"Promoting Science and Education through High Altitude Balloons and Amateur Radio"

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Jim Langsted KCØRPS

for:

285 TechConnect Club

August 1, 2009, Conifer, CO. USA

Edge of Space Sciences
EOSS
Resources
www.eoss.org

Elements of a Successful Flight

- Flight Prediction
- Setup and Ground Station Operations
- Coordination with FAA
- Launch
- Communications
- Tracking
- Recovery
- *Lunch*

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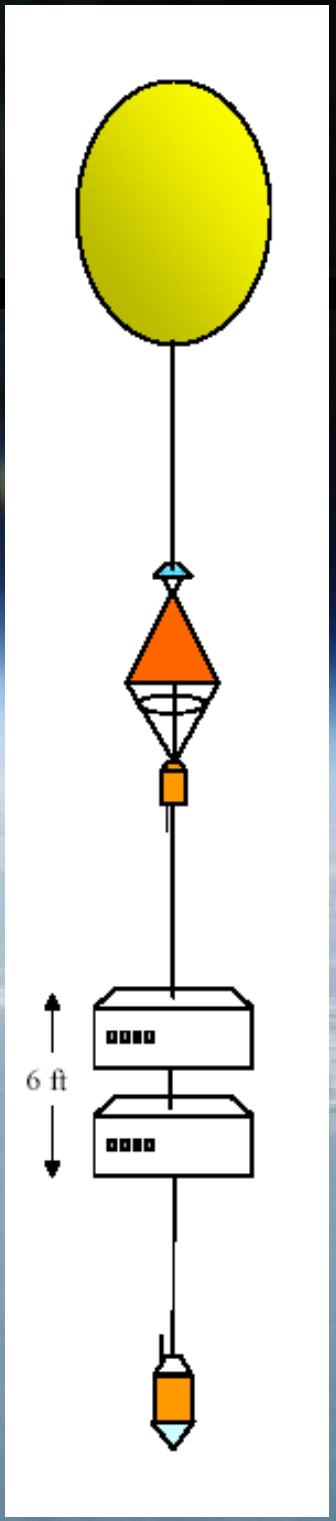
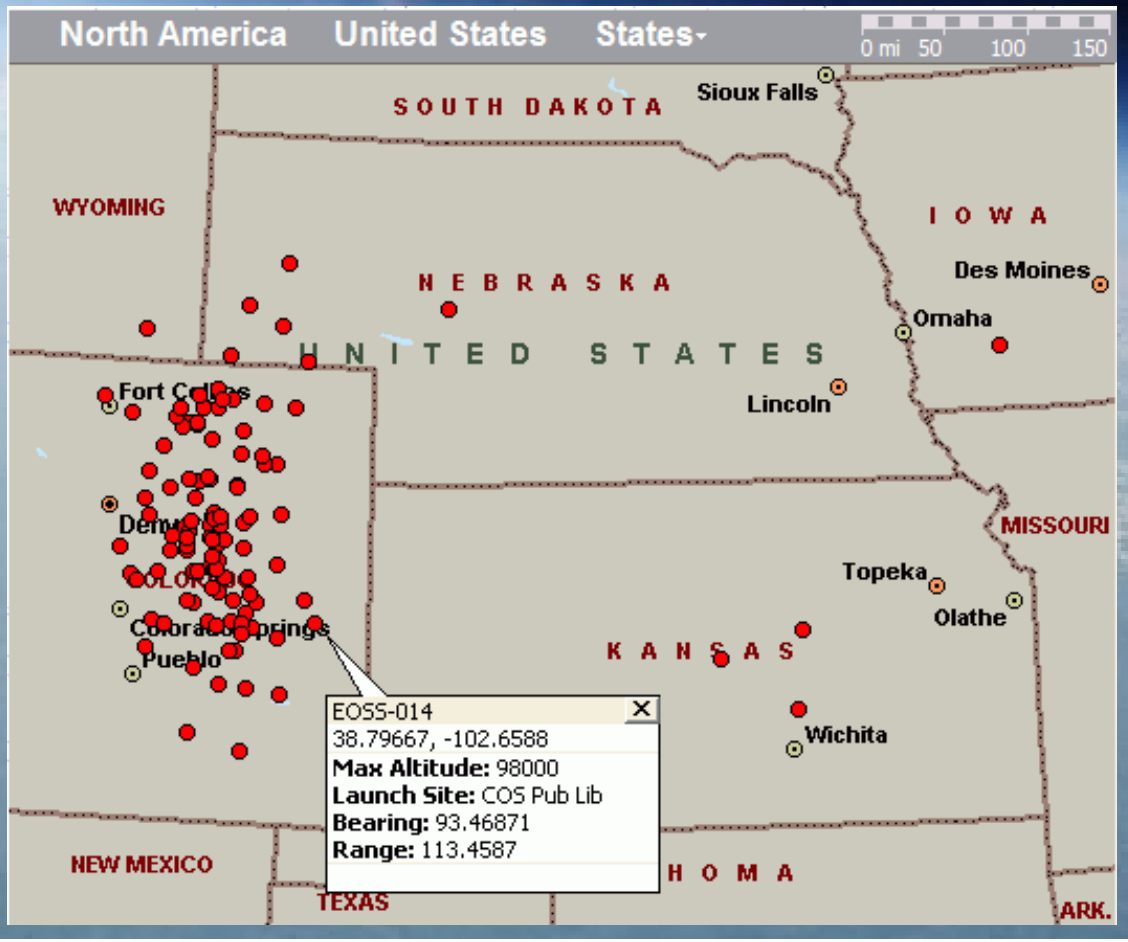


Yeah? So what?

