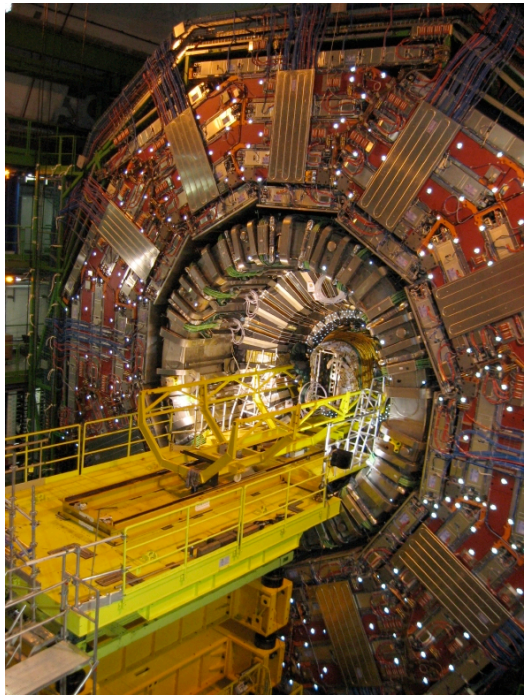
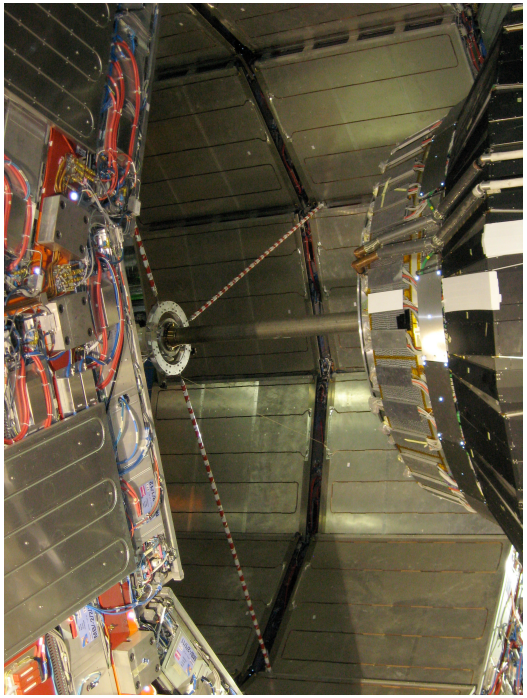
The CMS Integration project & design office

G.W. Faber _ ETH-Zurich

CMS Engineering & Integration Centre.





"Started before 1994 _ 2009 and beyond"

ILD meeting CERN 21-01-'09

CMS Integration

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Organization	*(how it started)*
Quality Management	*(what people did not want)*
Sociological "challenges"	*(good BBQ memories)*
Communication	*(the most difficult part in life)*
Tools	*(as few, as simple as possible, "kiss")*
Lessons learned	*(probably not, some people don't like history)*
Engineering Databases	*(evolve with the detector development)*

Just some notes

Outlook LHC _ SLHC *(still lots of work after Detector completion)*

Conclusion

Organization

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F. Pauss _ H. Hofer _ A. Herve

1/ Thanks to their "Unconditional" support for the Integration effort,
within the available (limited) resources over many years.
2/ Optimized position inside the "Federal" CMS organization,
linked to Management and Technical coordinators.
3/ Simplified "Self learning" and "Iterative process" approach,
continuous verification/validation of evolving detector designs.
4/ Engineering & Integration positioned as a service to CMS Physics,
conceptual design, modular for rapid access, opening/closing.

The CMS Integration has been a complete success.

The proposal to create a CMS project office was refused by the collaboration. Project leaders acceptance of a "Neutral Integration office" was not evident. No budget line existed for integration, the Cern policy did not foresee onsite integration offices and supported "WWW Out sourcing". Therefore ETH-Z has taken a major and leading role in the CMS Integration effort.

