

*Exceptional service in the national interest*



SHOCK THERMODYNAMICS  
**STAR**  
APPLIED RESEARCH



# DECIPHERING THE TWO-STAGE GUN VELOCIMETRY GHOST SIGNAL

*B. G. Farfan, T. F. Thornhill, C. S. Alexander, W. D. Reinhart*

68<sup>th</sup> Meeting of the Aeroballistic Range Association

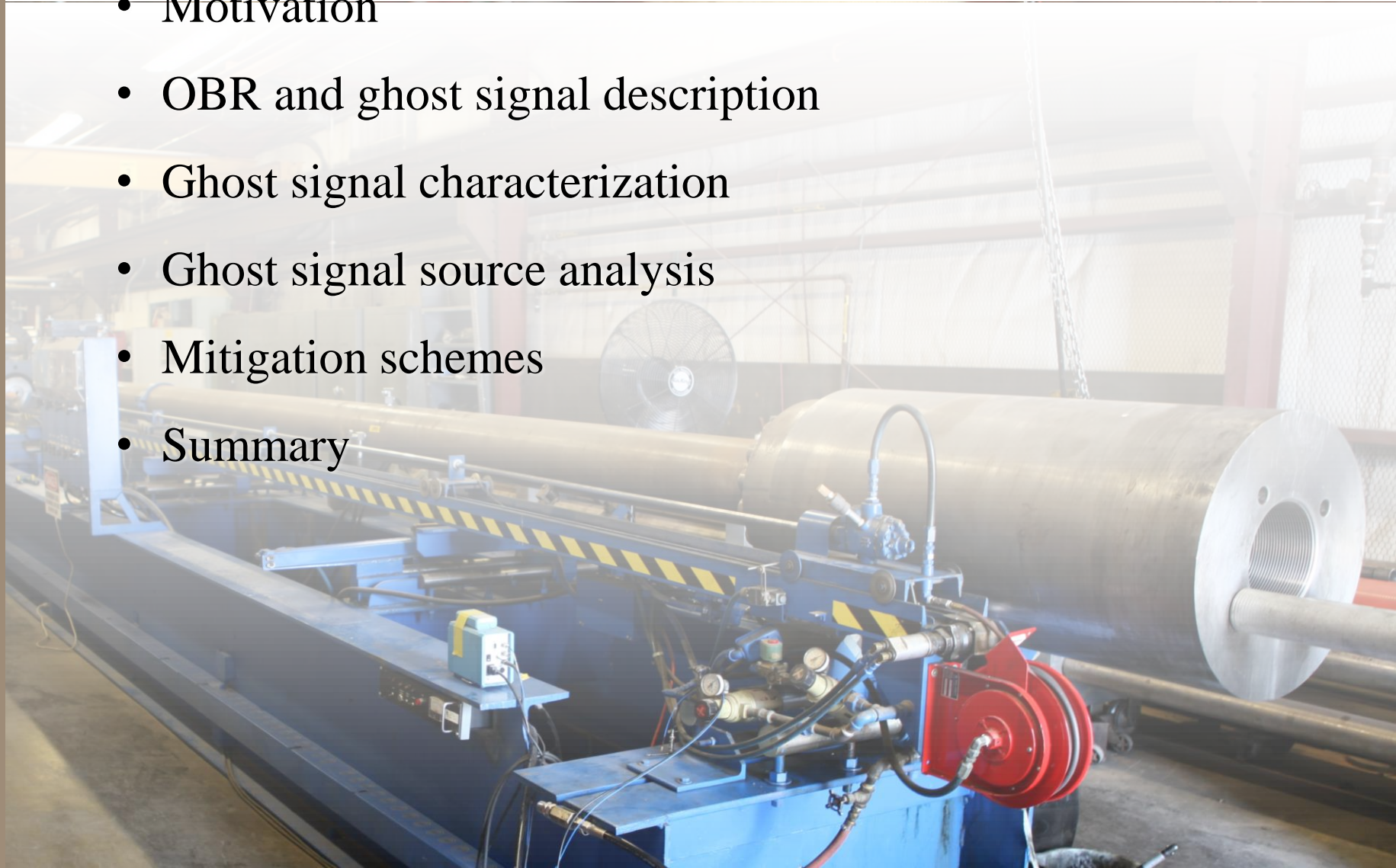


Sandia National Laboratories is a multimission laboratory managed and operated by National Technology and Engineering Solutions of Sandia LLC, a wholly owned subsidiary of Honeywell International Inc. for the U.S. Department of Energy's National Nuclear Security Administration under contract DE-NA0003525.



