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SAND2017-10015C



DECIPHERING THE TWO-STAGE GUN VELOCIMETRY GHOST SIGNAL

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68th Meeting of the Aeroballistic Range Association



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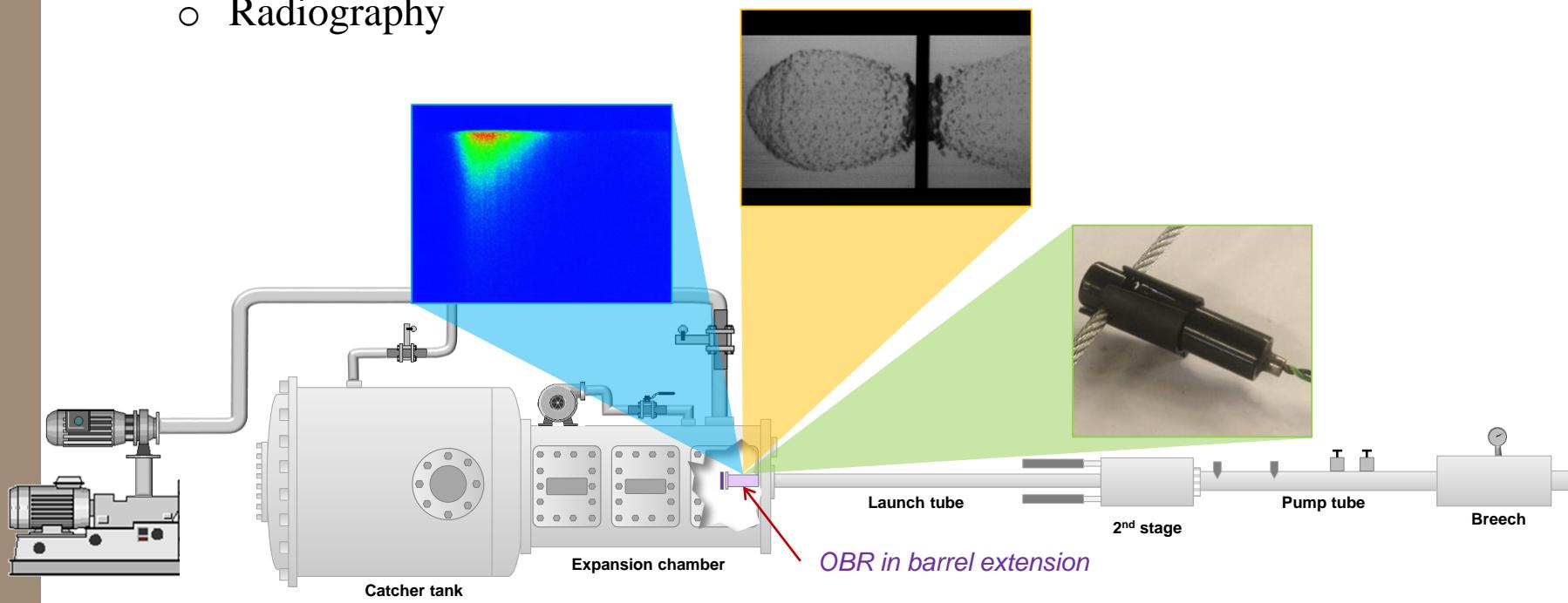
OUTLINE

- Motivation
- OBR and ghost signal description
- Ghost signal characterization
- Ghost signal source analysis
- Mitigation schemes
- Summary