- Amateur high altitude balloons go to "The Edge of Space" …
  - Typical apogees of 100,000 ft MSL
  - Radio horizons of 400 miles
  - Above 99% of the Earth's atmosphere
  - Too high for (most) aircraft or model rockets
  - Not really "space" (360,000+ ft MSL), but close enough for science and student experiments

EOSS History

- EOSS-001 – November 18, 1990
  - Robert Clement Park, Littleton, CO
- EOSS-145 – August 1, 2009
  - 100% recovery
- EOSS-006
  - May 30, 1992
  - 18 hours, 218 miles
- Predictions



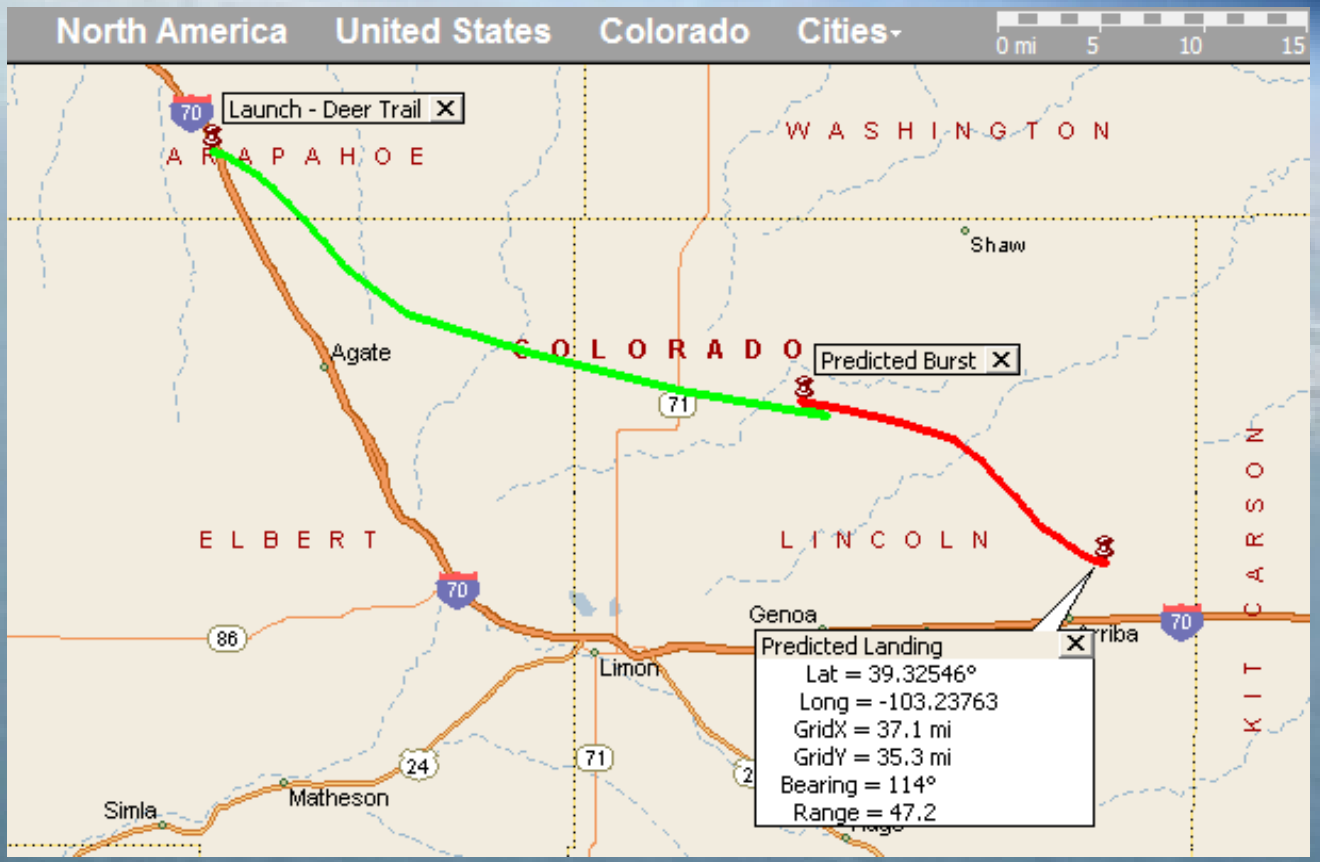
The Father of Amateur Radio Ballooning

- First ever ARHAB: Pauli OH2DV (Finland) May 1967

- Bill Brown WB8ELK's pioneering US flight August 15, 1987 from Findlay, OH carrying ATV & 2m FM transmitter.

Predictions

- **Rick von Glahn NØKKZ**
  - **Balloon Track for Windows**
    - **Implementation of several WB8ELK programs**
    - **Several additional elements**



Predictions (wind models)

Models

Model Name	Prognostication Window	Increment	Max Altitude
RUC	12 hours	hourly	~54,000 ft. (100 HPa)
NAM 12 km	48 hours	3 hour	~ 68,000 ft. (50 HPa)
NAM 40 km	84 hours	3 hour	~ 68,000 ft. (50 HPa)
GFS short	0-84 hours	3 hour	~ 88,000 ft. (20 HPa)
GFS medium	0-180 hours	6 hour increments	~ 88,000 ft. (20 HPa)
GFS long	192-384 hours	12 hour increments	~ 88,000 ft. (20 HPa)
AFWA 15 km	48 hours	3 hour	~ 68,000 ft. (50 HPa)
AFWA 45 km	72 hours	3 hour	~ 68,000 ft. (50 HPa)

Prognostication Window

Below is a chart that shows the number of hours a given model can forecast into the future.

