AIA TAP AWARDS

ISE Lab

Interdisciplinary Science and Engineering Lab

“ISE Lab is, indeed, the temple of our future, where the university’s pioneering research will find a home built on the foundation of openness and collaboration: where new discoveries will redraw the boundaries of human knowledge, and new innovations will help us harness it: where young talent will be developed and deployed to solve the problems that challenge us locally and globally: where students will see everyday the enormous power of putting science to work.”

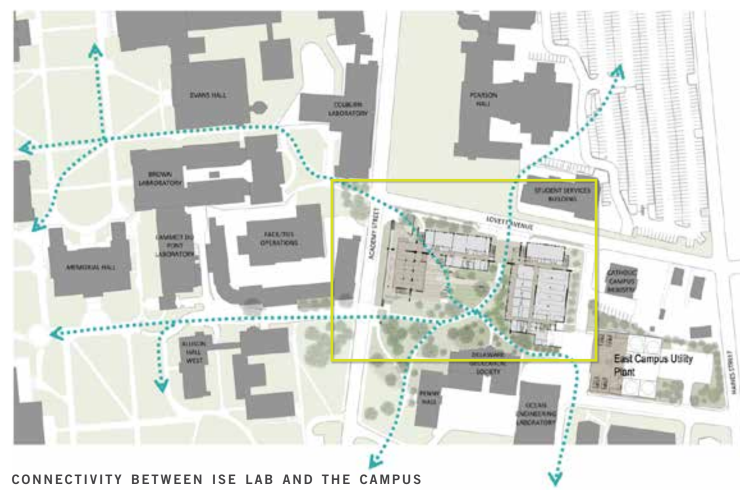
PATRICK T HARKER, PRESIDENT UNIVERSITY OF DELAWARE, 2013

Introduction

Opened in the fall of 2013, the University of Delaware's Interdisciplinary Science and Engineering Laboratory (ISE-Lab) was designed around the philosophy of integrating teaching, learning and research. This 194,000-square-foot facility is intended to engage students and stimulate excitement about science and engineering for a new generation.

The ISE-Lab includes classrooms and teaching laboratories, as well as state-of-the art imaging and synthesis laboratories and a class 100/1000 clean room. Also included are spaces for open collaboration for teams of researchers and offices for University institutes related to energy and the environment.

SITE PLAN



CONNECTIVITY BETWEEN ISE LAB AND THE CAMPUS

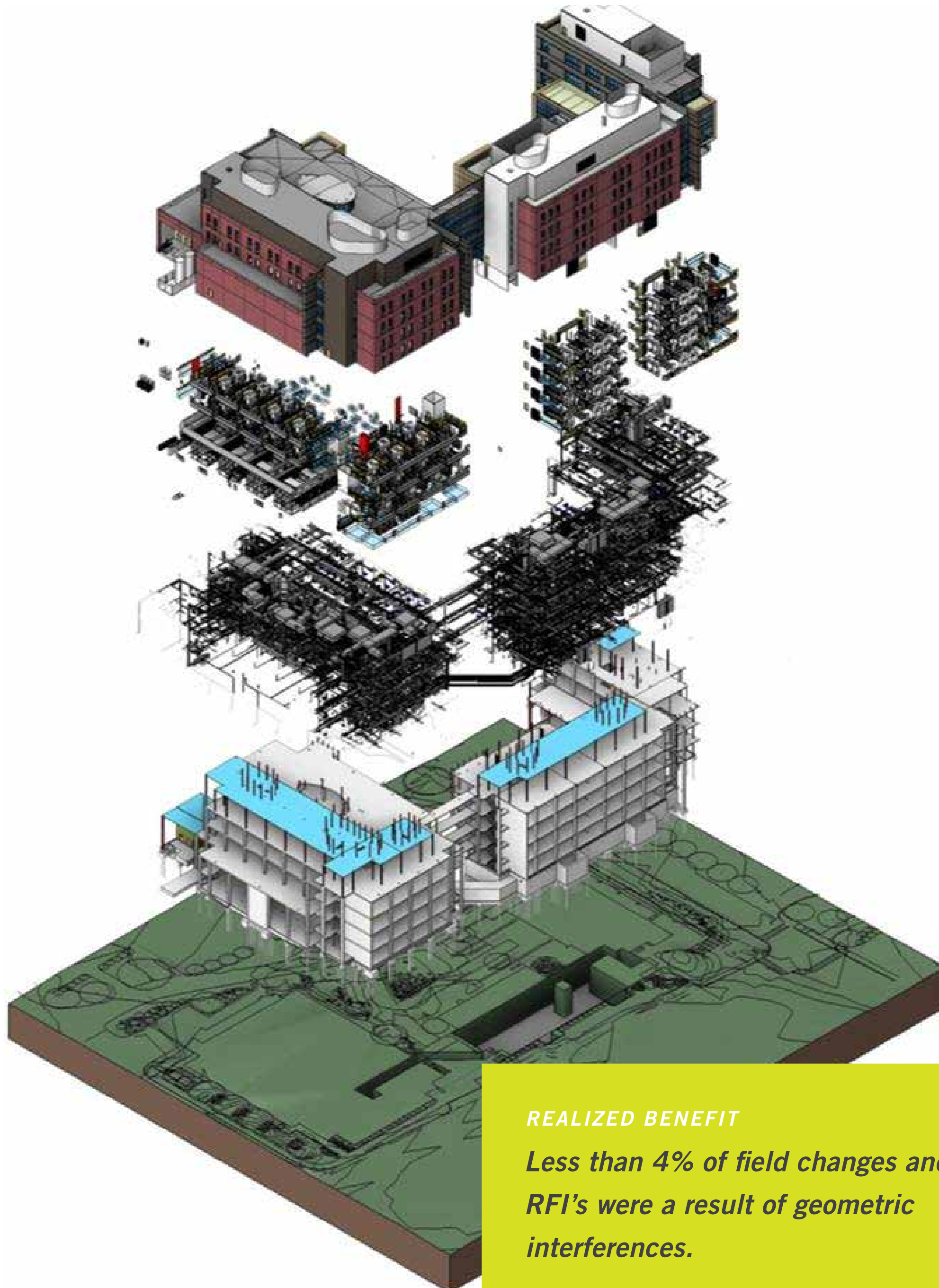
Architect's Statement

The University challenged the design and construction team to rethink how the traditional materials of campus Georgian architecture could be incorporated in an entirely new design style. The team embraced this challenge as an opportunity to rethink the building's design style, but also to deliver a modern building that could only be realized through modern project delivery techniques.

The resultant process affected everything from the selection of consultants, to collaboration with the Construction Manager, to how design ideas were presented to the client. The architect and consulting engineers developed thirteen design models using Revit, which were combined to allow a full understanding of how each building system affected the other. These models were constantly available to the CM team and fabricators via the project cloud, and were used for takeoffs, coordination, scheduling, and site layouts.

The free and open sharing of design models with the CM and fabricators fostered a sense of trust among the stakeholders, as well as fully leveraging design intent models and datasets.

This greatly improved understanding of the building design and enhanced communication between team members.



REALIZED BENEFIT

Less than 4% of field changes and RFI's were a result of geometric interferences.

Integrated Project Team

ANALYSIS
3DS Max
Project Falcon
Autodesk 360

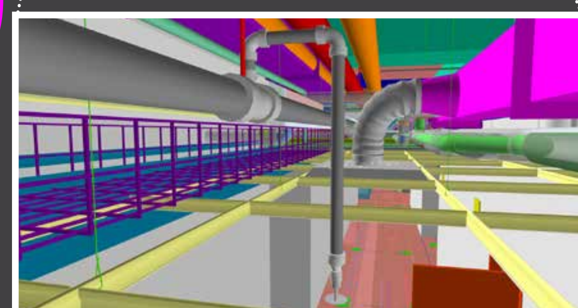
DESIGN
REVIT
3DSMax
Infrastructure Modeler
Showcase
Sketchup
Civil 3d
LandCadd

COORDINATION
Navisworks
Design Review

CONSTRUCTION
TEKLA
Quantity Takeoff
Navisworks Manage
Revit
Bluebeam
BIM 360 Glue
AutoCAD Electrical
CAD Duct
Pipe 3D
Inventor 3D

VISUALIZATION
Showcase
3DS Max
Design Review
Autodesk 360

QUALITY ASSURANCE
Design Review
Quantity Takeoff



REALIZED BENEFIT

Reduction in construction time of more than 60 days. This allowed classes to begin at the start of the fall semester.

