FCC

FUTUR COLLISIONNEUR CIRCULAIRE
Étude de faisabilité

Progress on layouts and designs for FCC surface sites

11 June 2024, San Francisco

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CERN

Summary

1. Context and coordination

2. Look back to the mid-term review:
   - Collaboration with Fermilab (USA)
   - Costing material with Rendel (UK)

3. Productions and updates for the final report:
   - Process followed
   - Update on drawing activities
   - Cost and schedule

4. Next steps for Surface Sites:
   - Environmental integration
   - Architectural design/concepts
   - Technical Design

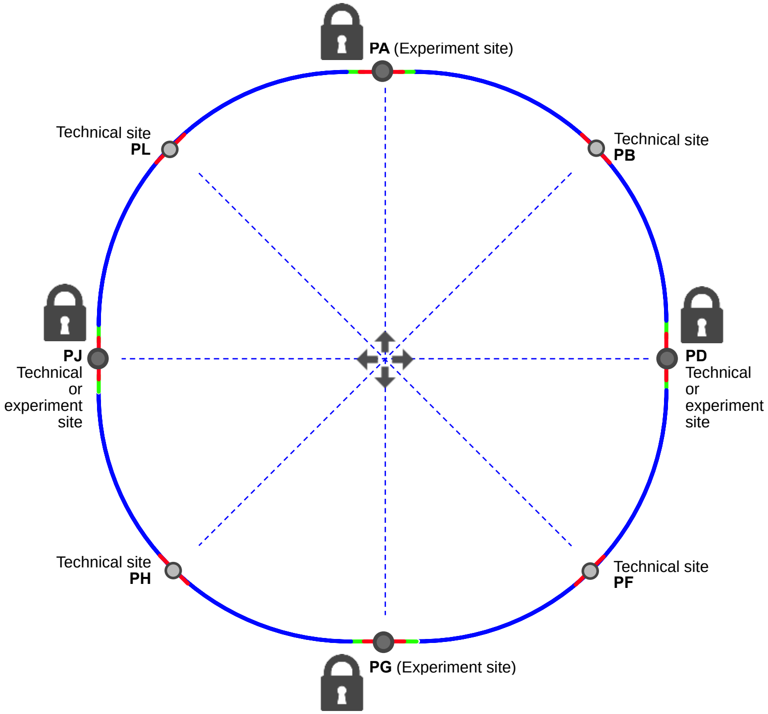
Context

8 Surface sites as:

- 4 Experiment sites
- 4 Technical sites

- 7 sites in France
- 1 site in Switzerland

- 2 sites in urbanised areas
- 6 sites in rural areas



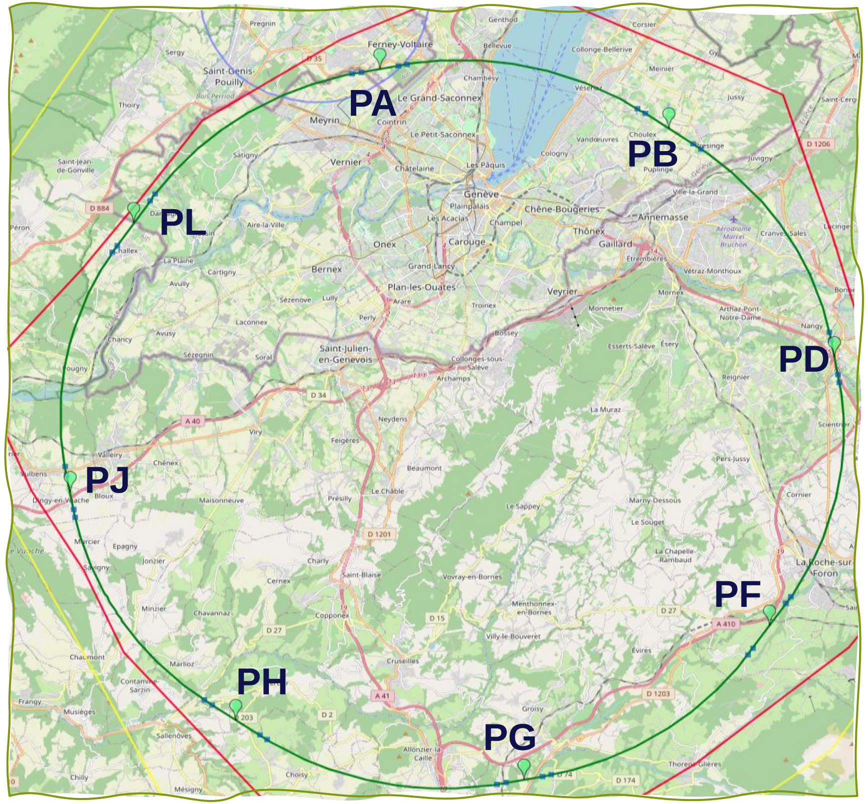
Schematic of FCC: *Experiment and Technical Sites*