Self learning process

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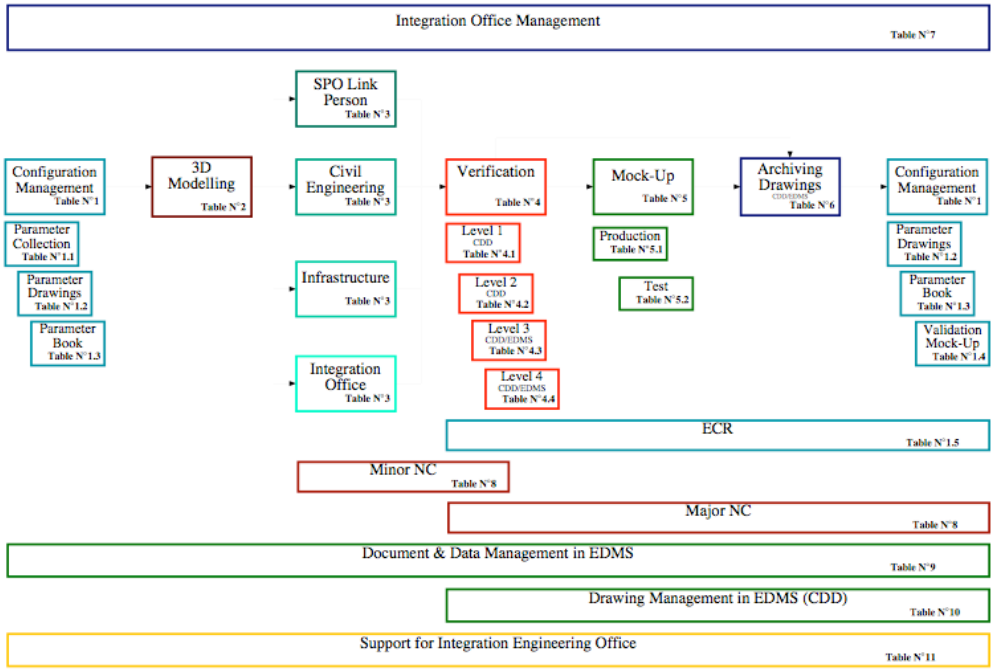
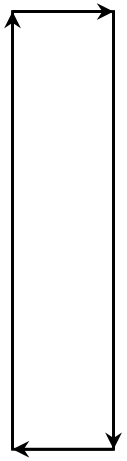
Simplified “Self learning” and “Iterative process” approach



Parameter agreement *“CMS MB”*
Detector envelope definition
No-Go zone definition
Configuration management
- 3D modeling
- Distribution
- Verification
- Validation
- Archiving
- Versioning



Engineering change request
Non conformity management
Review processes

Quality management

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CMS Quality Management had to be introduced without *"Pain"*

transparent to the sub_detector collaborations. ***(Quality manual never written)***

General acceptance level for QM application is still *"extremely low"*

fear for paper work, administrative, restrictive and no benefit.

Implemented into:

Engineering & Integration processes

Review processes ***(still marginally accepted _ major problem "politically correct review outcome")***

Engineering & design /

Production /

Construction /

Logistics /

Assembly & Installation

Tools: Scenario & process oriented developments

Failure and risk analysis

Change control management

Non Conformity management

Sociological "challenges"

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A sociological "*services oriented*" Integration Team experience,

major role of the "Link person" for each of the detector systems, additional engineering and design support from outside Institutes.

Team building

shared projects and easy information exchange, consensus oriented.

Responsibilities

projects "owned" by team members, attached to sub-detector tasks.

Reporting lines

towards sub-detector technical coordinator and management board.

Hierarchy

"as flat as possible", personnel delegated, working @ Cern outside their existing home institute organization.

Link person tasks are essential.

Very small "Core" integration team.

Contacts with many "Cern" service providers.

Some refused to accept the General Integration effort

Communication

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Communication is extremely difficult if there's a "wall" in between.

Short communication lines into the Federated CMS collaboration structure is difficult *(impossible)* without free "horizontal" channels.

A common integration office with space for visiting engineers and designers has shown essential to the success of the CMS integration.

