EM Scopes Belong on the Moon

E4H Environments for Health Architecture

Lab Design CONFERENCE April 23 – 25, 2018 | Sheraton Philadelphia Downtown Hotel | Philadelphia, PA

Introductions

Brian DiLuiso, AIA

25+ years - academic, clinical research, medical device, pharmaceutical, and biotechnology business sectors

Chip Calcagni, AIA

30+ years - medical, research, and laboratory spaces for major healthcare institutions

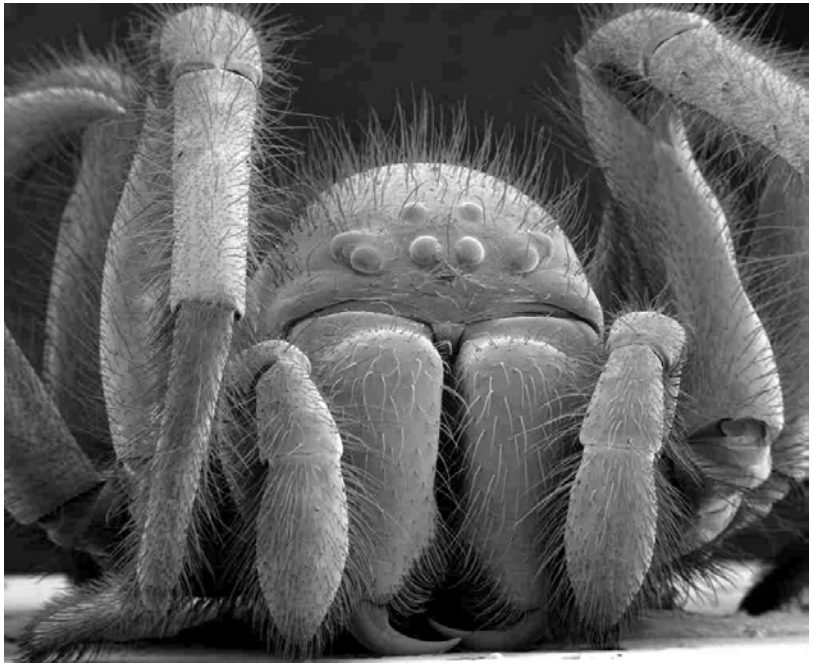
e4h ENVIRONMENTS FOR HEALTH ARCHITECTURE

By the numbers

- 100% health & life sciences
- 6,500+ projects
- 400+ clients
- 7 offices
- 160+ design professionals
- 40+ years experience
- $6 billion in completed projects

Electron microscopes were invented in 1931

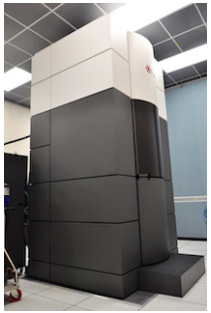
Max Knoll and Ernst Ruska

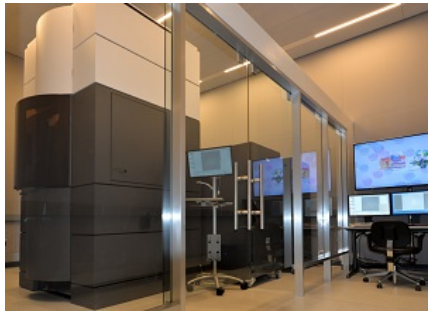


12,000 times magnification

What is an electron microscope or TEM?

