Ceramic/Metallic Heat Exchanger Development

9th Annual SECA Workshop

Pittsburgh, PA.

August 7, 2008

Anthony F. Litka

Project Objective

- Combine ceramic and metallic heat exchanger cores to produce a low cost, high effectiveness, recuperator for cathode air preheating

Hybrid Recuperator Advantages

Metallic

Advantages

- Manufacturability
- Extended Surface
- Compactness
- Thermal Shock

Disadvantages

- High Cost
- Fouling/Oxidation

Ceramic

Advantages

- Low Cost Materials
- High Temp Stability
- Single Casting

Disadvantages

- Thermal Shock

Hybrid

Advantages

- Low Cost Materials Throughout
- Modular Manufacture
- Temperature Gradients on Ceramic are Reduced
- Materials Optimized for Temperature
- Thermal Expansion Unrestrained

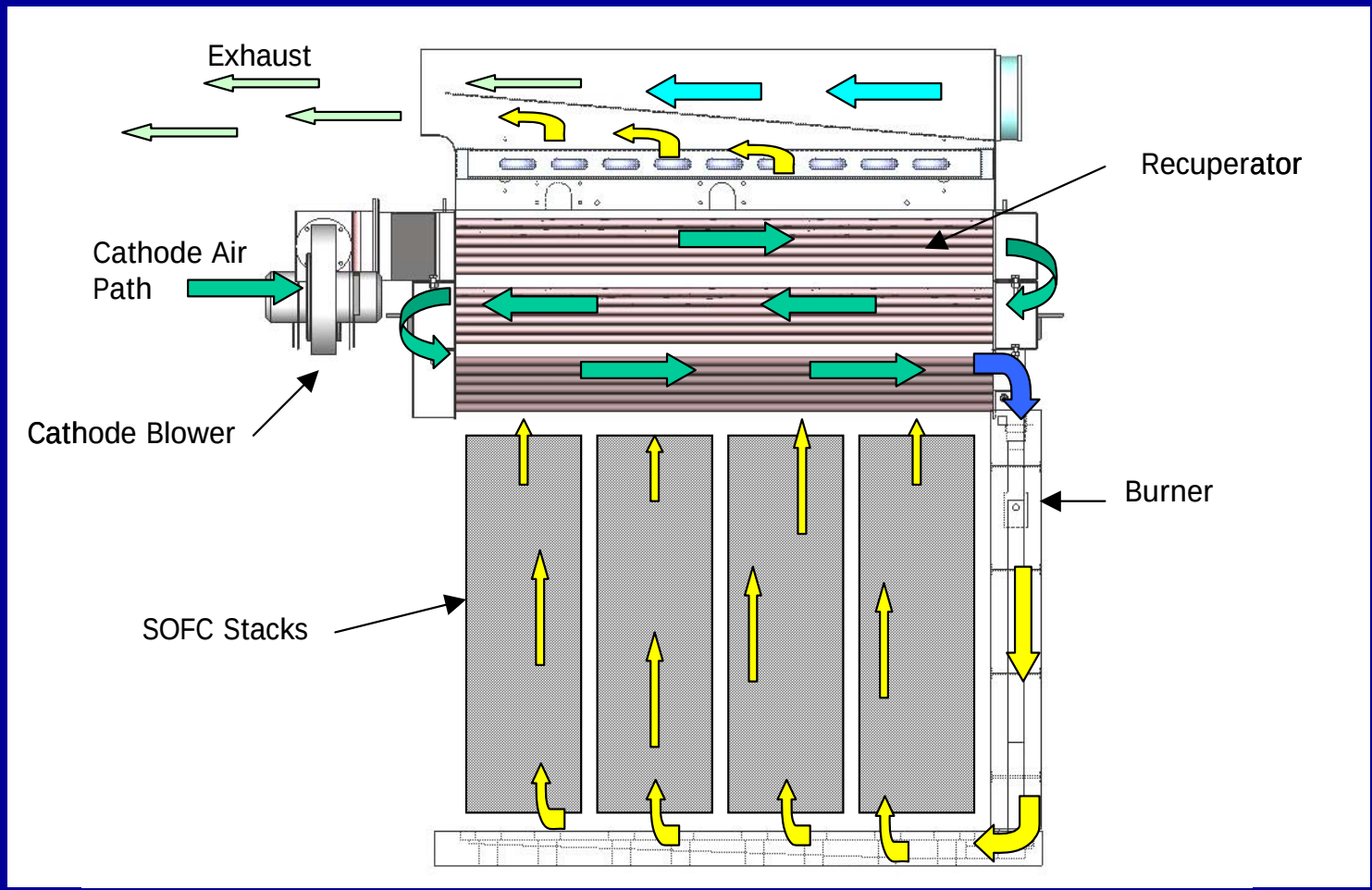
Acumentrics
Trusted Power Innovations

Recuperator Specification

- Exhaust Inlet Temperature – 850 – 950 C
- Air Outlet Temperature – 725 - 800 C
- Effectiveness – >85%
- Total Pressure Drop – 1250 Pa
- Equal Air and Exhaust Flowrates
- Air Flow – 150 lpm per kWe

