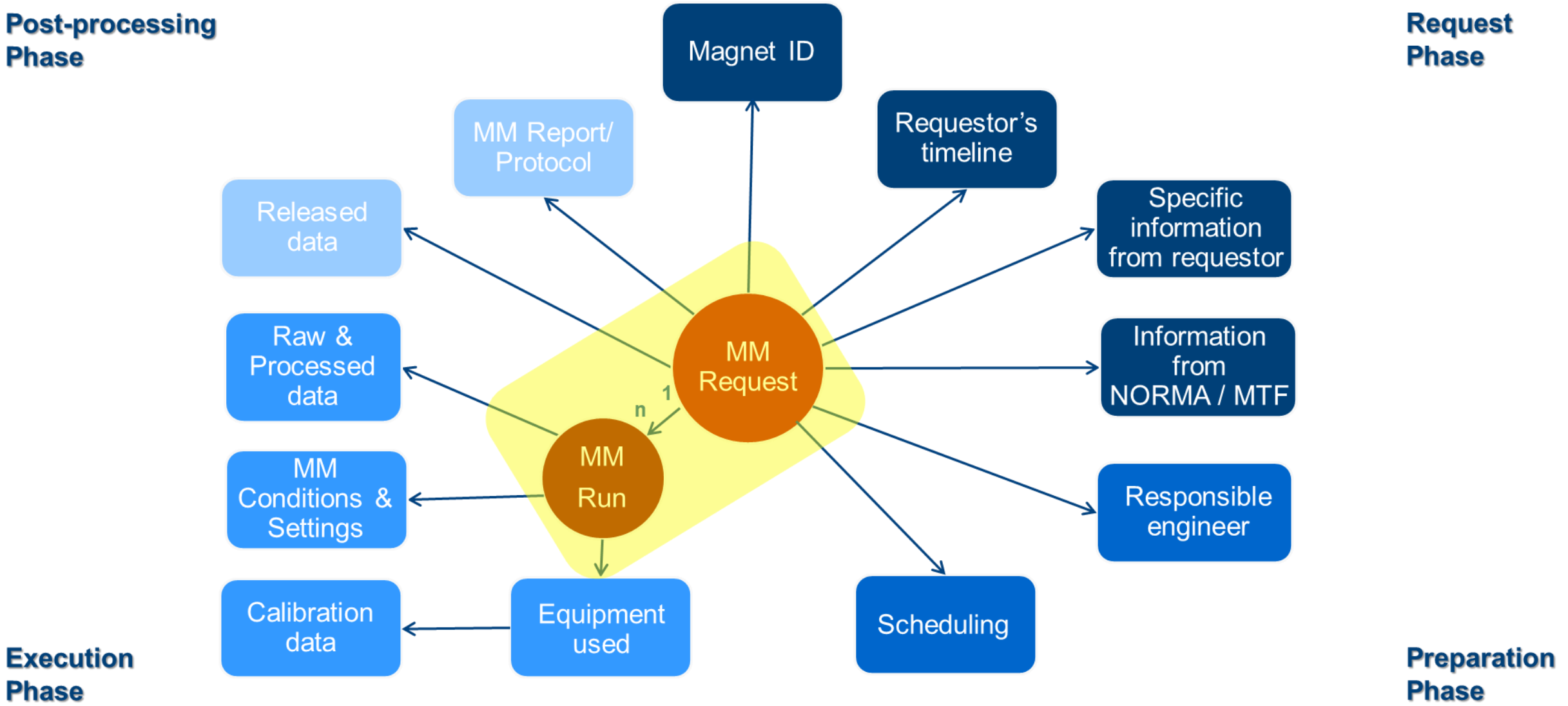
- ✓ Next milestone: upcoming measurement campaign for HL-LHC
- ✓ More complex system:
  - Measurements in cryogenics conditions
  - Need for reduced feedback loop
  - Complex data structure
  - High volume of data
- ✓ Preparation already done
- ✓ Re-use of features of existing scripts & development of advanced features

Traceability & Reporting

How many times have we measured a magnet?



How many Meas. Runs have we performed to fulfil a Request?



