On the brink of a new maintenance management project at CERN

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on behalf of the
CERN EN-TE-BE maintenance management project team
(with contributions by: A. Day, R. Nunes, G. Peon, J. Ortolà, D. Tommasini)

Contents

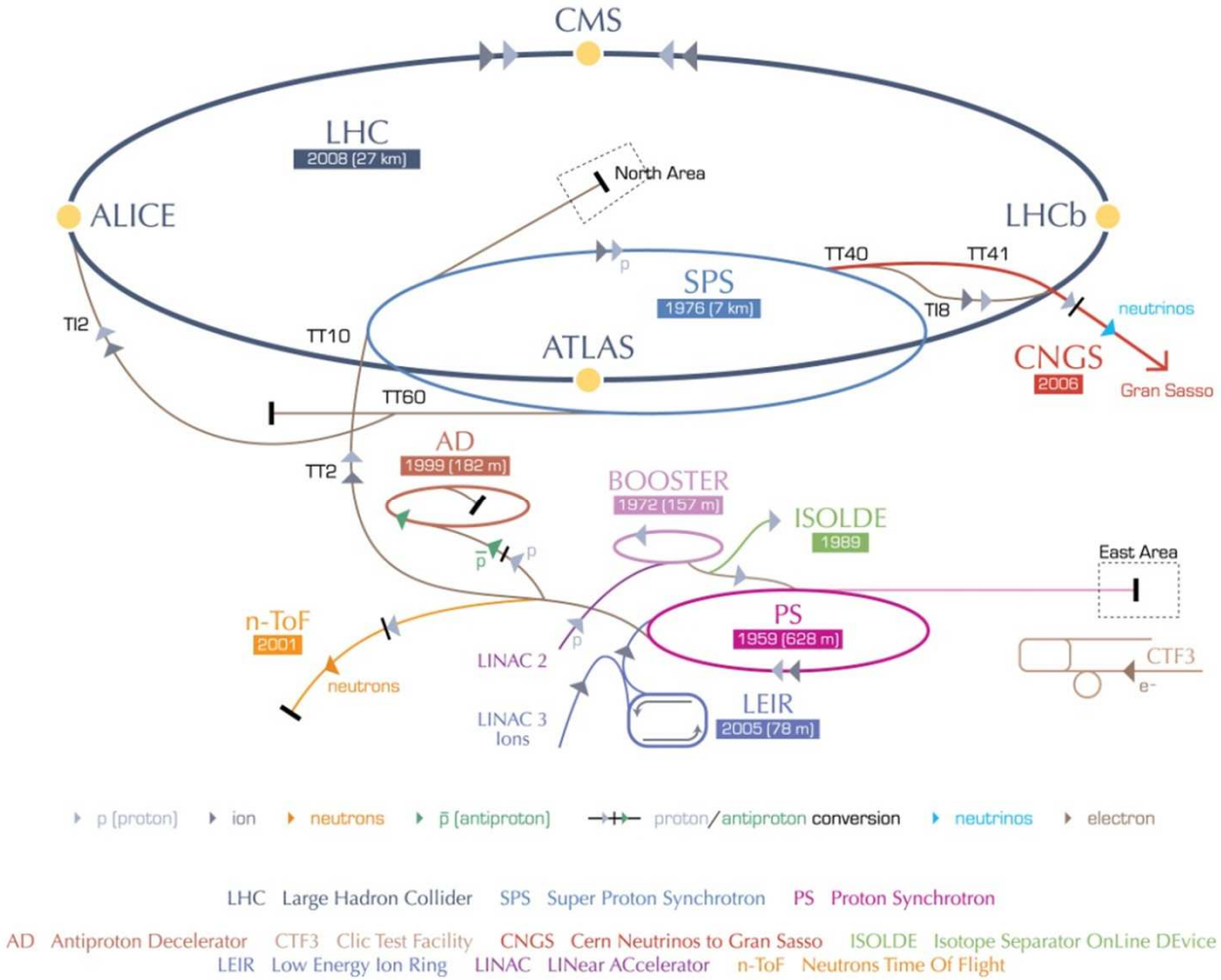
- Introduction
- Maintenance at CERN
- Where are we today?
- The new maintenance project

CERN

Contents

- Introduction
  - CERN, its ’s accelerators and detectors
- Maintenance at CERN
- Where are we today?
- The new maintenance project

CERN and its accelerator complex

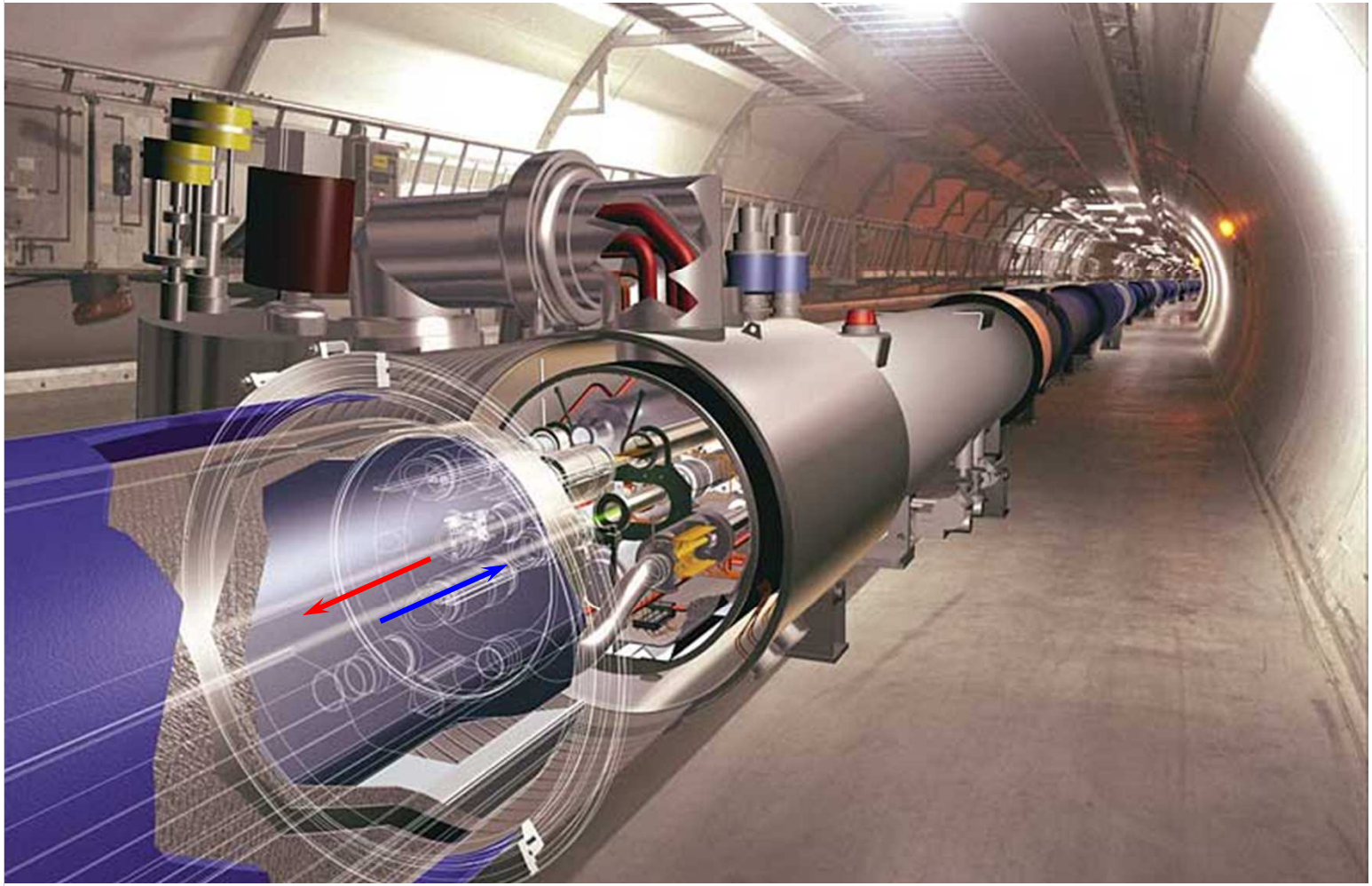


20	member states
2378	employees
9923	users from
574	institutes and universities
5	Accelerators
83	experiments
1026 MCHF	**budget**

