Integration and accelerators.

Y. Muttoni EN-ACE-INT

EDMS 1918808

Summary

- ✓ Mandate EN-ACE-INT
- ✓ Accelerator map and accelerator lifetime
- ✓ Kick off integration studies
- ✓ Overview design office
- ✓ Integration work process

Mandate EN-ACE-INT

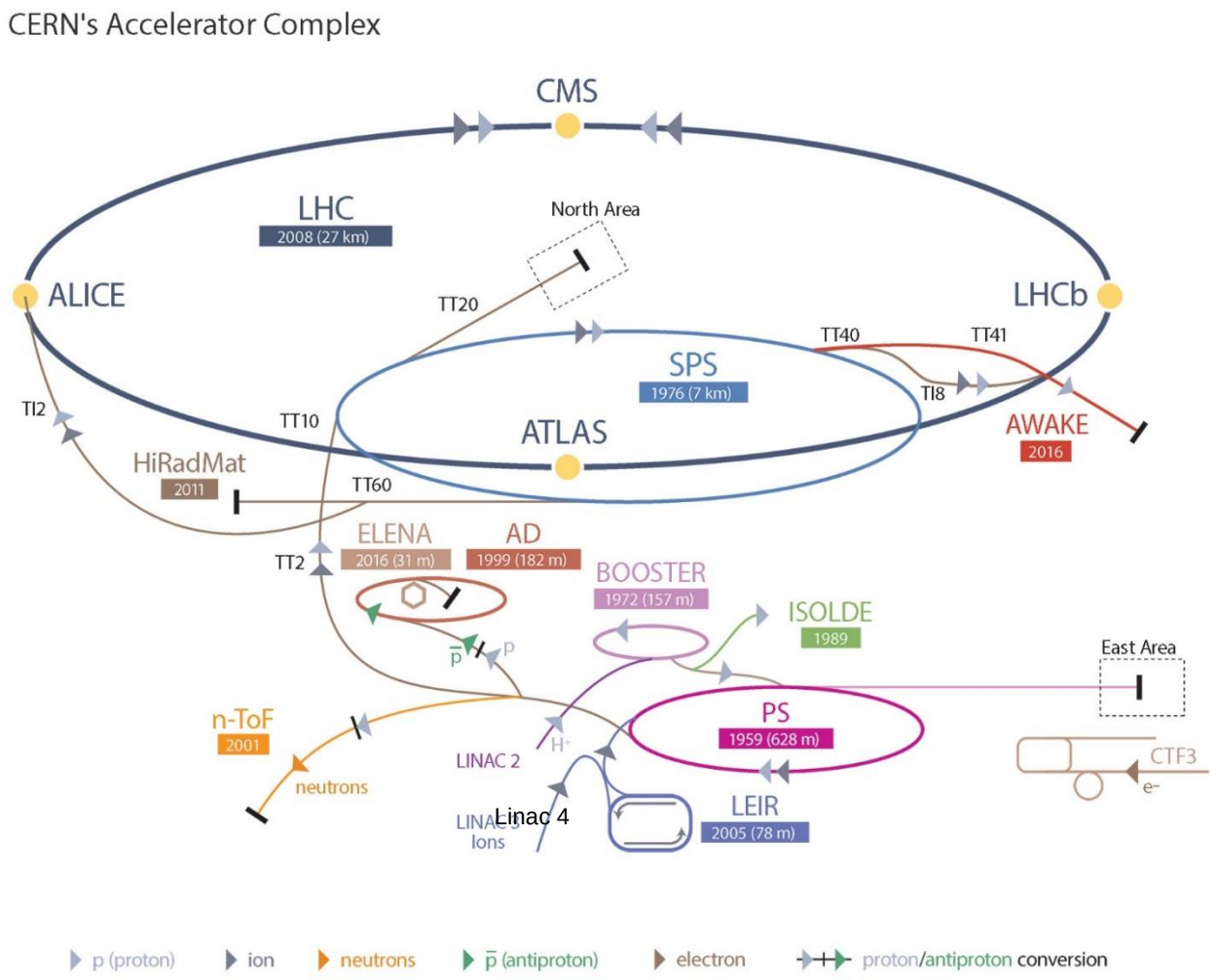
- Provide the current 3D CAD* data environment (using also reverse engineering) to realize new equipment studies.
- Centralize all the new 3D CAD data provided by all the design offices involved in a project (see slide integration work process)
- In order to guarantee the correct installation of each machine equipment and also to avoid the interferences during installation phases, handling and transport.
- The accelerators** managed by EN-ACE-INT section are Linacs (2,3 and 4), PS complex (PS, Booster, LEIR), SPS machine, LHC machine and all the transfer lines between them.
- The external services buildings as BA (SPS), SD (LHC), SM18, 311 are also managed by us.

CATIA SMARTEAM

CAD Software and CAD data management used to do the integration work.

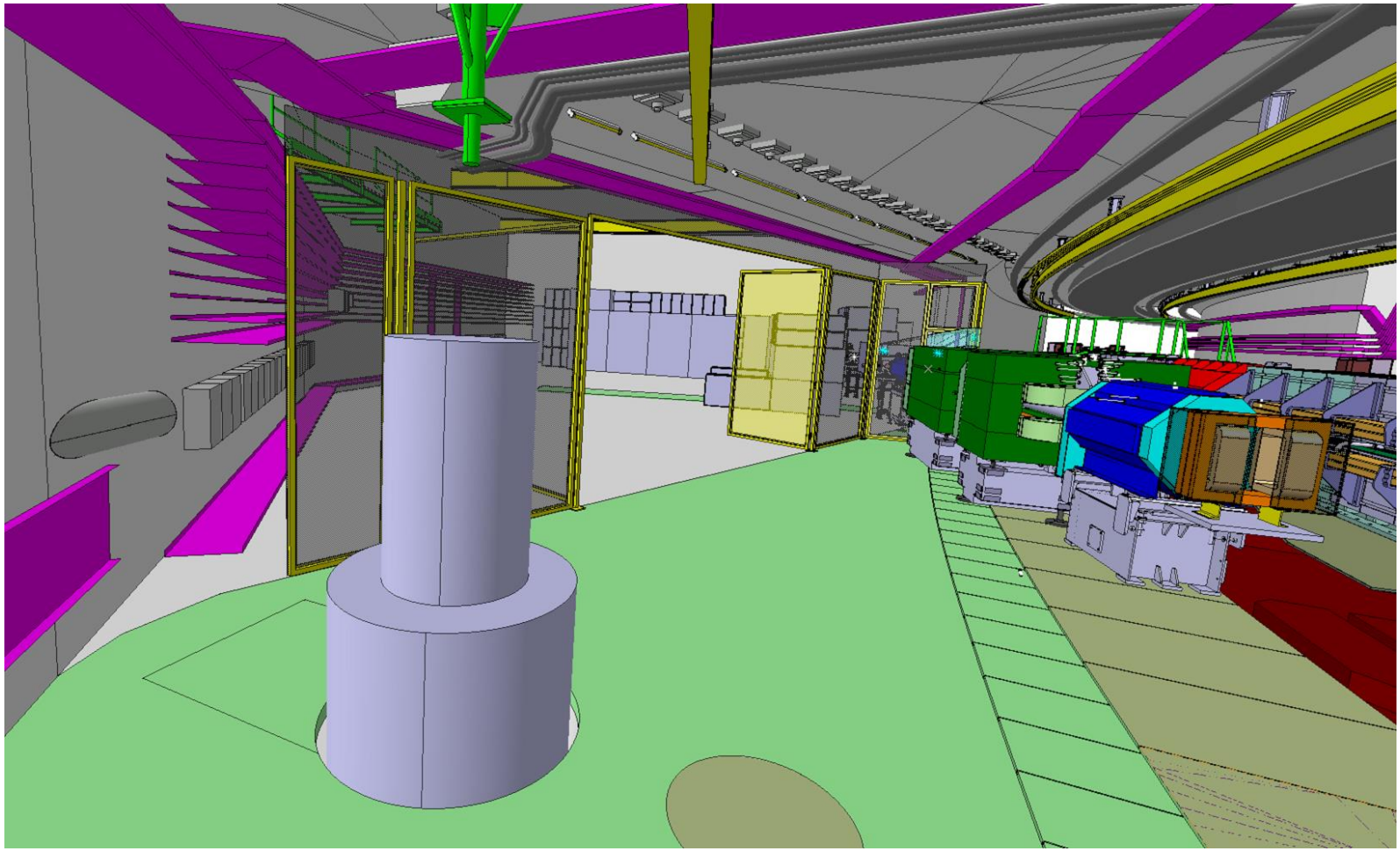
* CAD Computer Aided Design
** Also Awake, HieIsolde, Elena and more

