Introduction to ANSYS FLUENT®

MAE 6230
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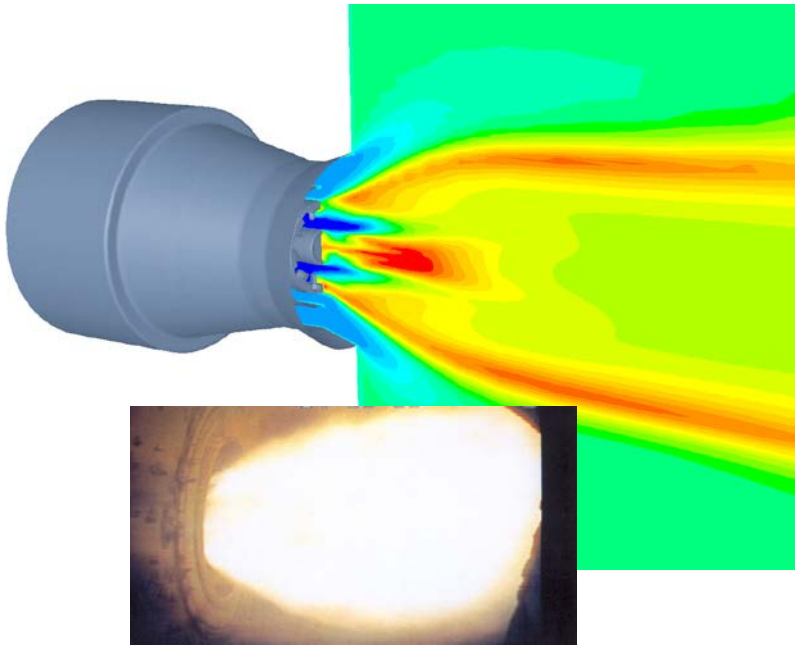
  - M 3:30-4:30 pm, R 3:30-4:30 pm, F 2:30-3:30 pm

Where to get these slides?

- https://confluence.cornell.edu/display/SIMULATION/files

ANSYS Inc.

- One of the leading commercial simulation software companies
- Founded by Cornell alum Dr. John Swanson in 1970
- FLUENT was acquired by ANSYS Inc.
  - Incorporated into ANSYS Workbench framework

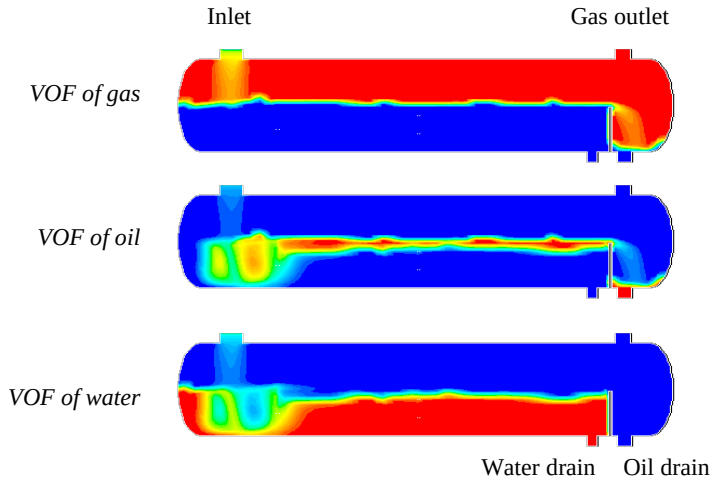


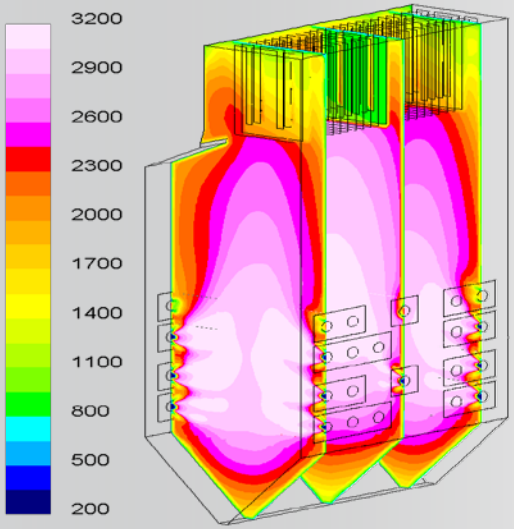
Introduction

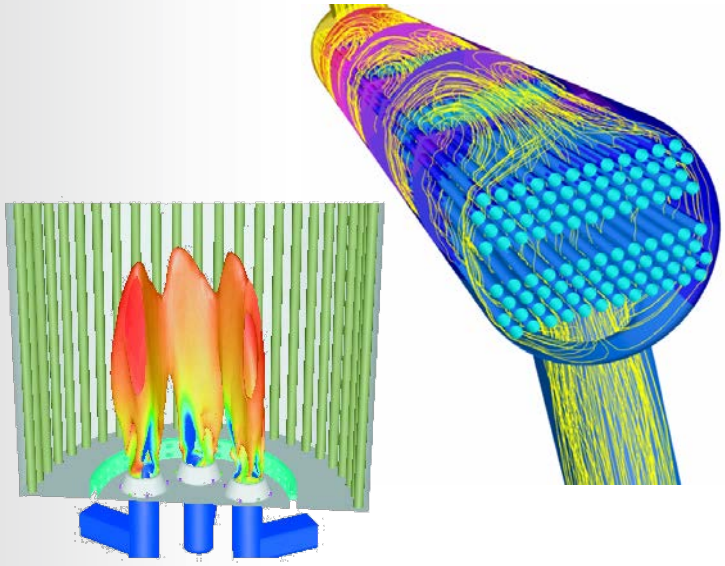
- The applications encountered in the power and energy industry are very diverse and challenging
  - Energy and Power Generation
    - Fossil fuel
    - Renewable energy
  - Energy Efficiency
    - Energy reduction, re-use and conservation
    - Product optimization and increase energy intensity
  - Environment
    - Pollution reduction and control
    - Carbon separation and capture

