CAD INTEGRATION

(TASK 1. 3D ENGINEERING DESIGN OF IR AND MDI MECHANICAL LAYOUT WITH INTEGRATION)

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Outline

- PBS, WBS, REQUIREMENTS
- PDM, CAD SHARING AND COOPERATION
- WORK IN PROGRESS / STATUS

PBS - summary

FCCee-MDI Breakdown Structure

ID CODE		
1		INTERACTION REGION AND MACHINE INTERFACE
1	1	Vacuum chamber
1	2	Magnets
1	3	Cryostat
1	4	Shielding
1	5	IP detectors
1	6	Supporting structures (Main)
1	7	Electrical and hydraulic connections main routes
1	8	Mechanical IR assembly tools

PBS - detail

1	**1**		**Vacuum chamber**
1	1	1	IP AlBeMet chamber
1	1	2	IP AlBeMet chamber cooling system
1	1	3	AlBeMet-copper transitions
1	1	4	Y chamber
1	1	5	Y chamber cooling system
1	1	5	Bellows
1	1	6	BPMs
1	1	7	Vacuum equipment (pumps, gauges)
1	1	8	Vacuum chamber supports
1	1	9	Remote vacuum connection
1	1	10	Chamber alignment system

1	**2**		**Magnets**
1	2	1	Compensating solenoid left
1	2	2	Compensating solenoid right
1	2	3	Screening solenoid left
1	2	4	Screening solenoid right
1	2	5	Quadrupole 1.1, left
1	2	6	Quadrupole 1.2, left
1	2	7	Quadrupole 1.3, left
1	2	8	Quadrupole 1.1, right
1	2	9	Quadrupole 1.2, right
1	2	10	Quadrupole 1.3, right
1	2	11	Magnets power supply Cables
1	2	12	Magnets I/O Cables
1	2	13	Magnets alignment system
1	2	14	Magnets supports

1	**3**		**Cryostat**
1	3	1	Cryostat, left
1	3	2	Cryostat, right
1	3	3	Cryostat Cables/piping
1	3	4	Cryostat supports
1	**4**		**Shielding**
1	4	1	Solenoid shielding
1	4	2	Tungsten shielding
1	**5**		**IP detectors**
1	5	1	luminosity calorimeter
1	5	2	Vertex detector
1	5	3	Supports
1	5	4	Cables
1	**6**		**Supporting structures (Main)**
1	**7**		**Electrical and hydraulic connections main routes**
1	**8**		**Mechanical IR assembly tools**

WBS - summary

1		Task 1. 3D engineering design of IR and MDI mechanical layout with integration
1	1	Beam pipe design
1	2	Magnets integration
1	3	Cryostat integration
1	4	Shielding
1	5	IP detectors integration
1	6	Vacuum system Integration
1	7	Supporting structures
1	8	Thermal simulations
1	9	Management of electrical and hydraulic connections/routing
1	10	Mechanical IR assembly, disassembly & repair procedures
1	11	Project Design Management

WBS - detail

1 1	**Beam pipe design**
1 1 1	IR chamber conceptual design
1 1 2	IP AlBemet chamber design
1 1 3	IP AlBemet chamber cooling system study
	IP AlBemet chamber prototyping
1 1 4	Chambers thermo-structural analysis
1 1 5	AlBemet-copper transitions study
1 1 5 1	AlBemet-copper transitions preliminary design
1 1 5 2	AlBemet-copper transitions fabrication prototyping (?)
1 1 6	Y chamber design
1 1 7	Y chamber cooling system design
	Y chamber prototyping
1 1 8	Bellows design
1 1 8 1	Bellows preliminary study
1 1 8 2	Bellows fabrication prototyping
1 1 9	BPM integration
1 1 10	Vacuum equipment integration
1 1 10 1	Vacuum pumps
1 1 10 2	Vacuum gauges
1 1 11	Vacuum chamber supports design
1 1 12	Remote vacuum connection inclusion
	Remote vacuum connection prototyping