The success of every major construction project hinges on clear expectations and communication, a level of trust between all team members and a willingness to openly share data.

Building Information Modeling (BIM) was a critical component in integrating the entire project team and allowed a greater level of analysis and coordination, as well as understanding of the site and building systems.

The early establishment of the BIM Execution Plan led to clear delineation of roles, delivery methods and expectations in each phase of design and construction. The design team, consisting of Architect, Landscape Architect, Structural Engineer, Mechanical Engineer, Lab Designer and Civil Engineer set out to develop early design models, which allowed fundamental study of coordination problems.

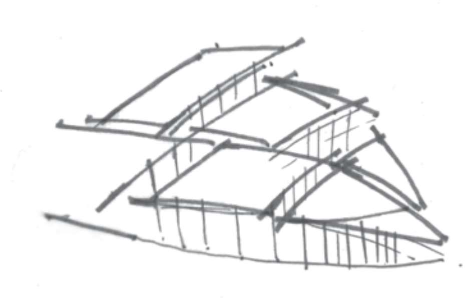
The intricate design models were shared with the Construction Manager prior to completion of documentation. Using the 4D scheduling program Synchro, the CM was able to determine that the building could be delivered earlier than previously thought.

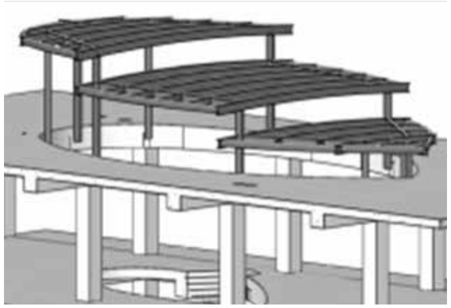
Complex Structural Coordination

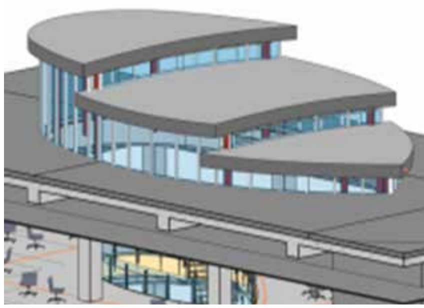
Specific components of the building's structural design required a greater level of analysis not typically undertaken in more conventional design. The structural engineer analyzed the structure in Tekla Structure, refined in Revit Structure and reanalyzed.

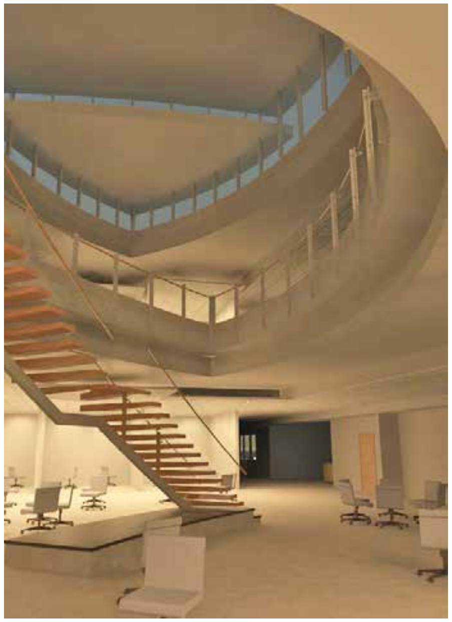
This process was continued in construction as steel fabricators created highly detailed structural models that were evaluated by the engineer.

Precise building layout was done using the structural engineer's design model input into GPS surveying equipment for drilled piles, edges of slabs, and elevations of structural elements.



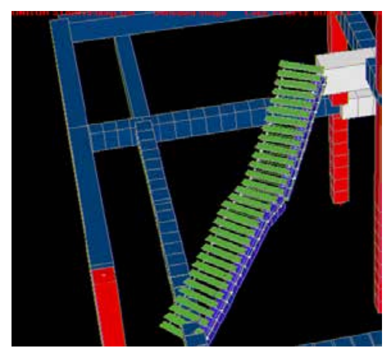


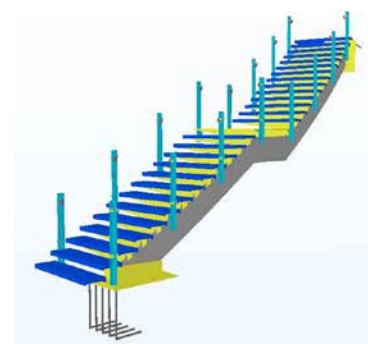




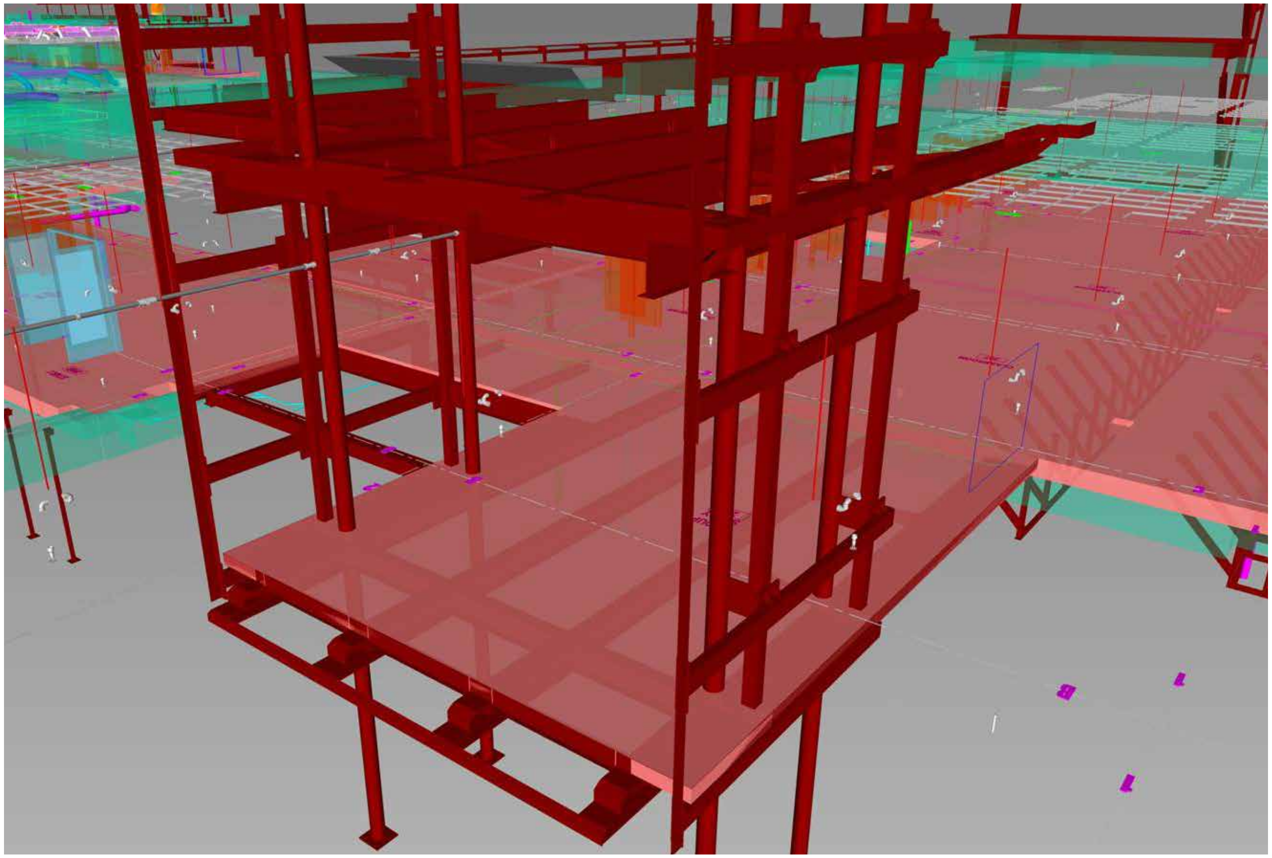
THE LEAF

The two institutes in this building focus on energy and the environment, both looking to nature for inspiration and ideas.





Early in construction, the CM required that each subcontractor prepare fabrication models for their portion of the work. This reinforced the importance of the critical nature of the coordination of building systems. The CM's BIM coordinator managed and compiled each fabrication model for frequent review meetings in the project trailer, as well as in the offices of the design team using web-conferencing technologies.