The role of the detector Link person has been to keep the information channels open, disseminate, implement rapidly technical conclusions.

Feed back from Link persons into the systems allowed the efficient tackling of technical problems concerning neighboring systems or general integration issues.

The autonomy of sub-detector collaboration design choices has been respected as much as possible. *(don't look too much into the kitchen)*

Tools

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WOGEI meeting *(chair CMS technical coordinator)*

exchange of ideas and choices of technical solutions.

Link meeting *(chair CMS general integration coordinator)*

short status reports and initiate problem solving processes.

Envelope dimensions *(proposed by the CMS technical coordinator to the management)*

defined for every element, simple, everything has to fit inside.

Interface designs *(proposed by the link persons, coordinated within the integration team)*

the only element spanning the volume between envelopes.

"No_Go Zone" (*owned by the Integration coordinator)*

free volume between envelopes determined after a risk analysis.

Data bases

Parameter Book	*"started on paper!!!"*
STD3D	*Euclid models conversion to Catia*
CDD	*2D drawing information*
EDMS	*Engineering documents repository*
Cabling / EMDb	*"As build / Installed"*

Lessons learned

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Keep maximum flexibility hidden in the design.
Services will take more space. (+50% in the final phase 40k to 60k)

Database structures have to be carefully organized.
Database structures have to be reorganized.

Don't count on a common accepted CAD/CAE system.
Prepare for changing/evolving CAD/CAE systems.

Rules, regulations and legal requirements change over time.

Problems identified by the Integration team have been spotted most of the time too early.

(Wait for the learning instant _ Create awareness)

Consolidation of acquired know-how is essential.

Have always two backup solutions.

CMS EMDb (Equipment management database)