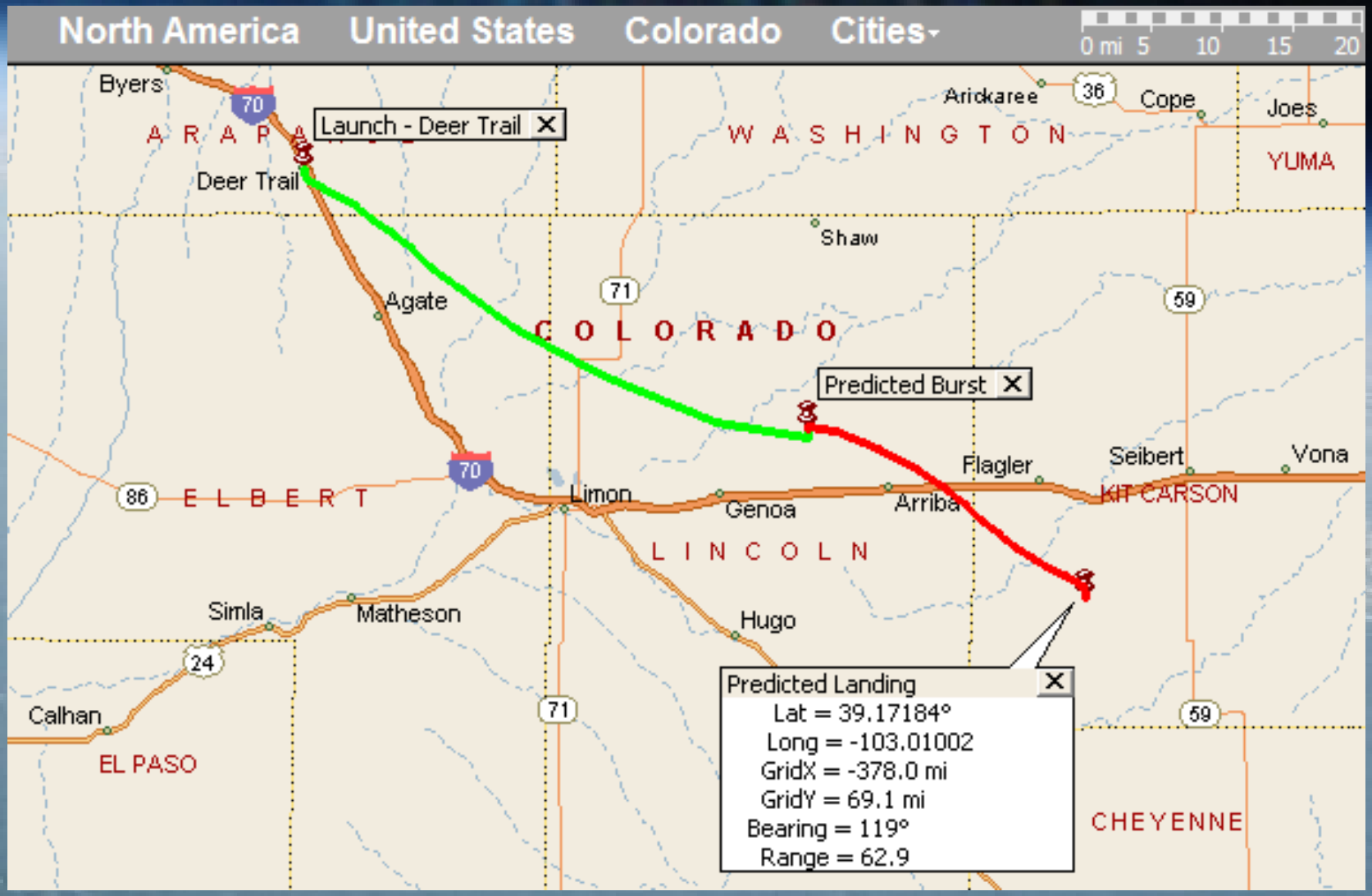
	Days		1		2		3		4		5		6		7		8			16
Model	Hours	12	24	36	48	60	72	84	96	108	120	132	144	156	168	180	192	204	...	384
RUC		■																		
NAM 12 km		■	■	■	■															
NAM 40 km		■	■	■	■	■	■	■												
GFS short		■	■	■	■	■	■	■												
