

Advancing Turbine Technologies for Relevant Inlet Temperature Profiles in the Steady Thermal Aero Research Turbine (START) Lab

DE-FE0032232

24 September 2024



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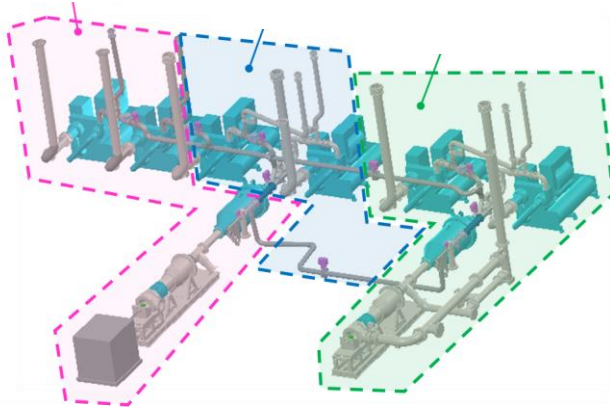
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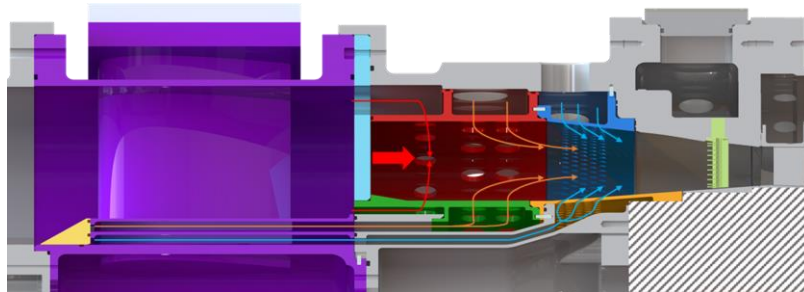
DOE-NETL PM: Matthew Adams



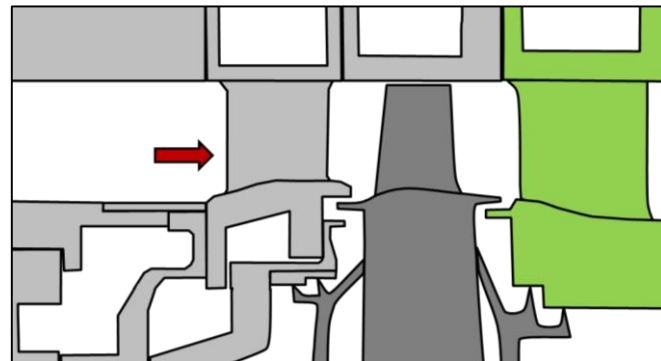
This presentation will review key project details outlining a portion of new capabilities comprising an expanded turbine research space at Penn State



New START+ facility design specifications



Turbine inlet profile generator capabilities



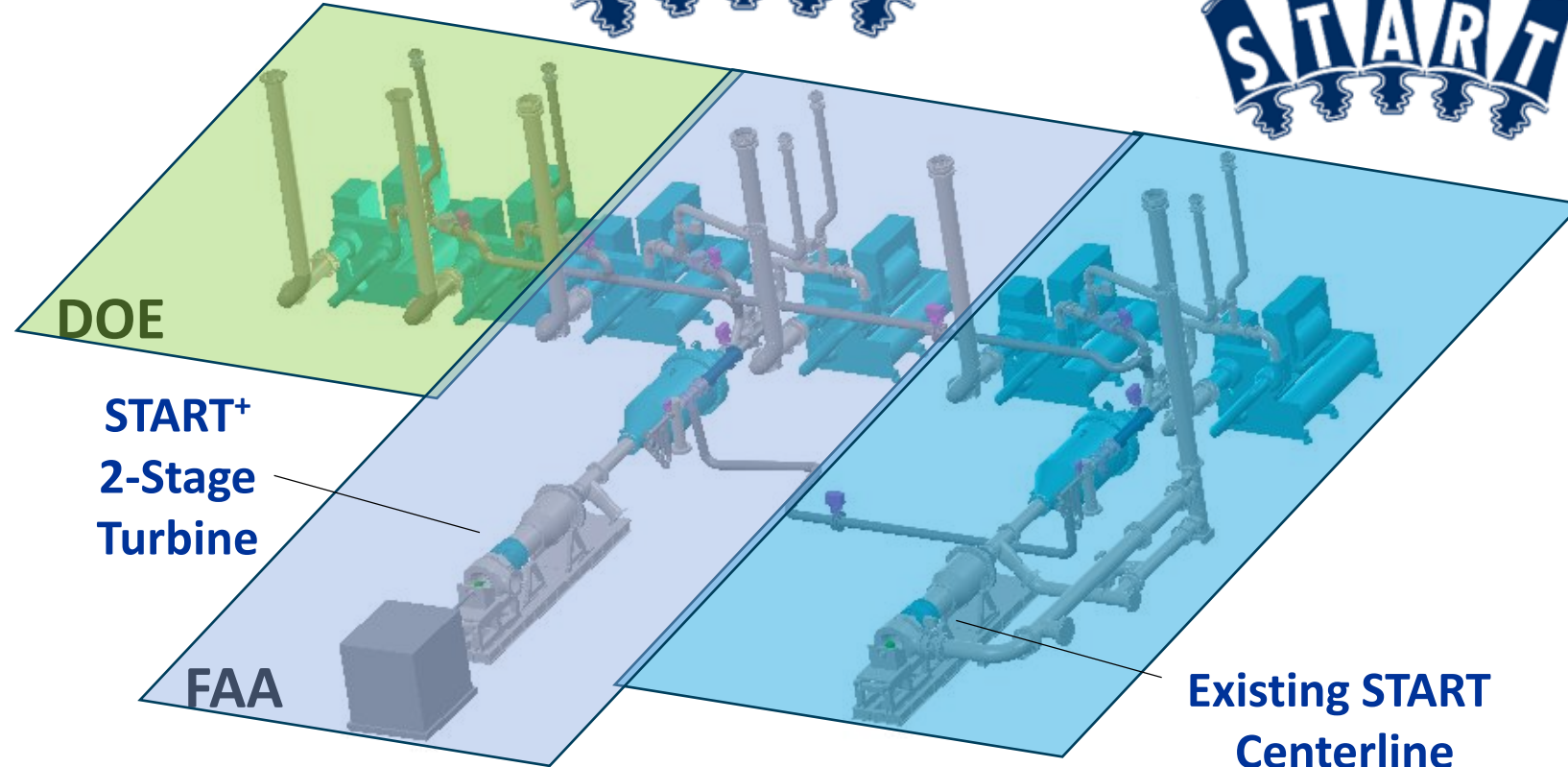
CMC hardware overview and integration plan

