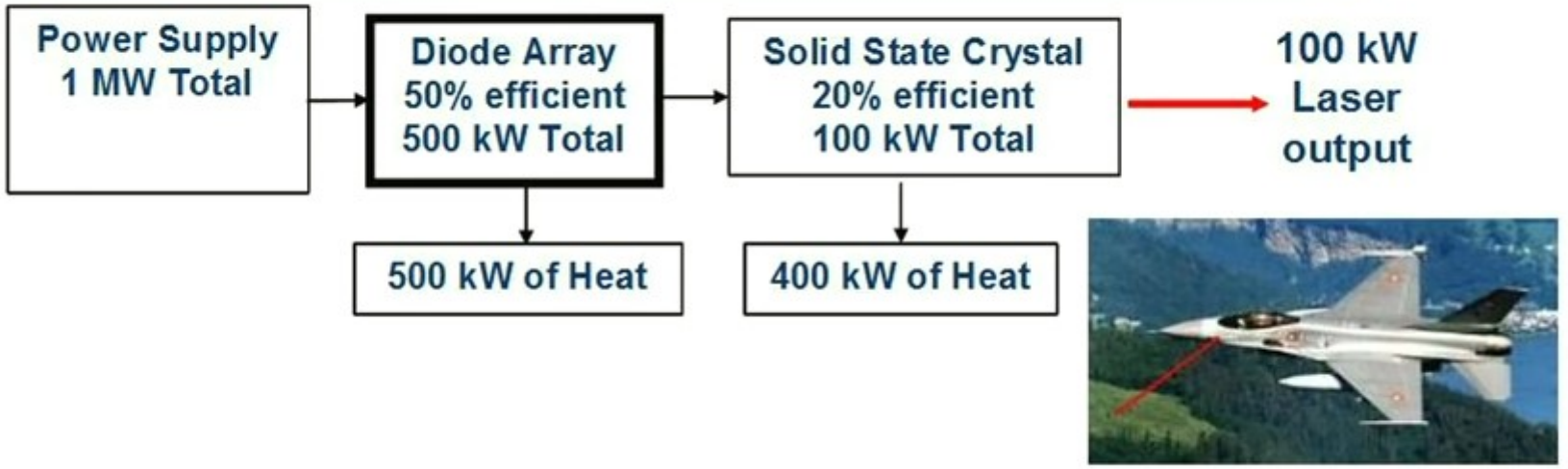
Why the need for research and development?

- Diode laser arrays are not just assemblages of diode lasers – rather they are integrated electronic, thermal and optical systems.
- These issues all require consideration in the design, assembly and testing.
- New thermal management and optics concepts make possible significantly improved diode laser arrays.
- These require array designs to make optimal use of the new knowledge and to manufacture improved arrays efficiently, effectively and at minimal cost.