GFS medium		■	■	■	■	■	■	■	■	■	■	■	■	■	■	■				
GFS long																	■	■	■	■
AFWA 15 km		■	■	■	■															
AFWA 45 km		■	■	■	■	■	■													

Predictions (wind models)

- 7 days

Predictions (wind models)

- 3 days



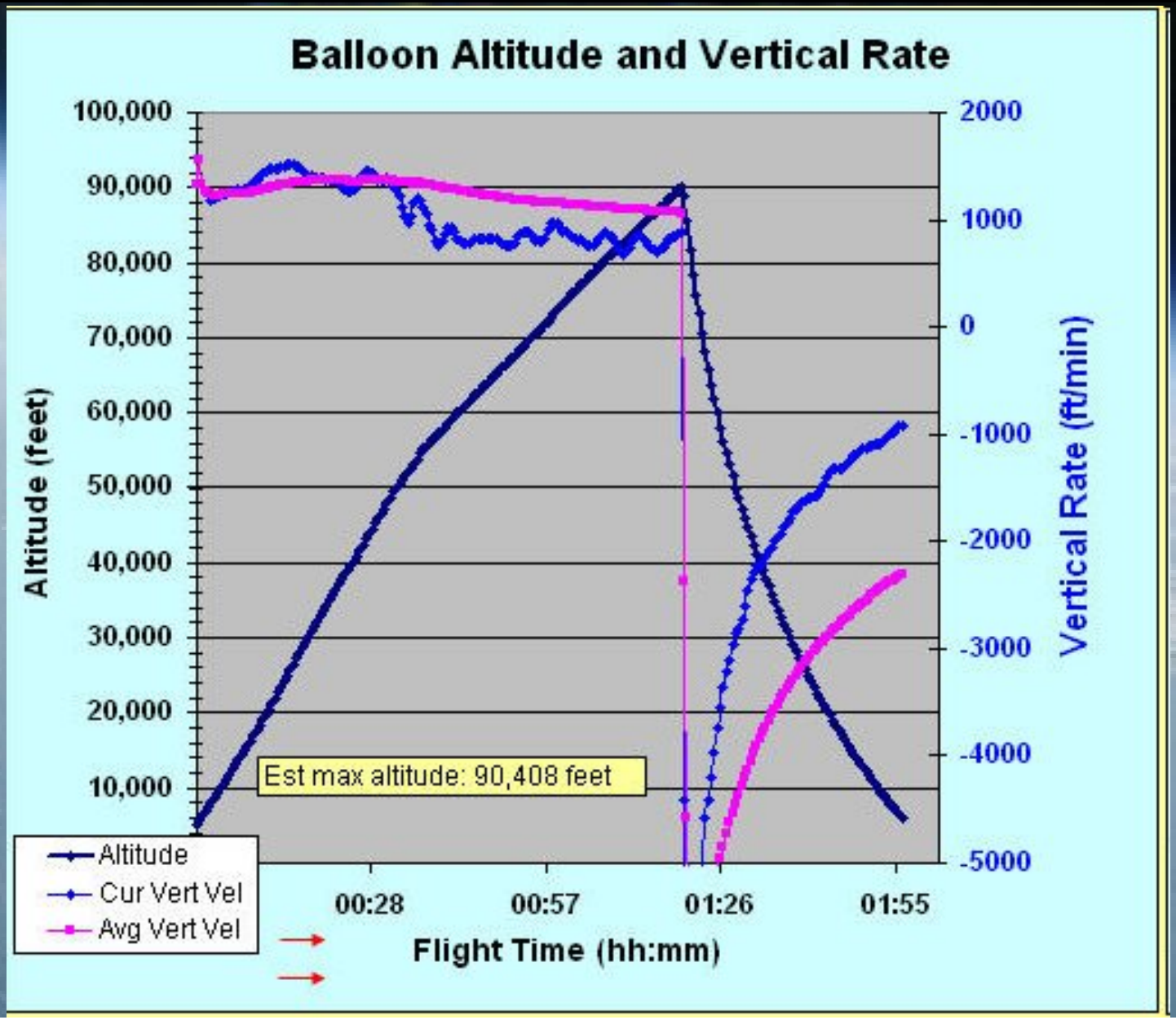
Predictions (wind models)

