

Cloud Labs & Biosecurity

Emerald Cloud Lab

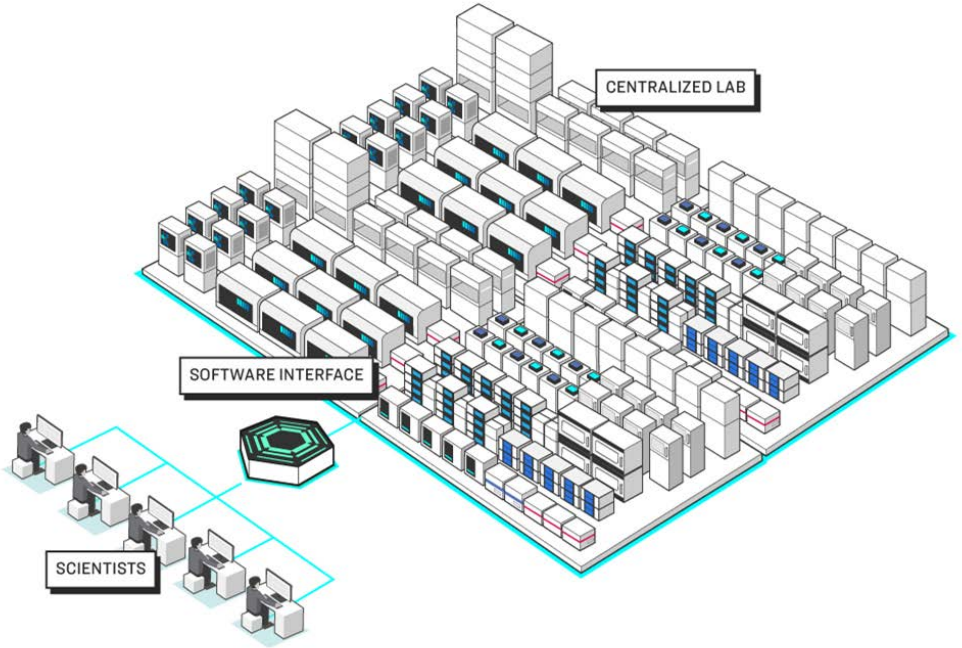
What is a Cloud Lab?

Remote-control scientific laboratory

Inspired by TSMC and the “foundry model”: centralized physical resource with distributed customer base

All experiments in Cloud Lab are driven by a defined instruction set, just like a microprocessor

Everything is procedural, not necessarily robotic



Cloud Labs let scientists focus on what they do best



Cloud Labs enhance biosecurity

Cloud Labs make laboratory research more, not less, secure

1. Rigorous validation checks of all experimental parameters and conditions
2. All instruments air-gapped from the internet
3. Complete, auditable trace history of all materials, actions, data, and metadata
4. Know-Your-Customer screening

Looking Forward: The next generation of biosecurity controls

Integration of more sophisticated screening tools

Simulation-driven tools can be added to the existing validation checks to catch threats not currently on screening lists

Splitting user roles

Different account permissions for ”scientists” versus “analysts”

Restrictions on experiment types

Company has already moved away from DNA/RNA synthesis

Required screening of customer samples

Identity verification for all samples shipped to an ECL facility

Thank you!

Thank you!



Emerald Cloud Lab

Address
15500 Wells Port Drive
Austin, TX 78728

Contact
dj@emeraldcloudlab.com

What do you get from a Cloud Lab?

Cloud Labs provide qualitative and quantitative benefits for scientists and scientific research

Three of the clearest are:

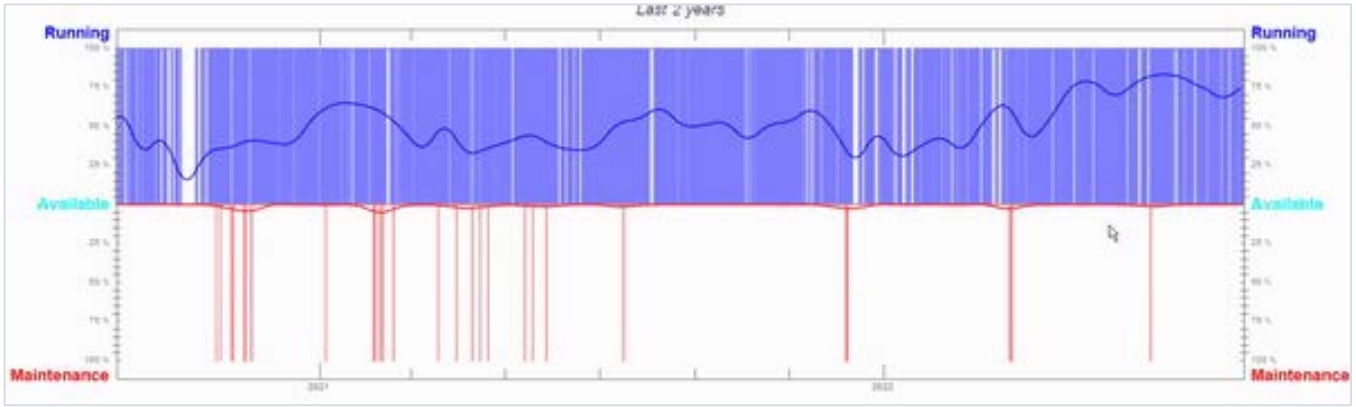
1. **Productivity:** How efficiently can scientists generate new data?
2. **Instrument Utilization:** How easy is it to share scientific equipment?
3. **Reproducibility:** How do you ensure an experiment can be repeated?

