Georgia Institute of Technology

Carbon-Neutral Energy Solutions (C-NES) Laboratory

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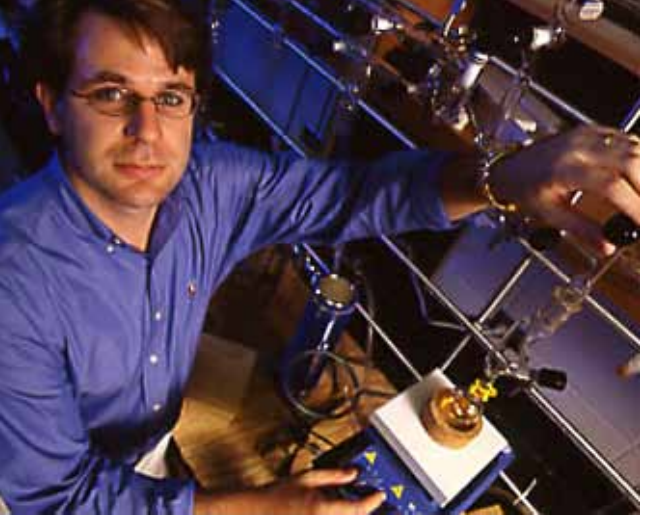
1 PROJECT MISSION

Georgia Tech is committed to developing its campus “in a way that supports the larger aspirations of the Institute - encouraging the development of a sustainable campus community, and creating distinctive architecture and open spaces” . In keeping with this goal, the mission for its new pilot-scale laboratory for Carbon-Neutral Energy Solutions (C-NES) is a carbon-neutral facility that will house tomorrow’s advanced energy technologies.

When completed, this sustainable state-of-the-art facility will house cutting-edge energy research with interdisciplinary high-bay research capabilities. This project will provide opportunities to educate students and provide breakthrough research initiatives, while also demonstrating the building’s carbon-neutral features.

For the next fifty years, there will be an overarching need for synergistic, pilot-scale energy-conversion technologies to advance energy-dependent industries; this is critical to meeting the nation’s energy needs. There are enormous opportunities to expand existing sponsor relationships, and more importantly, attract new industry partners with significant research needs.



2 PARTNERSHIPS FOR INNOVATION AND SUCCESS

Industry Collaborators

Manufacturing education has been ingrained in Georgia Tech since its founding — a time when the South was transforming its economic foundation from agriculture to industry. As the region's manufacturing prospered, the Institute responded with specialized research programs focusing on top trends in innovative manufacturing. Georgia Tech has fostered a long history of working with industrial groups to engage in collaborative research efforts.

Enabling industry collaboration is a primary goal for C-NES. Innovation on capital intensive technologies must be done to meet today's energy challenges. These challenges will be focused on near- and long-term projects with an identified strength in applied research.

C-NES will enable researchers to evaluate laboratory results at bench- or pilot-scale. The results are expected to lead to technologies that can then be scaled further to meet the needs of research sponsors. Such an arrangement allows companies investing in C-NES-based research to test new concepts before deciding on larger investments.

Opportunities for industry to participate in activities that leverage C-NES include:

- Co-location of research activities, including those requiring high-bay and/or regular laboratory space
- Engagement of personnel with internationally recognized research leaders and their students
- Access to Georgia Tech activities, including seminars and discussion sessions that have the potential of generating new ventures

Prospective industrial supporters include:

Electric Power Sector

C-NES will be focused on translational and pre-commercial research and development to help the electric utility industry meet these challenges:

- Fuel flexibility to use existing domestic resources and develop new ones
- Gasification technologies and chemical processes to support diverse fuels
- Efficient combustion technologies
- Pre- and post-combustion pollution control technologies to meet or surpass regulatory requirements, particularly carbon capture

Georgia Tech researchers will collaborate with utility industry partners, government, and academic partners at C-NES to foster the development of innovative and cost-effective solutions.

Biomass Conversion

Georgia Tech has extensive capabilities in biomass processing and in chemical and biological characterization in the Institute of Paper Science and Technology, and the Schools of Biology, Chemical & Biomolecular Engineering, and Chemistry and Biochemistry. The biomass-processing laboratories in C-NES will enhance these capabilities considerably.