High average power diode pumped solid state laser



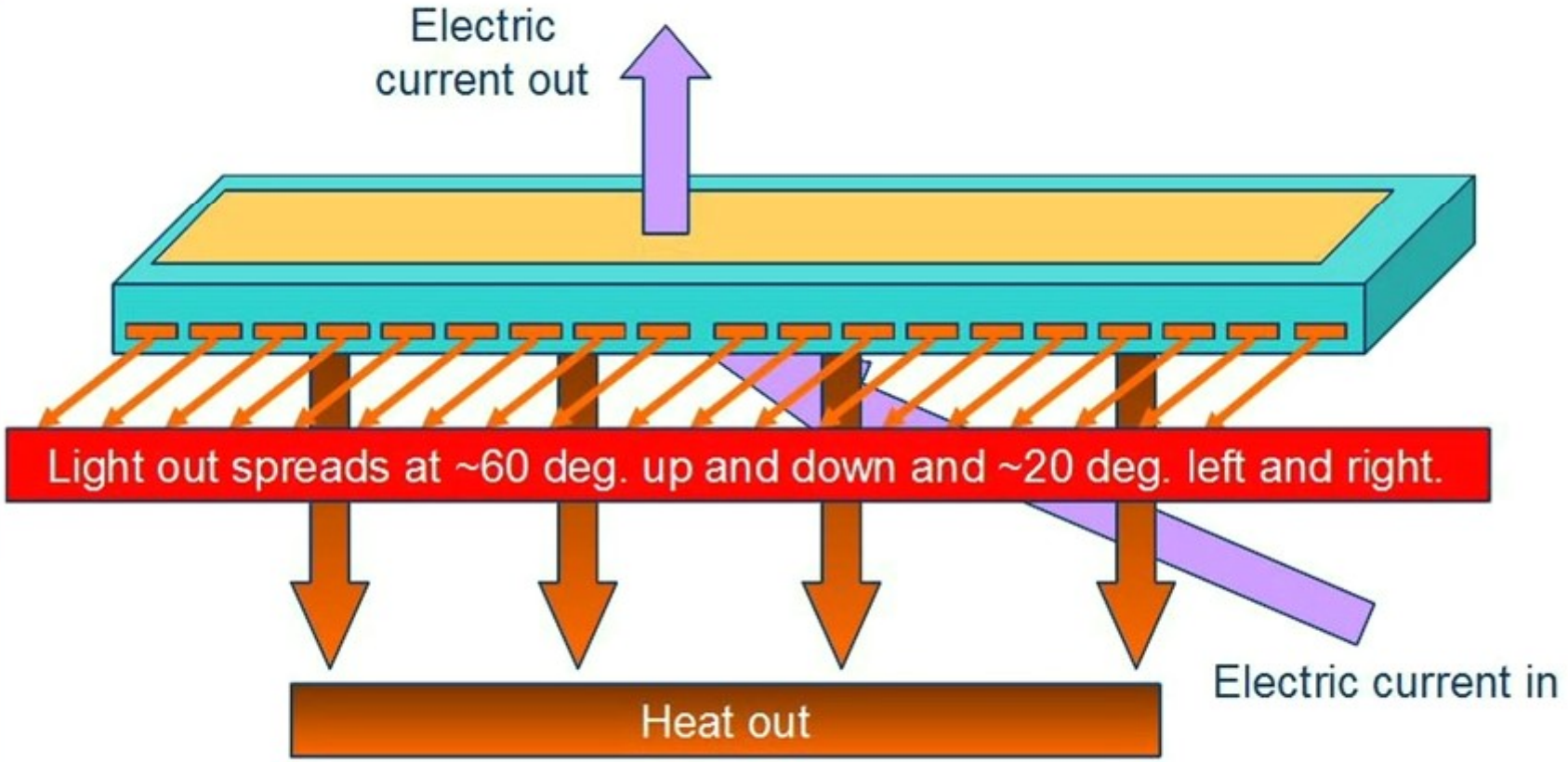
Motivation

A 100 kW laser weapon is made possible by advanced optics, optical control, thermal management technology and components

