

Pre-Burst Chaos

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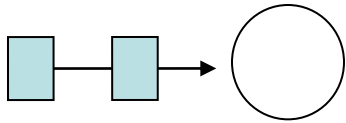
Greencastle, Indiana

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www.depauw.edu/acad/physics/base

Indiana Space & Earth Workshop
Flight 12 Nov.2009 video

72,000' first wind sheer
76,000' Payloads are stable
82,000' Payloads go horizontal

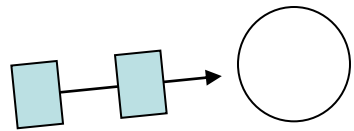


Taylor University Flight October 2009

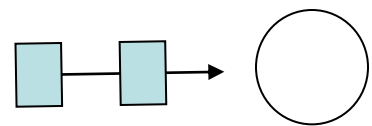
Flight for college student experiments including my son

Photos were shared by Jeff Dailey, Taylor University

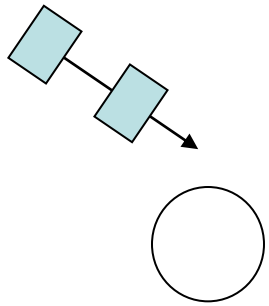
82,400'



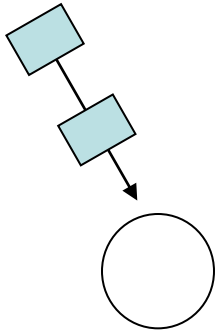
82,500'



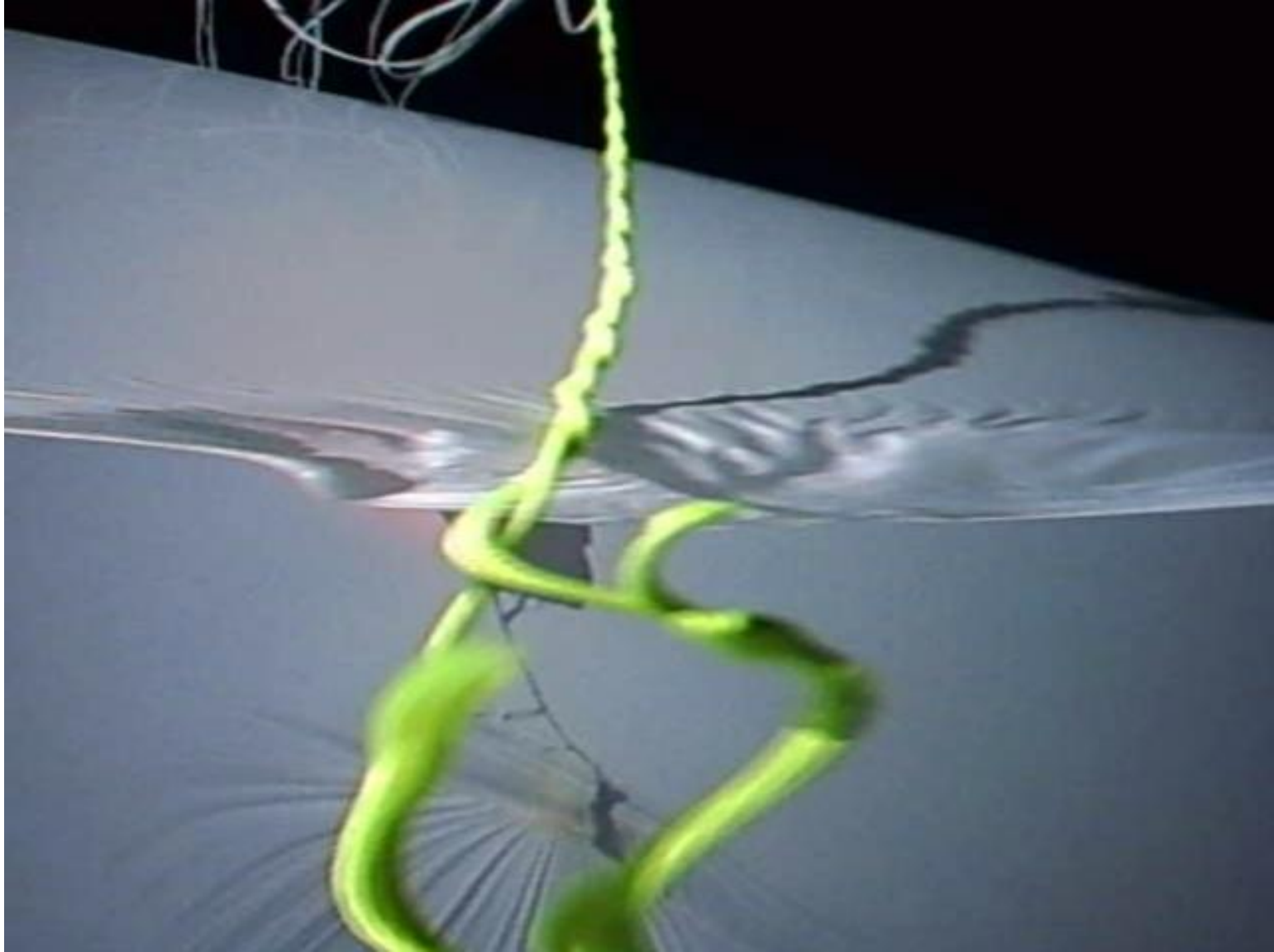
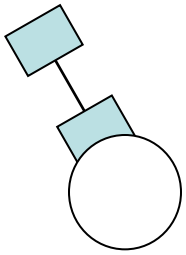
82,600'
Payload and
Command are
above balloon



