

# Collecting Missile 6DOF Using an Optical Tracking System

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U.S. Army Test and Evaluation Command





# Background

MMTS optical tracking system delivered to Redstone Test Center in 2012:



*Mobile Multi-Sensor TSPI System*





# Background

MMTS was spec'd for **TSPI** but quickly showed **6DOF** potential.

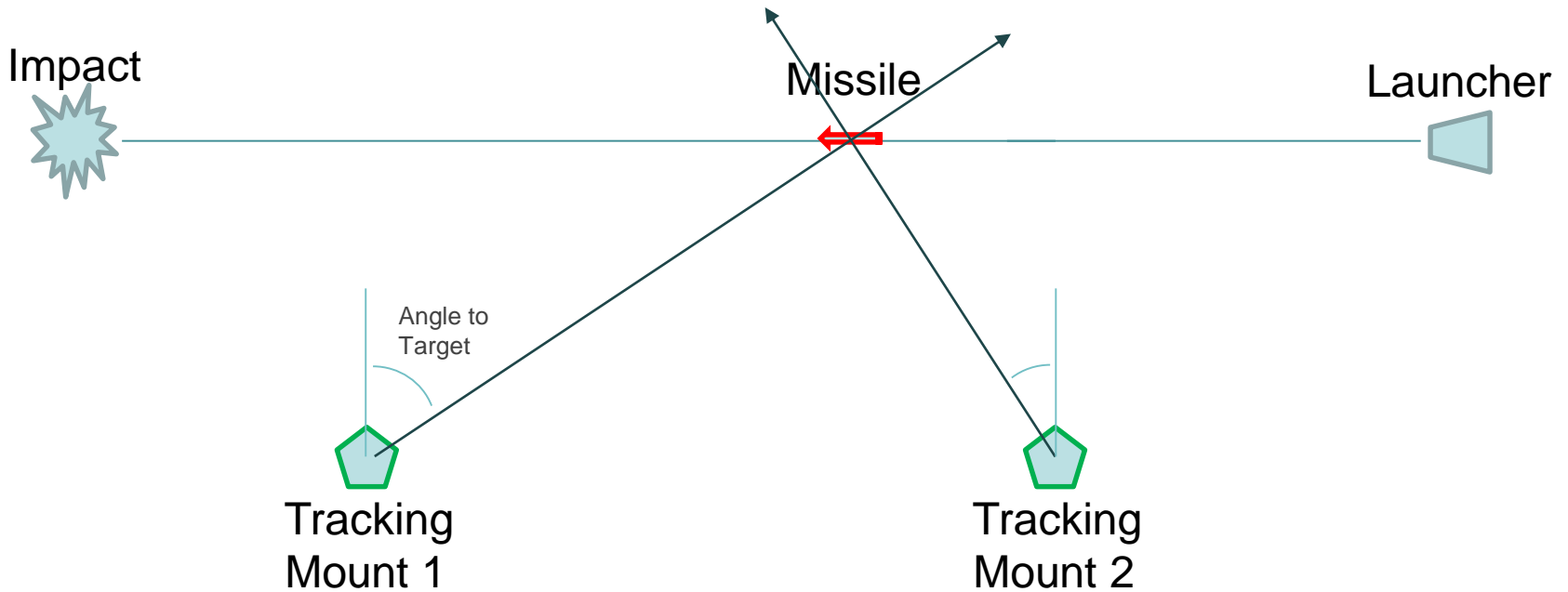
**TSPI** = XYZ target position

**6DOF** = XYZ target position + pitch, yaw, and roll



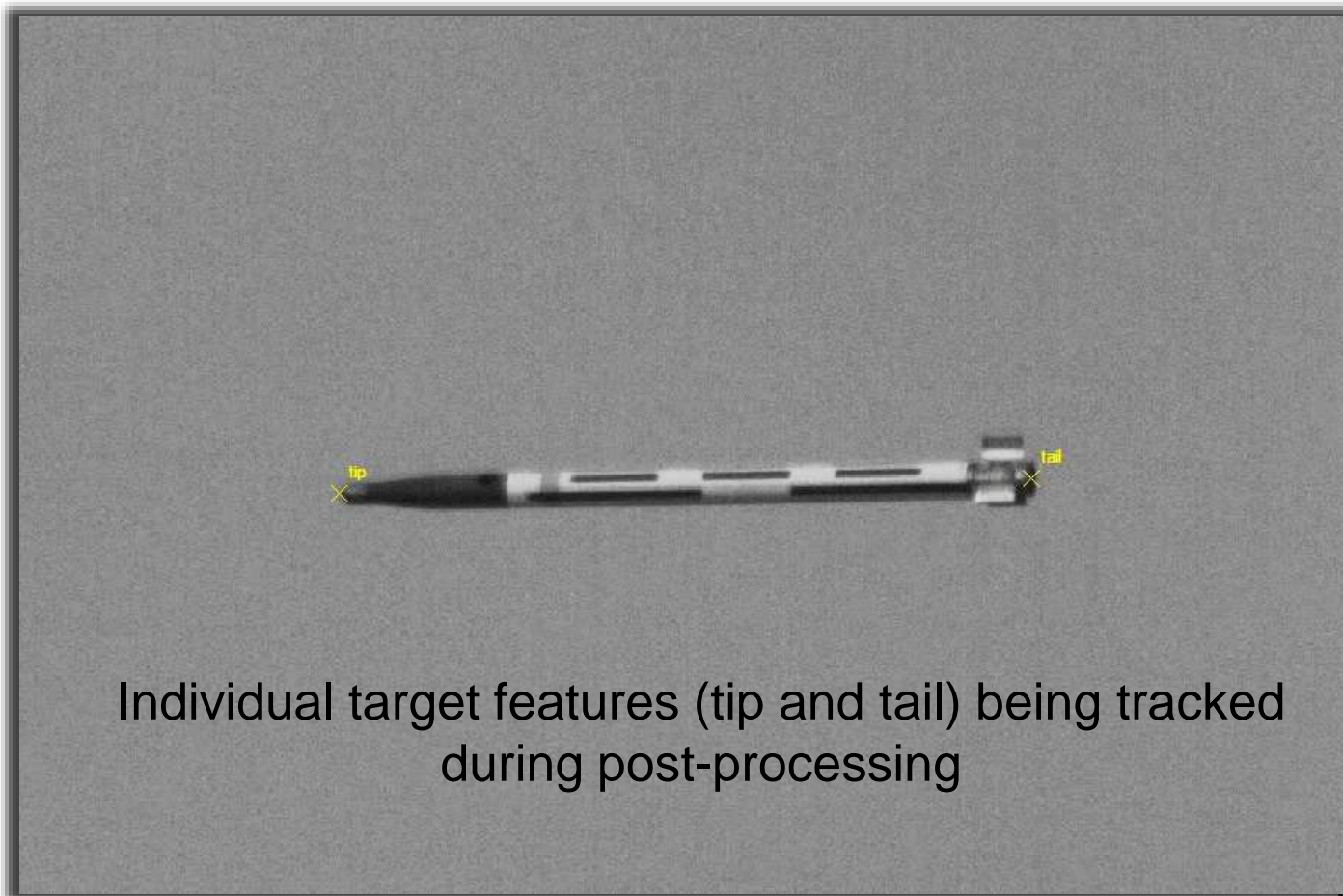


# Triangulating the Target Position



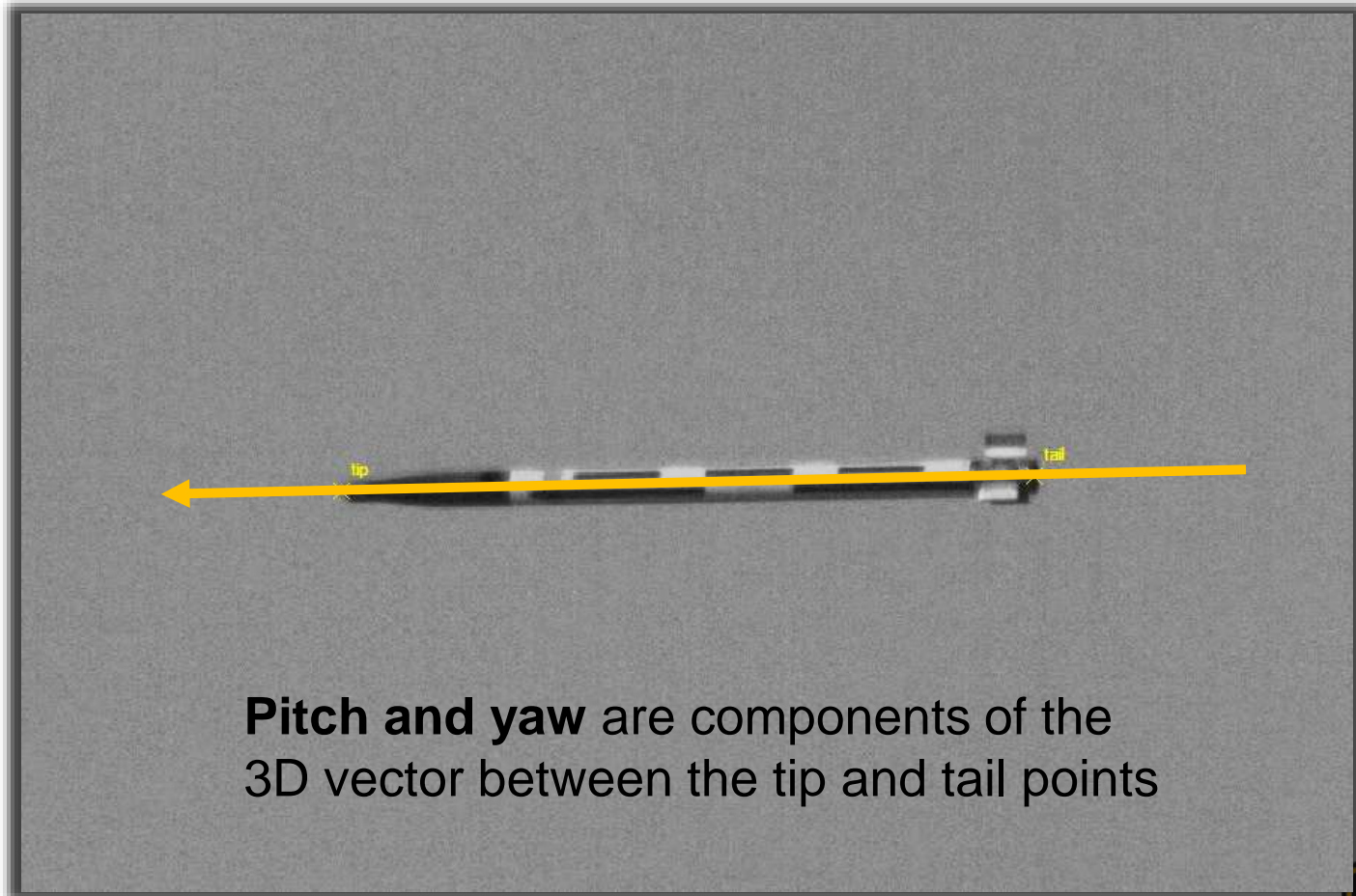


# Feature Identification for 6DOF





# Creating a Direction Vector







# 6DOF Post-Processing Session

The screenshot displays a 6DOF post-processing software interface with several windows:

- Tracking - C:\Users\jeremy\Desktop\275 for TE View\DEC 3\MMT52\_275\_03DEC2014\_Shot\_3**: Shows a 3D model of a Phantom 2 drone in flight. The interface includes a menu bar (File, Edit, View, Tools, Setup, Point, Window, Help) and a toolbar. A right-hand panel shows a tree view with "Phantom 2" expanded to "Default", containing "M Top" and "M Tail".
- Tracking - C:\Users\jeremy\Desktop\275 for TE View\DEC 3\MMT51\_201\_03DEC2014\_Shot\_3**: Shows a similar 3D model of a Phantom 1 drone. The right-hand panel shows a tree view with "Phantom 1" expanded to "Default", containing "M Top" and "M Tail". A status bar at the bottom right of this window displays: "Image: Time: File: -4813 2014-12-03 20:17:52.028; Current: [ 2405 2014-12-03 20:17:55.424; Last: -938 2014-12-03 20:17:58.956; Image size: (1280 x 800)".
- View**: A graph titled "To-Tail View" showing a green line plot of angular displacement in degrees over time. The x-axis ranges from 0 to 6 seconds, and the y-axis ranges from -5 to 5 degrees. The plot shows a noisy signal that generally increases from 0 to about 5 degrees.
- Point Zoom**: A zoomed-in view of the drone's tail section, showing a red crosshair and a purple vertical line. The zoom level is set to 4.
- Time Panel - Session v-Compare**: A control panel for time-based operations. It includes a timeline and playback controls. The data shown is: "File: 2014-12-03 20:17:52.852; Time: 2014-12-03 20:17:55.424; File: 2014-12-03 20:17:58.956; ID: 2014-12-03 20:17:52.868".
- Pitch**: A graph titled "To-Tail Pitch" showing a blue line plot of angular displacement in degrees over time. The x-axis ranges from 0 to 6 seconds, and the y-axis ranges from -5 to 5 degrees. The plot shows a noisy signal that starts at 5 degrees and decays towards 0 degrees.