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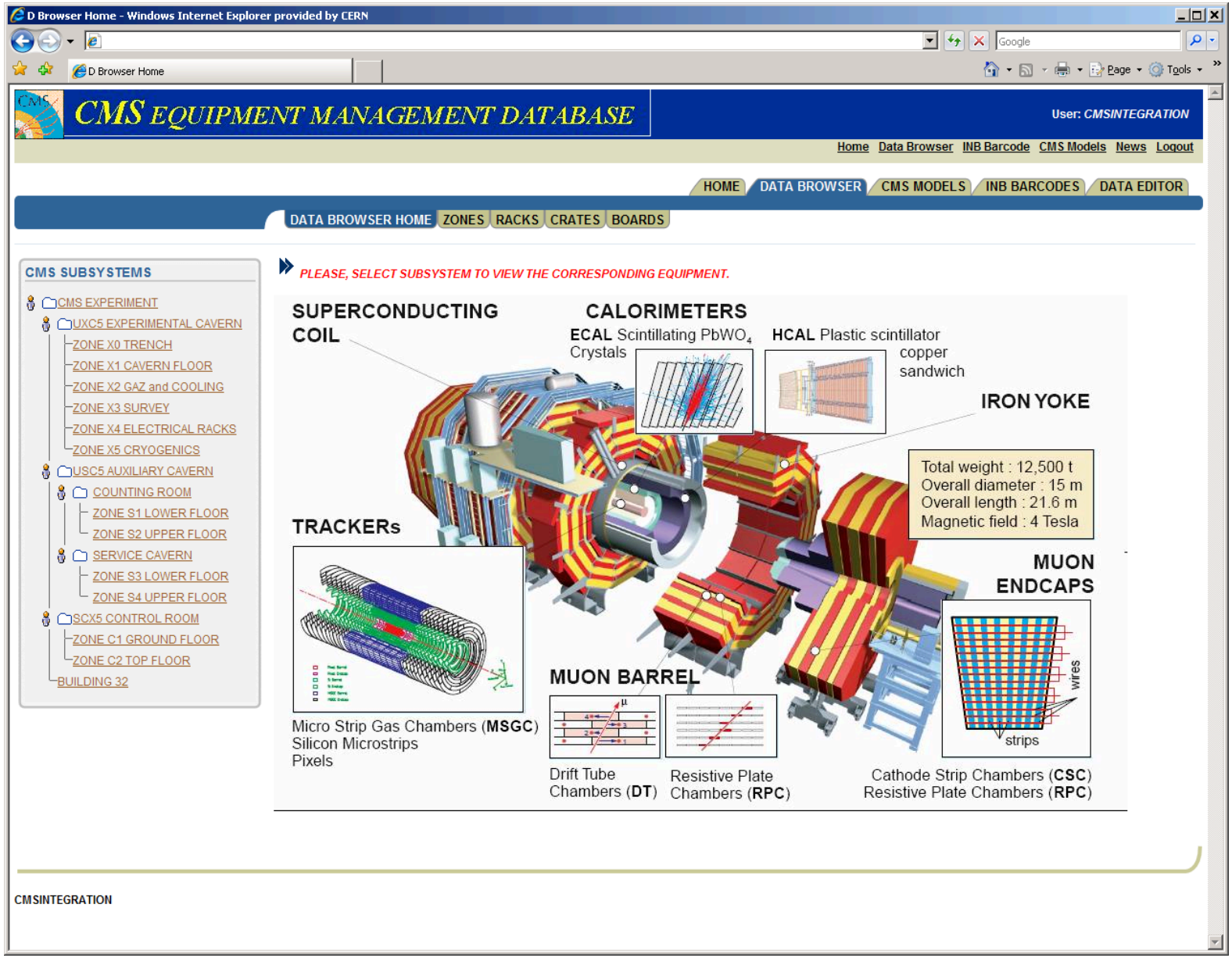
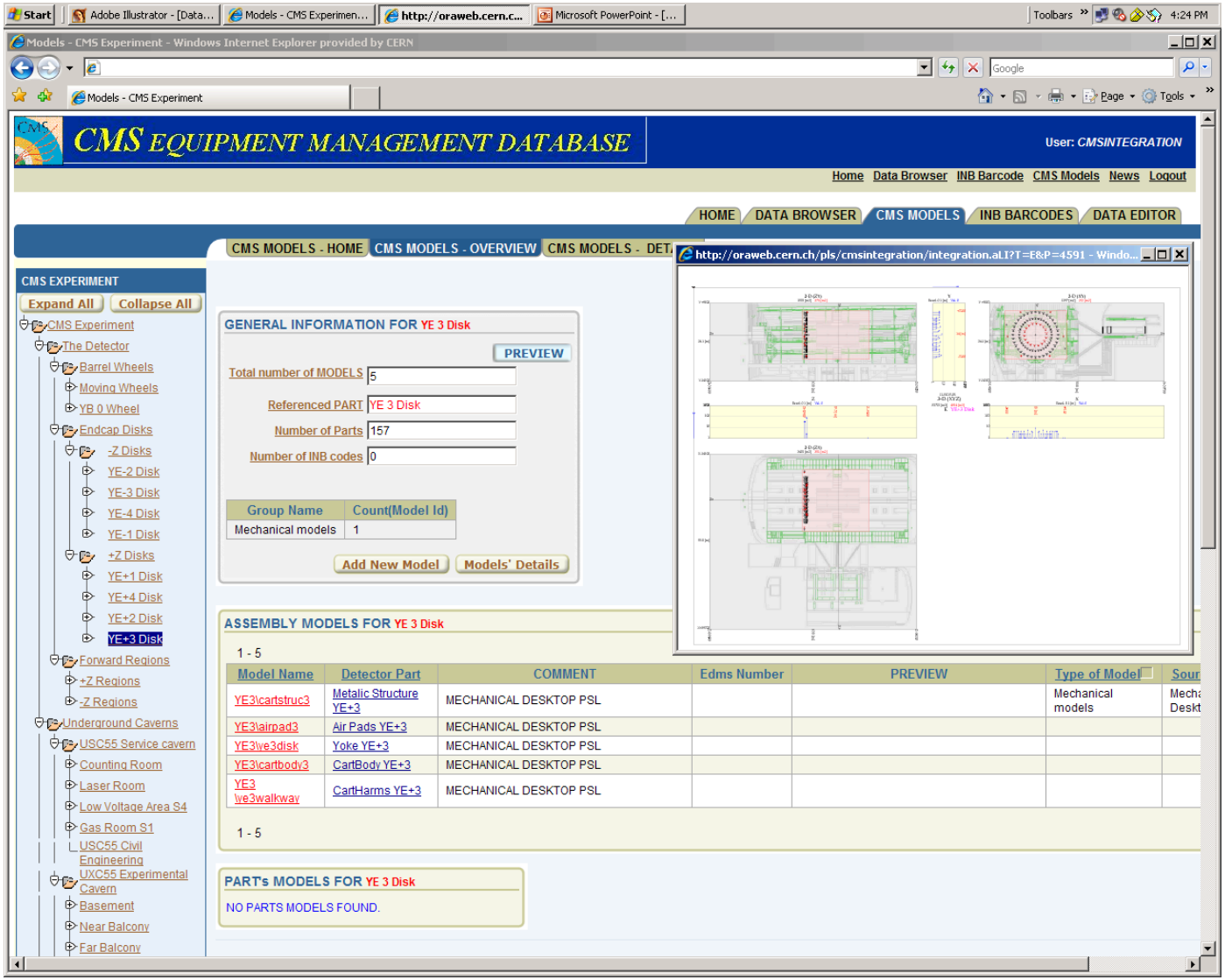