- 1 day

Predictions (wind models)

- Morning of

Predictions (ascent & descent models)



Predictions (descent model)

- Parachute model from Washington High Power Rocketry web pages
- Payloads add significant drag – use experience
- Post burst chaos (video)

DF Beacon

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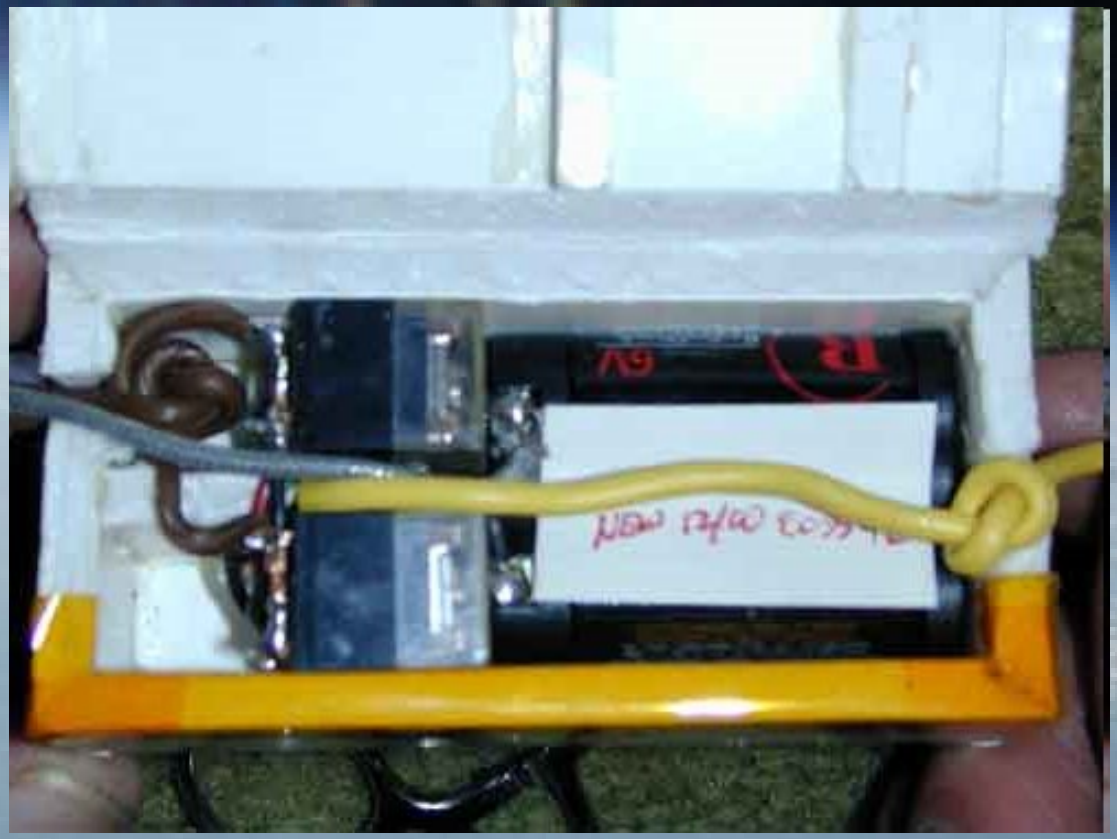
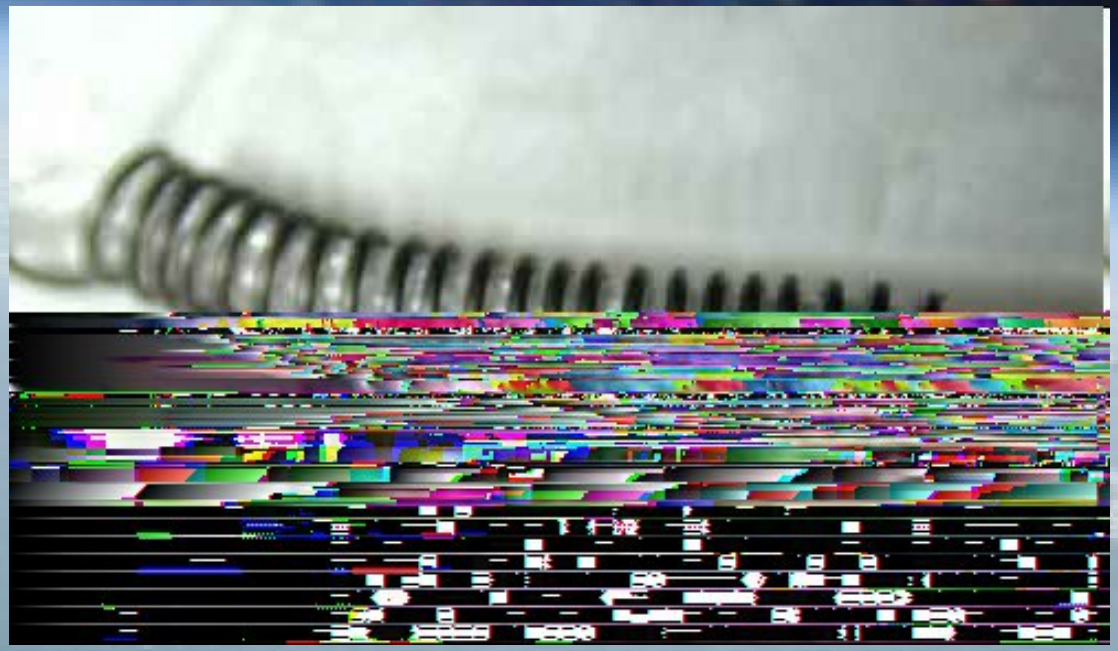


