PRELIMINARY LAYOUTS AND DESIGNS FOR TWO OF THE FCC SURFACE SITES

Damian DOCKERY (Fermilab)
Andrew FEDEROWICZ (Fermilab)
Brian RUBIK (Fermilab)
Overview

CERN x FNAL Collaboration

• Background on Collaboration
  • FNAL Team, CERN Visit
• Scope of work
• SITE PA (Experiment Site)
• SITE PB (Technical Site)
Aerial view of Fermilab campus. Fermilab is America’s particle physics and accelerator laboratory. We bring the world together to solve the mysteries of matter, energy, space and time.
Background on Collaboration

The route to FCC Week 2023

APR 2022
Draft agreement CERN & DOE

JUNE 2022
FNAL project team on board

NOV 2022
FNAL Visit CERN

JAN 2023
Start of Conceptual Design Development

TODAY!
Background on Collaboration

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

Background on Collaboration

CERN Trip: November 14-19th

- Total of 3 FNAL staff spent one week at CERN visiting LHC locations and proposed FCC sites with SCE team Tim Watson and Antoine Mayoux.

- The trip’s intent and itinerary at a glance:
  - Meeting with CERN staff and FCC stakeholders to tour existing LHC facilities.
  - Gain better understanding of the CERN building types, construction methods, and unique challenges at LHC surface sites.
### Background on Collaboration

**CERN Trip: November 14-19th**

<table>
<thead>
<tr>
<th>Location</th>
<th>Description</th>
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<tbody>
<tr>
<td>LHC Point 1 - ATLAS</td>
<td>Experiment and Cryo requirements</td>
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<tr>
<td>LHC Point 2 ALICE</td>
<td>Requirements for Energy Management</td>
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<td>LHC Point 5 – CMS</td>
<td>Site and Civil Engineering Requirements</td>
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<td>LHC Point 8</td>
<td>Cooling, Ventilation, Cryo Requirements</td>
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<td>Building 30</td>
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<td>Building 54</td>
<td>SCE overview of drafting and Revit Standards</td>
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<tr>
<td>Medical &amp; Fire Station</td>
<td>Safety Requirements</td>
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**Locations visited and meetings with FCC stakeholders**
Scope of Work

Site Visit: November 2022

New construction at LHC Point 5. Knauf acoustic panels lining the interior walls is one strategy used to control sound levels.
Scope of Work

Site Visit: November 2022

New construction at LHC Point 5. Installation of exterior building envelop
Scope of Work

**Deliverables: General Requirements**

- Develop building design and site layout for **2 surface sites**.
- These sites would be used a basis for estimating all 8 sites.
- **Final Deliverable includes:**
  - Preliminary Drawings w/specifications
  - Bill of Quantities
  - Architectural Visualizations
- FNAL deliverables are a collaboration with CERN that coordinates with SCE department strategy document describing industry standard contracting practices for large scale civil engineering projects.
- All renderings are conceptual and will be developed further as the study evolves

*Site PA (Experimental)*

*Site PB (Technical)*

*Surface sites PA and PB (FNAL deliverables)*
Scope of Work

**Deliverables: Preliminary Drawings**

- 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
Scope of Work

Deliverables: Bill of Quantities / Technical Report

- Based on Revit model output + some manual entry for quantities not able to be modeled
- 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)
- Uses standards established by the Civil Engineering Standard Method of Measurement (CESMM4) by the Institution of Civil Engineers

<table>
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<th>Quantity</th>
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<td>DOOR- SECTIONAL-OVERHEAD</td>
<td>Sectional Door</td>
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<td>W7</td>
<td>WALL - EXT. INSUL METAL PANEL</td>
<td>Double-skinned steel cladding and 2 layers of insulation</td>
<td>Metal building envelope and insulation</td>
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<td>Wall Concrete THK 200mm</td>
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<td>WALL - CONCRETE</td>
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<td>Wire-mesh fence</td>
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<td>Excavation of soil</td>
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Bill of Quantities: SD - Head Shaft Building
SITE PA
Experimental Site (Ferney-Voltaire, France)
SITE PA

Existing Site: Local Area

- ~5.5 ha site located in France near semi-urban development
- 5km northeast of CERN campus
- 2km west of Geneva Airport
- Neighbors existing LHC surface site (Point 8)
SITE PA

Existing Site: Local Area

- ~5.5 ha site located in France near semi-urban development
- 5km northeast of CERN campus
- 2km west of Geneva Airport
- Neighbors existing LHC surface site (Point 8)
SITE PA

**Existing Site: Constraints & Considerations**

**Constraints** identified by CERN SCE:
- Located in semi urban area
- Ongoing construction projects
- Protected “Zone Humide” and compensation zone north of parcel
- Gas Pipeline south of parcel
- Required site access along east side of parcel

**Considerations** identified by CERN SCE:
- Maintain visibility from the adjacent road toward the Alps.
- Proposed building heights should be similar to existing structures in area
Existing semi urban development located south of proposed Site PA
SITE PA