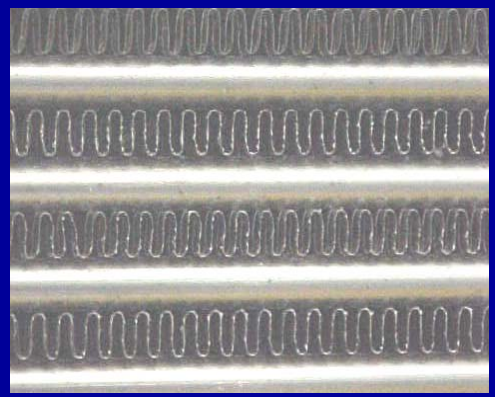
Acumentrics
Trusted Power Innovations

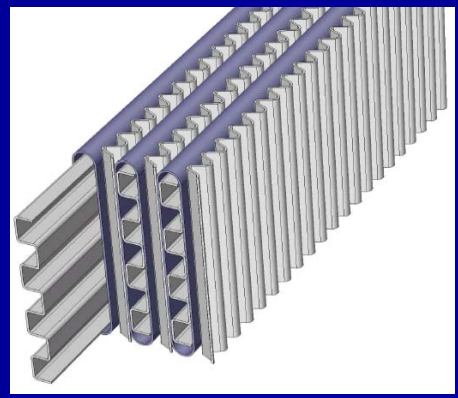
Initial Generator Configuration



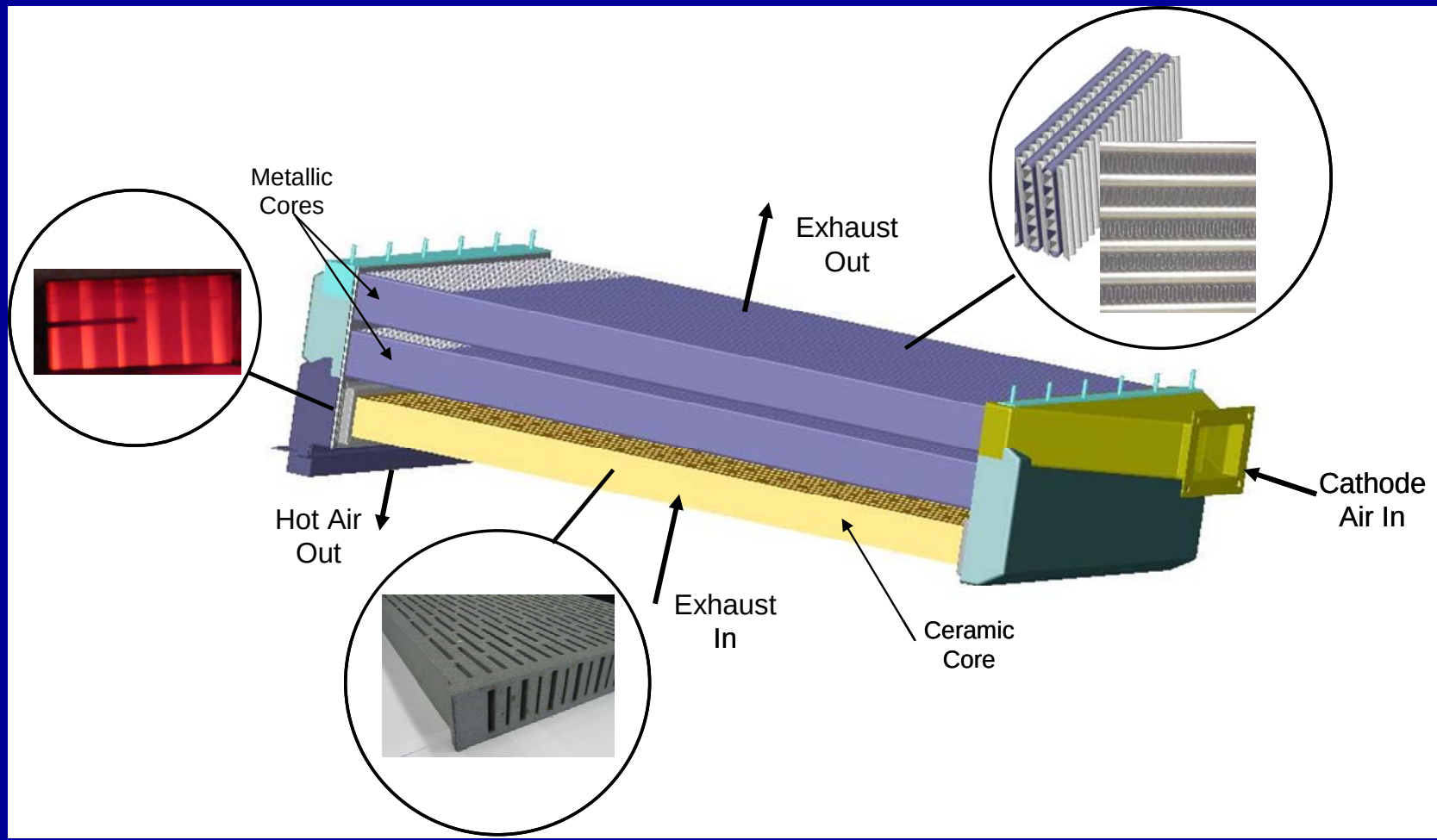
Acumentrics
Trusted Power Innovations

Cross Flow Metallic Recuperator