DF Beacon



APRS Module

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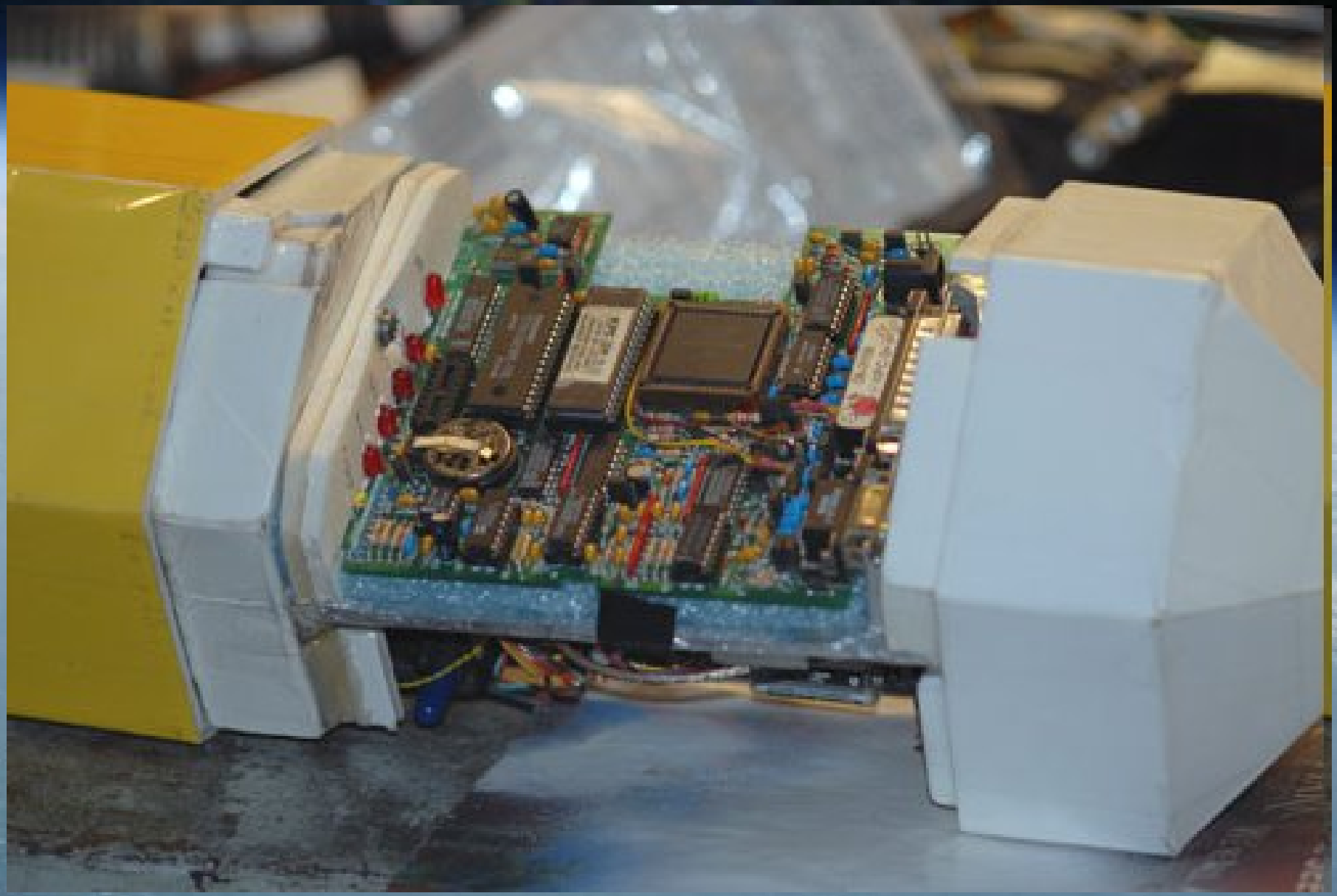
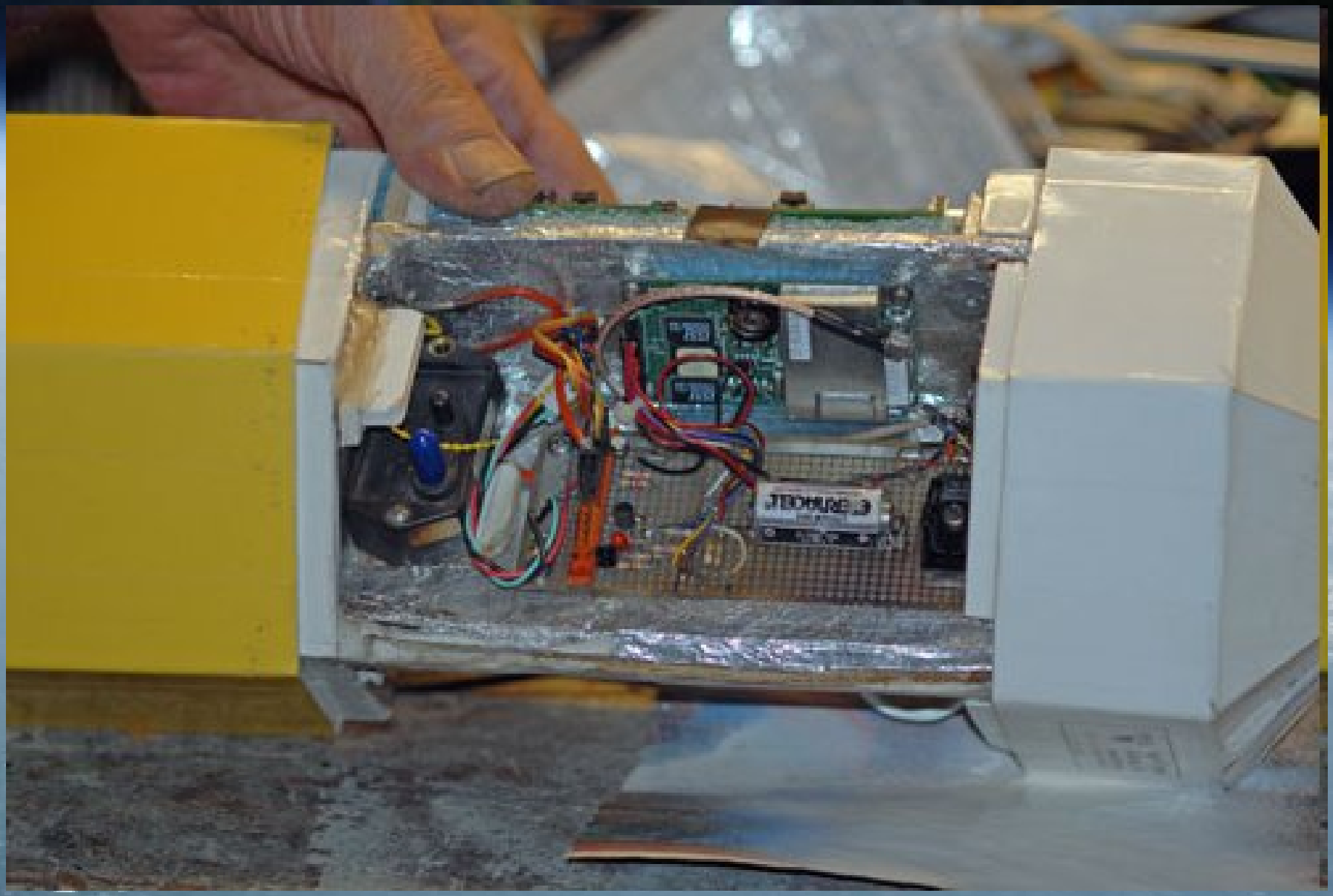


