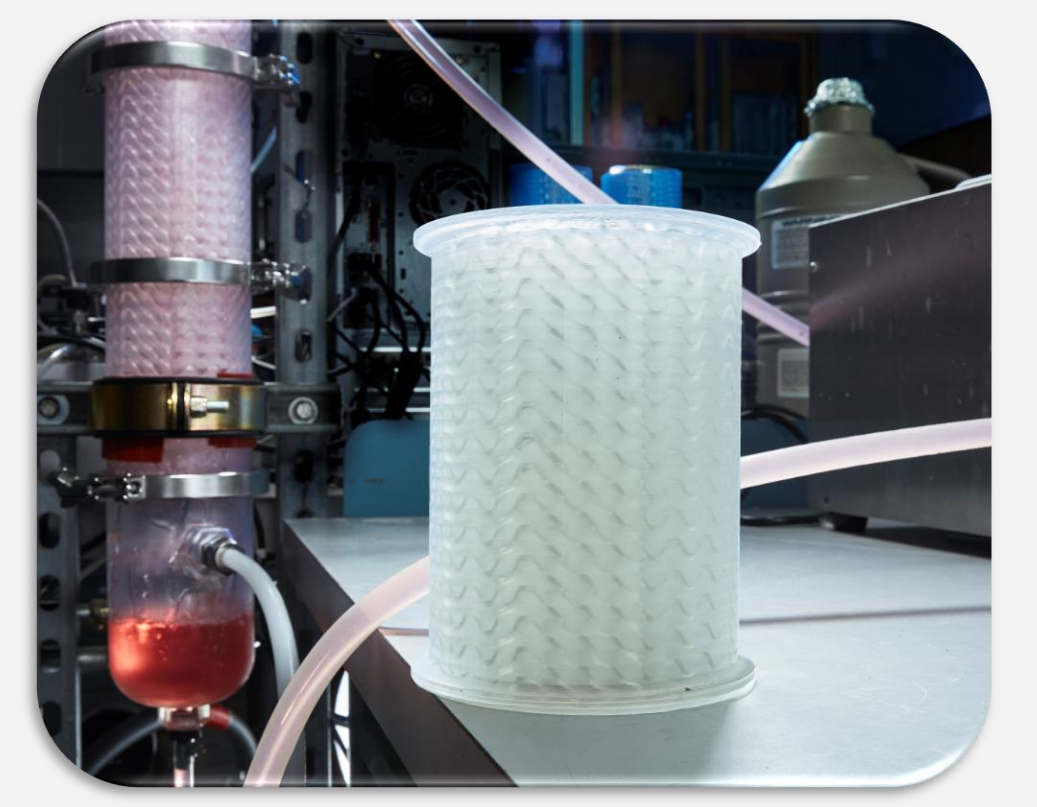


Scaled validation of advanced structured packing at the

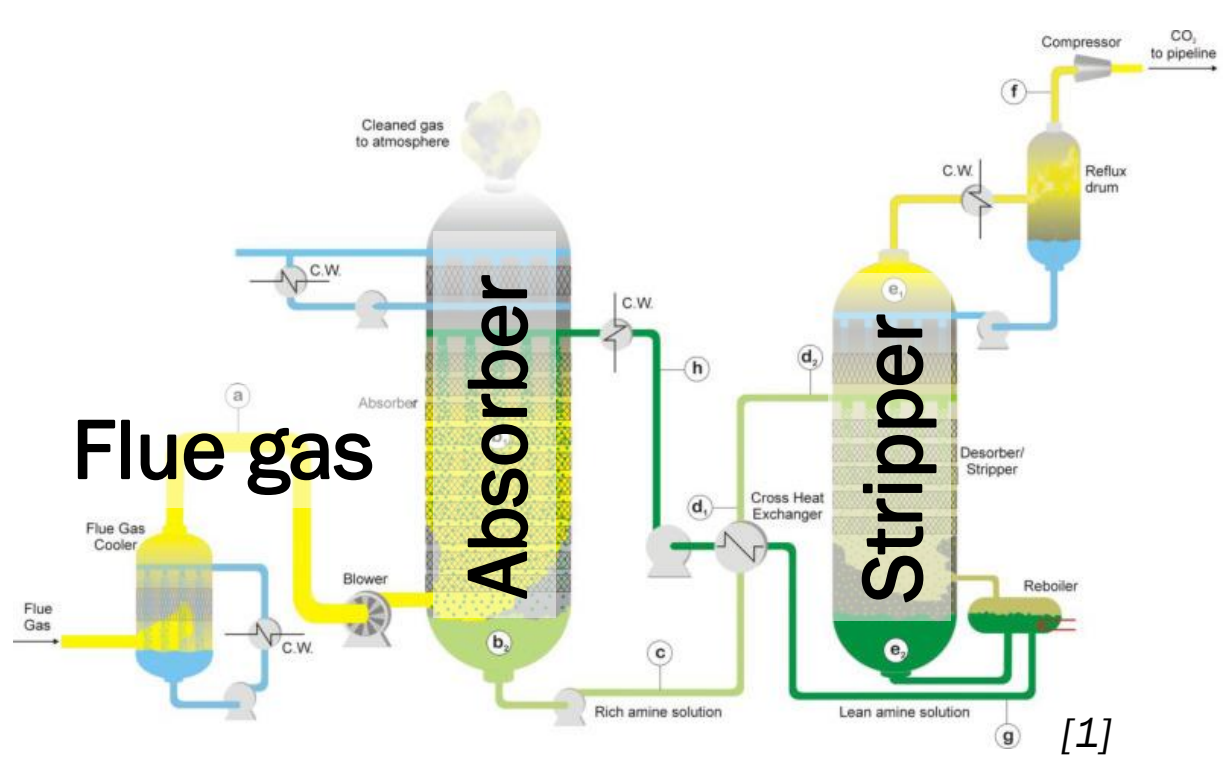
National Carbon Capture Center (NCCC) SSTU