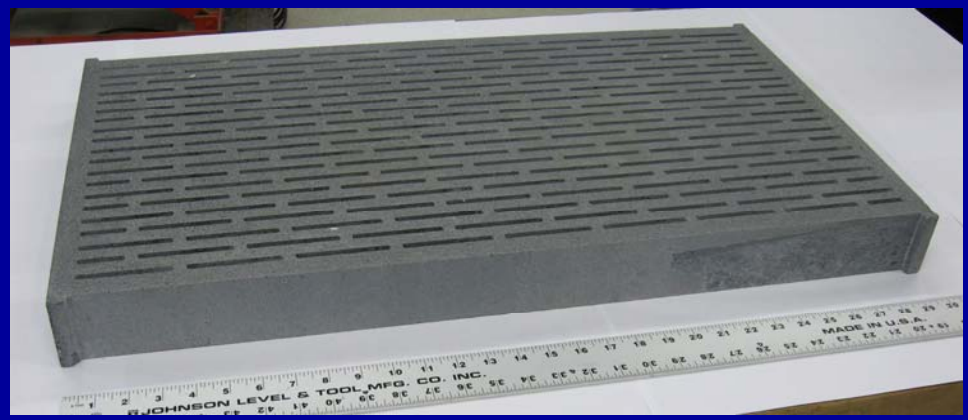


Cross Flow Hybrid Recuperator Concept



Acumentrics
Trusted Power Innovations

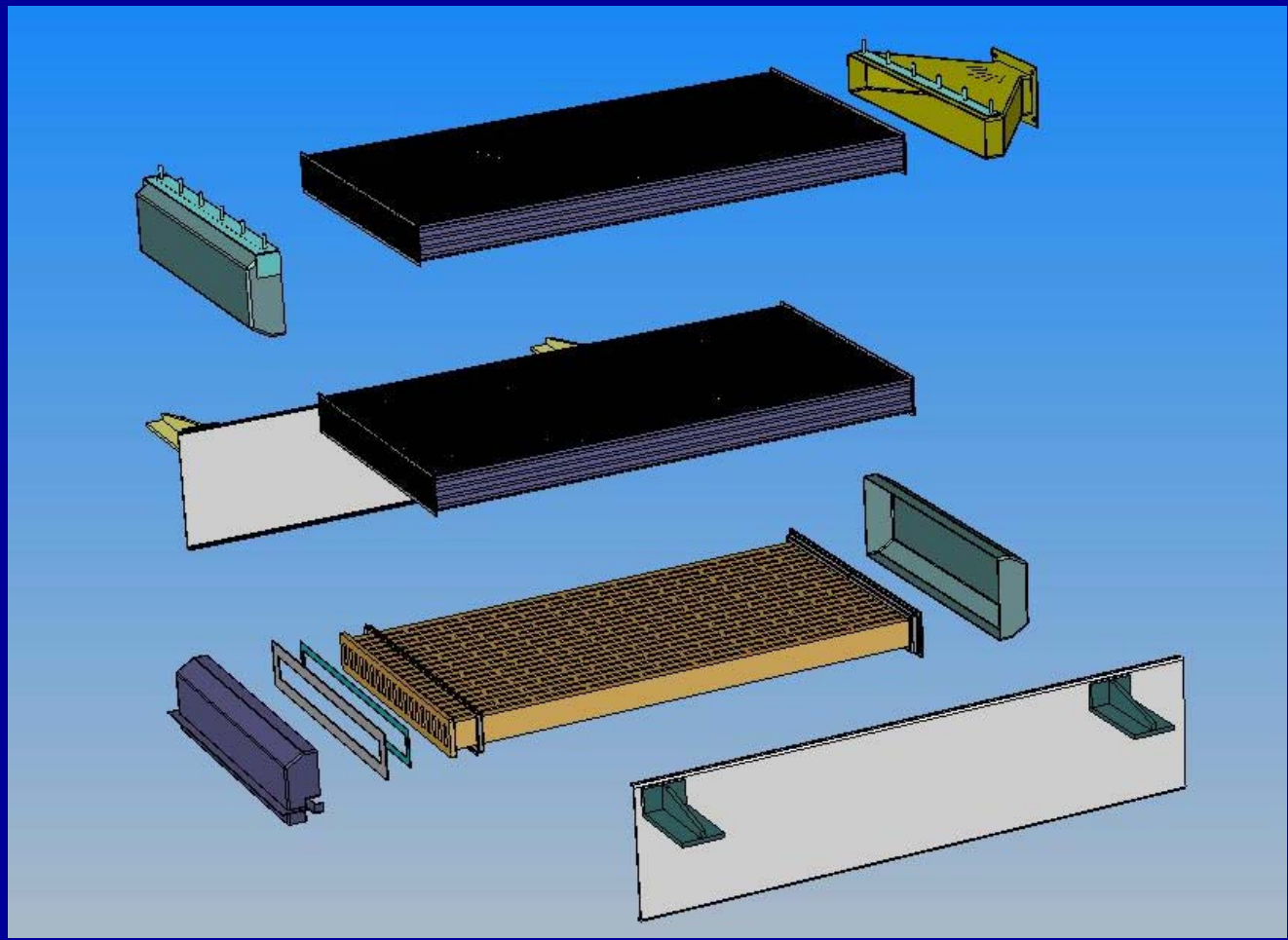
Ceramic Core



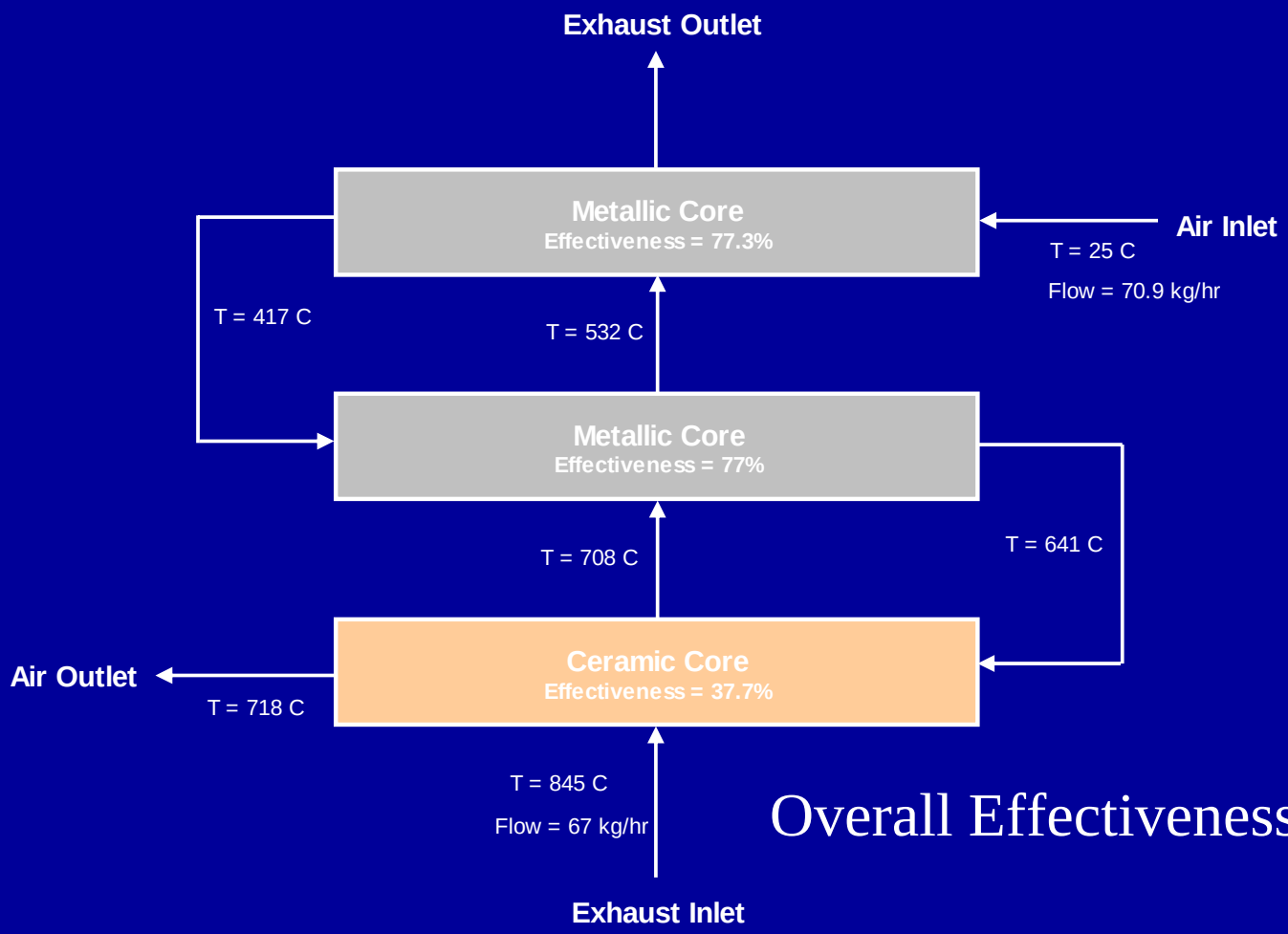
Manufactured by Blasch Precision Ceramics , Albany NY