FABRICATION MODEL

CONSTRUCTION

CO-LOCATION OF FABRICATORS' MODELING TEAMS DURING CONSTRUCTION

Sustainability

Three green roof areas are featured in the design, which reduce heat gain and filter storm water runoff. Photovoltaic panels on the roof of the east wing demonstrate solar power to students while reducing the building's energy consumption. Sunlight analysis guided the landscape architect when selecting plantings for green roofs, as well as placement of the PV panels. The exterior materials of the building were studied throughout the design process for thermal performance. Energy modeling of the thermal assembly allowed the design team to zero in on the optimal solution for the envelope.

Other significant sustainability measures include automated control of energy use for the whole building, including integrated building controls that turn off equipment and lights when labs are empty, as well as daylight harvesting measures that dim lighting when sunlight provides adequate illumination.

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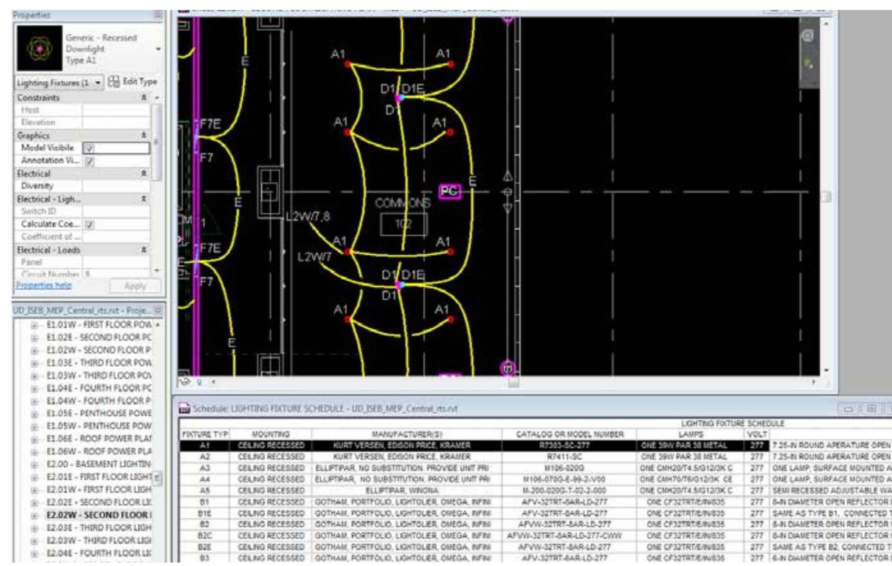
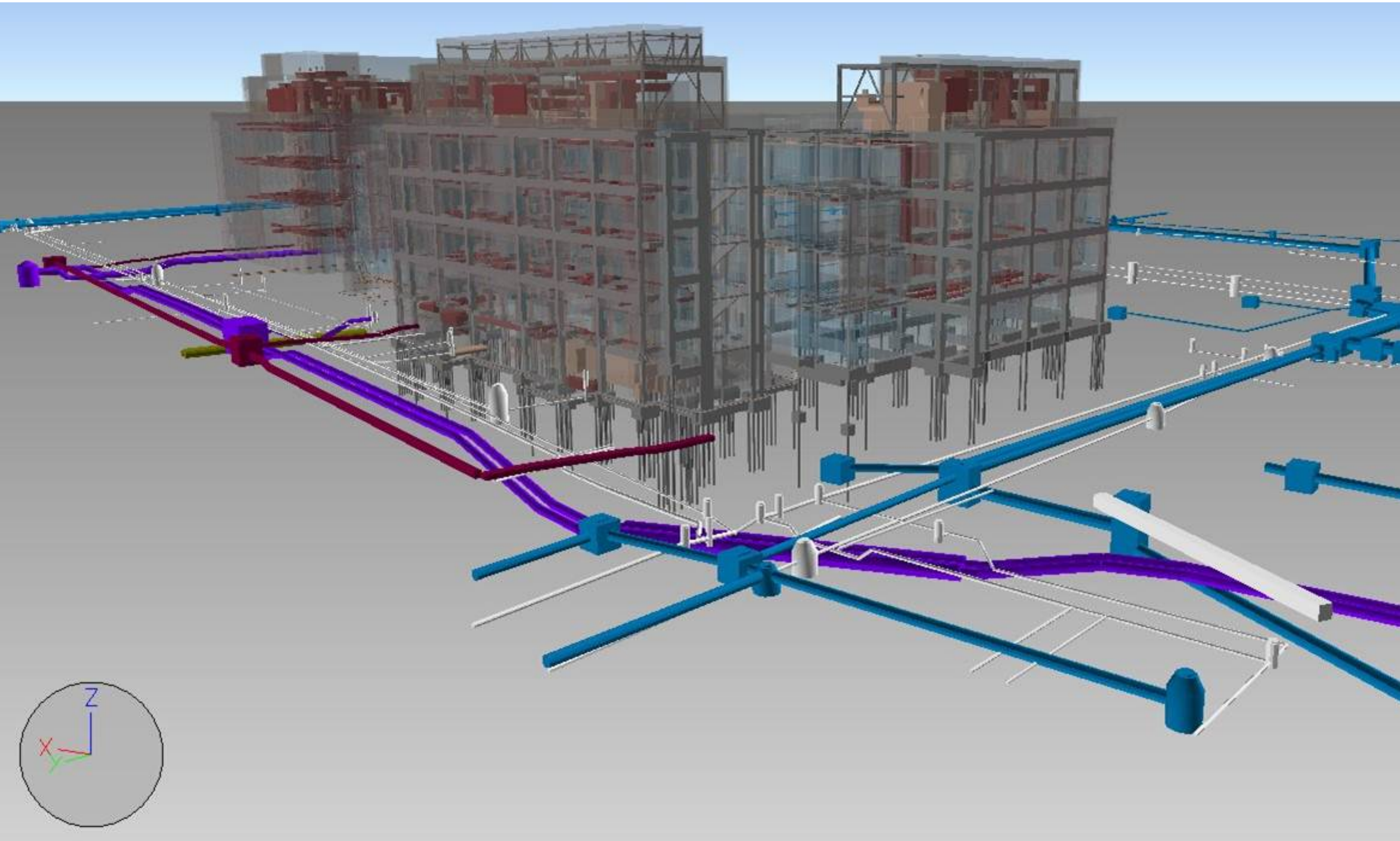
Lighting analysis studies were performed using Radiance, and resultant wattages and lamping for light fixtures showed a significant reduction in lighting power density.



Intricate Site Infrastructure

Following the BIM Execution Plan, the civil engineer modeled the existing utilities surrounding the building in Civil 3D in order to coordinate new and existing utility profiles, as well as the interaction between the utilities and the deep building foundations.

This enabled sophisticated layouts of new infrastructure to route through and between existing infrastructure and new deep pile foundations – thereby optimizing the layout and providing focused coordination of site systems.



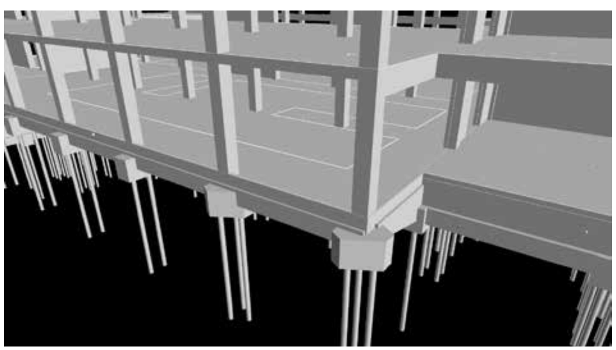
As a companion to the utility modeling, the site topography was modeled in detail. This included mini bio-retention swales which needed to be closely coordinated with the below-grade utilities and foundations.

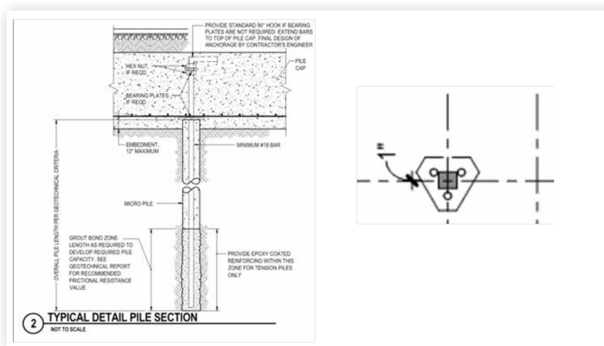
REALIZED BENEFIT

Robotically-controlled bulldozers enabled a greater level of control for site grading and retention swales.