Nathan C. Ellebracht^{*,†}, Du T. Nguyen[†], Lucas S. Thigpen[†], Hannah V. Eshelman[†], Mengyao Yuan[†], Nicholas R. Cross[†], Wenqin Li[†]

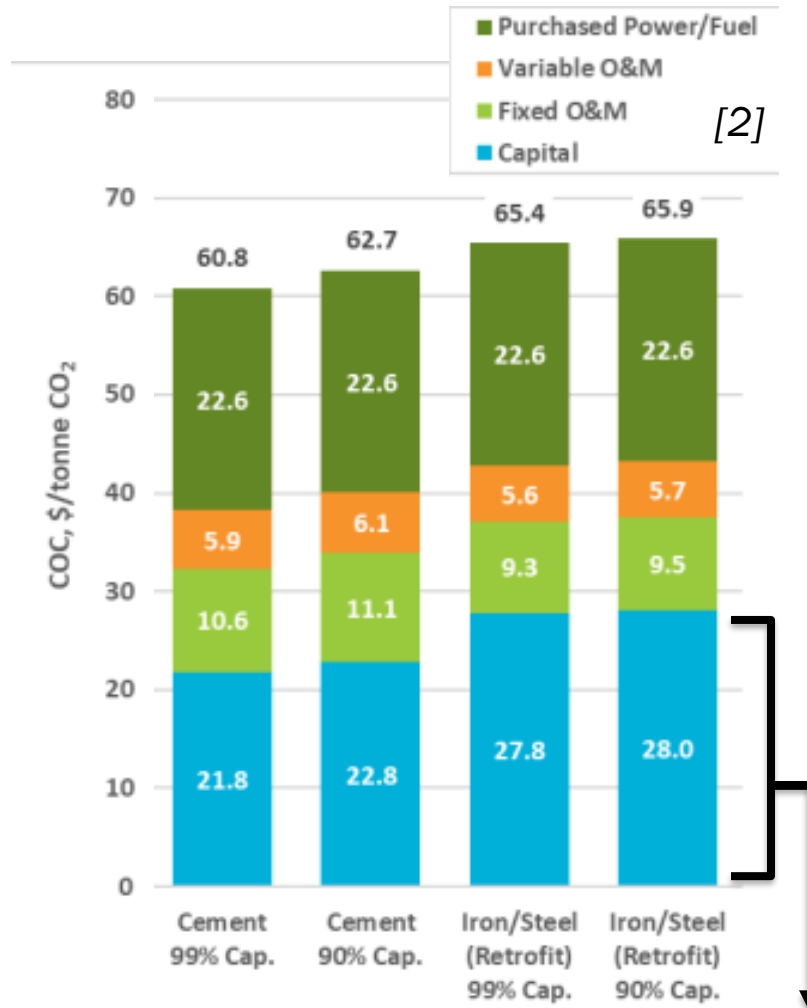
[†]Lawrence Livermore National Laboratory, Livermore, CA 94550; contact: ellebracht1@llnl.gov