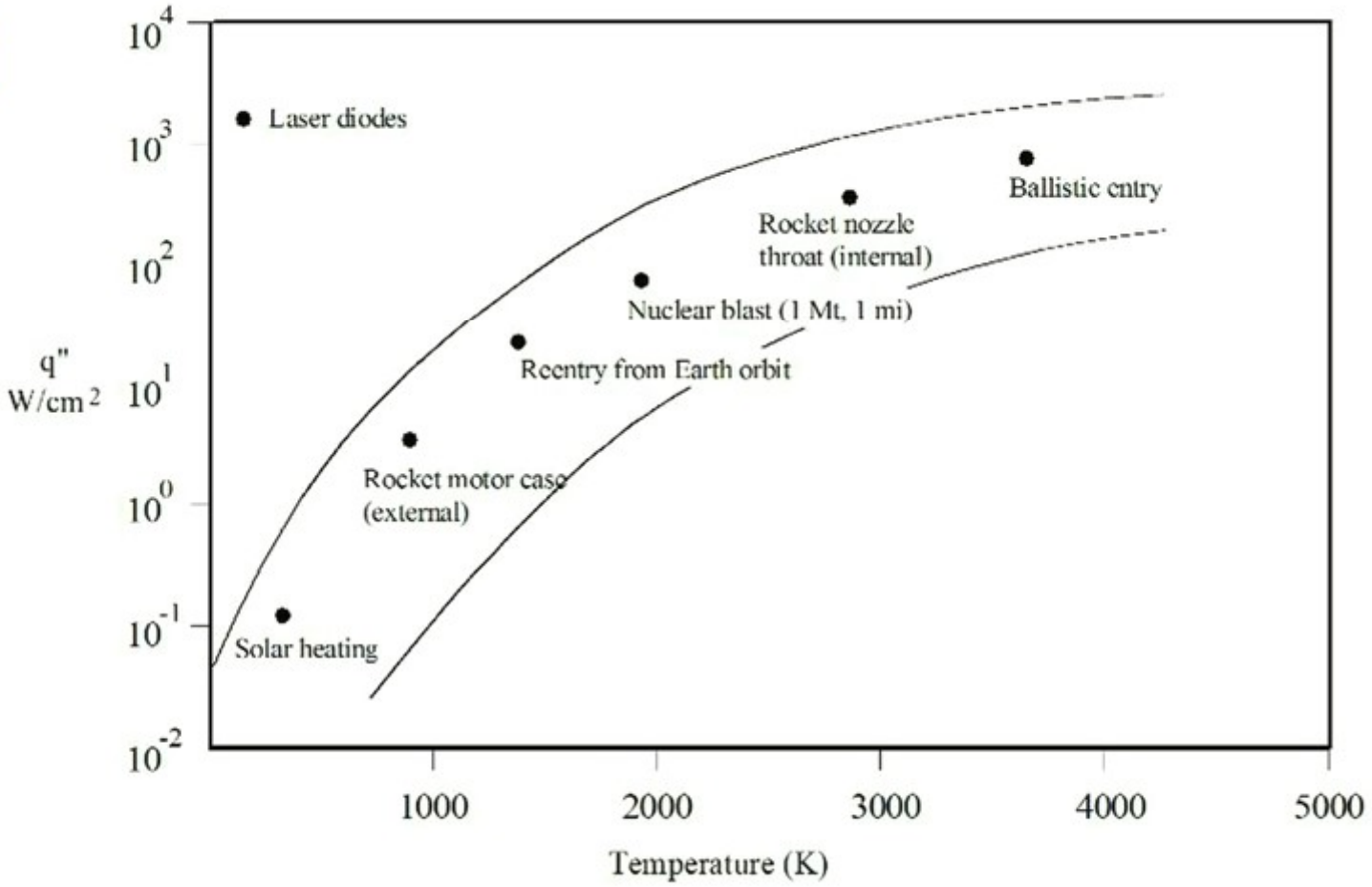
Challenges

- Management of pump source thermal issues and emitted light
- Acquisition of very high flux heat load
- Rejection of total waste heat load