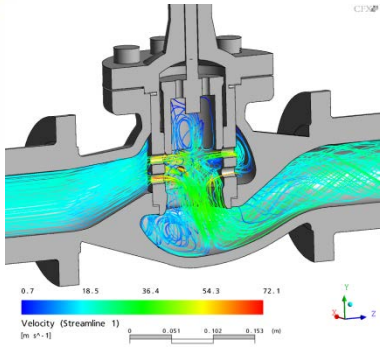
Client Problems in Power and Energy Industry

- Equipment design
- Equipment optimization
- Retrofit
- Troubleshooting
- Energy reuse and reduction
- Pollution capturing



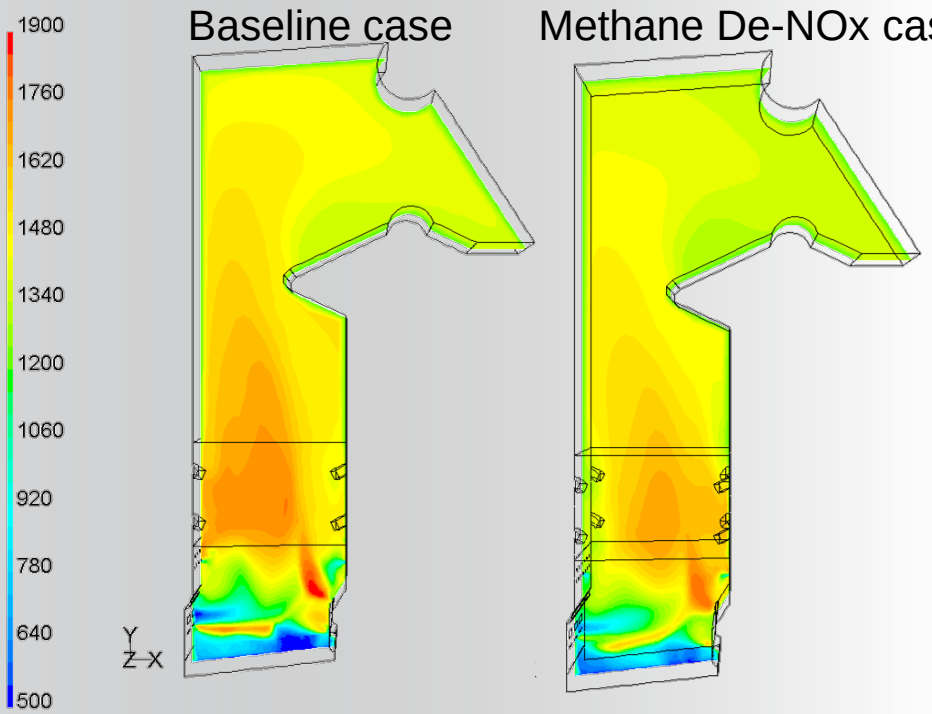






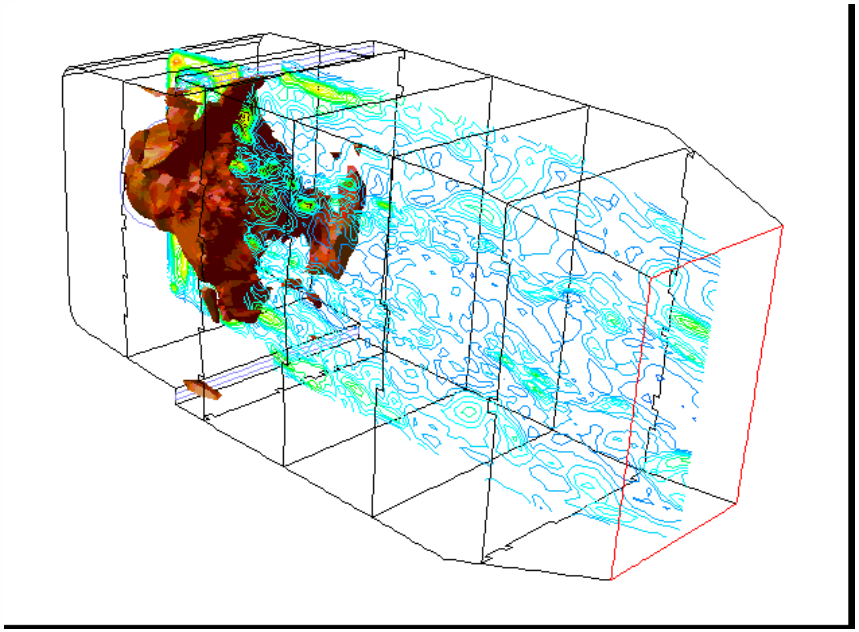
Various Applications (1)