SOLVENT-BASED POINT SOURCE CARBON CAPTURE

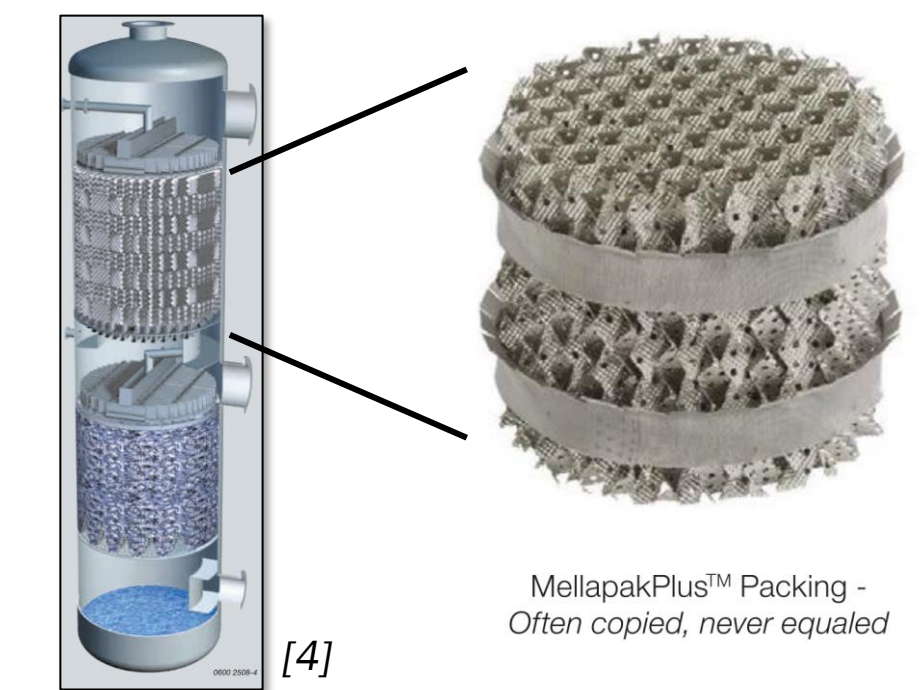


Cost of CO₂ capture for hard-to-abate industry



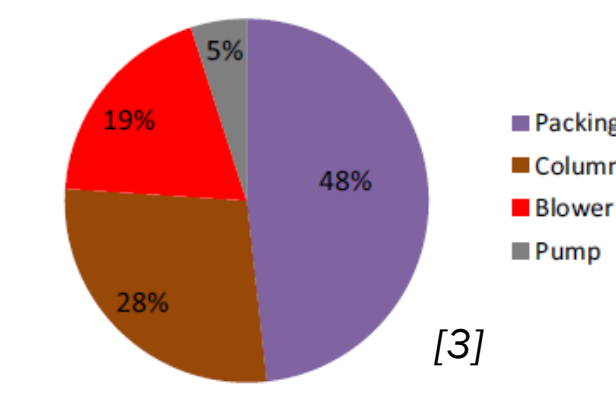
Where is there opportunity for cost and performance improvements?

- Capital costs are a significant driver
- Column & packing are 75% total
- Improved performance → reduced size