The future viability of fuel derived from biomass is unclear; but with the development of efficient and effective conversion technologies, fuels derived from biomass could become a significant factor in fuel availability. Research in C-NES will provide options for converting biomass into liquid fuels or feedstocks for chemical manufacturing.

Transportation Sector

C-NES will incorporate a laboratory dedicated to the development of clean diesel technologies, high-efficiency gasoline technologies, and the evaluation of engine exhaust as a function of fuel. The engines laboratory will be fully integrated with the pre- and post-combustion separation activities in C-NES.

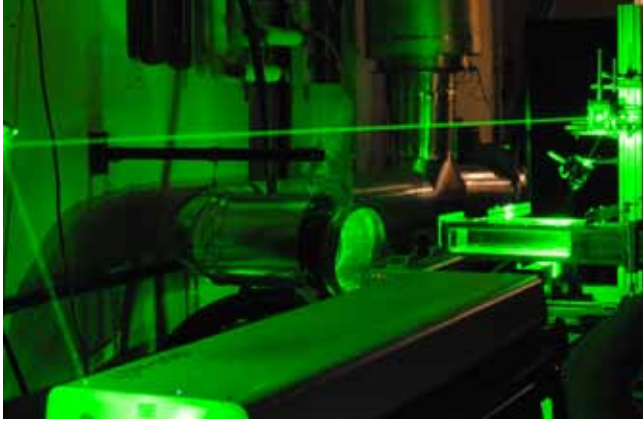
A significant percentage of carbon dioxide emissions come from the exhaust of internal combustion engines used primarily in the transportation sector. Reduction of this component will come from:

- Increased electrification of the transportation fleet
- Size and weight reduction of vehicles
- Increased efficiency of internal combustion engines
- Improved pre-combustion and post-combustion fuel and exhaust separation technologies

Chemical and Petrochemical Process Industries

Catalysis and bio-catalysis are utilized for conversion of both fossil-based raw materials (coal, natural gas, oil) and renewable materials (biomass of various kinds) into chemicals and fuels. New catalysts and catalytic processes are being developed at Georgia Tech for such purposes.

Separation technologies often consume a significant fraction of the energy used to operate a chemical or petrochemical facility, and improvements in the efficiency of such operations can have a significant impact on process economics. A remarkable portfolio of separation specialties exists at Georgia Tech; An example from one specialty is the work on extending membrane technologies to processes involving non-aqueous materials.



3 RESEARCH PROGRAMS

The facility will be a center for translational and pre-commercialization research in carbon-neutral energy conversion technologies. Initial areas of focus include, but are not limited to:

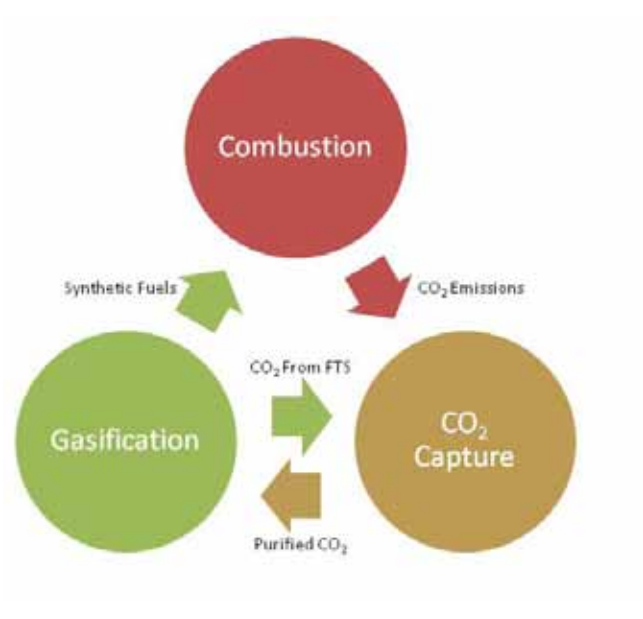
- **Combustion**
- **Gasification**
- **Carbon Dioxide Capture**

An important benefit of this facility is the integration of various processes that together, fully and efficiently complement each other. Collocating interdisciplinary research teams will facilitate opportunities for synergistic collaborations. Initially, research at C-NES is expected to focus on Georgia Tech groups and associated partners from:

- **Aerospace Engineering**
- **Chemical Biomolecular Engineering**
- **Chemistry and Biochemistry**
- **Mechanical Engineering**

It is likely that there will also be participation from:

- **Biology**
- **Civil and Environmental Engineering**
- **Georgia Tech Research Institute (GTRI)**
- **Materials Science and Engineering**
- **Physics**



4 PROCESS INFRASTRUCTURE

Research and development programs proposed for C-NES may require industrial-scale storage and distribution systems, along with heated compressed air, high and low pressure steam, multiple liquid fuels, process cooling water, and related controls. Currently, process systems are under development to serve the experimental combustion equipment, gasification research equipment, and CO_2 capture.