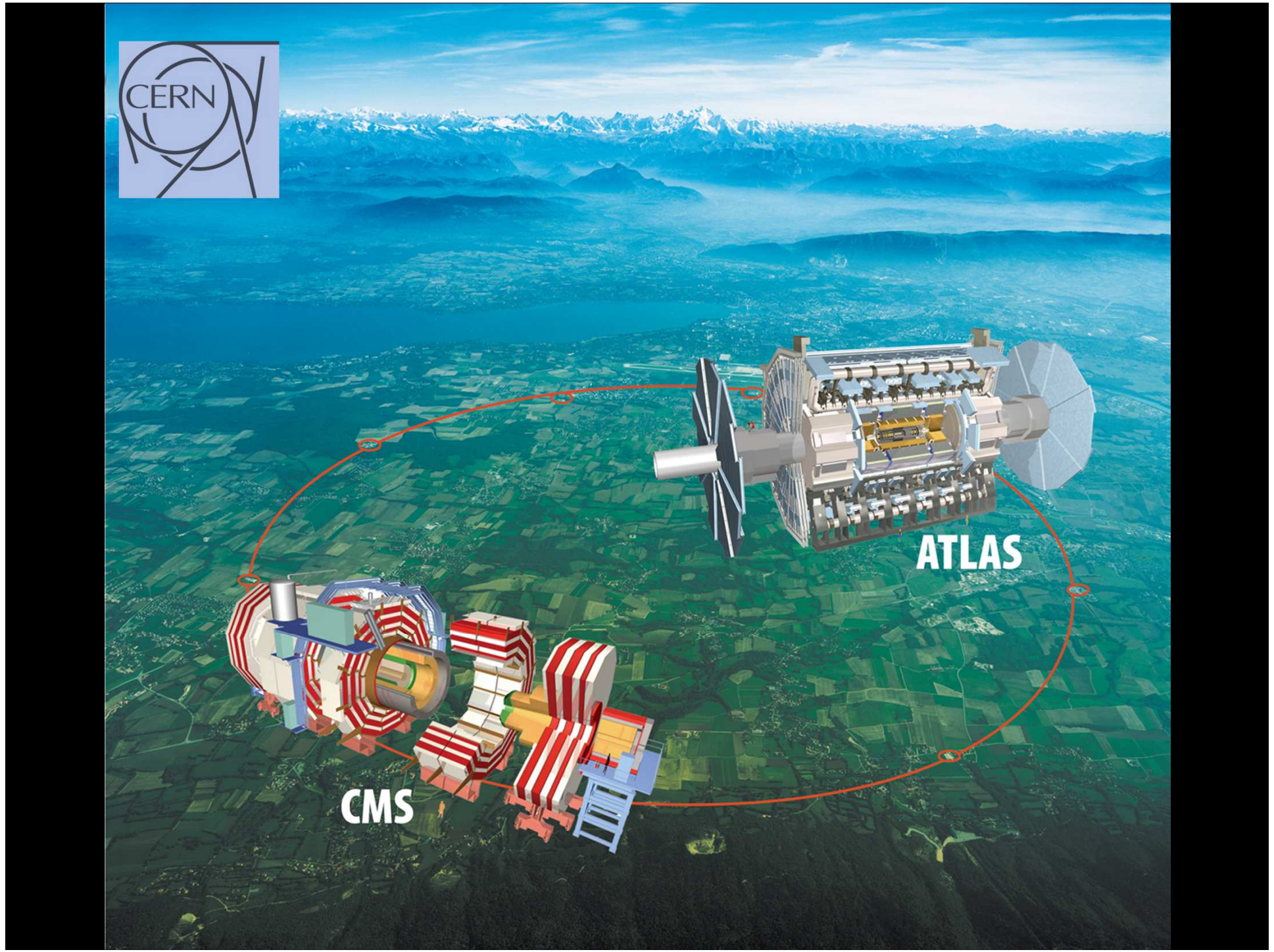
Map not to scale

The Large Hadron Collider

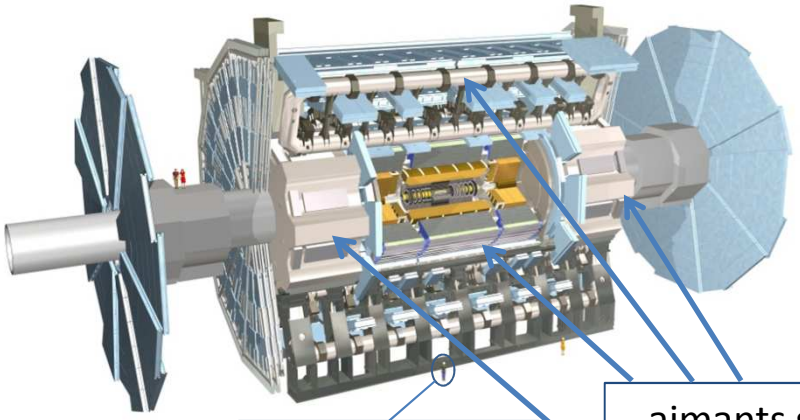
p-p collision 10^{34} $cm^{-2}.s^{-1}$, 14 TeV, 0.5 GJ stored energy



27 km of highly complex installations and components

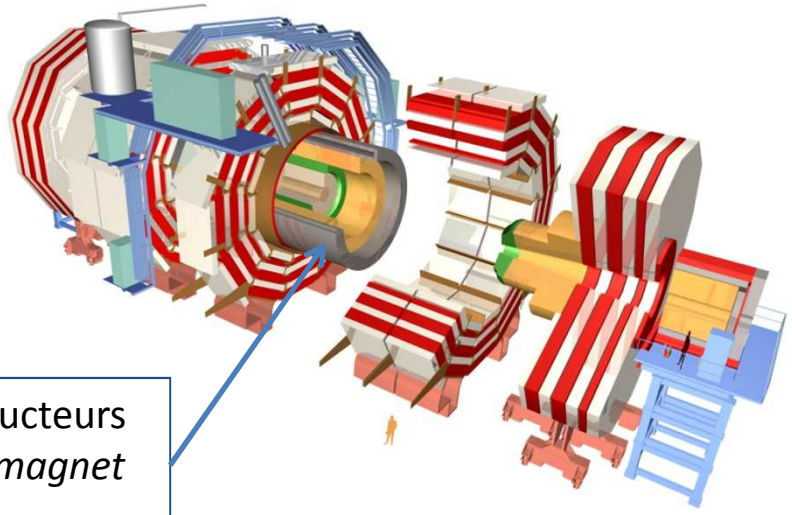

CERN
ATLAS
CMS

Les détecteurs ATLAS et CMS
The detectors ATLAS und CMS



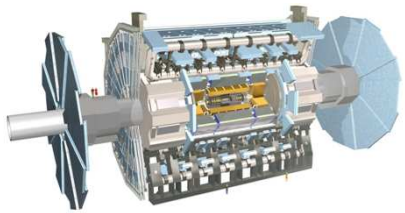
taille d'une personne
size of a human

aimants supraconducteurs
supraconductiong magnet coils

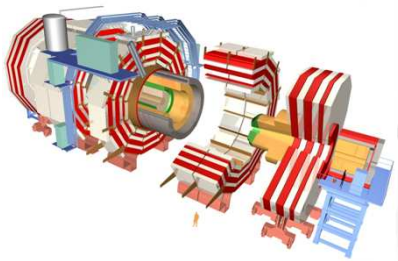


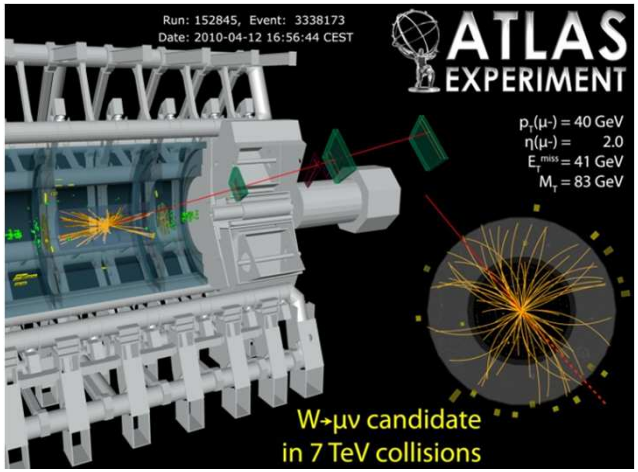
ATLAS	
dimensions, *mass*	46 m x 25 m x 25 m 7'000 t
lieu, *place*	Meyrin, CH
aimants, *magnets*	1 solenoid L=7m d=3m 8 toroids 25 m x 5 m 16 toroids 5 m x 5 m

CMS	
dimensions, *mass*	25 m x 15 m x 15 m 12'500 t
lieu, *place*	Cessy, F
aimant, *magnets*	1 solenoid L=12.5m d=6.5m