MellapakPlus™ Packing - Often copied, never equaled

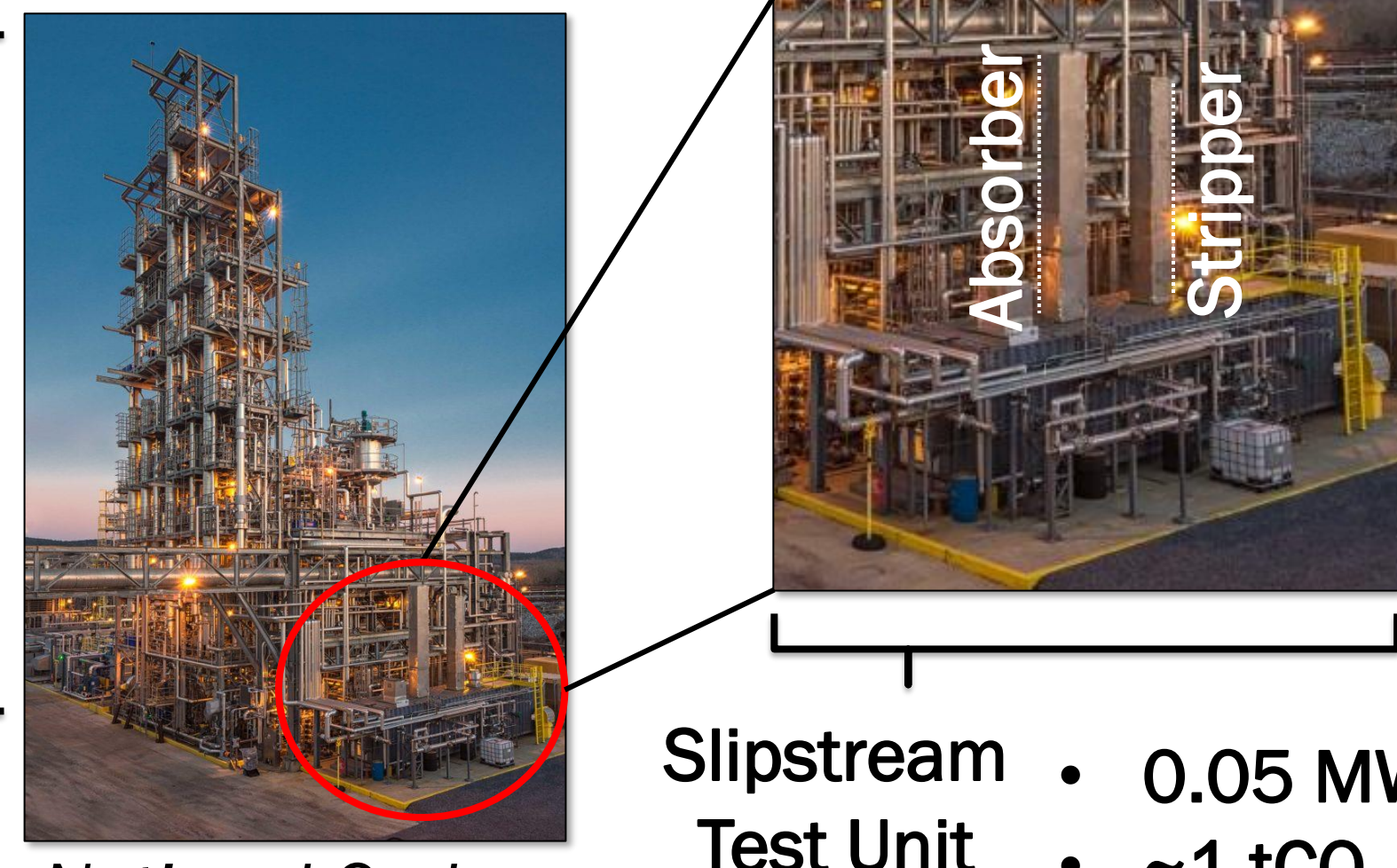
Improved structured packing → solvent-agnostic performance gains → reduced column size & CAPEX



NCCC SLIPSTREAM TEST UNIT (SSTU)

Pilot Solvent Test Unit (PSTU)