- **Industrial Boiler**



Courtesy of: Gas Technology Institute
and Reaction Engineering International

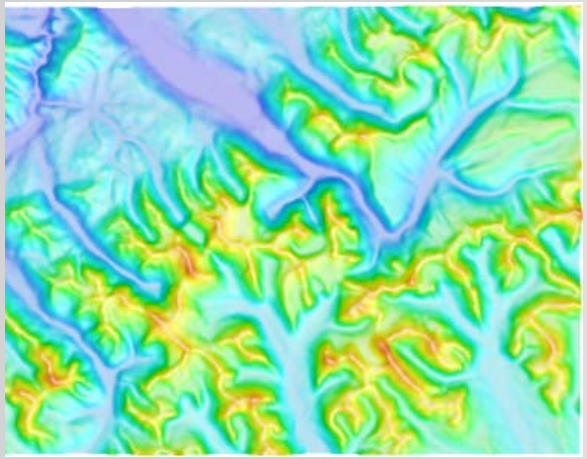
- **Gas turbine**

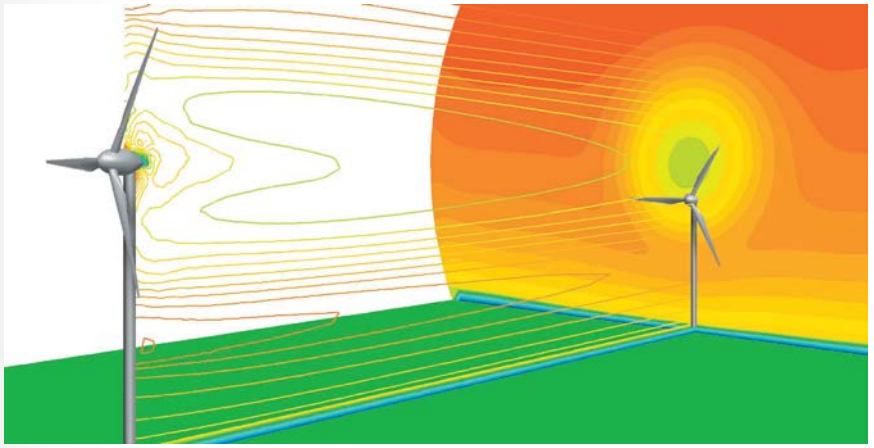


Courtesy of General Electric

Various Applications (2)

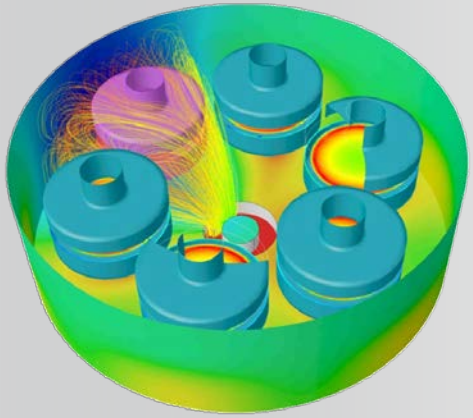
- **Wind energy: site selection (terrain modeling), blade design, shadow effect…**