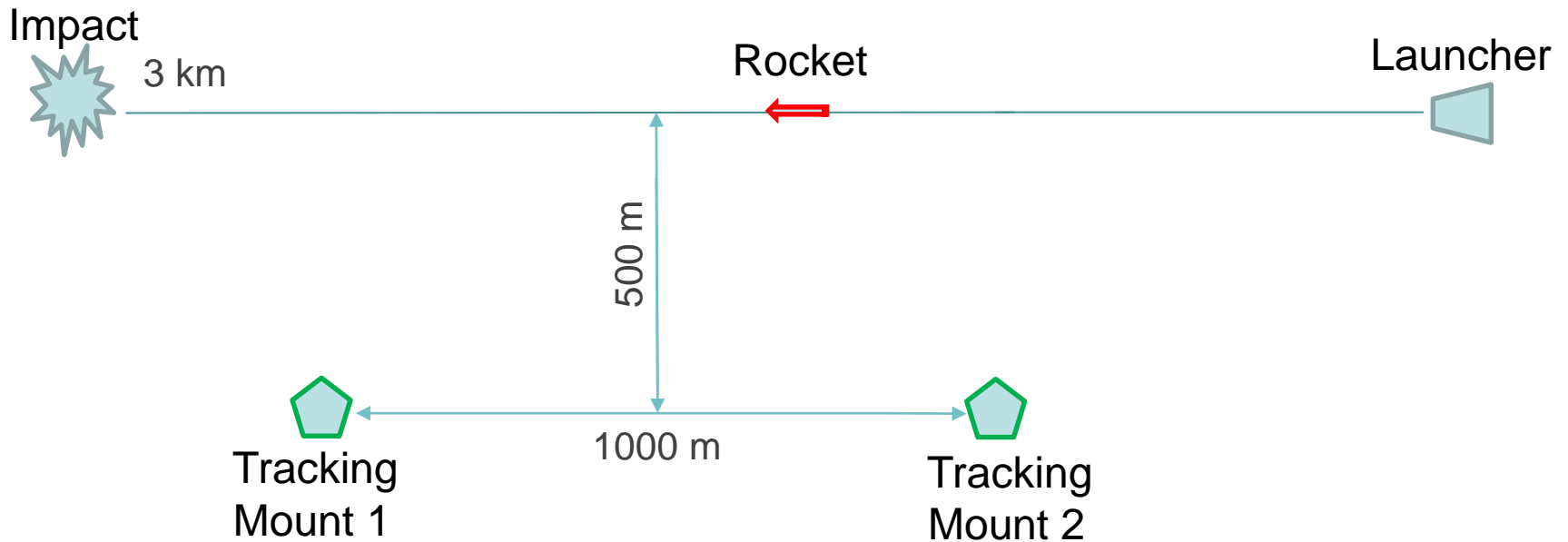
# MMTS Tracking Video







# Layout for 2.75" Rocket

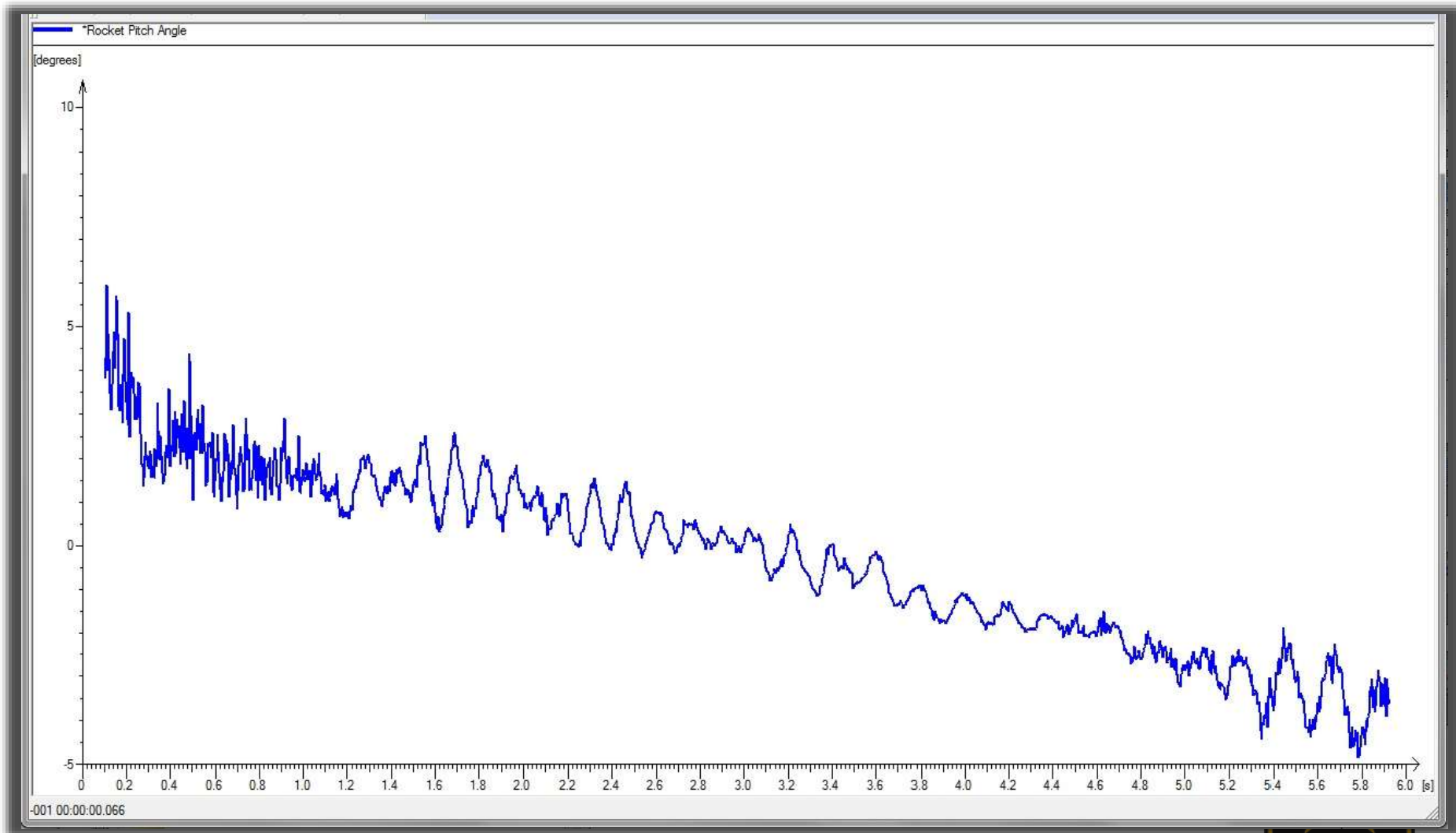


rocket height at apogee = 30 m AGL  
rocket max velocity = Mach 2