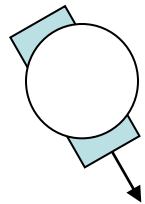
82,625'
Chute on top of
balloon



82,625'
Command flies
through balloon



82,625'
Post burst start



Memsic 2125 Dual-Axis Accelerometer

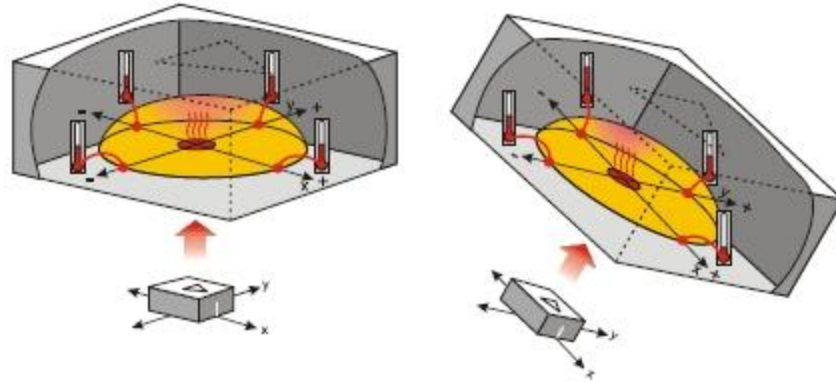
Measures ± 3 g on each axis

Simple pulse output of g-force for each axis

TTL/CMOS compatible 100 Hz PWM output signal with duty cycle proportional to acceleration