Free Sharing of Models & Data

The open sharing of model data between designers and contractors through IFC data exchanges fostered a sense of trust and reinforced the importance of the design integrity to the entire team of stakeholders. Sharing of fabrication models during construction continued lines of open communication and ensured the integrity of the coordinated building.



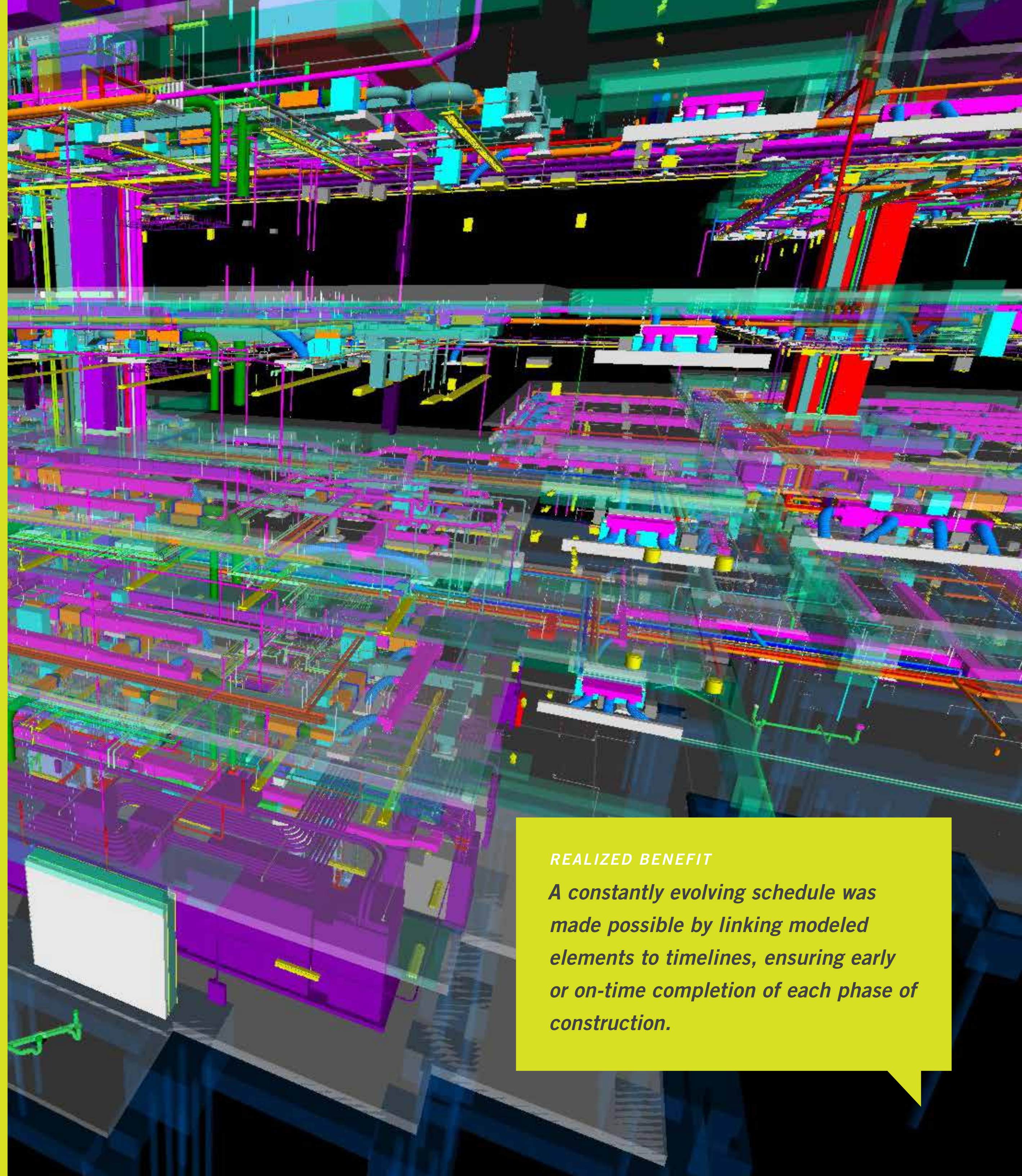


Construction Manager's Statement

The ISE-Lab is a project that required high quality and a fast paced schedule, which provided an opportunity for the CM to further develop construction services though the incorporation of our Virtual Design and Construction processes. Due to the complexity of the project, it was clear that BIM would be necessary to successfully complete the facility.

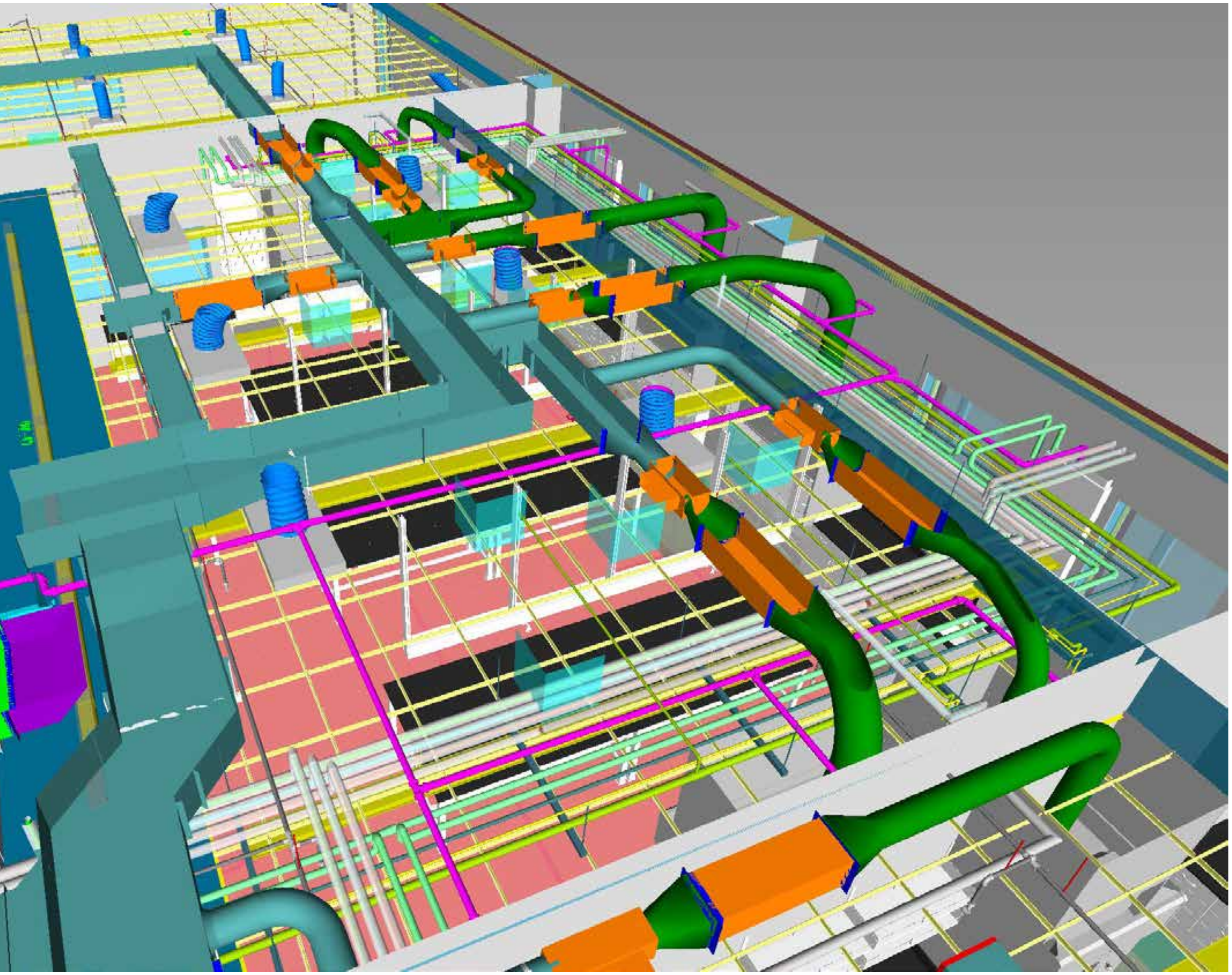
Our insistence on the use of BIM by each major subcontractor allowed the fast pace of the construction to be maintained while continuing to meet the Owner's high standards of quality. Fabrication models were compiled using Navisworks and regularly reviewed by each stakeholder in order to identify problem areas prior to actual installation, saving time and construction cost. In depth modeling coordination led to prefabrication of materials from multiple trades resulting in a faster install and higher quality product.

