



Global System For Monitoring Earth Radiation Balance



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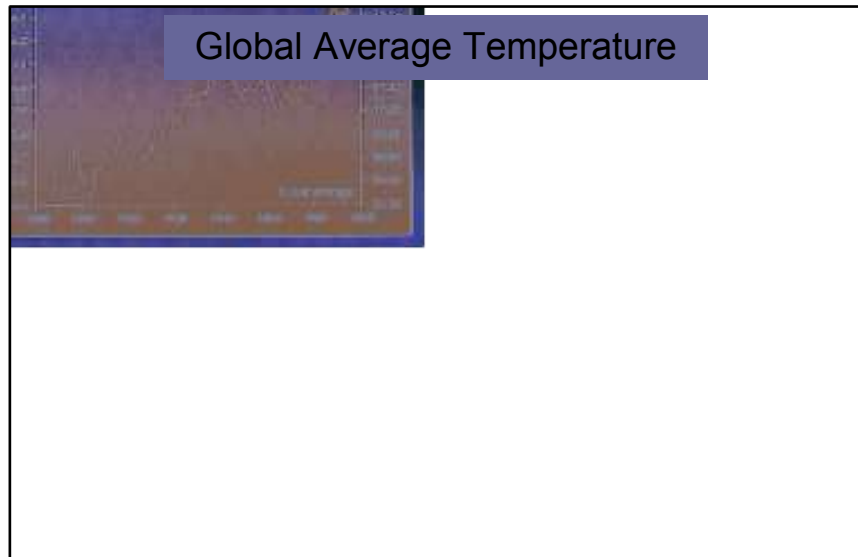


Outline

- The Problem
- The Context
- Proposed Solution
- ACR Theory
- ACR Design
- Preliminary Results
- Project Objectives

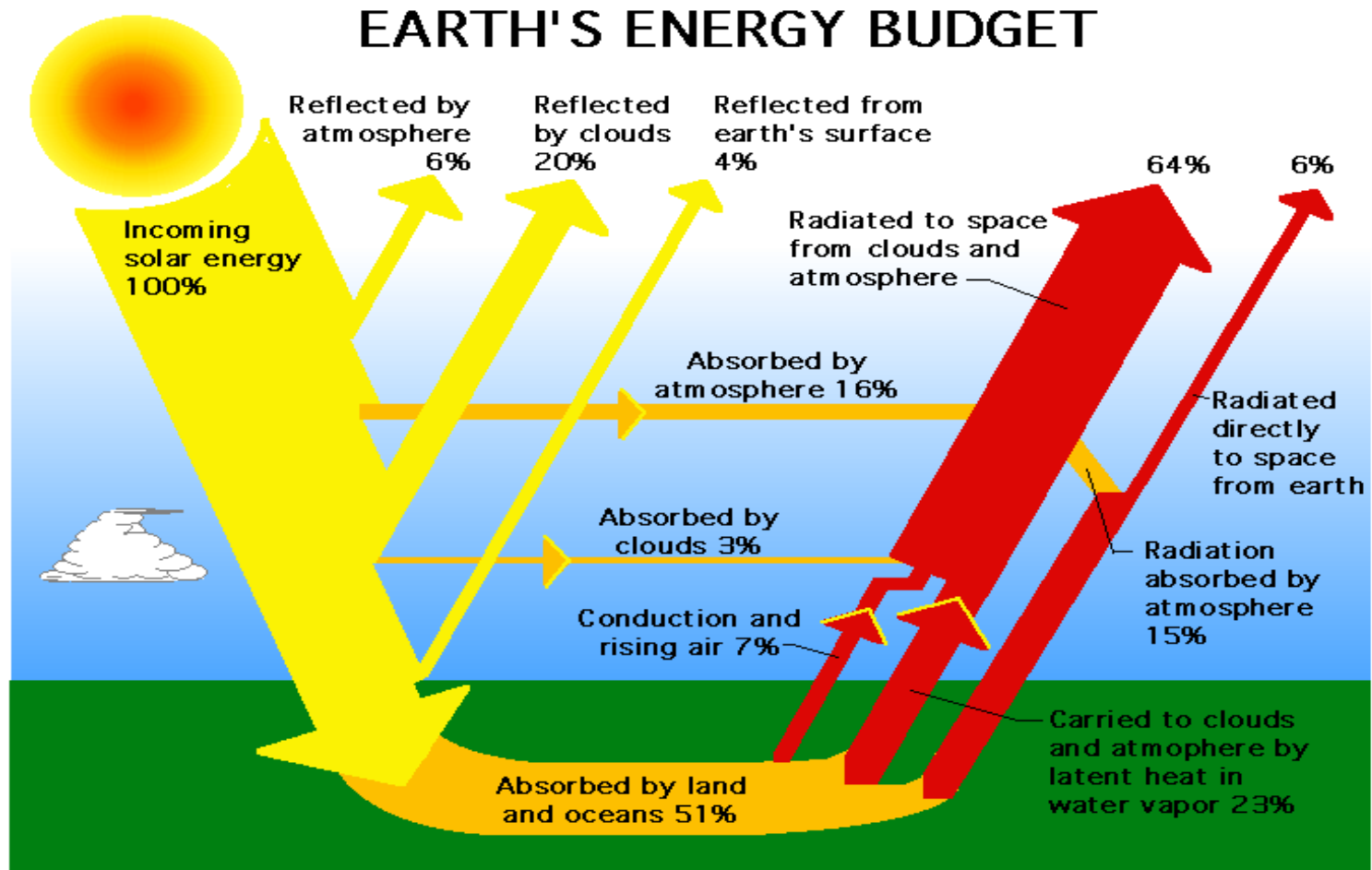
The Problem

- Need accurate measurements of Earth's radiation for
 - Weather Models
 - Earth Radiation Balance
 - Global Warming Questions



Global Radiation Balance

- Monitor radiation
- Reduce data uncertainty



Earth's Radiation Balance



QuickTime^a and a
Photo decompressor
are needed to see this picture.