Accelerator map



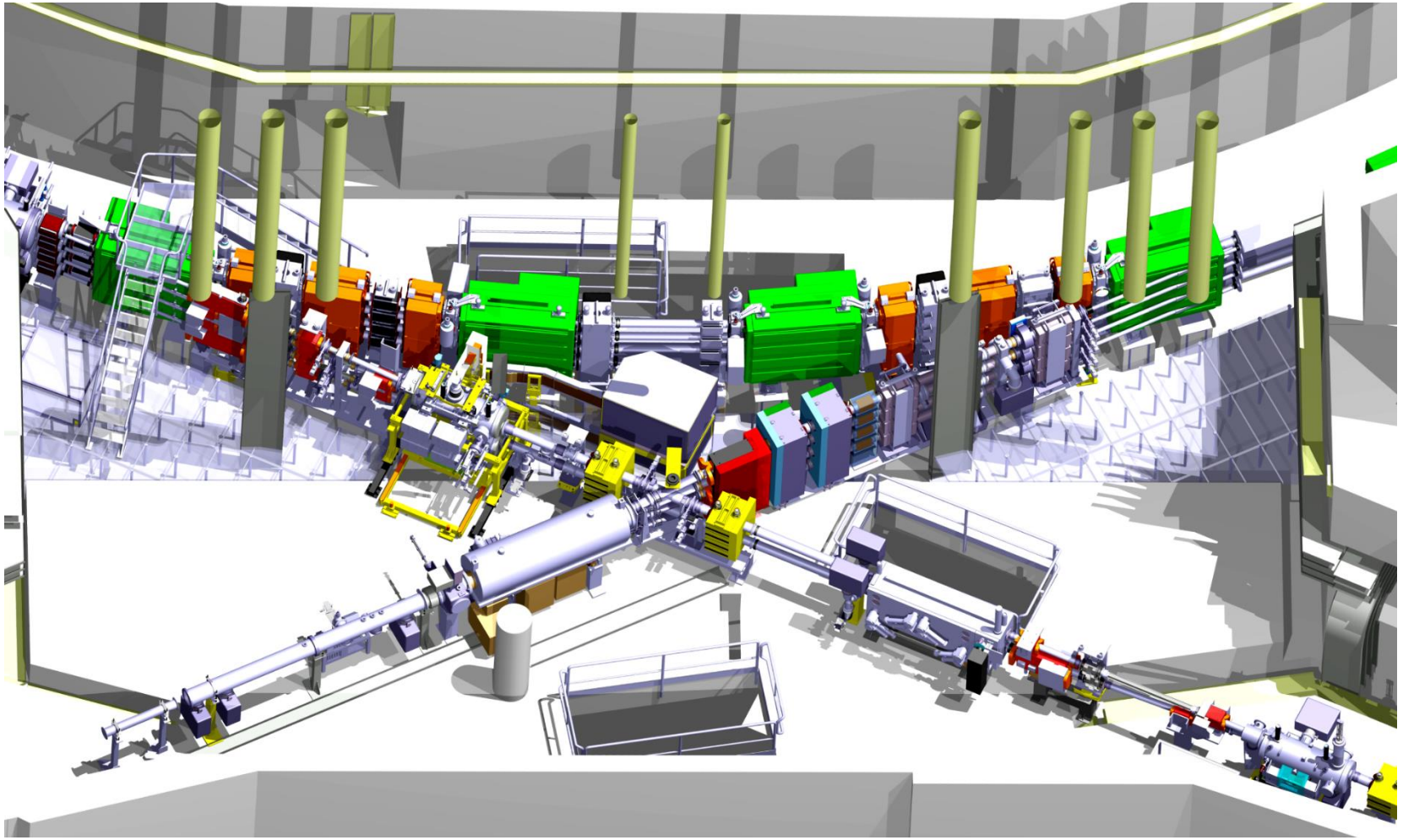
Lifetime of an accelerator

PS Machine first beam November 24th 1959



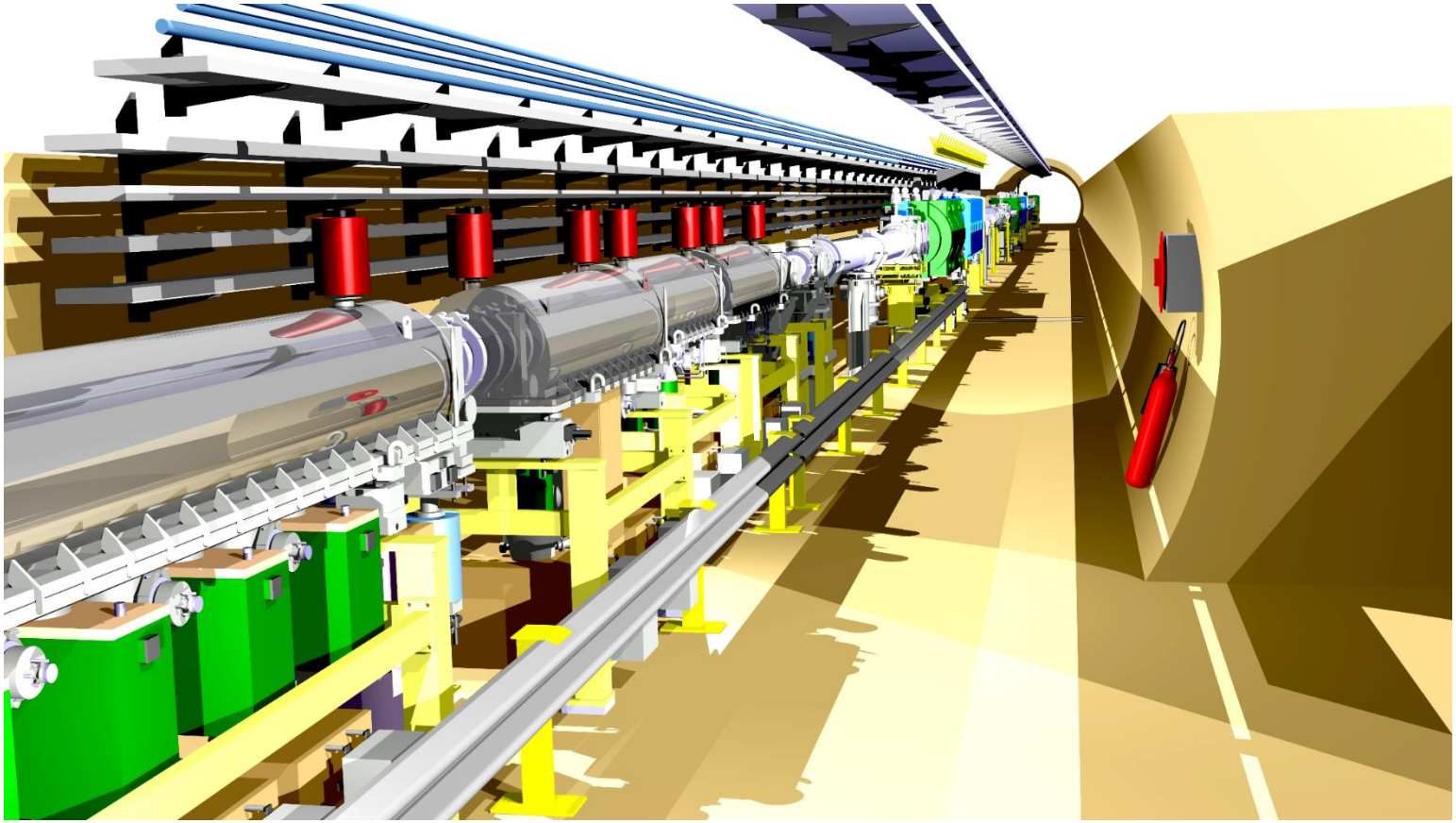
Lifetime of an accelerator

Booster machine first beam May 26th 1972