- Technique for obtaining high resolution images of biological and non-biological specimens
- Investigate the detailed structure of tissues and cells
- View thin specimens (tissue sections, molecules) through which electrons can pass generating a projection image
- Light microscopes have useful magnifications below 2000x while TEM up to about 10,000,000x

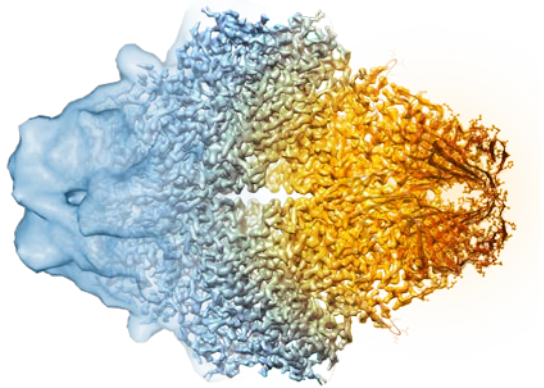




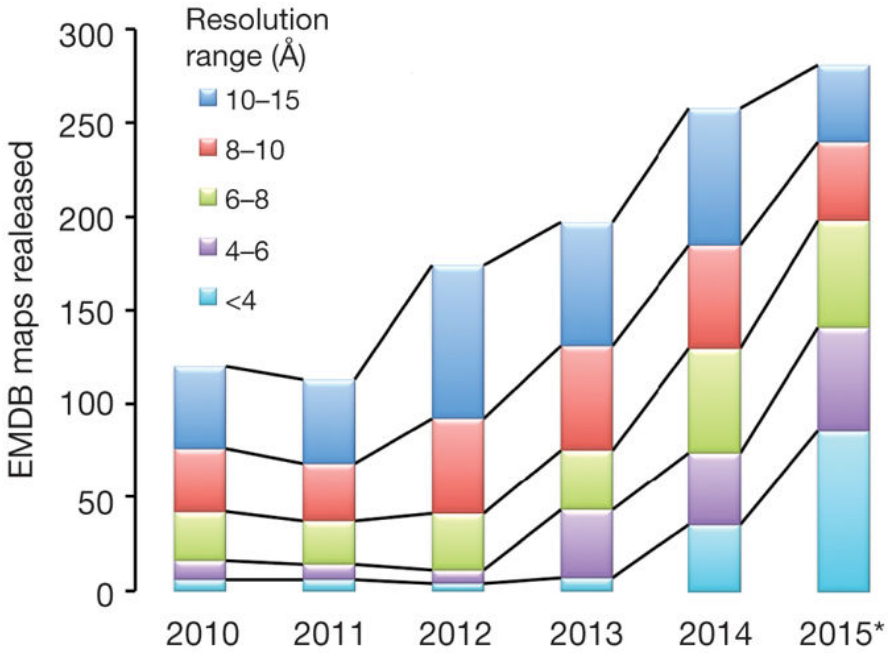
TEM

SEM

What is Cryo-EM?

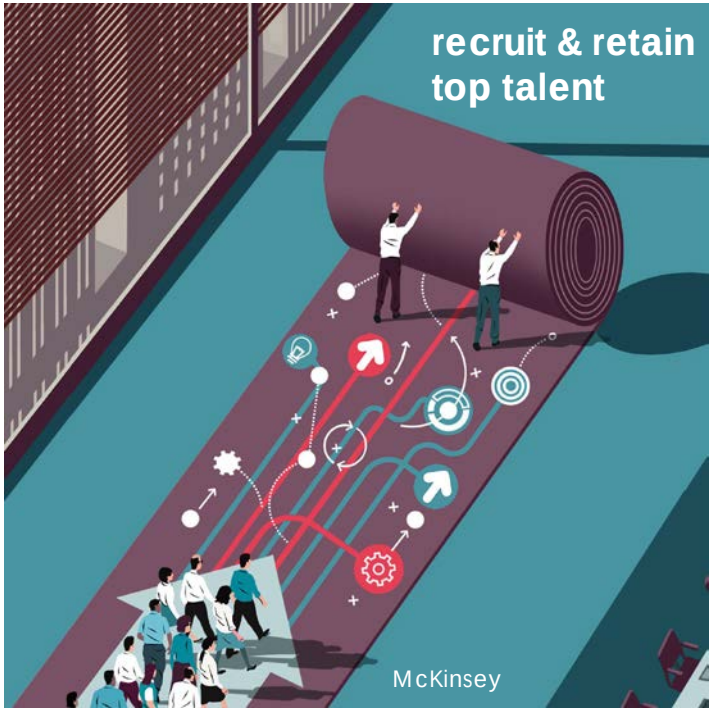


- Process begins with rapid vitrification so samples are not damaged
- Series of 2D images is acquired
- Data reconstructed to form 3D model of biological structure
- 3 Angstrom scale (1 ten-billionth of a meter or 0.3 nanometers)