Coordination

Main inputs for Surface Sites:

- Requirements from the Placement Team
- Specifications from the Technical Infrastructure Working Group

An iterative process in which design layouts are the outcome of the combination in between FCC requirements and existing external constraints.



Map: *Reference scenario and Surface Sites*

Mid-Term Review look back - Collaboration with FNAL

Over a year of collaboration with the FNAL team:

ISD Infrastructure Services Division
Engineering Group

Fermilab's in-house Architectural/Engineering (A/E) firm. The Engineering Department provides expertise for conventional facility design and construction activities and directs outside A/E services.

Tracy Lundin
Senior Strategic Planner

Damian Dockery
ISD/Deputy Director

Andrew Federowicz
Senior Architect

Brian Rubik
Senior Structural Engineer

Jacquelyn Dragovich
BIM Manager / Architect

LBNF Long Baseline Neutrino Facility
Near Site Conventional Facilities

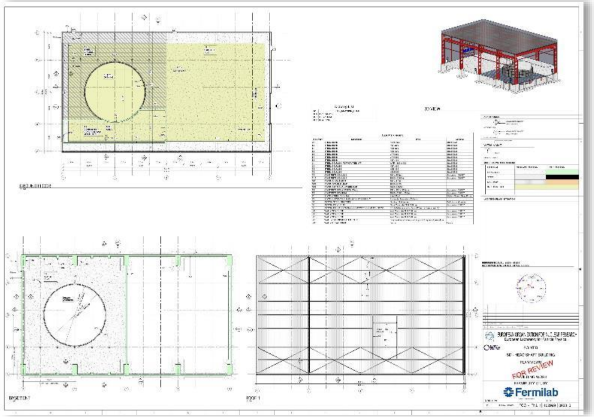
Thomas Hamernik
LBNF-NSCF Project Manager

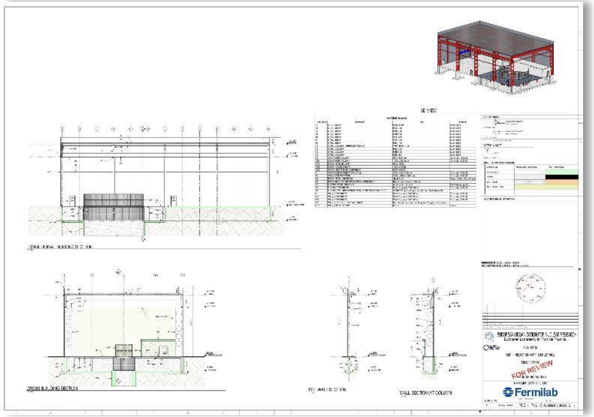
Kennedy Hartsfield
LBNF-NSCF Deputy Project Manager

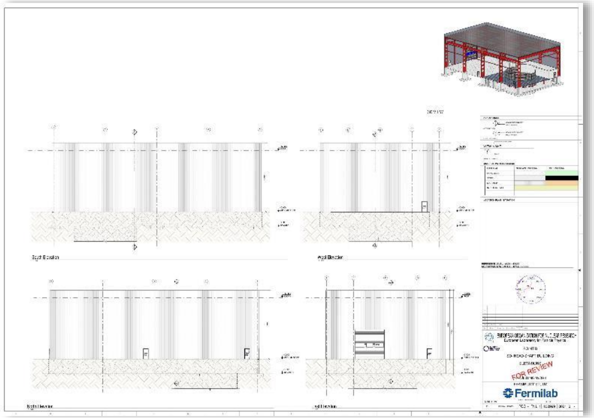
Mid-Term Review look back - Collaboration with FNAL

Deliverable 1:

Preliminary technical drawings for buildings developed using BIM software Autodesk Revit in accordance with SCE drafting standards.