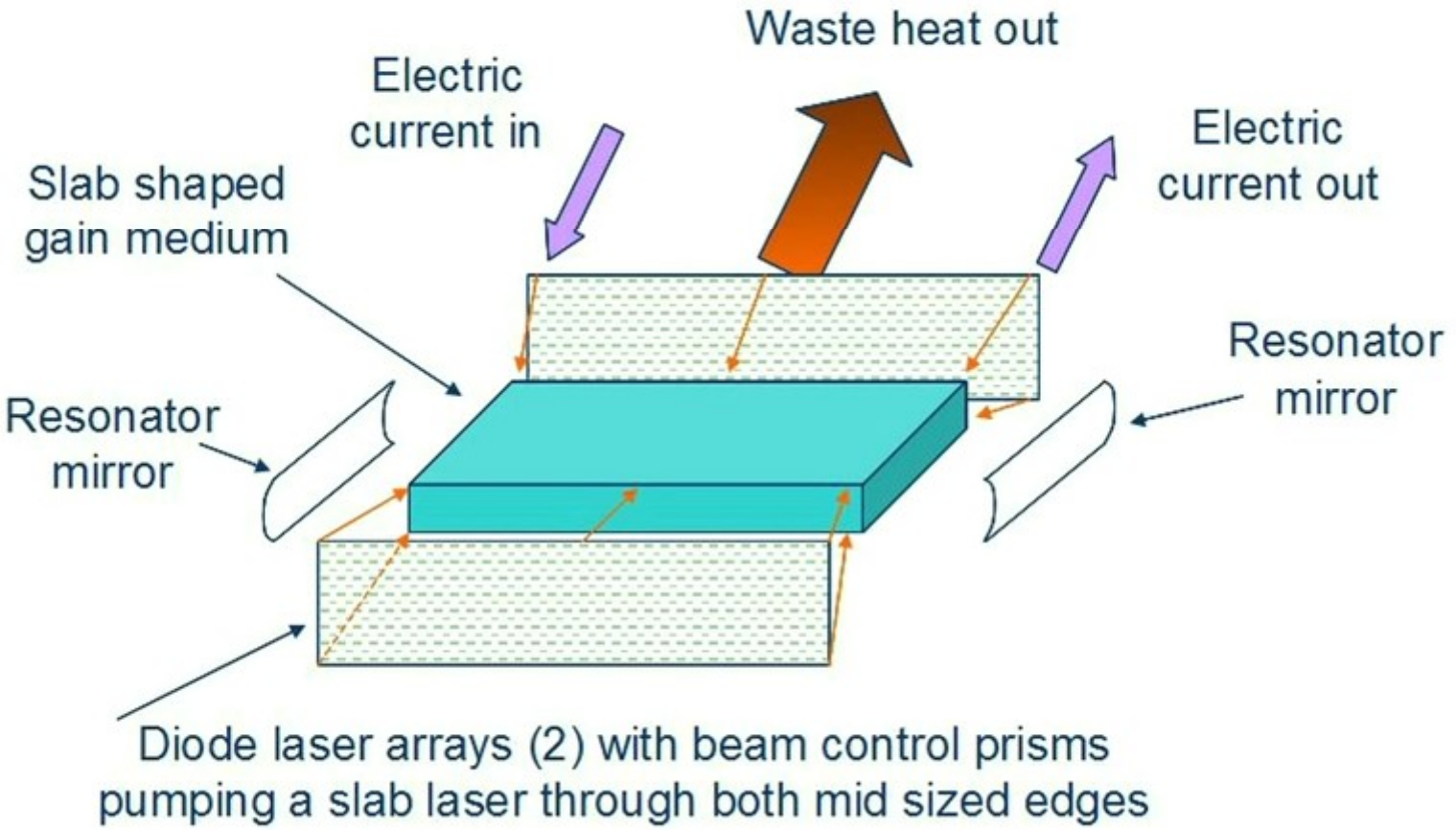
A diode laser bar



Heat fluxes for various events



A diode laser array pumped solid state laser



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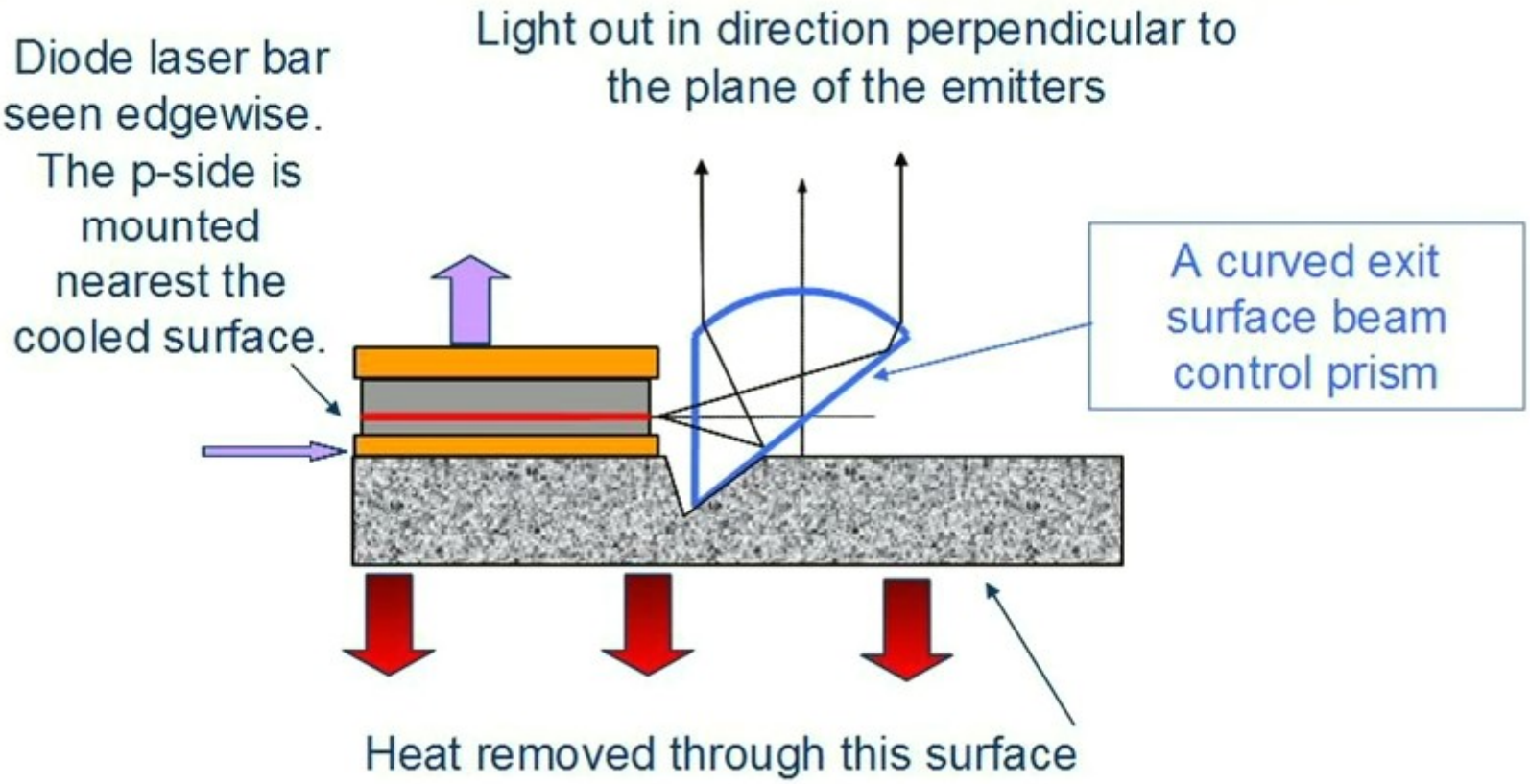
Key issues

