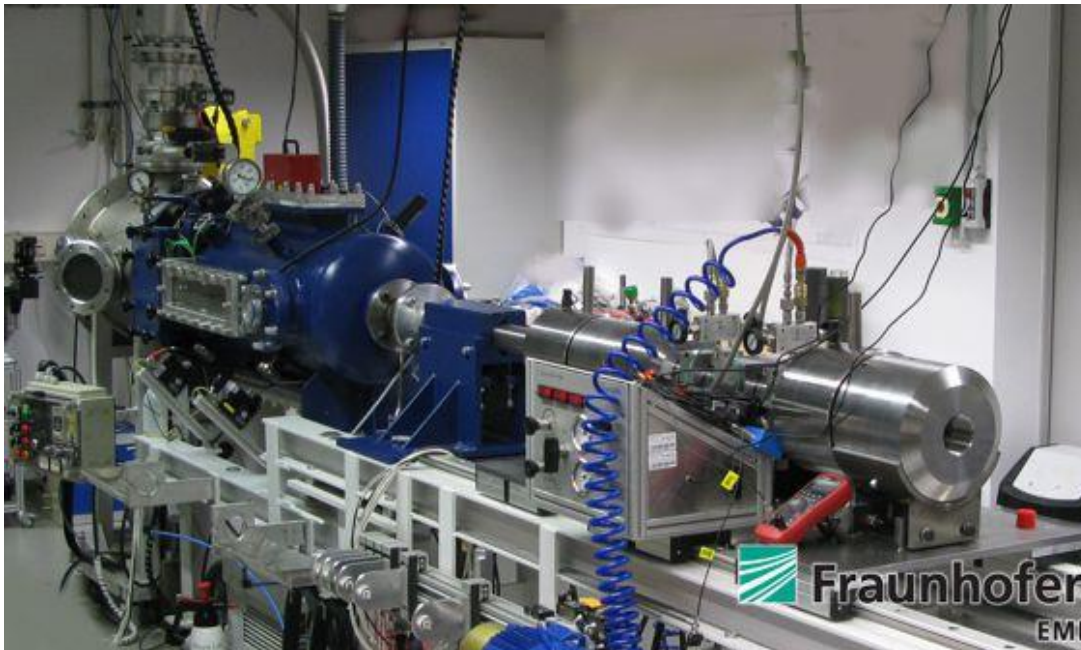


EMI'S TWINGUN – CONCEPT FOR A NEW LIGHT-GAS GUN TYPE HYPERVELOCITY ACCELERATOR

R. Putzar, Fraunhofer EMI

65th ARA Meeting, 19 – 24 Oct. 2014, Arcachon, France



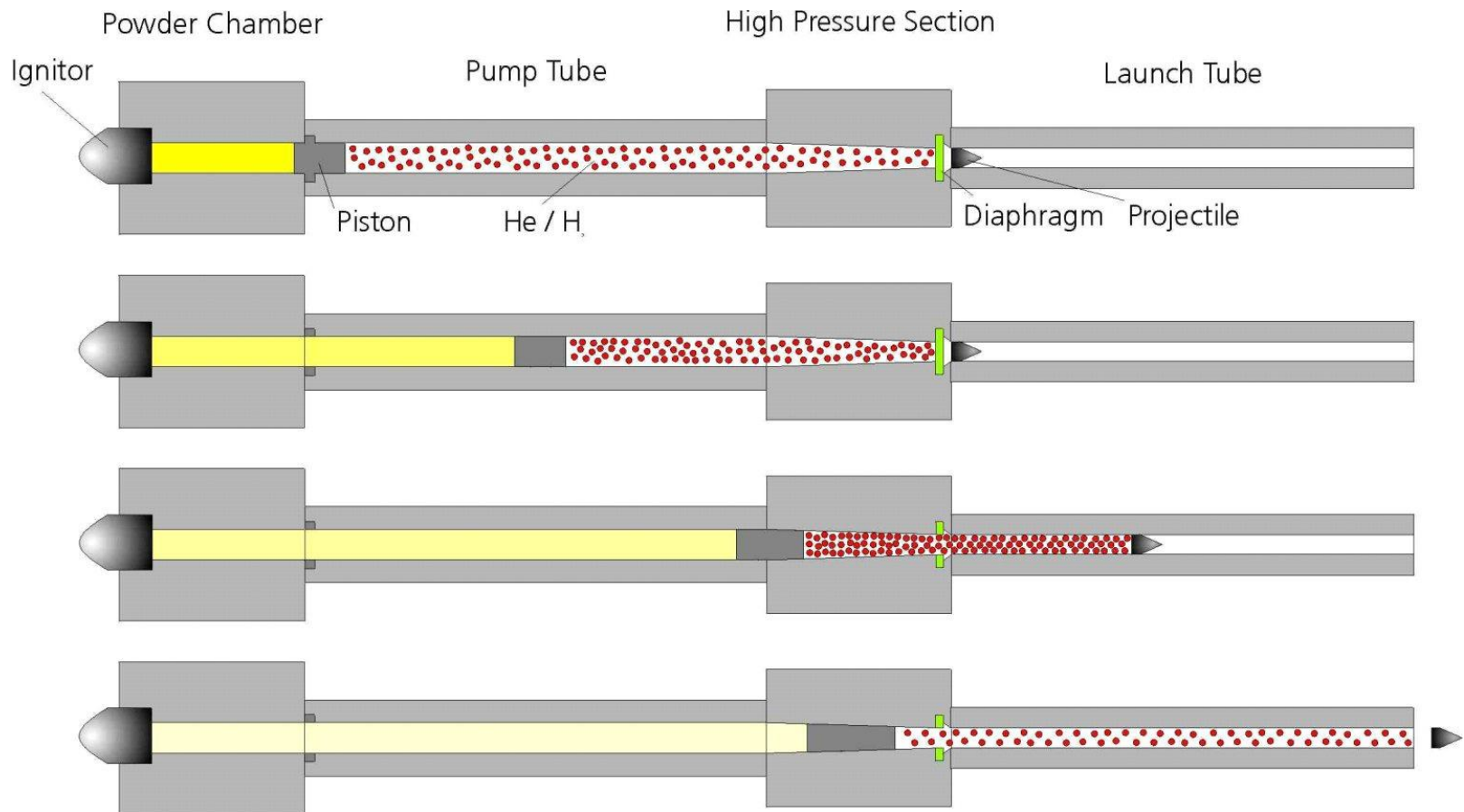