# OUTLINE

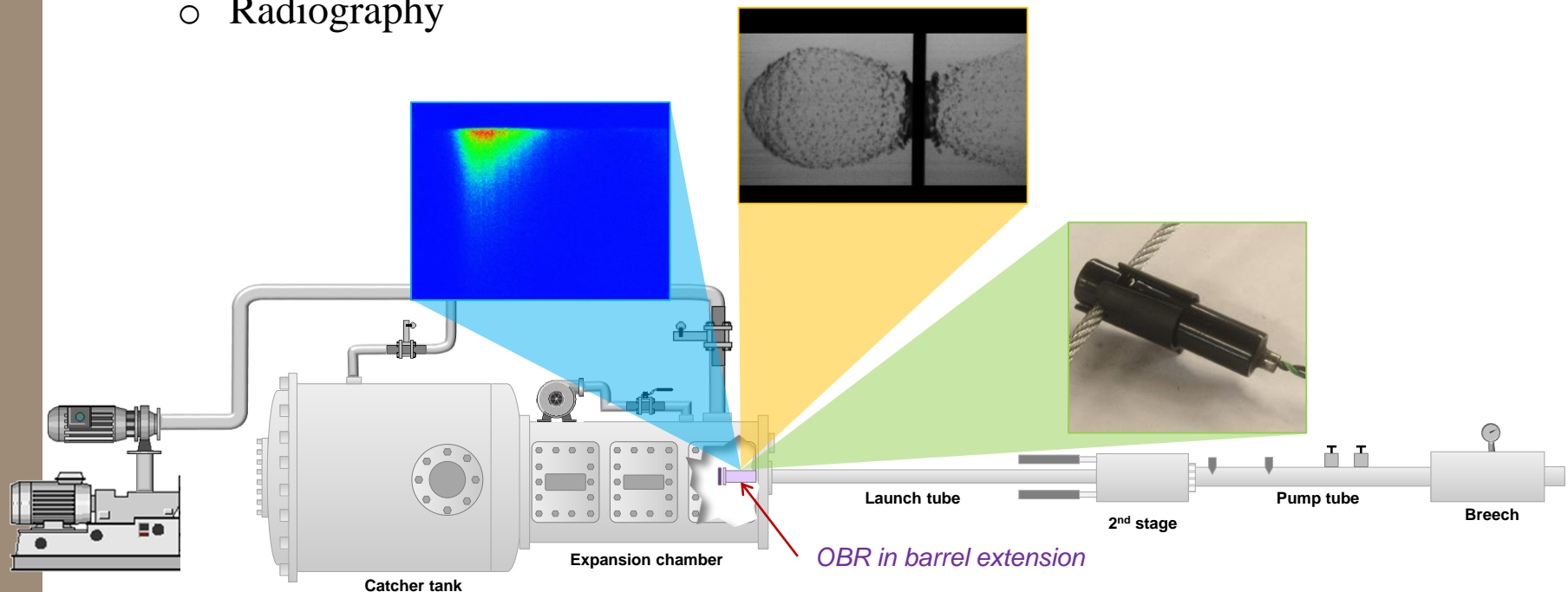
- Motivation
- OBR and ghost signal description
- Ghost signal characterization
- Ghost signal source analysis
- Mitigation schemes
- Summary