- Diode bar layout and electrical connection arrangements.
  - Substrate design, soldering, bar-to-bar buses, series or parallel connections, electrically resistive-thermally conductive substrate materials, thin insulating coatings on metallic substrates
- Optics design, components preparation and integration with diode bar array
  - Beam control prisms, molded or polished, materials selection, coating designs, average power load limits, positioning and aiming tolerances, fixturing
- Thermal management technique selection and implementation
  - Coordinated with layout and optics demands, assure lowest diode operating temperature, uniform emitter temperature, efficient heat rejection

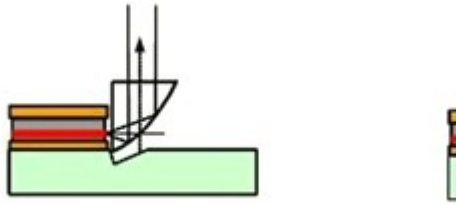
What does UCF have to offer?

- Our work on diode laser array thermal management and output light control.
- Key technologies:
  - EVAPORATIVE SPRAY COOLING
  - BEAM CONTROL PRISM OPTICS
- The possibilities:
  - Lower diode operating temperature
    - Higher efficiency.
    - Longer life.
  - Control of pump beam pattern .
  - Ease of manufacture and assembly.
  - More rugged, reliable and lower cost DEWs.