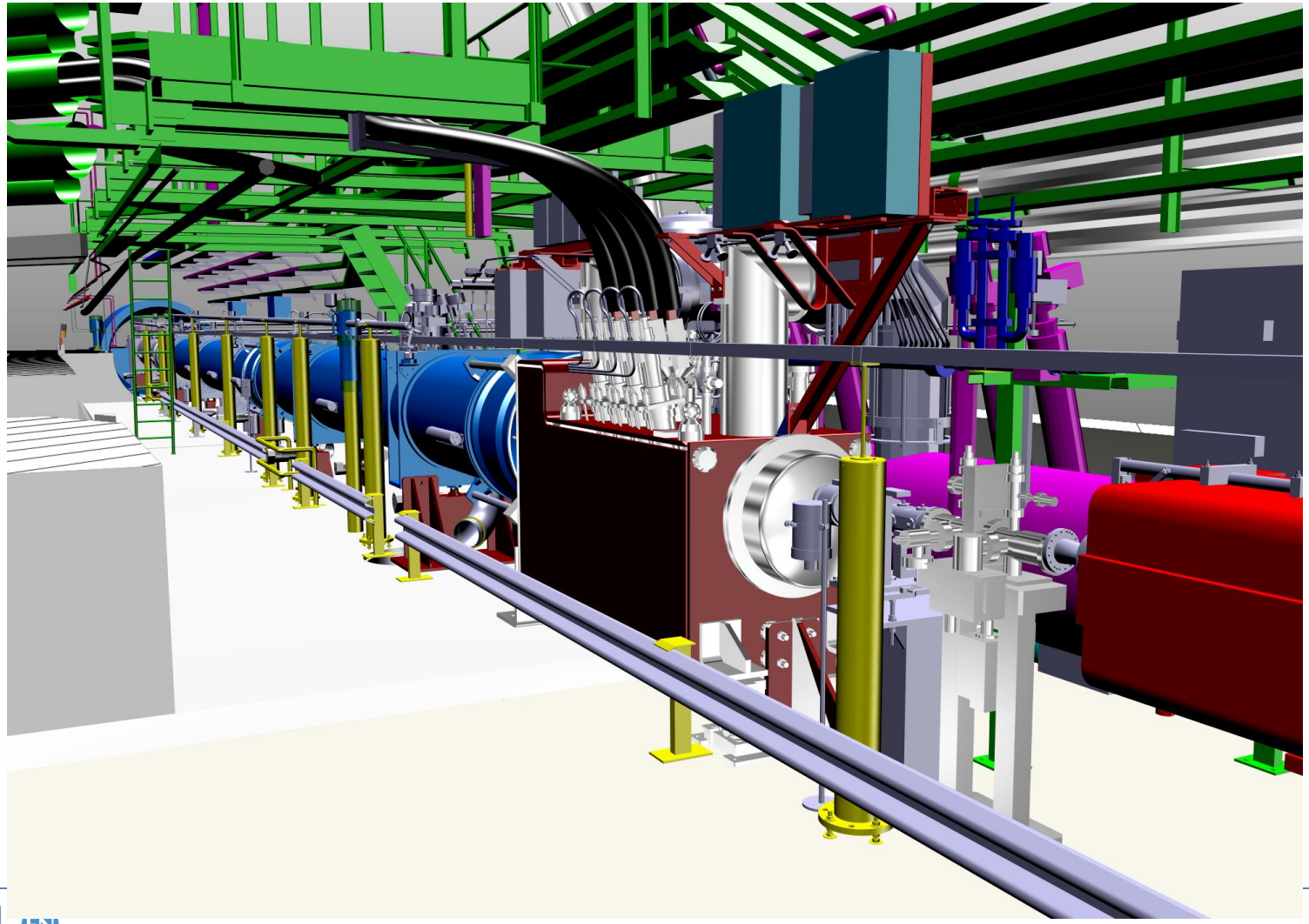
Lifetime of an accelerator

SPS machine first beam May 07th 1977



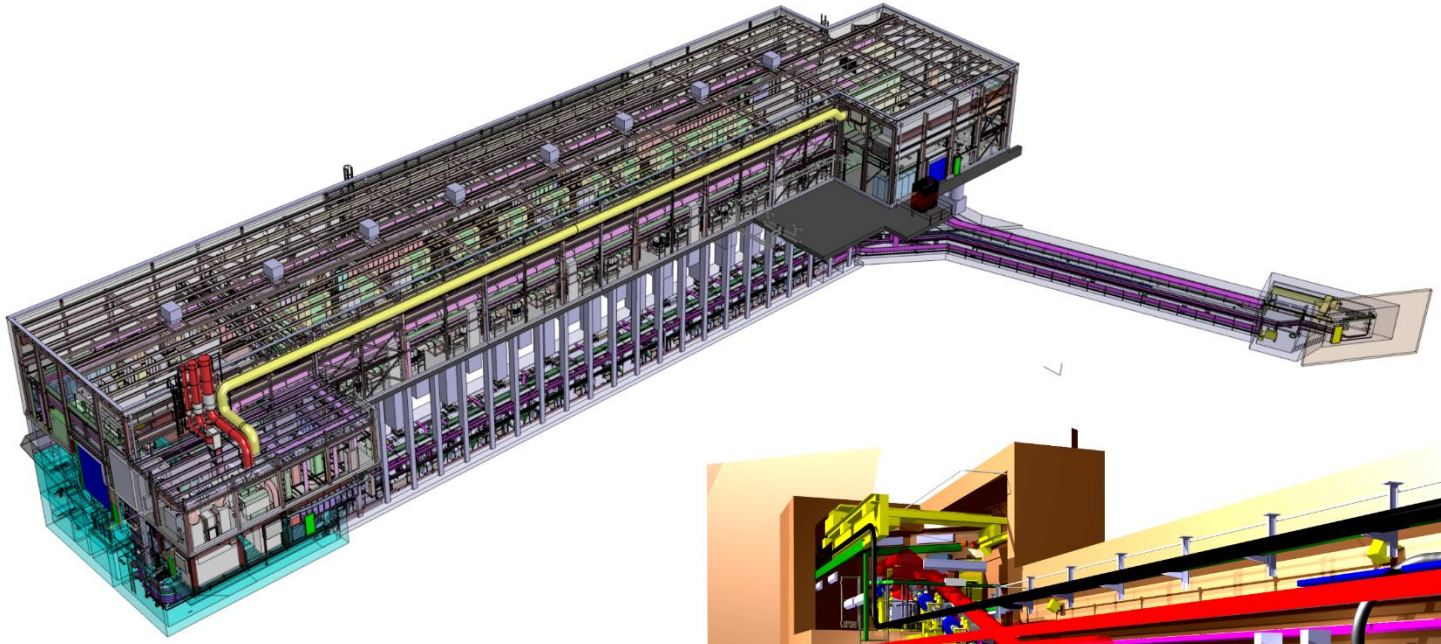
Lifetime of an accelerator

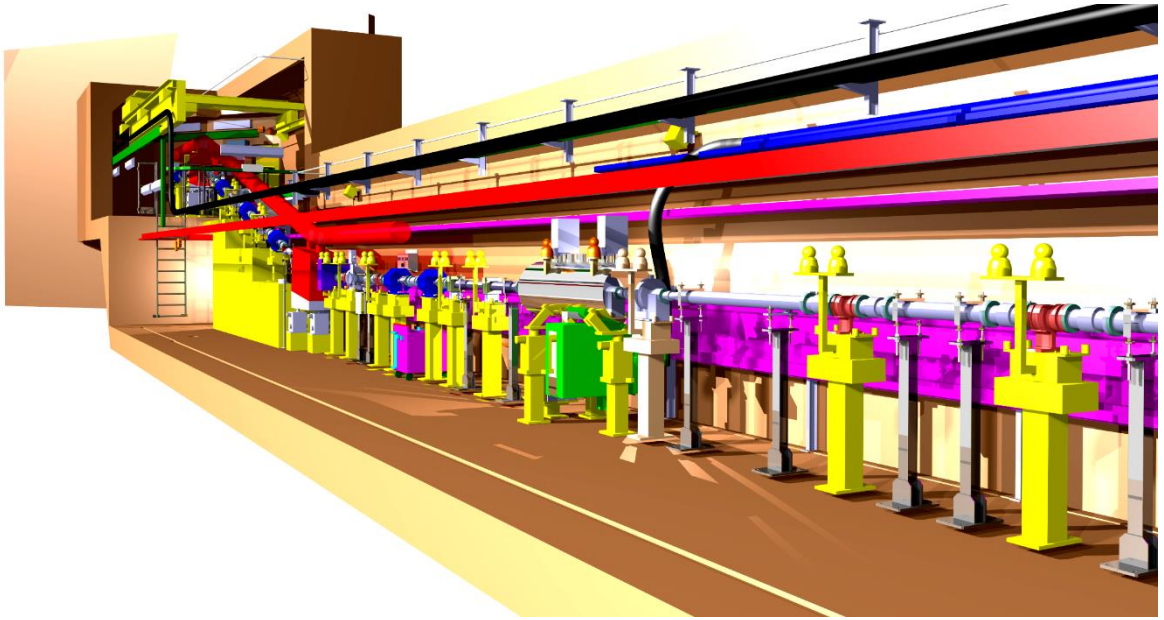
LHC machine first beam September 10th 2008