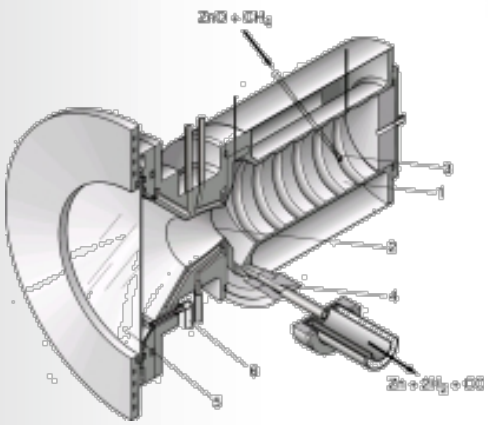


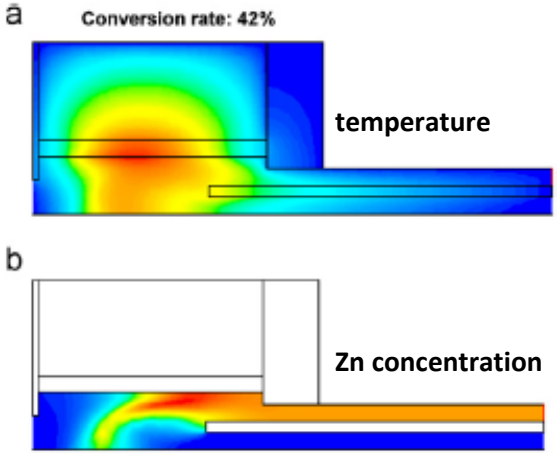


T. Hahm, J. Kröning, In the Wake of a Wind Turbine, Fluent News, Spring 2002

- **Solar energy: Equipment, wafer level, cell level, panel level…**

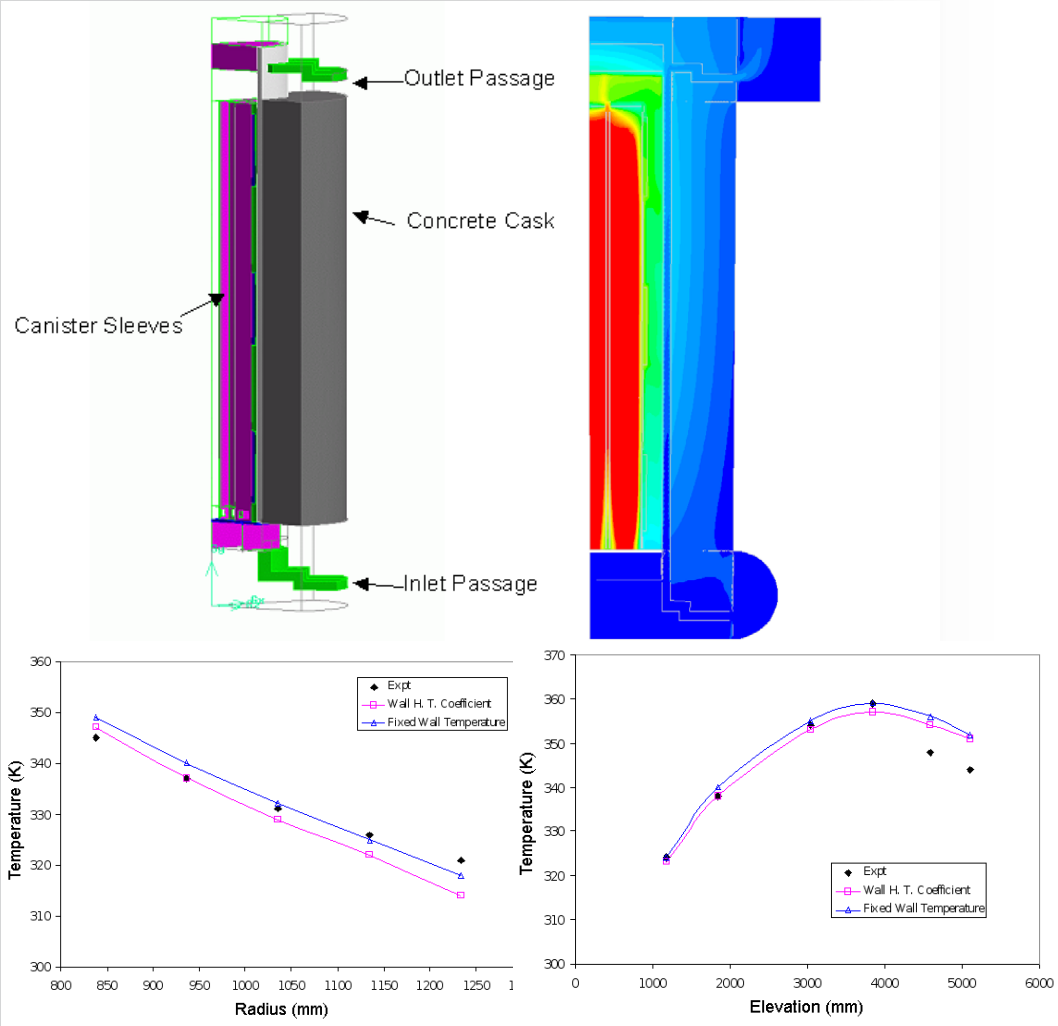




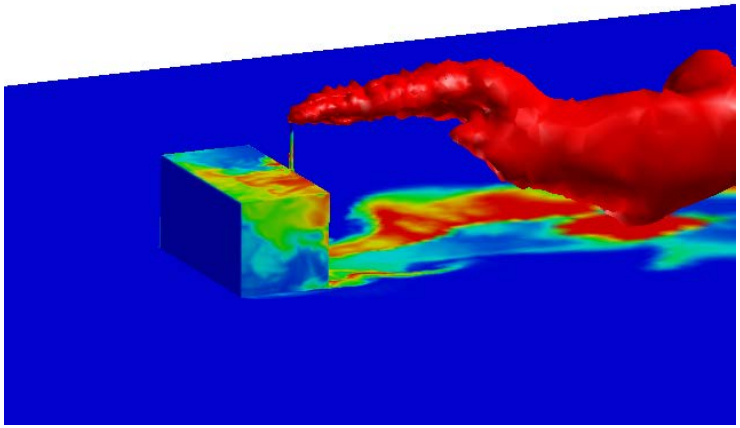


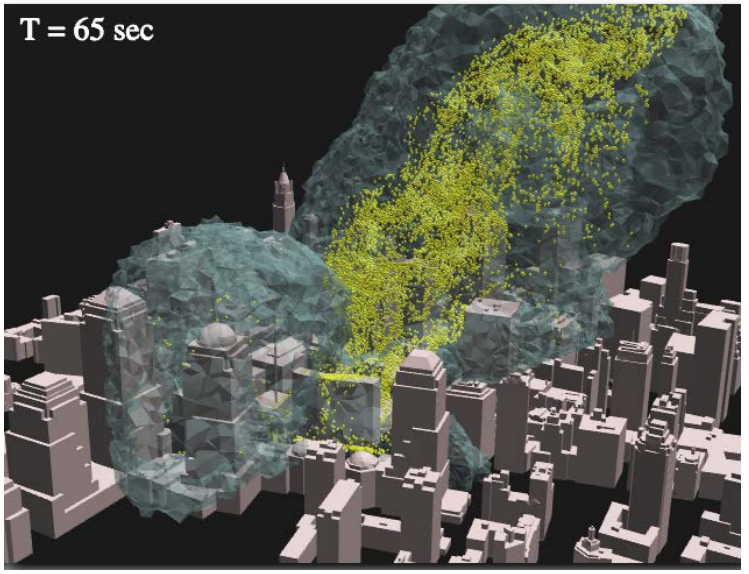
Various Applications (3)