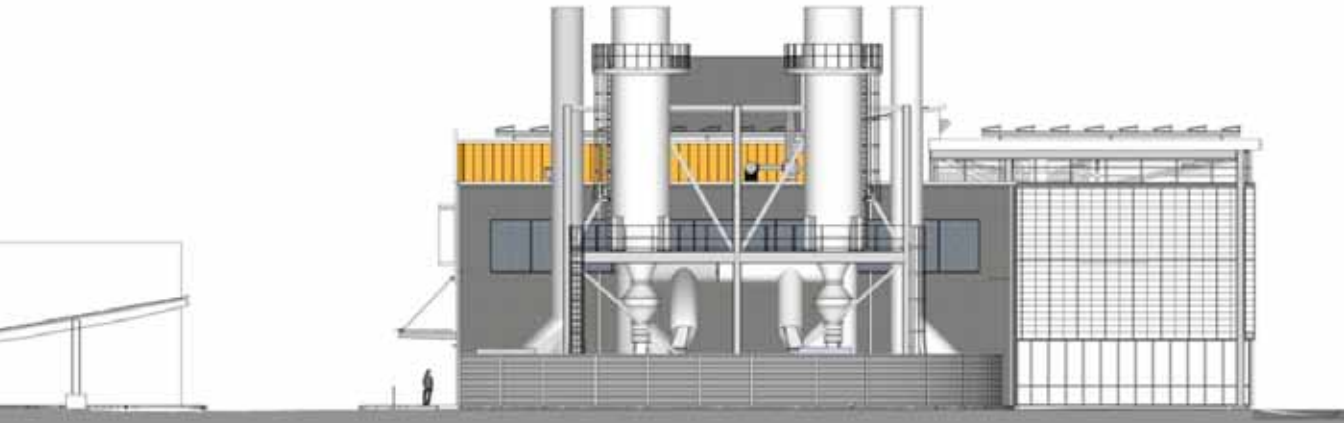
For these process-intensive research and manufacturing sectors, the infrastructure will provide the supply and distribution systems of liquid and gaseous materials, waste treatment equipment, controls and data acquisition, and safety systems. The infrastructure would support engines, turbines, gasifiers, and other equipment used for research. It provides the foundation for the research needs of future programs in the safest conditions possible, and with the most efficient and effective supply of chemicals and power.

The infrastructure is currently under design to achieve these goals in conjunction with the building plan. The facility and the surrounding bulk storage areas have been carefully evaluated for use, expansion, and safety with the types of materials used, and products created. By employing Process Hazards Assessment (PHA) techniques, potential safety and operational issues have been defined and plans made to mitigate them. The flexible design of the facility has minimized the need for modifications.

Broadly, the infrastructure expands on and includes:

- Bulk gas and liquid fuels storage areas and distribution
- Electrical distribution for process
- Gas and liquid heating equipment
- Gas compression equipment
- Piping mains
- Process chillers
- Process controls and a control room
- Process instrumentation
- Safety systems, including detection of hazardous gases

In addition to this, any research that creates an aromatic nuisance exhaust will flow through waste gas treatment flare devices; minimizing the impact to the neighboring Technology Enterprise Park Research Building's occupants and other surrounding neighbors and residents.