# MOTIVATION

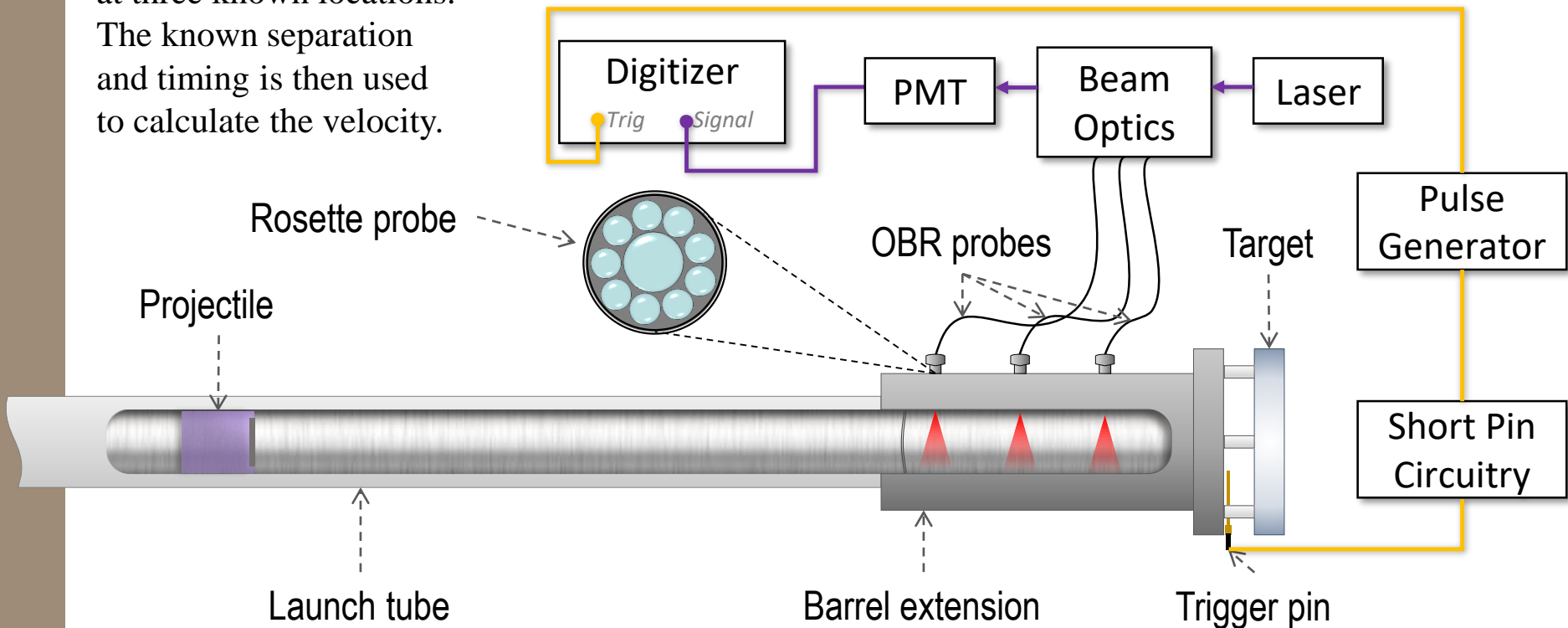
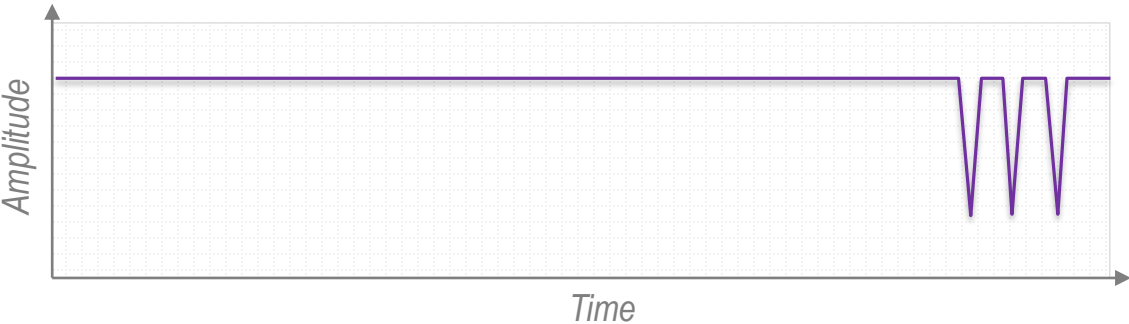
- Versatile trigger sources to run high speed diagnostics instrumentation are desirable in hypervelocity launchers.
- Sandia's Optical Beam Reflectance (OBR) system is an excellent trigger source candidate for various instruments and applications due to its location.
  - High-speed photography