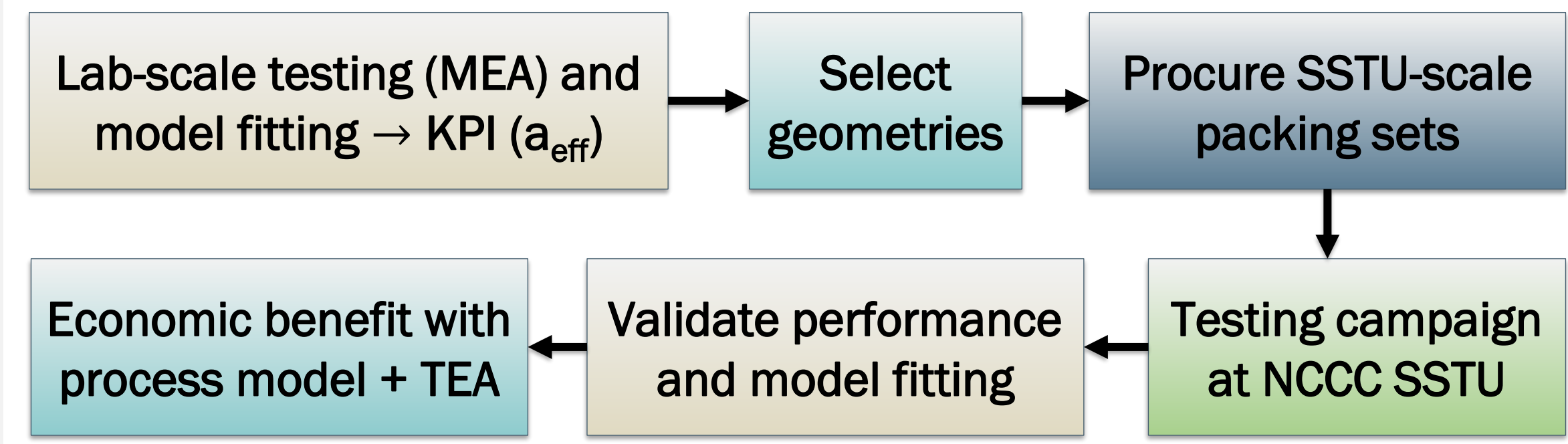
- 0.5 MWe
- ~10 tCO₂/d



National Carbon Capture Center, Wilsonville, AL

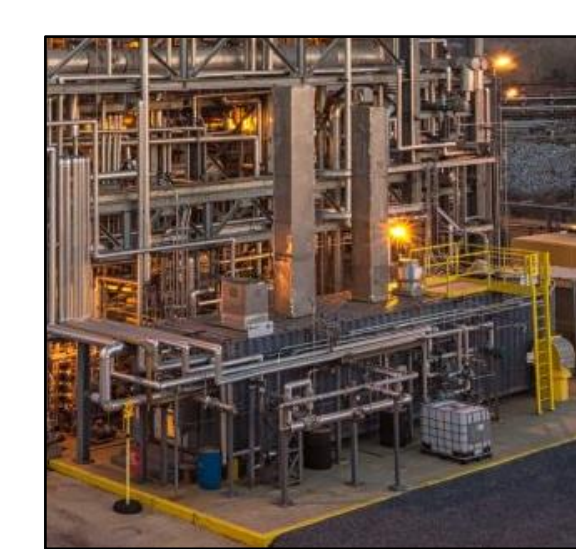
- SSTU Point Source Capture Operating Modes:
- Coal gas: ~12% CO₂ (slipstream from Gaston Steam Plant)
 - High CO₂ → L/G ~ 3, ~90% capture w/ 30 wt% MEA
 - NGCC: ~4% CO₂ (natural gas boiler flue gas, diluted)
 - Low CO₂ → L/G ~ 1, ~95% capture w/ 30 wt% MEA