www.parallax.com

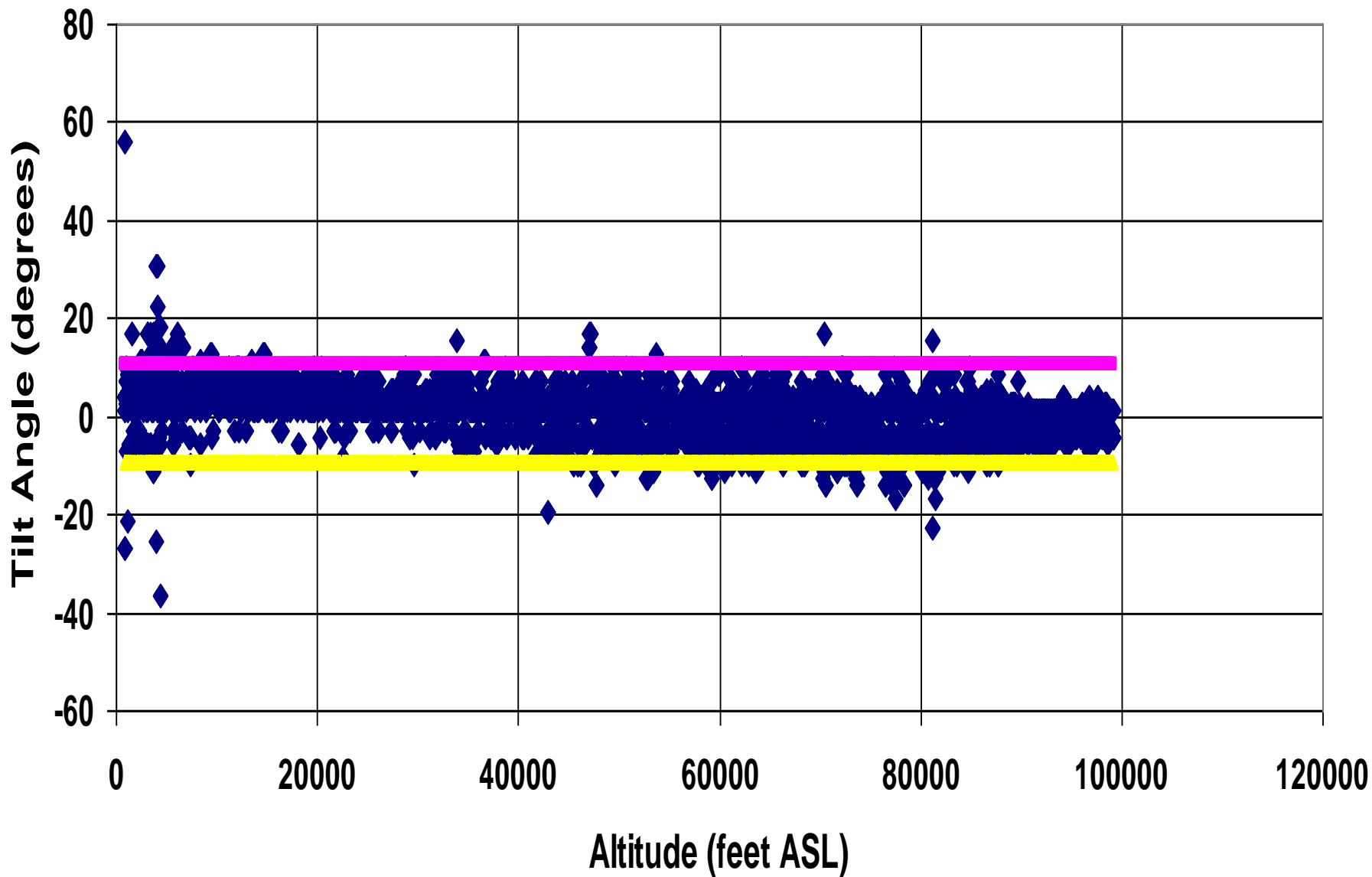
Theory of Operation



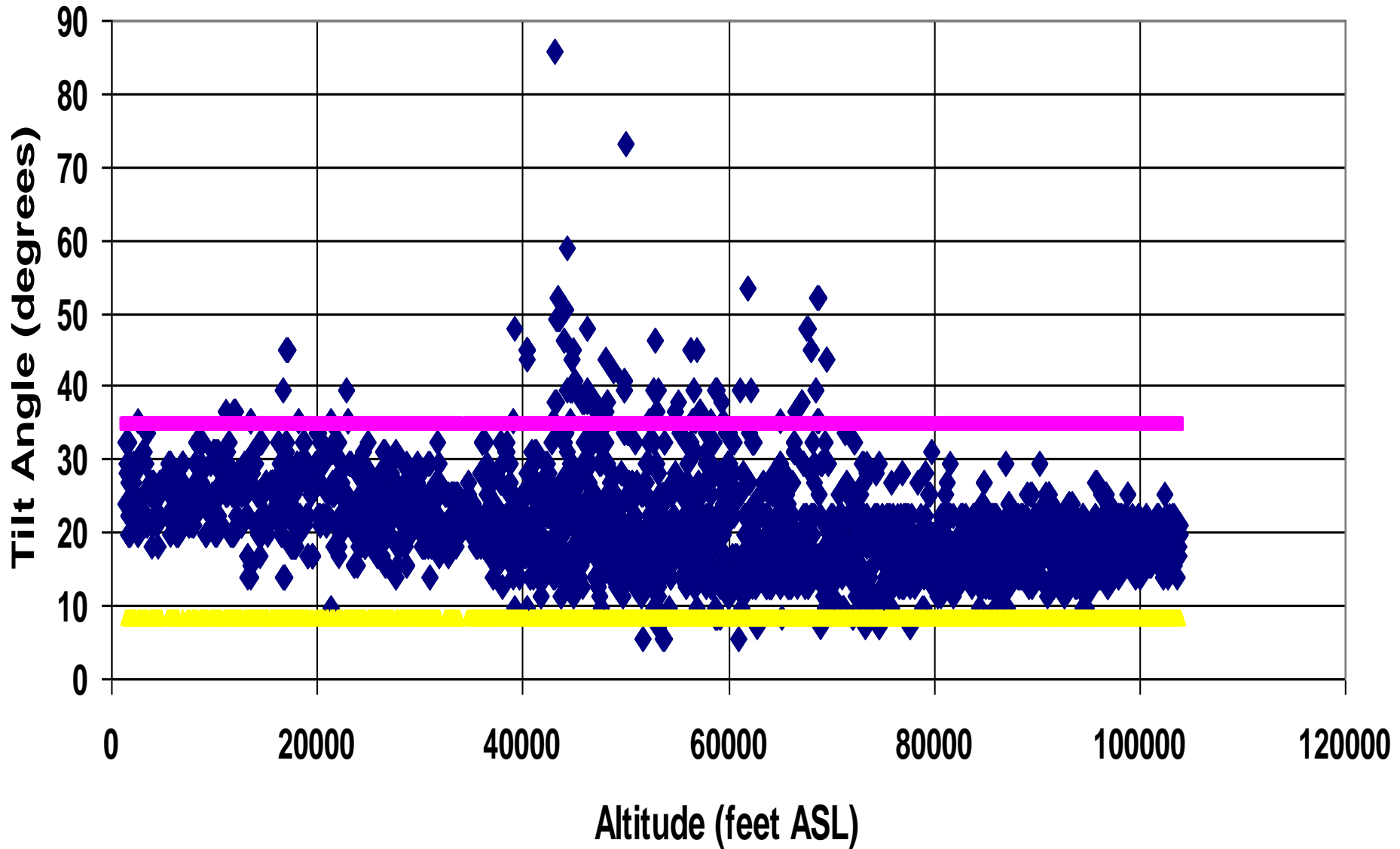
Heated gas bubble rises inside sensor. When tilted the temperature sensors read different values.

<http://www.parallax.com/Portals/0/Downloads/docs/prod/sens/28017-Memsic2Axis-v2.0.pdf>

BASE 28 Ascent



BASE 34 Ascent

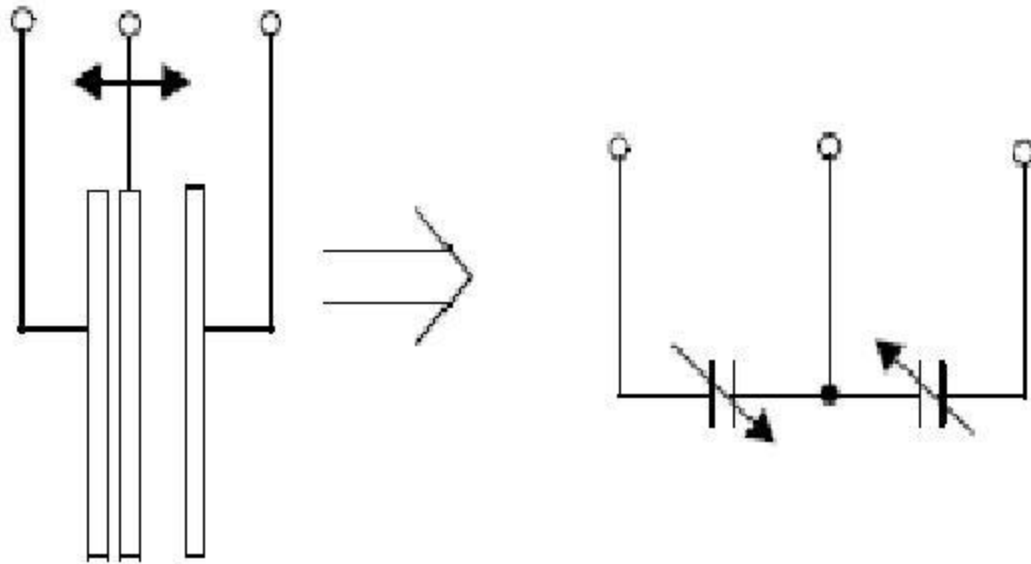


Freescale MMA7361L 3-Axis Accelerometer

- **$\pm 1.5g$, $\pm 6g$**
- **Operates on + 3.3 VDC**
- **Micromachined dual capacitors**
- **Voltage proportional to acceleration**
- **Zero acceleration = 1.65 Volts**