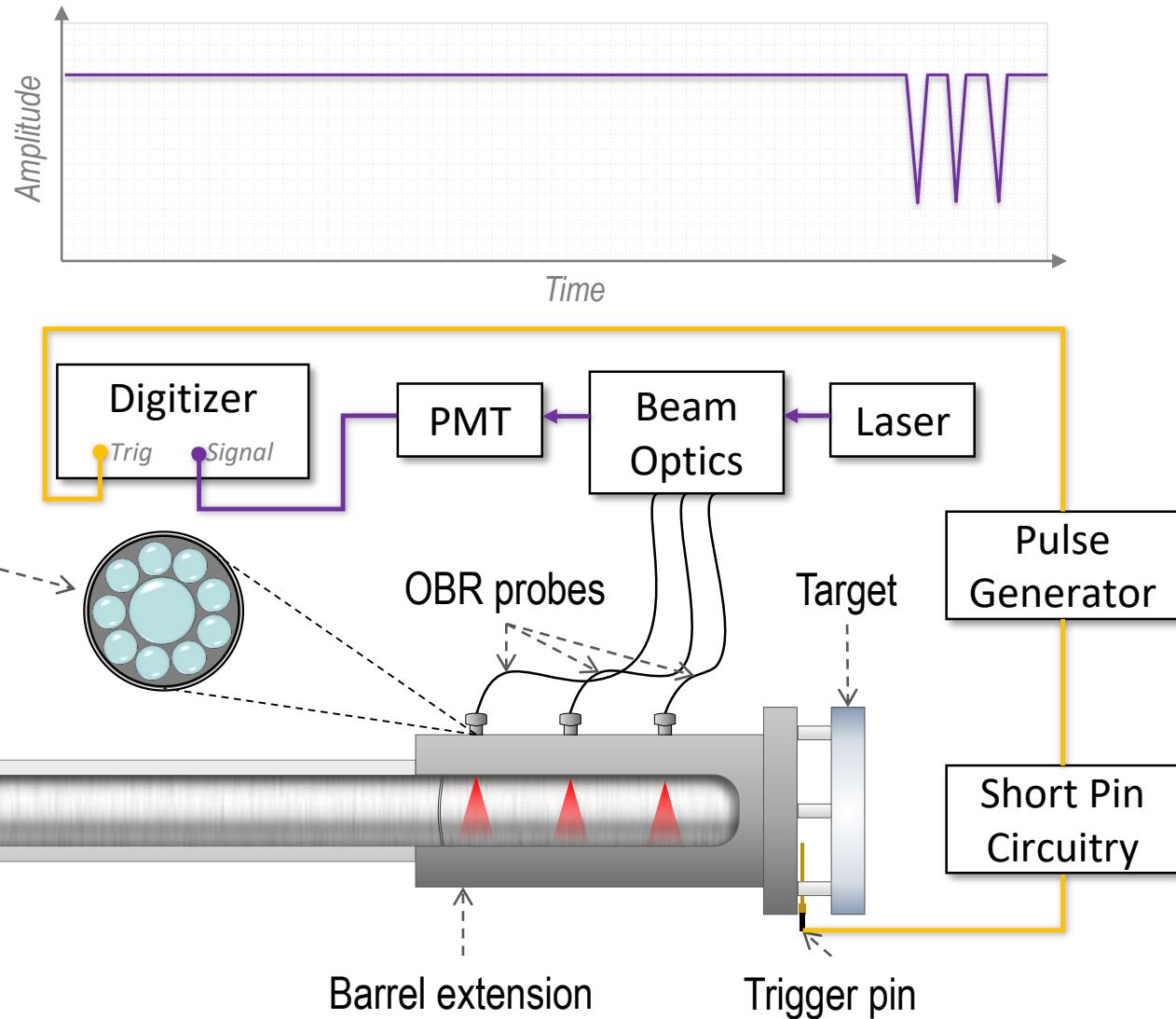
MOTIVATION

- Versatile trigger sources to run high speed diagnostics instrumentation are desirable in hypervelocity launchers.
- Sandia's Optical Beam Reflectance (OBR) system is an excellent trigger source candidate for various instruments and applications due to its location.
 - High-speed photography
 - Pyrotechnic Cutter
 - Streak cameras
 - Radiography