Lifetime of an accelerator

Linac 4 machine first beam May 09th 2017





Kick-off intégration studies

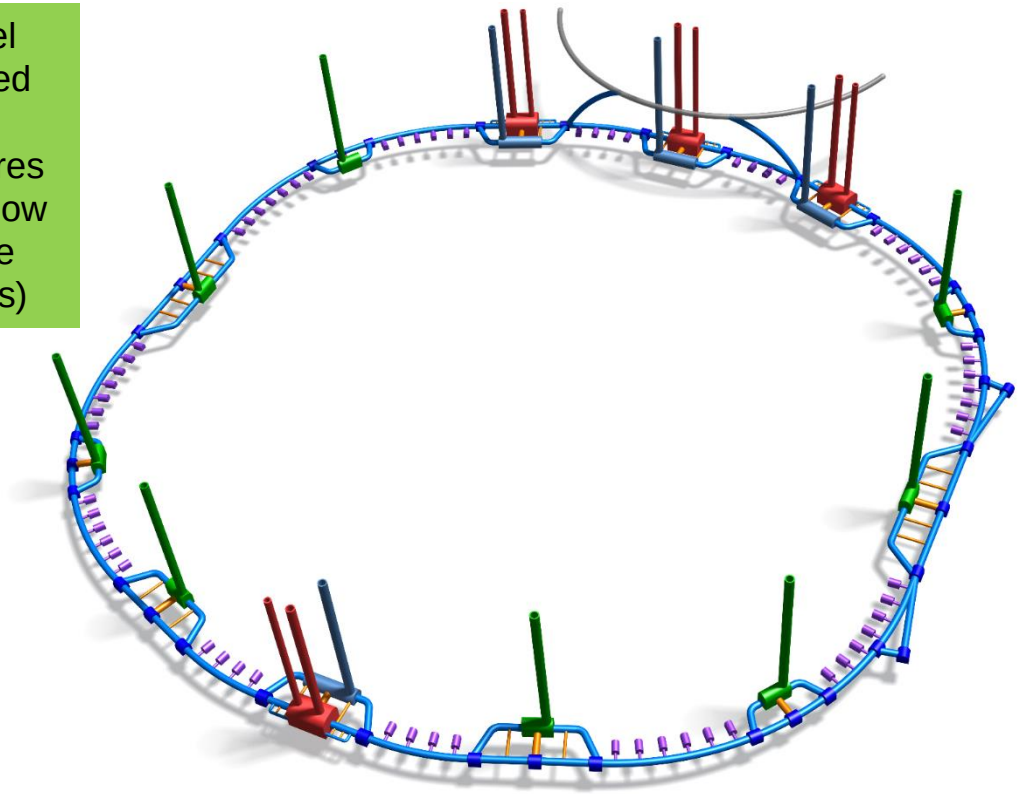
- In many case integration studies are managed by the optic beam files provided by the machine optical physicist.

- Two examples (see next slides)
  - New full complex like FCC (Future circular collider)
  - New equipment in an existing accelerator.

Overall schematic 3D view

not to scale

Single tunnel model updated with all main features known up to now (w/o FCC-ee enlargements)

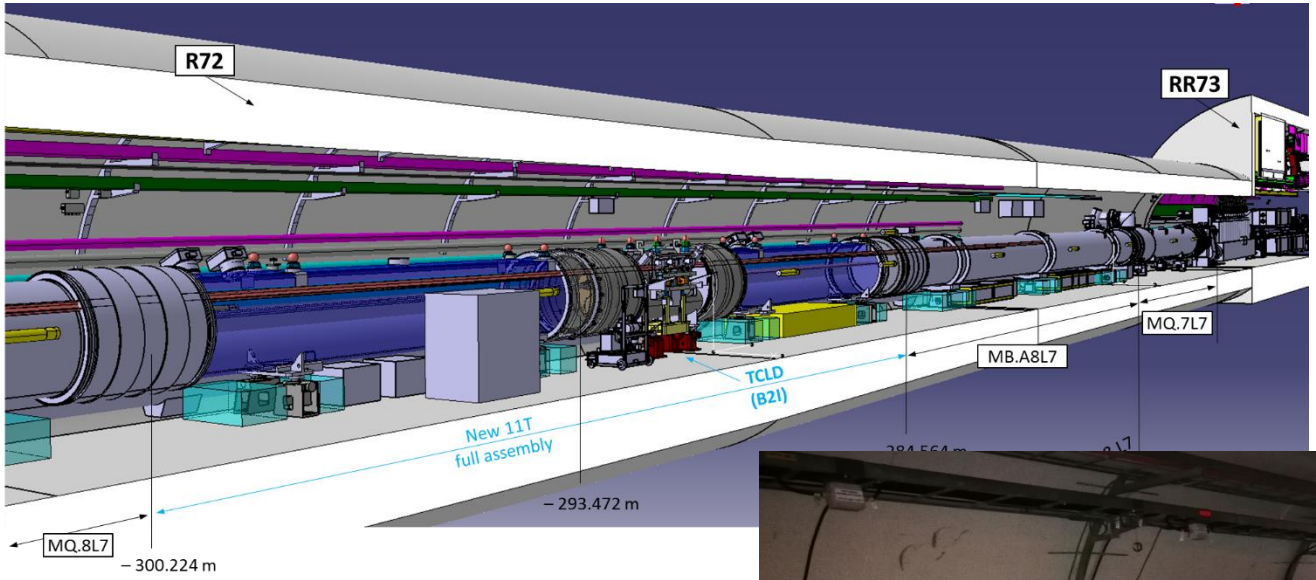


Colour code:

- Machine tunnels + bypass galleries
- Detector caverns + [illegible]
- Service caverns + access shafts
- Electrical alcoves
- Connection tunnels