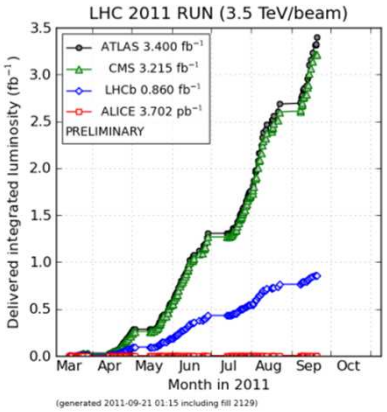


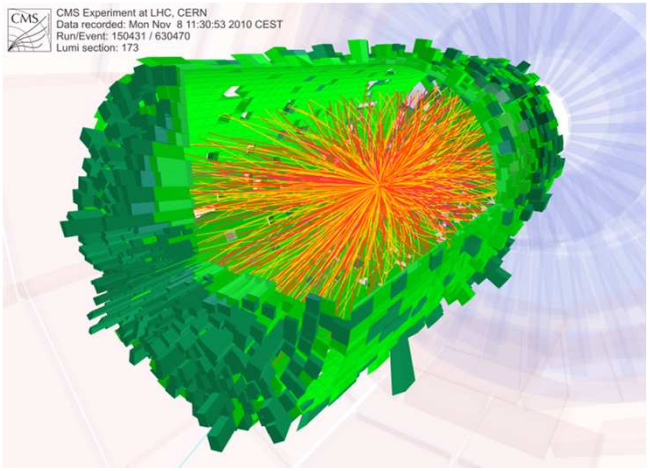
ATLAS and CMS



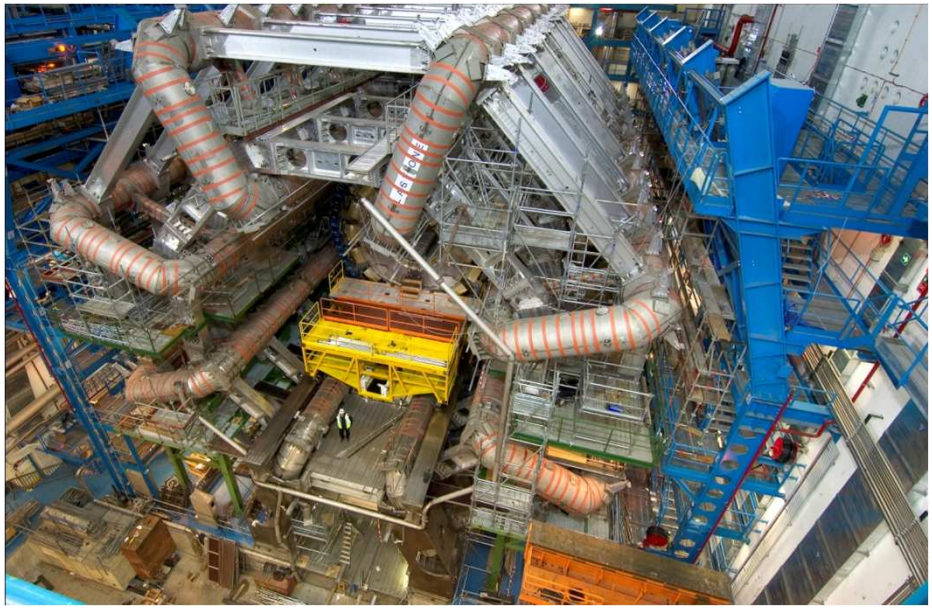


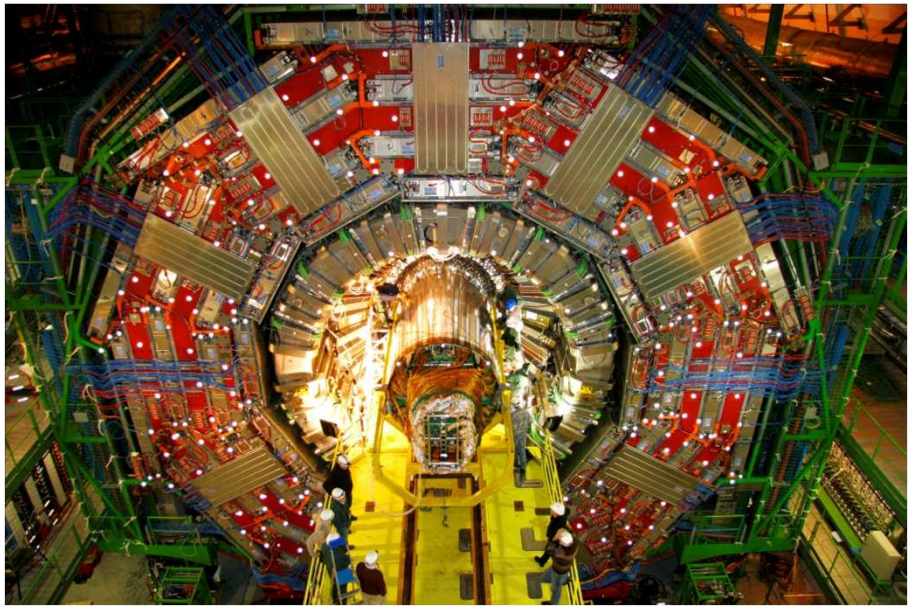
← images of particle collisions →





↓ *pictures from he construction phase* ↓





EXAMPLES MAINTENANCE

Contents

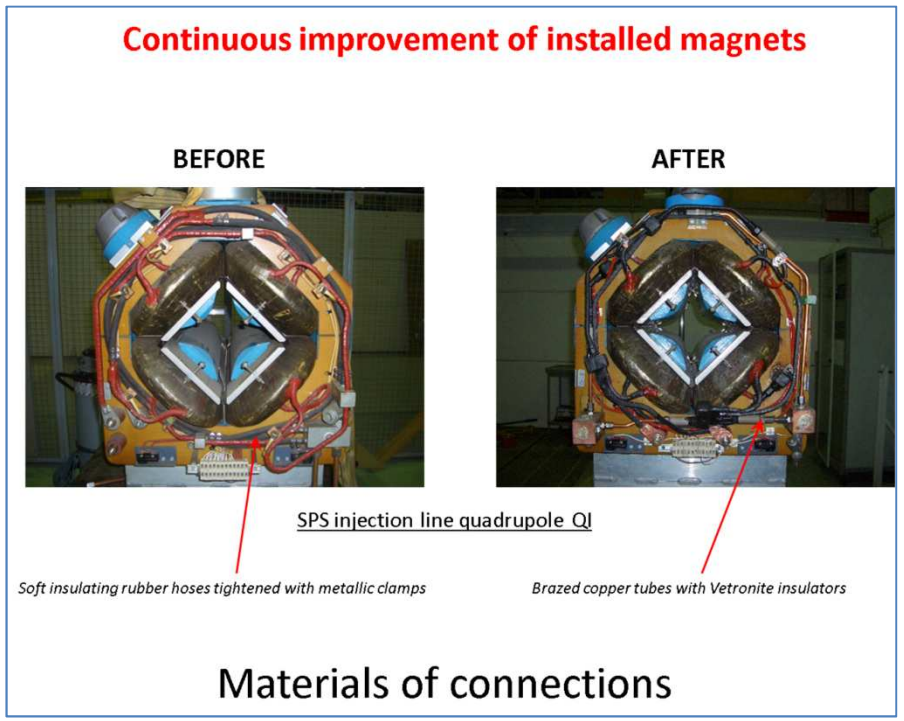
- Introduction
- Maintenance at CERN

  Where is there maintenance at CERN? A few non-exhaustive examples.
- Where are we today?
- The new maintenance project

Example warm magnets (TE-MSC)

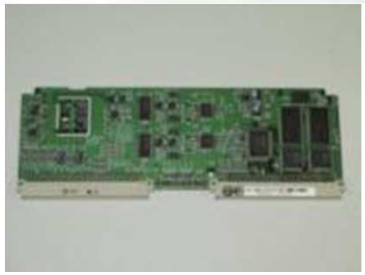
- 5000 installed + 1000 stored magnets, 45 000 tons
- In 2010 18 h machine down-time due to magnet failures
- 24h / 7d piquet service

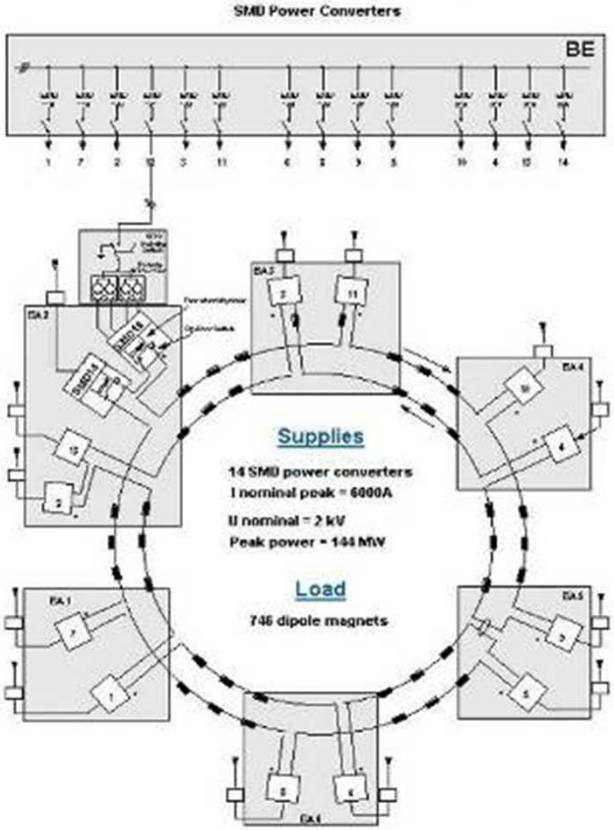
- 4 workshops: 2 radioactive + 2 non radioactive
- 44 staff (including contractors)



Example power convertors (TE-EPC)

The TE-EPC group is responsible for about 4500 power convertors installed on all the different accelerators of CERN.



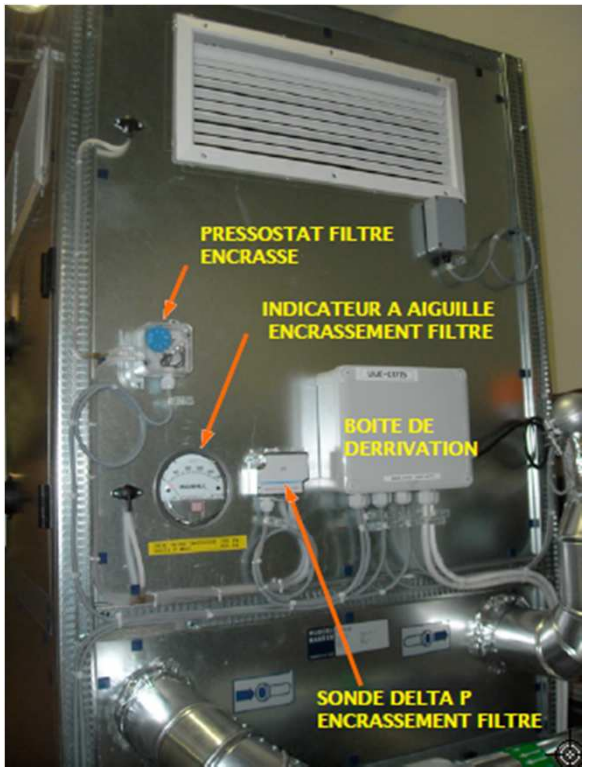


TE-EPC is in charge of the development, the maintenance as well as the operation round the clock.

EDMS Doc. 1095502

Example cooling and ventilation systems (EN-CV)

- EN-CV ensures the maintenance of the cooling systems, the ventilation, the compressed air systems, the sumps, the fire fighting circuits, the fresh water circuits through two contracts
- Each contractor provides about 23 workers managed by 2 team leaders, 2 planning assistants and 1 contract manager
- The contractor ensures an on-call service



Example industrial controls (EN-ICE)

- Centralised, CERN-wide, critical.
- A central critical store at CERN, for all PLC users accessible 24/7 with a complete but reduced Siemens and Schneider PLC stock.
- A store at each supplier premises with a delivery delay of 24 hours maximum. Service contract 10127148 (Siemens) and B1129 (Schneider).
- Only PLC related equipment (no instrumentation)

Example access systems (GS-ASE)

Equipment is mainly composed of

- Access points and doors, gates & barriers
- Cables and switches
- Controls equipment (card readers, biometric readers PLCs, PCs, etc..)
- Video cameras & intercoms
- Servers & databases
- Client computers
- Power supplies

ZORA - **Zo**nes de **RA**diation

SUSI – **Su**rveillance de**SI**te

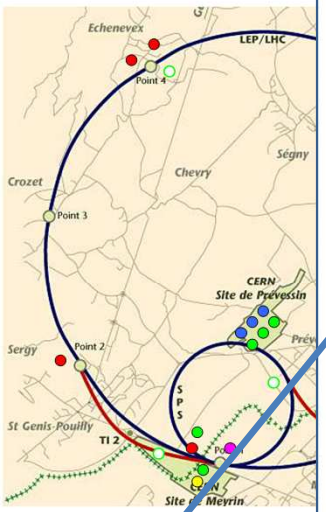
MRC	Equipment	Approx # of objects	Approx replacement value	Age
YLAC	LHC ZORA	1900	20 MCHF	< 5 y
YGAC	SPS ZORA	n/a	15 MCHF	< 20 y
YBAC	PS ZORA	n/a	10 MCHF	< 30 y
YSAC	SUSI	1500	5 MCHF	0 < 5y