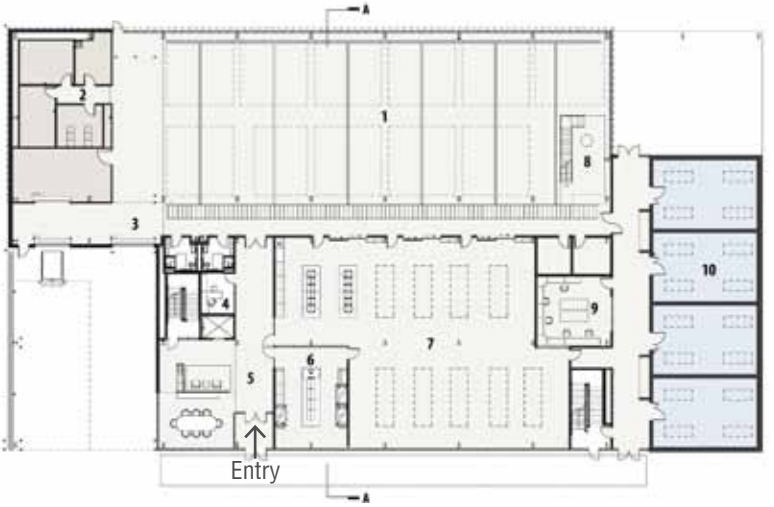
5 BUILDING INFORMATION

SIZE
42,000 gsf

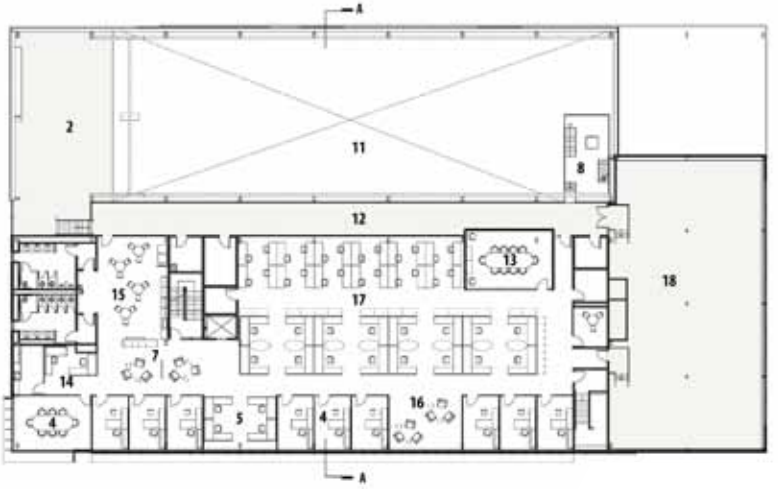
LAB SPACE TYPES
Flexible High-bay (30' clear)
Flexible Mid-bay (14' clear)
Wet Lab
Isolation Labs

OFFICE SPACE
Offices (9)
Workstations (40)
Conference Rooms (3)
Informal Meeting Space
Pantry