A. Navascues Cornago

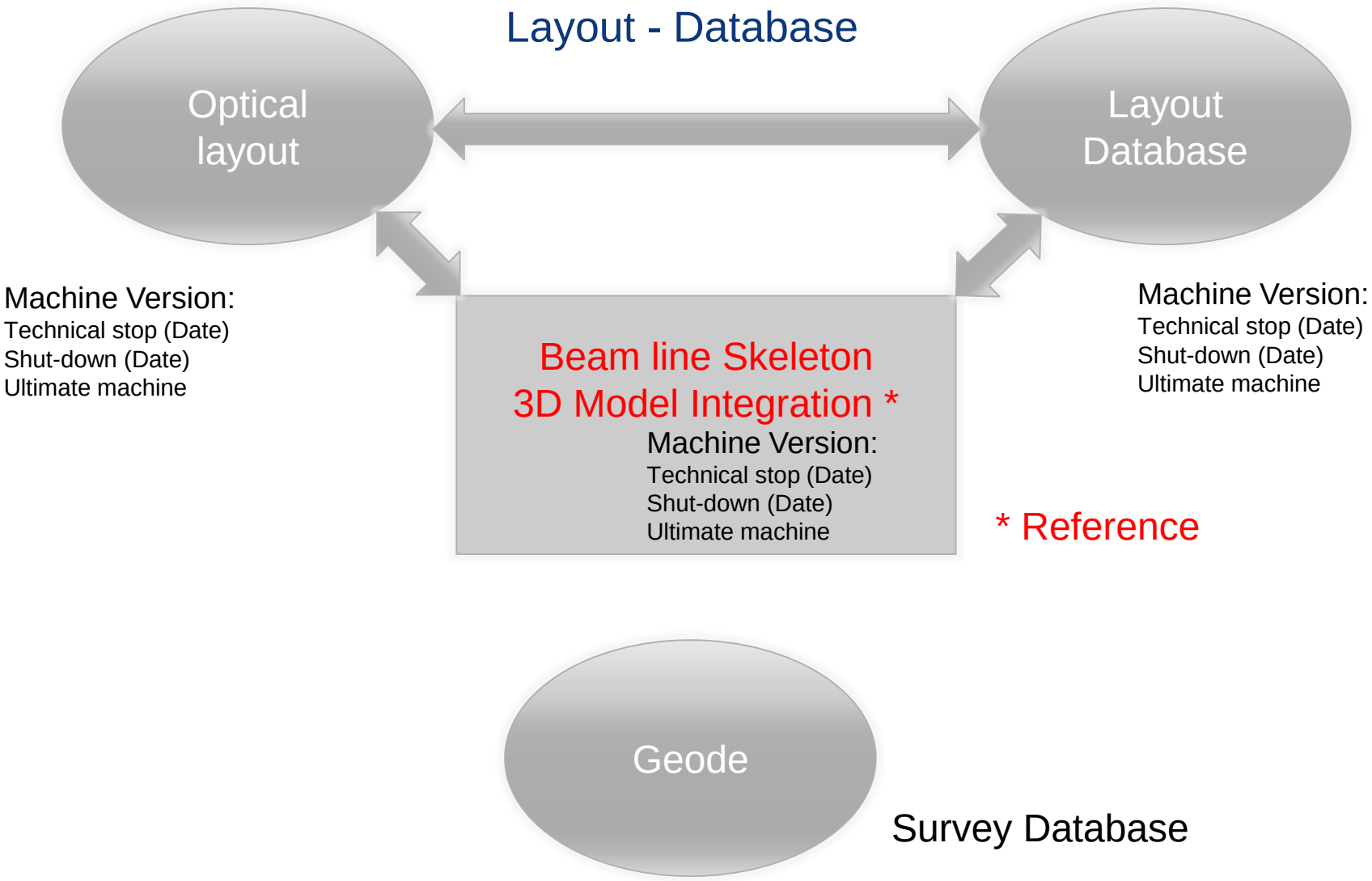
New collimator inside LHC machine



Area under study C8.L7 at R72 – layout RUN3

Courtesy of Maria Amparo Gonzalez De La Aleja Cabana

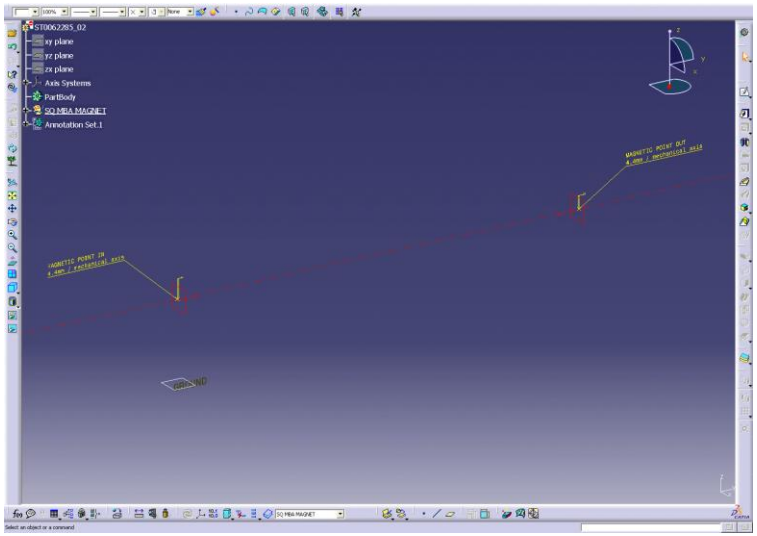
Overview design office EN-ACE Integration



Overview design office EN-ACE Integration

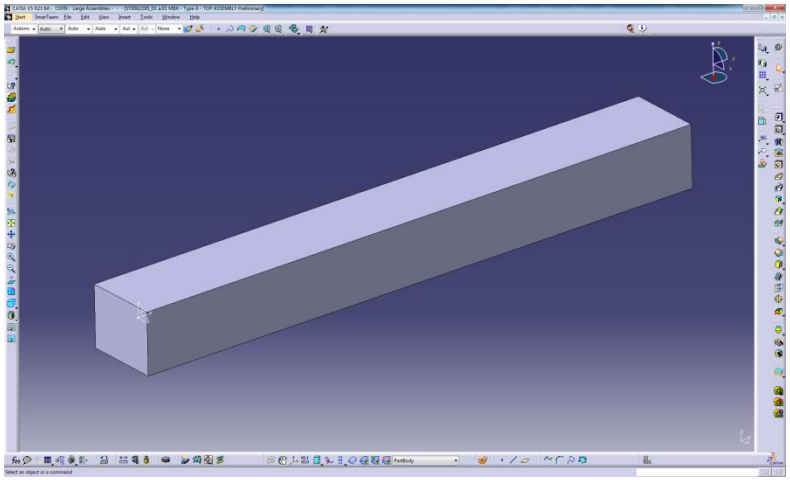
Deliverables:

- 3D Integration envelope

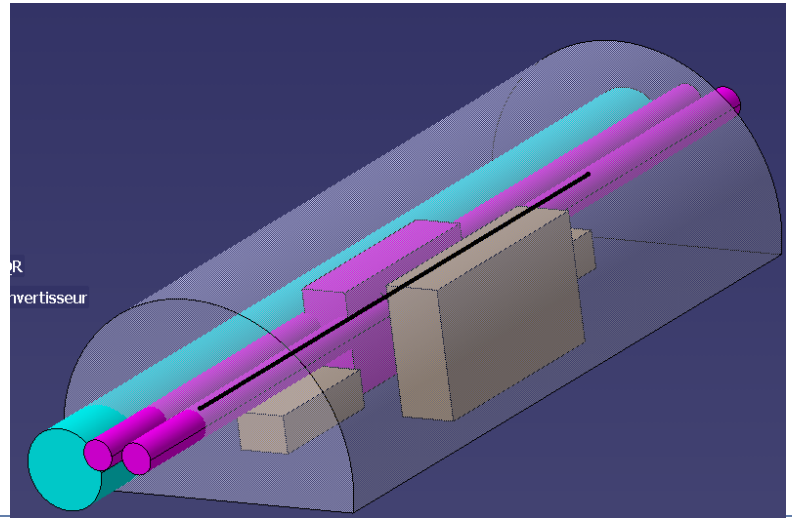


Skeleton with main parameters
Examples : Beam axis, entry/exit point, magnetic length…

3D envelope

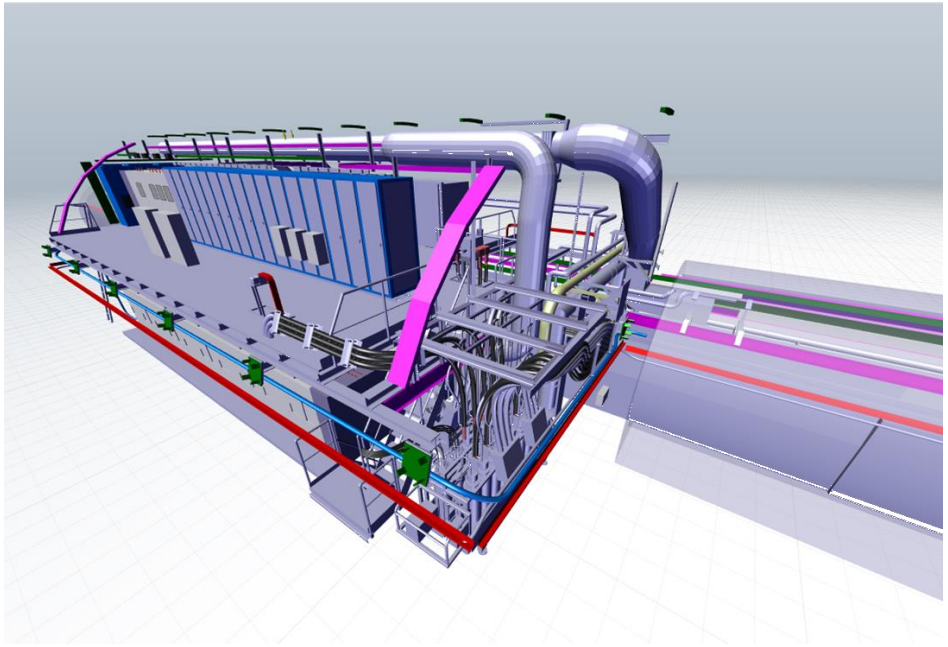


Assembly 3D envelope
Machine equipment,
Services



The design offices in the service groups

- Services and Infrastructure design offices
  - Electrical services EN/EL.
    - Cables trays, Racks layout.
  - Cooling and ventilation EN/CV.
    - Pipes, Water pump, Air duct.
  - Transport and handling EN/HE.
    - Transport volume, Handling equipment
  - Civil Engineering GS/SEM .
    - Building, underground cavern.
    - Metallic structure.
  - Cryogenic equipment TE/CRG.
    - Cryogenic pipes, cryogenic plants.