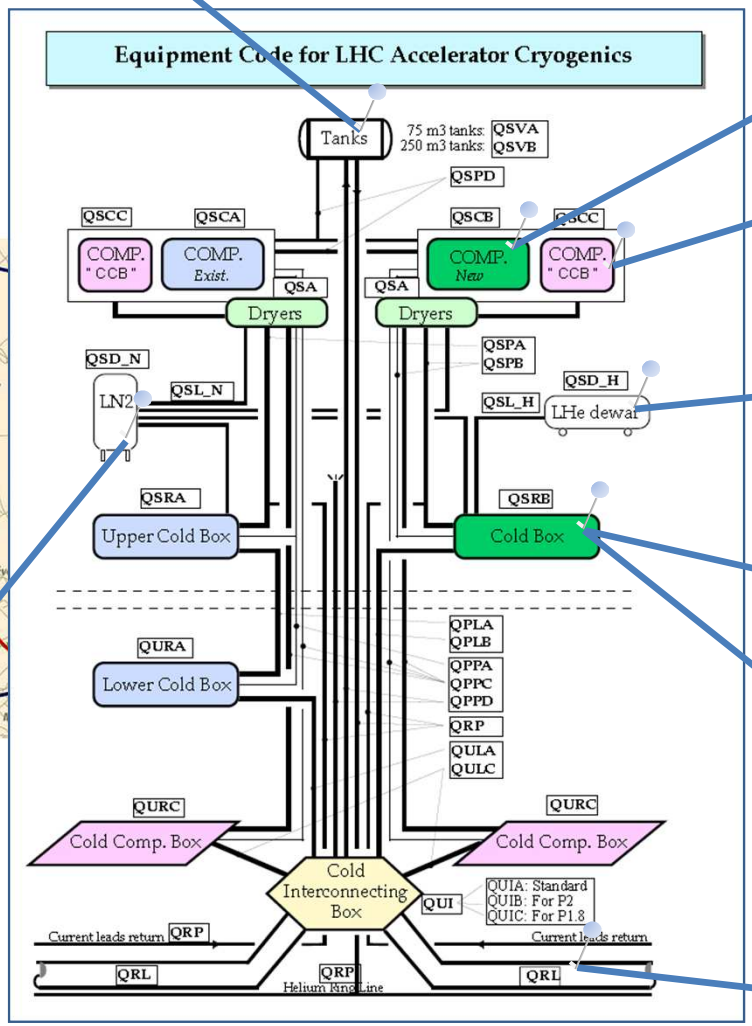
Example cryogenics (TE-CRG)

helium storage

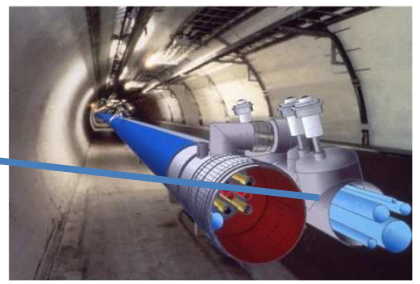
compressor stations

liquid helium storage





cold boxes



helium transfer line

liquid nitrogen storage

Example radiation monitoring equipment (DGS-RP)

363 Monitors

- Radiation protection
- Stray radiation
- Ventilation
- Water
- Weather
- Control


ARC


XRM IAM


AGM AMF TGM TMF

Stray radiation Monitoring


EPIC


ERC


HFM


PCM

Ventilation Monitoring


VGM - VAS

Water Monitoring station


RWM - RWS

Weather Monitoring


USA

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- Introduction
- Maintenance at CERN
- Where are we today?

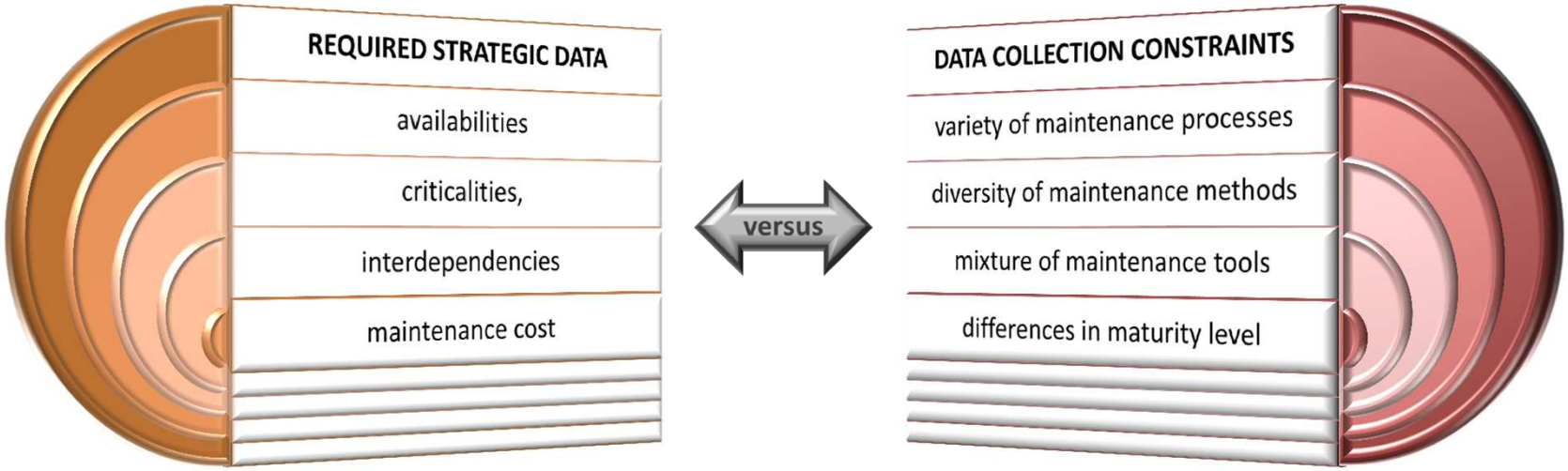
  CMMWG, CMMSB, maintenance review, CAMMS usage audit
- The new maintenance project

Where are we today? - Problem statement

Physics results demonstrate → equipment/facilities are well maintained,

however, CERN management wishes to go even further

→ e.g. to reduce the number of technical stops from 1 in 6 weeks to 1 in 12 weeks



therefore, several actions have been launched:

CMMWG, CMMSB, maintenance review, CAMMS usage audit

Maintenance at CERN

There are many different types of equipments and systems to be maintained

Examples of systems	number of maintained assemblies (a), items (i) or references (r)
Warm magnets (TE-MSC)	5'000 a
Power converters (TE-EPC)	4'500 a
Cooling and ventilation components (EN-CV)	56'000 i
Industrial controls (EN-ICE)	215 r
Access control systems (GS-ASE)	3400 a
Process plants (cryogenics) (TE-CRG)	35'000 i
Radiation monitoring equipment (DGS-RP)	1'700 a
Power supplies, power distribution (EN-EL)	46'000 i
...	

for which different strategies are applied

Insourcing outsourcing strategies
maintenance by CERN equipment owners
maintenance by CERN maintenance teams and/or on-call teams
maintenance by external contractors and their on-call teams
combinations of the above

for which the boundary conditions can be quite different;

Diversity of conditions
from very old (1950s) to brand new components
from prototype devices to catalogue components
from laboratory type installations to industrial plants
from undocumented items to fully traced components

and maintenance can be conditioned by quite different constraints

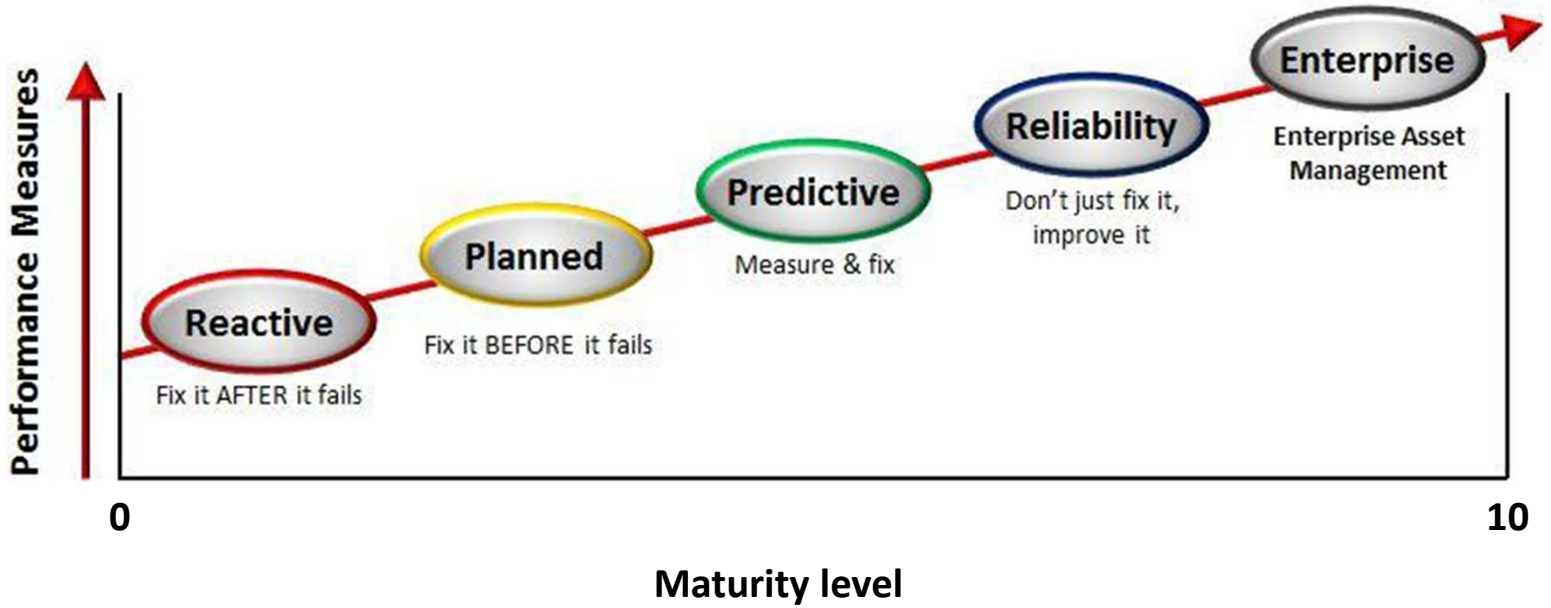
Maintenance constraints
limited or conditional access (tunnel, radiation controlled zones, installation or environment condition)
high level of safety qualification requirements
failures can have high impact on availability
little MTBF data
few or no redundancies