CMS EMDb (Equipment management database)

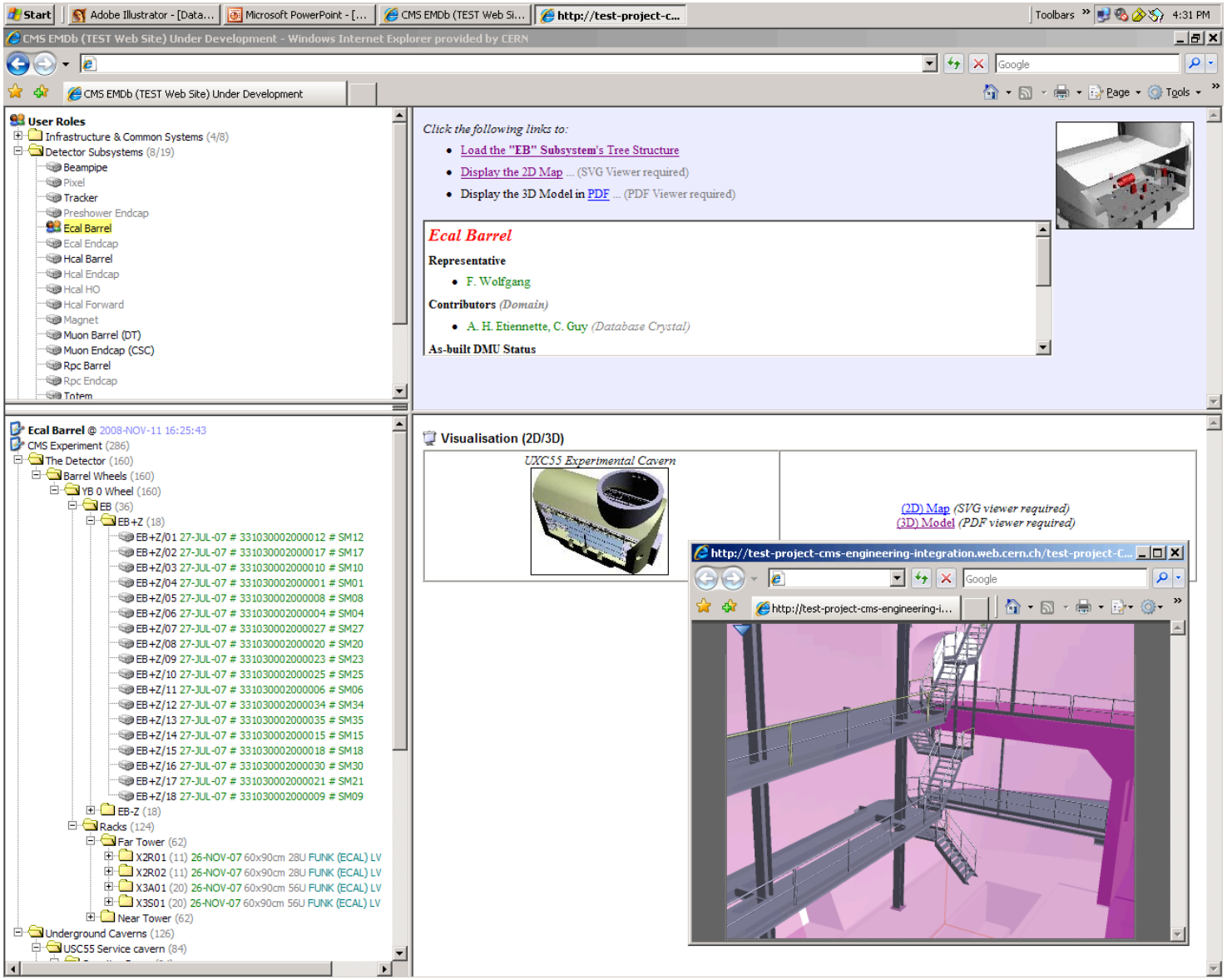
ETH Institute for Particle Physics



The EDMS database scan shows 20.2k CMS project Engineering documents.
The CMS cabling database manages 56k cables and services.
Equipments like Electronic -racks/-crates and other equipment 36k
Catia 3D files approximately 5k Euclid 3D files 22k and 2D drawings 7k
All together we manage today 146k DB entries at Cern and many more to come from the collaborating institutes next years.

CMS EMDb (Equipment management database)

ETH Institute for Particle Physics



Our estimate for 2009:
60k cables