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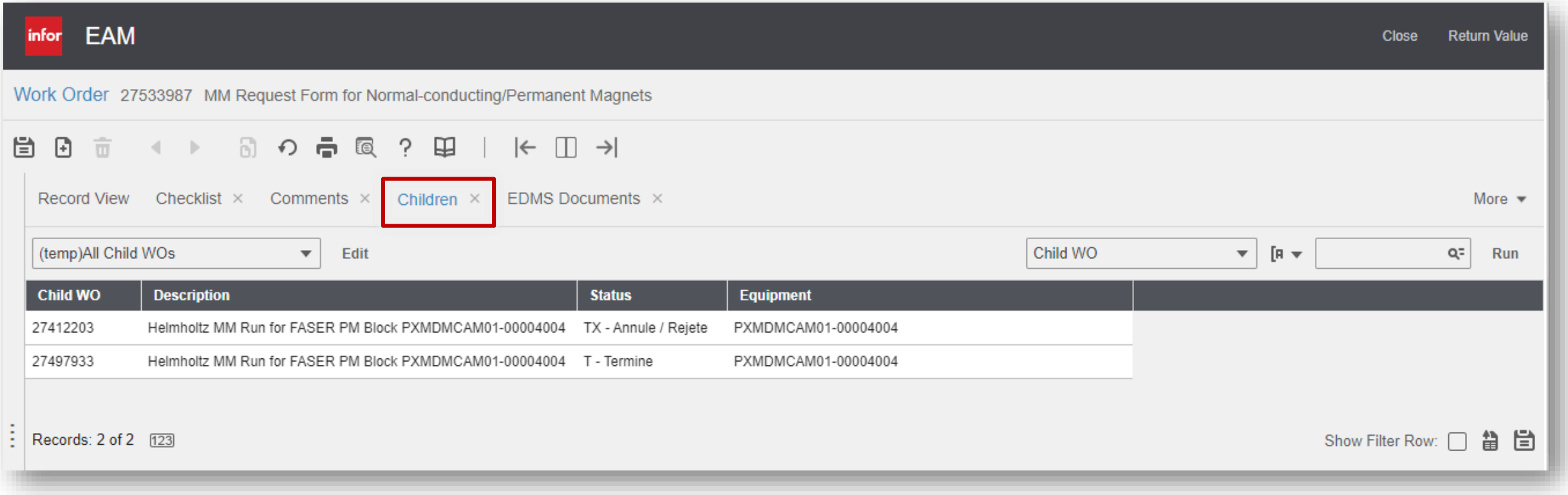
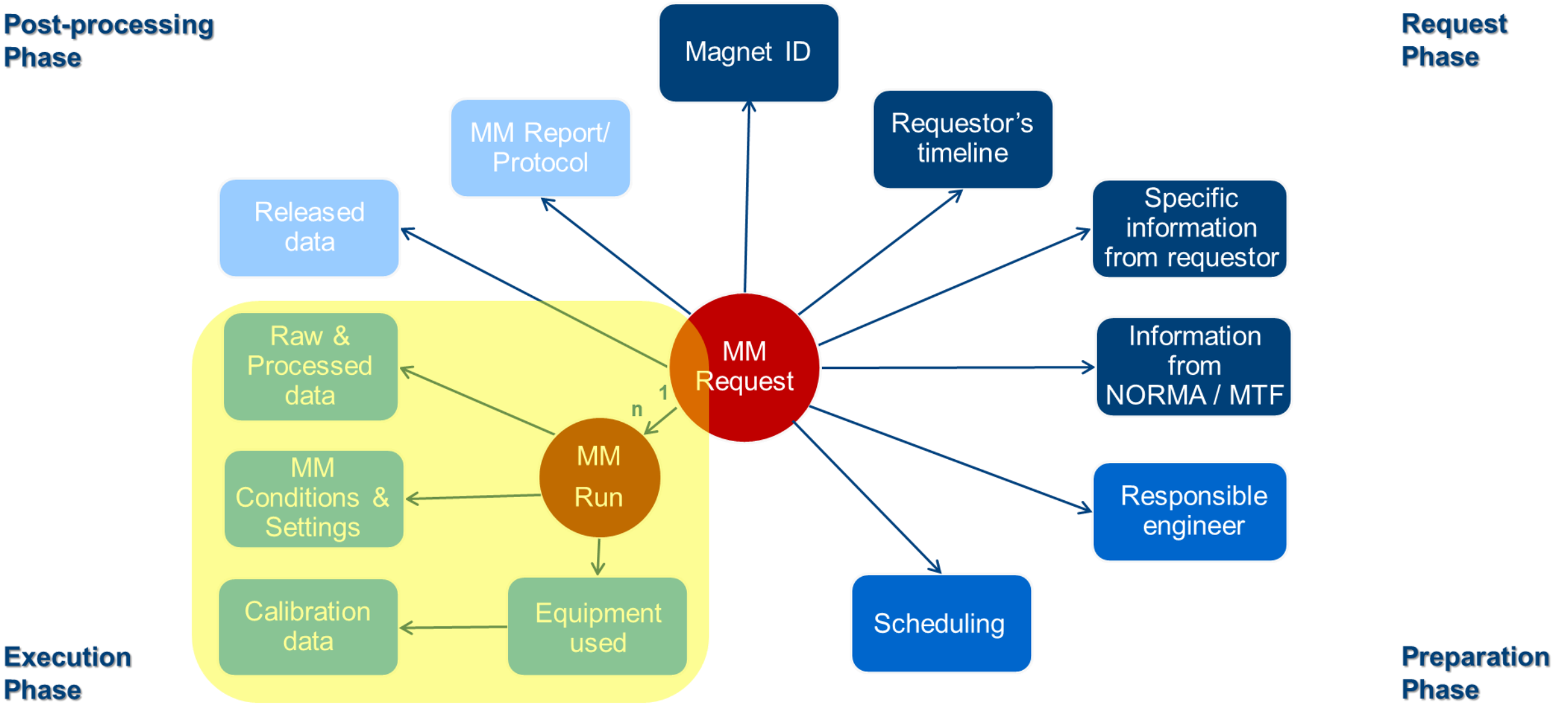