START will expand the lab to increase flow and pressure capacity for studying relevant turbine inlet profiles, CMC second-stage vanes, and a two-stage turbine



DOE Program Goals:

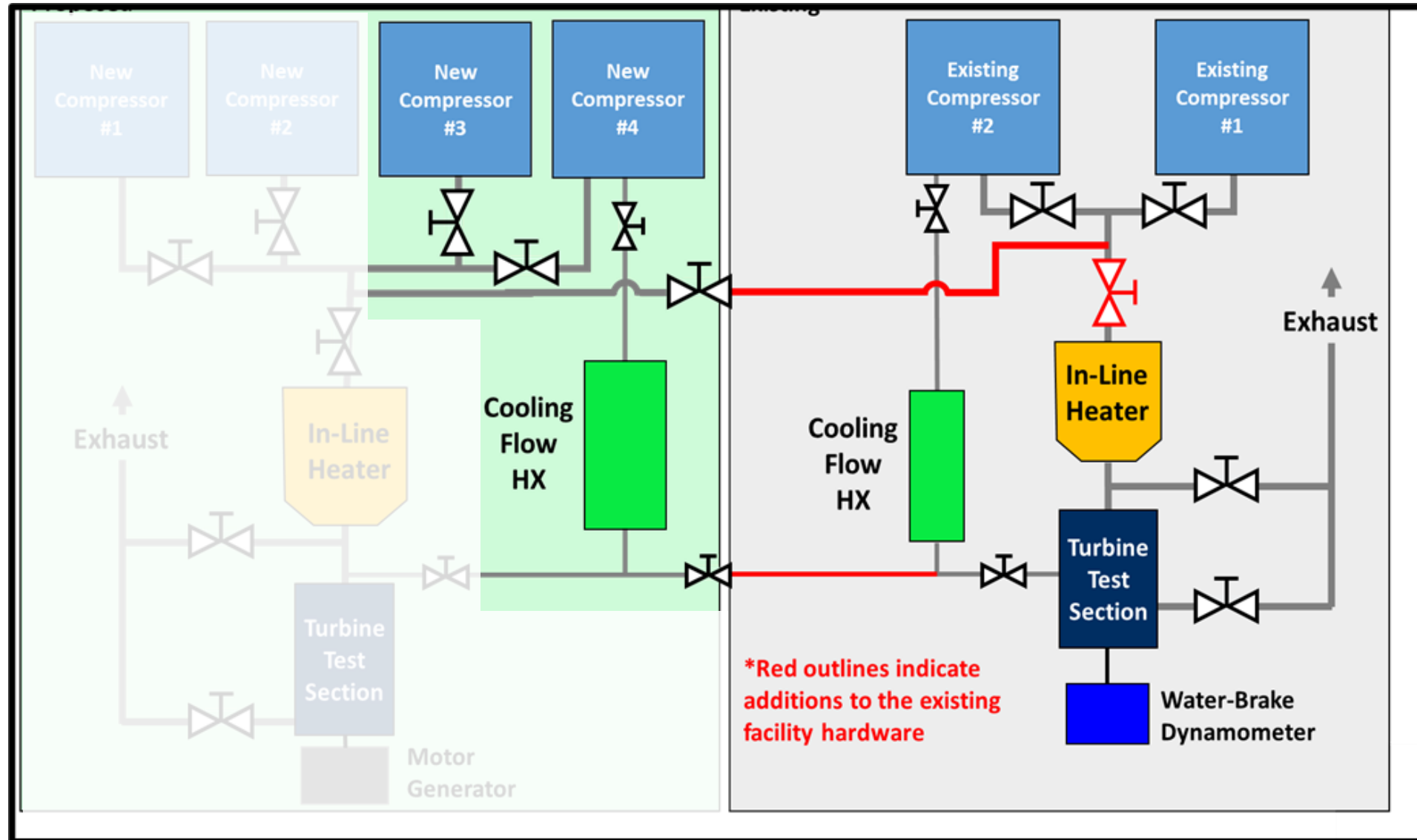
- Increase Flow and Pressure Capacity to START
- Relevant Turbine Inlet Profiles
- CMC Second Stage Vane



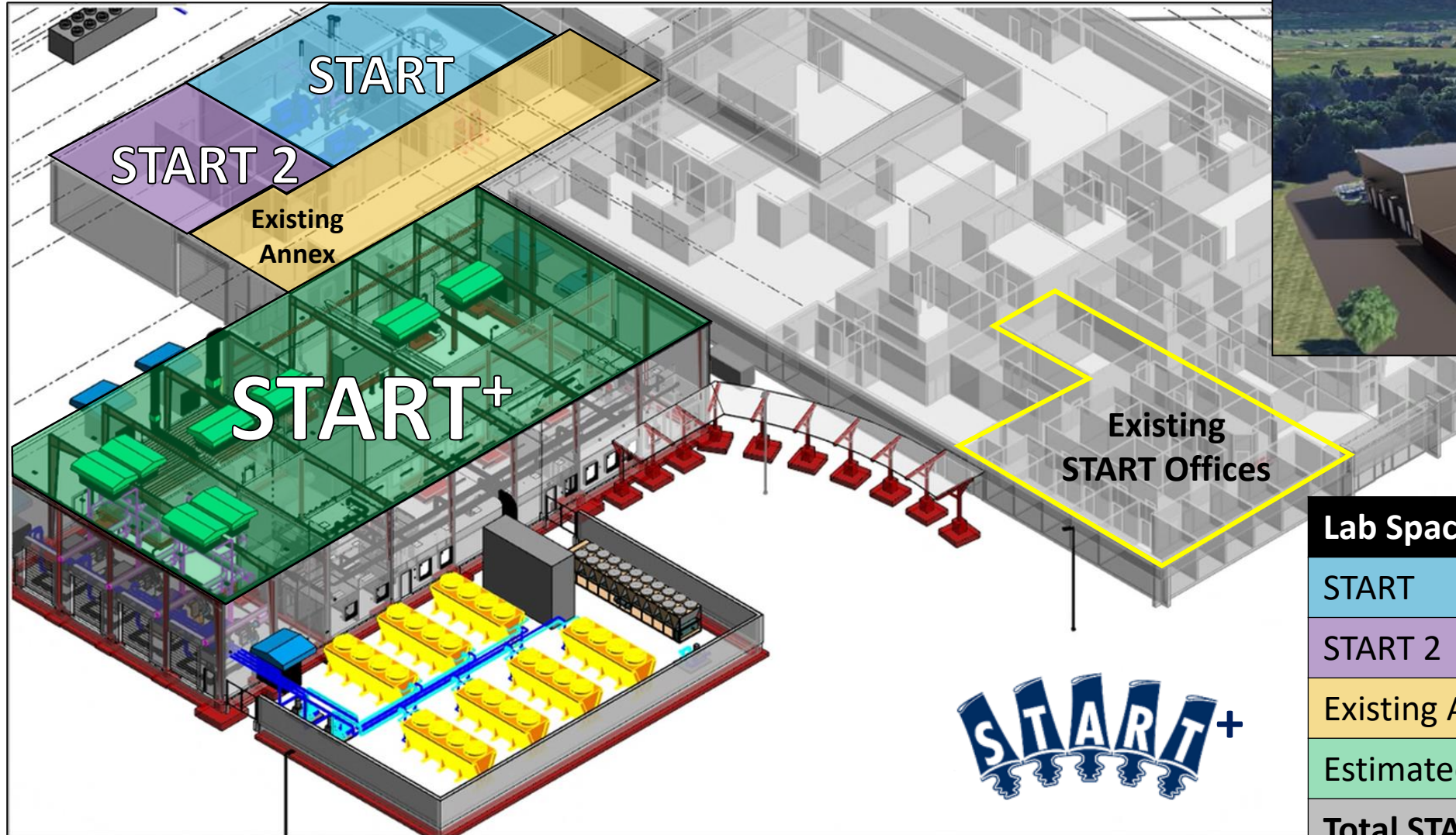
New compressors will enhance the air supply capability of the existing START facility to enable a broader range of turbine operating conditions