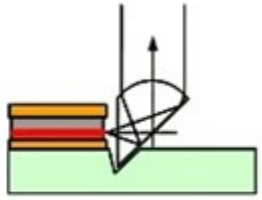
The generic beam control prism concept



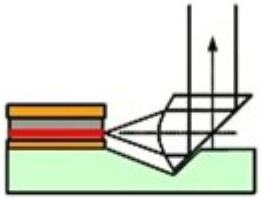
Some beam control prisms



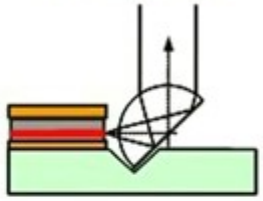
Curved reflective surface



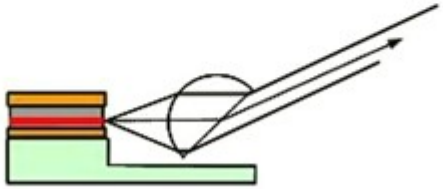
Curved exit



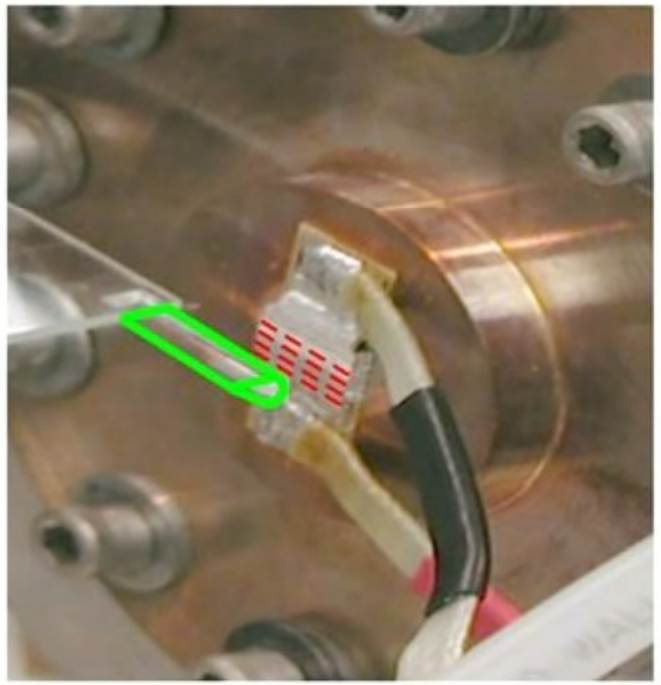
Curved entrance



Curved entrance and exit

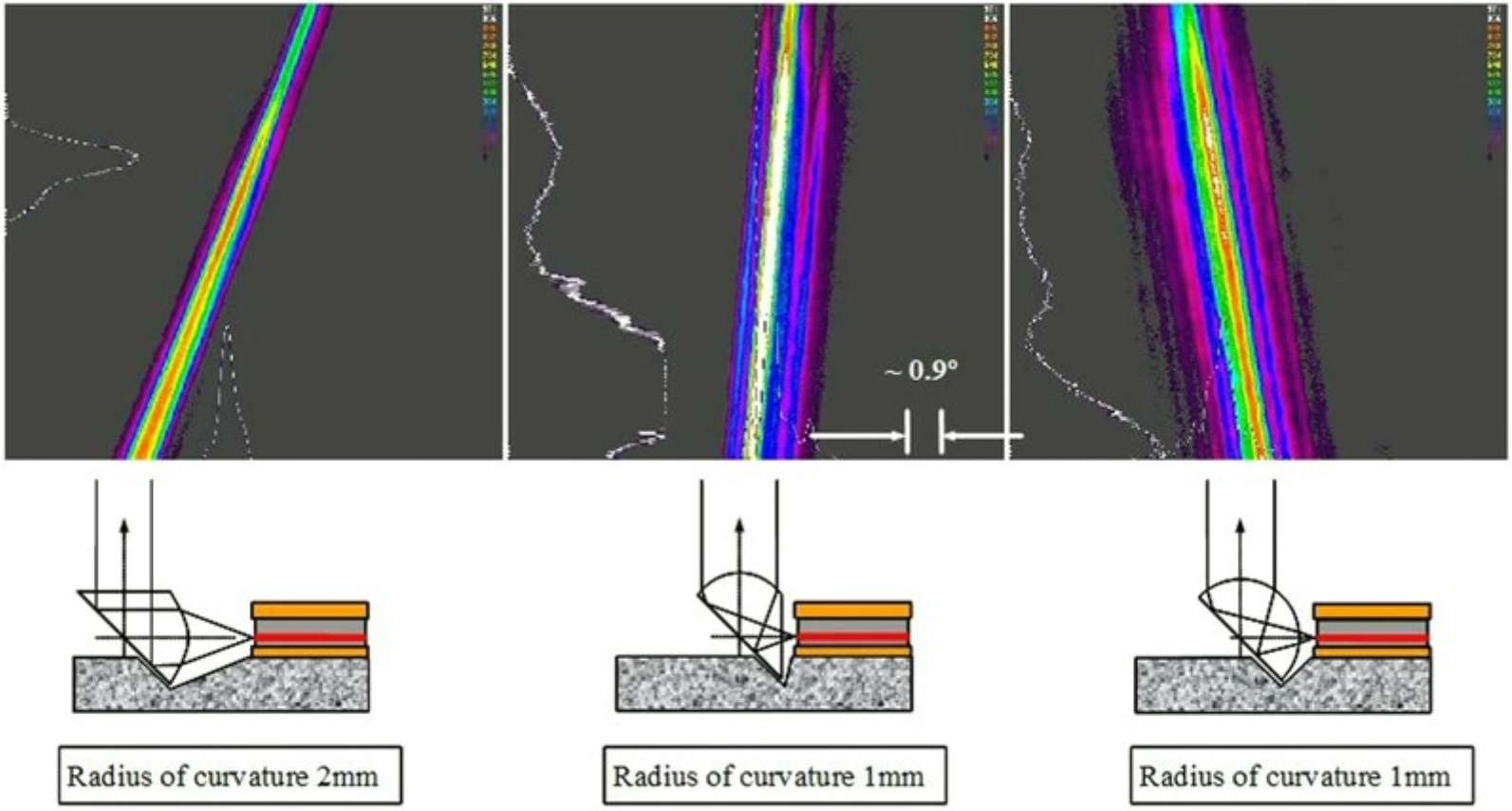


Refractive type