Plans: *Grounds/Foundation/Basement/Roof*

Sections: *Building, Typical Wall*

Elevations: *North/South/East/West*

Mid-Term Review look back - Collaboration with FNAL

Deliverable 2:

Bill of Quantities / Technical Report:

- Based on Revit model output + some manual entry for quantities not able to be modelled,
- Quantities of each material for all buildings (steel, concrete, insulation, paving, excavation, etc),
- Combined with Technical Report will allow for a cost estimate to be generated for each site (and extrapolated to other sites).

Bill of Quantities: SD - Head Shaft Building					
Type Mark	Description	Type	Material	Quantity	Unit
C1	STEEL COLUMN- PERFORATED WF	WFP 1500 x 400	Steel S235	31.0	t
C2	STEEL COLUMN	HEA 300	Steel S235	3.3	t
C5	STEEL COLUMN	HEB 300	Steel S235	4.1	t
C6	STEEL COLUMN	HEM 300	Steel S235	6.0	t
C9	CONCRETE COLUMN	500 x 500mm	Concrete - C30/37	6.4	m^3
C10	CONCRETE COLUMN	1000 x 2000mm	Concrete - C30/37	50.9	m^3
B1	STEEL BEAM	HEM 1000	Steel S235	40.7	t
B2	STEEL BEAM	HEA 200	Steel S235	20.7	t
B4	STEEL BEAM	HEB 220	Steel S235	3.1	t
B5	STEEL BEAM	HEB 800	Steel S235	22.1	t
B6	STEEL BEAM	UPN 200	Steel S235	4.6	t
B7	STEEL BEAM	UPN 300	Steel S235	9.6	t
B8	STEEL BEAM	HEA 100	Steel S235	4.6	t
S1	FLOOR- STEEL GRATING	Grating full diamond	Full diamond grating	247.0	m^2
S3	FLOOR- CONCRETE	Floor Concrete THK 300mm	Concrete - C30/37	994.0	m^2
S6	FLOOR- COLLABORATING- CONCRETE ON METAL DECK	CE-INT-Collaborating floor-120mm - Steel sheet 60	Concrete - C30/37	148.0	m^2
R1	ROOF- STEEL DECKING	Steel Roof	Steel Deck	1024.0	m^2
R2	ROOF- ROCKACIER INSULATION ASSEMBLY	Rockacier Insulation 200mm	Rockacier Insulation 200mm	1024.0	m^2
DP1	DOOR- SINGLE LEAF	900 x 2100h	Steel Door	4	nr
DP2	DOOR- DOUBLE LEAF	1800 x2100h	Steel Door	1	nr
DS2	DOOR- SECTIONAL-OVERHEAD	Sectional Door	Steel Door	2	nr
DS3	DOOR-OPENING AT SAS	INT-2000x2700h	Steel Door	1	nr
W7	WALL - EXT. INSUL METAL PANEL	Double-skinned steel cladding and 2 layers of insulation	Metal building envelope and insulation	1825.0	m^2
W1	WALL- CONCRETE	Wall Concrete THK 200mm	Concrete - C30/37	35.6	m^3
W2	WALL- CONCRETE	Wall Concrete THK 250mm	Concrete - C30/37	31.1	m^3
W3	WALL- CONCRETE	Wall Concrete THK 300mm	Concrete - C30/37	136.0	m^3
W5	WALL- WIRE MESH FENCE	Wire-mesh fence	Wire-mesh fence	185.0	m^2
F1	CONCRETE FOUNDATION WALL	350 x 350 x 350mm	Concrete - C30/37	35.0	m^3
F4	CONCRETE FOOTING	4000 x 2500 x 500mm	Concrete - C30/37	50.0	m^3
N/A	EXCAVATION	Excavation of soil	N/A	4501.7	m^3

Example of BoQ: *Head Shaft Building*

Mid-Term Review look back - Costing with RENDEL

<u>Deliverable 1:</u>

Detailed cost estimate report for:

- An experiment surface site (Site PA),
- A technical surface site (Site PB).

<u>Deliverable 2:</u>

Extrapolation of cost estimates for other surface sites using volume ratios per type of building

For the process of estimating and monitoring construction costs, we use the most used probabilistic calculation methodology defined by the Association for the Advancement of Cost Engineering International (AACEI) classifications (AACEI, 2019 IBR-97).