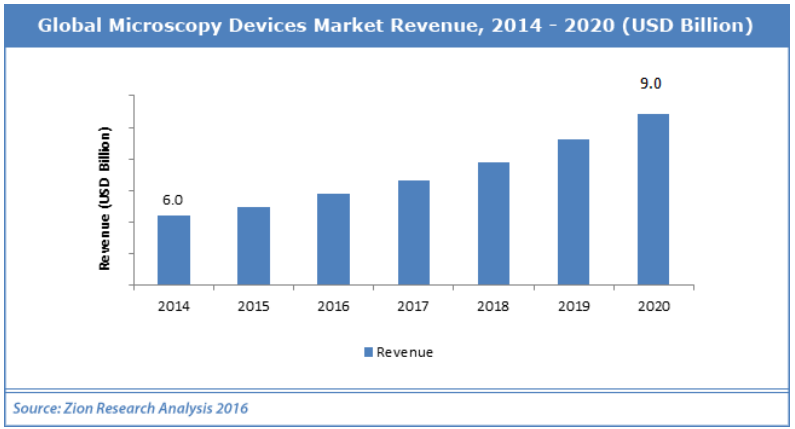


Nature Methods ***13***, *24–27 (2016)*

The business of EM scopes



	Science	Industry
Core	**MATERIALS SCIENCE** Universities, institutes, companies and government labs engaged in material science research & nanotechnology	**ELECTRONICS** Primarily semiconductor manufacturers
Growth	**LIFE SCIENCES** Universities, institutes, government labs and pharmaceutical companies engaged in life sciences research	**NATURAL RESOURCES** Mining and oil & gas companies, including industry service providers



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The business of EM scopes - Project & Staff Operating Costs

Case Study (4,300SF)

- 4 cryo electron microscope suites
- Sample prep laboratory
- Open workspace
- MEP support space
- Server Room
- Dedicated infrastructure (AHU, chillers, pre-action)

Initial Project Costs

- Construction Costs: 4,300SF x $1,630/SF = $7M
- Scope Costs: $4M x 4 scopes = $16M
- Soft Costs: $500k
- **Total Project Costs: $23.5M**