Acumentrics
Trusted Power Innovations

Cross Flow Configuration

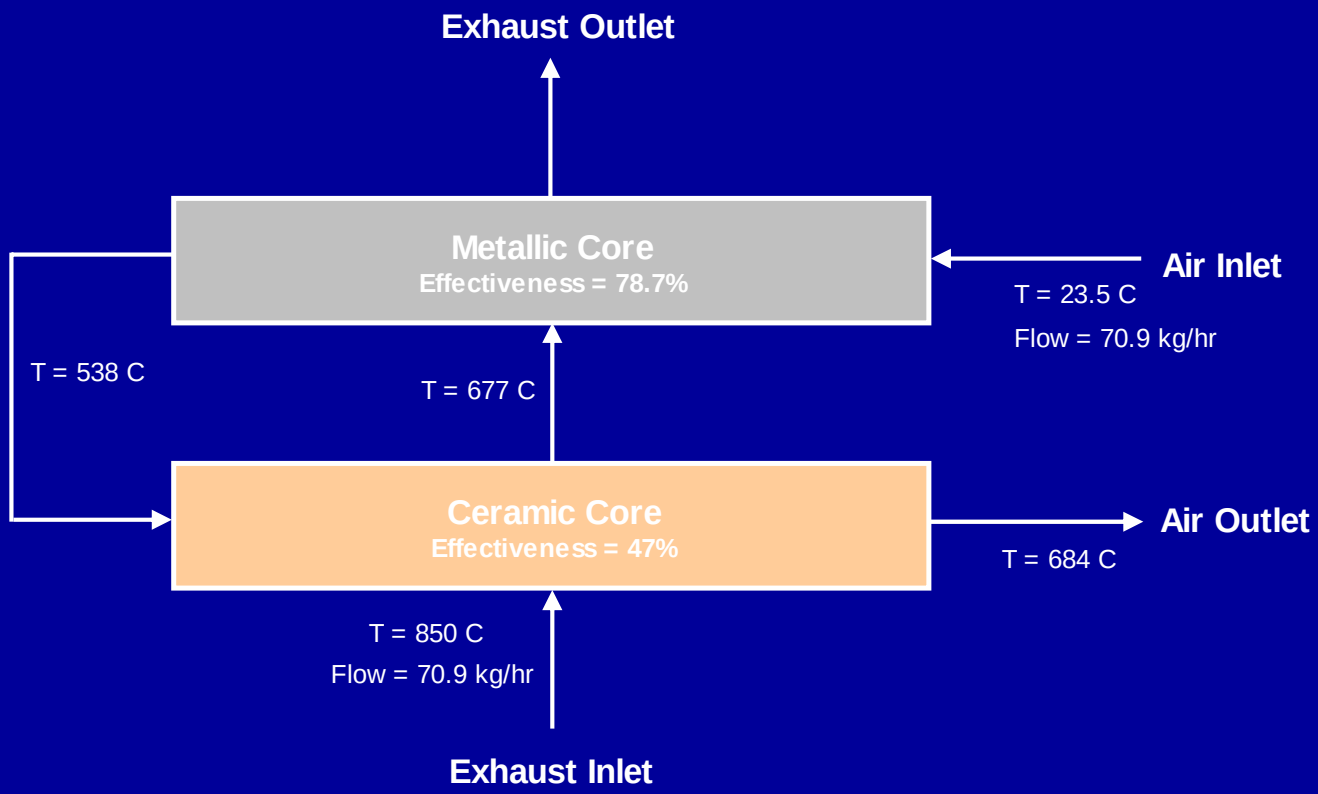


3 Pass Cross Flow Hybrid Performance



Overall Effectiveness = 85%

2 Pass Cross Flow Hybrid Performance

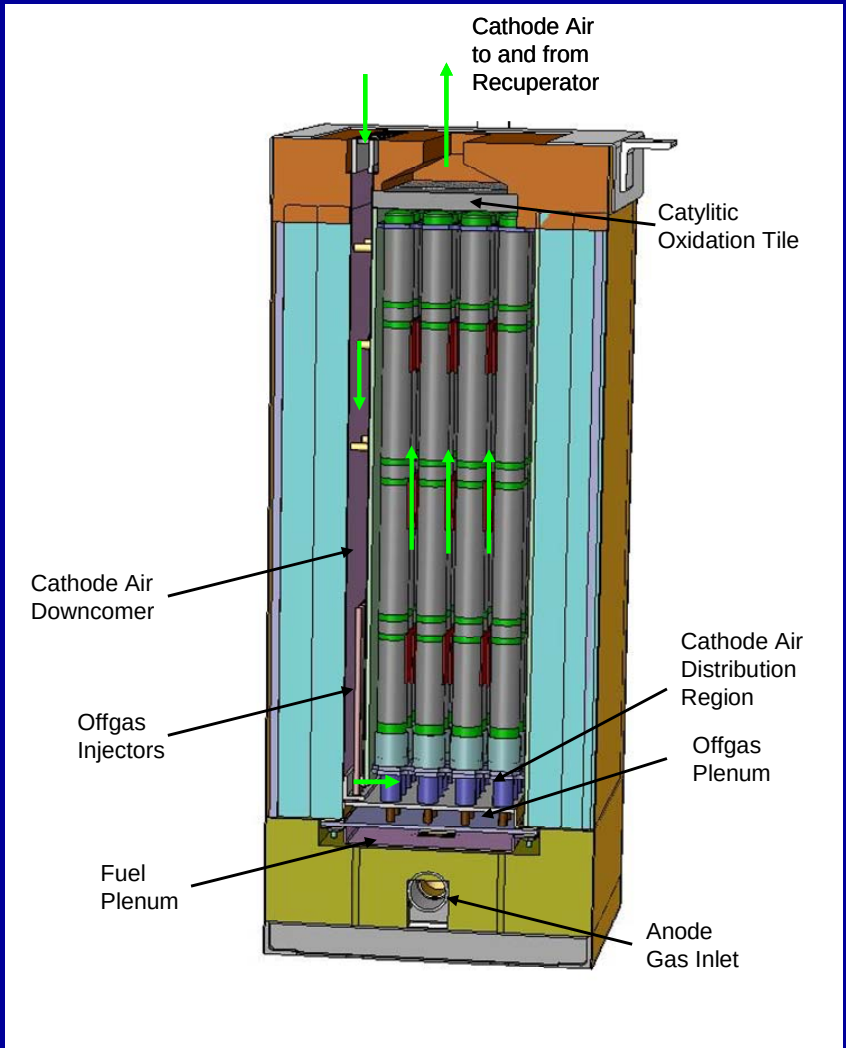


Overall Effectiveness = 80%

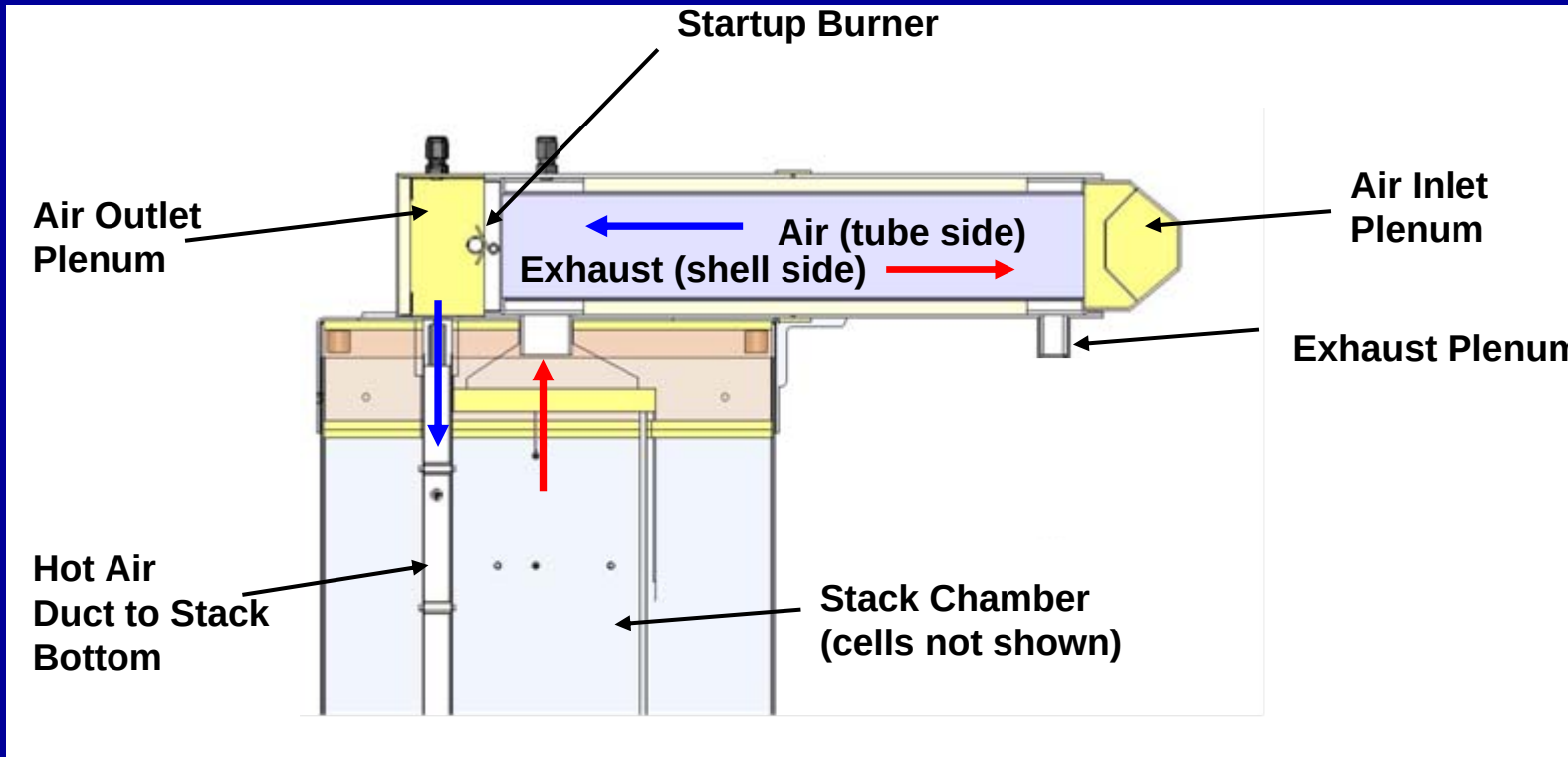
Acumentrics