100k equipment
20k Catia 3D and
a selection from the
2 000 000 construction
database elements held
in collaborating
institute databases.

Just some notes

Detector and Integration teams are working with the same objectives from opposite sides

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One Day

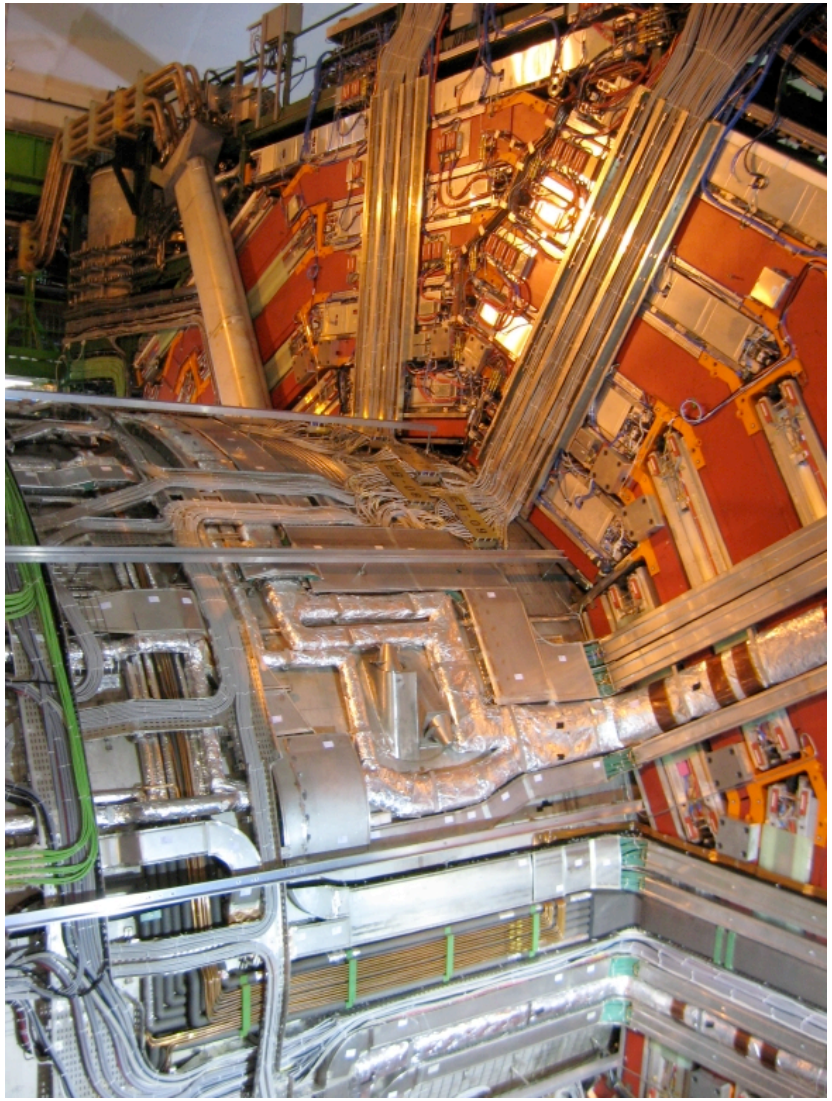
/ minor details become important obstacles.
/ symmetry breaking is a major cost element.
/ neglected detectors might become major players.
/ it is too late if problems are not solved early.
/ auxiliary systems need to be implemented.
/ alignment and survey channels might be blocked.