Staff Operating Costs

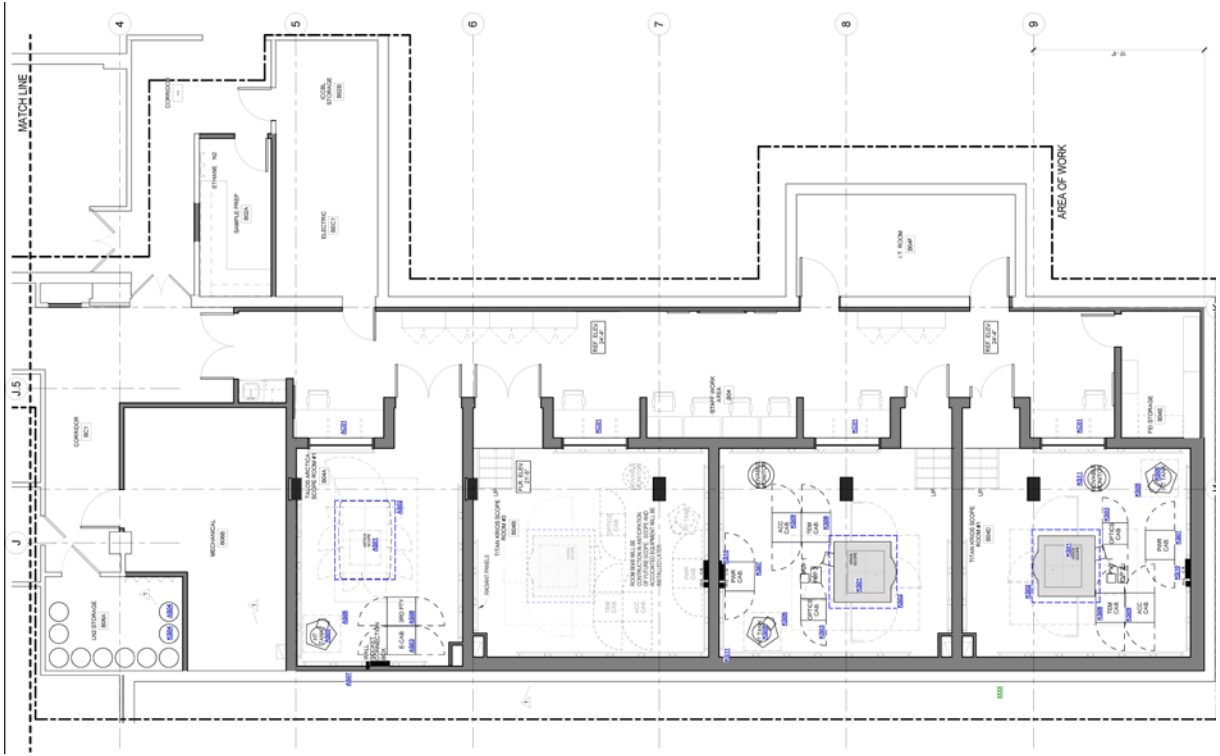
- 275 Days/Year (maintenance + downtime)
- 5 full-time staff (4 techs + 1 IT/Computational)
- 275 days x 24 hours = 6,600 Beam Time Hours/year
- **Total Staff Operating Costs:**
  6,600 hours x $90/hour = $600K/year

Services Offered	Non-Profit	For Profit
Technician Services	$80/hour	$250/hour
Transmission Electron Microscopy		
TEM Sample Prep (investigator prepares samples)	$275/sample	$550/sample
Beam Time (investigator runs scope)	$70/hour	$300/hour
TEM Sample Prep (GEM Lab prepares samples)	$320/sample	$640/sample
Beam Time (GEM Lab runs scope)	$115/hour	$230/hour
Sectioning (includes Technician Services)	$80/hour	$250/hour
GEM Evaluation by Staff (if applicable)	$50/hour	$100/hour
Negative Staining (includes 30 min beam time w/lab staff)	$60/sample	$120/sample

New research facility planning

Plan space to accommodate Cryo EM scope technology! (Adapting a building is complicated)

- Structural slab on grade
- High bay space
- Space for dedicated MEP systems
- Cryo delivery & storage
- Data and server storage

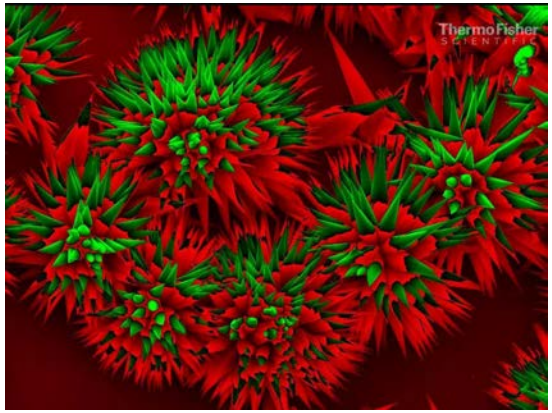


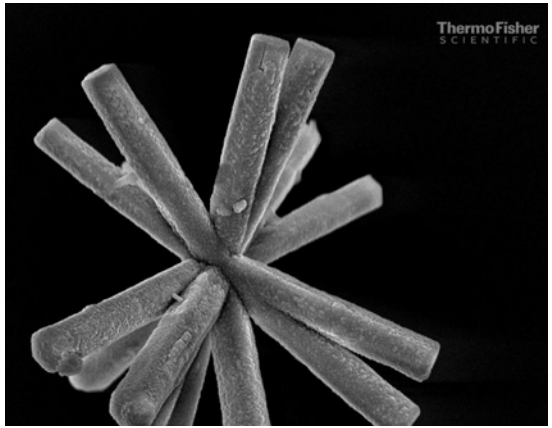
So, your client wants to build a Cryo EM scope facility!