Infrared

Outgoing Long Wave
Radiation (5-100 μm)
Jan. 2001-Dec. 2002

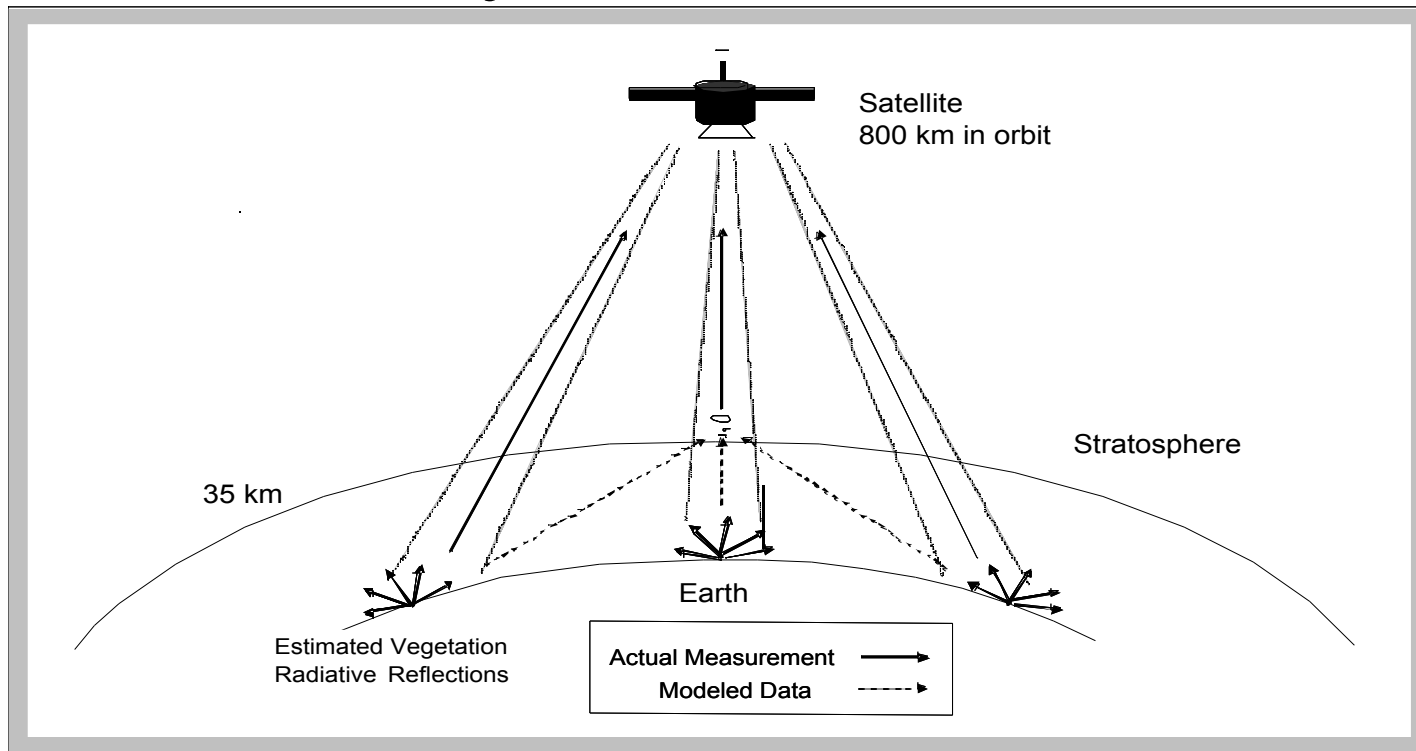
QuickTime^a and a
Photo decompressor
are needed to see this picture.

Visible

Outgoing Short Wave
Radiation (.3-5 μm)
Jan. 2001-Dec. 2002

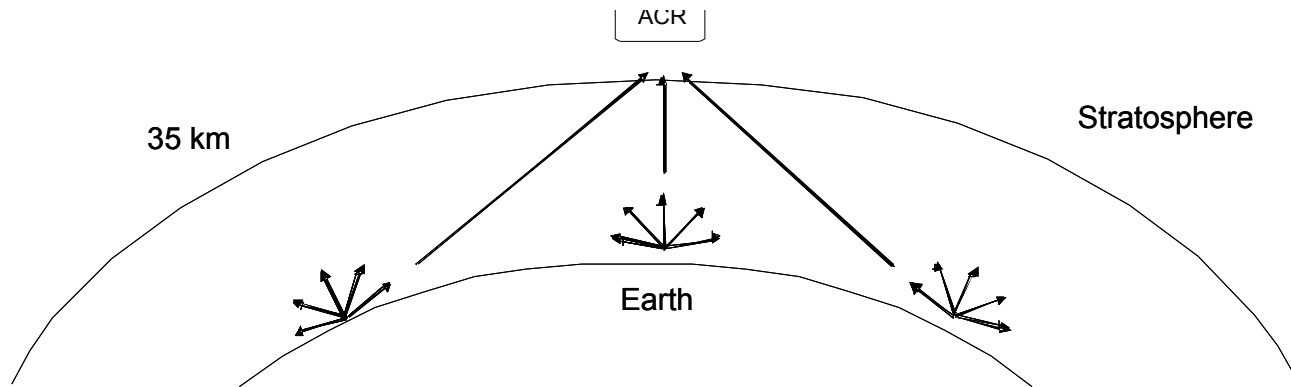
Existing Technology

- Satellite Based Measurements
- Extrapolate to 35 km
- Uncertainty in Results



Benefits of Direct Hemispherical Measurements at 35 km

- Reduce sources of modeling uncertainty
- Less modeling of vegetation and albedo
- Ground truth for satellite results



Scientific Balloons Fly at 35 km

- Current Balloon Development

- NASA flies balloons (<21 days)