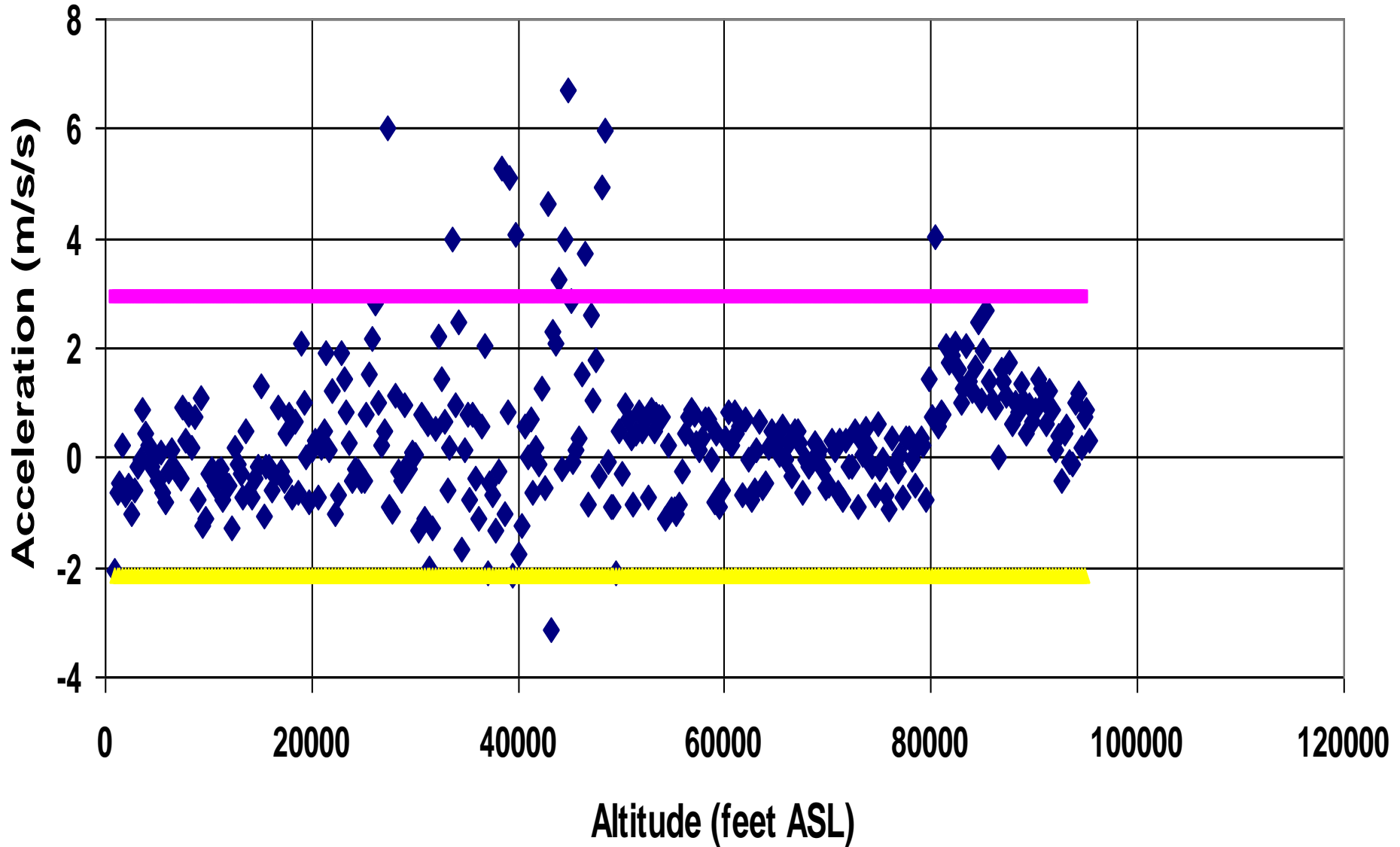
www.sparkfun.com

Acceleration



<http://www.sparkfun.com/datasheets/Components/General/MMA7361L.pdf>

BASE 43 Ascent



Clear Air Turbulence

http://www.turbulenceforecast.com/clear_air_turbulence.php

Clear Air Turbulence Forecast - CAT (3 hr US Forecast)

View Forecast: [3 hr](#) [6 hr](#)

[Ads by Google](#)