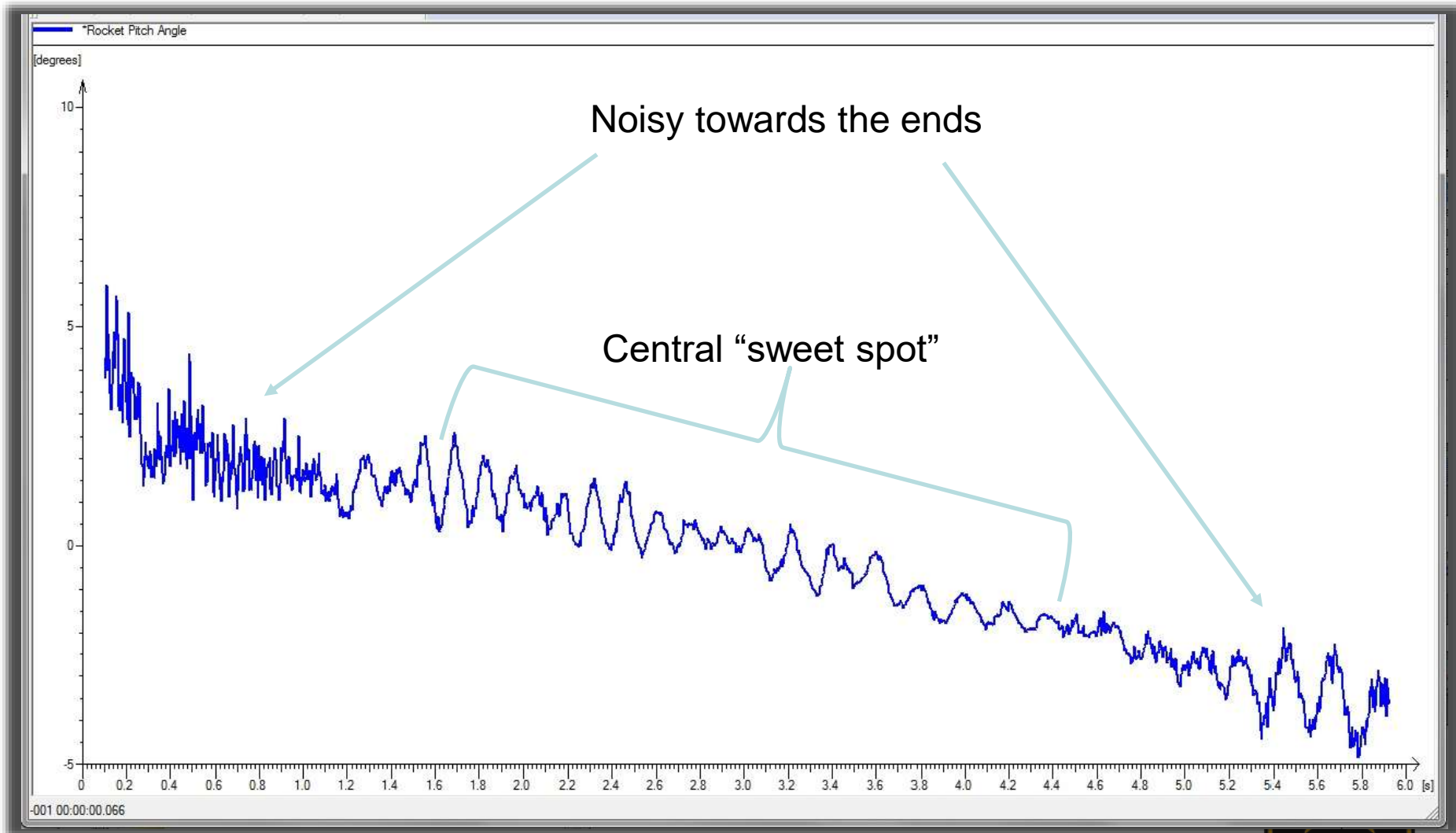


# Pitch



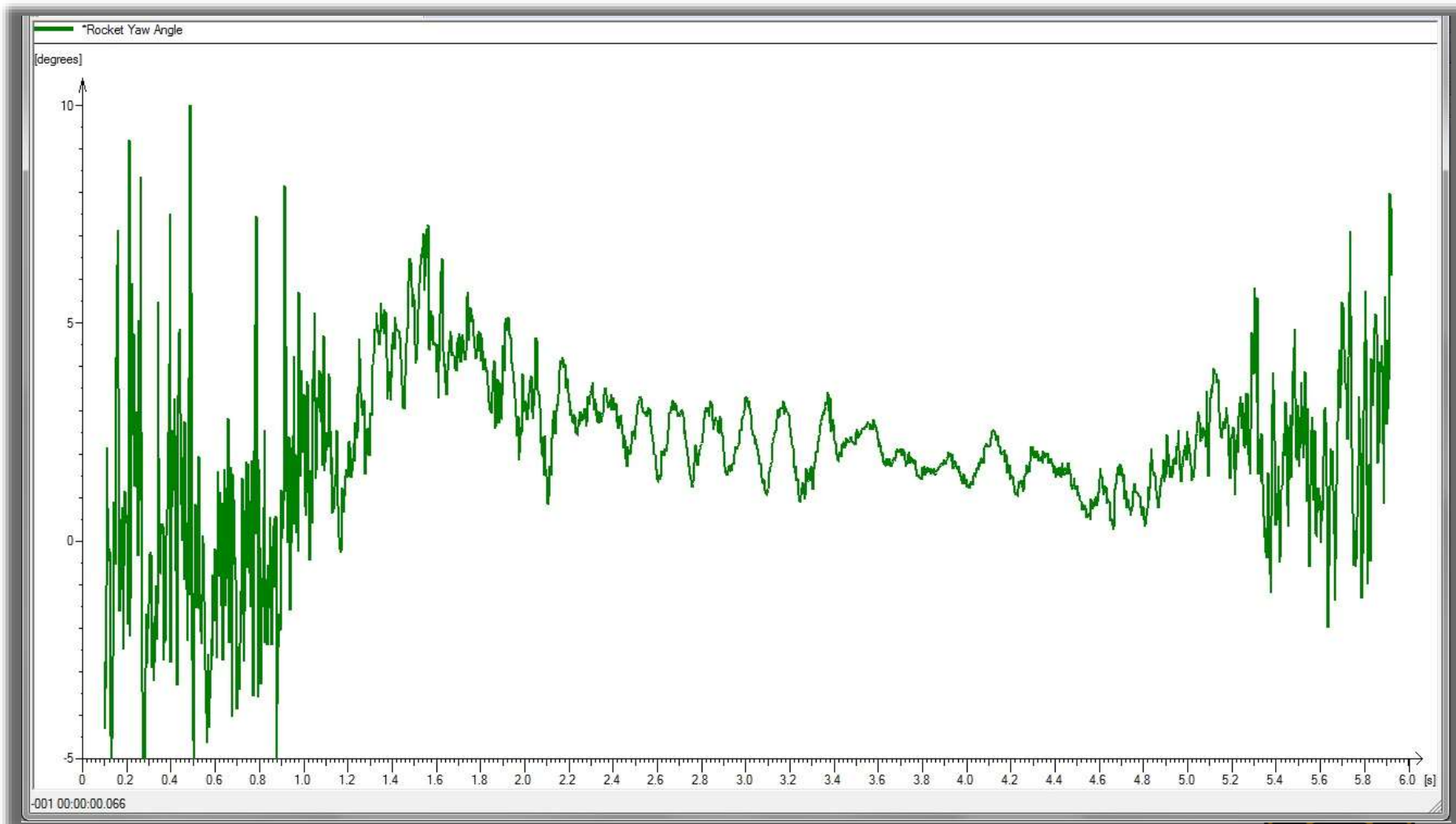


# Pitch





# Yaw





# 2.75" Rocket Video





- **Data has greater noise and error at ends because:**
  - Triangulation geometry is worse
  - Image quality is worse
- **Yaw has more noise and error than pitch because:**
  - yaw motion occurs in-plane with optical pointing lines