- Under development now

- Ultra long duration balloons

- 100 day flights

- Future

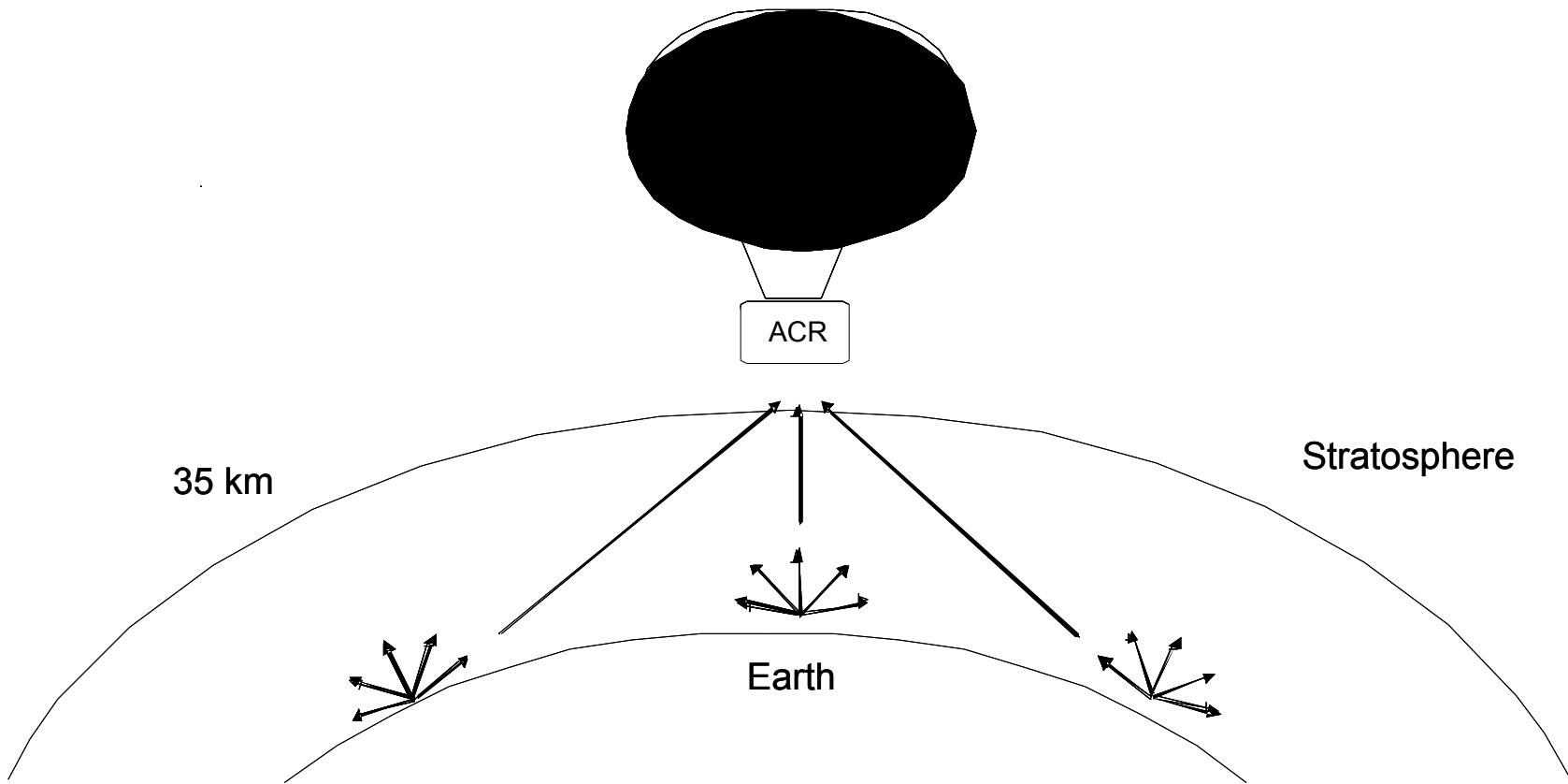
- 1–10 year flights

- “Permanent” station at 35 km

- Could Carry ACRs



ACRs on Stratospheric Scientific Balloons



Possible Future Stratospheric Balloon Networks

- 383 platforms (35 km)
- StratoSail® TCS (20 km)
- Control
 - Biological analog control algorithm
 - 15° to pole
 - Maintain uniform coverage
- 1 year
- 173,000x real time
- UKMO data

QuickTime[®] and a Graphics decompressor are needed to see this picture.