  - Pyrotechnic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





# OBR AND GHOST SIGNAL DESCRIPTION

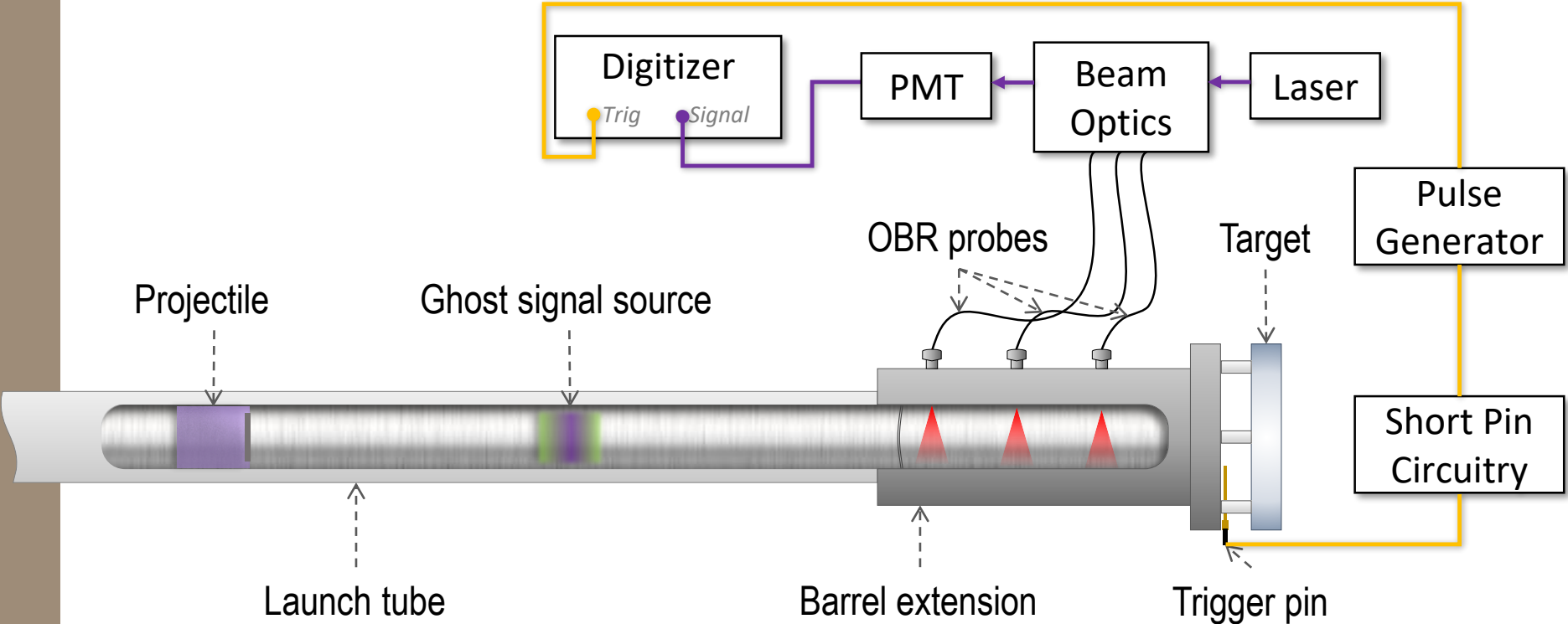
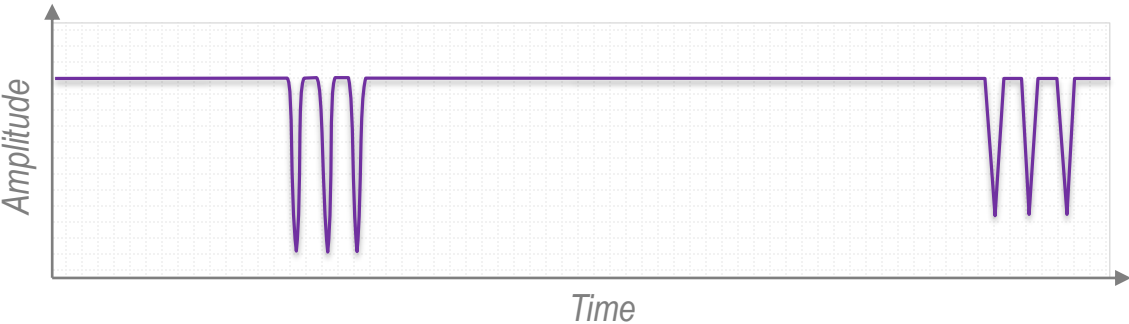
The OBR operation is based on a time-distance velocity determination. Laser light is reflected by the moving projectile at three known locations. The known separation and timing is then used to calculate the velocity.