PLANNED TESTING CAMPAIGN AT SSTU



Experimental campaign @ SSTU

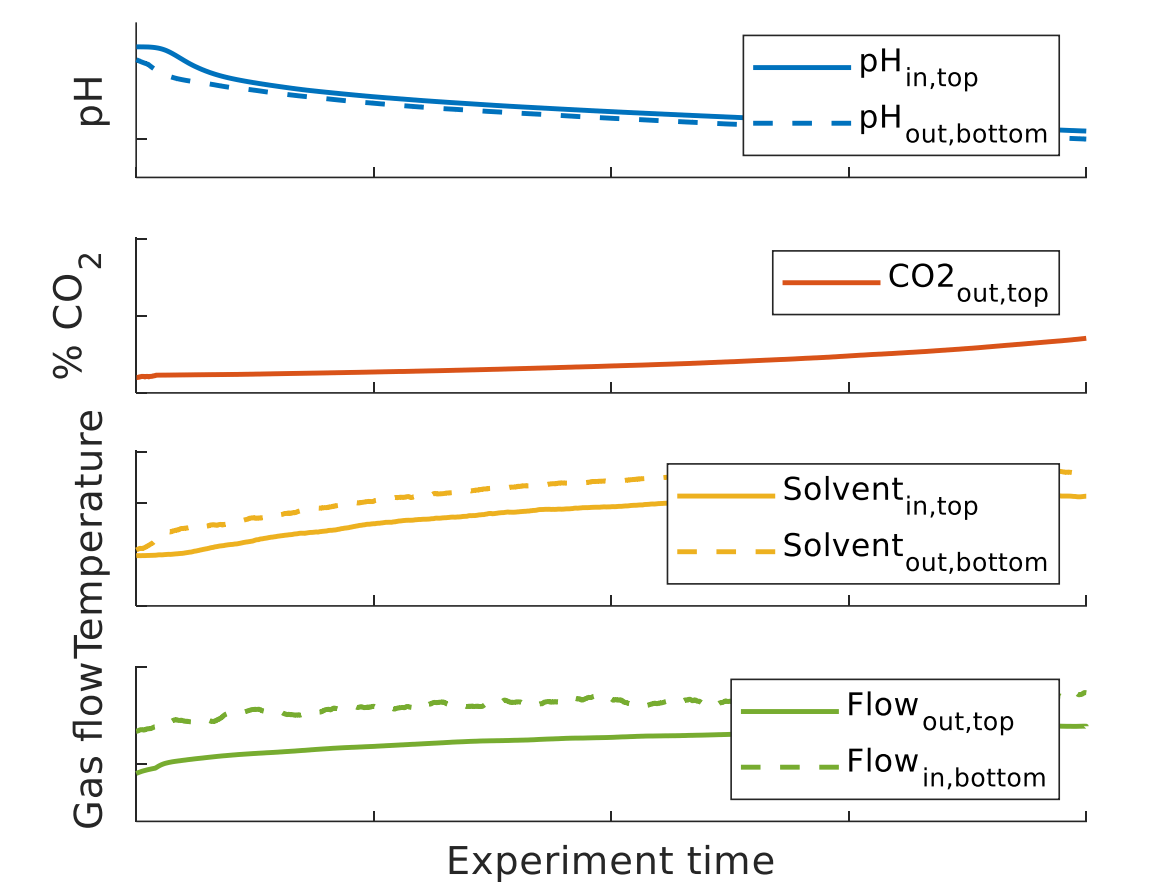
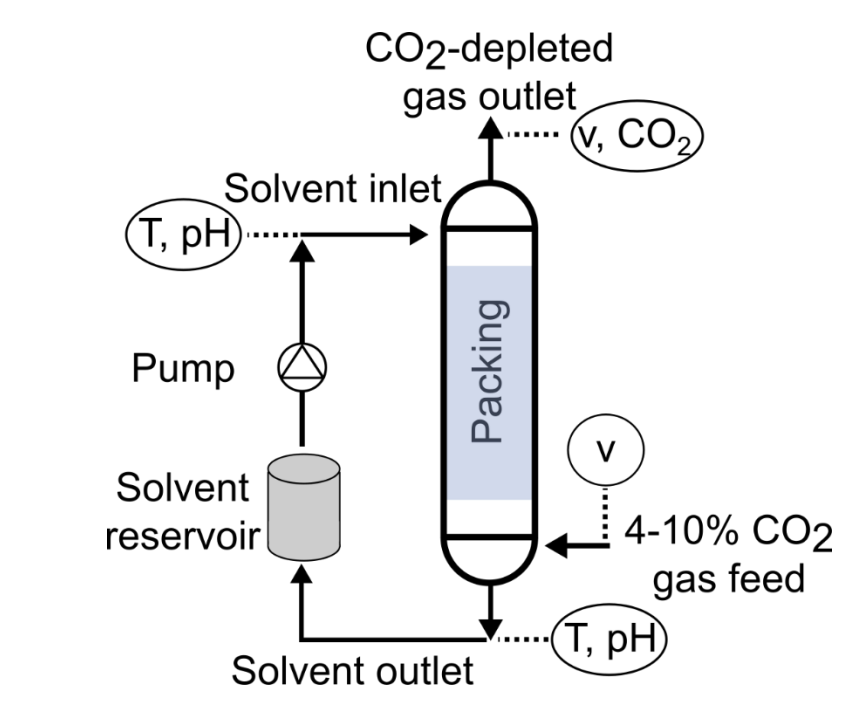
- LLNL packing geometry #1
 - Load & establish operational limits
 - Steady state capture
 - Limited parametric tests
- LLNL packing geometry #2
 - Same as above
- Conventional packing
 - Operate at comparable conditions to above



- Goals:
- Validate KPIs from lab-scale experiments
 - Verify operational limits (loads) with advanced geometries
 - Demonstrate improved CO₂ flux vs. conventional packing

PROGRESS, MODELING, AND ANALYSIS

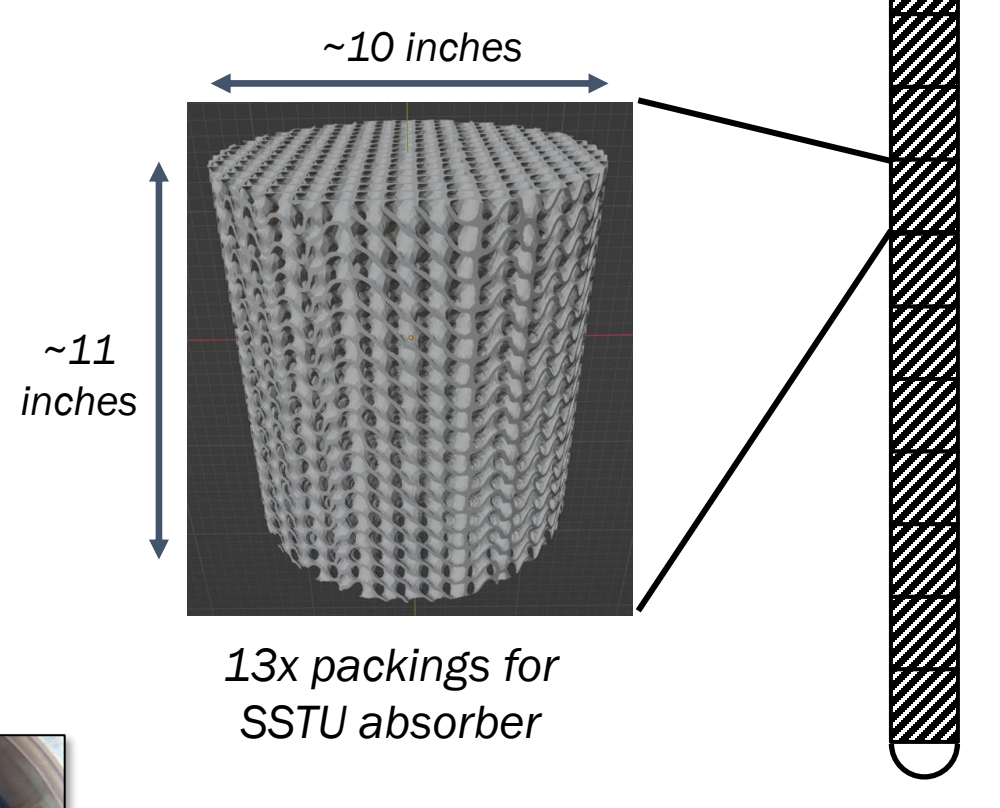
Lab-scale testing (MEA) and model fitting