APRS Module



FAA Coordination

- **Exempt vs. FAA Regulated**
  - 12# total, 6# each piece max
- **Certificate of Waiver or Authorization**
  - Exempt from:
    - Radar reflector
    - 1.5 kW transponder beacon
  - Additional requirements (trade off)
    - Preflight notification
    - Internet tracking (dist & bearing from VORs)
    - Cutdown capability
- **We coordinate with FAA on <u>all</u> flights**

Ground Station (Windsor)

Ground Station (Deer Trail)

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Ground Station

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Launch Operation

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Launch Operations

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Launch Operation

Tracking Operations

- Breakfast meeting at 5:00 am !
- Pre-position around predicted landing site before launch
- Tracking Coordinator
- Each tracker is DF capable
  - The only way before EOSS-21 !
  - Standard map and grid
- Communications
  - Wide area repeater
  - Simplex backup
- Onboard APRS tracking
  - Balloon and trackers
  - Digipeater on balloons
  - Non-standard frequency

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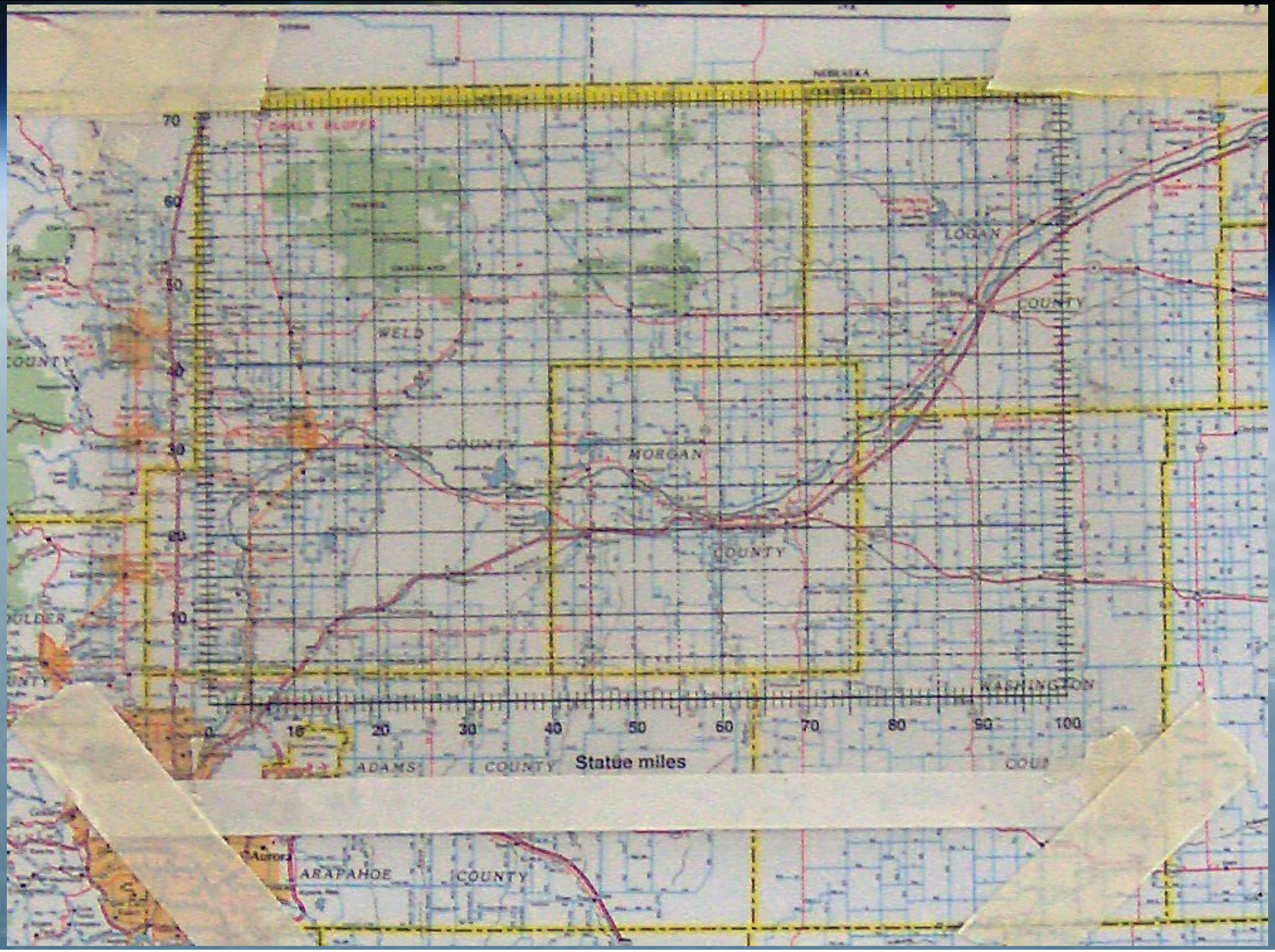
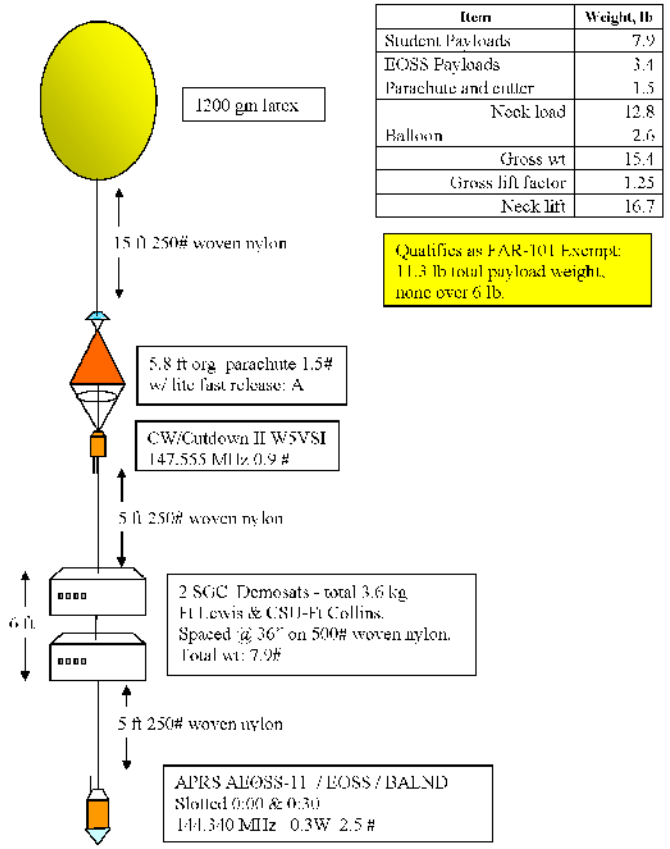
Tracking Operations



Tracking Operations

Payload Plan **EOSS-145** **1/2 Aug 2009 @ 0710**
Rev C – Final weights



Item	Weight, lb
Student Payloads	7.9
EOSS Payloads	3.4
Parachute and cutter	1.5
Neck load	12.8
Balloon	2.6
Gross wt	15.4
Gross lift factor	1.25
Neck lift	16.7

Qualifies as FAR-101 Exempt:
11.3 lb total payload weight,
none over 6 lb.

EOSS-145_Payload_Plan_C.doc

- **DF Beacon 147.555 MHz**
  - CW ID
  - 20 sec tone
  - 30 silence for cutdown receiver
- **APRS 144.340 MHz**
  - Time slotting (for multiple balloons)
  - GPS must work at altitude
    - Units that don't have:
      - Scud circuit
      - Self-limitations

Foxhunter's heaven

- Recovery is EOSS's "Prime Directive"
  - 100% out of 145 flights in 19 years
  - First 20+ flights (and some since then) relied strictly on RDF

– Since going GPS/APRS, observing the landing is common!

– Even with GPS and APRS, final recovery often relies on DFing.

– with some occasional help from Air One (KCØRIA/AM)