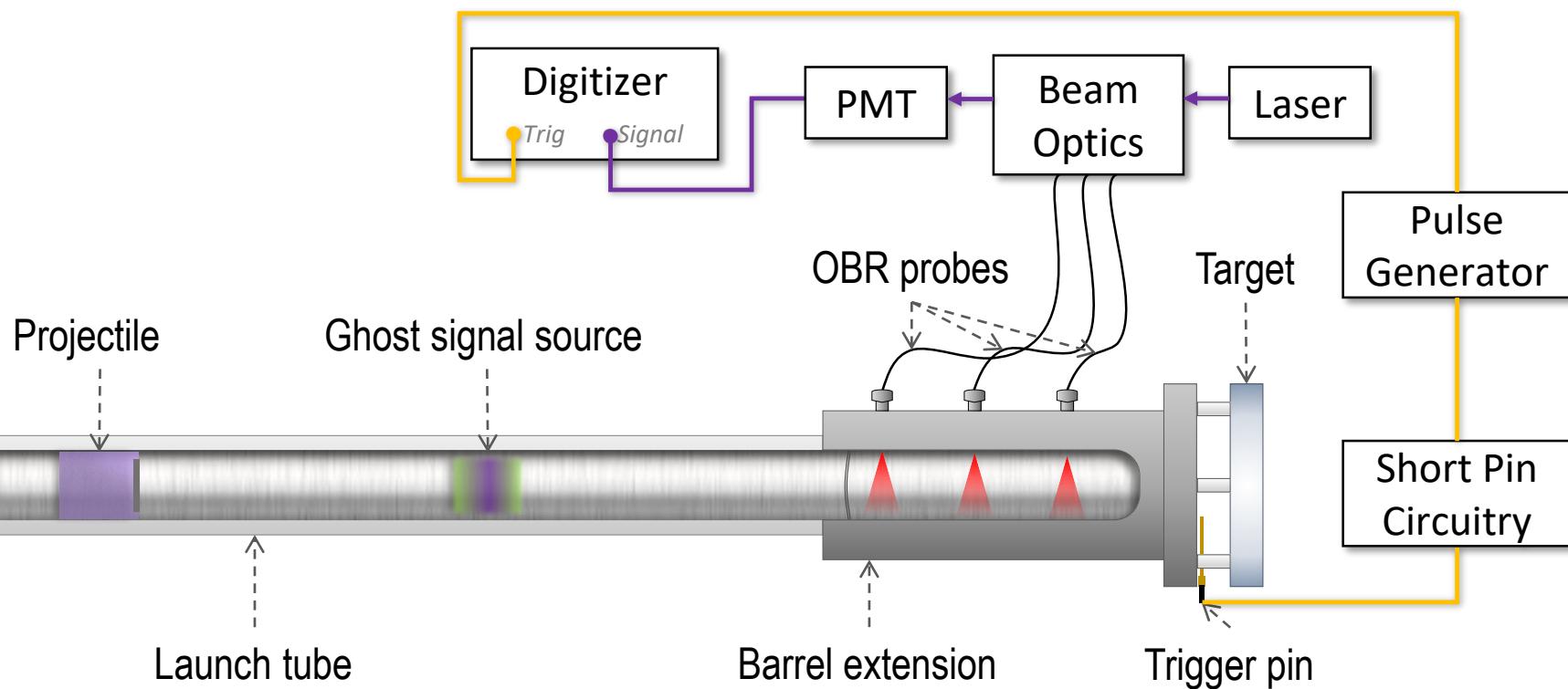
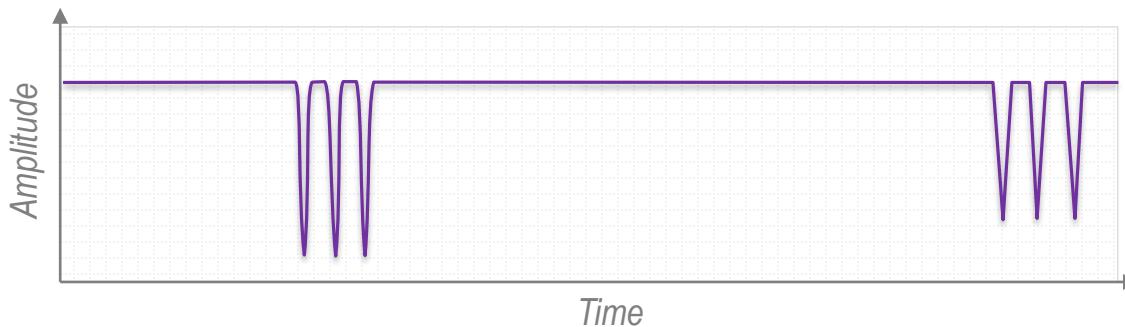
OBR AND GHOST SIGNAL DESCRIPTION

The OBR operation is based on a time-distance velocity determination. Laser light is reflected by the moving projectile at three known locations. The known separation and timing is then used to calculate the velocity.