Proposed Site: Buildings

**FCC-ee Buildings**

<table>
<thead>
<tr>
<th>Component</th>
<th>Description</th>
<th>Dim.</th>
<th>Hmax.</th>
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</thead>
<tbody>
<tr>
<td>SX</td>
<td>ASSEMBLY HALL</td>
<td>Interior: 25m x 100m</td>
<td>23m</td>
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<tr>
<td>SD</td>
<td>HEAD SHAFT BUILDING</td>
<td>Interior: 20m x 40m</td>
<td>15m</td>
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<tr>
<td>SUX</td>
<td>EXPERIMENT VENTILATION</td>
<td>Interior: 20m x 15m</td>
<td>15m</td>
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<tr>
<td>SF</td>
<td>COOLING PLANT</td>
<td>Interior: 60m x 11m</td>
<td>15m</td>
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<td></td>
<td>EVAPORATOR TOWER REJECT WATER TREATMENT</td>
<td></td>
<td></td>
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<tr>
<td></td>
<td>BASEMENT BUILDING</td>
<td>Interior: 60m x 11m</td>
<td>12m</td>
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<tr>
<td>SH</td>
<td>COMPRESSION STATION AND CONTROL ROOM</td>
<td>Interior: 25m x 17m</td>
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<tr>
<td>SU</td>
<td>TUNNEL AND SERVICES AREA VENTILATION</td>
<td>Interior: 40m x 15m</td>
<td>15m</td>
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<tr>
<td>SHE</td>
<td>PRESSURIZED HELIUM STORAGE</td>
<td>3 stacks of 3 bottles</td>
<td>Each skid: 27m x 15m</td>
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<tr>
<td>SR</td>
<td>POWER CONVERTERS BUILDING</td>
<td>Interior: 40m x 25m</td>
<td>8m</td>
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<tr>
<td>SE</td>
<td>ELECTRICAL BUILDING</td>
<td>Interior: 40m x 10m</td>
<td>6m</td>
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<td></td>
<td>ELECTRICAL SUBSTATION</td>
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<td></td>
<td>-ENERGY STORAGE</td>
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<td>-POWER TRANSFORMERS</td>
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<td>-SVC HARMONICS FILTERS</td>
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<td></td>
<td>-ELECTRICAL PARK</td>
<td>Surface Dim: 3715 SQ M</td>
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**FCC-hh Buildings**

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<th>Component</th>
<th>Description</th>
<th>Dim.</th>
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<tbody>
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<td>ASSEMBLY HALL</td>
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<td>Interior: 20m x 20m</td>
<td>15m</td>
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<td>SF (FCC-hh)</td>
<td>COOLING PLANT</td>
<td>Interior: 60m x 11m</td>
<td>12m</td>
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<td></td>
<td>EVAPORATOR TOWER REJECT WATER TREATMENT</td>
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<td></td>
<td>BASEMENT BUILDING</td>
<td>Interior: 60m x 11m</td>
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<td>SU (FCC-hh)</td>
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<td>SHE (FCC-hh)</td>
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<td>Each skid: 27m x 15m</td>
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<td>Surface Dim: 12.1m x 4.2m</td>
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SITE PA

Proposed Site: Layout

Responding to existing constraints and general considerations

FCC-ee structures shown in blue

FCC-hh structures shown in white
SITE PA

Proposed Site: Layout at FCC-ee
SITE PA

Proposed Site: Layout at FCC-hh
Existing heights of surrounding buildings

EXISTING COMMERCIAL SPACE
T/SLAB ~ 427m
BLDG. HT. ~13m

EXISTING SUPERMARKET
T/SLAB ~ 427m
BLDG HT ~ 10M

Existing heights of surrounding buildings
SITE PA

Proposed Site: Building Heights

SX
Assembly Building
T/SLAB: 422m
BLDG. HT 23m

SU
TUNNEL & SERVICES AREAS VENTILATION BUILDING
T/SLAB: 422m

SD
HEAD SHAFT BUILDING

EXISTING COMMERCIAL SPACE
T/SLAB ~ 427m
BLDG HT ~ 13m

EXISTING SUPERMARKET
T/SLAB ~ 427m
BLDG HT ~ 10m

+444m

+422m

SECTION SITE AND ADJACENT PROPERTY

23m
SITE PA

SX Assembly Building: Structural System

- Reinforced concrete foundation: piles, grade beams, slab
- Steel superstructure and roof decking
- Perforated steel columns to allow for mechanical / electrical services to pass through
- Steel panel cladding with insulation
- Precast concrete shielding blocks over shaft opening
- Steel columns support a 120 tonne overhead crane
SITE PA

SX Assembly Building: Structural System

Crane support beam
Perforated column
Concrete pile foundation
SITE PA

Thoughts/Considerations/Recommendations

Challenges:

- FCC-hh footprint expansion
  - Further study needed on site layout to verify ee and hh layouts will fit on parcel.
  - Need to further study synergies with LHC Point 8
  - Limited opportunity to increase building heights. Stacking building programs on multiple levels below grade could be an option.