Rendel	III		IV		V
	ORANGE	GREEN	RED	GREEN	ORANGE
0.0.0.0 SITE INSTALLATION	X				
1.0.0.0 CIVIL WORKS & INFRASTRUCTURES					
1.1.0.0 INFRASTRUCTURE-ROAD					
1.1.1.1 PREPARATION WORKS				X	
1.1.1.2 EXCAVATION		X			
1.1.1.3 PAVEMENT		X			
1.1.1.4 STORM WATER DRAINAGE/WASTE WATER NETWORKS/MISCELLANEOUS NETWORKS			X		
1.1.1.5 WASTEWATER TREATMENT			X		
1.1.1.6 VARIOUS NETWORKS			X		
1.1.1.7 SIGNAGE			X		
1.1.1.8 EQUIPMENTS				X	
1.1.1.9 GREEN SPACE				X	
1.2.0.0 MAIN STRUCTURAL WORK					
1.2.1.0 ADDITIONAL EARTHWORK		X			
1.2.2.0 FOUNDATION		X			
1.2.3.0 UNDERGROUND NETWORKS			X		
1.2.4.0 INFRASTRUCTURE		X			
1.2.5.0 SUPERSTRUCTURE		X			
1.2.6.0 ROOF SEALING				X	
1.2.7.0 CLADDING AND ROOFING		X			
1.2.8.0 MISCELLANEOUS		X	X		
1.3.0.0 FINISHING WORK					
1.3.1.0 FILLING IN CROSSING			X		
1.3.2.0 FLOOR PAINTING and COATING				X	
1.3.3.0 IRONWORK		X			
1.3.4.0 DOORS		X			
1.3.5.0 FALSE ROOF		X			
2.0.0.0 COMMON UTILITIES					
2.1.0.0 ELECTRICITY CFO-Cfa					X
2.2.0.0 FLUID VENTILATION					X

Example of PBS: *Classification and confidence level*

Final Report ongoing updates - Process followed

<u>An iterative process:</u>

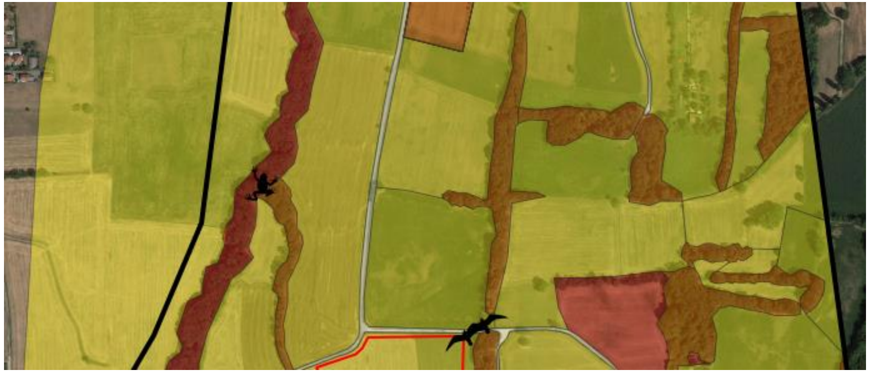
With the mid-term review report as baseline, current updates are taking place for Surface Sites.

This iterative process involves frequent work sessions as follows:

- Bi-monthly technical meetings with TIWG to discuss the updates of Surface Sites definitions and acceptability of external constraints (civil engineering or placement).
- Monthly meetings with Placement team and ecologists to better understand the placement constraints for each location.

Domain	Description
Computing	Elements that relate to the computing requirements for the accelerator. The computing for the experiments will not be included here.
Cooling	Elements that relate to the cooling of the particle accelerators and experiments.
Cryogenic refrigeration	Elements that relate to the generation of cryogenic temperatures (not proximity cryogenics of particle accelerator or experiment elements).
Electricity distribution	Elements that relate to the supply of electrical energy and its distribution between sites and to functional machine and detector elements.
Experiment	Elements that relate to the detectors.
Machine powering	Elements that relate to the powering of the particle accelerators (mainly magnets and RF).
Magnet	Elements that relate to the particle accelerator magnet system.
RF	Elements that relate to the particle accelerator radio frequency system.
Safety	Elements that relate to the protection of persons and in the natural environment.
Site	Elements that relate to the surface site and soil occupation.
Subsurface	Elements that relate to underground constructions.
Survey	Elements that relate to geodesy and survey.
Transport	Elements that relate to the transport of equipment and persons on surface and underground, on-site and off-site.
Utilities	General services that are pre-requirements for a site and its operation and which do not directly relate to the particle accelerators and the experiments.
Vacuum	Elements that relate to the creation of vacuum for the particle accelerators and experiments.
Ventilation	Elements that relate to the heating, air conditioning and ventilation of surface and subsurface construction elements.