# OBR AND GHOST SIGNAL DESCRIPTION

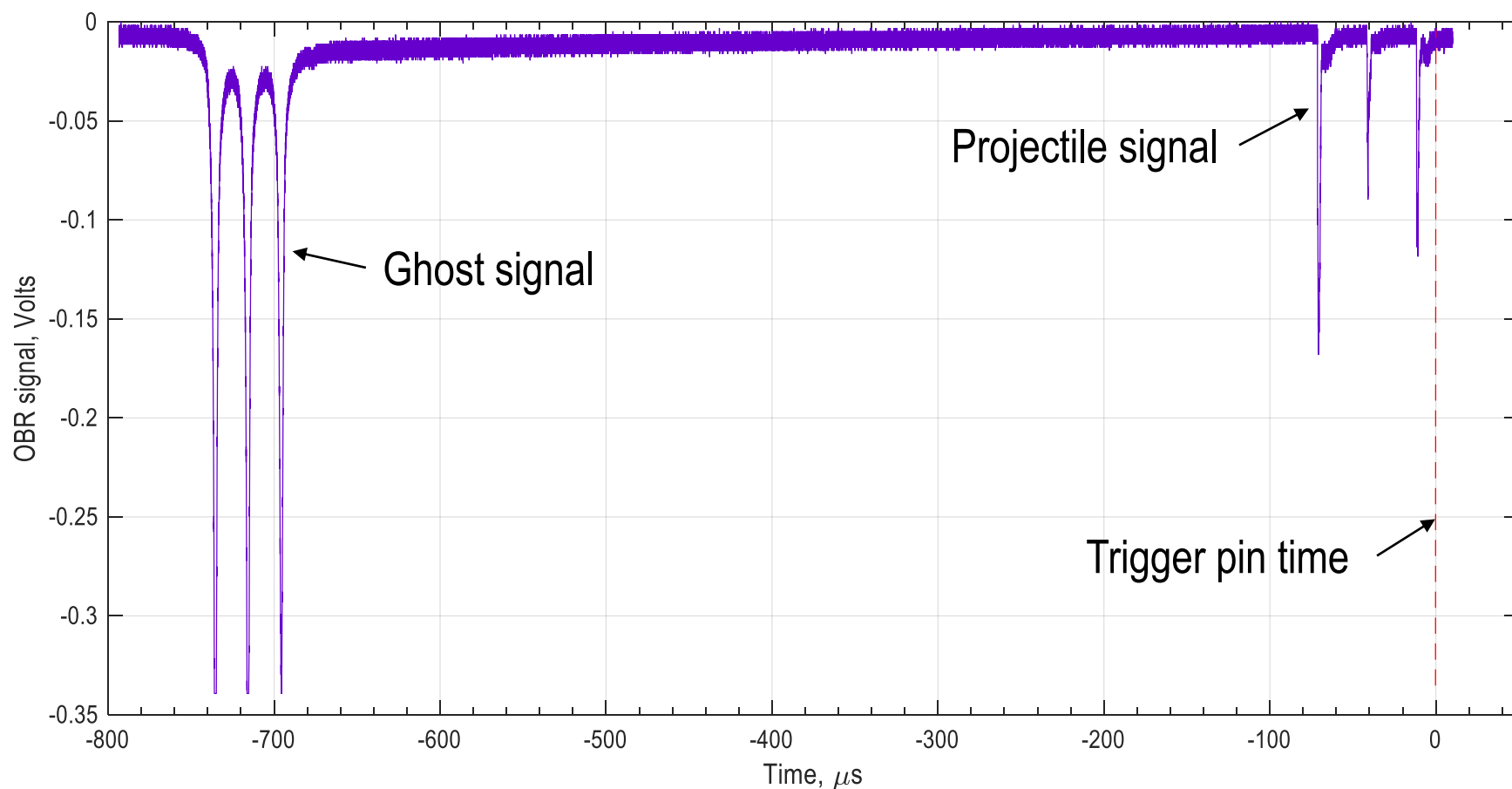
The OBR system detects a precursor velocity profile signal, or ghost signal, that restricts its use as a trigger source.