Legend

Red = balloon position

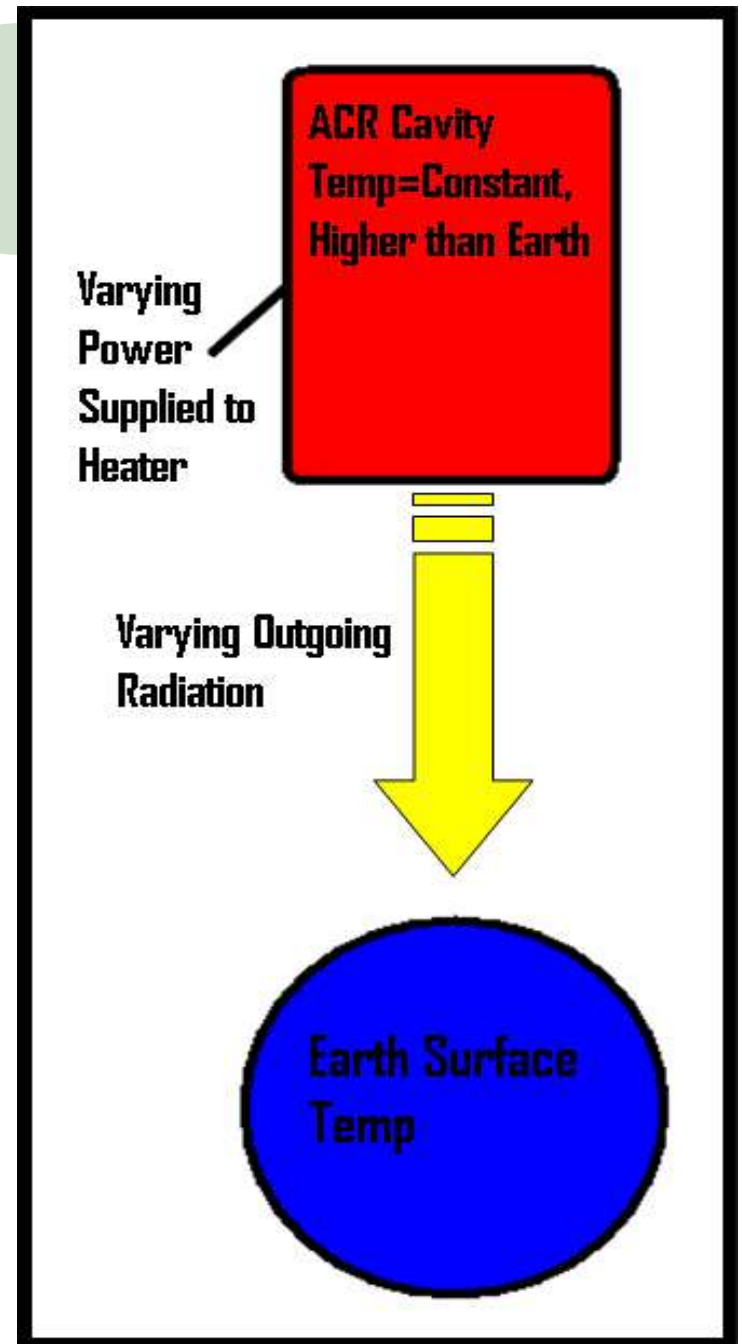
Yellow = 2° elevation angle view zone

Green = zone overlap

Simulation courtesy of
Global Aerospace Corporation

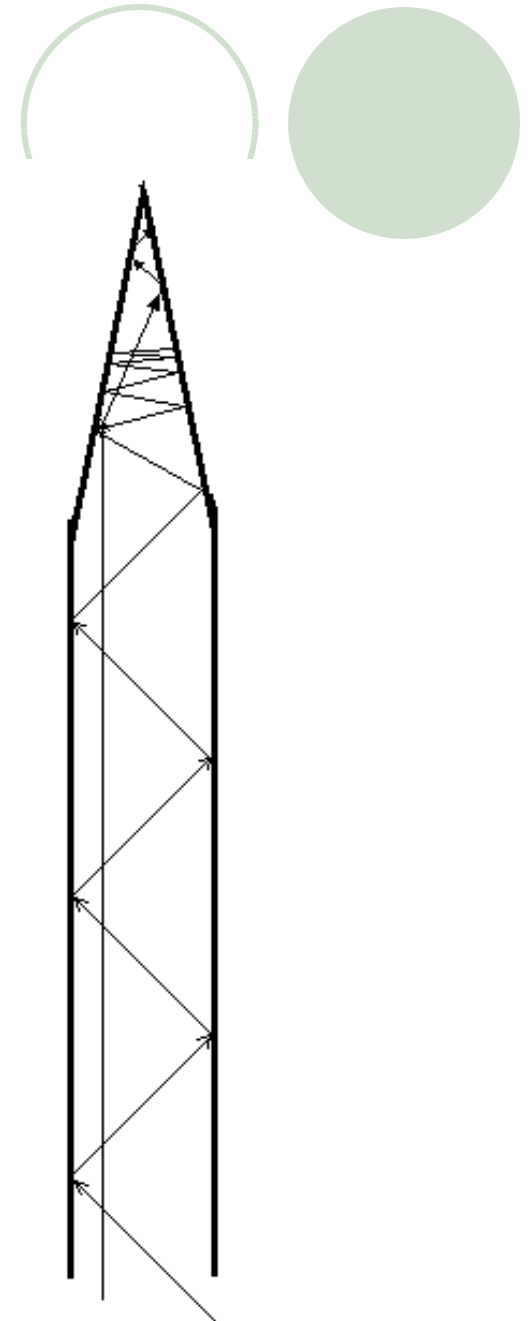
ACR Theory

- Active control of cavity temperature
- Variation of outgoing radiation
 - Warmer scene, less heater power
 - Colder scene, more heater power



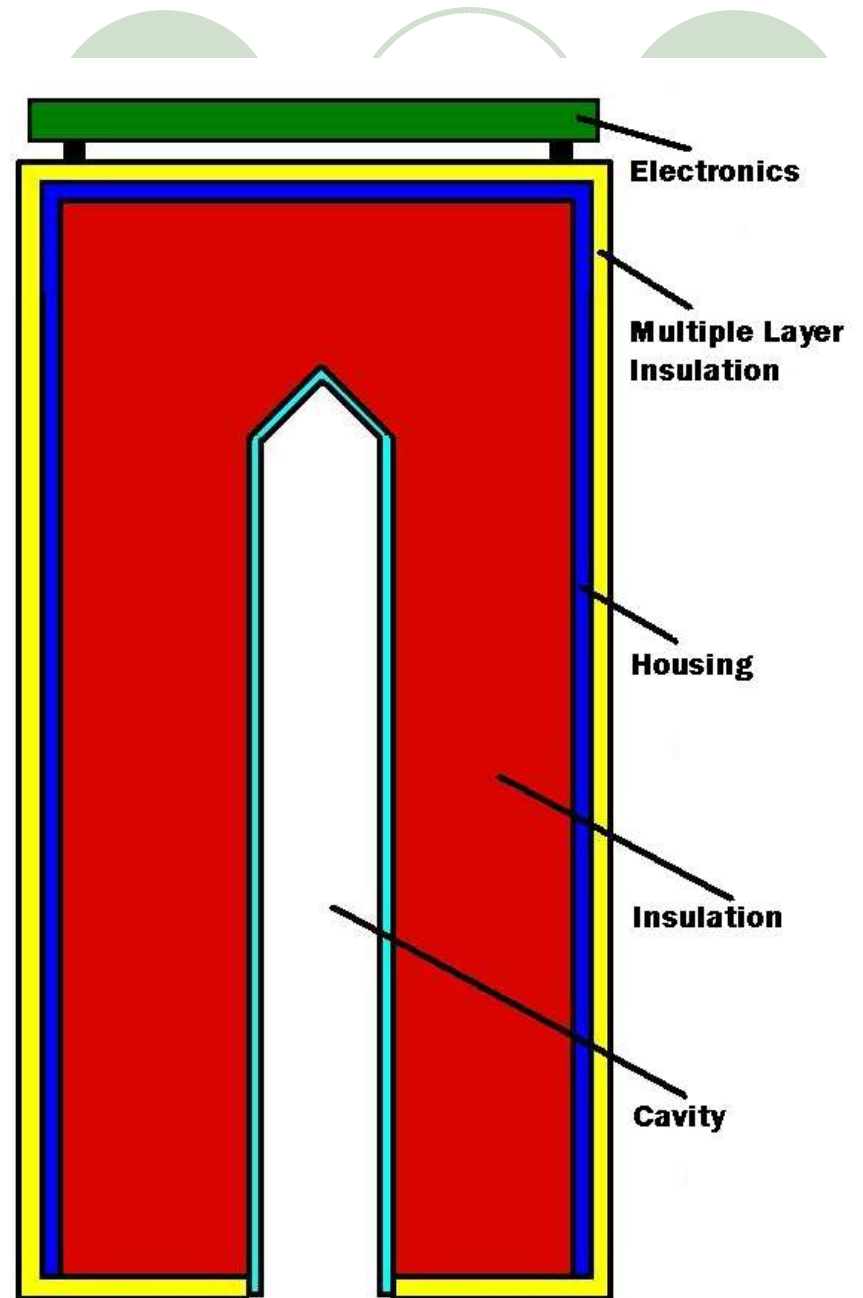
ACR – Internal Reflection

- Cavity Shape Encourages absorption
- Approximates a “Black” Body
 - 100% absorption
 - 100% thermal radiation
 - 0% reflection