Which are the details of a specific Meas. Run?



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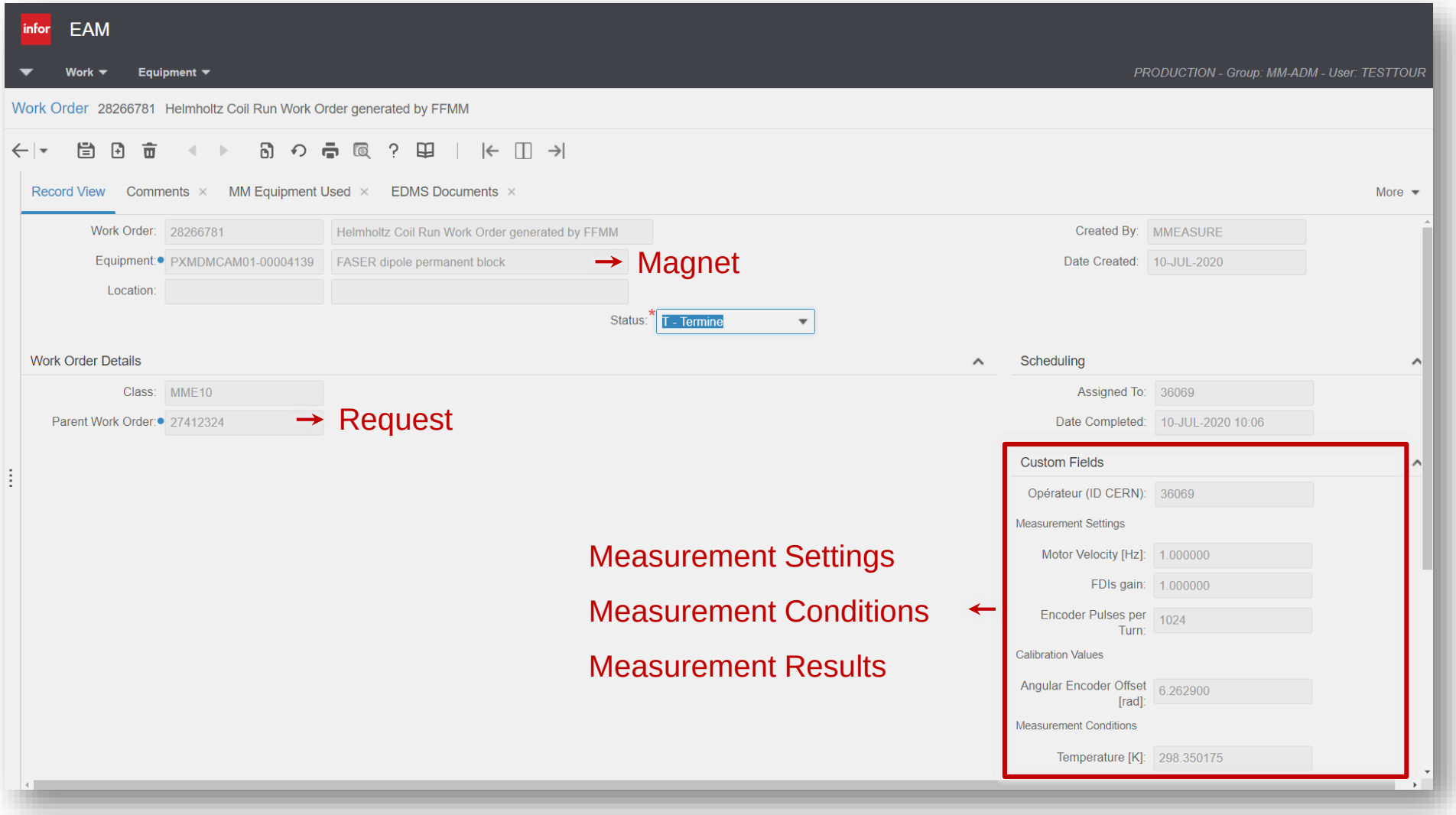