Trusted Power Innovations

Stack Size Reduction

Axial Flow Stack Geometry

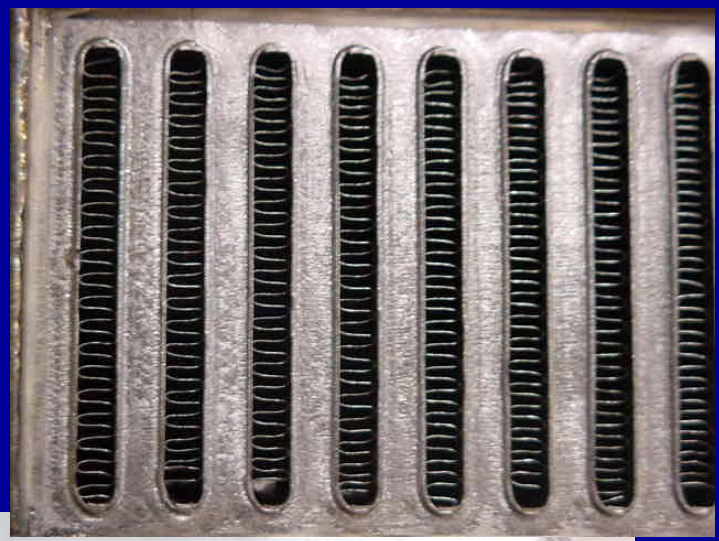


Counter Flow Recuperator



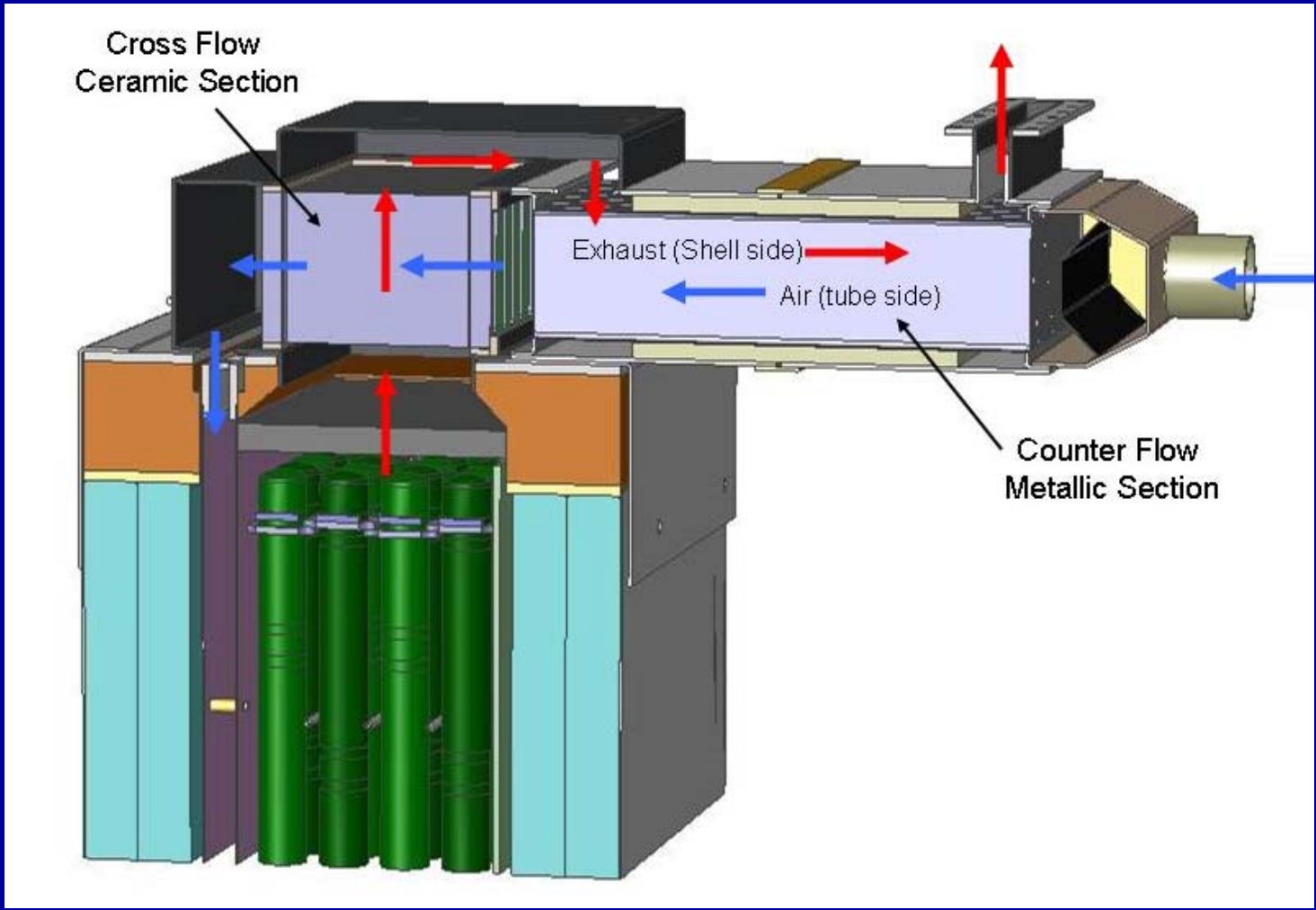
Acumentrics
Trusted Power Innovations

Counterflow Fin Core Recuperator

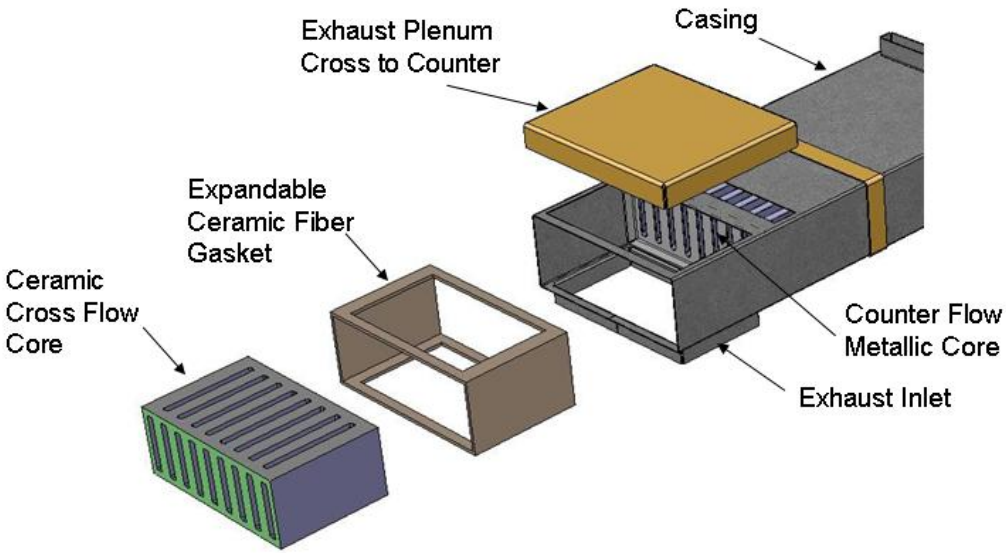


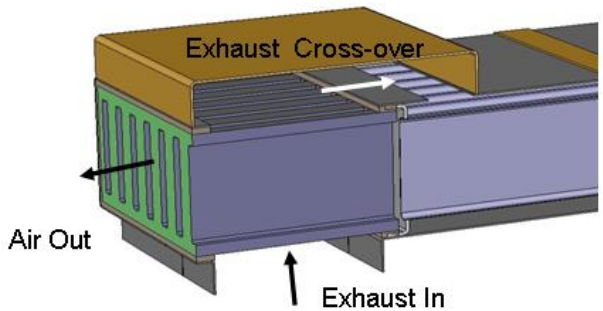