Examples of audit questions (CAMMS usage)

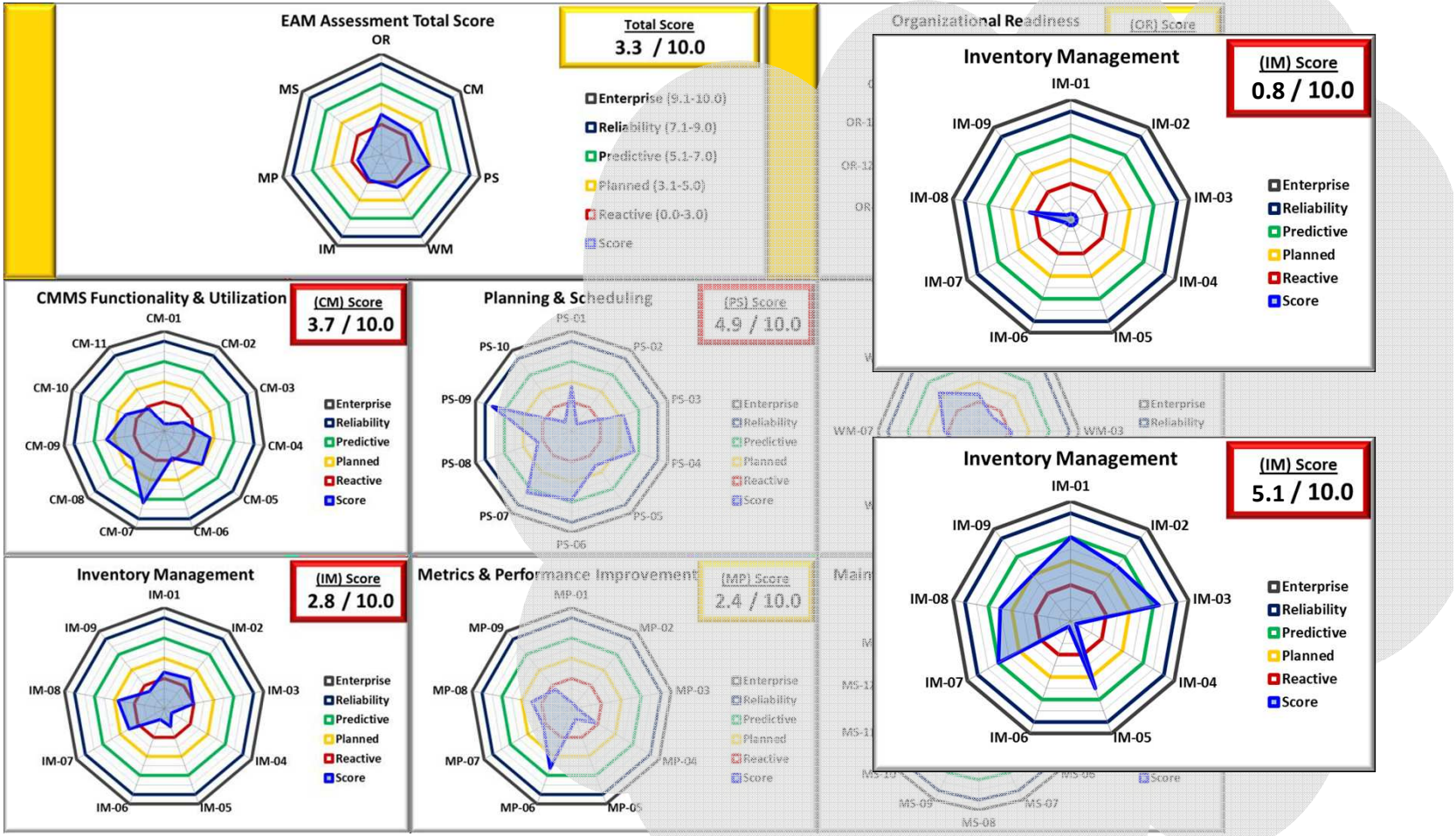
	Topic	Best Practice
CM-01	**Asset Bill of Materials**	Accurate Bill of Materials exists in the CMMS for all critical assets, including the number of used quantities and spare part naming.
IM-07	**Storeroom Organization**	The storeroom is organized and labeled, and parts are easy to locate with the most frequently used parts in a strategic location.
MP-03	**Communication Dashboard**	There is substantial visual communication of operational performance and updated communications in place.
MS-04	**Critical Spare Parts**	Critical spares exist for all assets, starting with the most critical, and a process exists for classifying a spare part as critical based on failure impact (safety, quality, process throughput, cost, etc.).
OR-03	**Asset Management Council**	A mature, multifunctional Maintenance Council is in place and performance reviews are completed on a monthly basis with Operations.

CAMMS usage audit evaluation

77 audit questions in 7 areas:	
CMMS Functionalities & Utilization	Organizational Readiness
Inventory Management	Planning & Scheduling
Metrics & Performance Improvement	Work Management
Maintenance & Reliability Strategy	



Some results of the CAMMS usage audit



The results help to identify the priorities for improvement.
They exemplify also that maturity levels can be quite different.

RESULTS OF ASSESSMENTS (GOOD EXAMPLES)

Example asset management (Infor)

Level 1 (P4 LHC installations)

= Installation site

Level 2 (cryogenic liquid storage)

= Installation

Level 3 (LN2 dewar)

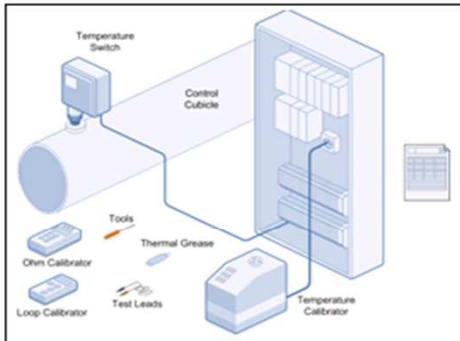
= Process unit

Level 4 (safety valve)

= Functional position

Asset

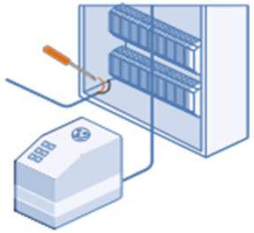
Example documentation



6.1 Make sure the required site equipment for the temperature test is available;

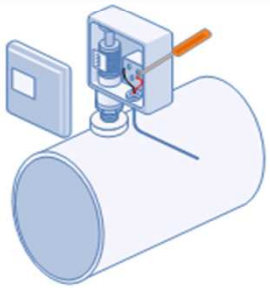
Temperature Calibrator
Loop Calibrator
Test Leads
Thermal Grease
Tools

Record the following data in the calibration report (Form1); date, operator, organisation. The manufacturers name, model no and tag no of the instrument to be tested. The manufactures name, model numbers and serial numbers of the calibration equipment to be used to perform the test. The application of the temperature switch.

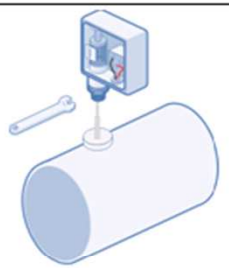


6.2 Connect the temperature calibrator to a spare power supply socket in the control cubicle.

Disconnect the temperature switch cable connections from the terminals inside of the control cubicle in order to prevent accidental short circuits.



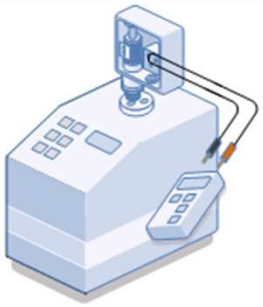
6.3 Open the switch housing and remove the wires from the switch terminals. Record or mark the position of the wires relative to the switch terminals.



5.4 Remove the temperature switch from the pipework by either unscrewing it from the thermowell or by unscrewing the compression fitting nut.

Slide the temperature switch capillary out of the thermowell.

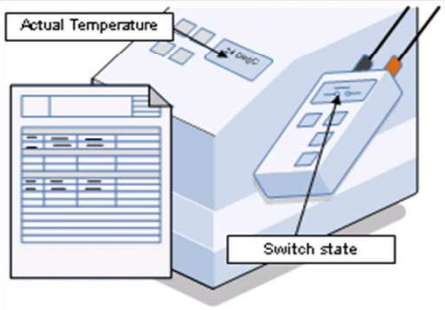
Clean the capillary of any thermal paste residue and inspect the capillary for any damage.



5.5 Place the temperature switch capillary into the test socket of the dry cell temperature calibrator. Ensure that the socket is a good fit for the capillary.

Connect the loop calibrator to the signal output screw terminals of the temperature switch.

Set the calibrator to the continuity test function.

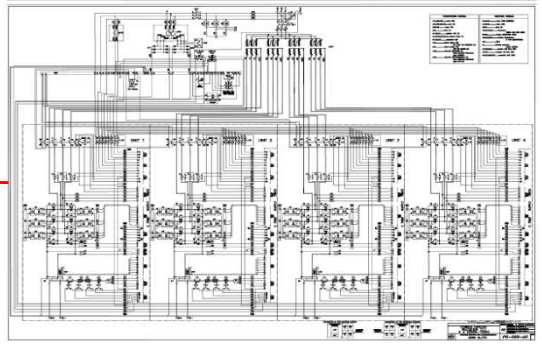


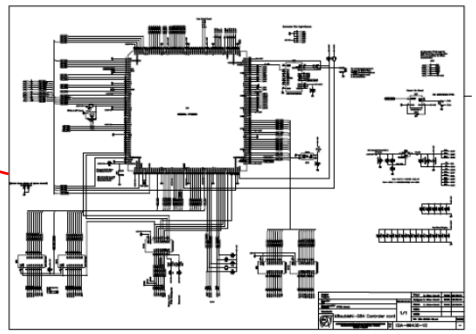
5.6 Adjust the control temperature setting of the temperature calibrator to 5degC below the required setting. Ensure sufficient time for the temperature to stabilise.