Expansion options surrounding Site PA.
SITE PB
Technical Site (Switzerland)
SITE PB

**Existing Site: Overview**

- ~4ha site located on Swiss rural land approximately 15km east of the CERN campus
- Local opposition to new industrial buildings by is anticipated.
SITE PB

Existing Site: Overview

**Constraints identified by CERN SCE:**

- Located on Swiss rural land with expensive properties in surrounding area opposed new “industrial buildings”
- Protected forest (west), Protected stream (north), Buried gas pipeline (south)

**Considerations identified by CERN SCE:**

- Entrance to site located on the NW side of site. Road external to site will follow path of existing track.
**SITE PB**

Proposed Site: Buildings

### FCC-ee Buildings

- **SY**
  - ACCESS CONTROL BUILDING
  - Dim. Interior: 21m x 15m
  - Hmax: 4m

- **SD**
  - HEAD SHAFT BUILDING
  - Dim. Interior: 24m x 43m
  - Hmax: 14m

- **SU**
  - TUNNEL AND SERVICES AREA
    - VENTILATION
    - Dim. Interior: 21m x 30m
    - Hmax: 15m

- **SF**
  - COOLING PLANT
    - Dim. Interior: 22m x 12m
    - Hmax: 10m

- **ES**
  - ELECTRICAL BUILDING
    - Dim. Interior: 43m x 10m
    - Hmax: 6m

- **SE**
  - ELECTRICAL POWER BUILDING
    - Dim. Interior: 40m x 10m
    - Hmax: 6m

- **SR**
  - POWER CONVERTERS BUILDING
    - Dim. Interior: 40m x 25m
    - Hmax: 8m

### FCC-hh Buildings

- **SD (FCC-hh)**
  - HEAD SHAFT BUILDING EXPANSION
    - Dim. Interior: 24m x 40m
    - Hmax: 14m

- **SU (FCC-hh)**
  - TUNNEL AND SERVICES AREA
    - VENTILATION
    - Dim. Interior: 21m x 30m
    - Hmax: 15m

- **SH (FCC-hh)**
  - COMPRESSION STATION AND CONTROL ROOM
    - Dim. Interior: 20m x 30m
    - Hmax: 10m

- **SF (FCC-hh)**
  - COOLING PLANT
    - Dim. Interior: 22m x 12m
    - Hmax: 10m

- **SES**
  - ELECTRICAL POWER BUILDING
    - Dim. Interior: 40m x 10m
    - Hmax: 6m

- **H**
  - ELECTRICAL SUBSTATION
    - ENERGIZED STORAGE
    - POWER TRANSFORMERS
    - VHC HARMONICS FILTERS
    - ELECTRICAL PARC
    - Surface Dim.: 3715 SQ M

- **SO**
  - STORAGE FOR RADIOACTIVE OBJECTS
    - Dim. Interior: 20m x 10m
    - Hmax: 8.2m

- **SHE (FCC-hh)**
  - LIQUID AND PRESSURIZED HELIUM STORAGE
    - 7 stacks of 6 bottles
    - Each stack: 27m x 15m
    - Hmax: 9m
    - 12 QSD
    - Each QSDH DIM: 30m x 6m
    - Hmax: 6m

- **SLN (FCC-hh)**
  - LIQUID AND PRESSURIZED HELIUM STORAGE
    - Surface Dim.: 12.1m x 4.2m
    - Hmax: 15m
SITE PB

Proposed Site: Layout

Responding to existing constraints and general considerations
SITE PB

Proposed Site: Buildings at FCC-ee
SITE PB

Proposed Site: Buildings at FCC-hh
Aerial View of Proposed Site PB
View from main gate of proposed Site PB

View overlooking Site PB entrance
SY Access Building

SY Access Control Building shown adjacent to the main site entrance
SY Access Building

Building Program

1. Main Entrance
2. Secondary Entrance
3. Lobby/Display Area
4. Control Room
5. Networking/Data Room
6. Medical First-aid Room
7. Conference Room (10 People)
8. Private Offices
9. Security Guard Office
10. Kitchenette/Break Room
11. Restrooms
12. Storage
Site PB / SF Cooling Plant

The SF building host the cooling tower structures that are required to extract the heat loads from the machines for the underground.
Site PB / SF Cooling Plant

Proposed Structural System

- Reinforced concrete foundation: spread footings, slab on ground
- Reinforced concrete superstructure to help with sound attenuation
- Acoustic insulation panels on the interior walls to further reduce noise transmission to exterior
- Prefabricated concrete exterior wall panels with insulation
- Crane support beams for 3.5 tonne overhead crane
- Steel grating “false floor” to allow easy access to basement equipment level
Site PB / SF Cooling Plant

Proposed Structural System

Crane support beam

Steel grating “false floor” with basement below
Conclusion

• All deliverables (Revit models, preliminary drawings, bill of quantities, technical report) have been transferred to CERN

• CERN has contracted a cost estimating firm to take this information and generate cost and schedule estimates that will be incorporated into the overall FCC feasibility study

• We’ve thoroughly enjoyed this opportunity for continued collaboration with our CERN colleagues and hope to remain a part of this effort in the future

• Special thanks to our CERN colleagues: Tim Watson, Antoine Mayoux, Ludovic Barthelemy, Angel Navascues Cornago.