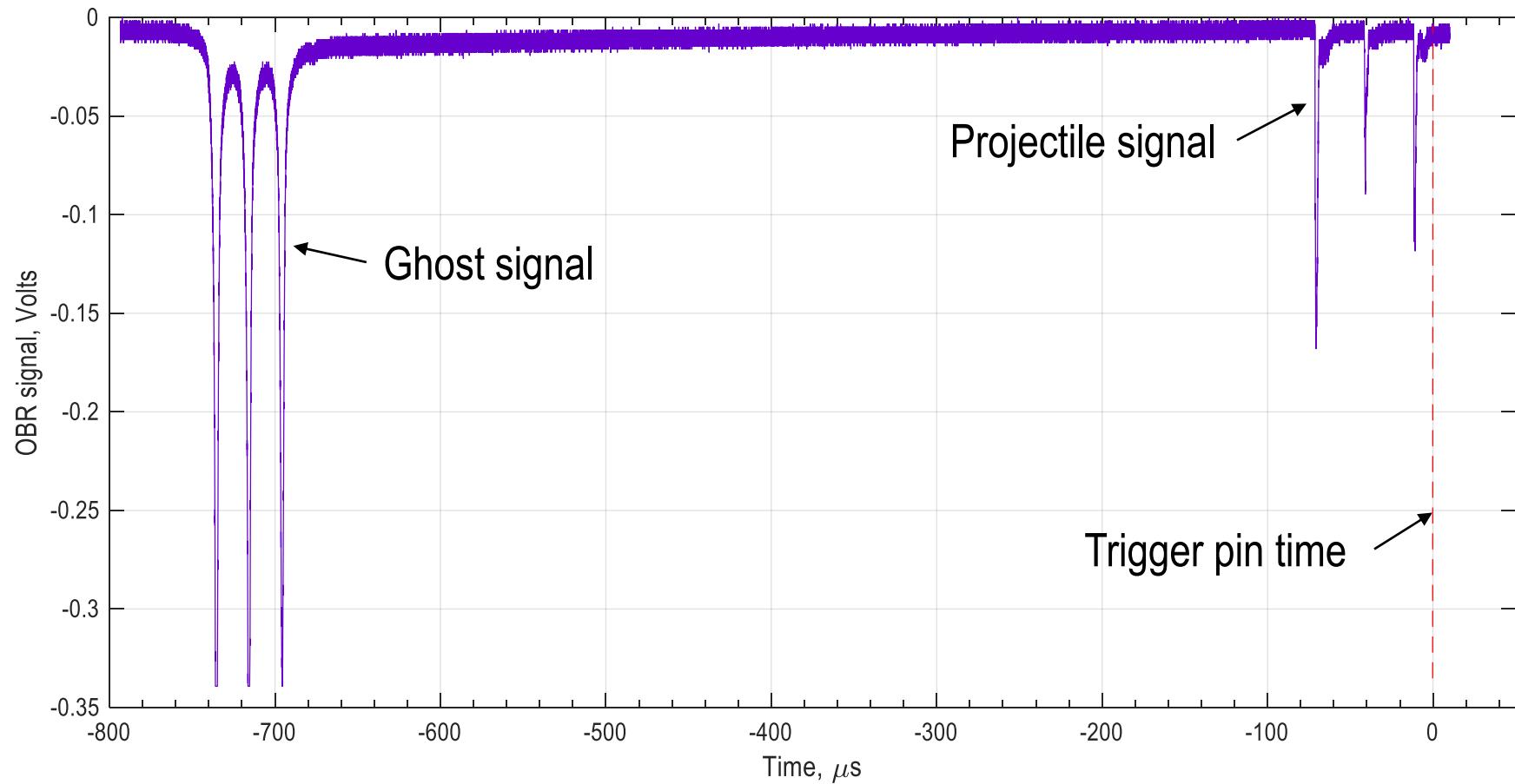
OBR AND GHOST SIGNAL DESCRIPTION

The OBR system detects a precursor velocity profile signal, or ghost signal, that restricts its use as a trigger source.