High productivity when lab work is removed

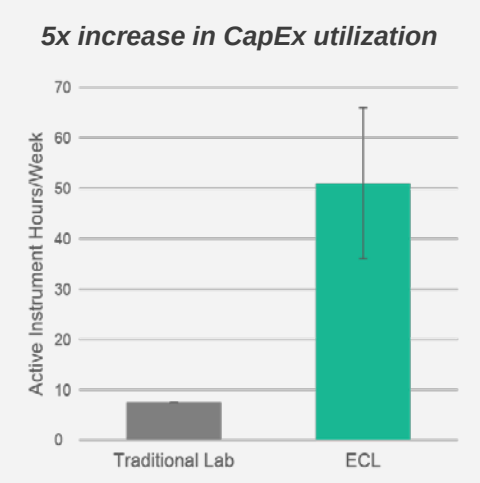
Example User	*Protocols Completed*	*Samples Processed*
Example Analytical Chemist	**90** protocols /week **8.3** minutes of user activity /protocol	**1,015** samples /week **44** seconds of user activity /sample
Example Molecular Biologist	**113** protocols /week **3.3** minutes of user activity /protocol	**2,706** samples /week **8.3** seconds of user activity /sample
Example Synthetic Chemist	**145** protocols /week **2.3** minutes of user activity /protocol	**1,453** samples /week **13.4** seconds of user activity /sample

Data is based on real, anonymous users selected from the system. User Activity is based on recorded Command Center activity of each user. Only time intervals of consecutive interactions with Command Center that have a gap of less than 25 minutes are considered in the calculations including an additional 10 minute buffer after the last activity of each interval.

Maximized utilization for scientific instruments

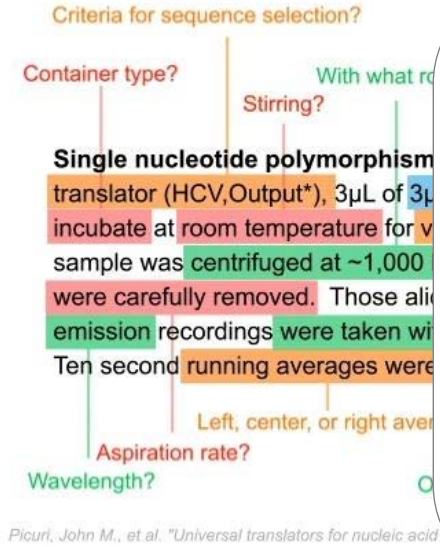


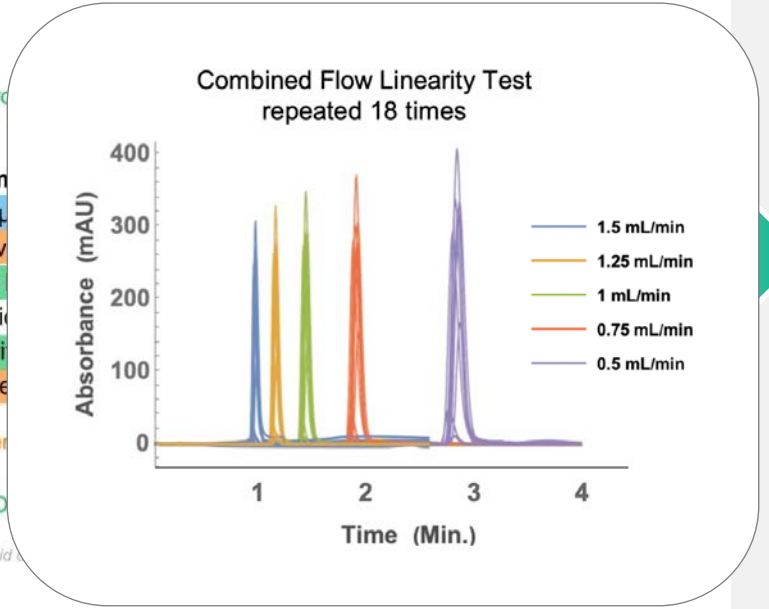
Instrument utilization chart for high use equipment. The x-axis is time, each bar in blue is a single experiment run on the instrument, and each bar in red is a time when the instrument is out for maintenance.