1 2	**Magnets integration**
1 2 1	Conceptual CAD model inclusion
1 2 2	Engineered CAD model inclusion
1 2 3	Cables routing
1 2 4	EM forces data inclusion
1 2 5	Magnets supports design
1 3	**Cryostat integration**
1 3 1	Conceptual CAD model inclusion
1 3 2	Engineered CAD model inclusion
1 3 3	Cables/piping routing
1 3 4	Cryostat supports design
1 3 5	Mounting strategy definition
1 4	**Shielding**
1 4 1	Conceptual CAD model inclusion
1 4 2	Engineered CAD model inclusion
1 4 3	Supports design
1 5	**IP detectors integration**
1 5 1	luminosity calorimeter
1 5 1 1	Conceptual CAD model inclusion
1 5 1 2	Engineered CAD model inclusion
1 5 1 3	Supports design
1 5 1 4	Cables routing
1 5 2	Vertex detector
1 5 2 1	Conceptual CAD model inclusion
1 5 2 2	Engineered CAD model inclusion
1 5 2 3	Supports design
1 5 2 4	Cables routing

1 6	**Vacuum system Integration**
1 6 1	(sub-task re-distributed: see above sub-tasks)
1 7	**Supporting structures**
1 7 1	(sub-task re-distributed: see above sub-tasks)
1 7 2	Integration of Task 4 (Alignment &vibration) inputs
1 8	**Thermal simulations**
1 8 1	Thermal management of the whole IR
1 8 2	(sub-task re-distributed: see above sub-tasks)
1 9	**Management of electrical and hydraulic connections/routing**
1 9 1	(sub-task re-distributed: see above sub-tasks)
1 10	**Mechanical IR assembly, disassembly & repair procedures**
1 10 1	Study of mounting strategy
1 11	**Project Design Management**
1 11 1	PDM tool definition
1 11 2	PDM tool settings
1 11 3	PDM tool maintenance

REQUIREMENTS

Component	REQUIREMENTS FOR INTEGRATION								
	conceptual/preliminary drawing	weight	anchor points	I/O cabling	Power supply cabling	Cooling Piping	Thermal issues	Alignment issues	Engineered CAD model
Vacuum chambers	☑	⚙	⚙				⚙		⚙
SR absorbers/masks	☑								⚙
Vacuum equipment									
Compensation solenoid	☑								
Screening solenoid	☑								
Quadrupoles	☑								
Correctors									
Cryostats									
Alignment system									
LumiCal	☑								
Vertex detector									
BPMs									
Shieldings (solenoid)									
Shieldings (external)									
Bellows	☑								
Supports									

☑	=done	⚙	=work in progress

Open questions for mechanical model

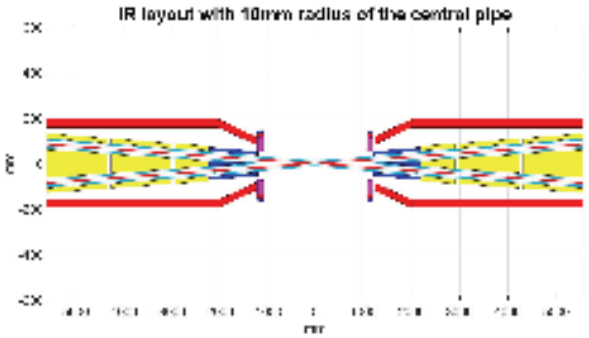
Conceptual design of IR elements/systems:
some are under study, others require optimisation,
others are yet missing

- **Progress with the mechanical assembly** adding all the main components as they will be provided by the experts of the different systems.
- Introduce the weight of the components to design the **supports** and start with the structural studies. This will allow the optimization of the different options of different configurations of supports for **vibration** mitigation, in collaboration with LAPP.
- Space for the **alignment system** to fulfill the stringent requirements.
- **Thermal and mechanical simulations** Just started, with preliminary studies (cooling of central pipe, strength of simplified X pipe to vacuum load at several thicknesses)
- We will define the **strategy for the integration.**