ACR Design Issues

- Thermal Management
- Cavity Geometry- size, shape, aperture
- Cavity Temperature Control
- Cavity Calibration



ACR Design- Mechanical Systems

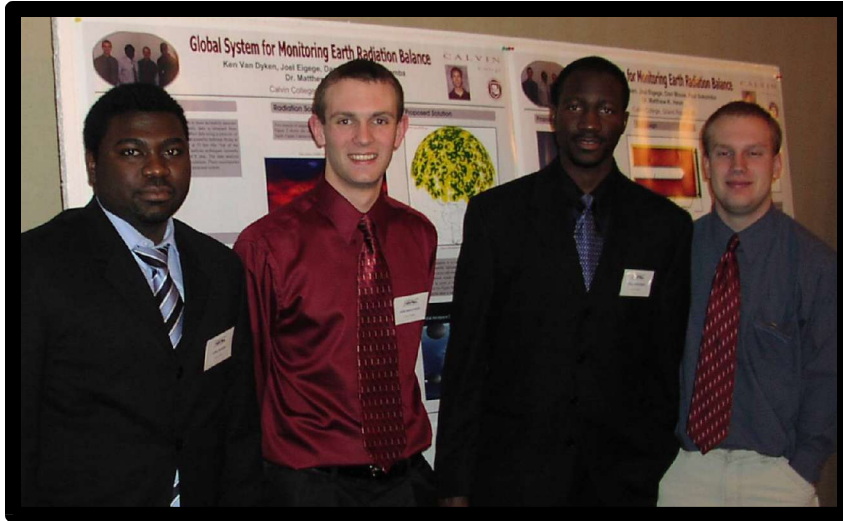
- Cavity geometry design
- Thermal Management
 - Cavity temperature control
 - Cavity temperature distribution
- Weather balloon interface

ACR Design- Electrical Systems



- Power and heater system
- Feedback system
 - Digital or analog
 - PI, PID, or other servo mechanism
- A/D and data storage
- Data transmission

Continuing Calvin College Senior Design Project



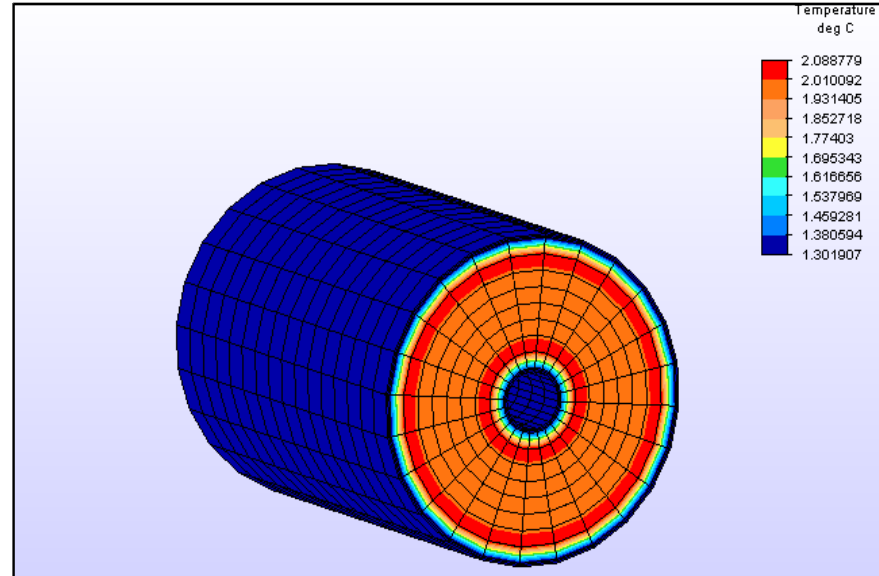
- Initial Project Development
(03-04)
 - Project Proposal
 - Demonstration ACR Prototype



- Project Continuation
(04-05)
 - Finalize ACR Prototype Design
 - Demonstration of Concept Balloon Flight

Initial Project Development (03-04)

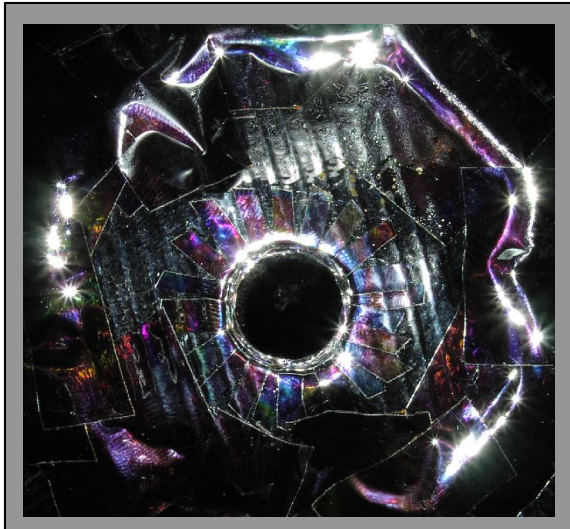
- Thermal Model for cylindrical cavity design
 - Algor[®] Finite Element Model
 - Numerical Model of Thermo-Electric System