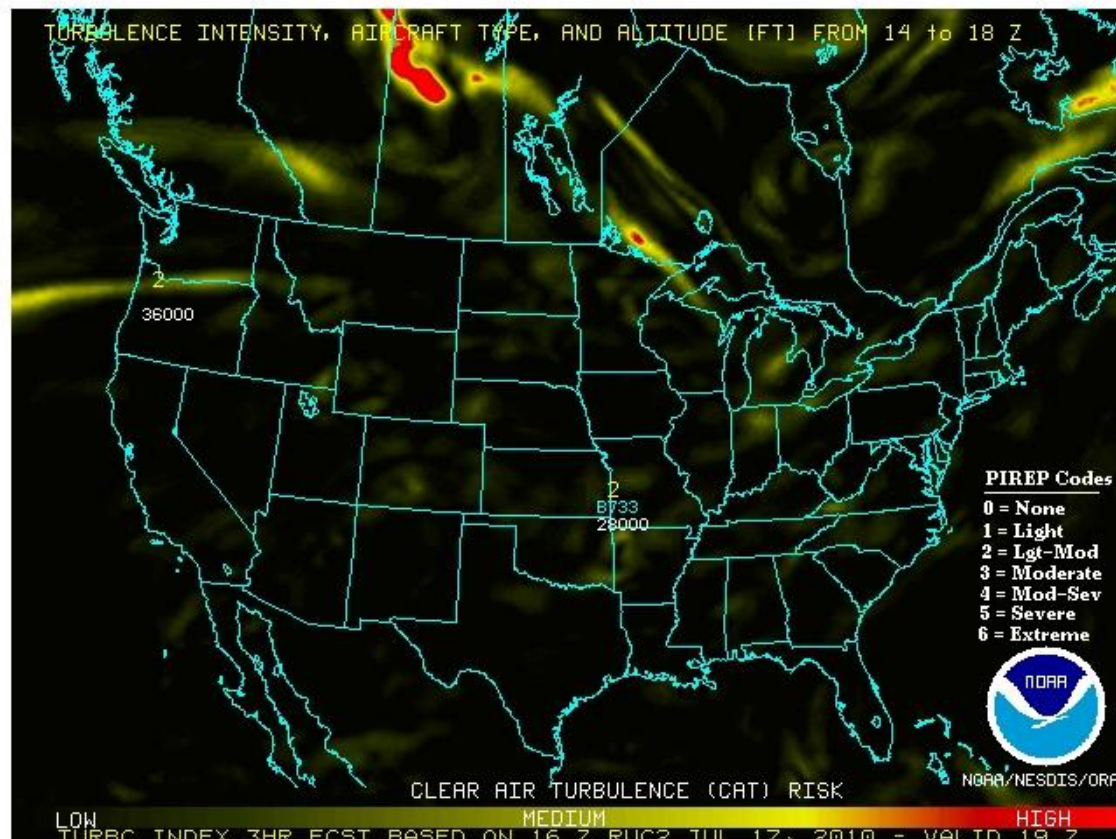
[Scared of Flying](#)

[Turbulence Fear](#)

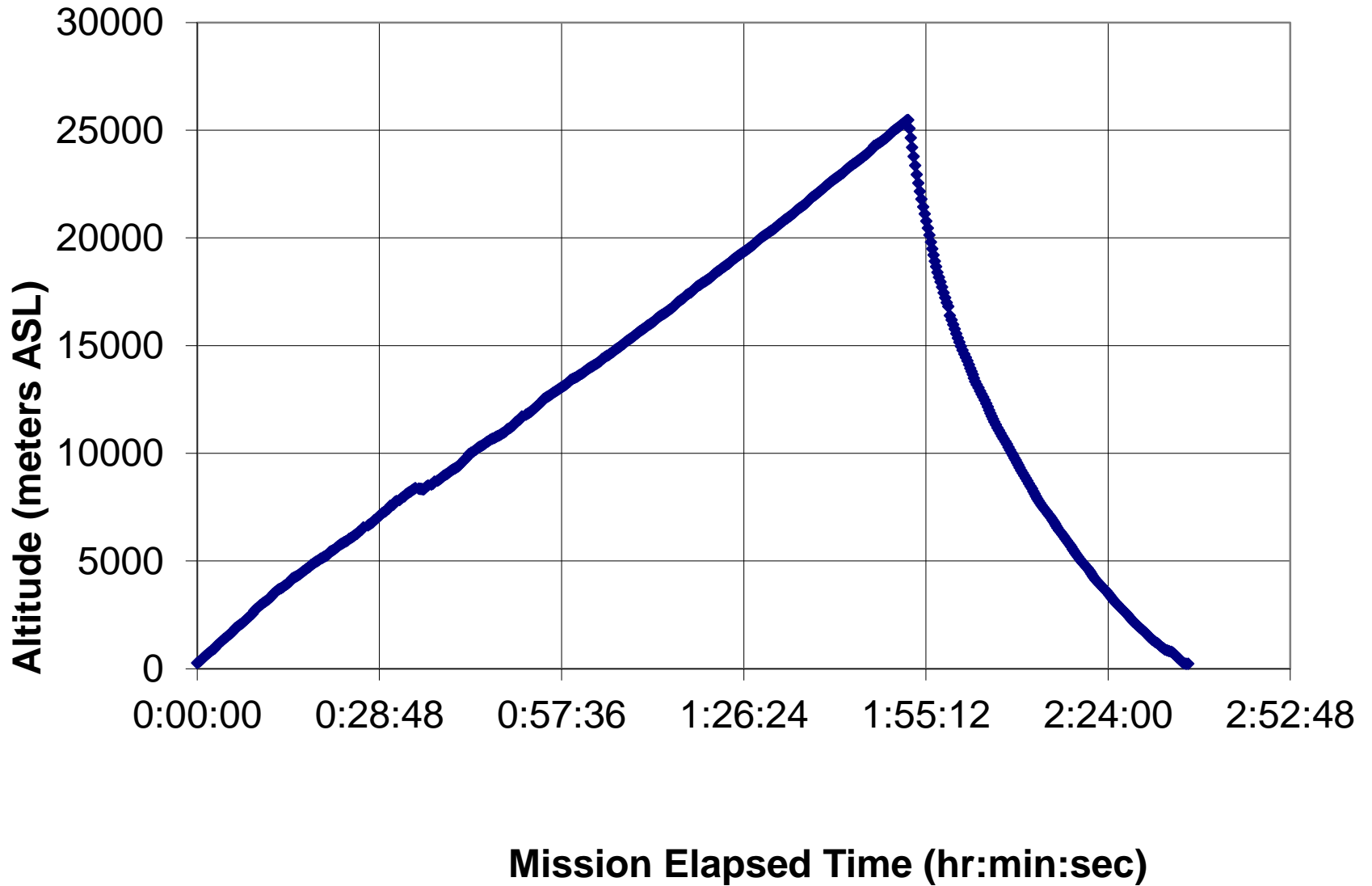
[Air Flight Ticket](#)