- **Nuclear power**



- **Pollutant dispersion**

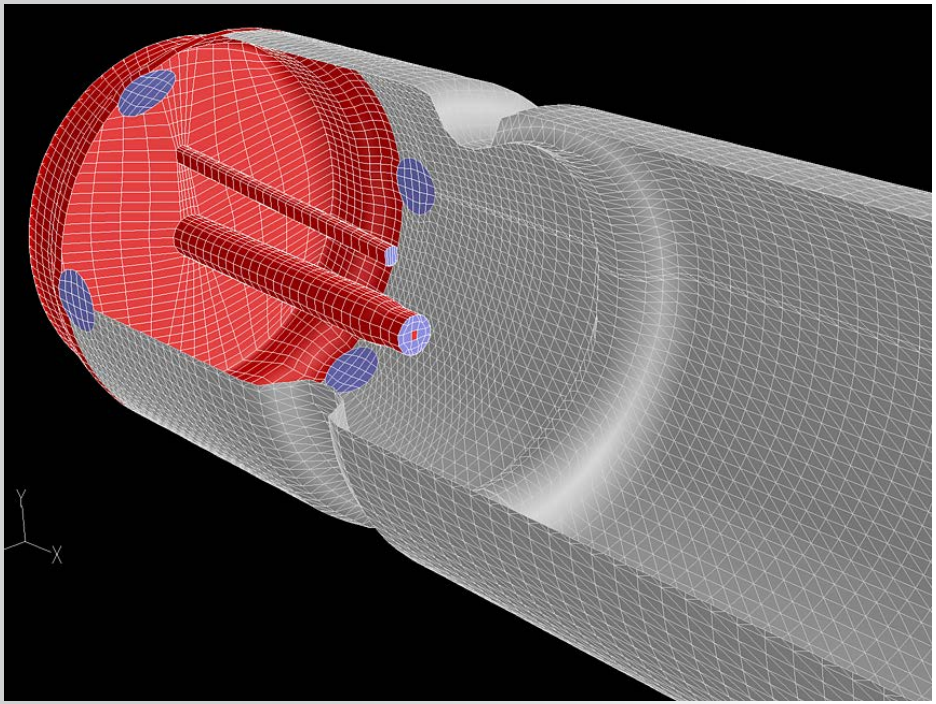




Lime Kiln Burner Retrofit (1)

Study of burner positioning

- **to reduce refractory wear**



Courtesy of Coen Company

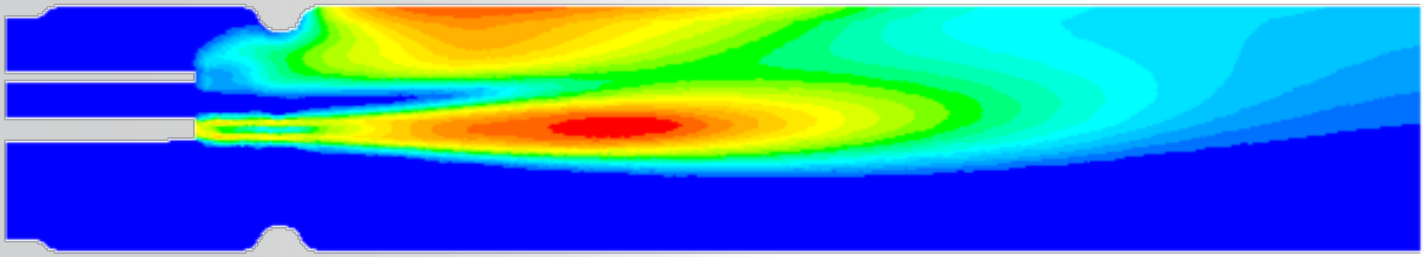
"Fluent's CFD software was extremely useful in developing a design that worked as expected. This helped us to minimize the amount of post-installation adjustments, saving thousands of dollars on the project."

Ken Camino, Coen Company

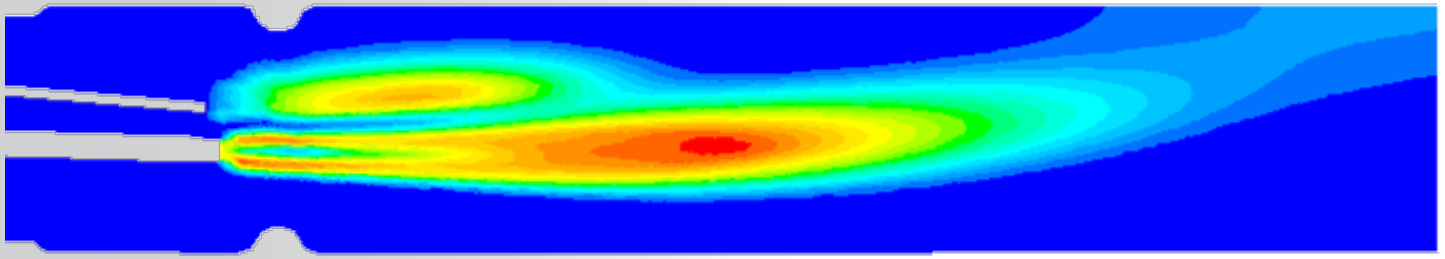
Kiln Burner Retrofit (2)