LEED RATING GOAL
Platinum



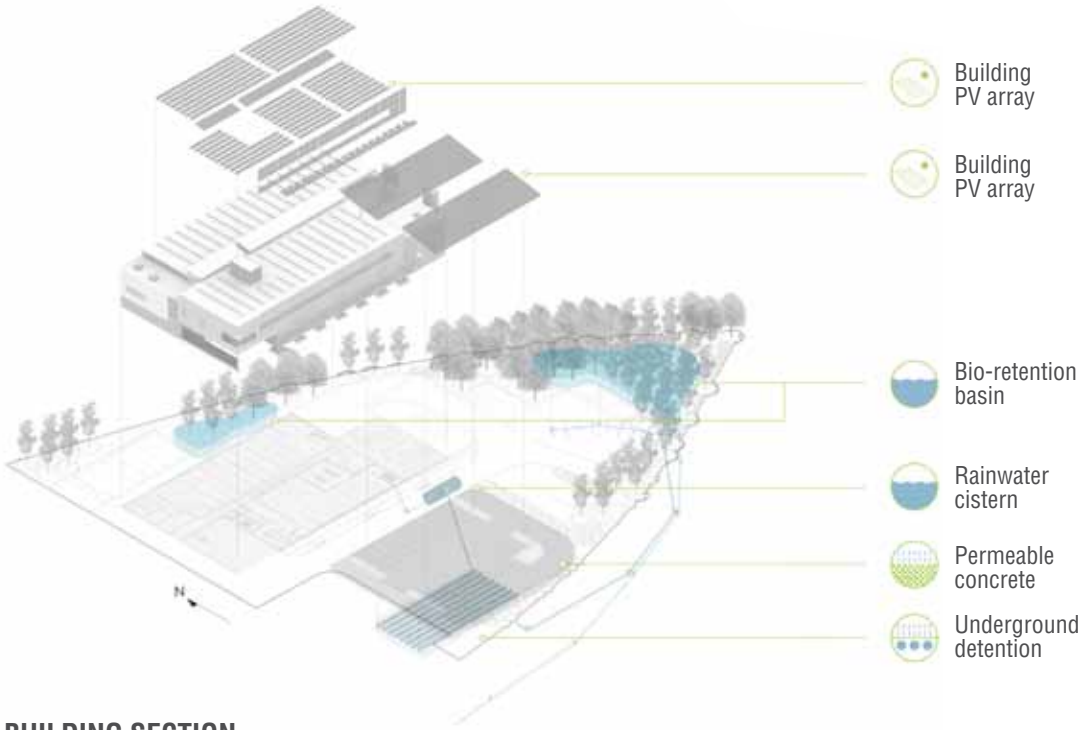
FIRST FLOOR PLAN



SECOND FLOOR PLAN

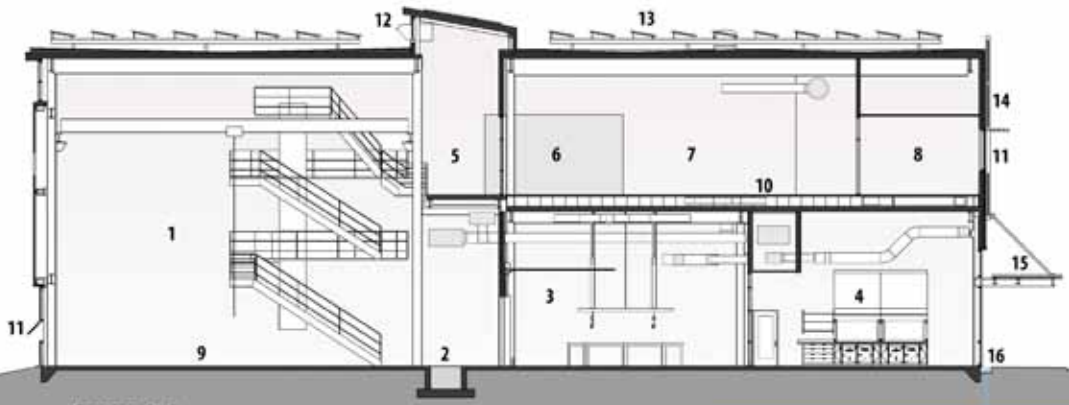
1 High-bay
2 Mechanical
3 Loading
4 Office
5 Lobby
6 Wet Lab
7 Mid-bay flex lab
8 PEFR
9 Control rom
10 Isolation lab
11 Open to below
12 Catwalk
13 Conference
14 Admin
15 Pantry
16 Interactive space
17 Open space
18 Isolation mech

SUSTAINABILTY FEATURES



BUILDING SECTION

1 High-bay
2 Utility service trench
3 Mid-bay flex lab space
4 Wet lab
5 Catwalk
6 Conference
7 Open office
8 Office
9 Radiant floor heating
10 Under floor air distribution
11 Operable window
12 Forced natural ventilation fan
13 PV array
14 PV wall
15 PV canopy
16 Rain water collection channel
17 Rain water cistern