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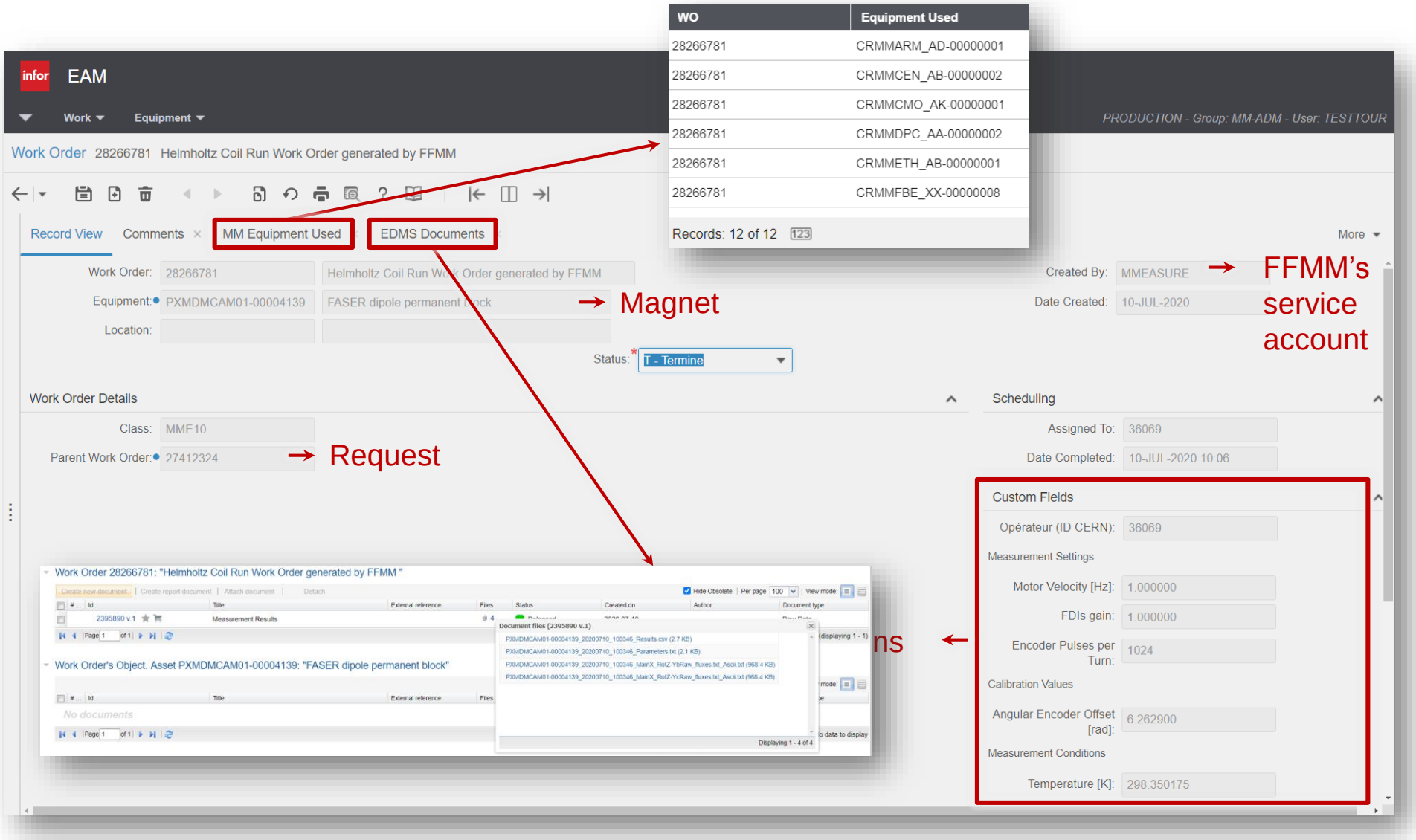