Acumentrics
Trusted Power Innovations

Counter Flow Hybrid Recuperator



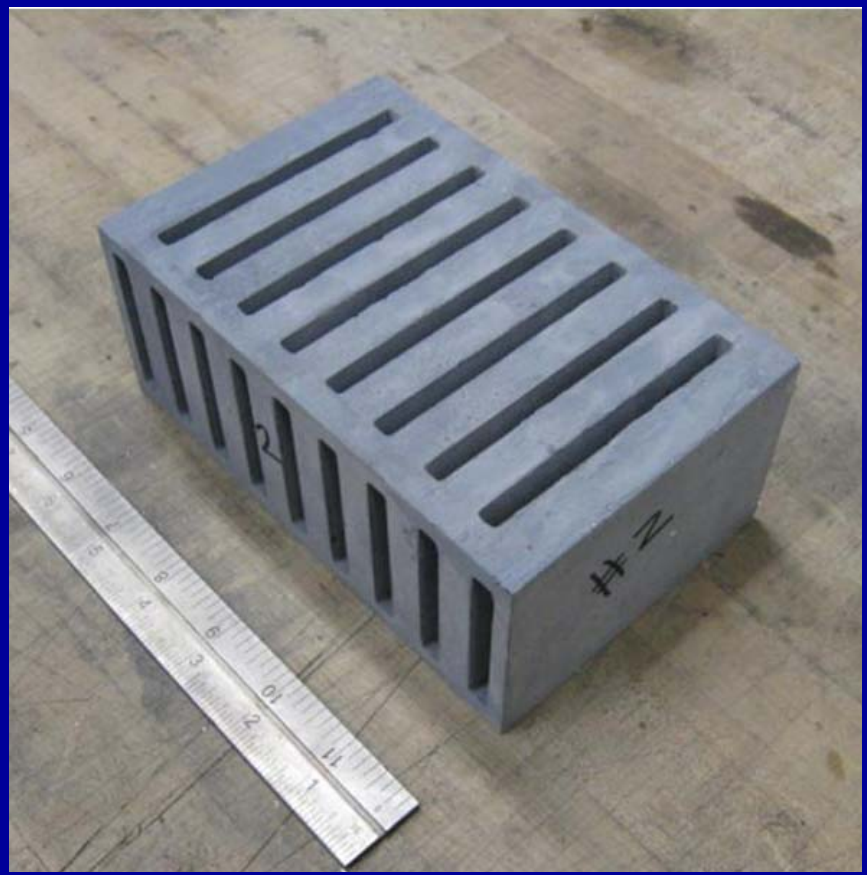
Recuperator Assembly





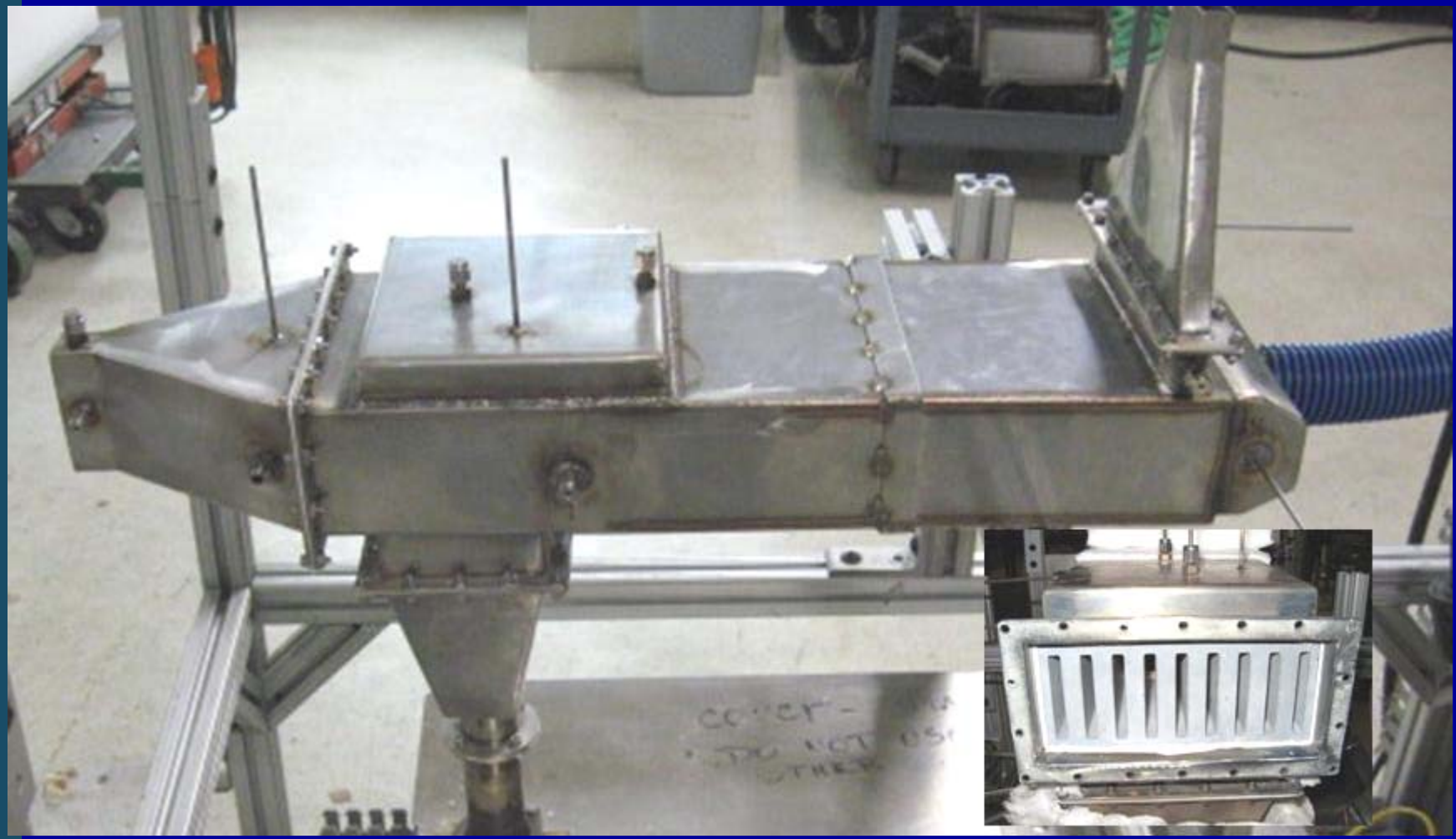
Acumentrics
Trusted Power Innovations

Ceramic Monolith



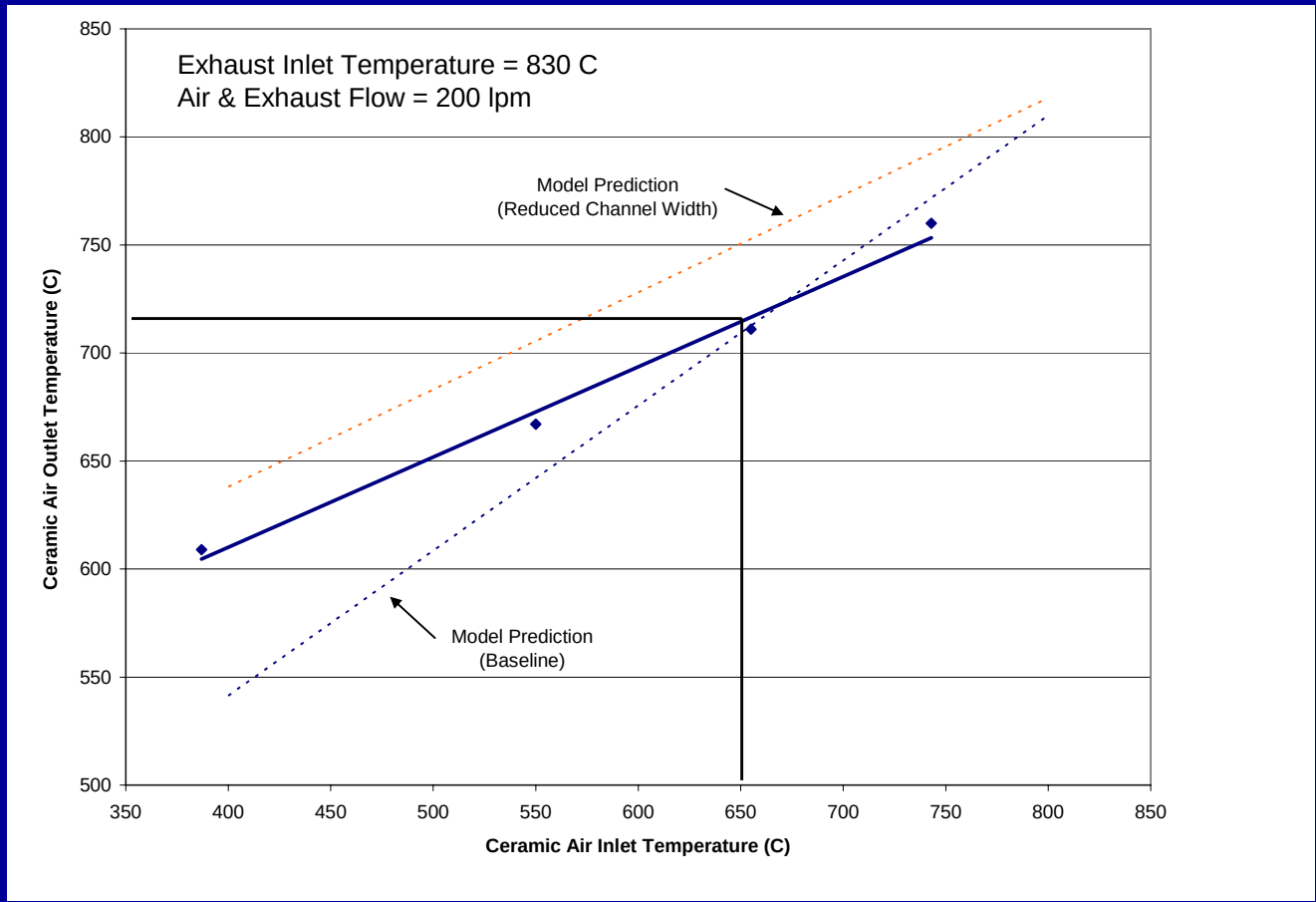
Acumentrics
Trusted Power Innovations

Fin Core Hybrid Cross/Ctr Flow