# 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.

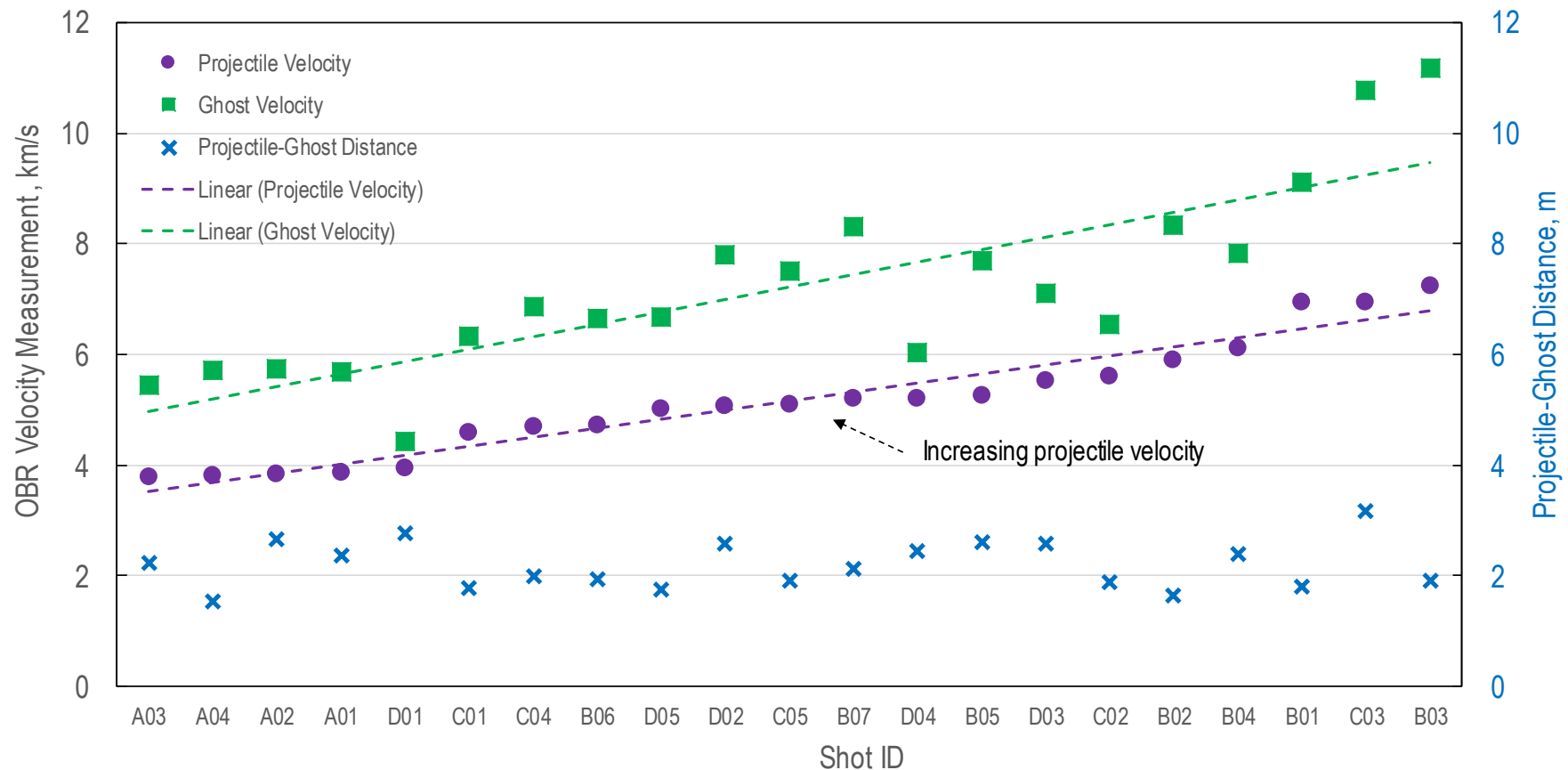




# GHOST SIGNAL CHARACTERIZATION

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

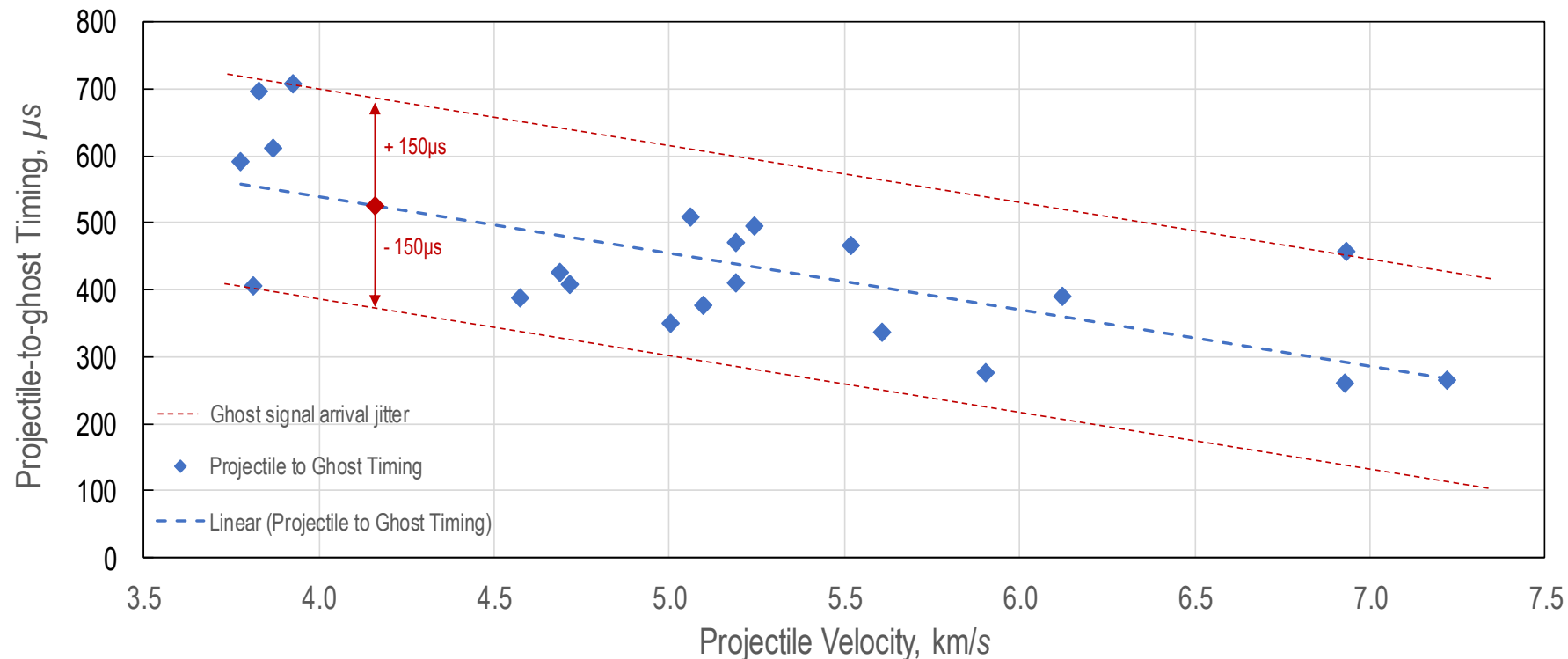






# GHOST SIGNAL CHARACTERIZATION

- 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.