Which is the current status of the Requests?

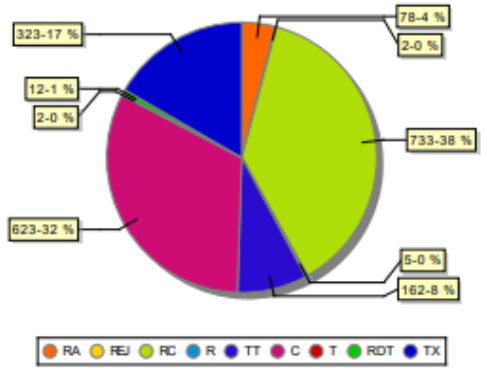
European Organization for Nuclear Research
Organisation européenne pour la recherche nucléaire

CMMS Service - MM section: Work orders per status
Extracted on: 27/08/2020 03:41:22

Prompt	
	Project:
	Scheduled Start Date from : <no value> This filter will be removed
	Scheduled Start Date to: <no value> This filter will be removed
	Status:
	Assigned to:

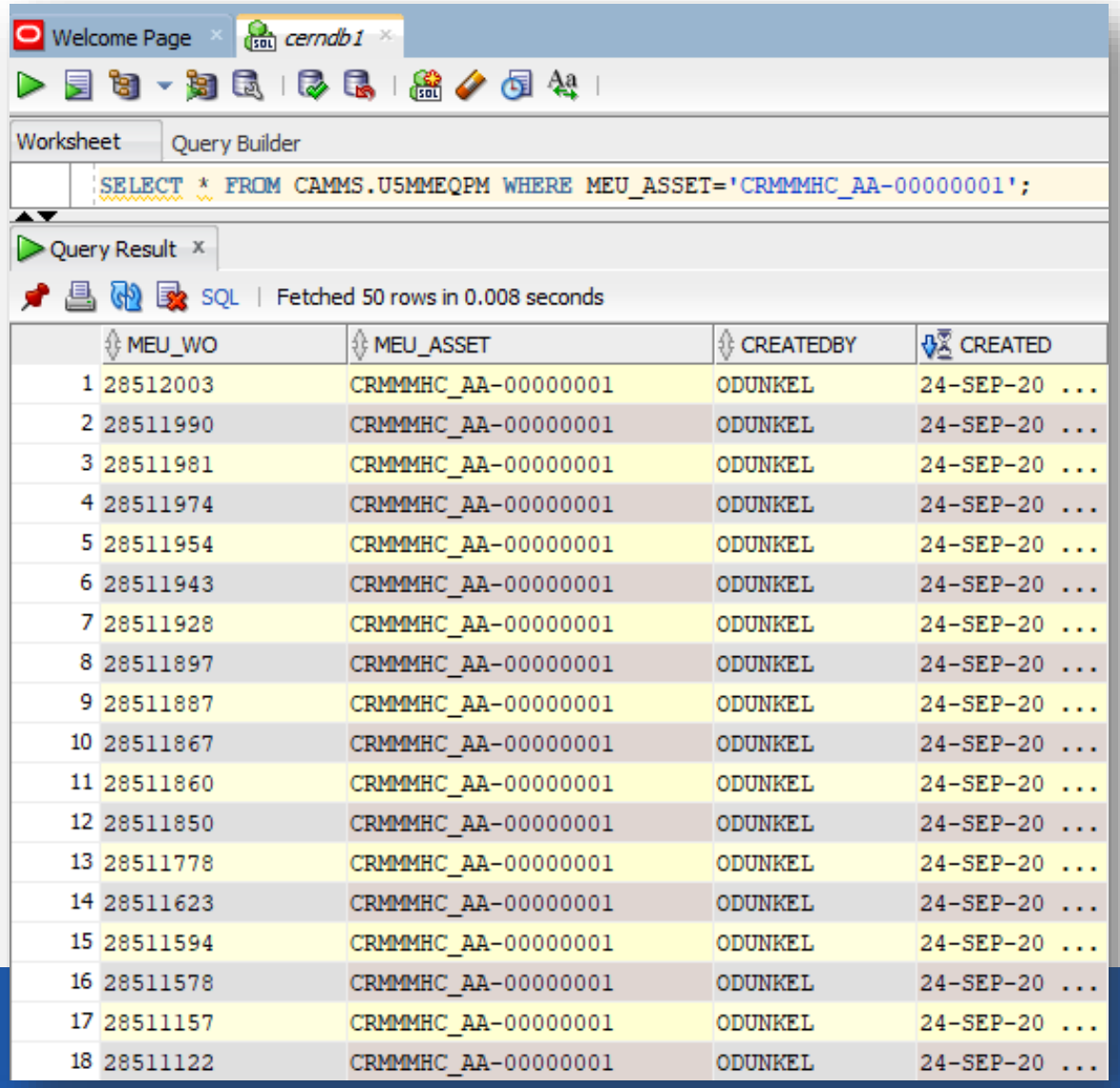
R - Lance: WO created, remains with client
RDT - Demande de travaux lance: WO sent to the section's coordinator
RA - Accepte: WO accepted by the section, engineer assigned to it
RC - En cours: Magnetic Measurement is ongoing
TT - Termine, attente validation CERN: MM finished, waiting for a report
C - Completed: MM finished and WO closed

Number of work orders per status



WO Code	Status	Equipment name	Project	Completed date	Creator	Assigned To
25211409	RA	CRMHRMC001-CR000004			NBOURCEY	PETRONE CARLO 79775 168208
28251587	RDT	CRMMMAR_AJ-00000014			MMEASURE	BELTRON MERCADILLO RICARDO 78642 165160
28253705	RDT	CRMMMCO_AD-00000030			MMEASURE	BELTRON MERCADILLO RICARDO 78642 165160
28152998	RDT	CRMMMPB_AF-00000001			MMEASURE	BELTRON MERCADILLO RICARDO 78642 165160
28164074	RDT	CRMMMPB_AH-00000020			MMEASURE	BELTRON MERCADILLO RICARDO 78642 165160
28167118	RDT	CRMMMPB_AH-00000033			MMEASURE	BELTRON MERCADILLO RICARDO 78642 165160
28233994	RDT	CRMMMPB_AK-00000001			MMEASURE	BELTRON MERCADILLO RICARDO 78642 165160

In which Meas. Runs have we used a specific piece of equipment?