New Addition

Existing



The design of the new lab addition is complete including the arrangement of the air compressors and equipment

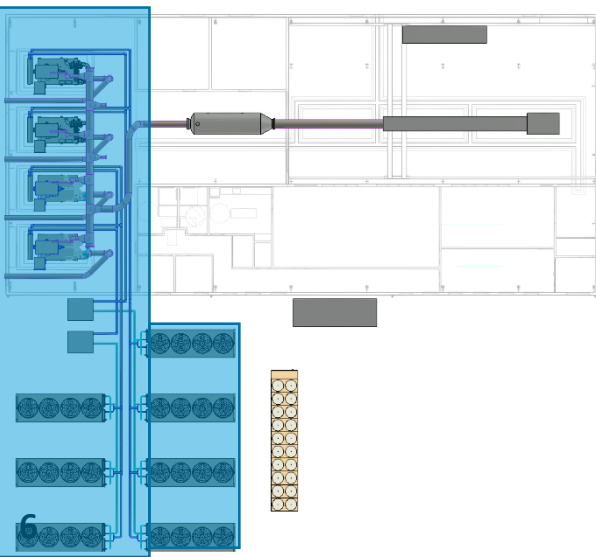


Lab Space	Size [ft ²]
START	4,800
START 2	3,000
Existing Annex	5,200
Estimated START+	13,000
Total START Complex	26,000