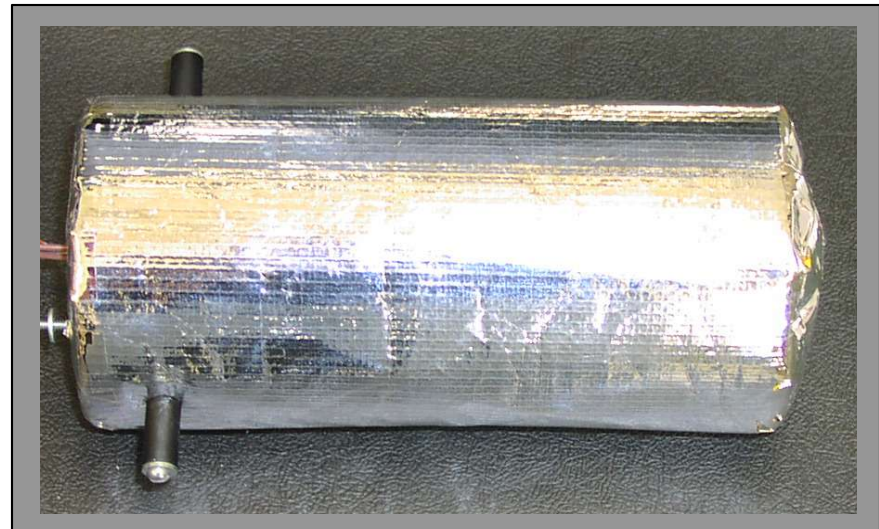
Algor[®] Thermal Model

03-04 Prototype Development

- Implementation of PID temperature control
- Prototype ACR constructed

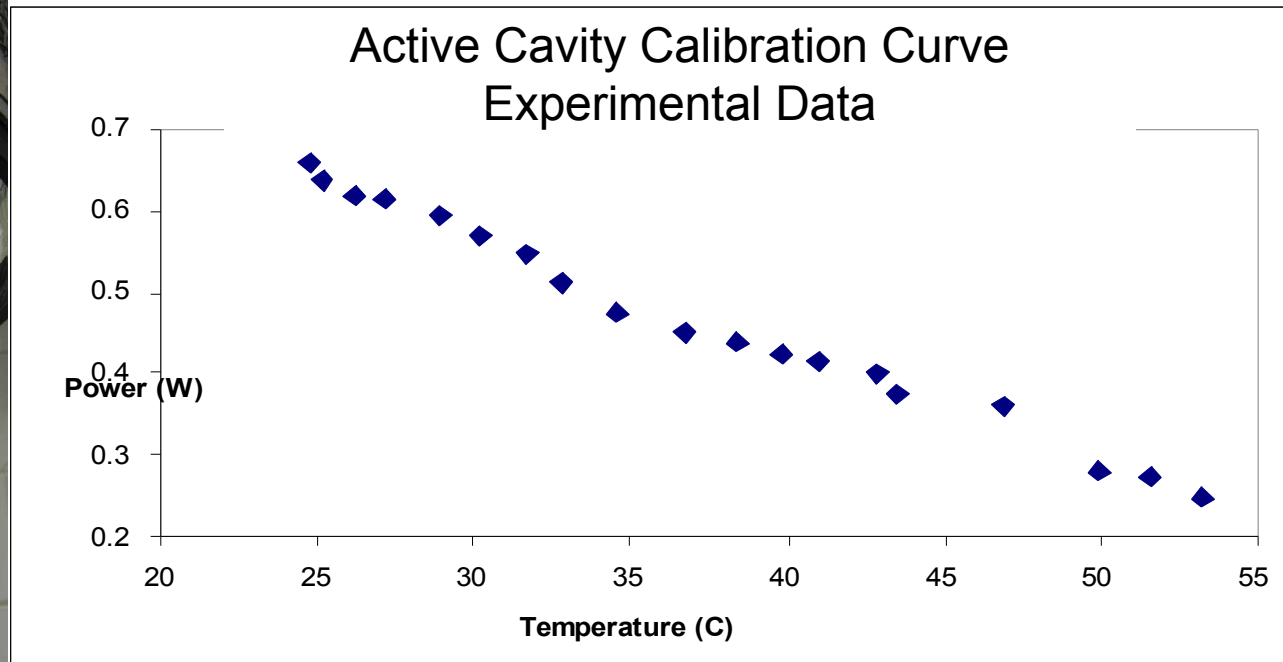


Cavity Aperture



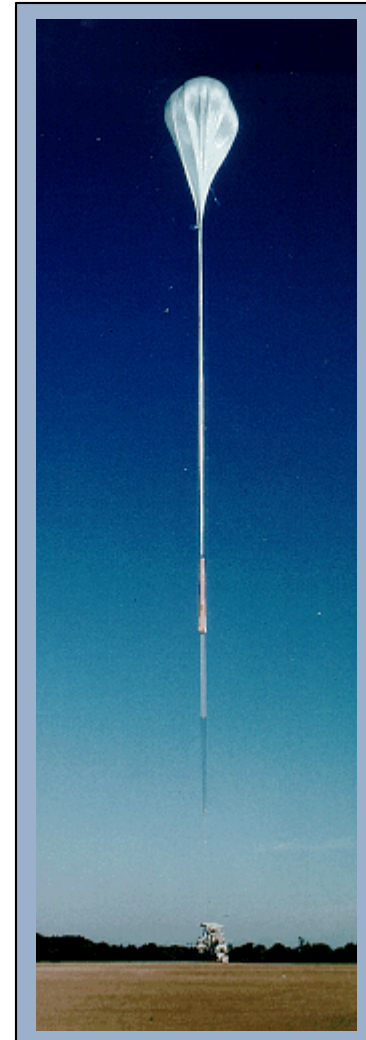
Cavity Side Profile

Prototype Calibration



2004-05 ACR Objectives

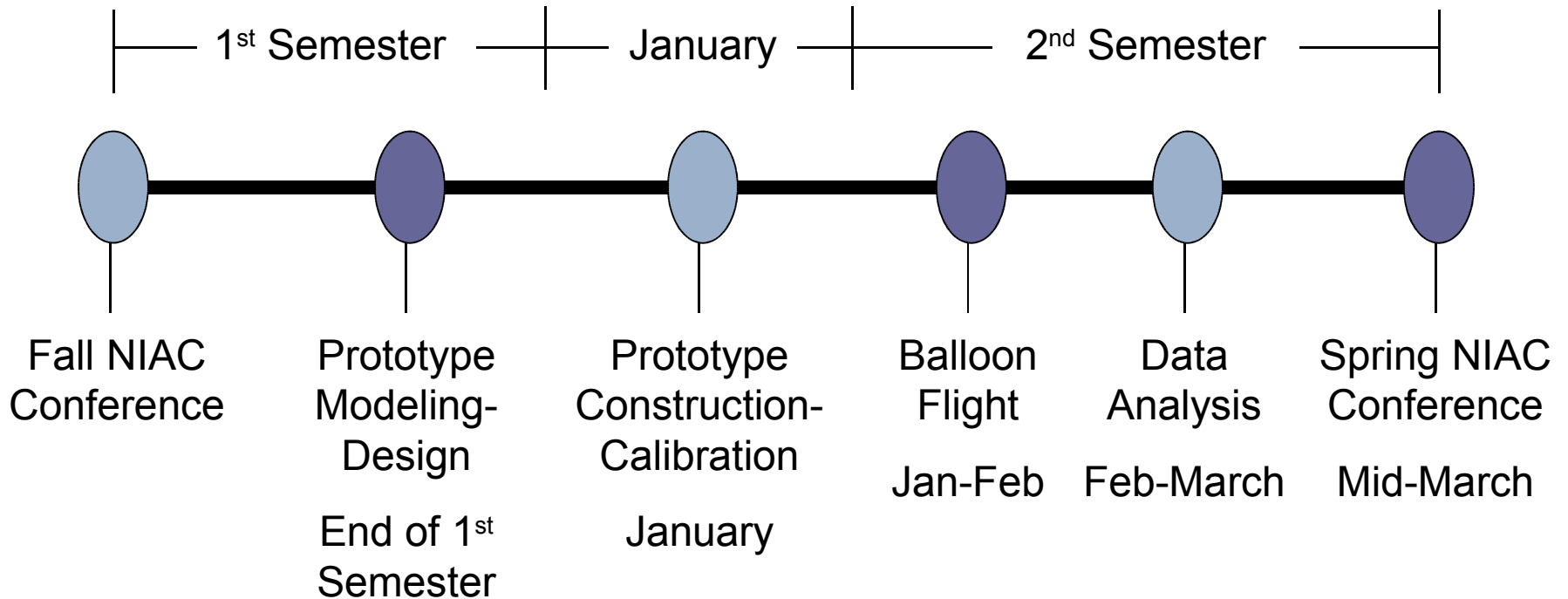
- Thermal redesign of ACR cavity
- Electrical controls finalization
- Construct flight ACR's
- Interface mech/elect with weather balloon radiosonde
- Demonstration of concept balloon flight with weather balloon