OBR AND GHOST SIGNAL DESCRIPTION

- Typical recorded OBR signal revealing how a ghost signal appears before the projectile signal, which was recorded right before the trigger at time zero.

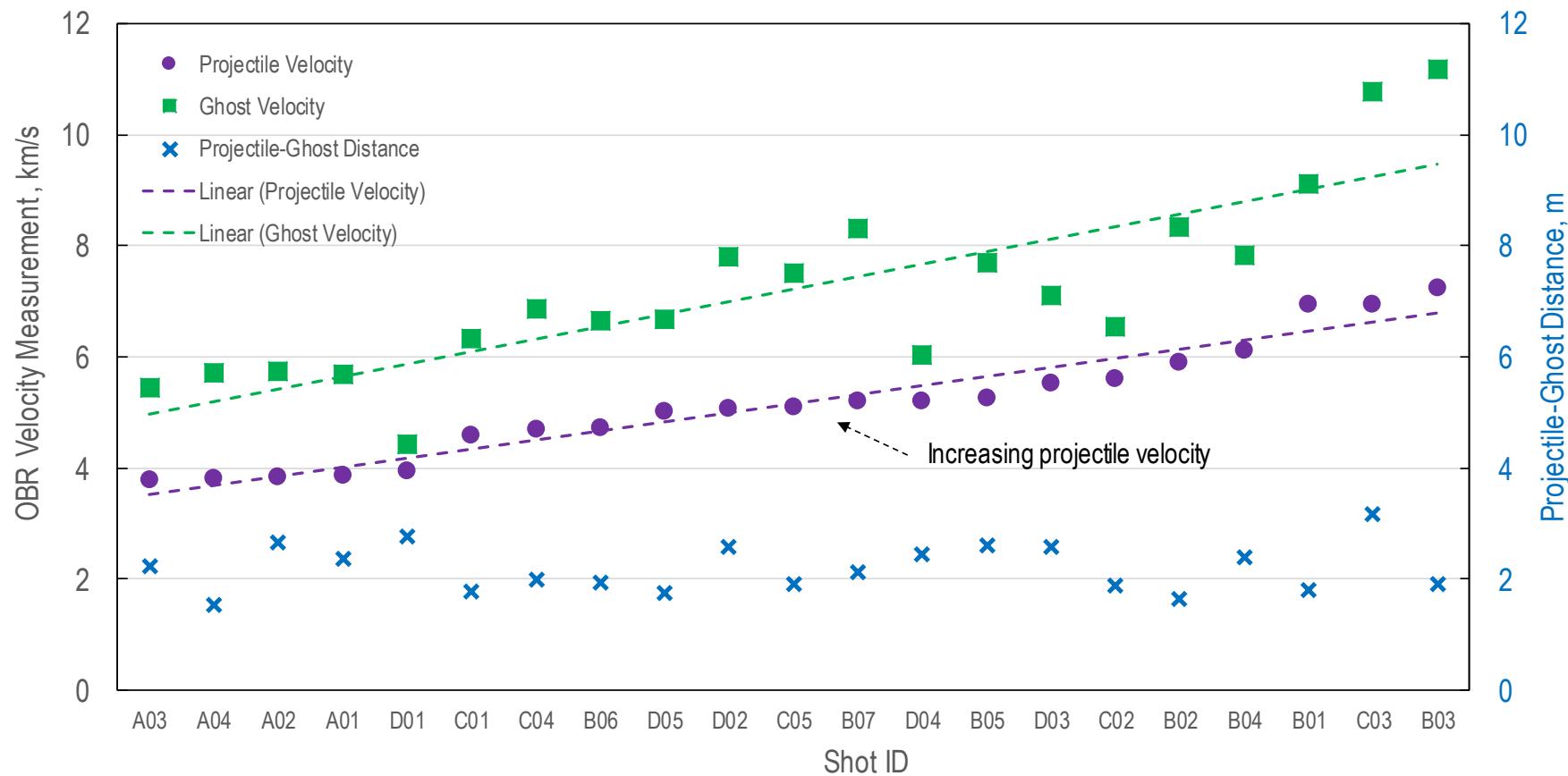




HOST SIGNAL CHARACTERIZATION

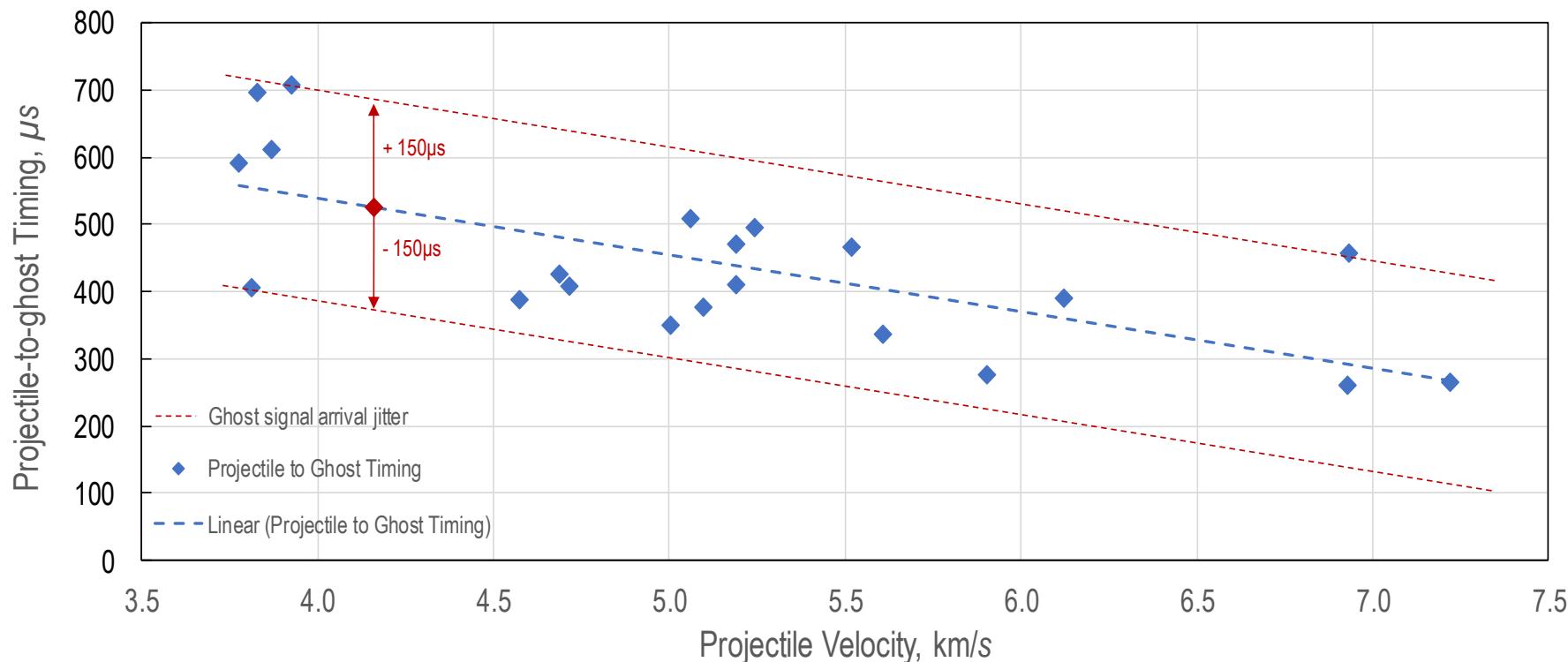
Data recompilation from SNL's shot records with OBR measurements:

- Ghost signal is faster than projectile (1.4 times on average)
- The velocity gap slightly increases as projectile goes faster
- Projectile and ghost source are approximately 2 meters apart at the OBR location