Database extract: *Specifications for a Surface Site by TIWG*



GIS extract: *Fauna and Flora sensitive grid*

Final Report ongoing updates -

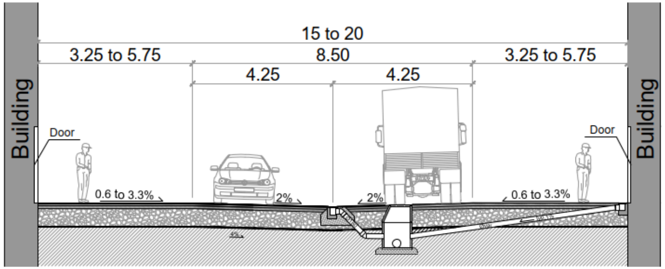
Drawing activities

Zoom on phasing and hypothesis:

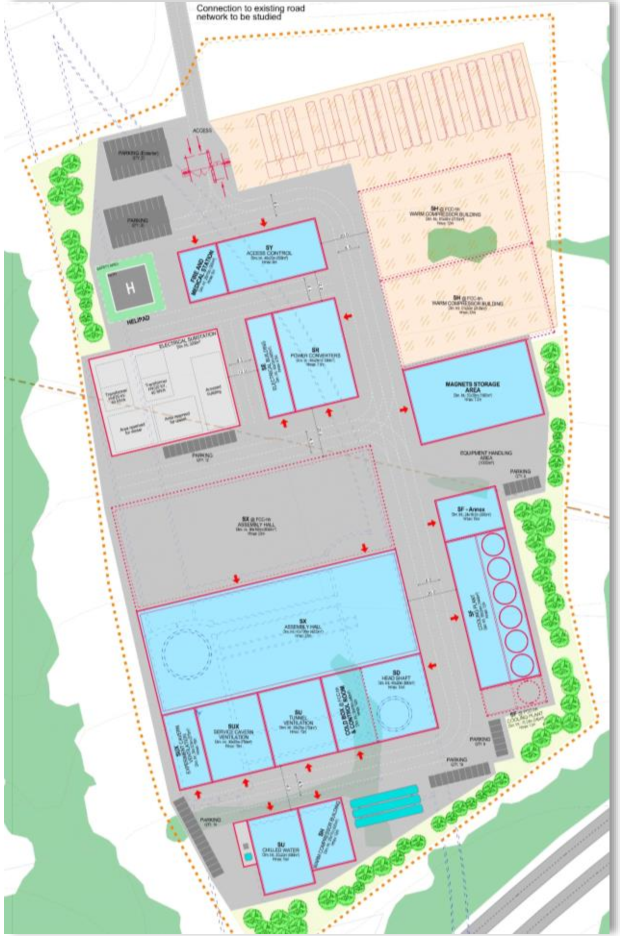
Drawing activities for surface sites allow a preliminary approach on phasing. We're showing on layouts 2 different eras as followed:

- FCC-ee layout
- FCC-hh layout

Hypothesis for roads within the site are made in collaboration with TIWG, and all vehicle tracking are checked to ensure smooth logistics



Road section: *Typical section of roadway*



Technical layout: *FCC-ee and FCC-hh*

Credit to: Angel Navascues Cornago, Draftsman at CERN

Final Report ongoing updates -

Drawing activities

Final material for Surface Sites:

Production of layouts for each surface sites with various level of details to serve as baseline to:

- Assess Cost & Schedule
- Confirm space compatibility
- Precise tunnel connexions