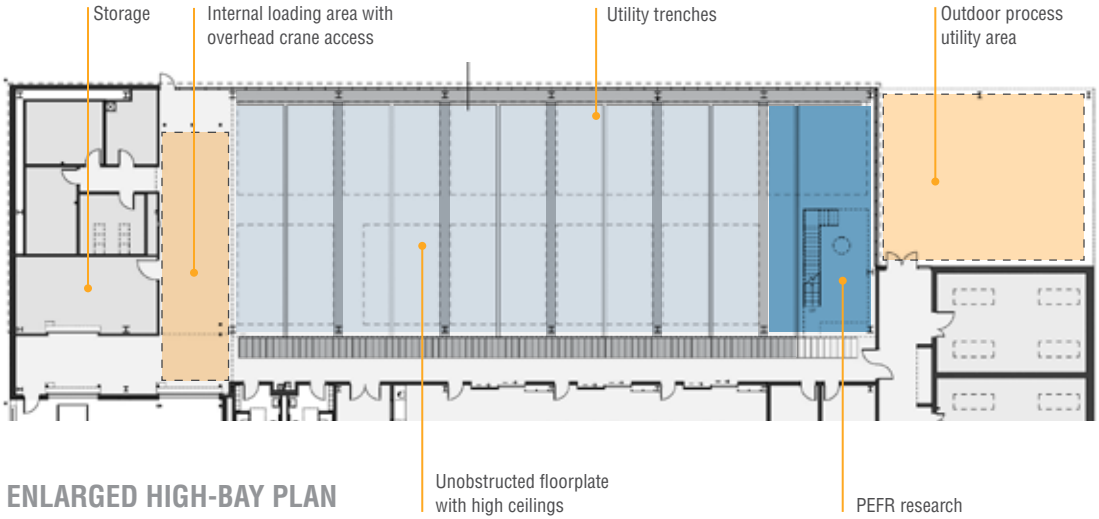


Section A_A

from roof

HIGH-BAY CAPABILITIES

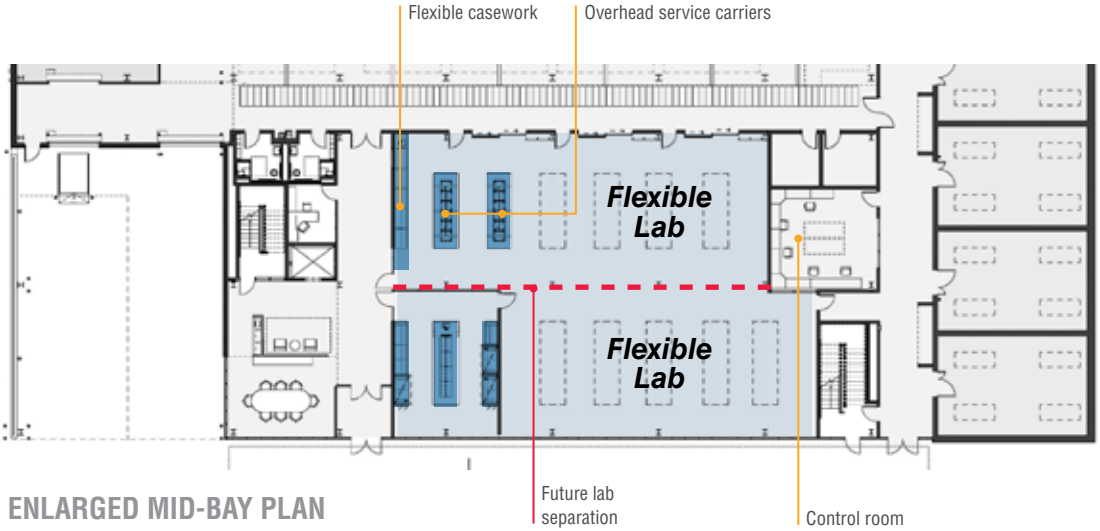
- 30’ clear space
- Large unobstructed floor plate
- 1’x1’ utility trenches located 21’ on center
- 2-ton overhead crane
- Large truck access into high-bay
- Direct access to mid-bay and loading dock



ENLARGED HIGH-BAY PLAN

MID-BAY CAPABILITIES

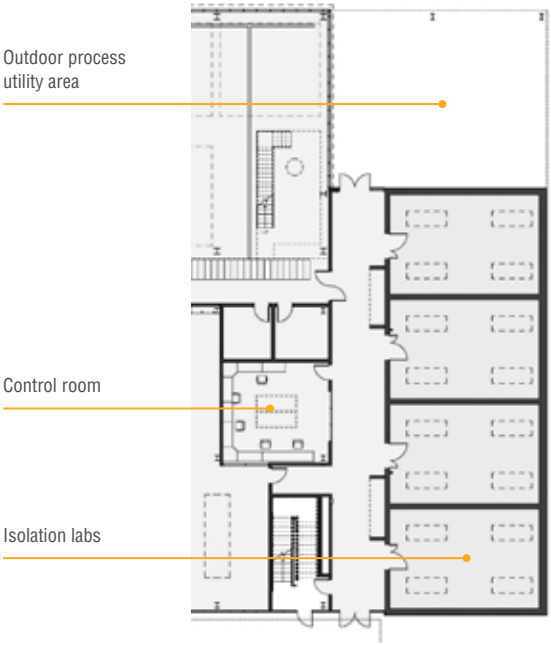
- Sub-dividable open floor plate
- 14' high space
- Direct access to high-bay via three large overhead doors
- Casework design allows for maximum flexibility
- Utilities provided overhead to maximize floor plate use