Integration has to serve the interest of the detector therefore no sub-detector can be satisfied with the results of the integration effort.

Don't copy CMS Engineering & Integration, you might want to use some of its experience.

The balance between the general overview and the detailed detector knowledge is the core integration team.

The integration team has to keep its independence.



Today's CMS Integration activities

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Equipment management database organization

- As build CMS 3D models to be entered into the database (ALARA)
- Add relevant construction and position data (INB zone / activation / physics _ one day ???)
- Deploy barcode system on all equipment installed in UXC and USC

Geometry, implementation, installation and integration studies are continuing.

- Shutdown configurations, implement lessons learned ……..
- Last minute design requests for CMS general tooling, Castor, Totem, BCM and … others.

Follow-up "jumped work packages"

- UXC / LHC tunnel interface (shielding / hermetic for ventilation)
- Safety systems (sniffer / fire detection system filters)
- Improve opening / closing monitoring *(200+ sensors added)* and guiding rail system

Recover from Euclid to Catia Engineering software switch

- Adapt to new Catia tools and methodology
- 3D / 2D design data partly lost, recover from Euclid backup PC
- 3D data transfer not reliable, check all files and recover from errors

Detector upgrade preparations

- YE4 / RE2 / FP7 _ TC / TK cooling / SLHC / Consulting CLIC & ILC

CMS - SLHC & FP7

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Organization upgrades SLHC / CMS2 > start foreseen 2017 / 2019
project office, coherent data repository.

Radiation, personnel and equipment - protection systems,
remote handling, observation and fault analysis.

Planning and preparations for maintenance and repair interventions,
"Alara" requirement, viable scenarios, procedures, rapid access.

Design and implementation of tooling, shielding, traceability systems,
Hardware (handheld PCs) and software projects.

As build and as installed detector configuration including 3D models,
update 3D models and add; survey data, materials compositions, material/parts activation maps, construction & location data.

Data transfer from Euclid into the Cern Catia 3D Engineering software,
CMS@cern, we produced 21240 Euclid models and 7122 drawings.

Conclusion

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Simplicity, good collaboration and excellent communication have shown to be essential to the success of the CMS Integration effort.

CMS upgrades are still relative faraway, compared to the preparatory work done, still upgrades are for tomorrow! Therefore a budget line has to exist in addition to “Maintenance & operations” and funding should be planned from the beginning of such major projects.

Next generations of Engineers should be supported to join this adventure and acquire the know-how to build future detectors.

Without the support and help of the many unnamed persons working on CMS, all over the world, this project would have been impossible.

Careful planning of distributing hidden safety margins is essential.