[30 Day Weather Forecast](#)

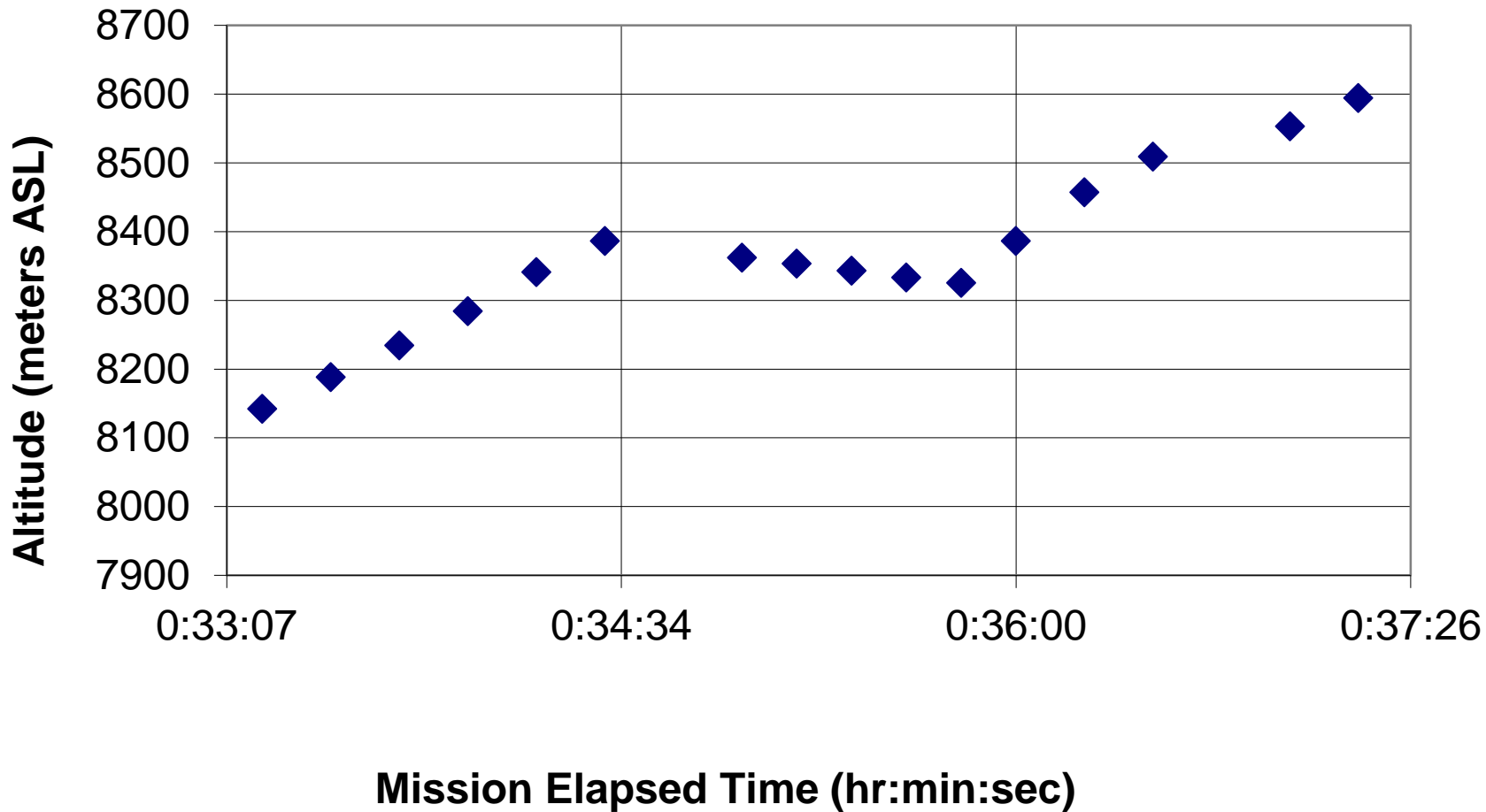
This is a computer generated map of potential clear air turbulence areas, with overlays of actual encounters of clear air turbulence indicated by the numbers and altitudes on the map.