- High demand
- No time or $$ to build
- Rush to market
- Available space likely needs significant infrastructure upgrades

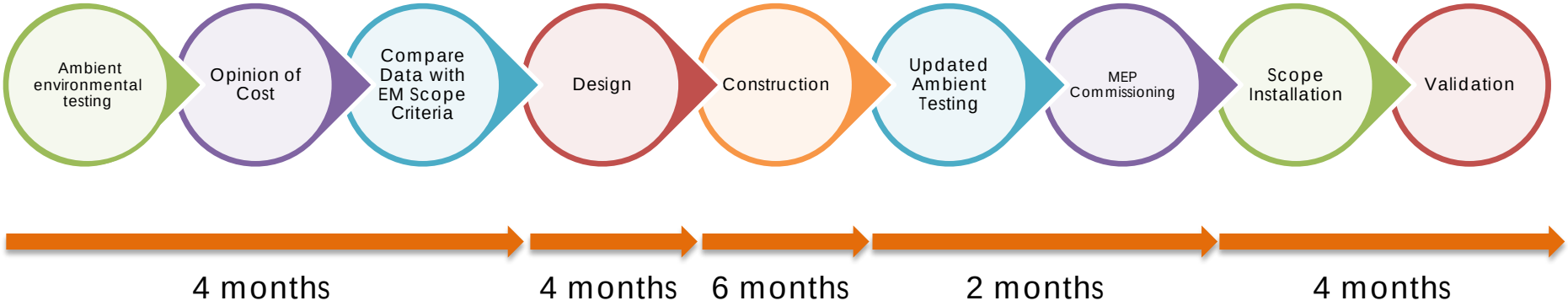
Feasibility study

- Dimensional clearances
- Infrastructure capacities
- Future construction activities
- Seasonal operations
- Structural/geotechnical
- Ambient conditions