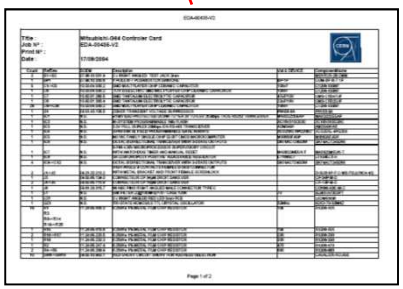
Now set the control temperature setting to 5degCabove the required setting. Record the temperature that the switch changes state and the state of the switch open or closed. Set the control temperature setting to 5degC below the required setting and record the temperature that the switch state changes to the original state.

Example document management (EDMS)

- DC
  - Switching
    - HCRPZBJ001 : S50T : Power Converter GEREG Switching
      - HCREHAR002 : GEREG
      - HCRYAAC001 : Output Contactor Base Plate
      - HCREHBA001 : Base plate 50Hz
      - HCRLAAL001 : Self DC Filter
      - HCRYAAD000 : Switching Plate
      - HCRPCAB001 : Power Module
      - HCREHBB001 : Front Panel
        - HCRBPAA000 : Command Panel Card
        - HCRUAAF000 : Ampermetre et Voltemetre
      - HCRTNAT001 : Transformateur d'intensite (50A/1A)
      - HCRTMAB000 : Power Transformer







Example work order management (sharepoint)

RAMSES > RAMSES Users > Request for Intervention > Bug DAI 3.0.5-h

Request for Intervention: Bug DAI 3.0.5-h

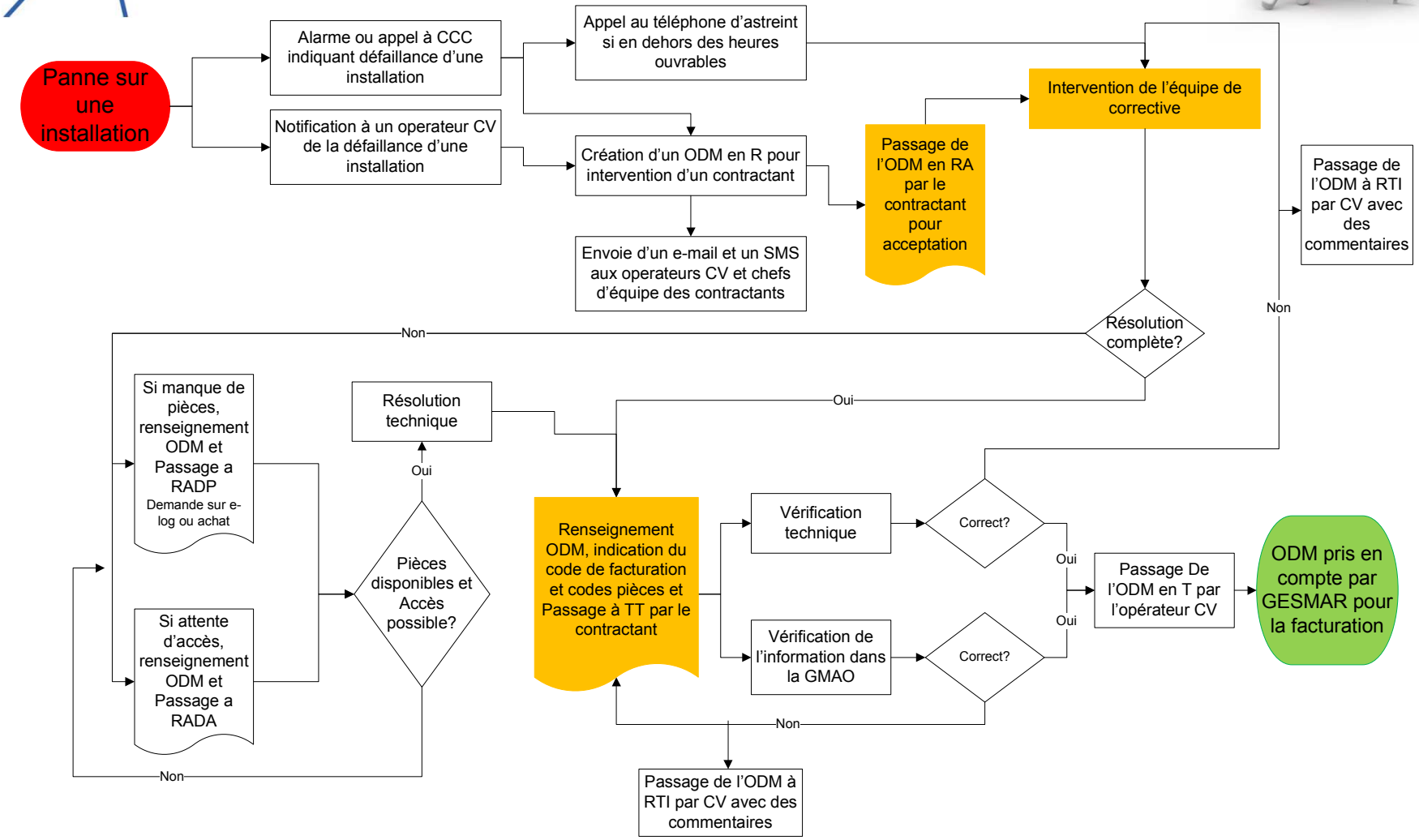
The content of this item will be sent as an e-mail message to the person or group assigned to the item.

Close

New Item | Edit Item | Alert Me | Version History

Title	Bug DAI 3.0.5-h
Status	Resolved
Intervention Requested By	Gustavo Segura Millan
Assigned To	Gustavo Segura Millan
RAMSES Equipment Name	DAI
Location	N/A
Site	
Priority	High
Description Of Intervention / Issue	Le DAI n'affiche pas tous les points de la base de donnes. Dans les fichier attaches il y a une screenshot du DAI en mode table ou on voie ARCON que donne 1 valeus par heure. On voie clairement que il y a des valeurs manquantes. Pour la memen voie de mesure, si on fait un select directement sur la bases (voir fichier excel attache) on peut voir que les donnes sont efectivement dans la base de donnes. Le meme probleme est vue dans plusiers voies: PMVG11C, PMVG11F, PMVG11R, PMVG172F, PMVG51C, etc
Work Log	Laurent Martin (08/11/2010 12:44): Bonjour Gustavo, Avec Isabelle Deschamps, nous n'avons pas constaté de valeurs moyennes minute en base sur la période et les voies que tu as mentionnées. Voir ci-joint le fichier "PMVG51C_ok.bmp" (version DAI utilisée = 3.0.5-h). N'hésite pas à générer un nouveau ticket si tu retrouves le même problème. Cordialement, Laurent MARTIN Laurent Martin (13/07/2010 18:01): Bonjour Gustavo, Le problème a été transmis à Isabelle Deschamps. Cordialement, Laurent MARTIN Gustavo Segura Millan (10/06/2010 17:15): J'ai attache le fichiers et marque en rouge les donnes que sont pas affiches par le DAI. Le fichier excel contiene aussi le code de la requete sql. La data sur exel et en UTC (dump de la base) donc il y un decalage de 2 heure avec le screen shot du DAI. Cordialement, Gustavo Julien Regnard (08/06/2010 10:53): Pourriez-vous attacher le fichier cité à cette requête d'intervention car celui-ci est manquant. Est-il possible de préciser le "Sampling Mode" utilisé ? Merci d'avance.

Example maintenance work flow



Example asset organisation (Infor)

List view | Record view | Comments | Custom fields | Events | Costs | Readings | Warranty | Equipment hierarchy

Equipment: EHT102/4E — TRANSFO.66/18KV 38MVA
Organization: * — Default organization
Type: Position fonctionelle
Department: ERL — SCHNEIDER-SOTEB RES
Status: Installe et Maintenu
Class: ET * TRANSFORMATEUR
Production
Category: ETHNP — TRANSFORMATEUR A HUILE NON PROTEGE
Safety
Profile:

Hierarchy

Parent:
Location: SEH4
Position:

PM Details

Manufacturer: ZAPO
Serial number: 146043
Commission date: 17-03-1992
Meter unit:
PM plan:

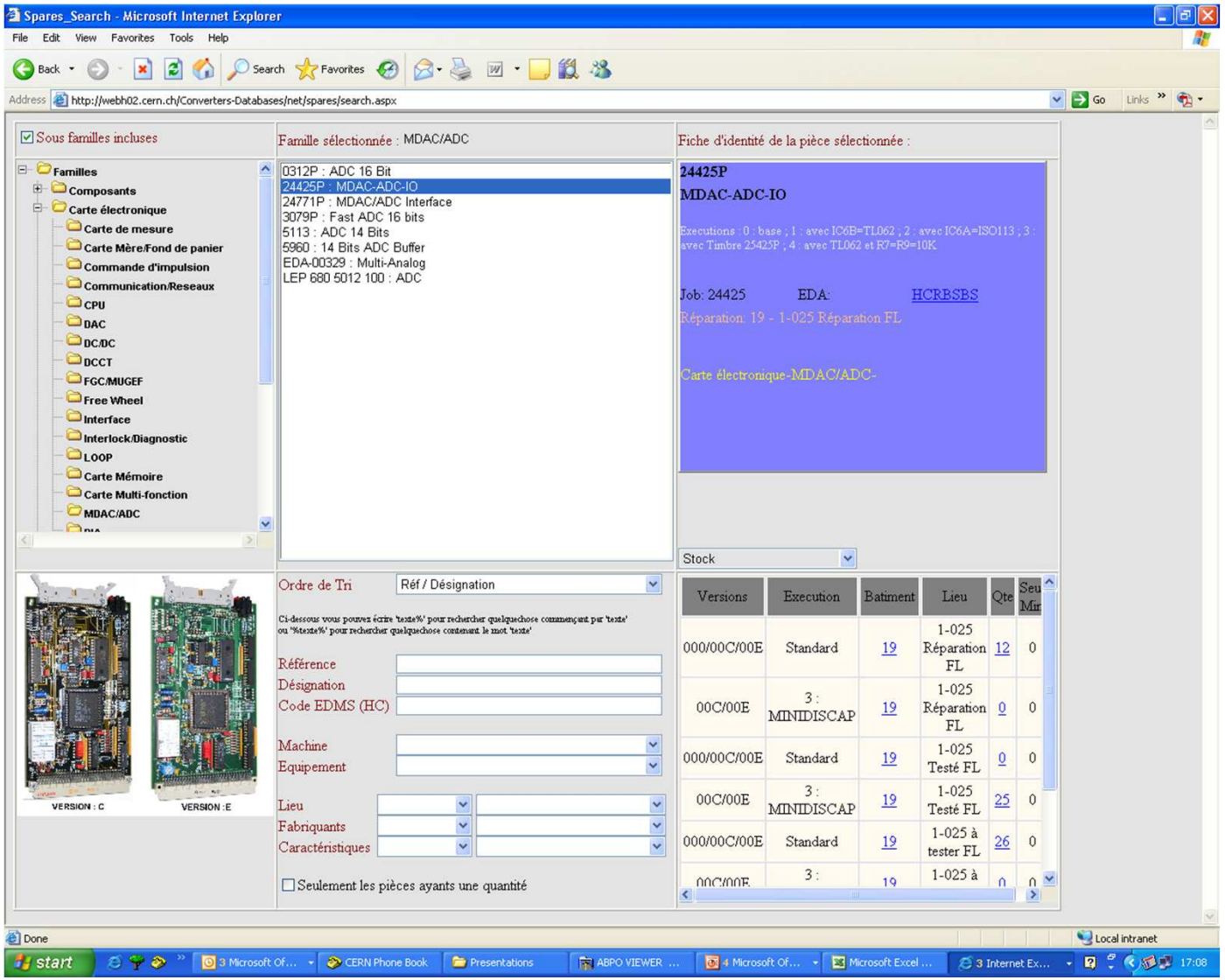
List view | Record view | Comments | Custom fields | Events | Costs | Readings | Warranty | Equipment hierarchy