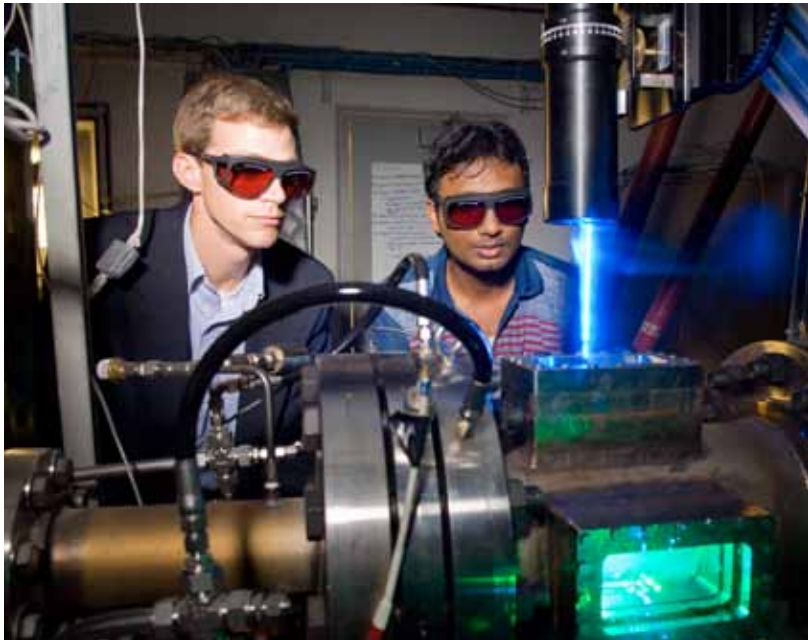
ENLARGED MID-BAY PLAN

ISOLATION LAB CAPABILITIES

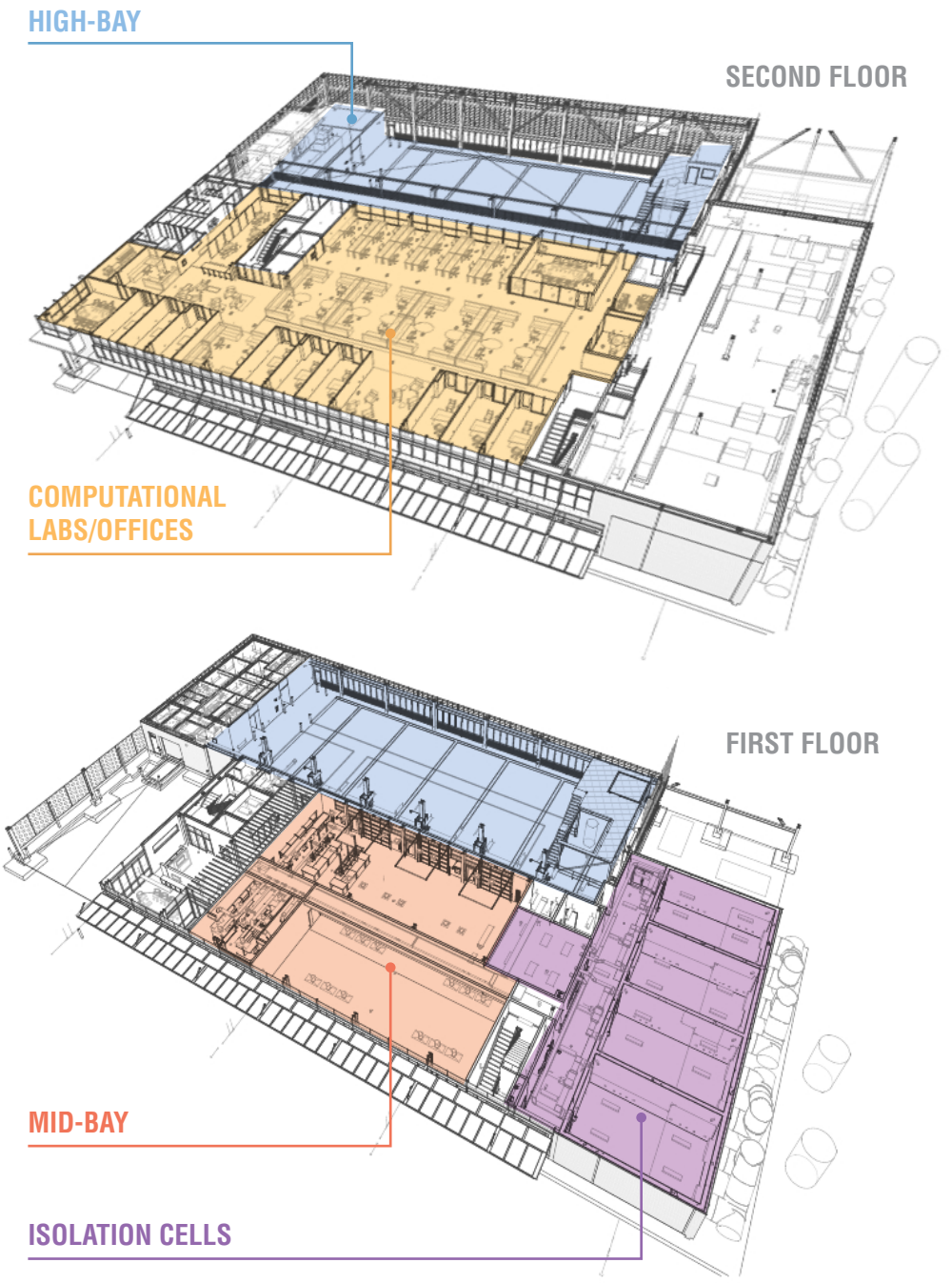
- 12” thick concrete walls allows for sound isolation and added protection
- Large 5’ door openings allow ease of access
- Control room is located adjacent to isolation labs
- Wide linear equipment corridor located adjacent to isolation labs
- Depending on need/ hazard, utilities can be piped directly from the outside