→

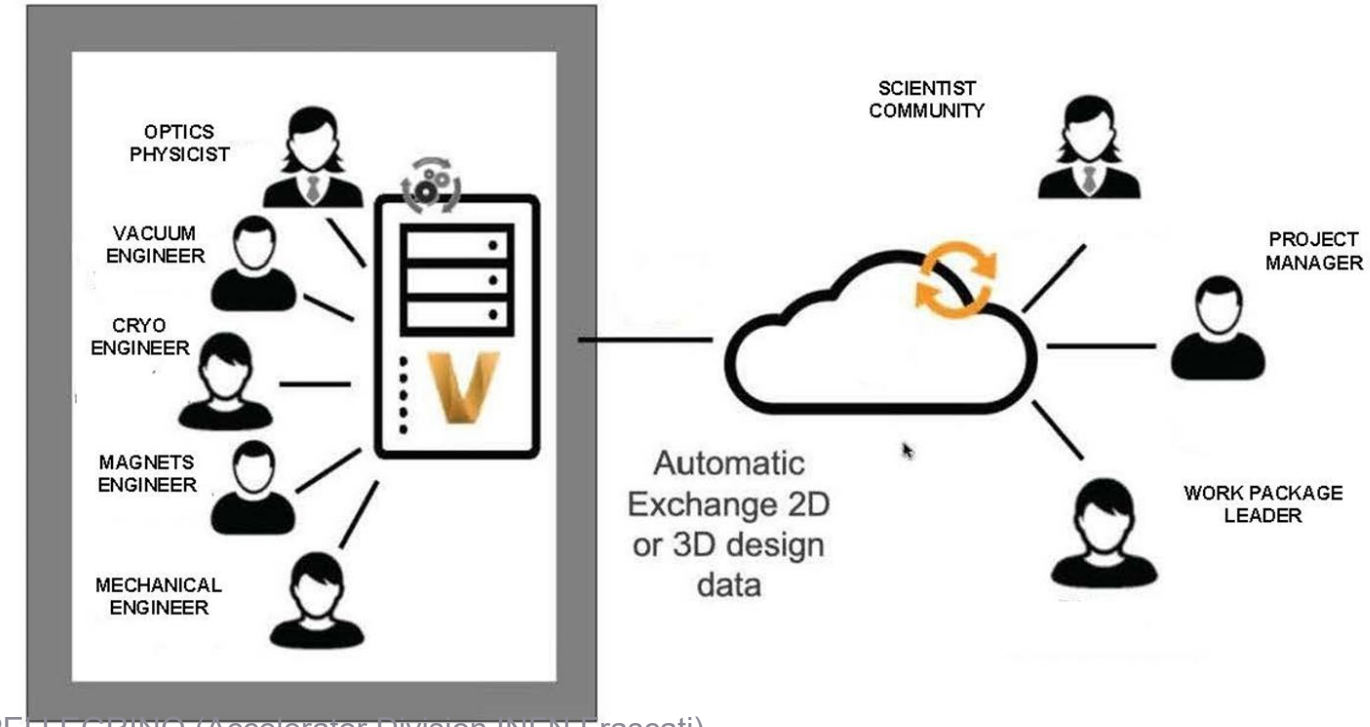
Cryostat design
IR beam diagnostic devices
IR corrector magnets
Shielding
Vacuum system
Remote vacuum connection

Vertex detector (& other IP detectors)



PDM, CAD SHARING AND COOPERATION

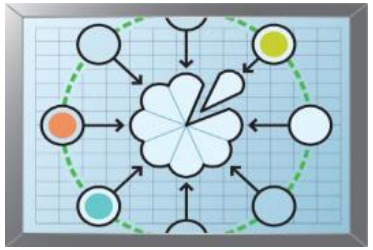
PRODUCT DESIGN MANAGEMENT:
Engineering data management
Web access for non-CAD users
CAD cooperation
Version control
Change management
and so on…