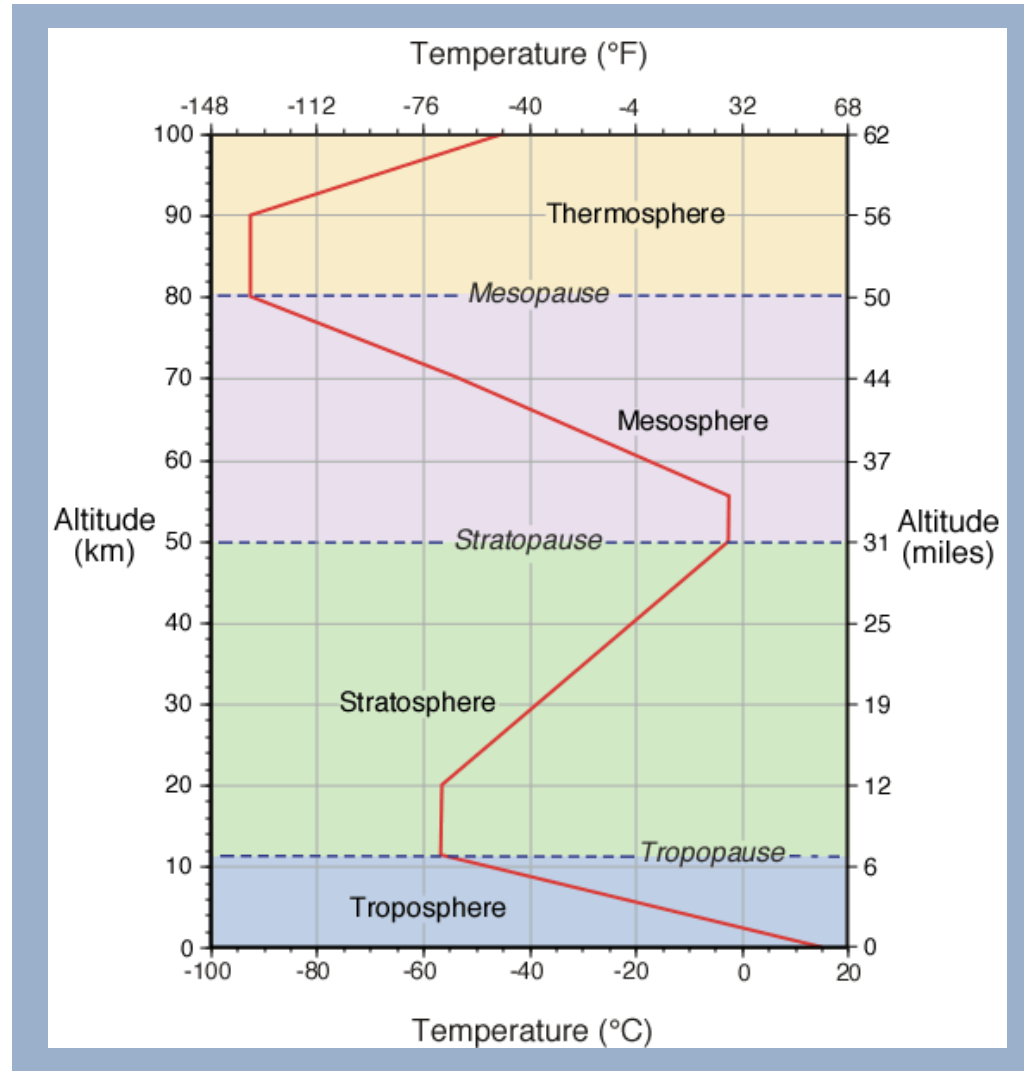
Design Comparison

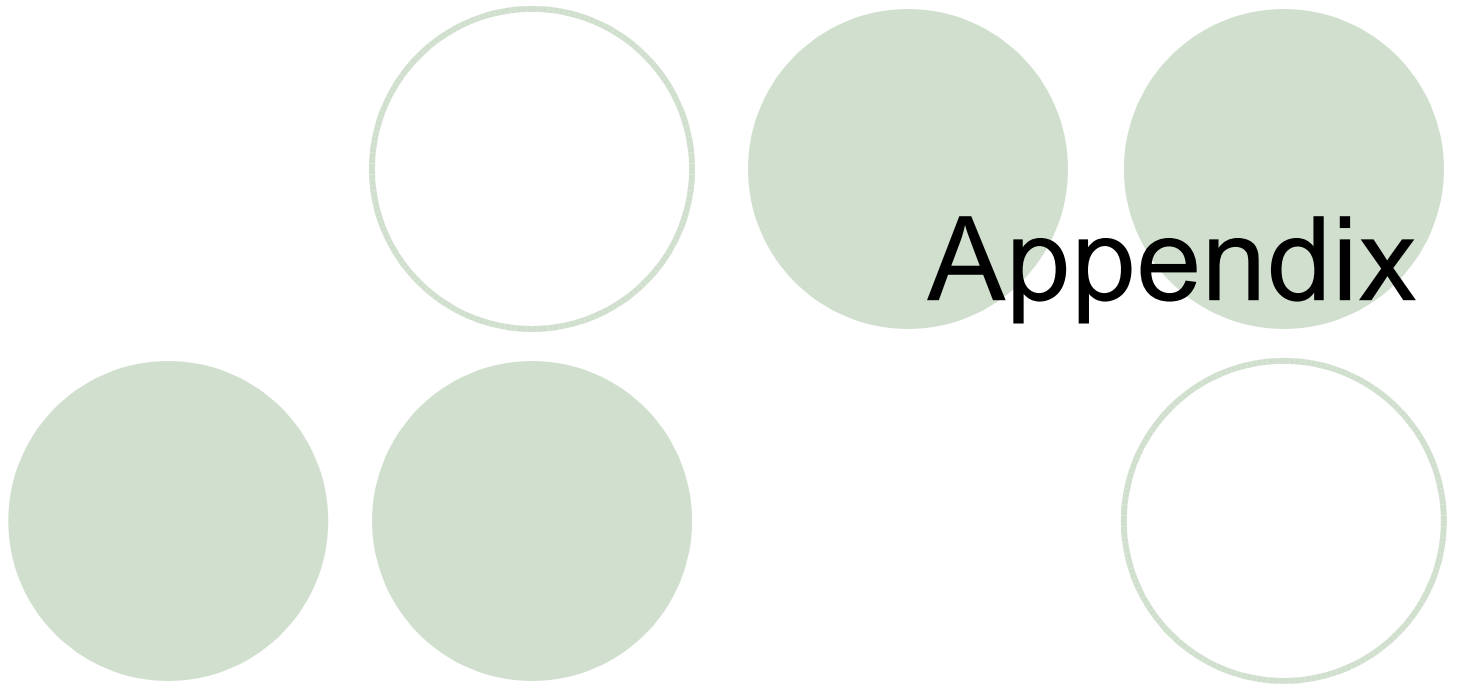
	2003-04	2004-05
Mass	0.67 kg	< 0.5 kg
Surface Density	-	3 oz/in ²
Power Consumption	< 1.0 W	< 0.5 W
Power Source	AC line	Battery
Environment Temp	300 K	>240 K
Altitude	0 m	0–25 km

2004–2005 Schedule



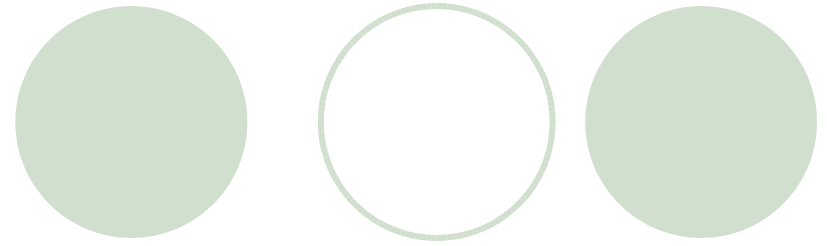
Questions?