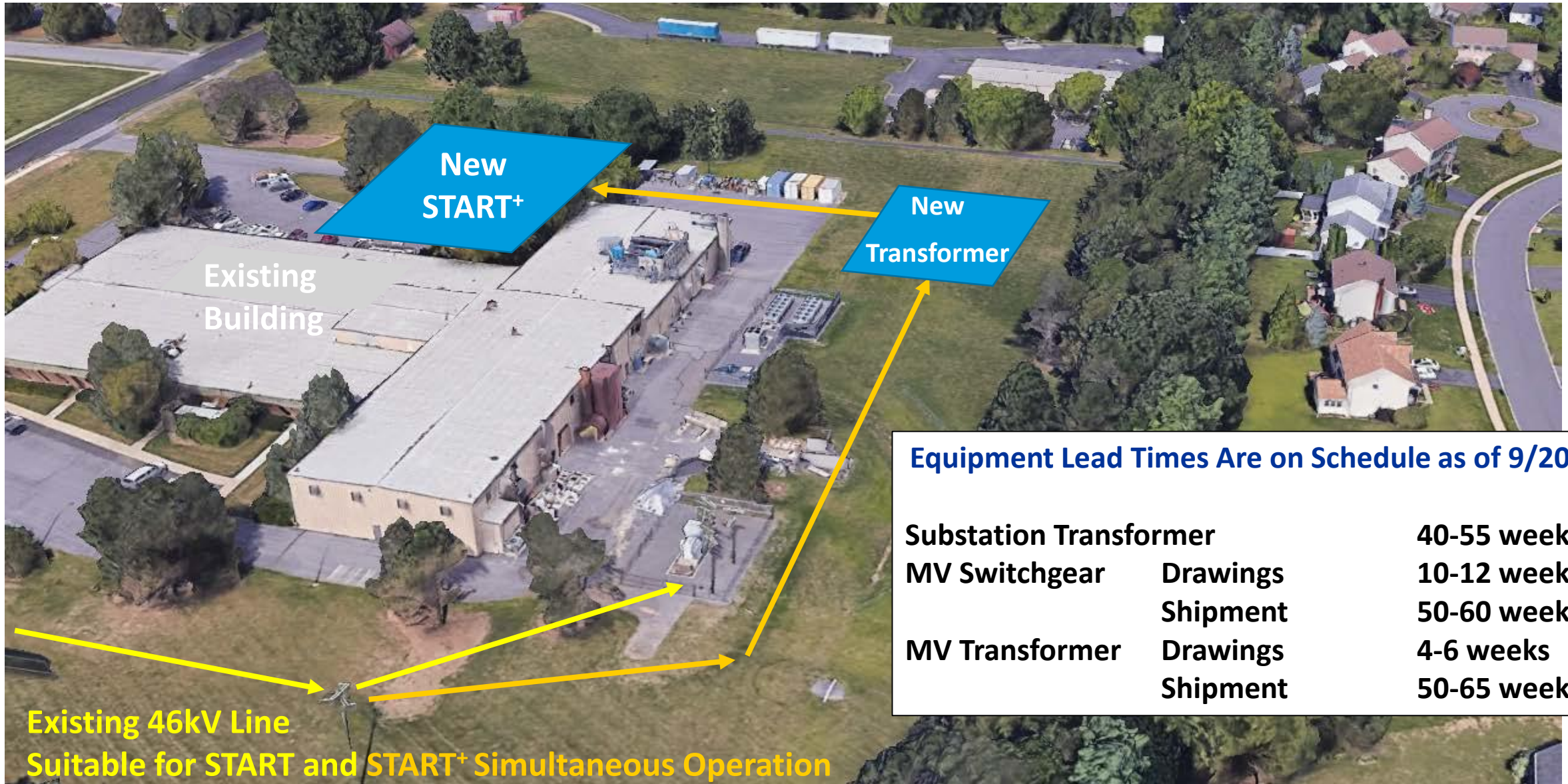


Our START team worked to complete the compressor specification with FS Elliott

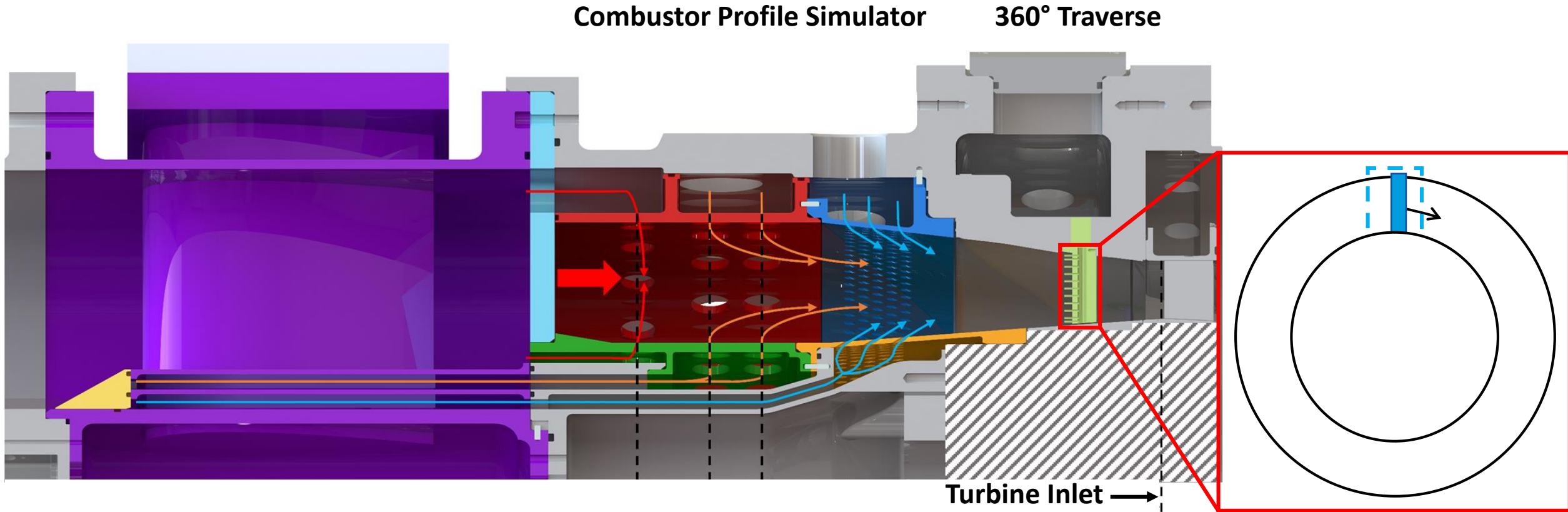
Compressor Specification	Existing START	START+
Compressor Stages	2	3
Total Horsepower	3000	9000
Flow Rate per Unit	12 lbm/s	12 lbm/s
Number of Compressors	2	4
Total Number of Coolers	2	7



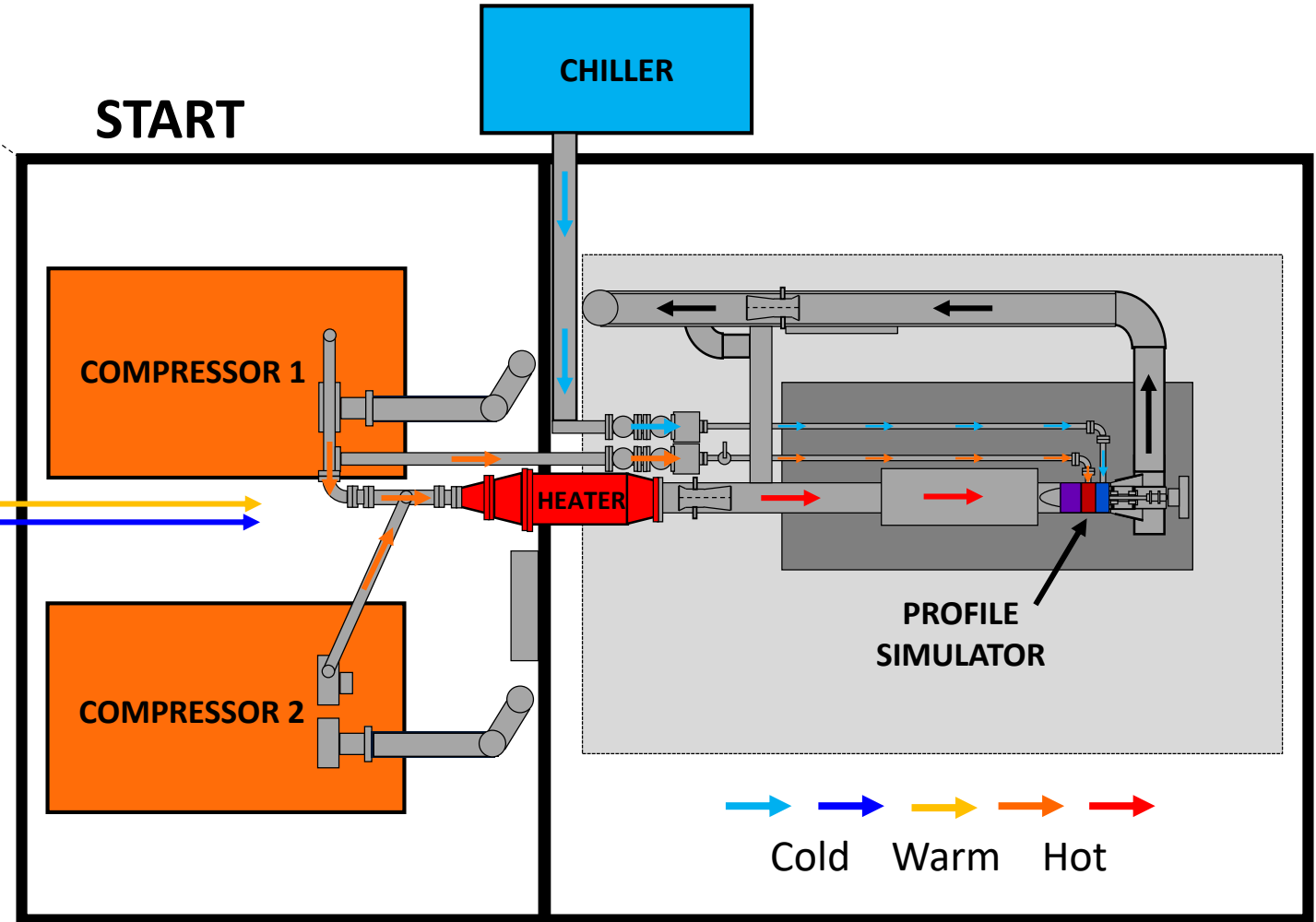
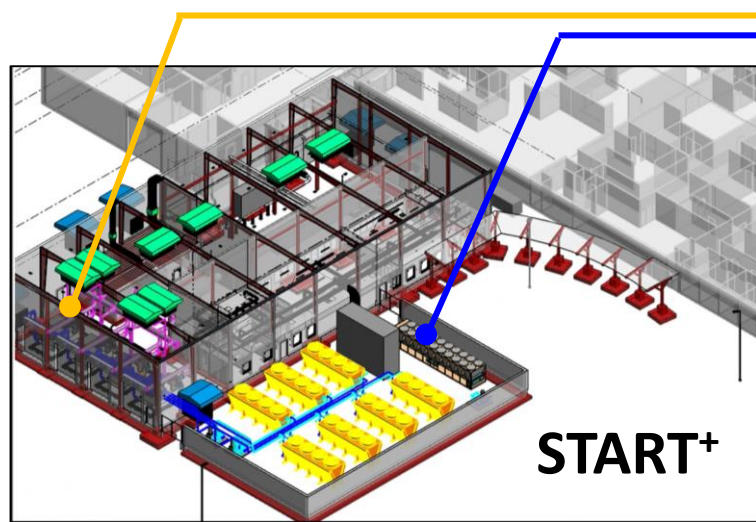
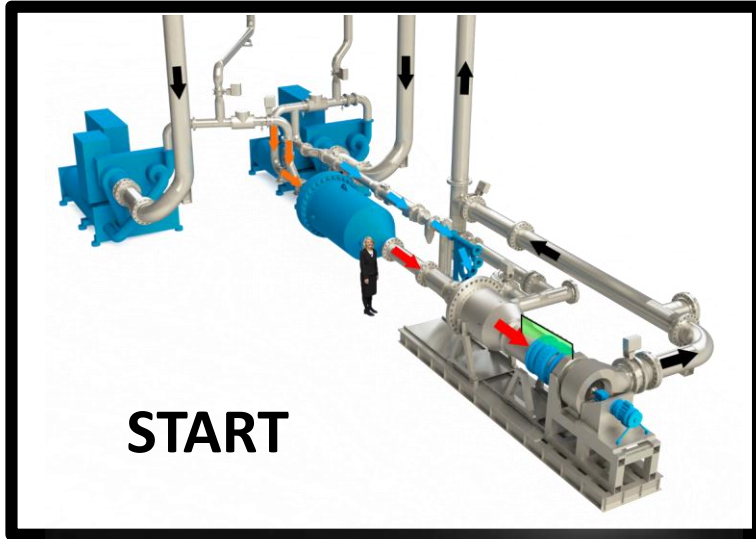
The new air compressors require additional high voltage power equipment, and lead times currently meet project schedule