Instruments in a Cloud Lab are shared like runways at a busy airport

Codifying experiments provides push-button reproducibility






```
Experiments Fluorescence Kinetics[
   "Reaction Mixture",
   PreparatoryUnitOperations->{
      Transfer[
         Source->Model[Sample,StockSolution,"IDE Buffer"],
         Destination-> Model[Container,"2mL Tube"],
         Amount->20 Microliter,Label->"Reaction Mixture"
      ],
      Transfer[
         Source->Model[Sample,"7.5uM HCV Translator"],
         Destination->"Reaction Mixture",
         Amount->18 Microliter,
         AspirationMixVolume->10 Microliter,
         NumberOfAspirationMixes->10,
         AspirationMixRate-> 100 Microliter/Second
      ],
      Transfer[
         Source->Model[Sample,"30uM HCV RNA"],
         Destination->"Reaction Mixture",
         Amount-> 3 Microliter
      ],
      Incubate[
         Sample->"Reaction Mixture",
         Time->5 Minute,
         Temperature->Ambient,
         MixType->Pipette,
         NumberOfMixes->10,
         MixVolume->30 Microliter,
         MixRate-> 100 Microliter/Second
      ],
      Centrifuge[
         Sample->"Reaction Mixture",
         Intensity->800G,
         Rotor->Model[CentrifugeRotor,"20R FA361.5"],
         Time->10 Second
      ]
   },
   AliquotVolume->25 Microliter,
   AliquotContainer->Model[Container,Cuvette,"2mL UV Quartz"],
   AssayVolume->2 Milliliter,
   ExcitationWavelength->355 Nanometer,
   EmissionWavelength->420 Nanometer,
   ReadTime->1 Second,
   RunTime->1000 Second
]
```

Cloud Labs make laboratory work faster and cheaper

3-8x Increase in test execution throughput

30% Decrease in average turnaround time

50% Cost reduction on operating labs

50% Cost reduction on facilities



Emerald Cloud Lab

Cloud Labs offer a multi-dimensional approach to science

Open-ended Research

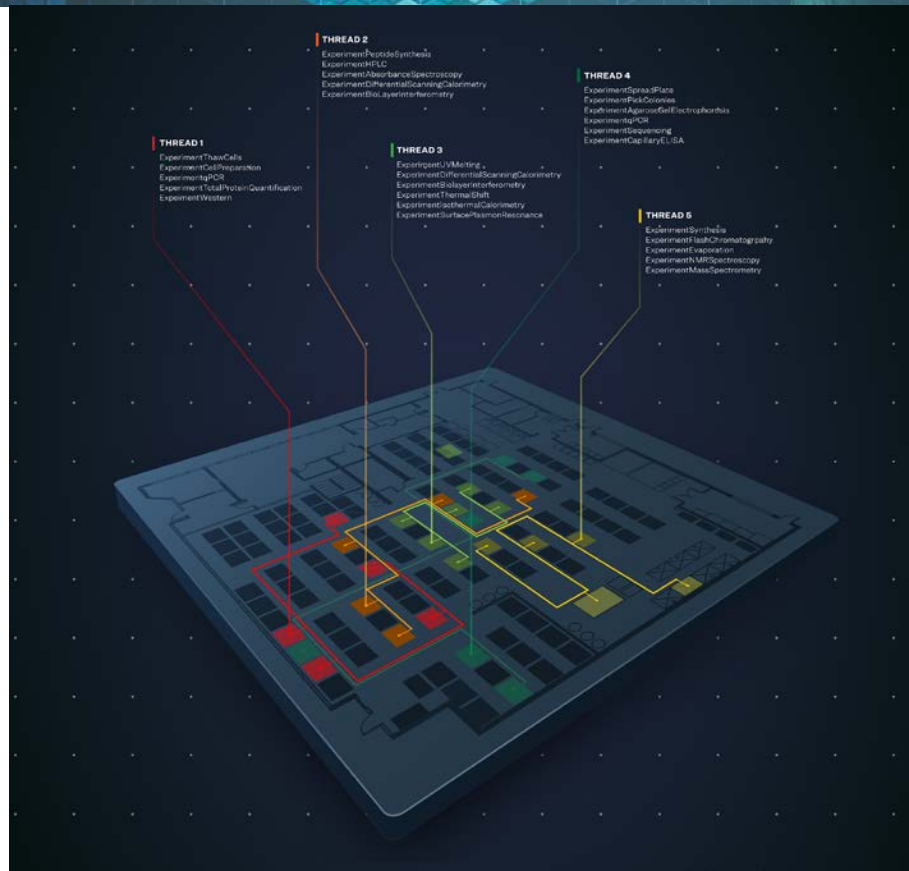
Scientists design, execute, and analyze new experiments daily. Instrumentation used, methods tests, and samples deployed can change at any time. This degree of flexibility is central to the Cloud Lab vision and inherent to how they are architected.

High-Throughput Experimentation

Executing many instances of the same experiment type using automation and common sample form factor. Commonly accomplished in a Cloud Lab via an automated workcell.

Self-driving Labs

Algorithm-driven “closed loop” systems combining AI and robotics to iterate toward a particular scientific goal or outcome. In a Cloud Lab, this simply involves connecting these programs to the software stack/API.



Emerald Cloud Lab

Network of Cloud Labs

Worldwide network of interoperable Cloud Labs, all speaking the same language will fundamentally change the way laboratory research is done.