Recovery Operations

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Recovery Operations

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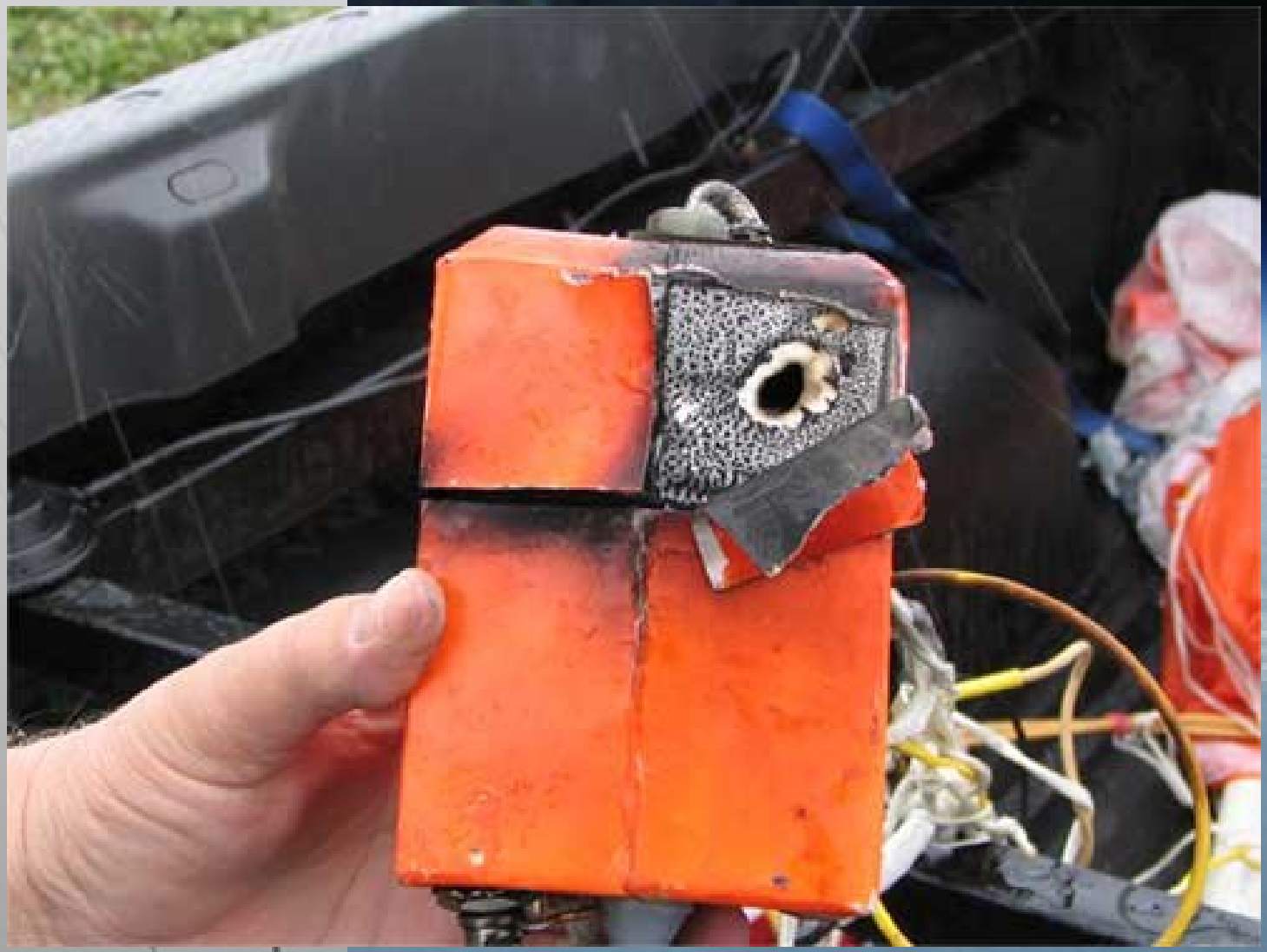
Even thru some “rough” landings!



Recovery Operations

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Recovery Operations

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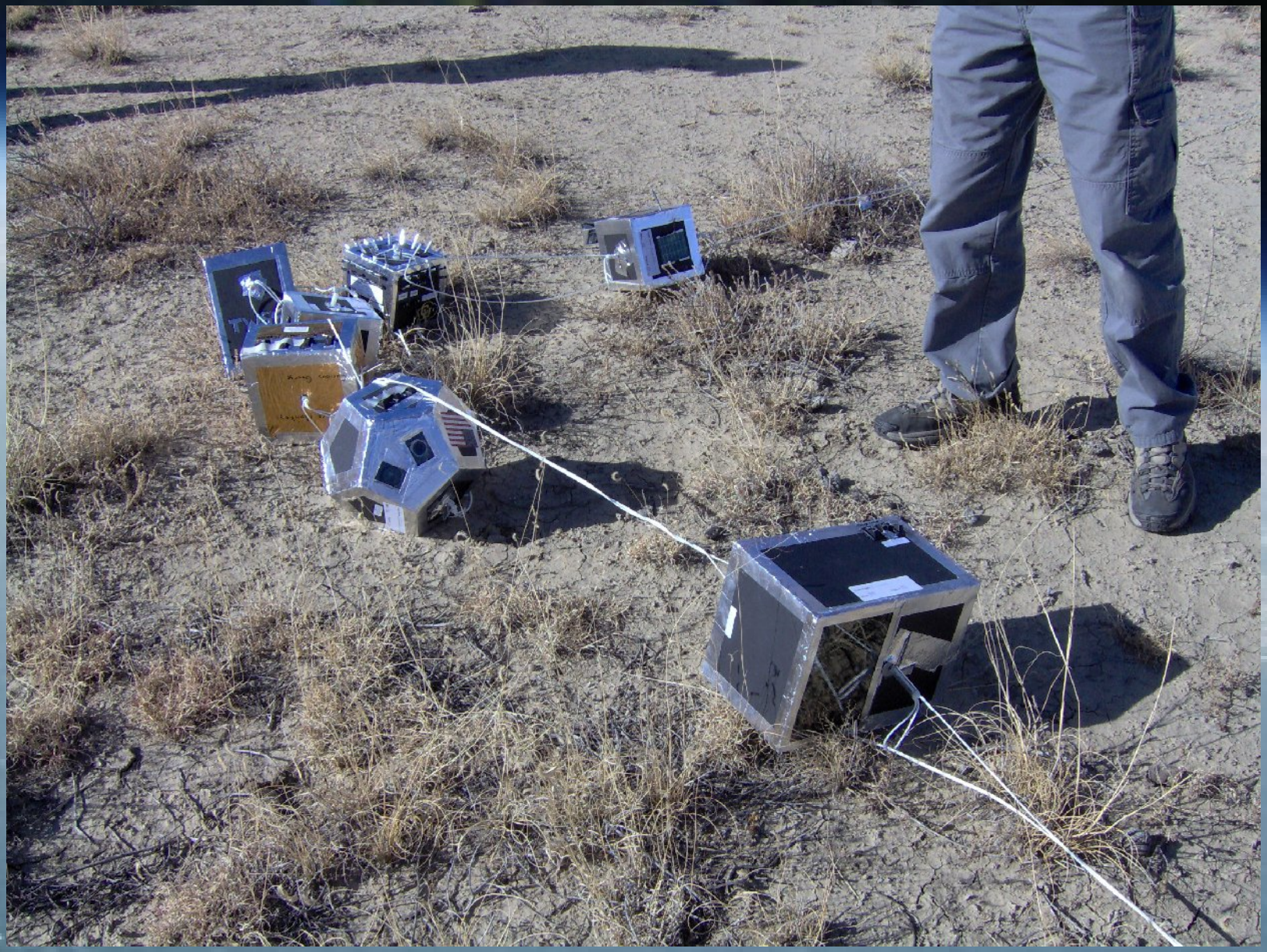
Recovery Operations



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Recovery Operations

Recovery Operations

(GPSL video)

(The End!)