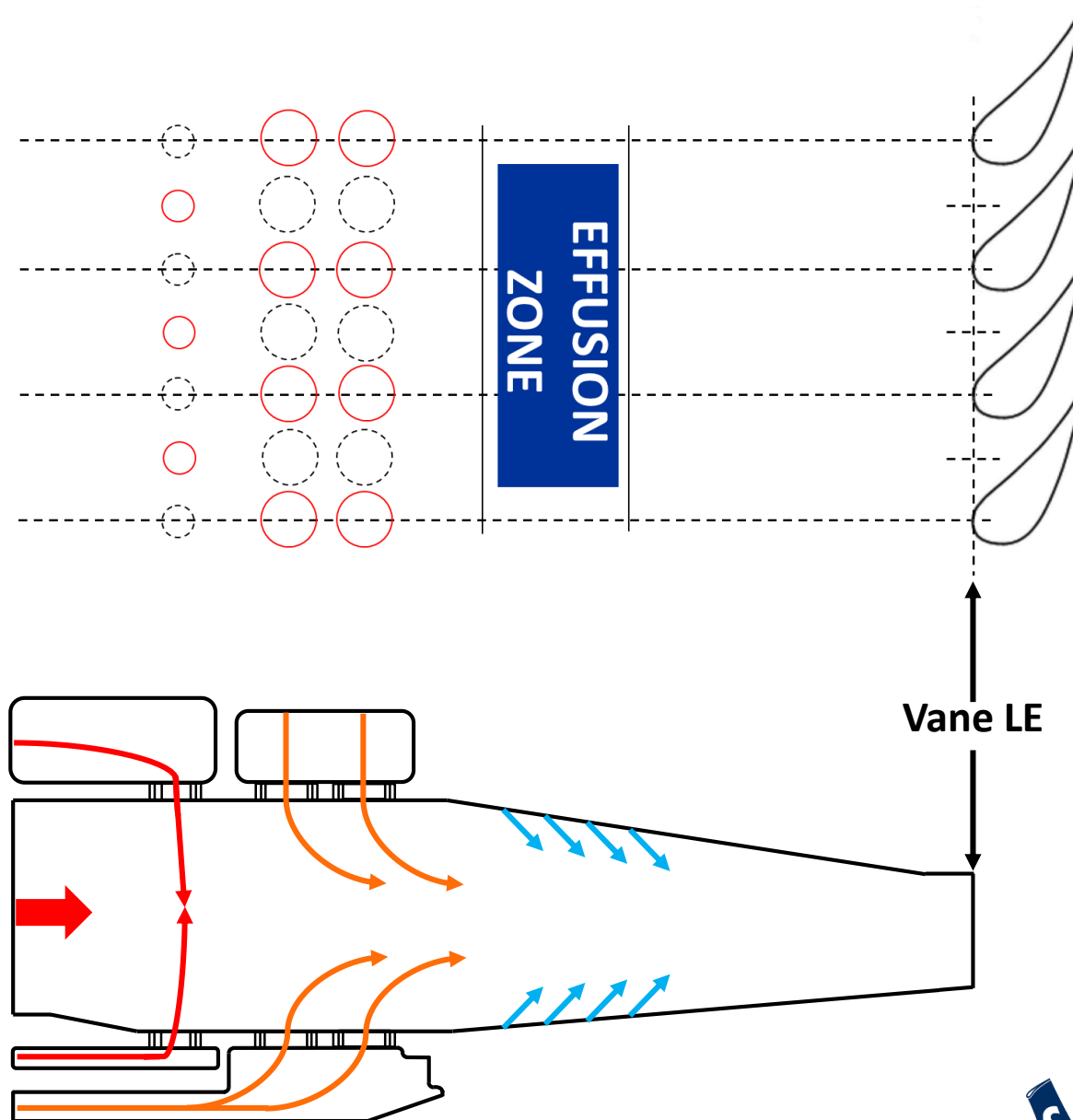
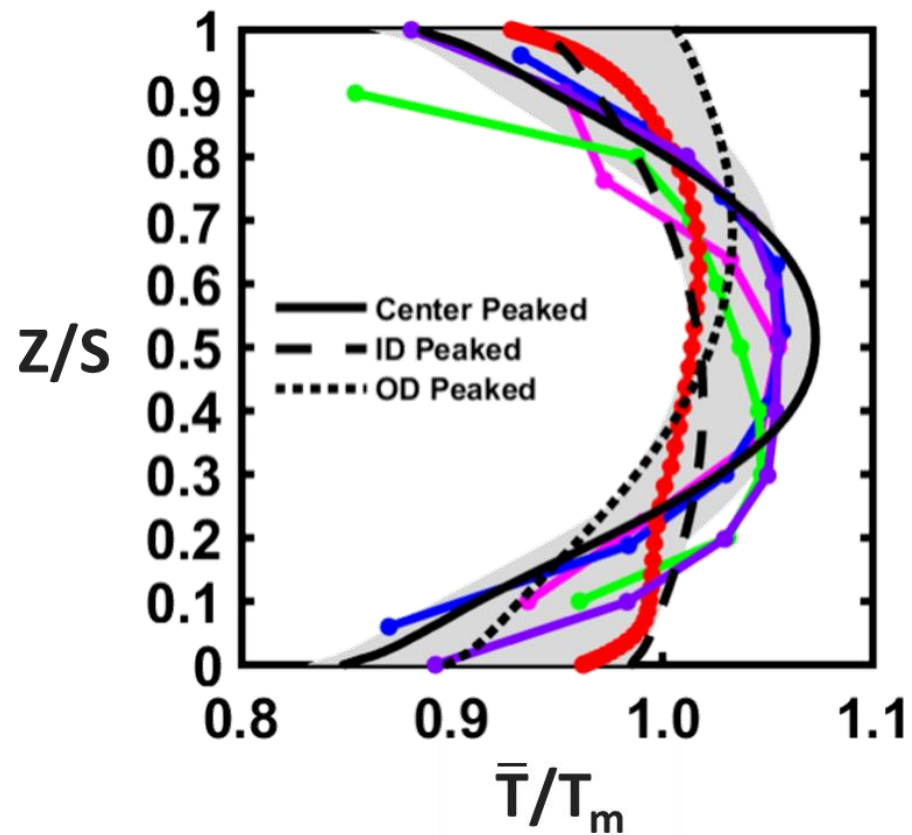
A detailed design has been developed to simulate different profile shapes at the inlet of the START test turbine