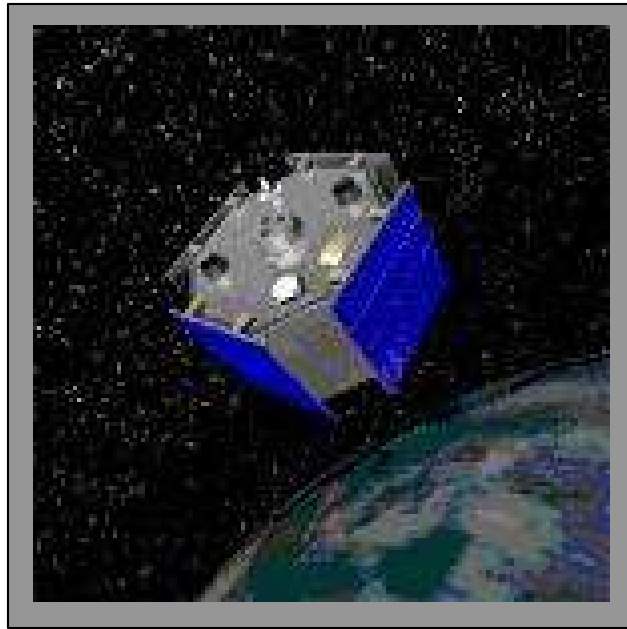
Appendix

Proposed Solution



- Radiation Measurement

ACR



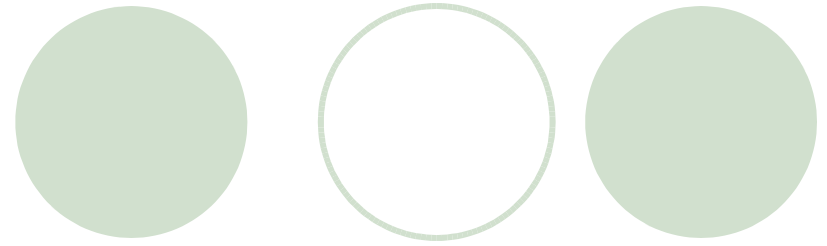
Satellite

vs.



Scientific Balloon

Proposed Solution



- Radiation Measurement
 - Active Cavity Radiometer (ACR)



Global aerospace html link here

Educational Context



- Calvin College
 - Senior Design Course