HOST SIGNAL CHARACTERIZATION

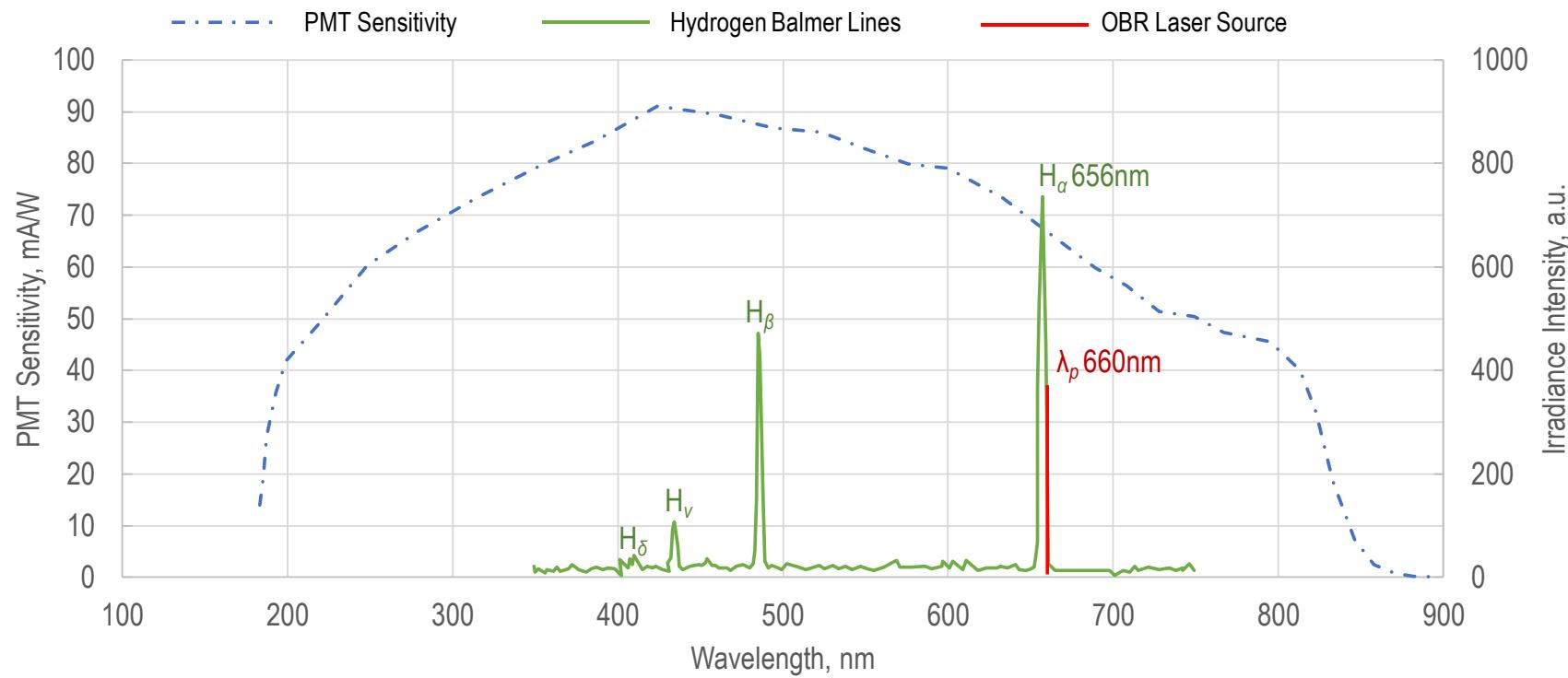
- Time between projectile and ghost signal at the barrel extension location is plotted against projectile velocity.
- The projectile and ghost signals get closer to each other at the barrel extension as the projectile velocity increases.