Deliverables:

- 3D Model for integration (Theoritical/As built*)
- PID Piping Instrumentation Diagram
- Specification drawing
- Installation drawing
- Mechanical drawing

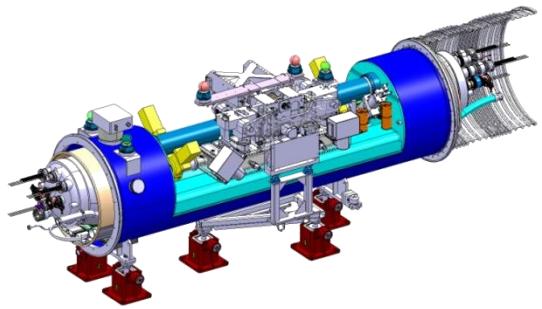
* To be clarify by methodologies

Design office overview Mechanical

- Machine equipment EN/MME
  - Vacuum chamber, magnet, collimator ….
- Detector equipment inside the machine PH
  - Roman pot, detector scintillator ….

Deliverables:

- 3D Model detail assembly for manufacturing and as built
- 2D drawing detail assembly for manufacturing and as built

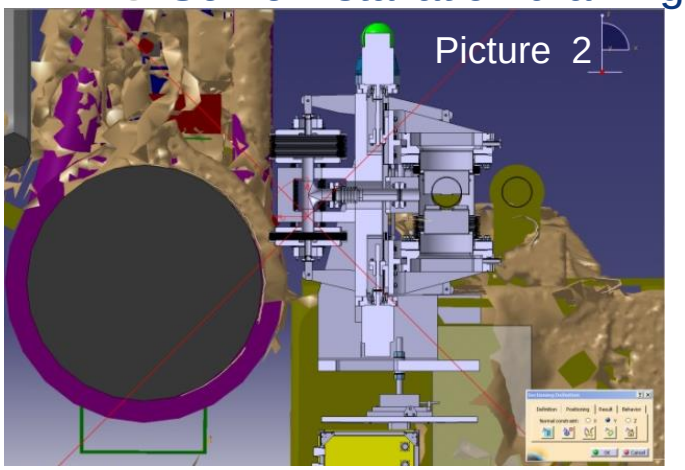


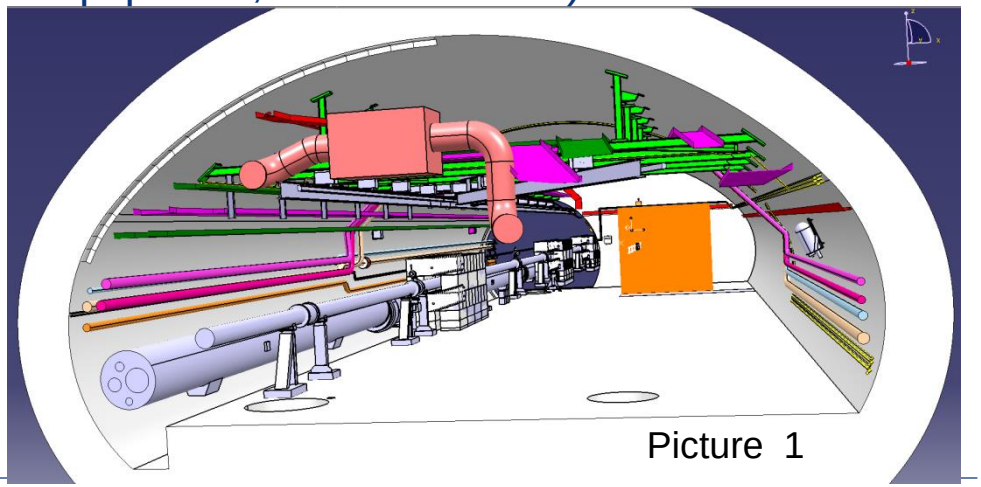
LHC Collimators in DS plus QTLC

Overview design office EN-ACE Integration

Deliverables:

- 3D Integration assembly of the services for the machine (Picture 1)
- Simplified models of machine equipment (Magnet, collimator, vacuum pipe) (Picture 1)
- Layout machine in 3D and 2D layout drawing and 2D layout differential layout
- Meshing scan* to check installation services (Picture 2) or do reverse engineering.
- Some mechanical drawings (Doors, shielding blocks, light metallic structure)
- Some installation drawings (fire equipment, access control).

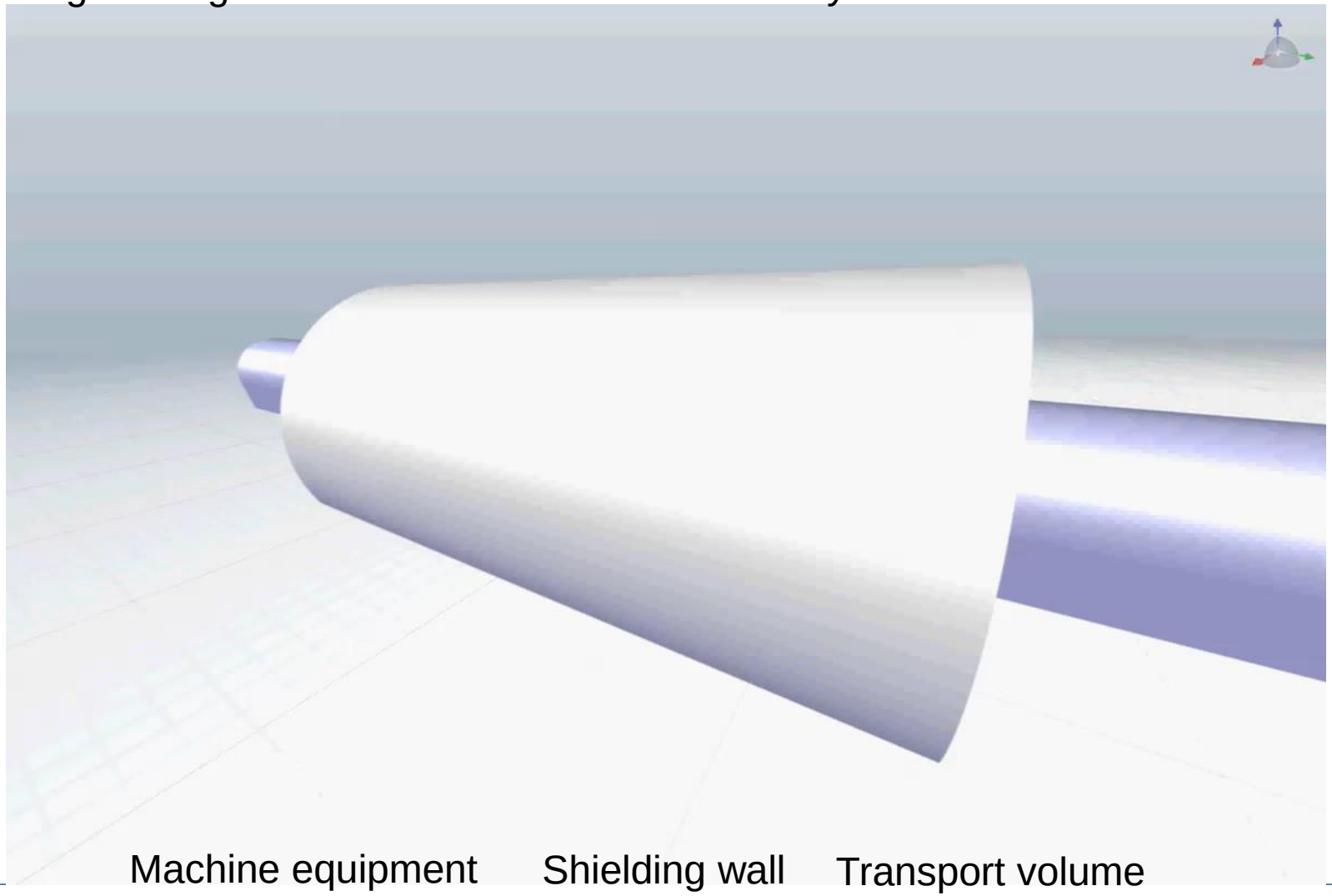



Picture 1

*cloud of points treatment provided by survey Team using a laser scanner

Integration example - video

Civil engineering Metallic structure Cables tray Air duct Electrical racks



Machine equipment Shielding wall Transport volume

Integration work Process

Study phase

3D models

Integration meeting

Integration Team + *Design offices*

Mechanical design office

- Vacuum
- Machine Equipment
- Magnet
- Beam Instrumentation
- RF equipment
- Etc..