The effective communication made possible by BIM during each phase of the project ensures each party understands the complex coordination and reinforces the importance of collaboration with each team member. As problems are uncovered, solutions are tested virtually and evaluated by each party. This atmosphere of collaboration gives each stakeholder a sense of ownership in the project's success. Install in the field is held to high standards knowing that the complex systems left little tolerance between trades.



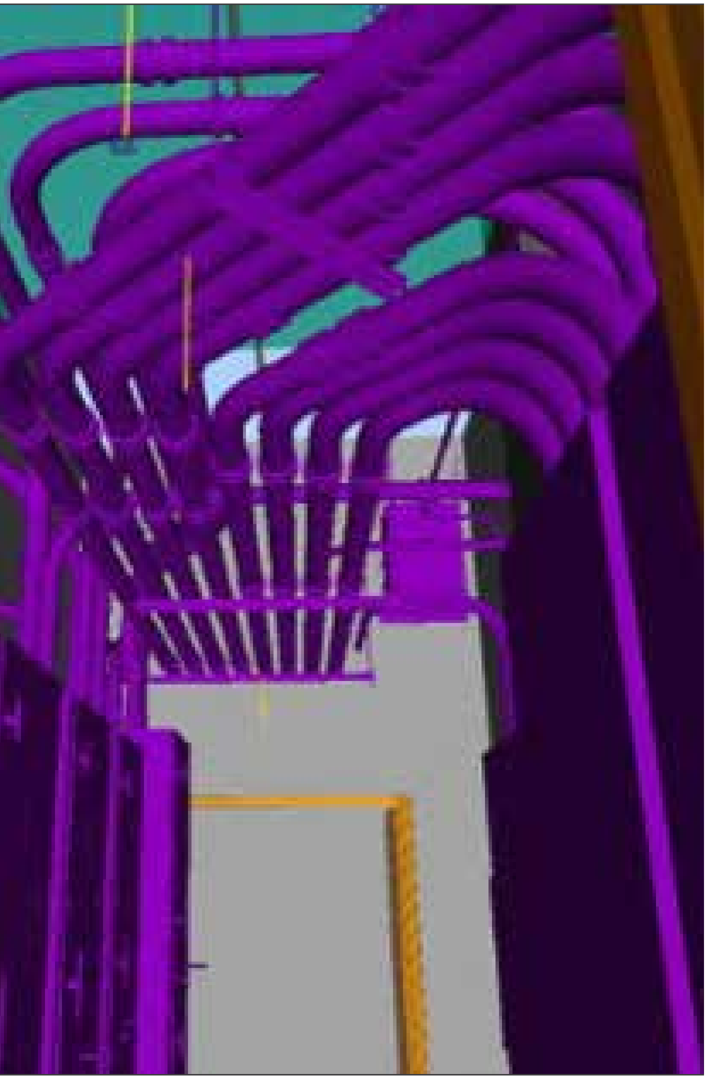
REALIZED BENEFIT

A constantly evolving schedule was made possible by linking modeled elements to timelines, ensuring early or on-time completion of each phase of construction.



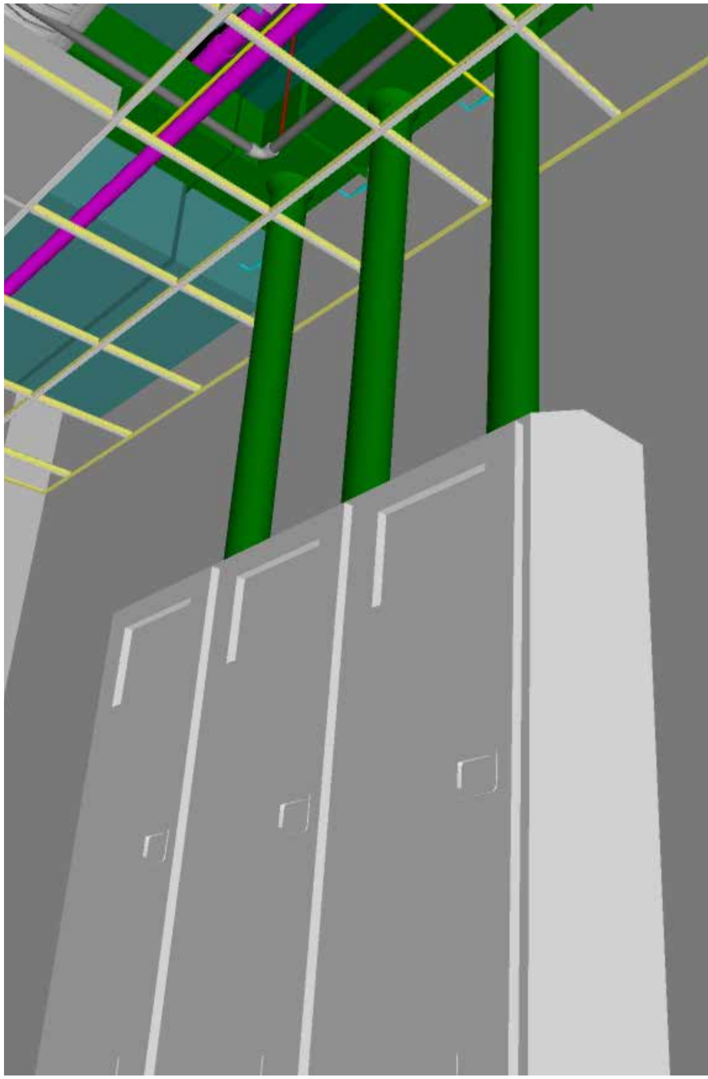
Coordination of Complex Systems

The intricate interaction between site, architectural, structural and MEP systems was facilitated by incorporating BIM dataflows into the project design processes. Accurate models from several consultants and fabricators allowed close and constant coordination, saving valuable time and reducing the number of RFI's and Change Orders by substantial amounts.