BASE 44



BASE 44 ascent



Atmospheric Gravity Waves

- **Surface features (mountains)**
- **Convection (thunderstorms)**
- **Frontal Systems**
- **Jet Stream Interface**
- **Energetic Particles / Solar Radiation**

Wavelengths of 10 – 100s of kilometers

Periods of 10 minutes – several hours

Seen in some cloud formations:

Nacreous clouds in troposphere (15-25 km)

Noctilucent clouds in mesosphere

Airglow, Kansas in thermosphere (90 km+)

Wind - Flight String Interaction

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Force due to wind is proportional to air density and cross-sectional of object

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Payload boxes are fixed size

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Force due to wind is proportional to air density and cross-sectional of object

Payload boxes are fixed size

Balloon gets larger

Force on Expanding Balloon

Altitude (feet)	Volume (cu ft)	Area (m²)	Air Density (kg/m³)	4.5m/s Wind Force (N)
0	300	5	1.22	62
36,000	1,300	14	0.36	50
66,000	5,500	35	0.09	31
105,000	35,000	120	0.01	16

Simulations with Interactive Physics Version 2.5

Assumptions: 1.5 kg Balloon

300 cu. ft of He is 1.5 kg

3 payloads on 3 meter strings

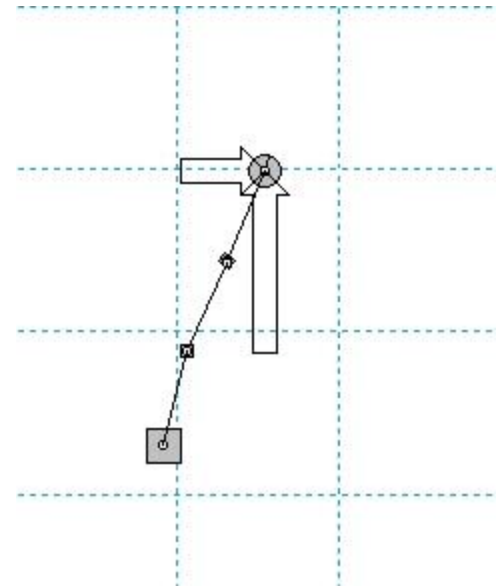
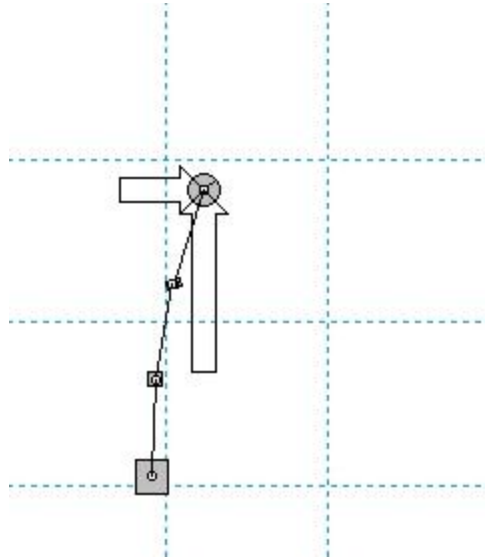
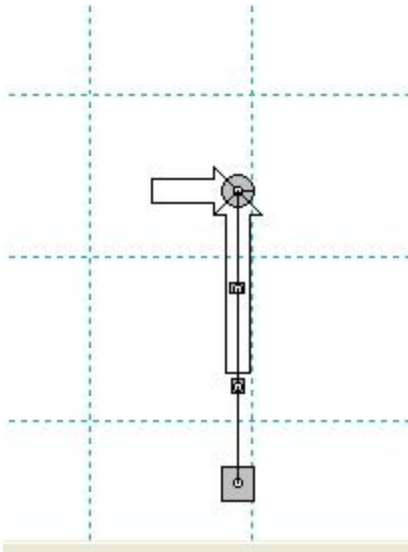
Top payload of 0.4 kg