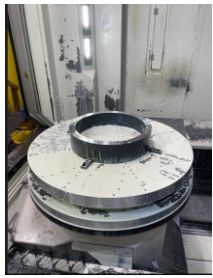
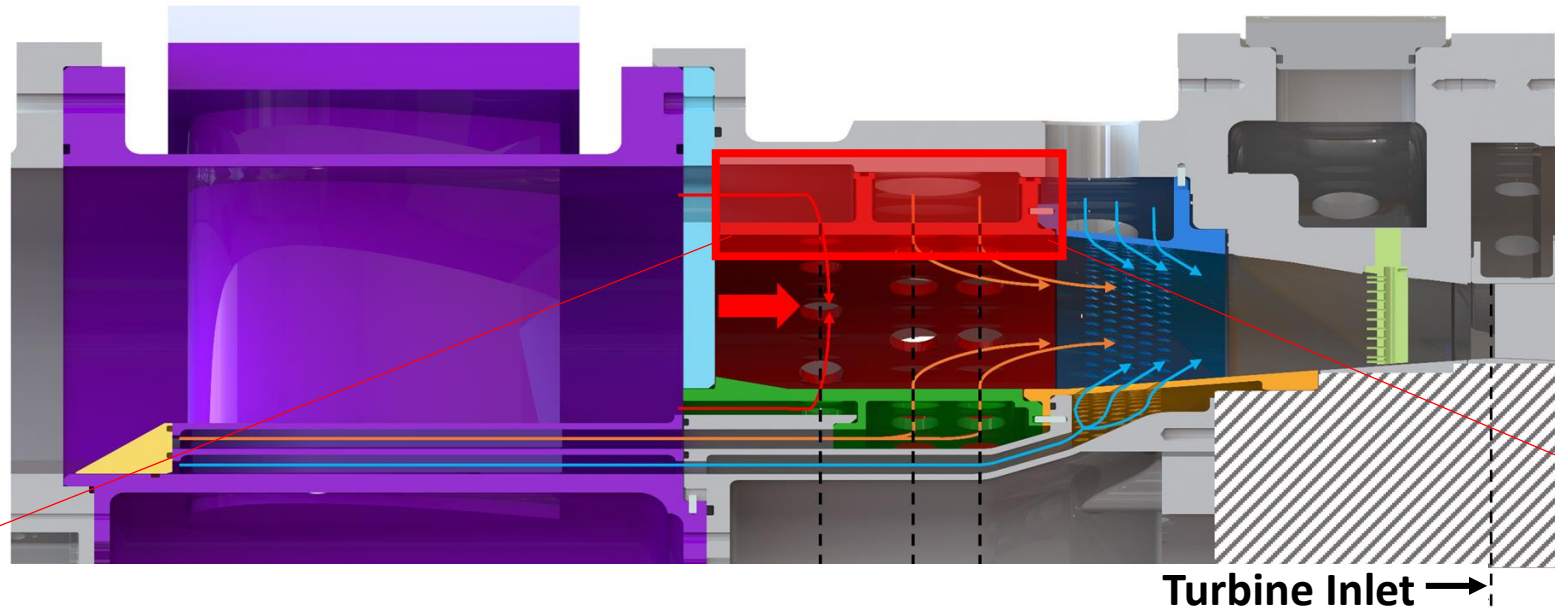
The simulator will use existing equipment and START+ capabilities to provide air flow at multiple temperatures for generating a range of inlet thermal profiles



Numerous CFD studies were conducted to determine operating envelopes



The combustor simulator hardware components are continuing to progress well through manufacturing stages and should be ready for installation in 2025

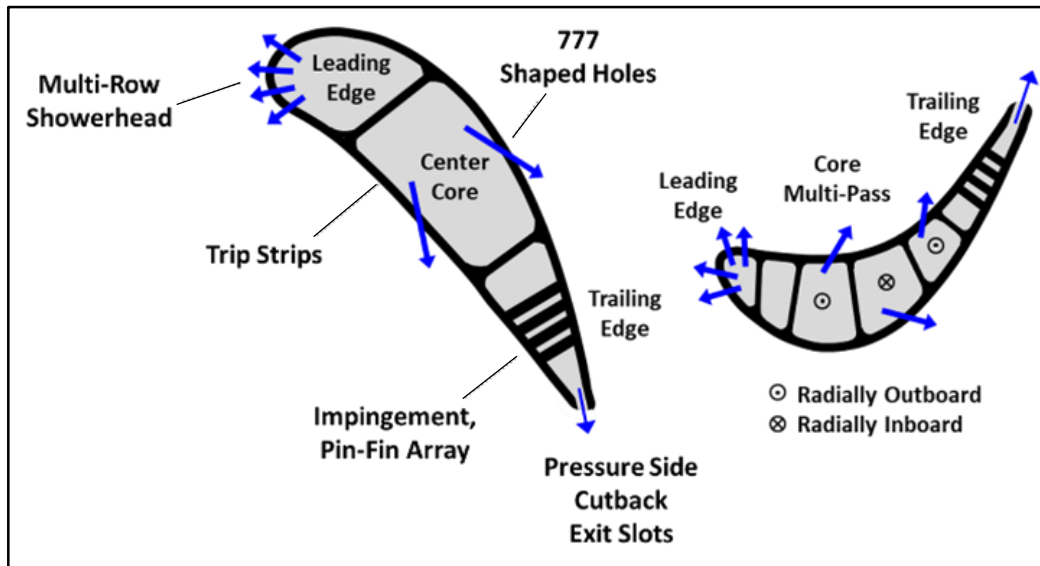


Inlet profile effects with the combustor simulator will be evaluated using the National Experimental Turbine (NExT) geometry as a primary research vehicle