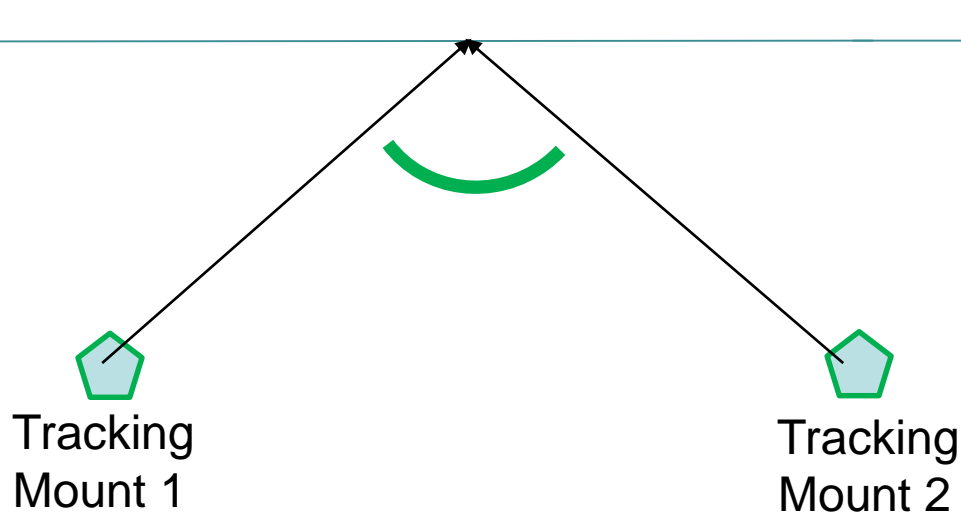




# Nearly Ideal Intersection Angle

Impact

Launcher





# Poor Intersection Angle

Impact



Launcher



Tracking Mount 1

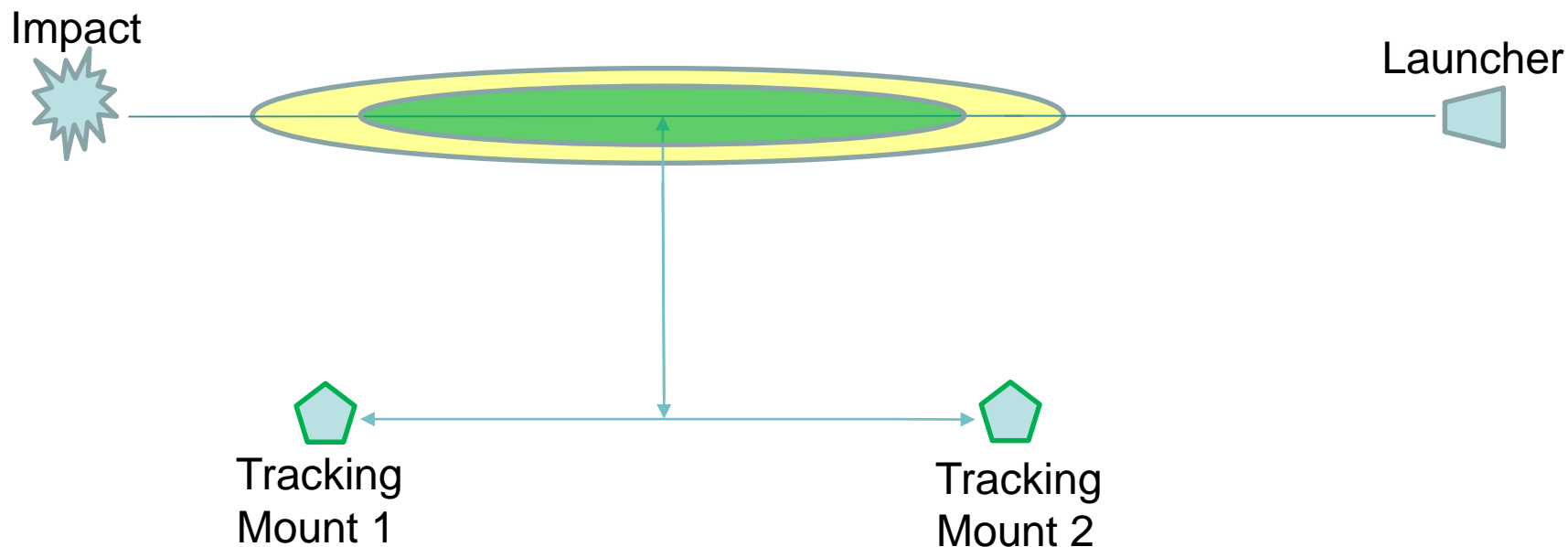


Tracking Mount 2