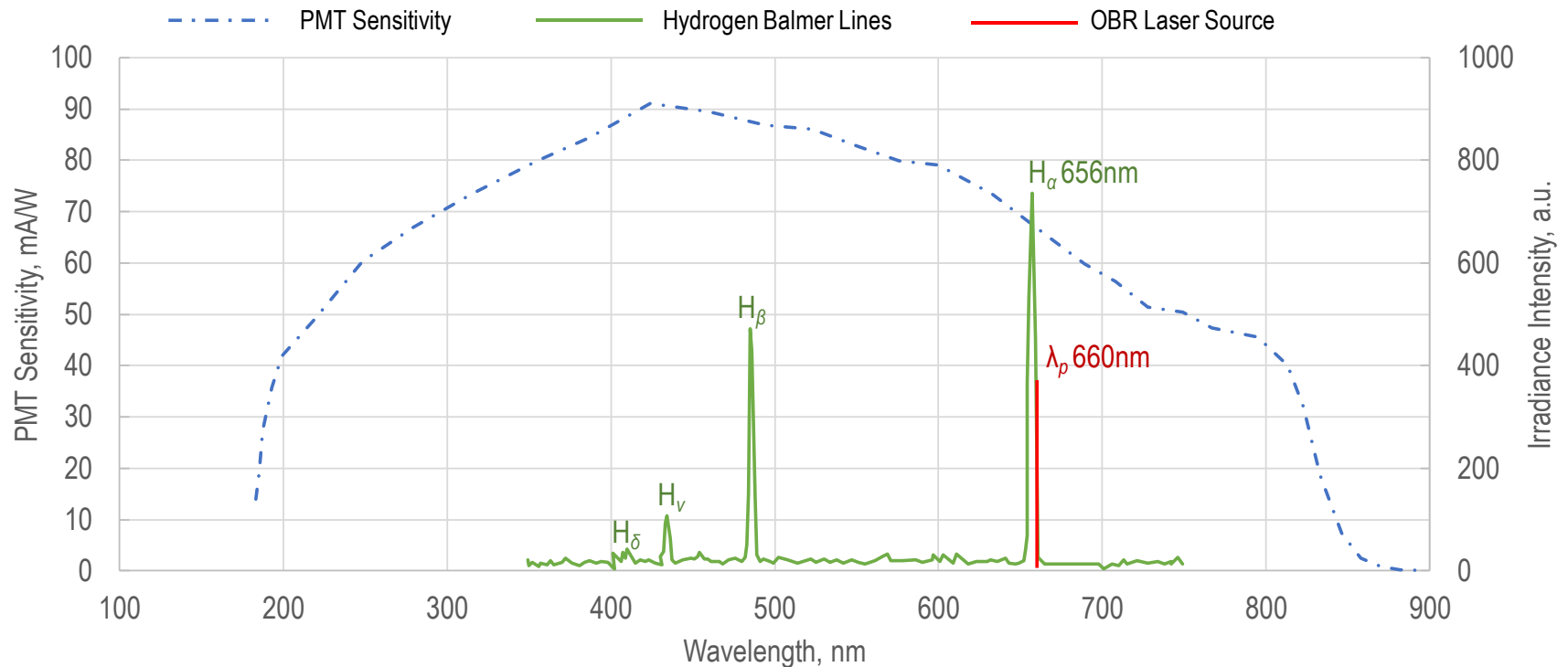






# GHOST SIGNAL SOURCE ANALYSIS

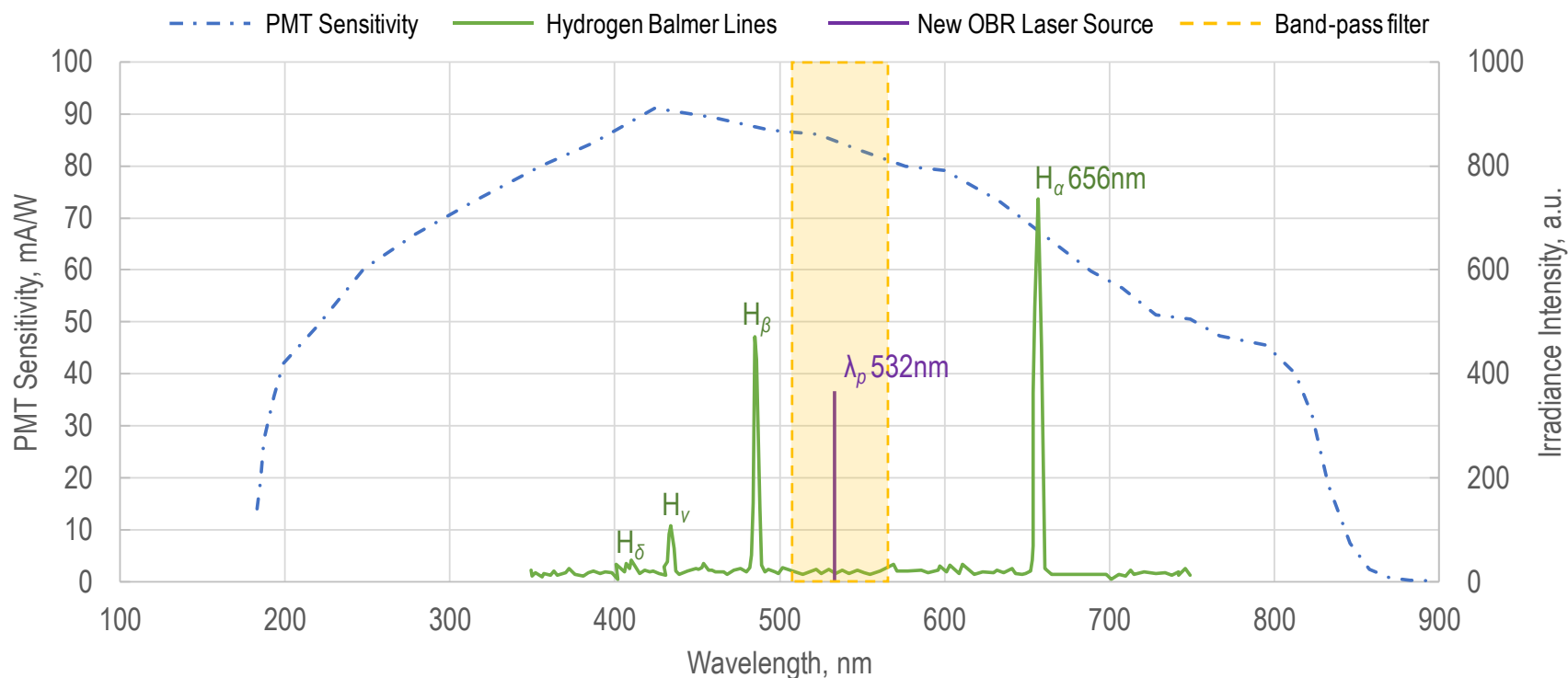
- Based on the working principle of the OBR system there are two main possible means for the observed ghost signal: Light reflection or emission from the unknown source.
- The most likely origin of the ghost signal is a light emitting source such as hydrogen plasma that is picked up by the OBR.