A fully-cooled one-stage turbine geometry designed collaboratively for research utility

A shared learning vehicle for manufacturing, computational capabilities, and turbine performance



[Thole et al., 2020]



The National Experimental Turbine (NExT) program continues to pay dividends to the turbine community and the OEM partners



Solar® Turbines
A Caterpillar Company

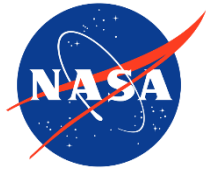
Honeywell

SIEMENS
energy

AEROSPACE

AGILIS

NExT research continues with OEM partners, including two funded proprietary projects to-date



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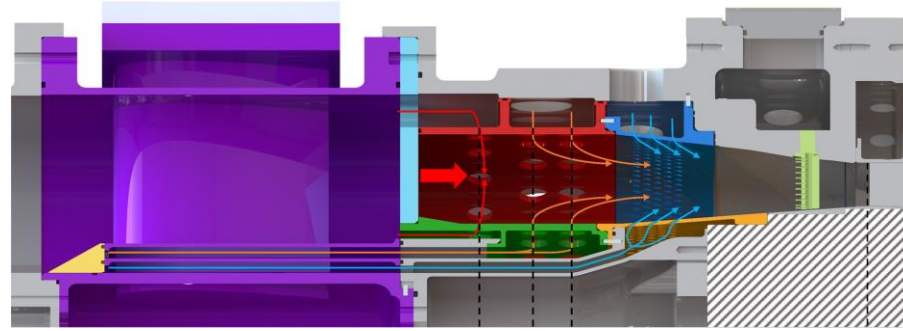


ASCENT
AVIATION SUSTAINABILITY CENTER

A broad partnership of government agencies is well-engaged behind the NExT leadership of NETL

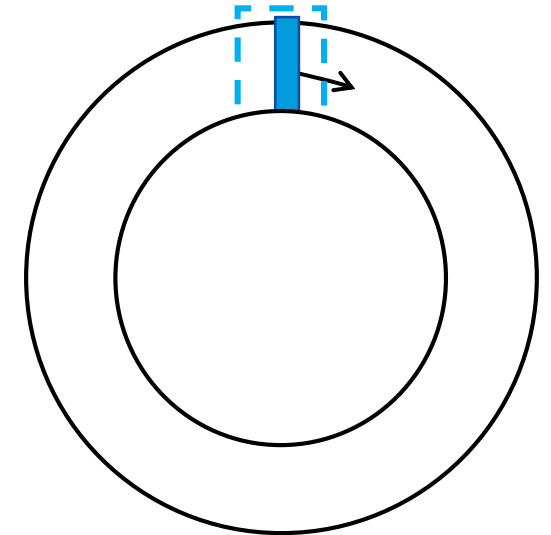
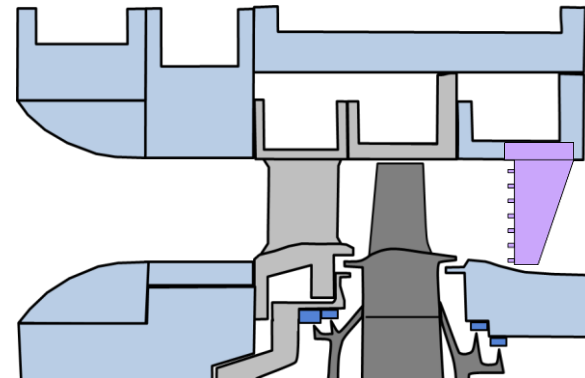


Turbine profiles effects will be measured using established instrumentation methodologies that underpin aerothermal research expertise in the START Lab