Main burner and waste gas gun were reoriented, based on CFD predictions

before

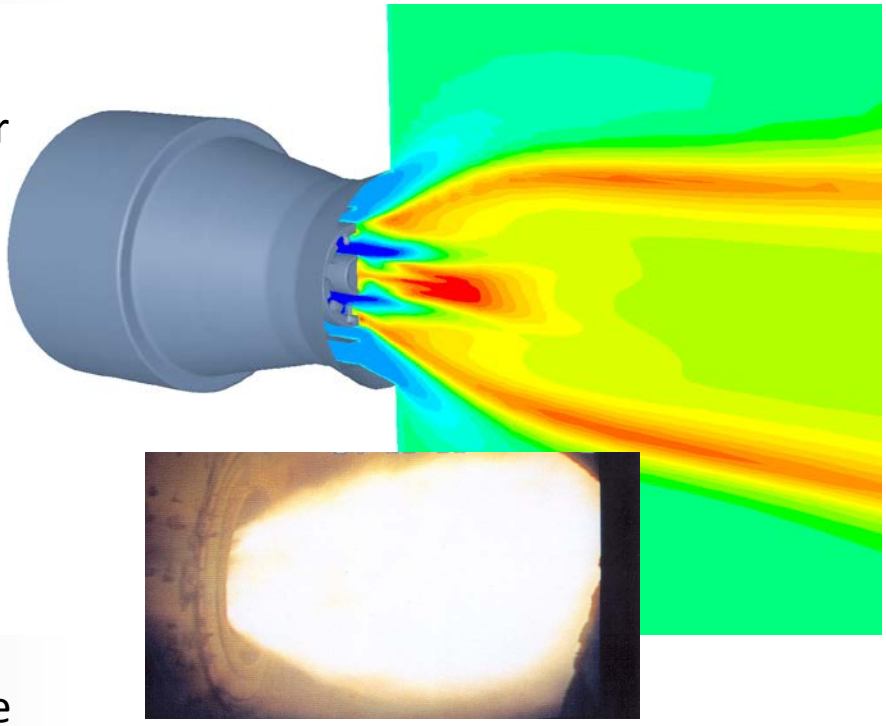


after



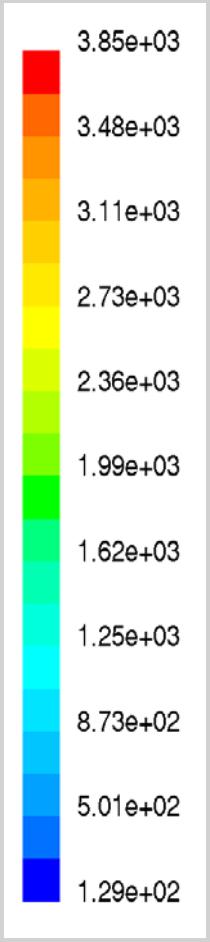
Low NOx Burner

- Minimizing generation of pollutants in combustion process is sometimes more cost effective than post-combustion treatment
- Flow modeling can be a very valuable tool for virtual prototyping of low NOx burners
- Methodology should be validated
- GE EER Approach:
  - Apply CFD to predict low-NOX burner performance in 3D full-scale burner test furnace.
  - Use model to predict impacts of load, coal type, and burner operation (tertiary air swirl strength) on flame shape, stability, and NOx emissions.
  - Compare model predictions to test furnace input/output results.