# MITIGATION SCHEMES

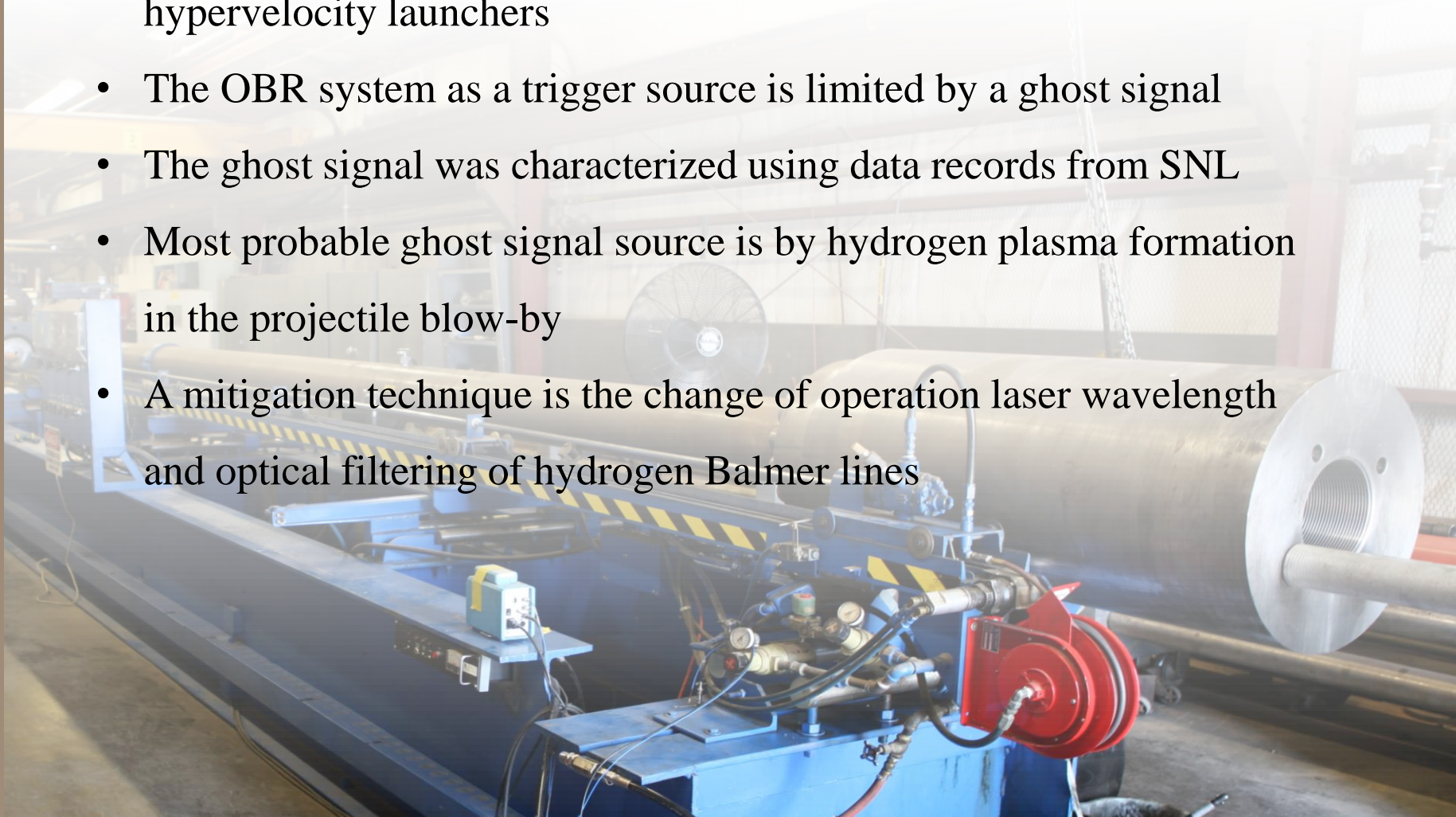
- Using the actual ghost signals as a trigger source is a plausible solution if the application tolerates the jitter observed.
- The most effective mitigation technique is by optically filtering the OBR signal to eliminate the Balmer lines with a band-pass filter and new operation laser wavelength.





# 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





SHOCK THERMODYNAMICS



A P P L I E D   R E S E A R C H

*Thank you !*