	MEU_WO	MEU_ASSET	CREATEDBY	CREATED
1	28512003	CRMMMHC_AA-00000001	ODUNKEL	24-SEP-20 ...
2	28511990	CRMMMHC_AA-00000001	ODUNKEL	24-SEP-20 ...
3	28511981	CRMMMHC_AA-00000001	ODUNKEL	24-SEP-20 ...
4	28511974	CRMMMHC_AA-00000001	ODUNKEL	24-SEP-20 ...
5	28511954	CRMMMHC_AA-00000001	ODUNKEL	24-SEP-20 ...
6	28511943	CRMMMHC_AA-00000001	ODUNKEL	24-SEP-20 ...
7	28511928	CRMMMHC_AA-00000001	ODUNKEL	24-SEP-20 ...
8	28511897	CRMMMHC_AA-00000001	ODUNKEL	24-SEP-20 ...
9	28511887	CRMMMHC_AA-00000001	ODUNKEL	24-SEP-20 ...
10	28511867	CRMMMHC_AA-00000001	ODUNKEL	24-SEP-20 ...
11	28511860	CRMMMHC_AA-00000001	ODUNKEL	24-SEP-20 ...
12	28511850	CRMMMHC_AA-00000001	ODUNKEL	24-SEP-20 ...
13	28511778	CRMMMHC_AA-00000001	ODUNKEL	24-SEP-20 ...
14	28511623	CRMMMHC_AA-00000001	ODUNKEL	24-SEP-20 ...
15	28511594	CRMMMHC_AA-00000001	ODUNKEL	24-SEP-20 ...
16	28511578	CRMMMHC_AA-00000001	ODUNKEL	24-SEP-20 ...
17	28511157	CRMMMHC_AA-00000001	ODUNKEL	24-SEP-20 ...
18	28511122	CRMMMHC_AA-00000001	ODUNKEL	24-SEP-20 ...

Which are the calibration results of a specific Array?

infor EAM

Work Equipment PRODUCTION - Group: MM-ADM - User: TESTTOUR

Asset CRMMMPB_AM-00000001 PCB Coil - CERN - L22W7.T60.N10.S250

Tabs

(temp)MM Coil Calibration Data Edit Parent Asset Run

Parent Asset	Asset	Description	Alias	Status	Efficient Coil Area (mounted calib.) [m^2]	Calibration Date (mounted)
CRMMMAR_AM						
CRMMMAR_AM-00000001	CRMMMPB_AM-00000001	PCB Coil - CERN - L22W7.T60.N10.S250	L22W7....	Installe et Maintenu	0.0117418120916619	28-JUL-2020 12:09
CRMMMAR_AM-00000001	CRMMMPB_AM-00000002	PCB Coil - CERN - L22W7.T60.N10.S250	L22W7....	Installe et Maintenu	0.0117381126868854	28-JUL-2020 12:09
CRMMMAR_AM-00000001	CRMMMPB_AM-00000003	PCB Coil - CERN - L22W7.T60.N10.S250	L22W7....	Installe et Maintenu	0.0117329529594706	28-JUL-2020 12:09
CRMMMAR_AM-00000001	CRMMMPB_AM-00000004	PCB Coil - CERN - L22W7.T60.N10.S250	L22W7....	Installe et Maintenu	0.0117346492585819	28-JUL-2020 12:09
CRMMMAR_AM-00000001	CRMMMPB_AM-00000005	PCB Coil - CERN - L22W7.T60.N10.S250	L22W7....	Installe et Maintenu	0.0117413951116846	28-JUL-2020 12:09
CRMMMAR_AM-00000002	CRMMMPB_AM-00000006	PCB Coil - CERN - L22W7.T60.N10.S250	L22W7....	Installe et Maintenu	0.0117313481046658	28-JUL-2020 13:48
CRMMMAR_AM-00000002	CRMMMPB_AM-00000007	PCB Coil - CERN - L22W7.T60.N10.S250	L22W7....	Installe et Maintenu	0.0117286410704893	28-JUL-2020 13:48
CRMMMAR_AM-00000002	CRMMMPB_AM-00000008	PCB Coil - CERN - L22W7.T60.N10.S250	L22W7....	Installe et Maintenu	0.0117283326284504	28-JUL-2020 13:48
CRMMMAR_AM-00000002	CRMMMPB_AM-00000009	PCB Coil - CERN - L22W7.T60.N10.S250	L22W7....	Installe et Maintenu	0.0117246576365757	28-JUL-2020 13:48
CRMMMAR_AM-00000002	CRMMMPB_AM-00000010	PCB Coil - CERN - L22W7.T60.N10.S250	L22W7....	Installe et Maintenu	0.0117367730419845	28-JUL-2020 13:48
CRMMMAR_AM-00000003	CRMMMPB_AM-00000011	PCB Coil - CERN - L22W7.T60.N10.S250	L22W7....	Installe et Maintenu	0.0117266555374391	28-JUL-2020 14:49

Records: 50 of 50 123 Show Filter Row:

Benefits (1/2)