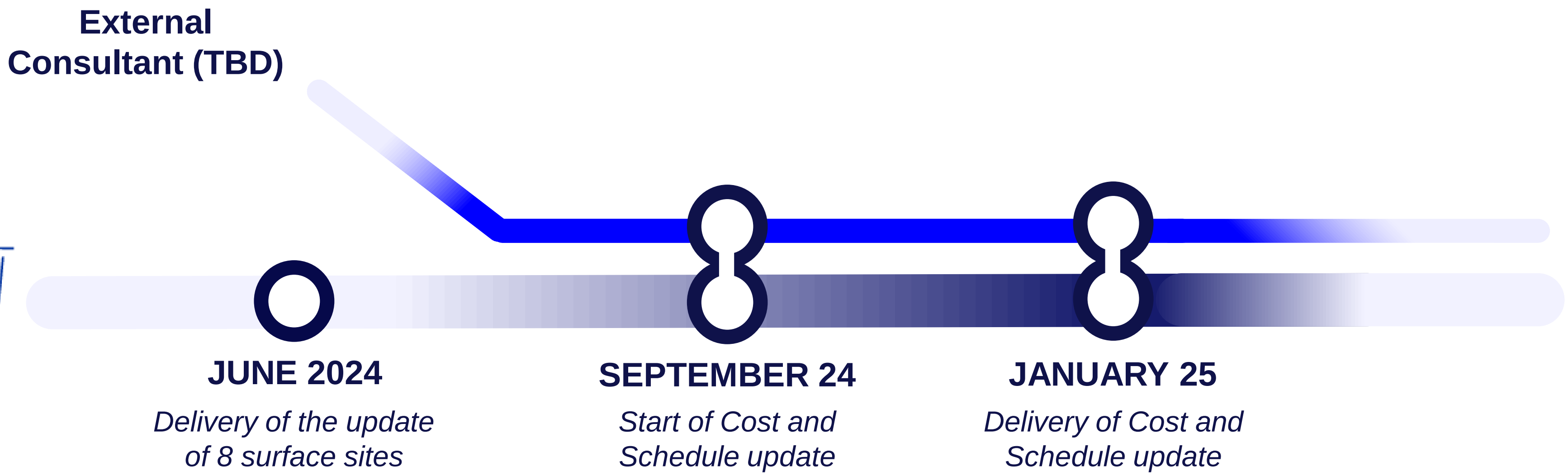
***Technical layouts:** Baseline for the final report*

***Simplified versions:** For integration discussions*

Credit to: Angel Navascues Cornago, Draftsman at CERN

Final Report ongoing updates - Cost and Schedule

Timeline for Cost and Schedul update:



Next steps for Surface Sites - Environmental integration

Objectives:

From the Environmental Initial State Analysis, in collaboration with Placement team and ecologists, integrate environmental constraints and opportunities.

Next steps for Surface Sites - Architectural/Design Concept

<u>Objectives:</u>

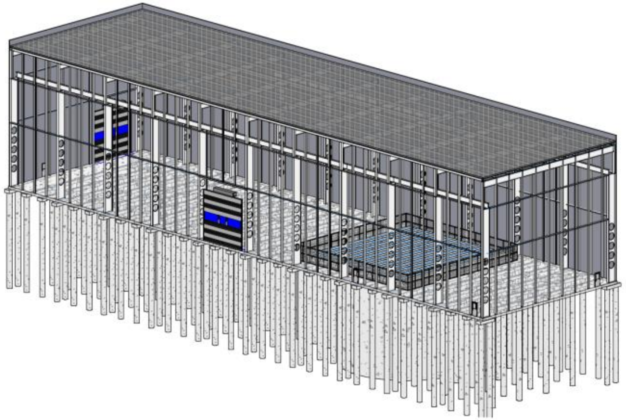
Develop specific urban, architectural and landscaping concepts for each site in collaboration with Host States and local entities.

Draft Conceptual Views of a Surface Site: *Credit to EFFEKT Architects (DN)*

Next steps for Surface Sites - Technical Design

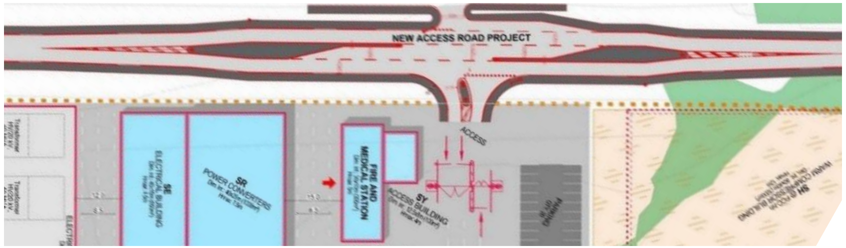
<u>Objectives:</u>

Confirm the specifications by TIWG to optimise and further develop designs for surface sites buildings



Example of 3D BIM Model: *FCC-ee assembly hall*

Develop a pre-design of infrastructure and amenities (access roads, utility networks, retention basin…)



Example of road study: *New junction*

Conclusion

Thanks to coordination with internal teams at CERN, collaboration with Fermilab, specific studies with consultants, the FCC feasibility study will be complete for Surface Sites with layouts, cost estimate and schedule.

Next steps for FCC Surface Sites will step up the involvement of Host States and local entities.

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