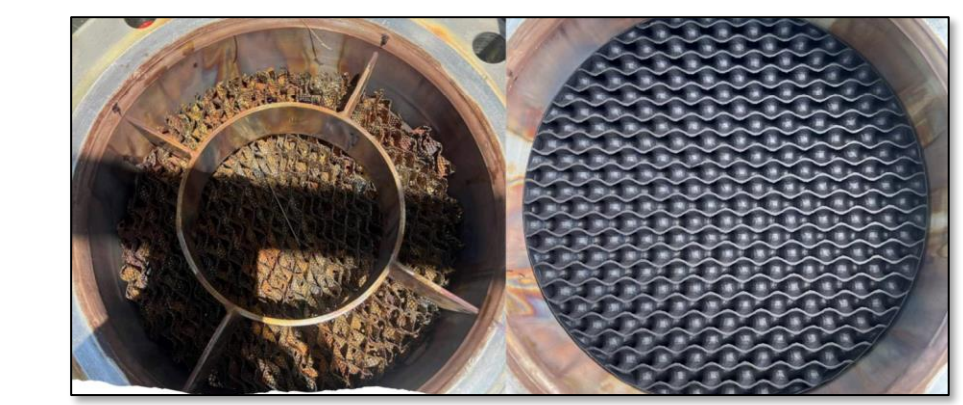
Lab-scale absorber testing (MEA)