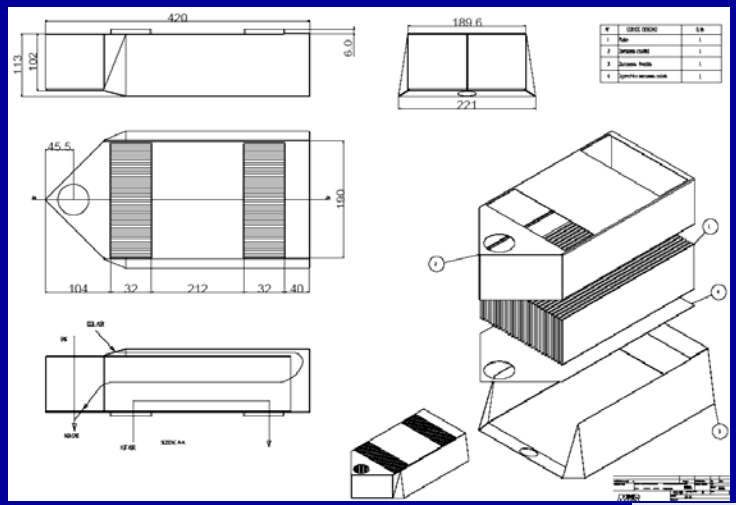


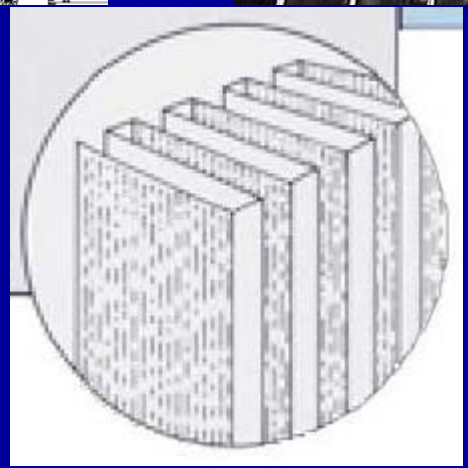
Acumentrics
Trusted Power Innovations

Ceramic Core Performance



Folded Sheet Recuperator

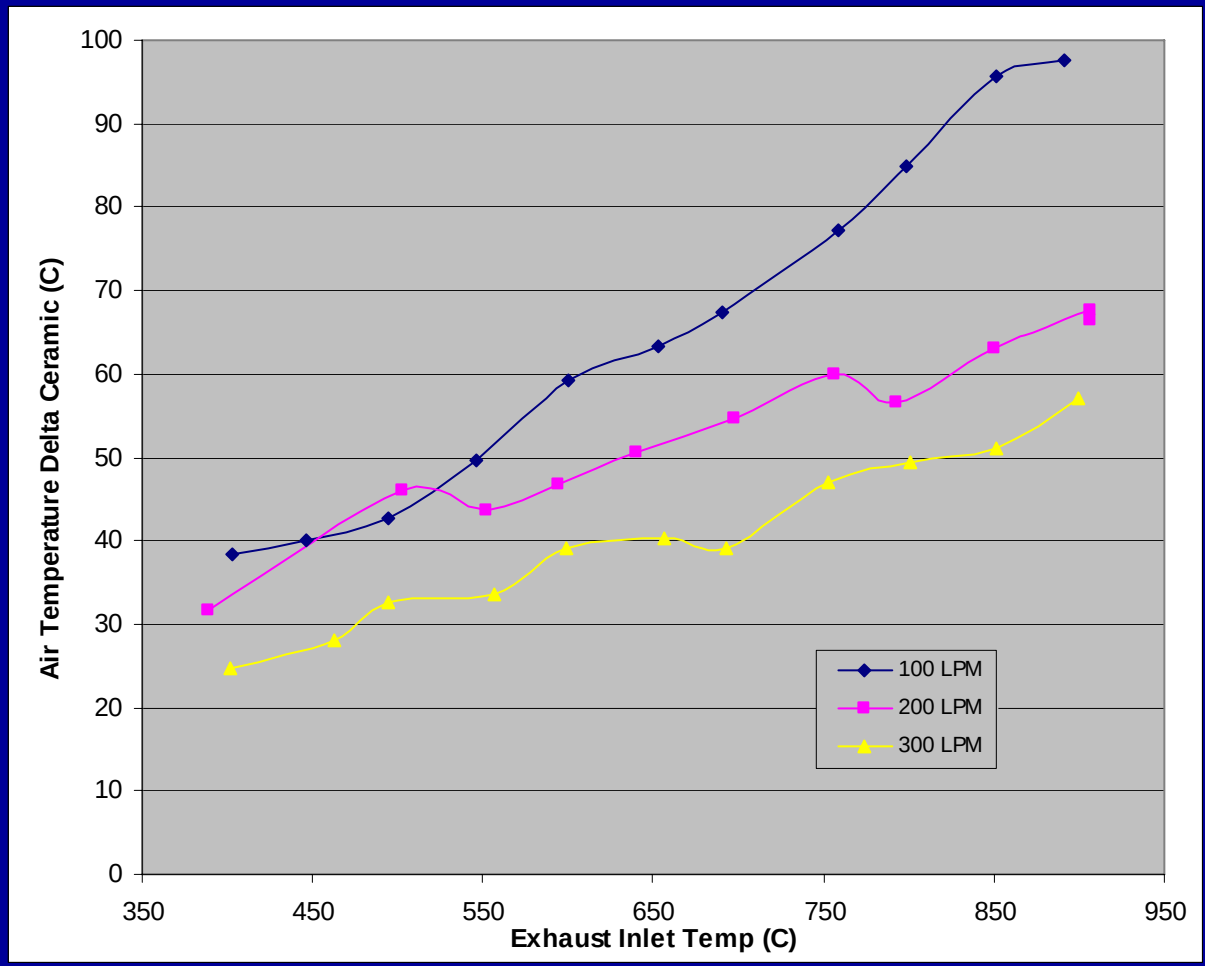




Folded Sht Hybrid Performance Gain

Air Flow	Ovl Effectiveness	
lpm	Metallic	Hybrid
100	0.71	0.787
200	0.705	0.816
300	0.698	0.780

Cross/Ctr HX Performance



Acumentrics
Trusted Power Innovations

Future Activities

- Complete performance testing
- Conduct both long term and thermal cycle testing
- Evaluate techniques to optimize ceramic core heat transfer – more passages, fins
- Evaluate and demonstrate heat exchanger geometry to larger sizes