ENGLARGED ISOLATION LAB PLAN



BUILDING MECHANICAL SYSTEMS



HIGH-BAY

Mechanical

- Non-conditioned space (no humidity or temperature control)
- Mechanical ventilation of 9-10 ACH
- Future capacity to add AHU to provide conditioned air
- Radiant flooring
- Stainless steel ductwork allows for higher than normal exhaust temperatures
- Dangerous gas monitoring available

Electrical/Lighting

- 100 amp 208 volt(v) panel for large loads
- 400 amp 480v panel at every other bay
- Switch room is capable of providing more load as needed
- 55fc average light levels at 36" above finished floor

Plumbing

- High-bay is considered "dry." Utility pathways via trenching systems provide gases, water, and drainage as needed
- No floor drains
- Natural gas and water
- Hand wash sinks, safety showers, and eye washes throughout

COMPUTATIONAL LABS/OFFICES

Mechanical

- Under-floor supply strategy allows for flexible workstation arrangement

Electrical/Lighting

- Dimmable light control with photo cell control for daylighting

MID-BAY

Mechanical

- Designed for more than six air changes per hour
- Initial build-out has three to four hoods and six task exhausts with capacity for expansion
- Dangerous Gas Monitoring System (DGMS) ready
- Chiller can provide up to 30kva of cooling load. Smaller equipment would be handled through Individual cooling units

Electrical/Lighting

- Dimmable light control, with photo cell control for daylighting
- 55 foot candle (fc) average at 36" above finished floor
- Task lighting at bench areas for higherlight-level needs
- Overhead service carrier and benches will have 120/208v outlets

Plumbing

- Natural gas and water with capacity for future local gases
- Capped floor drains located every 21'
- Overhead utilities

ISOLATION CELLS

Mechanical

- 30,000 CFM of supply per cell. Air supply is relieved through local stacks
- Supply streams can be paired to provide up to 60,000 CFM at 2 cells
- Dangerous gas monitoring is provided for hazardous gases

Electrical/Lighting

- Controlled light environment
- 120v, 208v, and 408v, provided at four locations at each cell
- Observation/security cameras at each cell

Plumbing

- Three large capacity drains located at each cell
- Water at each cell
- Gases can be piped through the exterior of the building as needed

About the Georgia Institute of Technology

Georgia Tech is an innovative intellectual environment with more than 900 full-time instructional faculty members and more than 20,000 undergraduate and graduate students. The Institute is a national and international leader in scientific and technological research and education. Over the past decade, overall research expenditures doubled to $611 million, while federal research expenditures nearly tripled. Georgia Tech consistently ranks among the top ten in research outlays among universities without a medical school. In addition, Georgia Tech annually contributes an estimated $2.15 billion to the metro-Atlanta economy.

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