Middle payload of 0.5 kg

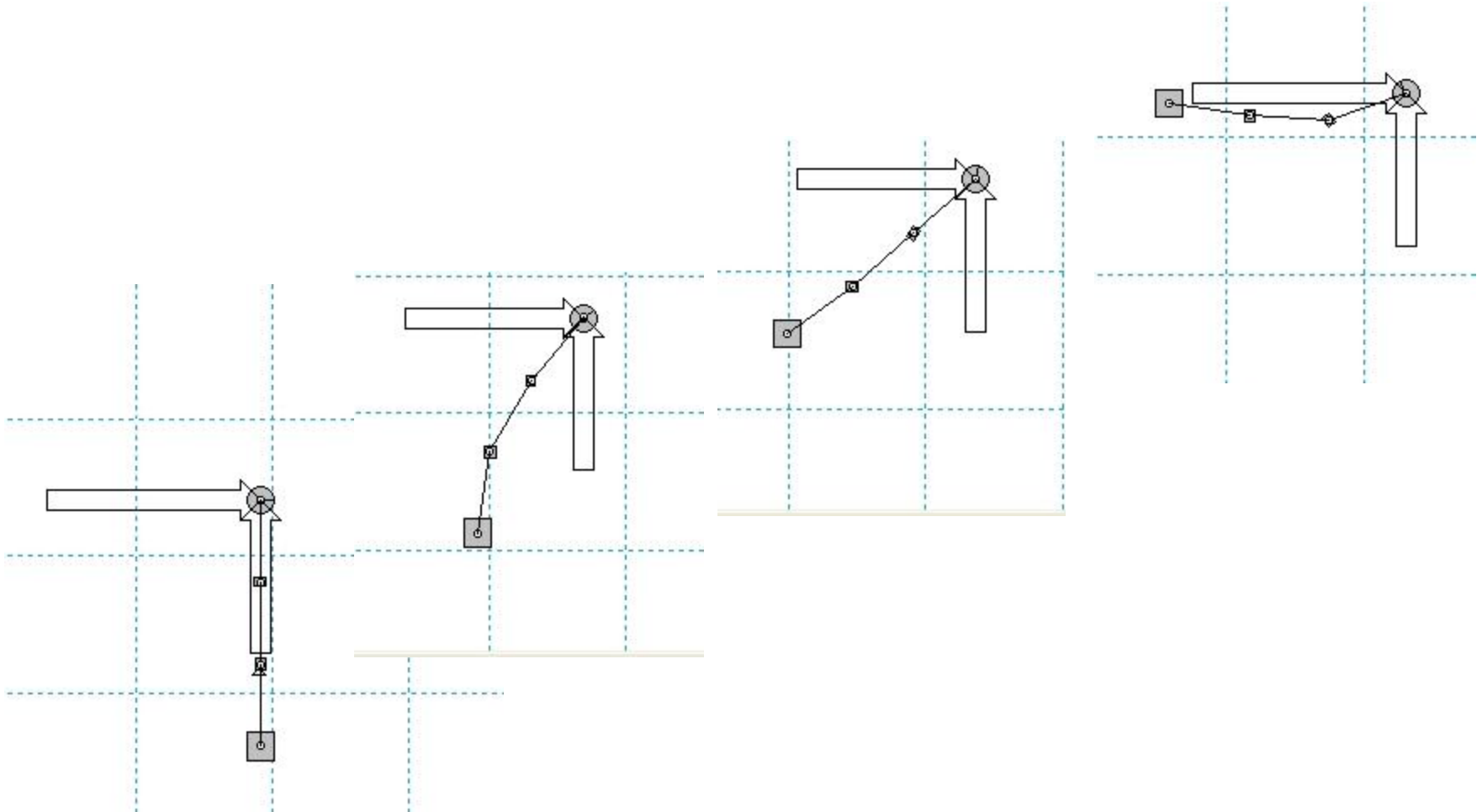
Bottom payload of 2 kg

TOTAL WEIGHT OF FLIGHT STRING = 58 Newtons

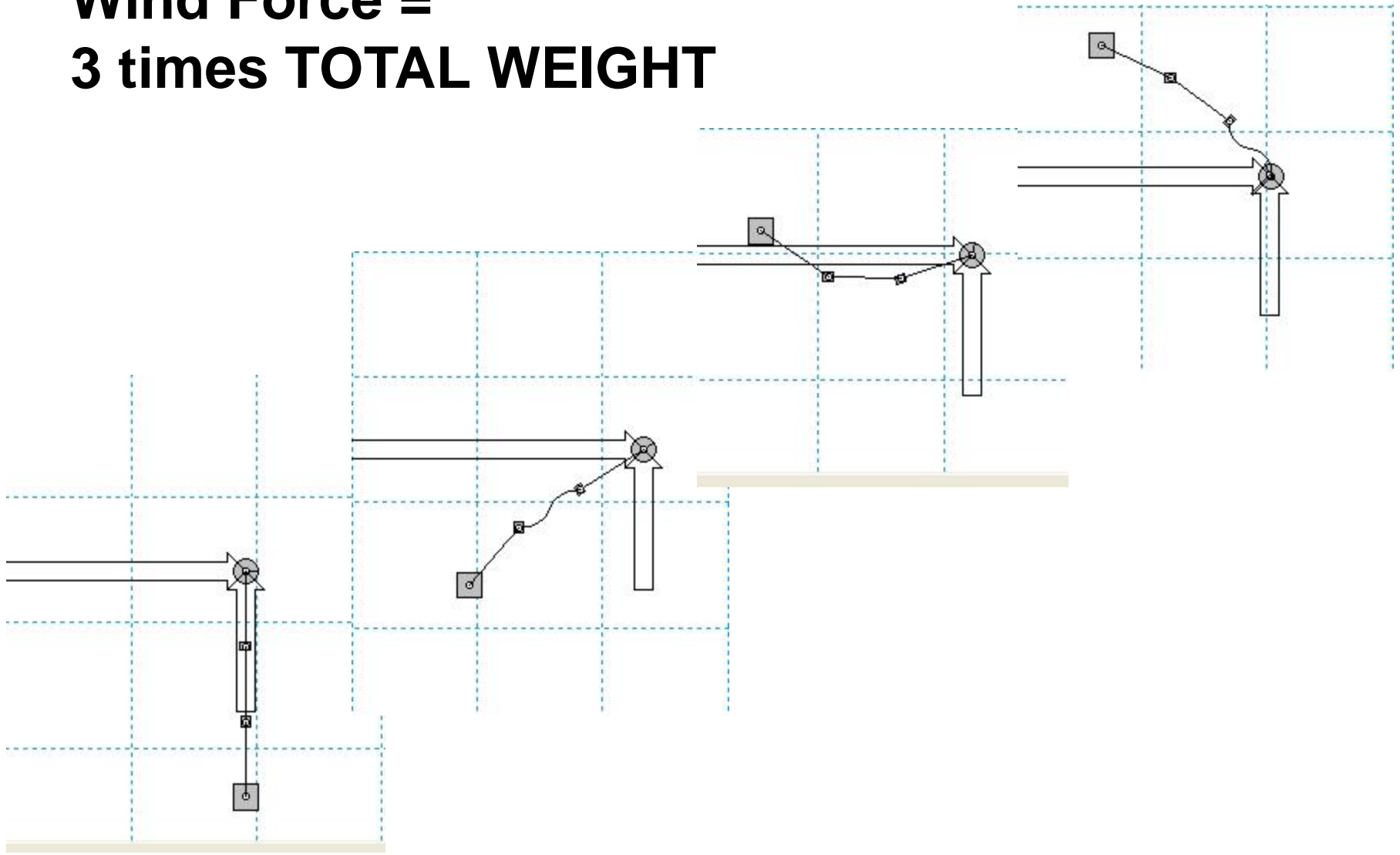
**Wind Force =
1/3 TOTAL WEIGHT**



Wind Force = TOTAL WEIGHT



**Wind Force =
3 times TOTAL WEIGHT**



RECOMMENDATIONS

Fly accelerometers

Carefully review all flight videos

Expect the unexpected