Services design office

- Civil engineering
- Metallic structure
- Lift
- Shielding
- Piping
- Ventilation
- Ventilation door
- Câbles tray
- Electrical Eq.
- Cryogenic Eq.
- Access control
- Sector door
- Transport & handling
- Security Eq. Fire detection
- Survey

Share the 3D data with external design office

Integration work Process

Study phase

3D models

Integration Team + *Design offices*

Mechanical design office

- Vacuum
- Machine Equipment
- Magnet
- Beam Instrumentation
- RF equipment
- Etc..

- Civil engineering
- Metallic structure
- Lift
- Shielding
- Piping
- Ventilation
- Ventilation door
- Câbles tray
- Electrical Eq.
- Cryogenic Eq.
- Access control
- Sector door
- Transport & handling
- Security Eq. Fire detection
- Survey

Integration work Process

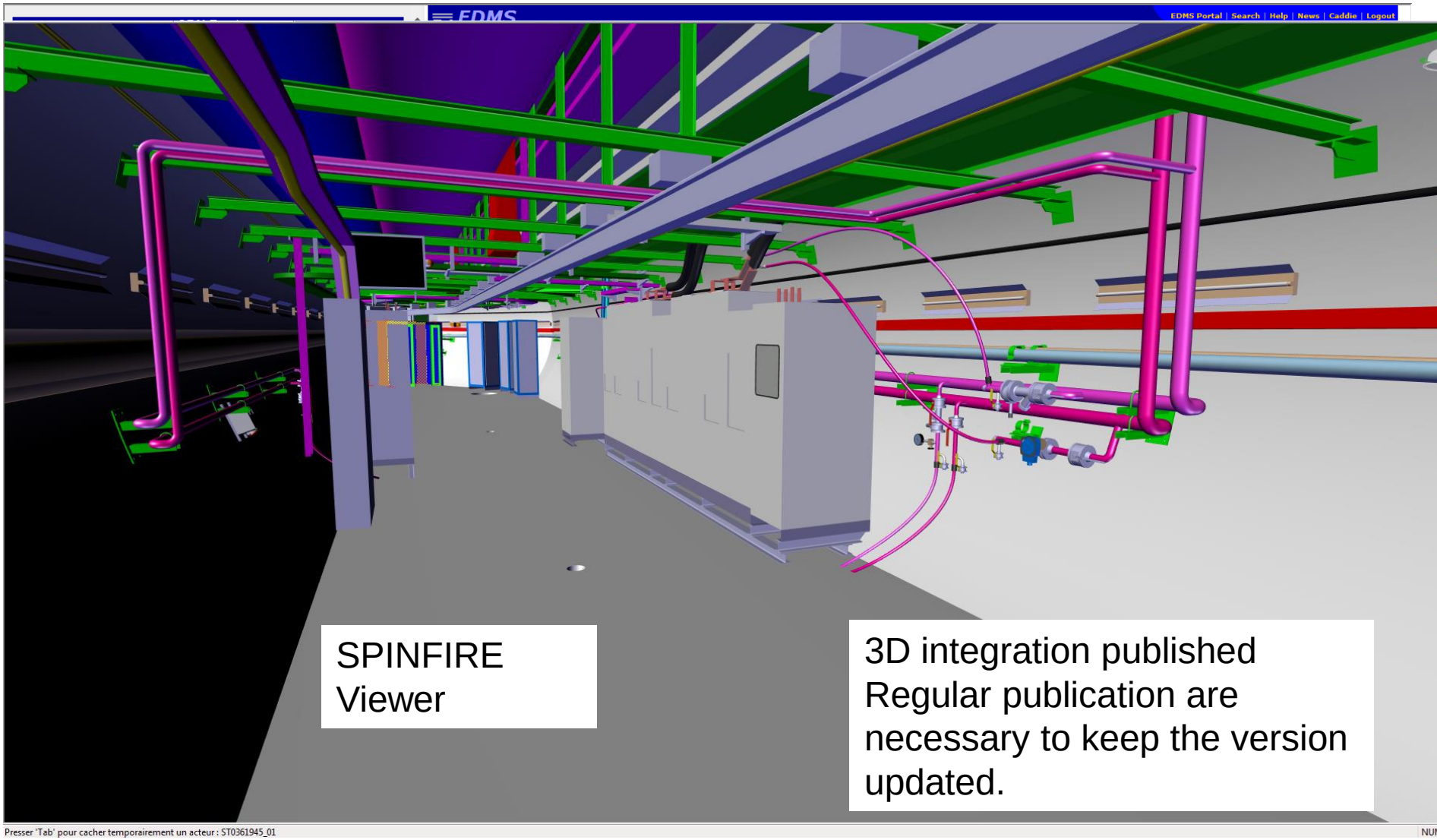
Study phase

3D models

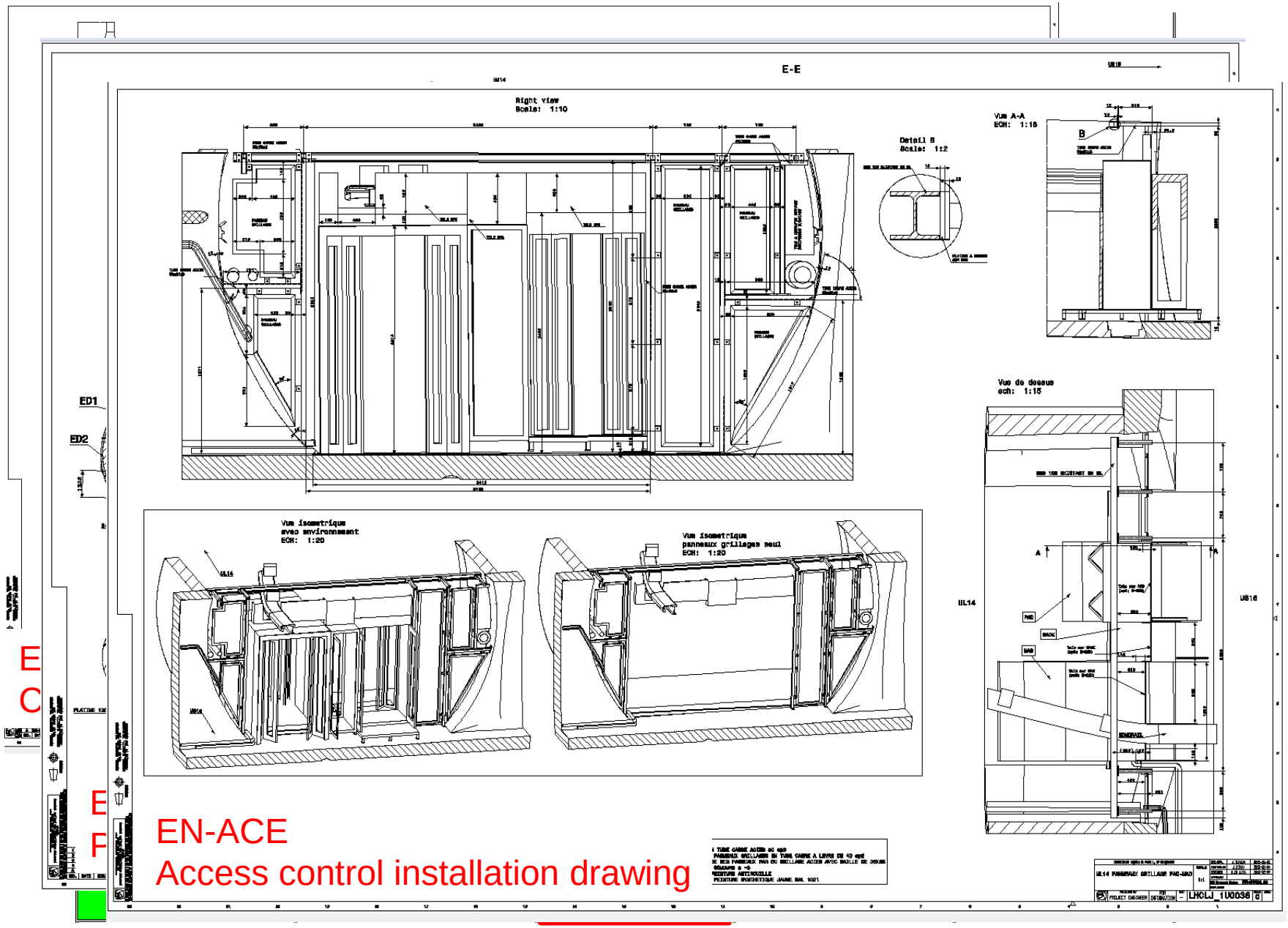
Installation drawings or Installation presentation

Design offices Integration team

- Civil engineering
- Metallic structure
- Lift
- Shielding
- Piping
- Ventilation
- Ventilation door
- Câbles tray
- Electrical Eq.
- Cryogenic Eq.
- Access control
- Sector door
- Transport & handling
- Security Eq. Fire detection
- Survey



The 3D publication provided 3D view to non CATIA/Smarteam users.