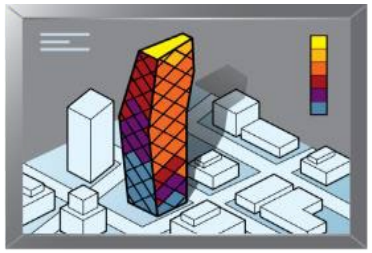
USERS

DATA RETRIEVAL AND RE-USE

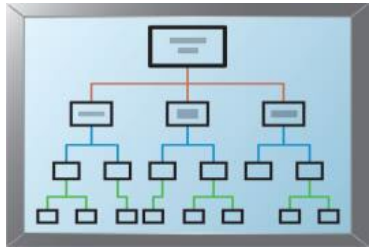
CONCURRENT DESIGN



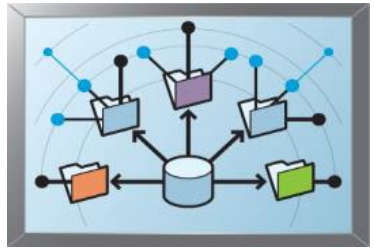
Any-CAD INTEGRATION



TRACKING OF RELASHIONSHIPS

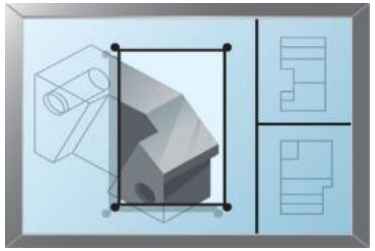


DESIGN ORGANIZATION

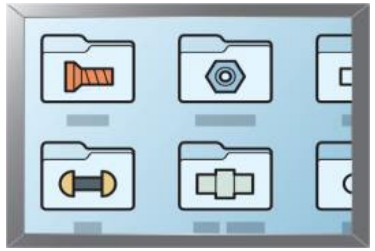


PROCESSES

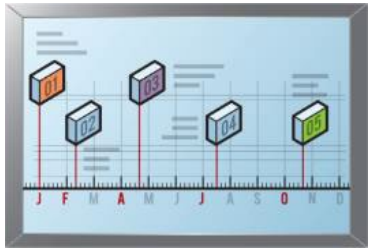
PUBLISHING AND VISUALIZATION



DETAILS STANDARDIZATION

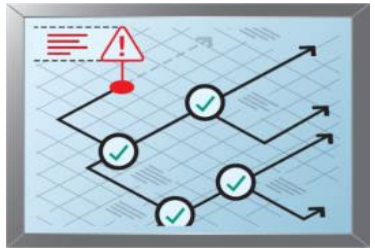


COMPONENT'S LYFECICLE AND REVISIONS



APPROVAL WORKFLOW

CHANGE MANAGEMENT

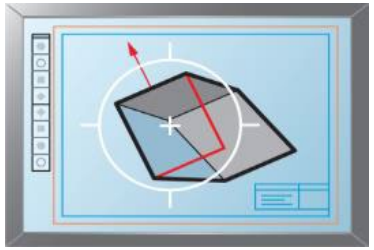


ORGANIZATION

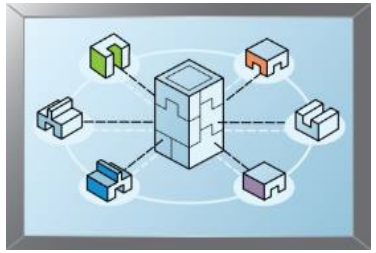
DATA SAFETY AND BACKUP

REPORTING

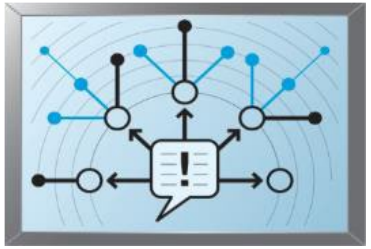
WEB ACCESS FOR NON CAD USERS



REMOTE ACCESS FOR DESIGNERS



INTEGRATION WITH OTHER DATABASES



CAD & PDM @ Frascati Mechanical Engineering Group (Accelerator Division)

- Autodesk INVENTOR Pro 2020 (INFN National License)
- Autodesk VAULT Pro 2020
  - 9 Mech Eng Group users
  - 3 external users from other Frascati Groups
- Autodesk Sharedviews
  - Any number of external non-CAD users via WEB (access via web-link – you can manipulate the 3D model, take measurements, make sections, take and share notes, save images…)

WORK IN PROGRESS

We should start using a collaborative tool for CAD at a broader level (i.e. outside the Frascati Group)

- First Option: use the CERN standard tools (should we switch to CATIA?)
- Backup provisionary choice: extend the Frascati Autodesk Vault Pro license to other CAD users (about 500€/user) to collaborate in designing components and/or import neutral format CAD files in our system.
- In any case, here https://autode.sk/2ZMssyr you find the CAD model at the present status (geometrical study)

WORK IN PROGRESS -2

- Collect components design, have and give feedbacks on them (status: updates needed)
- Design (CAD & thermo-mech simulation) of:
  - Paraffin cooled AlBeMet central chamber and Y chamber (status: advanced)
  - Bellows and transitions (status: good)
  - Layout and space management (status: just started)
  - Supports (status: not yet started)
- Prototyping proposal (*). Cost estimate 100’000 € (status: to be approved)
  - Central IP chamber
  - AlBeMet162-Cu transition with integrated bellow

(*) see Fransesini presentation

FCC

INFN LNF

THANK YOU FOR YOUR ATTENTION

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