Detailed coordination model of main electrical conduits

Installed condition of main electrical room

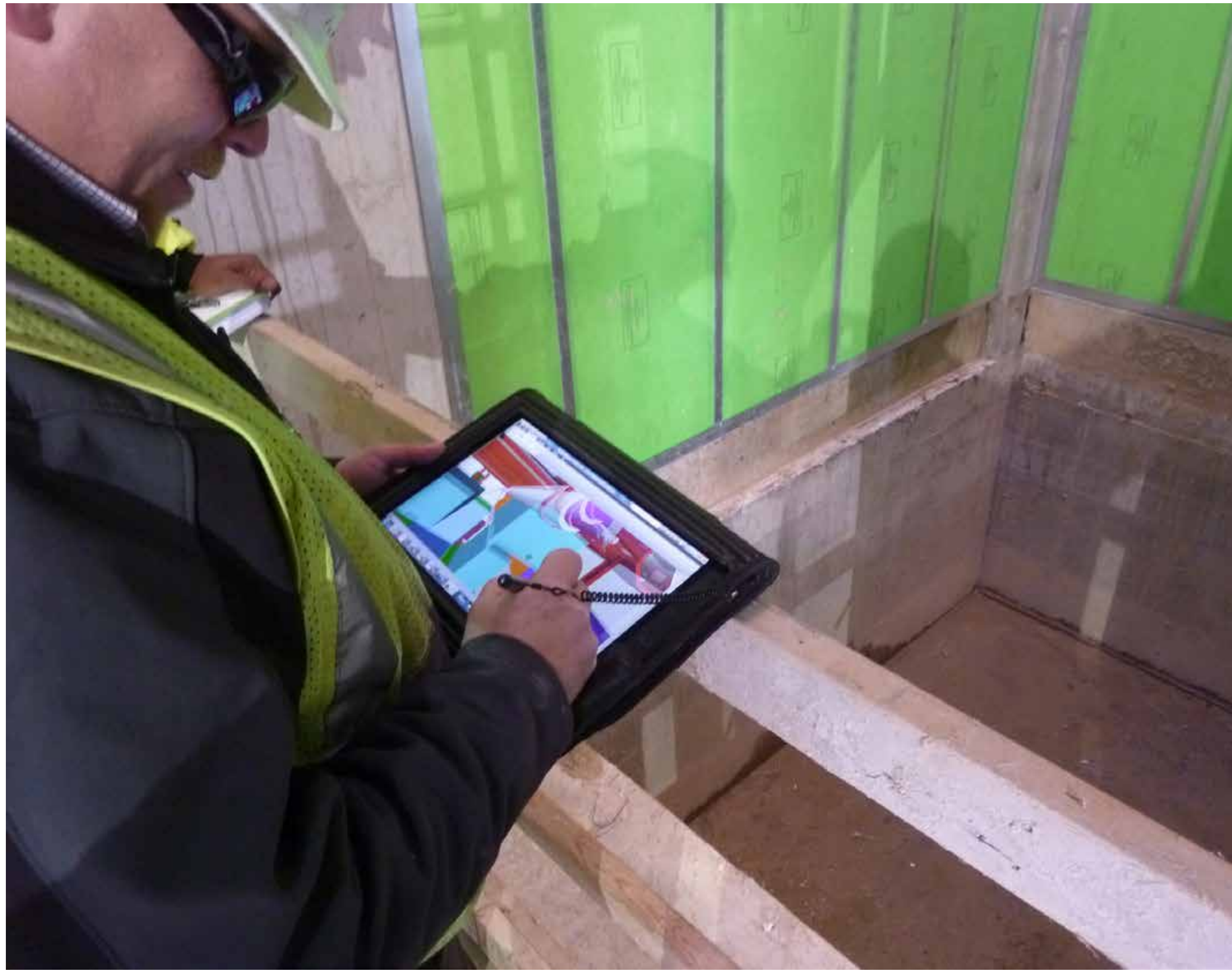


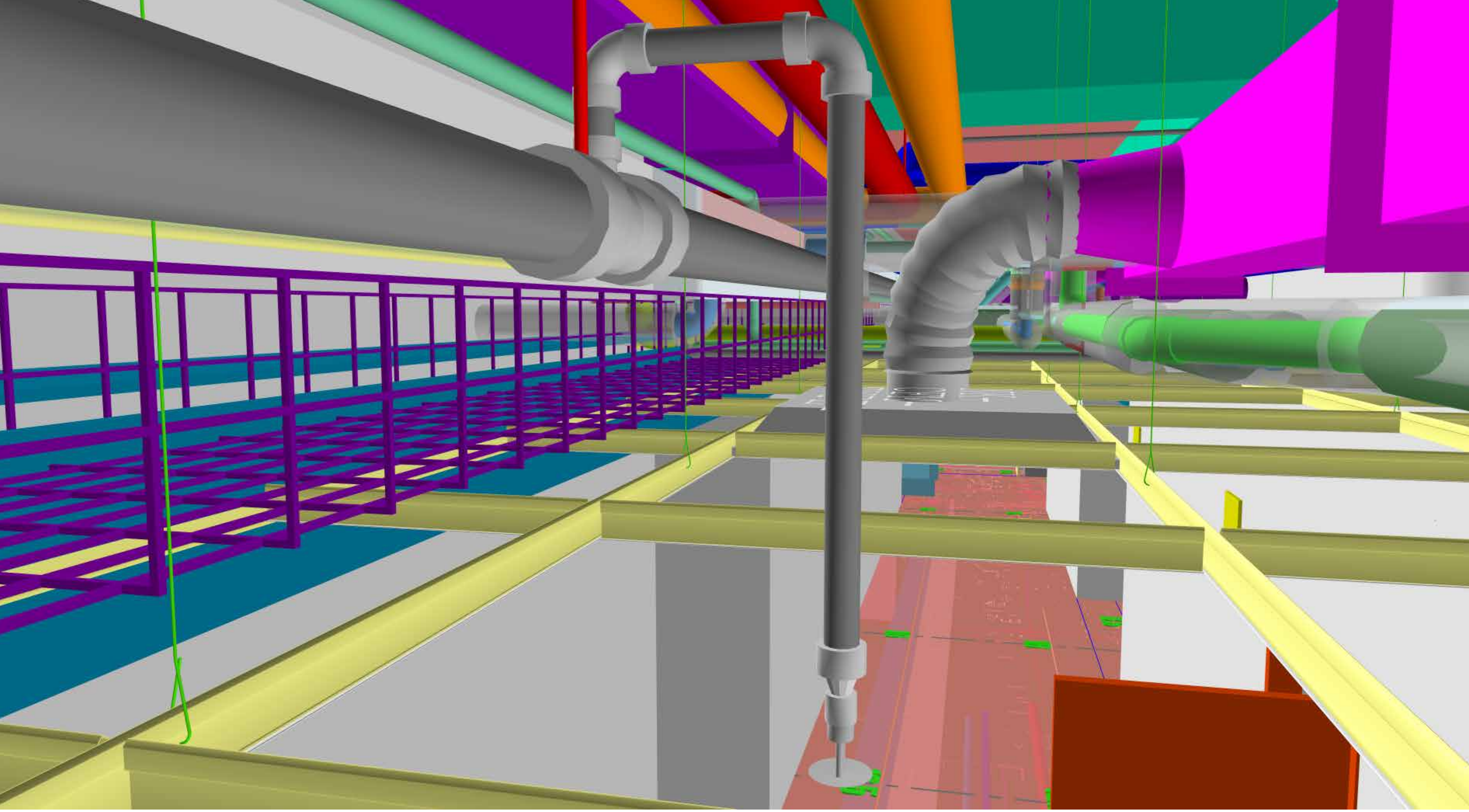
Information modeling of all panelboards and conduits

Virtual Construction Sequencing

The interaction between standard building systems and specialized laboratory systems was closely coordinated. BIM enabled better decision-making for the sub-contractors for installation.

Using mobile virtual reality technology with BIM 360 Glue, installers were able to visualize and understand construction sequences.