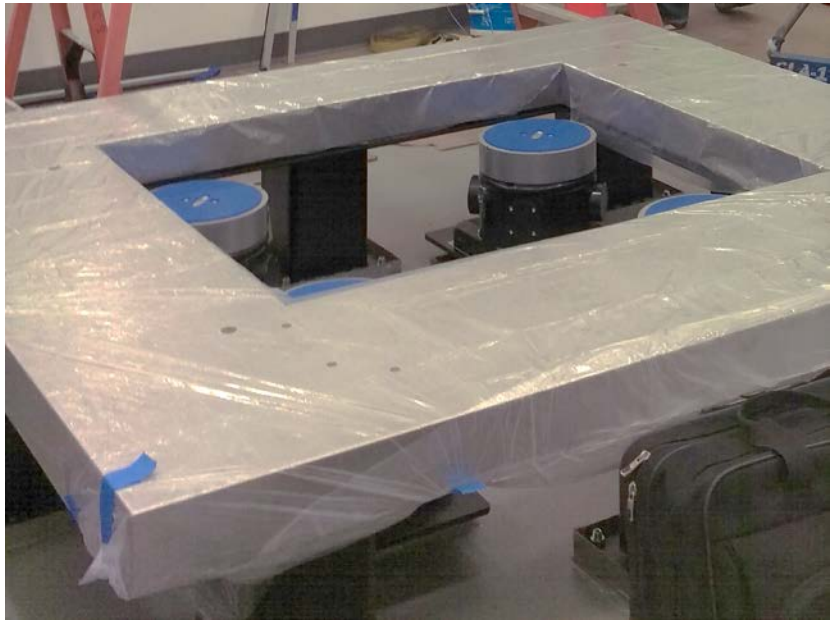
Project Timeline



Key Environmental Influencers

Key influencers - vibration

Design considerations - vibration

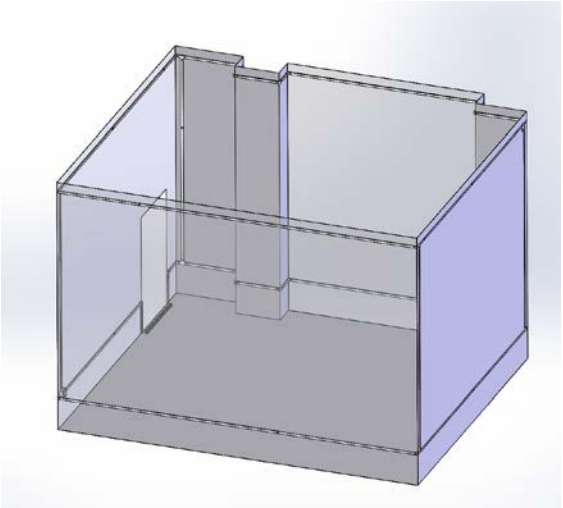


- Isolation platforms
- Floor slab design (mass vs. isolated)
- LN2 Dewar deliveries

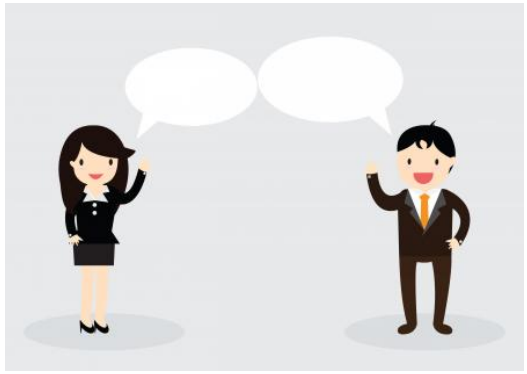
Key influencers – electromagnetic fields

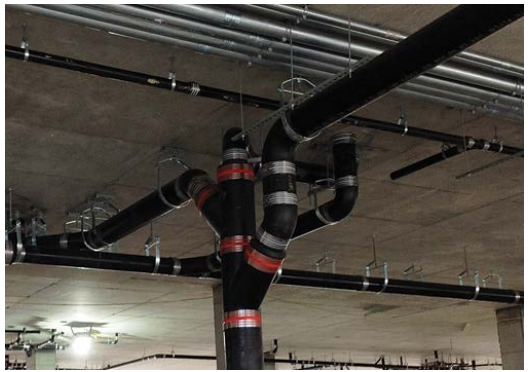
Design considerations - electromagnetic fields