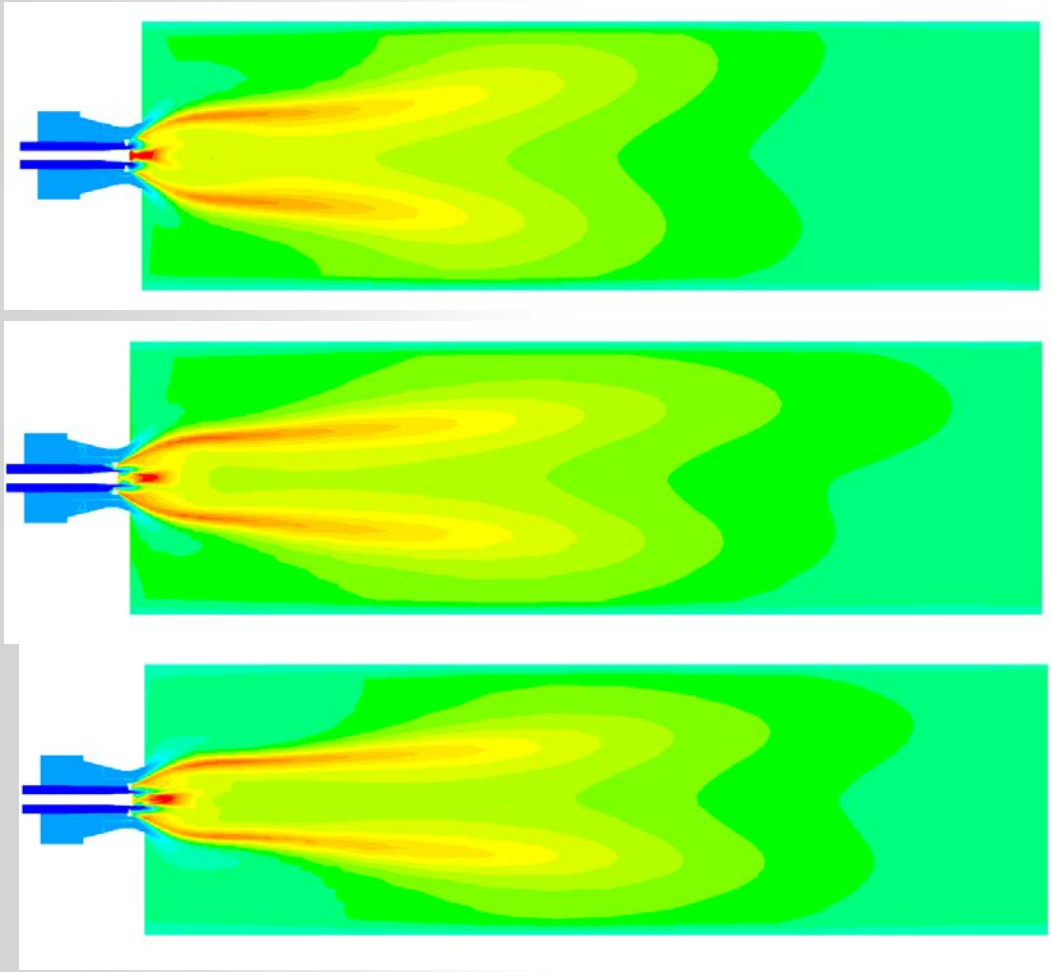


Courtesy of GE Energy and Environmental Research

Temperature Profiles



T, deg. F

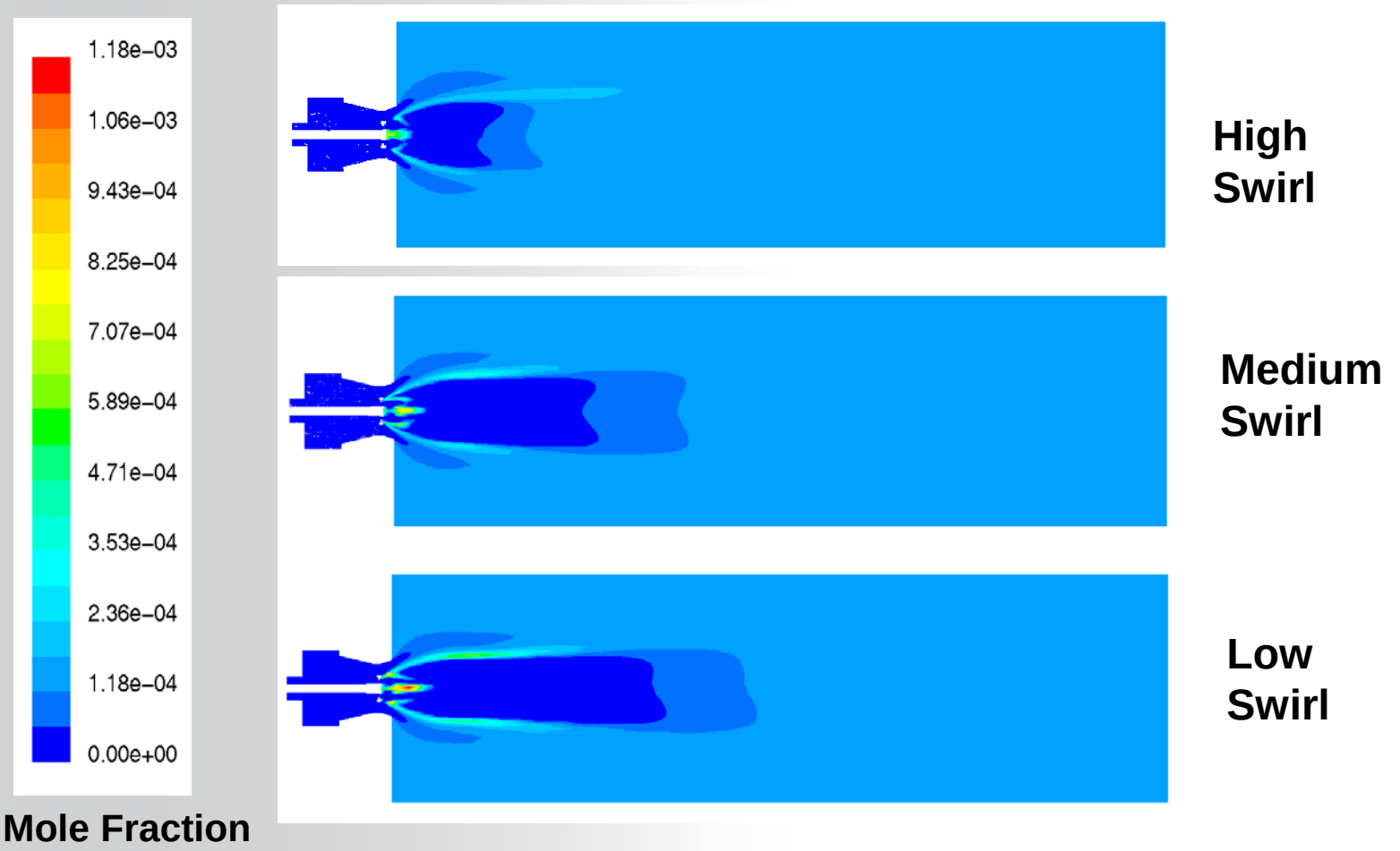


High Swirl

Medium Swirl

Low Swirl

NOx Concentration Profile



Low NOx Burner Input/Output Comparison

Parameter	Value	Measurements					CFD Predictions				
		FEGT deg. F	O2 %	CO2 %	CO ppm	NOx ppm	FEGT deg. F	O2 %	CO2 %	CO ppm	NOx ppm
Load (MW)	23.2	1,532	3.83	14.4	66	175	1,580	3.94	15.3	63	149
	27.9	1,580	3.38	15.1	46	191	1,598	3.48	15.6	39	163
	34.2	1,735	3.68	14.9	12	256	1,634	3.76	15.3	22	258
TA Swirl	-150	1,642	3.05	15.0	31	205	1,602	3.16	15.8	47	162
	-100	1,592	3.48	14.8	40	221	1,561	3.59	15.5	65	168
	-25	1,580	3.38	15.1	46	191	1,598	3.48	15.6	39	163
Coal Type	US Bit.	1,580	3.38	15.1	46	191	1,598	3.48	15.6	39	163
	European Bit.	1,653	2.33	14.7	64	163	1,554	2.58	16.5	39	157
	S. African Bit.	-	2.12	14.5	26	205	1,612	2.23	17.4	31	220

CFD agrees well with experimental results

Computer Labs with ANSYS

- CIT public labs
  - B7 Upson
  - 318 Phillips
  - ACCEL lab in Carpenter Hall
- Swanson Lab (163 Rhodes)
- Store data on your own flash drive

Swanson Lab (163 Rhodes)

- 16 Dell T5500 workstations
  - 2 quad-core Intel Xeon 2.26GHz processors
  - 30 GB of RAM
  - Extensive software suite
    - ANSYS including FLUENT
    - MATLAB
    - CAD software: Solidworks, Creo/ProE
- Suitable for large finite-element models (> ~200k elements)

Accessing the Swanson Lab

- All students enrolled in MAE 6230 have been given access
- Get in by swiping your Cornell ID
- Log in using your netid
  - May need to activate your netid by going to *http://netid.cornell.edu/adactivation*
- Store data on your own flash drive
  - Hard drive gets wiped clean on reboot

Swanson Lab: What to do if you have access problems?

