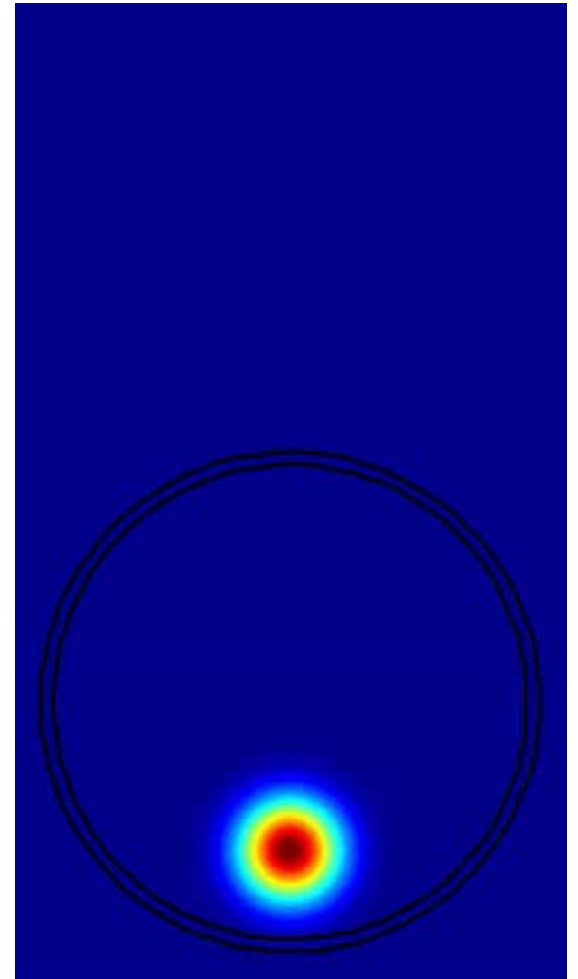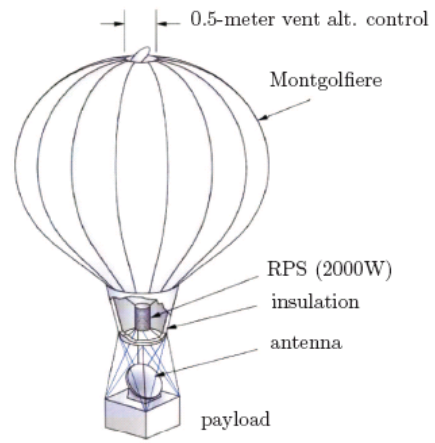# CFD of the thermal performance of a Titan Montgolfiere:

Aditya Bhujle
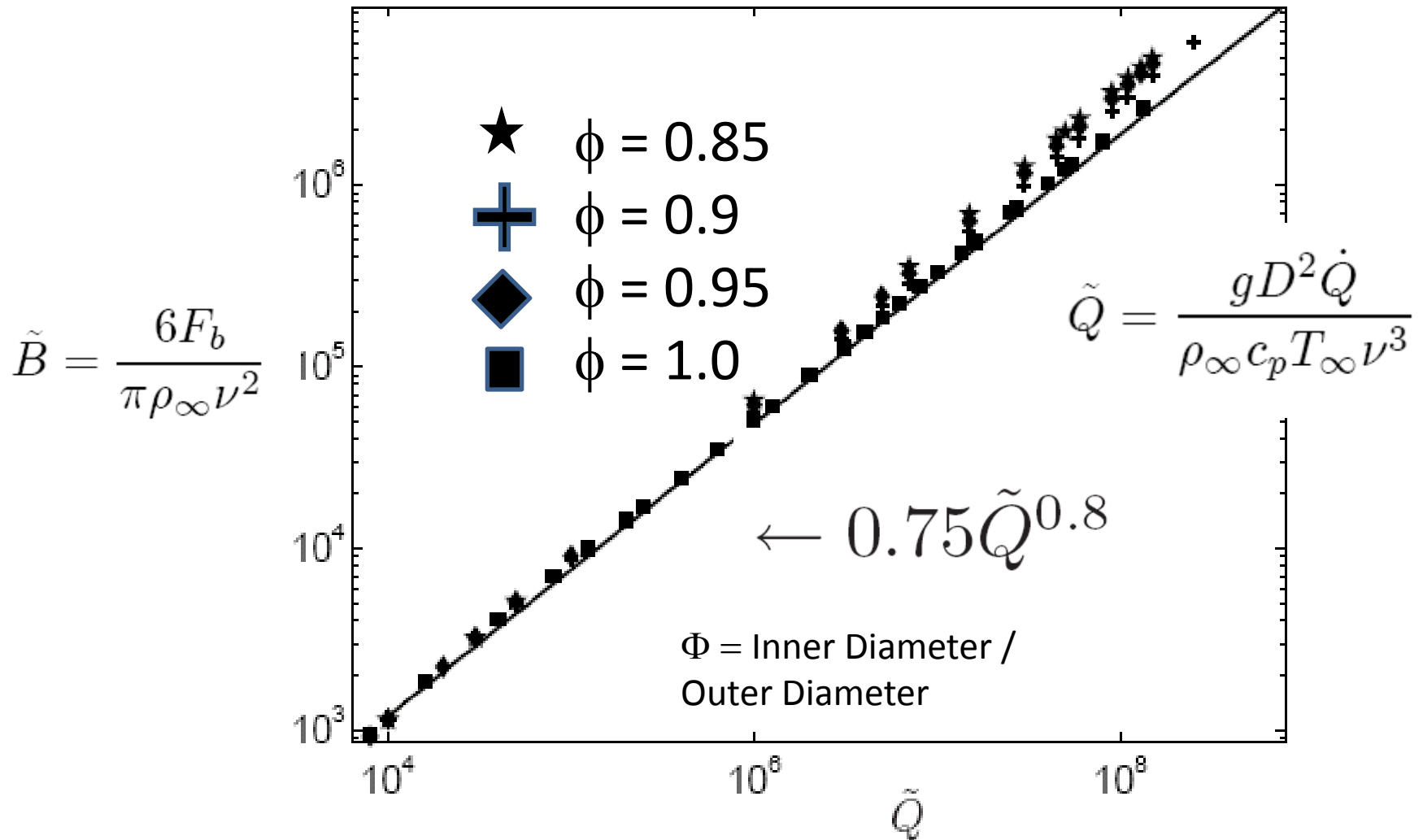Mentor: Dr. Tim Colonius

SURF 2009
CALIFORNIA INSTITUTE OF TECHNOLOGY

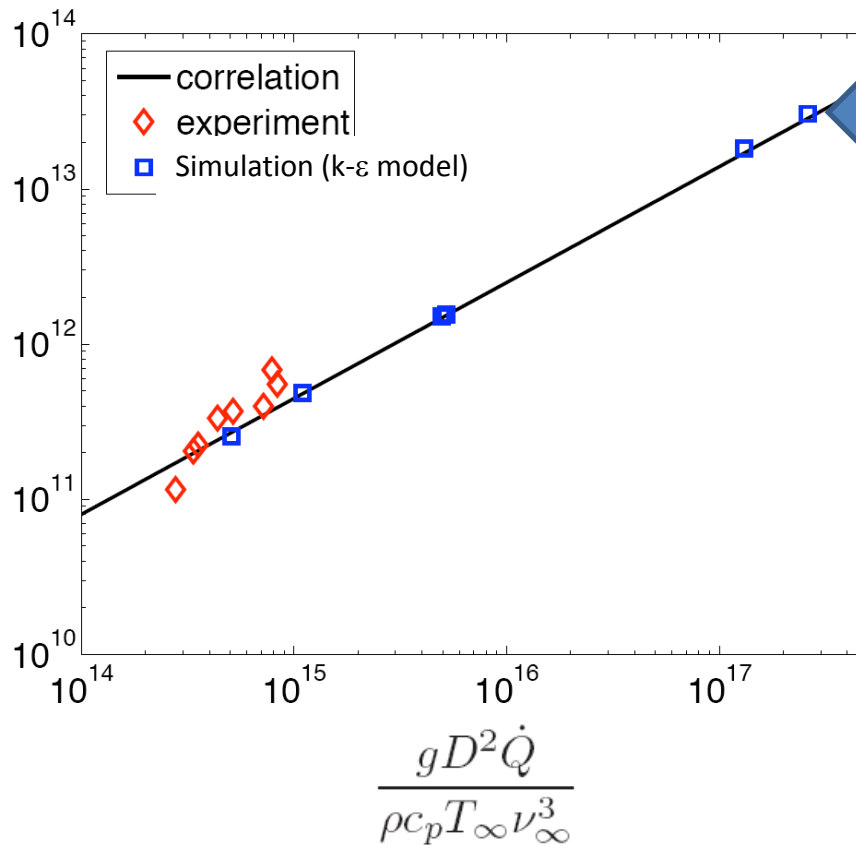0.5-meter vent alt. control

Montgolfiere

RPS (2000W)

insulation

antenna

payload

Laminar steady-state results

$$\tilde{B} = \frac{6F_b}{\pi \rho_\infty \nu^2}$$

$$\tilde{Q} = \frac{gD^2\dot{Q}}{\rho_\infty c_p T_\infty \nu^3}$$

★ $\phi = 0.85$

✚ $\phi = 0.9$

◆ $\phi = 0.95$

■ $\phi = 1.0$

$\leftarrow 0.75\tilde{Q}^{0.8}$

Φ = Inner Diameter / Outer Diameter

Theory, experiment and (turbulent) simulation

$$\tilde{B} = \frac{6F_b}{\pi \rho_\infty \nu^2}$$

Legend:
- correlation
- experiment ◇
- Simulation (k-ε model) □

x-axis: $\frac{gD^2\dot{Q}}{\rho c_p T_\infty \nu_\infty^3}$
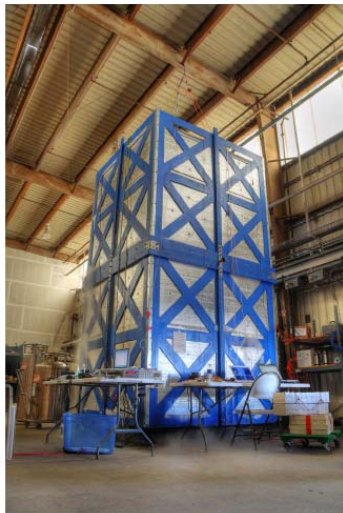
Heat input = 2kW
D = 9 m
@ Titan atmos
(T∞=83k)
Predicted load: B/g
= 176 kg

Predicted temperature contours
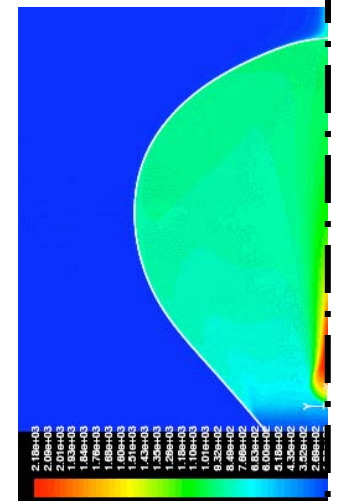
Objectives (Surf 2009)

- Previous work shows that qualitative behavior of laminar regime similar to turbulent regime
- Extend laminar balloon simulations to consider transient behavior
- Control vent controls altitude
  - Need to predict transient timescales upon venting
- Previous simulations used closed balloon
  - Add realism by opening bottom