# Notional 6DOF "Sweet Spot"



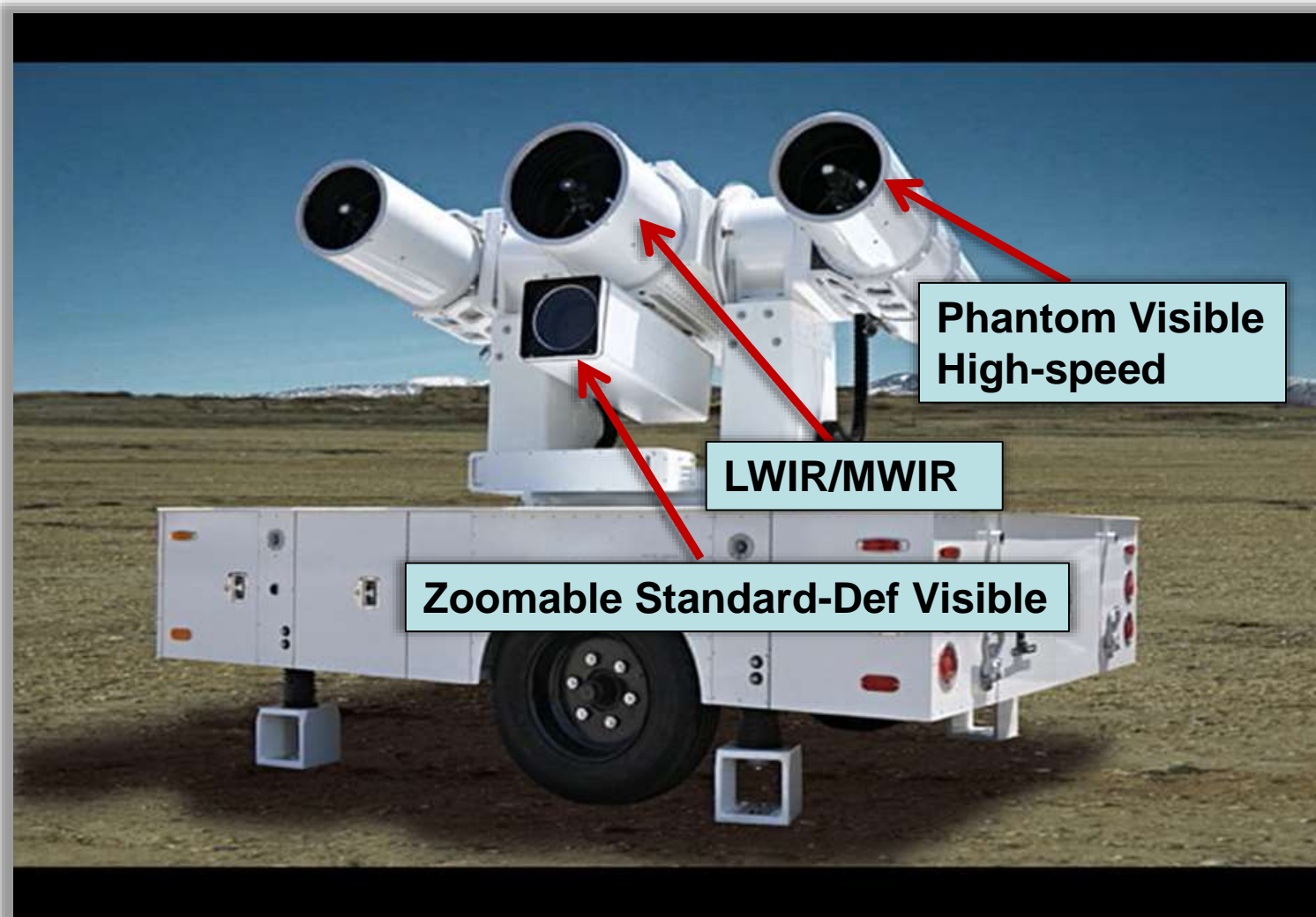


Questions  
Comments  
Recommendations



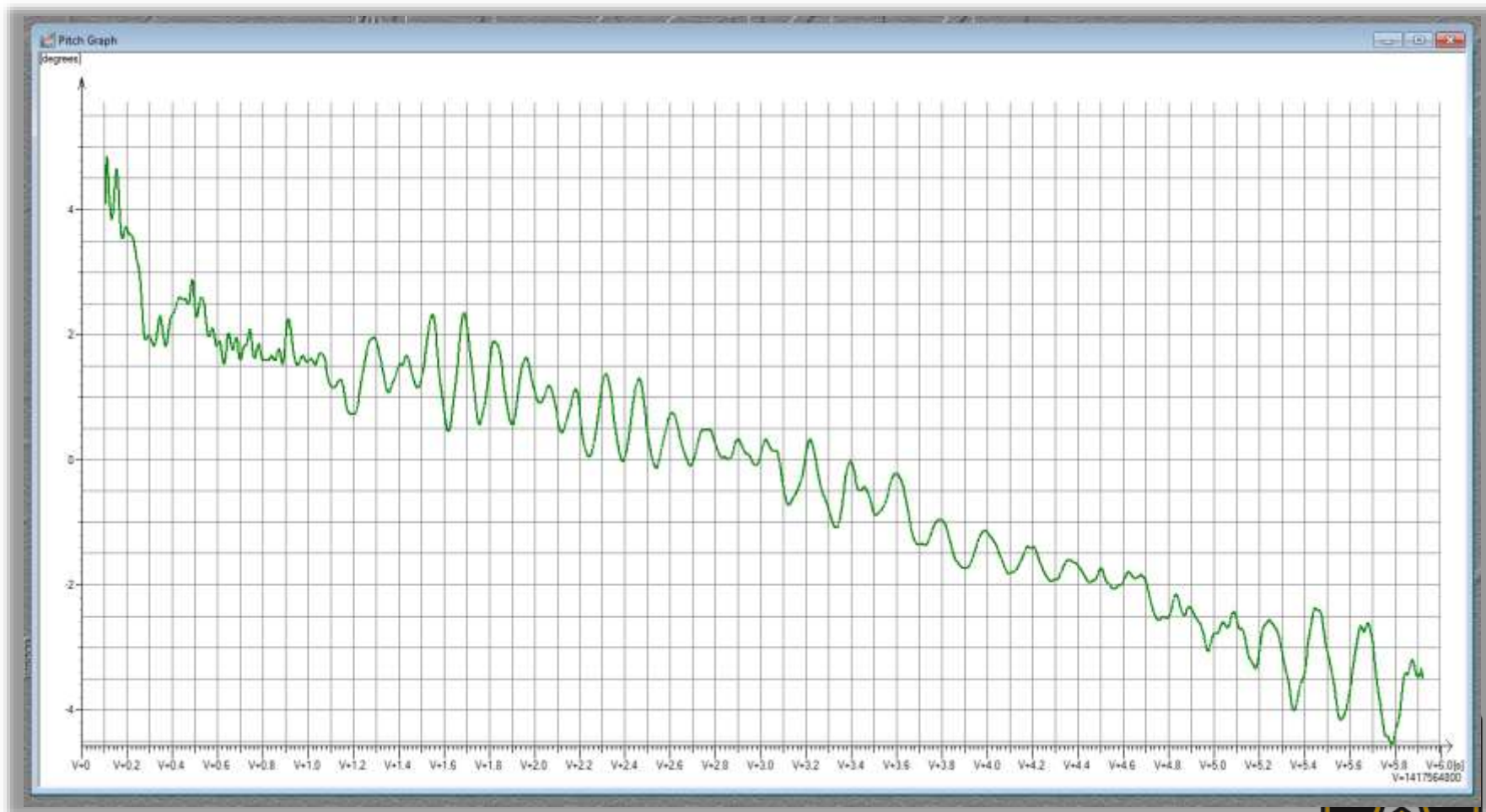


# MMTS Tracking Pedestal





# Low-pass Filtered Pitch







**MMTS Control Van With Pedestal**





# Typical Layout