- May not have access if you added late
- Report access problems by e-mail to:
  - Rajesh Bhaskaran bhaskaran@cornell.edu
  - Patti Wojcik pmw27@cornell.edu
    - Can talk directly to Patti in 258 Upson (faster turnaround)

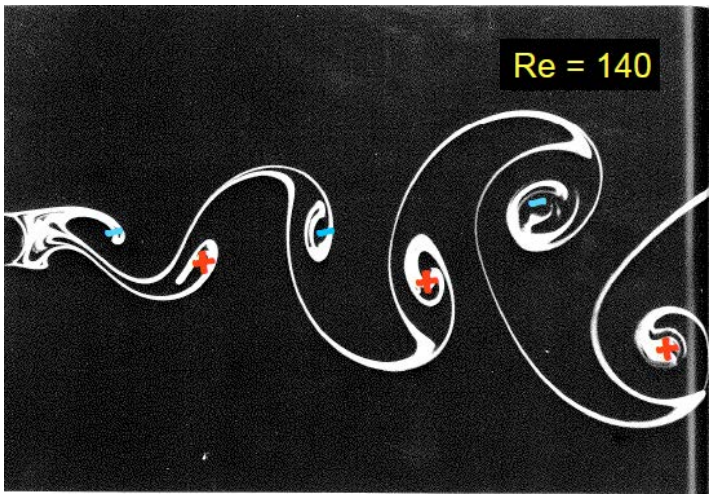
Learning FLUENT: *SimCafe* wiki

- Contains ANSYS and FLUENT tutorials from MAE classes and projects
- *https://confluence.cornell.edu/x/8IEaBQ*
- Or Google “cornell fluent”

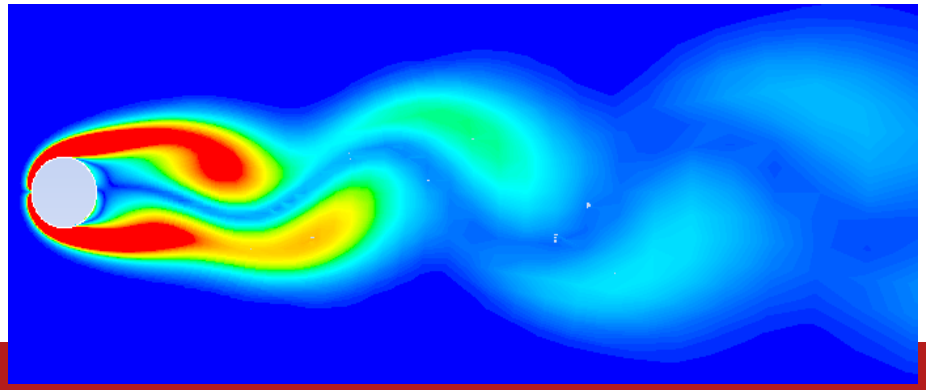
Learning ANSYS: ANSYS Customer Portal

- *http://www.ansys.com/customerportal/*
- Information necessary for registering:
  - Company name: *Cornell University*
  - Customer/Account Number: *248463*
- After registering and logging in, select "Training"
  - Contains materials from ANSYS Inc.'s customer training sessions

Cylinder

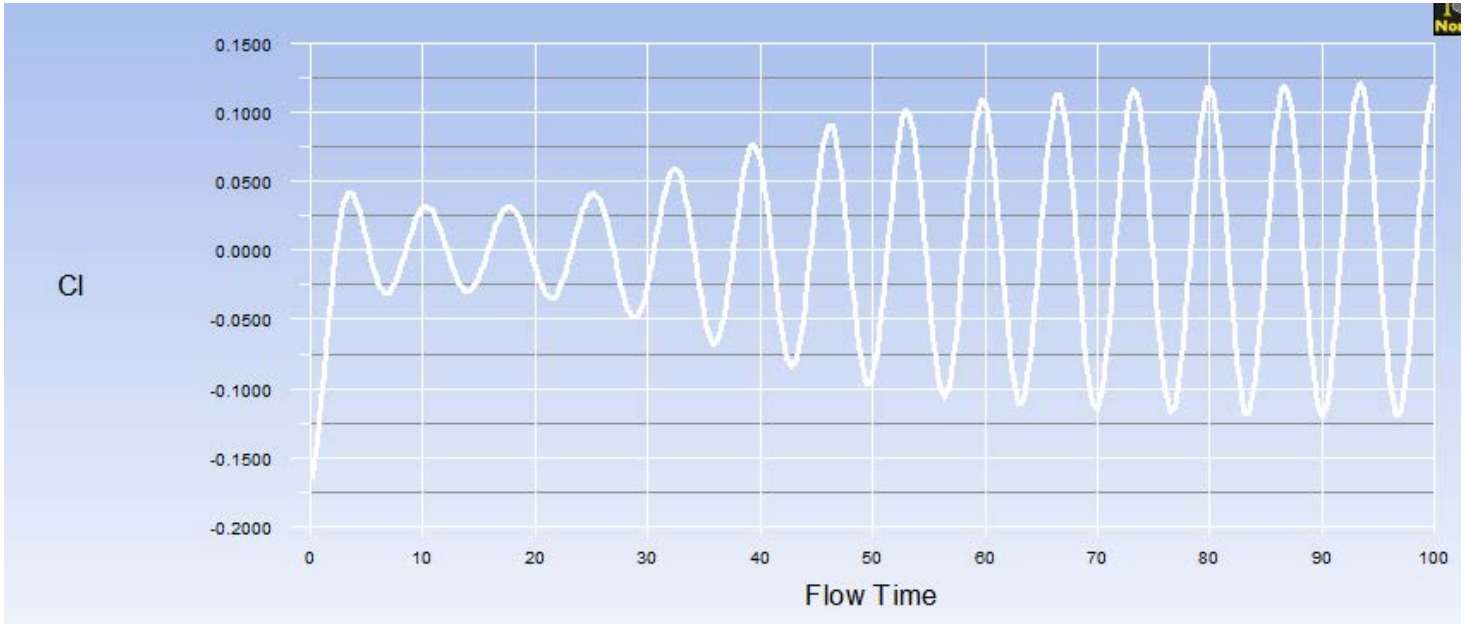


Re = 120
1000 time units



Cylinder

- Transient phase



Cylinder

- Oscillatory phase