Test bed for BCP properties

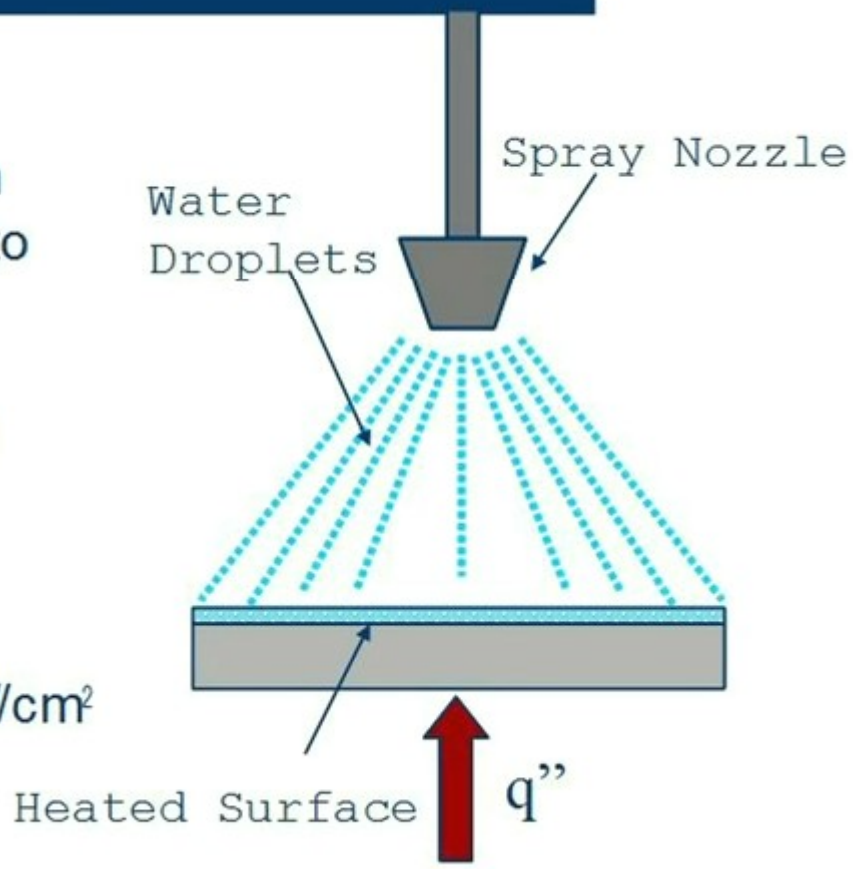
Experimental demonstration



Phase-Change Heat Transfer Techniques

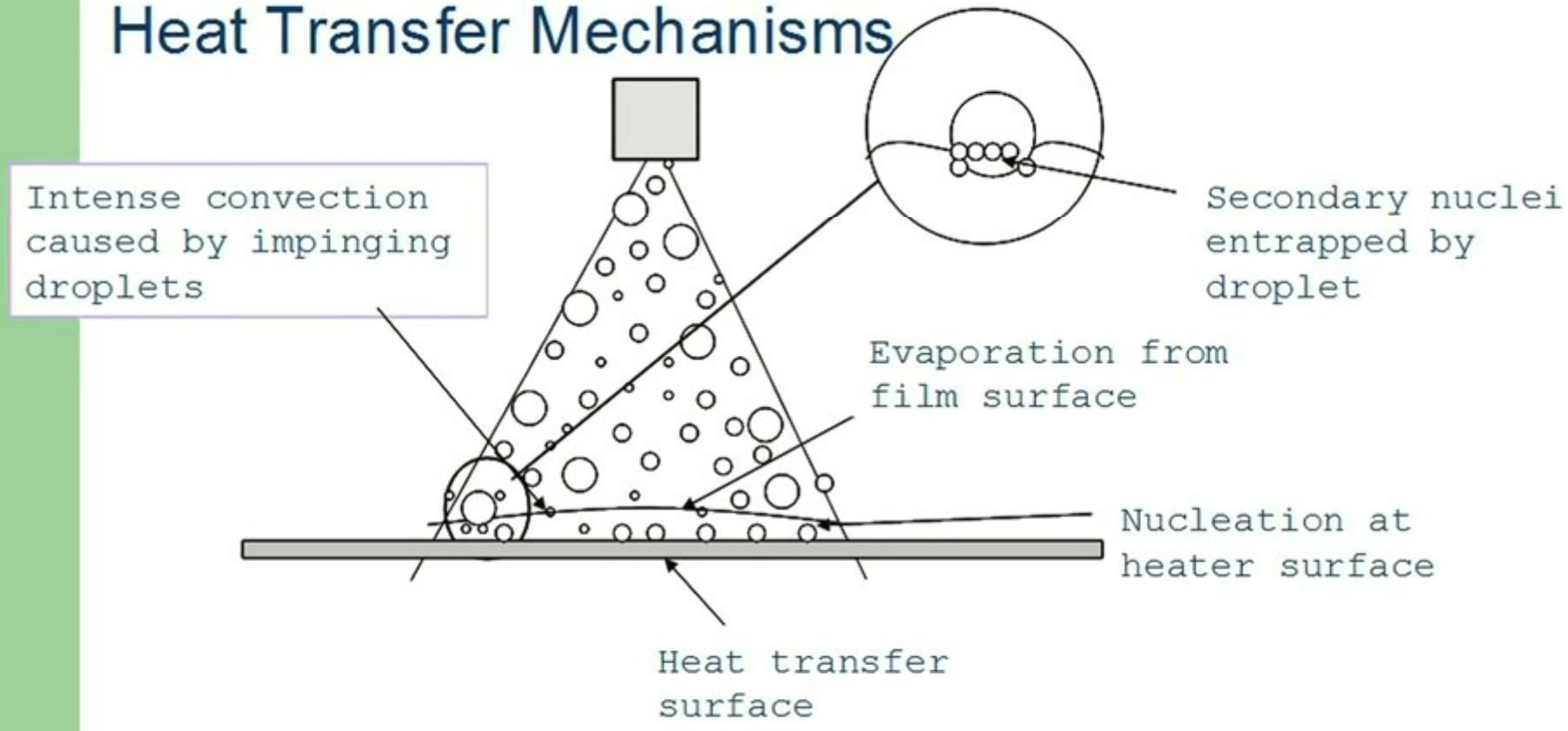
Spray Cooling

- Droplets are deposited from nozzle to a heated surface to create surface nucleation, evaporation, enhanced convection, and 'secondary nucleation'
- Highest heat flux removal capability of all two-phase techniques; around 1000 W/cm^2 for water