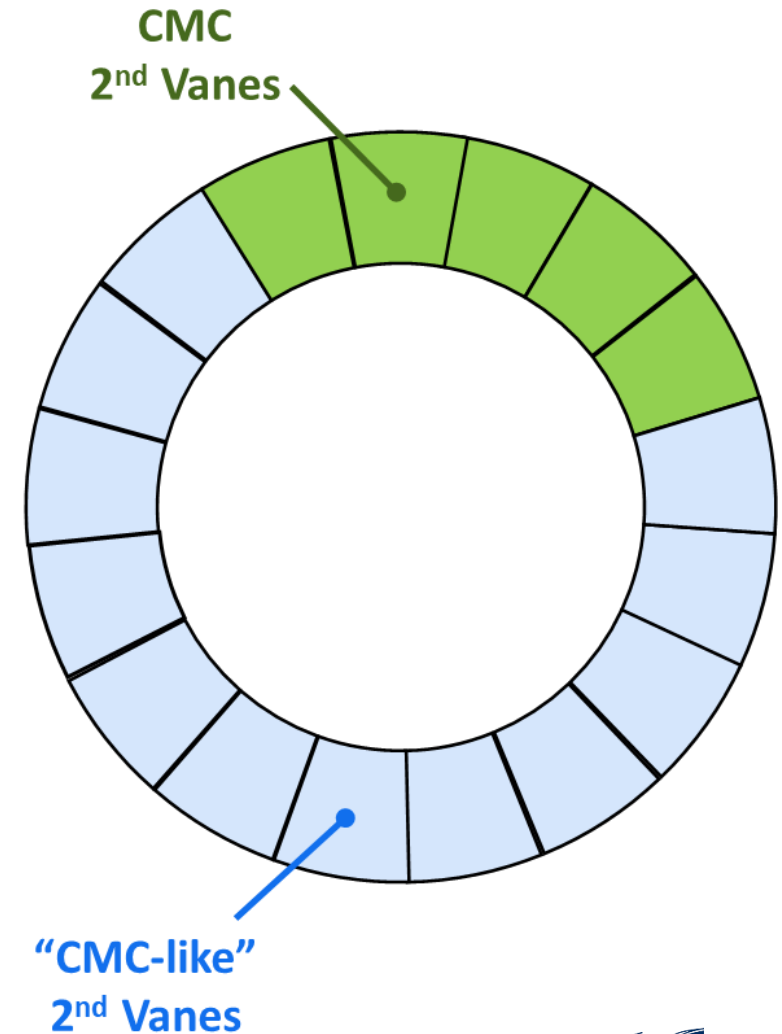
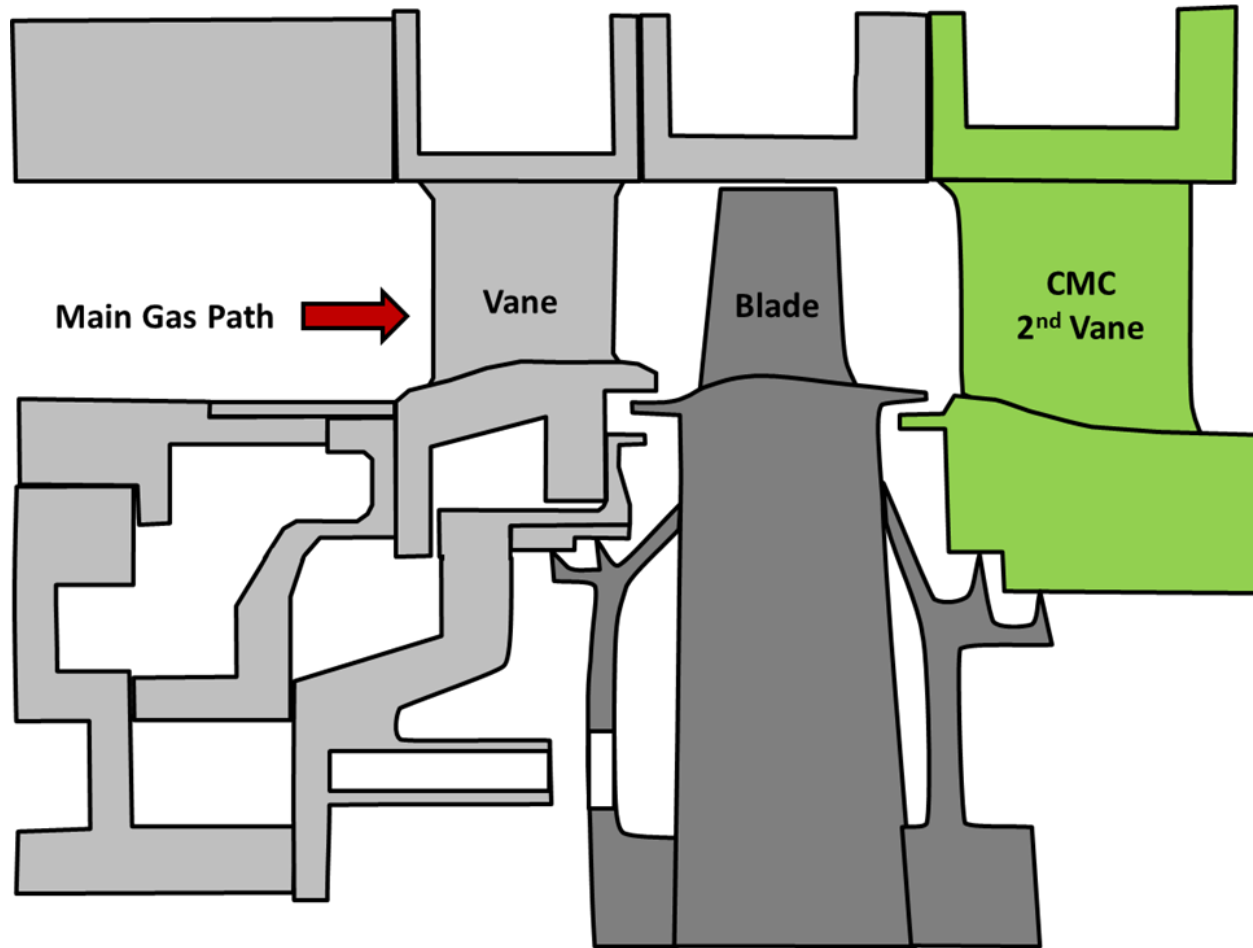


Blade heat transfer

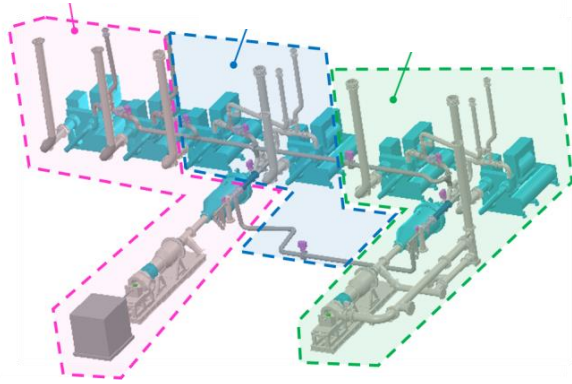
Stage thermal efficiency



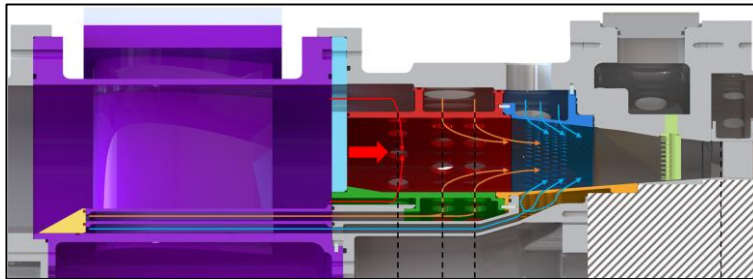
A CMC 2nd vane will be integrated into the existing START facility and evaluated for 1.5-stage turbine efficiency effects due to CMC-unique design characteristics



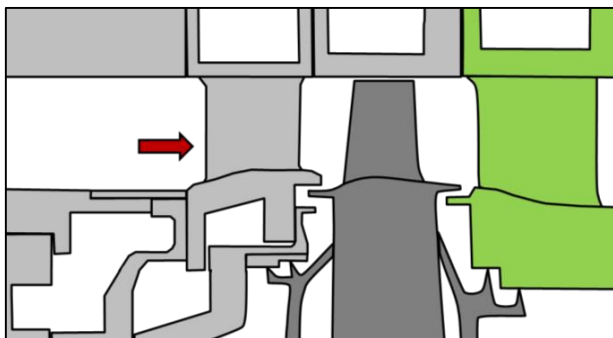
This project with DOE-NETL is enabling new opportunities that are important for the future advancement of turbine power generation needs



START⁺ will be a new facility that enhances existing START Lab research capabilities while also supporting a new 2-stage turbine



A new inlet profile generator will be complete in FY25 to experimentally demonstrate relevant turbulence BCs and temperature profiles for H₂



The installation of CMC-2V hardware will create new learning enabling integration of high-temp materials for future turbine designs