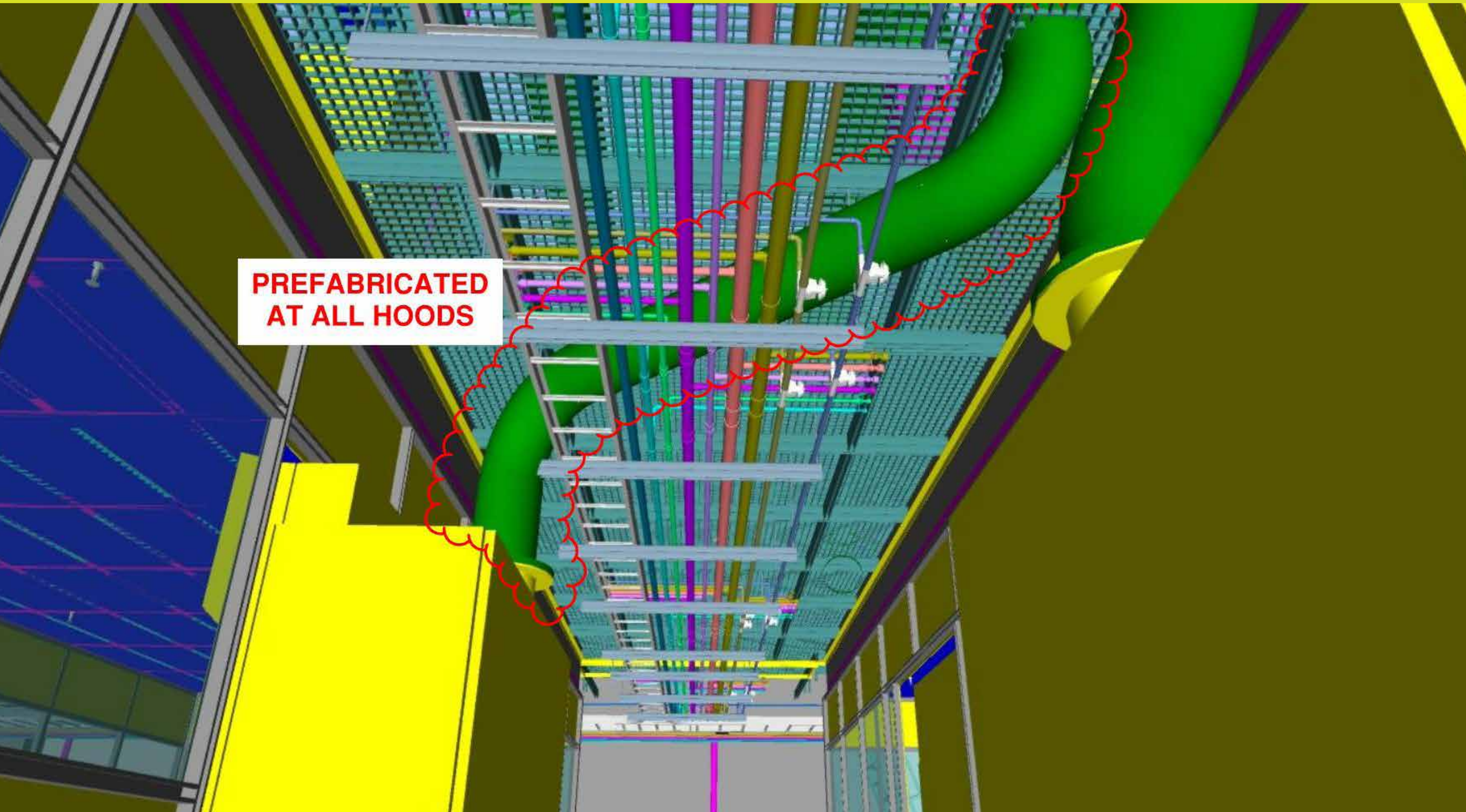




Highly detailed coordination model of all above-ceiling systems

Prefabrication of Materials

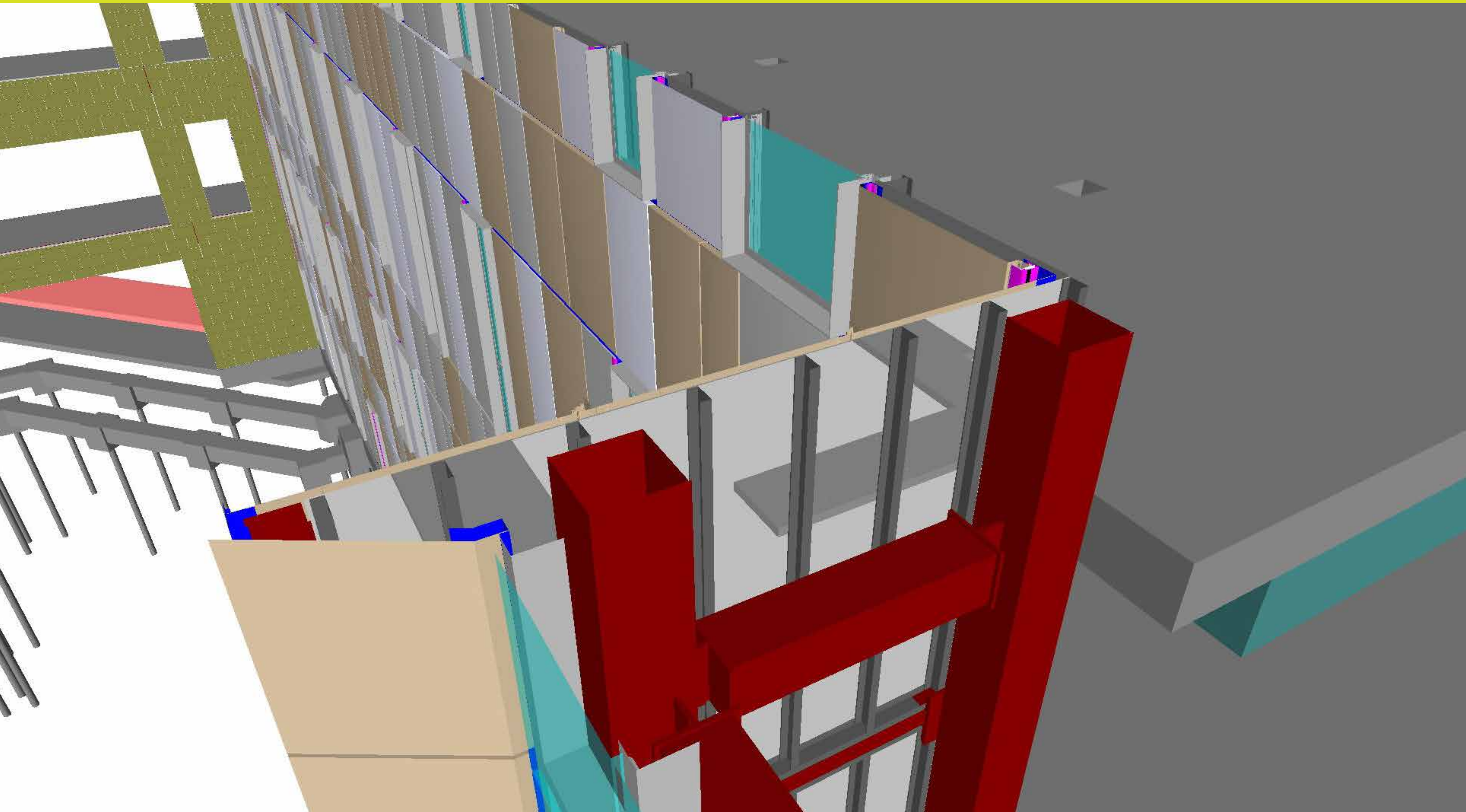
CLEAN ROOM DUCTWORK

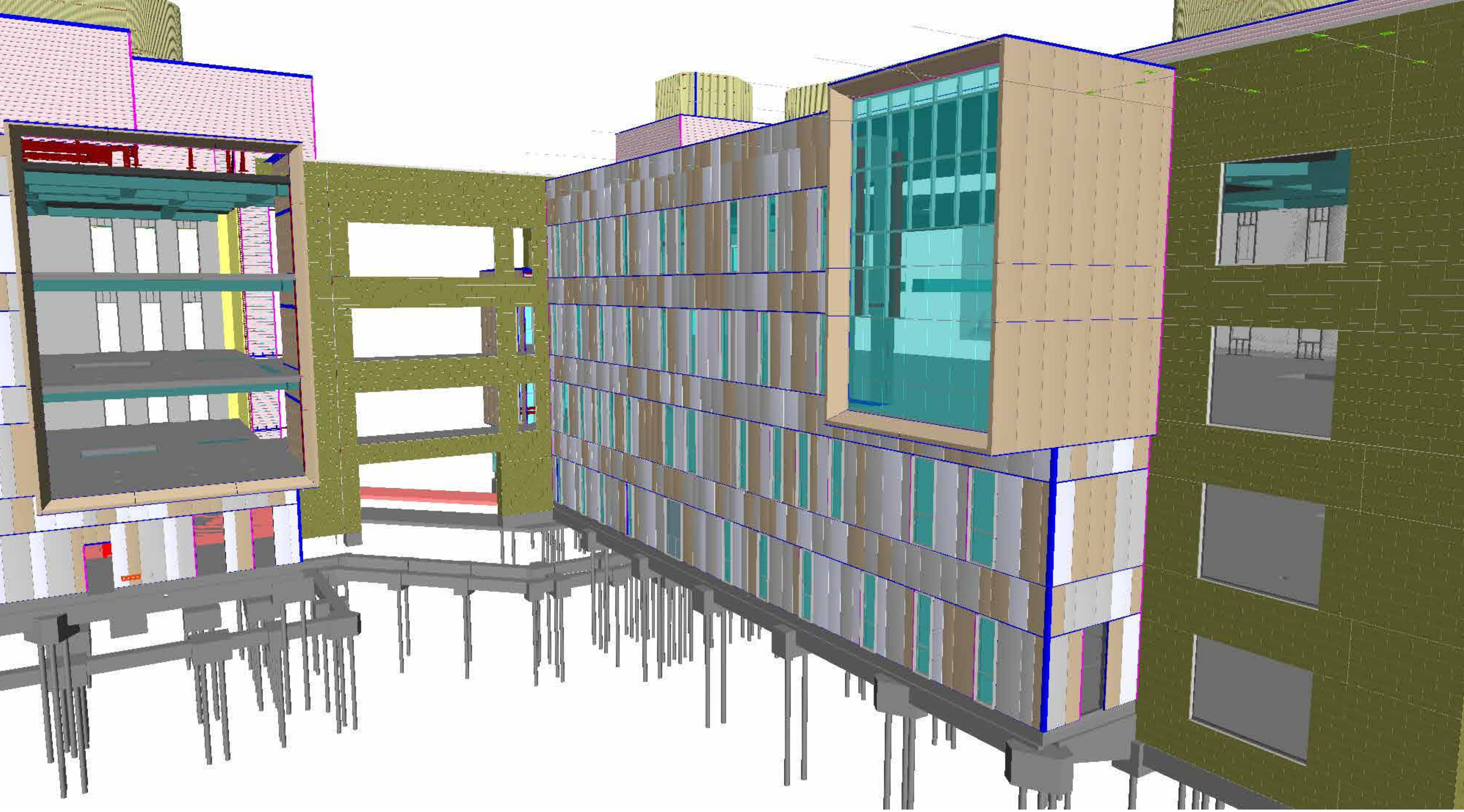


Clean Room Duct Work

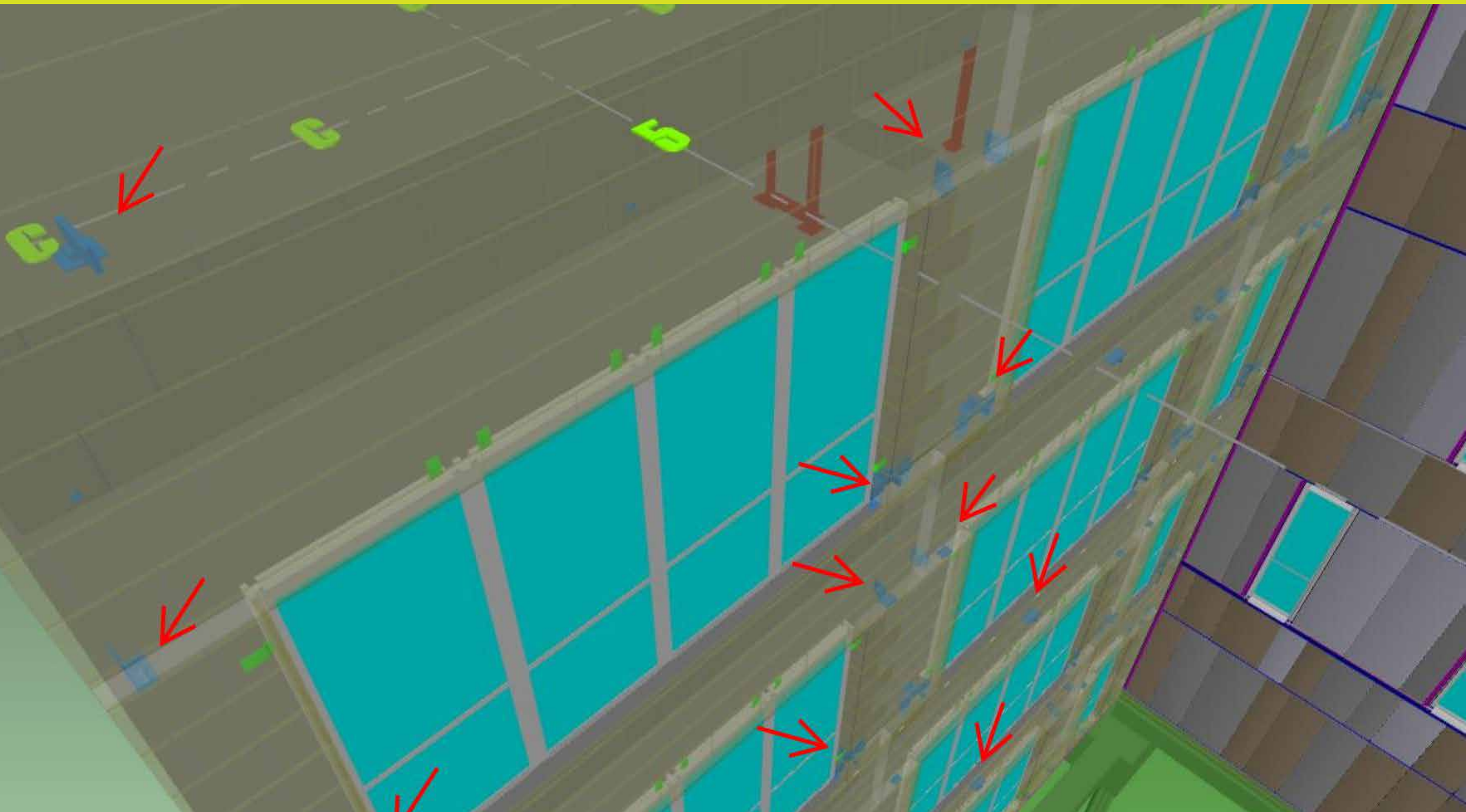
Prefabrication
of Materials

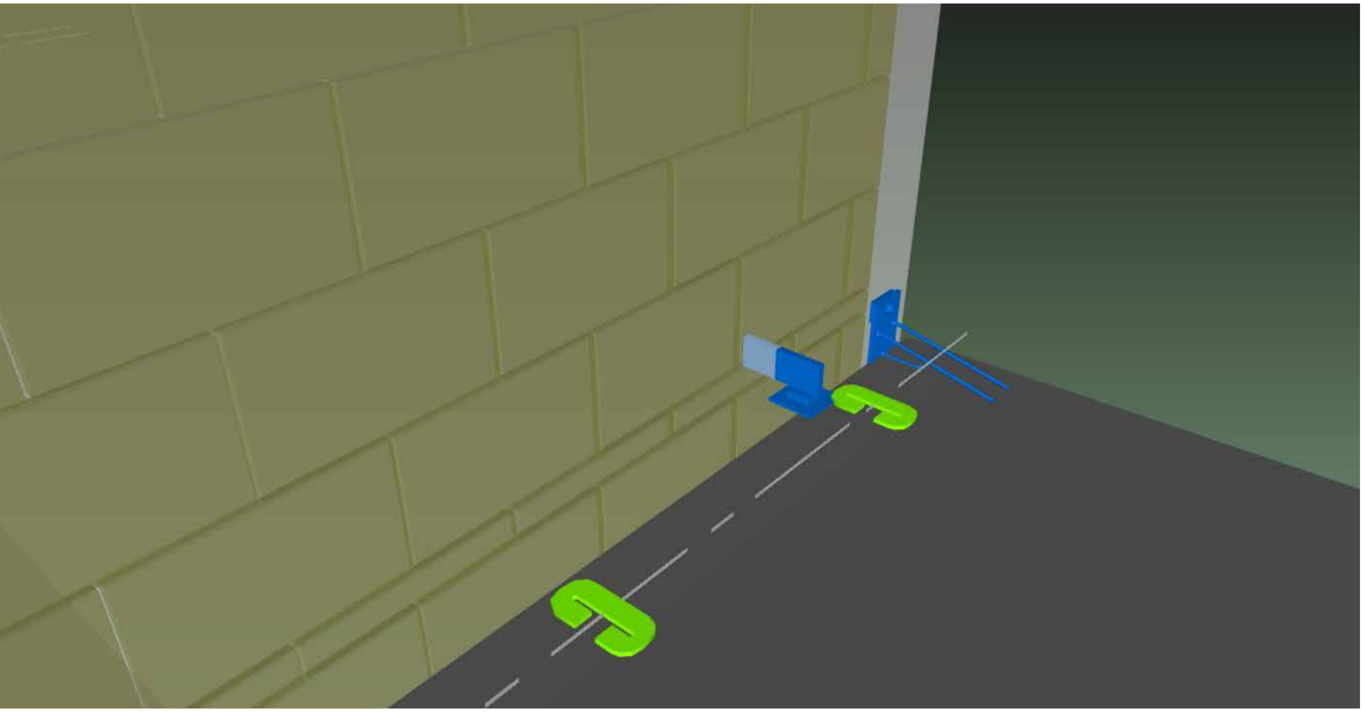
METAL SKIN PANELS





Insulated metal panels





Skin Fabrication

Owner's Statement

We set out to assemble a team of industry-leading design and construction professionals that would bring innovative processes and technologies to contribute to a successful project.

We brought together a team that embraced the spirit of collaboration from the outset of the project. Their incorporation of the latest technologies and BIM processes fostered an atmosphere of innovation and communication between all major stakeholders. BIM was the catalyst for continuous improvement that was crucial to the continued success of this important project.

We continue to work with our facilities group to incorporate BIM into our maintenance programs, allowing more integrated management of this and future facilities. We made it clear to our project partners that we had high standards for this new facility and accountability was an important component.

Our expectations continue to be exceeded as the result of constant collaboration and communication.