Equipment: EHT102/4E — TRANSFO.66/18KV 38MVA — *

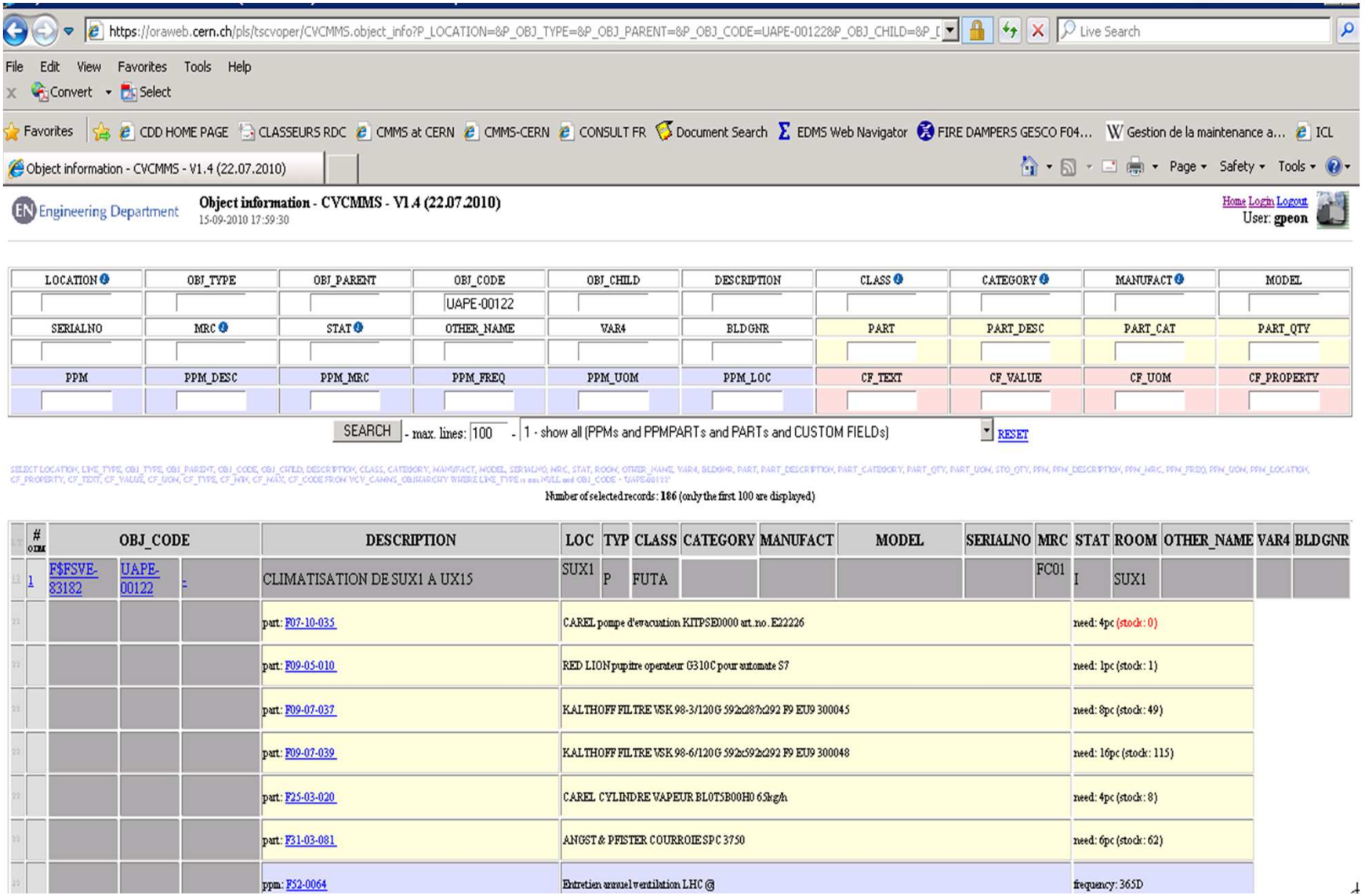
1

Détenteur (ID CERN)		
Resp. Technique (ID CERN)		
Année de construction	1991	
Masse totale	75600	kilogramme
Frequence	50	hertz
Puissance apparente	38000	kilovoltampere
Type de transformateur	TMH-38000/66-Y1	
Tension primaire	66000	volt
Tension secondaire	18000	volt
Intensite primaire	332.4	ampere
Intensite secondaire	1218.8	ampere
Type de regleur	A VIDE	

Example spares management (web based)



Example report tool (web based)



Example report tool (Business Objects)

Overview					
Work Order		**WO Type**	CD - Correctif Depannage (CD)		
Created on	23/11/2010	**Created by**	NCALVET		
Description	Remplacement du positionneur 6 CV 670 P8				
Equipment	QSCB-8-6CV670	**Description**	VANNE DE REGULATION		
Department	SERV. INSTRUM. SOUS TRAITANT (QSSE)			**Location**	
Reported by		**PM Code**		**Reported on**	23/11/2010
Scheduled Start		**Problem Code**		**Failure Code**	
Started on	23/11/2010	**Completed on**	07/02/2011	**Status**	TP (TP - Termine et paye)

Work Order comments	by
-Probleme sur le delta P d'huile au niveau du filtre d'entree du Cp6 et Cp7 car nous avons tendance parfois a passer en dessous de la valeur d'arret. -Nous avons mis la regulation de la 6 CV 670 du set point a 3.8 bars au lieu de 3.3 bars. Ce set point est celui d'origine pour l'installation.	by NCALVET on 23/11/2010

Launching						
Priority	*	Toutes Priorités	**released on**	23/11/2010	**by**	MCUGNET

Activities and Trades			
Activity	**Trade**	**Estimated Duration**	**People required**
5	QTE (Technicien Elec/Instrum)	4	1

Parts Used			
Part	**Description**	**Activity**	**Quantity**
Q00160	POSITIONNEUR SVI AVEC CAPTEUR DE POSITION VANNE MASONEILAN	5	0
QIDEI	debugging of instrumentation	5	1

Intervention Report			
Activity	**Person**	**Started on**	**Hours**
5	DREVARD DOMINIQUE FRANCOIS 78849 163670 (Technicien Elec/Instru	21/12/2010	2

Comments (closing)	Completed
Suite au redémarrage de l'installation plus de problème rencontré (vu avec opération S06). la recopie suit correctement la demande.	by SCALLEJA on 07/02/2011
Vérification de la vanne effectuee. Léger décalage de la recopie de position par rapport à la demande. Réglage du gain pneumatique du positionneur SVI. meilleur réaction de la vanne lors de la demande, vu avec Opération PT8. A suivre lors du redémmarage.	by SCALLEJA on 07/01/2011

Intervention validation			
Check carried out:	07/02/2011	**Validation:**	by SCALLEJA

AUDIT …

CMMWG, CMMSB, review and audit conclusions

We do all apply a maintenance process based on the same basic principles.

There are already excellent best practice examples.

There are on the other hand also areas where only basic implementations exist.

There is a high demand for improvement from all sides.

A common approach is desirable.

Contents

- Introduction
- Maintenance at CERN
- Where are we today?
- The new maintenance project

  Objectives, path, structure

Objectives of the maintenance management project

Develop a modular maintenance management framework

- time target 2 years

Interface the framework with existing databases

- e.g. layout database, documentation repository (EDMS), intervention planning (IMPACT)
- and ensure that **no double data entry** is required between these systems

Define a method for identifying critical assets

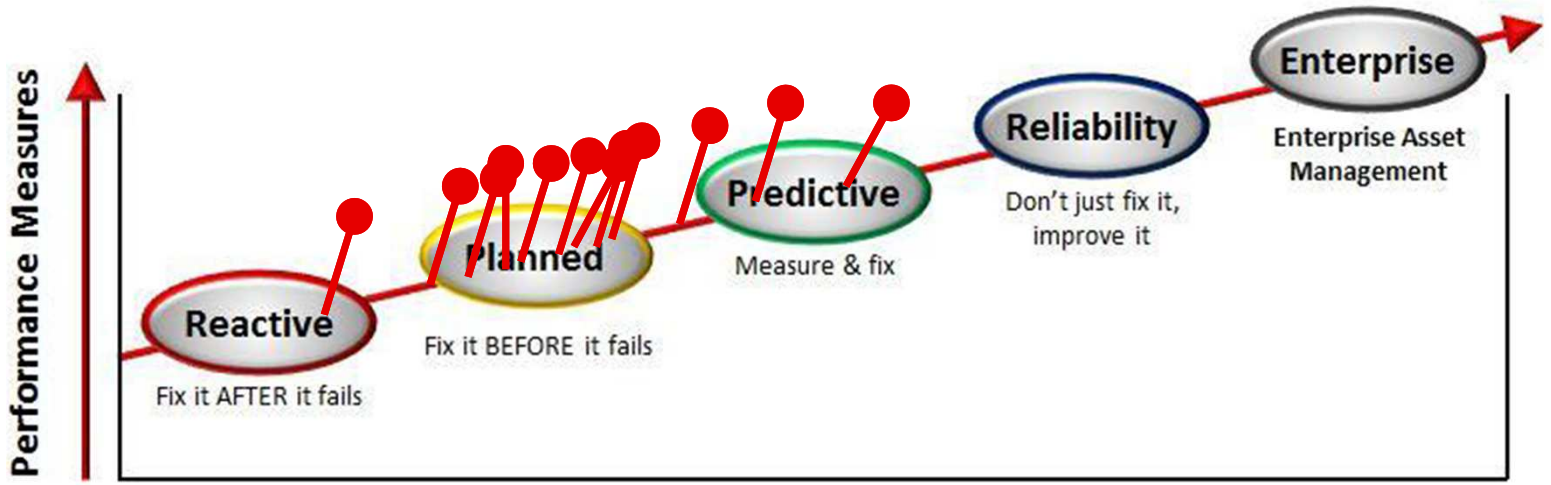
- and identify at least 95% of the critical assets.