EN-ACE
Access control installation drawing

Integration work process

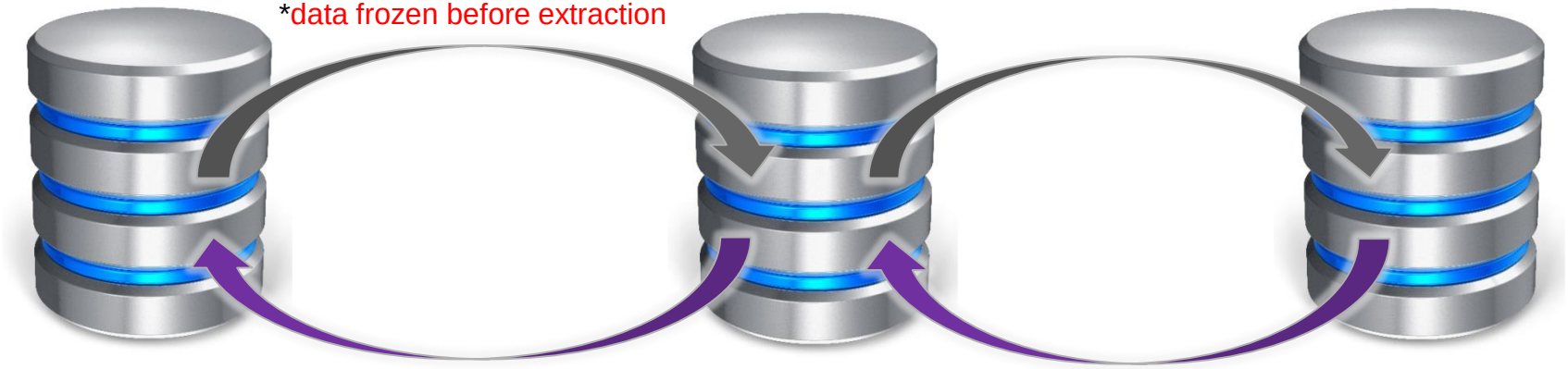
CERN Database
CAD data
Native format

Exchange database
CAD data
Native format
Neutral format

External Database
CAD data
Native format

3D environment*
3D envelope*
3D mechanical/services study*
*data frozen before extraction

Using data provided



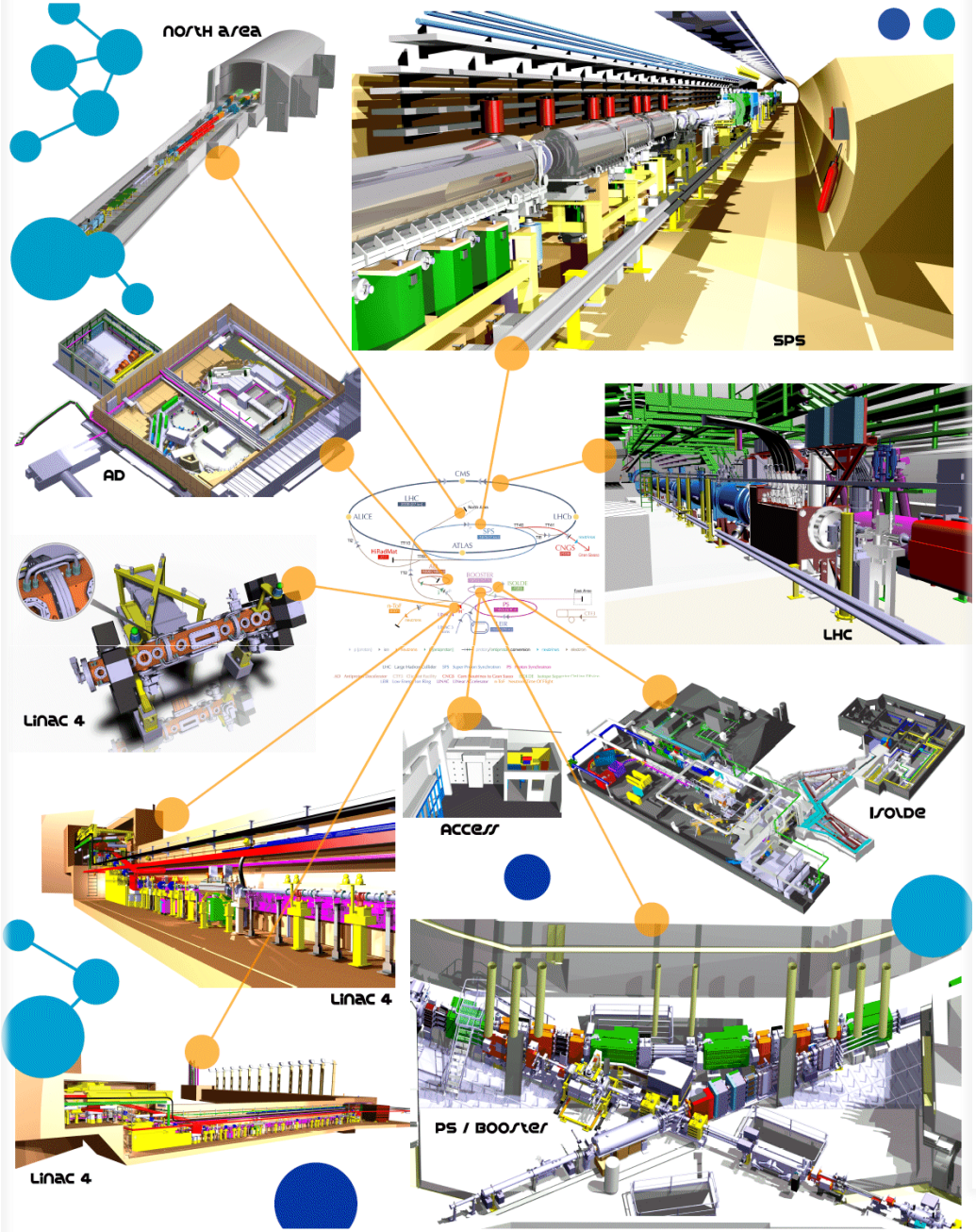
3D model checked by
Mechanical/Services design office
Integration design office

3D mechanical/services study
3D mechanical/services detailed model
3D simplified model

Thanks for your attention
Questions?

Spare slides

Some Integration examples



Some main points

- The cad data accelerator should be manage during a long time period.

- During the same period, software and hardware have evolution:
  - ✓ 2D drawing (drawing-board) to all in 3D model/2D drawing (CAD Software).
  - ✓ The volume of data increased, with the new CAD software is easier to duplicate the data.
  - ✓ No problem of data storage (space disk).
  - ✓ Each new evolution allows to increase the 3D model detail level …. every time the designer touch the limit.
  - ✓ Each new evolution allows to increase the equipment complexity and to reduce the space necessary for installation. Mandatory to keep the equipment at the right place with the right dimension.
  - ✓ Sharing data is mandatory. The data shared should be the last and the right.

Some main points

- The building integration should be divided by area to avoid biggest assembly.
- Avoid to use in integration product the 3D detailed model provided by the others design office.
- The best methodology to do the simplification of the 3D model has not yet found (who, by hand, software).
- Be careful with the 3D model provided by external companies - size and to many details.
- Orientation of the 3D model in the cad software. Orientation beam axis along the Y (+ = right) and the Z vertical (+ = sky direction).
- Do not use the save as command to avoid to duplicate the data.

- In the EN-ACE integration section we avoid to produce integration 2D drawing. Difficult to manage 2d drawing during the study cycle.
- In the integration process using the scan is mandatory. To do reverse engineering and also to check the new installation (not metrology).