Spray Cooling

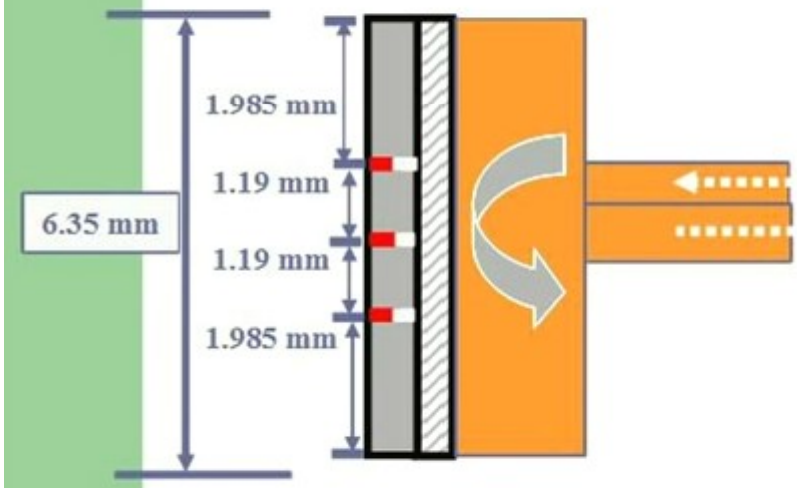
Heat Transfer Mechanisms

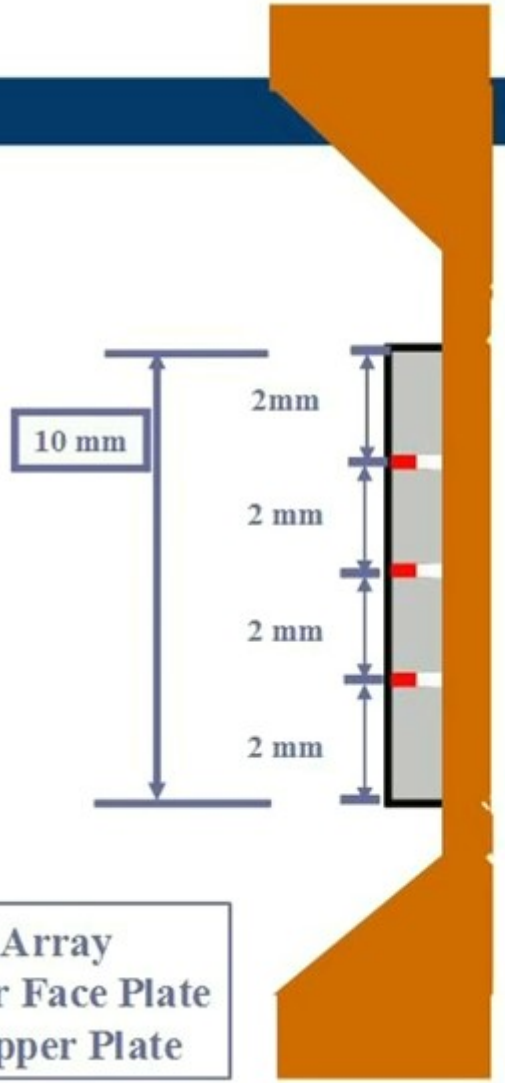


IMC Collaboration on Spray Cooled Design

Array Comparisons

IMC 90-Watt SilverBullet™
Mounted to E1 Heat Exchanger





60 Watt IMC Array
Mounted to Copper Face Plate
Spray-Cooled Copper Plate

Efficiency Comparison for Spray Cooling vs. Liquid Heat Exchanger