Ensure within the time frame of the project that the framework:

- handles **50% of the technical assets** covered by the framework
- manages **50% of the spare parts** in the perimeter of the framework
- makes available **50% of the documentation** required for maintenance tasks
- calculates the **MTBFs** of all critical assets

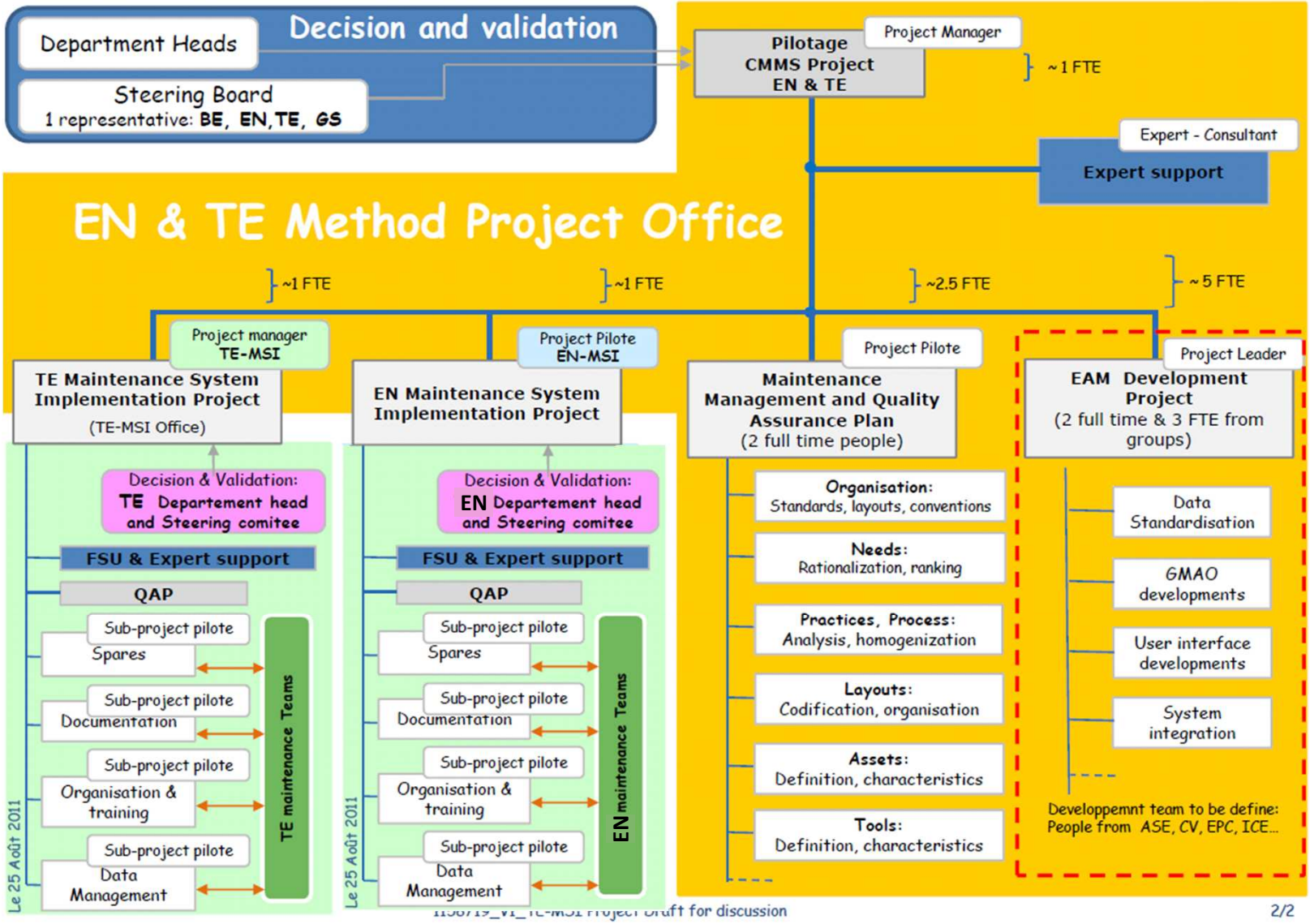
Conceive, elaborate and deploy an organization that shall ensure the continuity of the deployed methods

The path to pursue?



The maintenance management project shall ensure that each stakeholder will make measurable advancements in the maturity of his/her maintenance process.

The maintenance management project



Conclusions

Physics results demonstrate → CERN's equipment/facilities are well maintained.

However, the target is an even higher level in the maintenance process maturity.

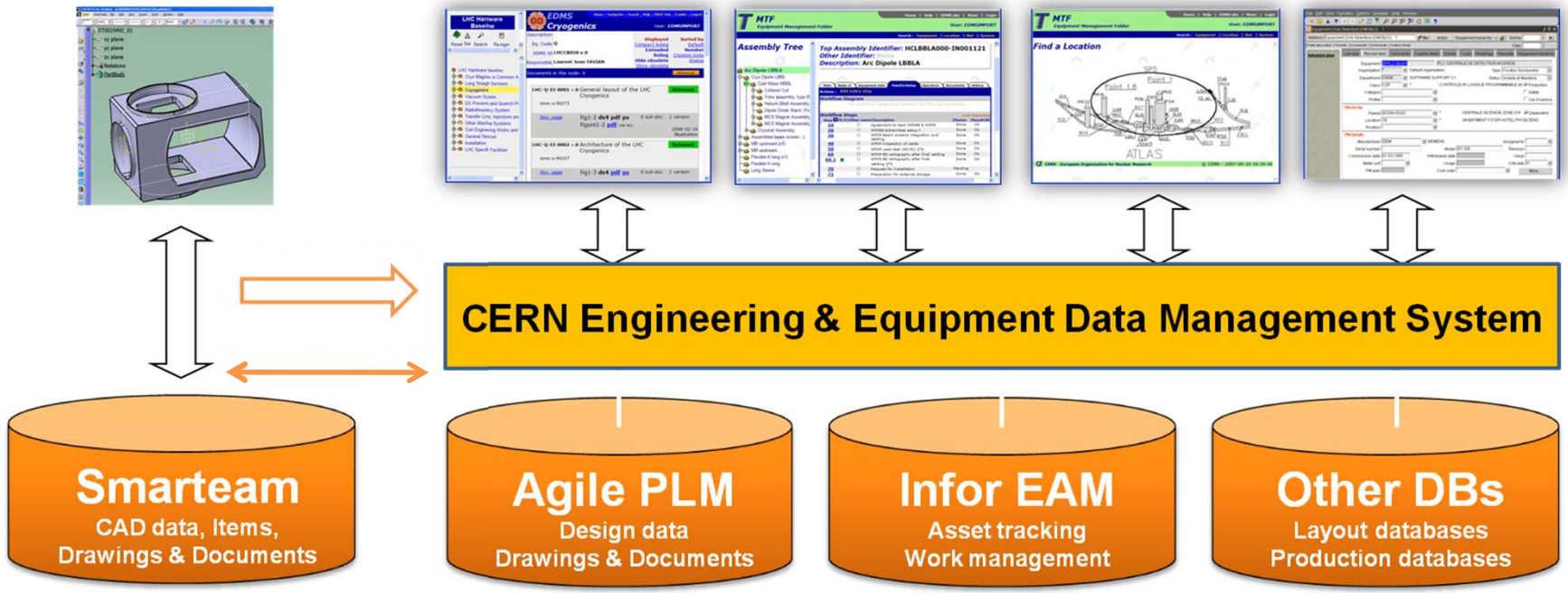
A comprehensive status quo of the maintenance has been established.

A highly motivated project team is preparing the implementation of a new maintenance management framework.

However, this is only the start ...

IN CASE

Example databases



* Agile PLM was formerly called Axalant
* Infor EAM was formally called Datastream7i

Nos défis II
Unsere Herausforderungen II

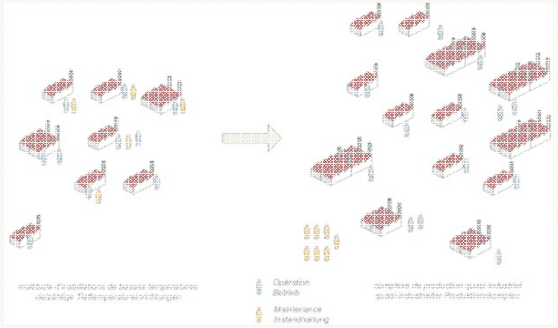
Du projet à l'opération
Vom Projekt zum Betrieb

2000 – 2008	depuis / *seit* 2009
Projet de construction *Bauprojekt*	Opération *Betrieb*

(Maintenance) → Maintenance

Insourcing versus outsourcing

Du laboratoire au complexe d'accélérateurs
Vom Labor zum Beschleunigerkomplex



Et dans le futur ? *Und in der Zukunft?*

- Une vision et une stratégie commune
  Eine gemeinsame Vision und Strategie
- Des méthodes « meilleure pratique »
  Methoden « beste Praxis »
- Une GMAO intuitive
  Ein benutzerfreunliches CAMMS


CERN


Maintenance Project