Geometry selection

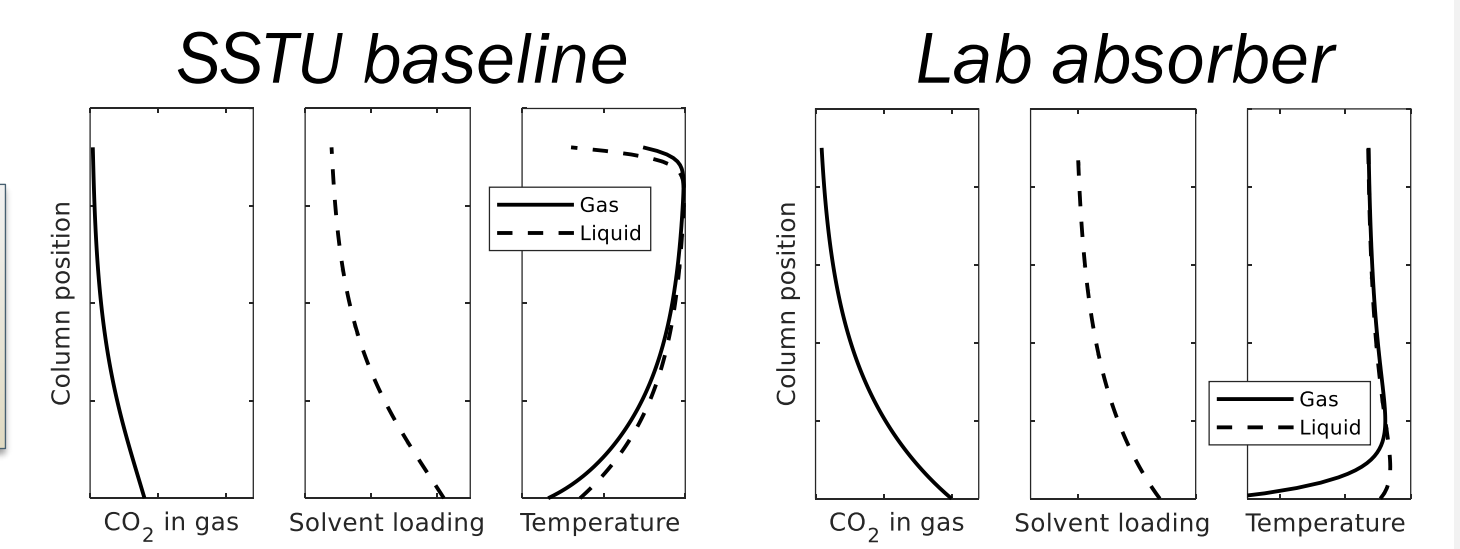
Procure SSTU packing sets



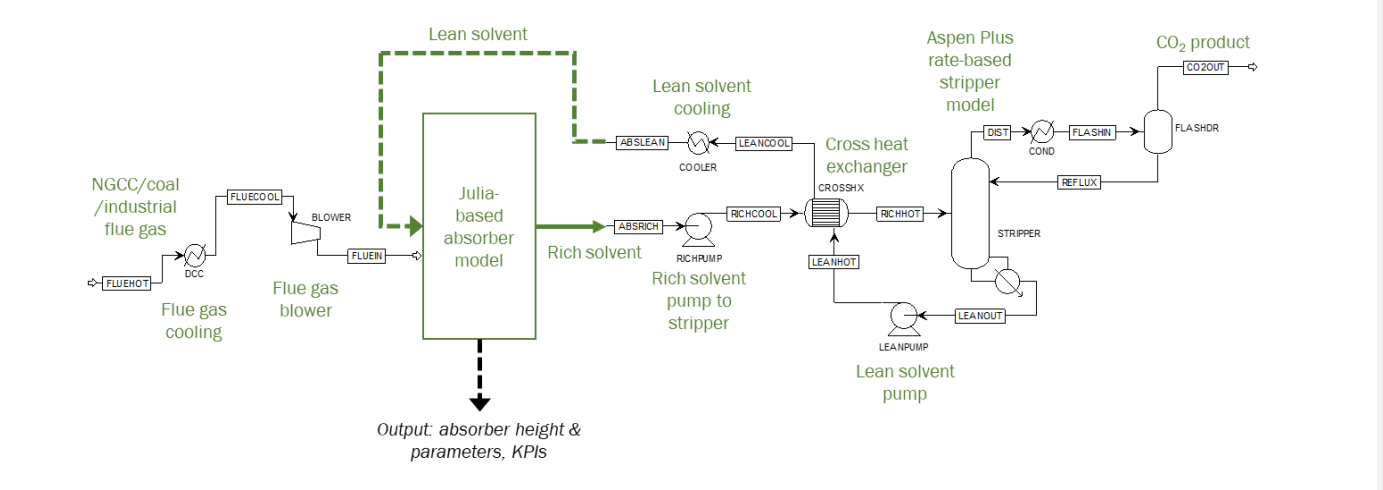
- 1 of 2 geometries finalized
- Compatible with SSTU absorber



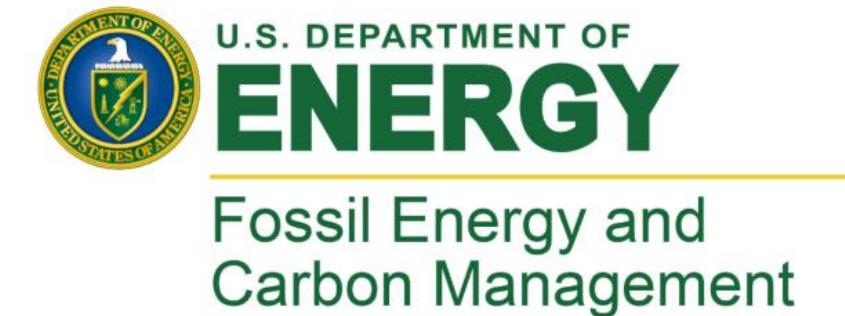
1D MEA absorber model for lab- and SSTU-scale



Integrated process and techno-economic model



ACKNOWLEDGEMENTS



FWP #FEW0297



[1] Krzemiński et al. *J. Sustain. Min.*, 2013
 [2] Hughes, Zoelle et al. *NETL-2023/3907*, 2023
 [3] Wang et al. *Int. J. Greenhouse Gas Control*, 2015
 [4] Sulzer Chemtech "Internals for Packed Columns," "Mass Transfer Technology"
 [5] Ellebracht et al. *Energy Environ. Sci.*, 2023