- ✓ Consistency & no duplications of data *(centralized database)*
- ✓ Fewer human errors *(manual entry of data minimized)*
- ✓ Streamline of procedures
- ✓ Systematic documentation without extra admin. overhead

  (equipment used, raw data, final results, meta-data)
- ✓ Time & workload savings
- ✓ More focus on the workflow

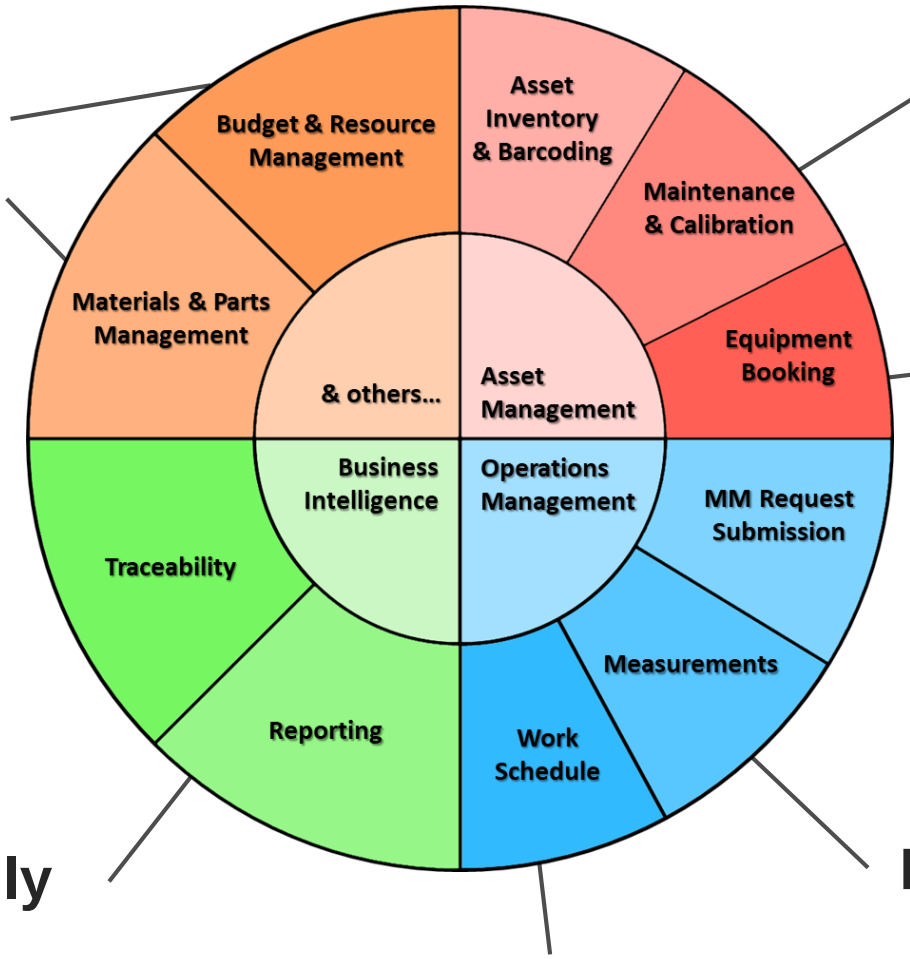
Benefits (2/2)

- ✓ Full history of maintenance, calibration & measurements available
- ✓ Full traceability of results *(reconstruction possible if needed)* & faults of equipment
- ✓ Latest information available instantaneously and in a few clicks
- ✓ User-friendly interfaces *(EAM Light, Infor EAM, FFMM, Pentaho Reports)*
- ✓ Knowledge transfer *(a single "view of all the data")*

Future Road-Map

Monitor budget & resources *(costs, materials, parts, man-power, etc.)*

Create alerts & task-plans
Handle warranties



Use Infor’s equip. booking functionality

Generate automatically the MM Protocols

Expand to other MM Systems

Use Infor’s Gantt chart functionality

Conclusions

- ✓ Management & Information System that:
  - integrates asset management, database structures, and FFMM to support our every-day activities.
  - increases the traceability and the quality of the results, while limiting the administrative overheads to a minimum.
- ✓ Effort is shifted to development & customization.
  - Re-use of functions & structures helps in this direction.
- ✓ Benefits already available, more to come as system expands!

Thank you very much for your attention!