- Passive Metal Shielding
- Active Shielding System
- Location of MEP Equipment



Key influencers – acoustics

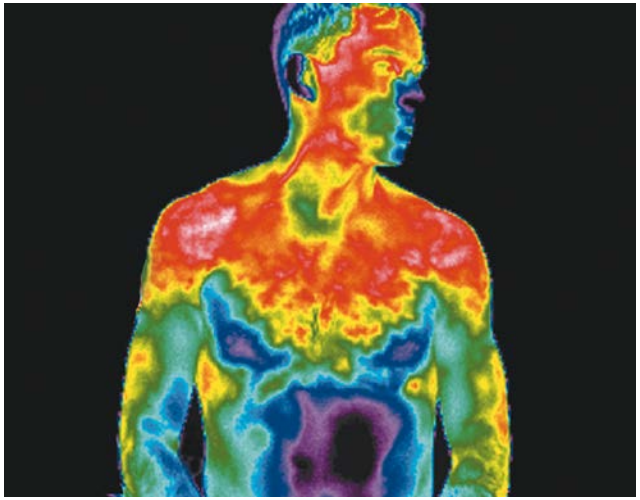




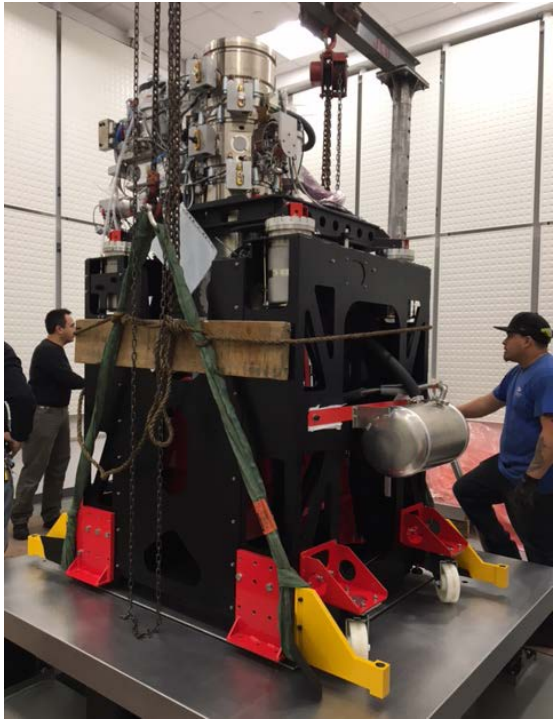
Design considerations - acoustics

- Scope Acoustical Enclosure
- Acoustical Wood Framed Partitions
- Sound Door and Windows
- Acoustically Lined Ductwork
- Acoustical Wall & Ceiling Panels
- Slow Air Movement (HVAC)

Key influencers – temperature



Design considerations – temperature



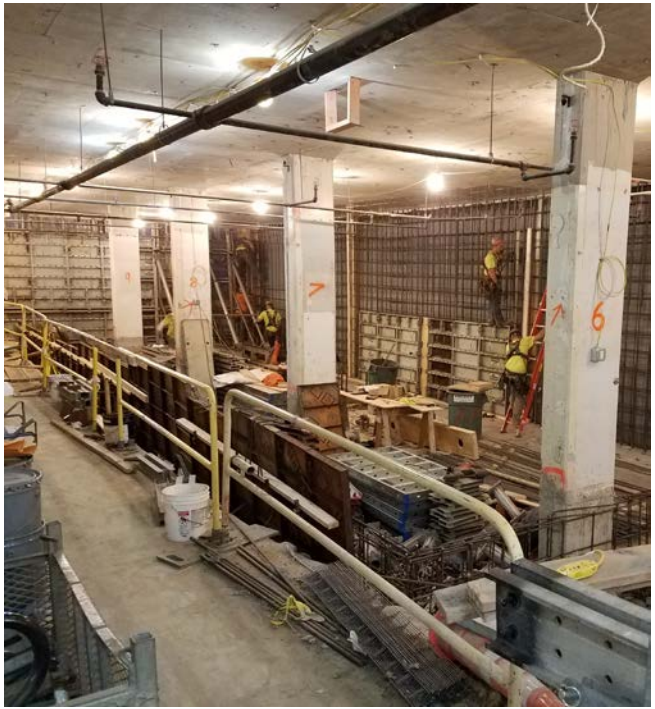
- Radiant chilled water panels
- Laminar air flow
- LED lighting
- < 80% relative humidity
- ISO8 clean air advised

Lean & operational flow considerations

- Sample prep lab
- Dedicated mechanical space
- Safety - low oxygen sensors
  (Sulfur Hexafluoride (SF6) & LN2 leakage, cameras, emergency buttons)
- Storage – servers for data collection, maintenance parts and tools
- How will the researchers interface with the microscope, locally or remotely?
- How will microscope service be performed?
- Operational redundancy

Case study – Memorial Sloan-Kettering Cancer Institute

Case study – Harvard Medical School



Questions?

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