HOST SIGNAL SOURCE ANALYSIS

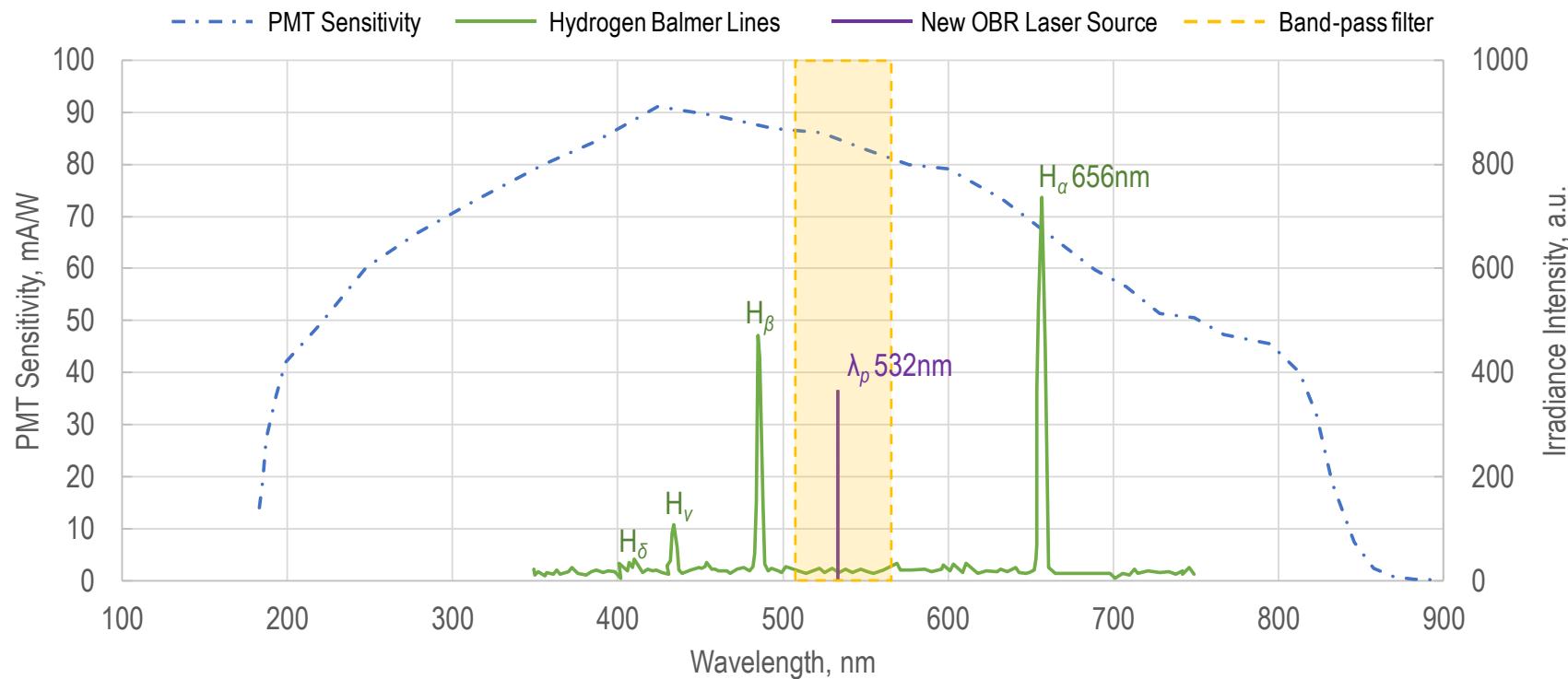
- Based on the working principle of the OBR system there are two main possible means for the observed ghost signal: Light reflection or emission from the unknown source.
- The most likely origin of the ghost signal is a light emitting source such as hydrogen plasma that is picked up by the OBR.





MITIGATION SCHEMES

- Using the actual ghost signals as a trigger source is a plausible solution if the application tolerates the jitter observed.
- The most effective mitigation technique is by optically filtering the OBR signal to eliminate the Balmer lines with a band-pass filter and new operation laser wavelength.





SUMMARY

- Sandia's OBR system is proposed as a versatile trigger sources for hypervelocity launchers
- The OBR system as a trigger source is limited by a ghost signal
- The ghost signal was characterized using data records from SNL
- Most probable ghost signal source is by hydrogen plasma formation in the projectile blow-by
- A mitigation technique is the change of operation laser wavelength and optical filtering of hydrogen Balmer lines



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Thank you !