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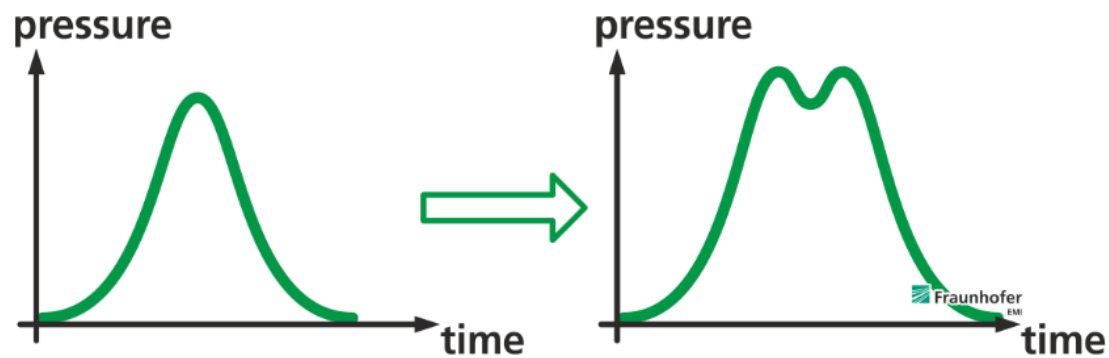
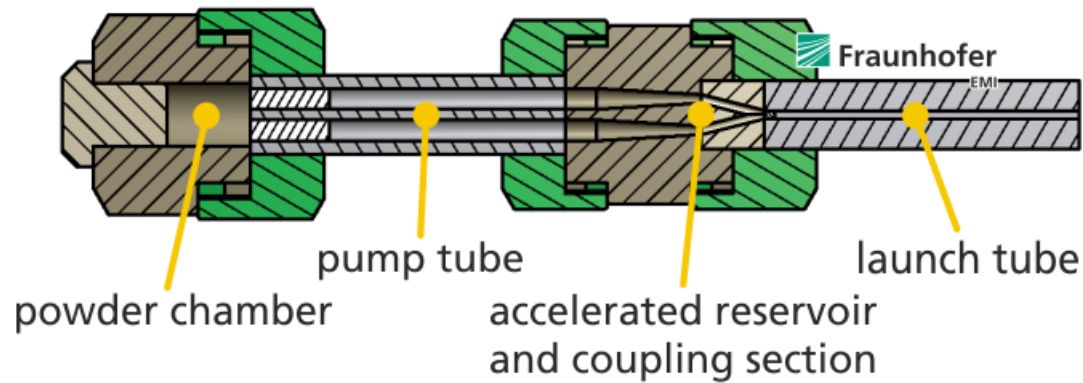
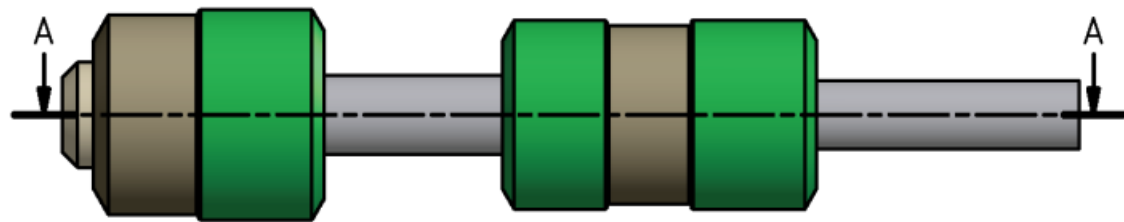
Bundesministerium
für Wirtschaft
und Technologie

aufgrund eines Beschlusses
des Deutschen Bundestages

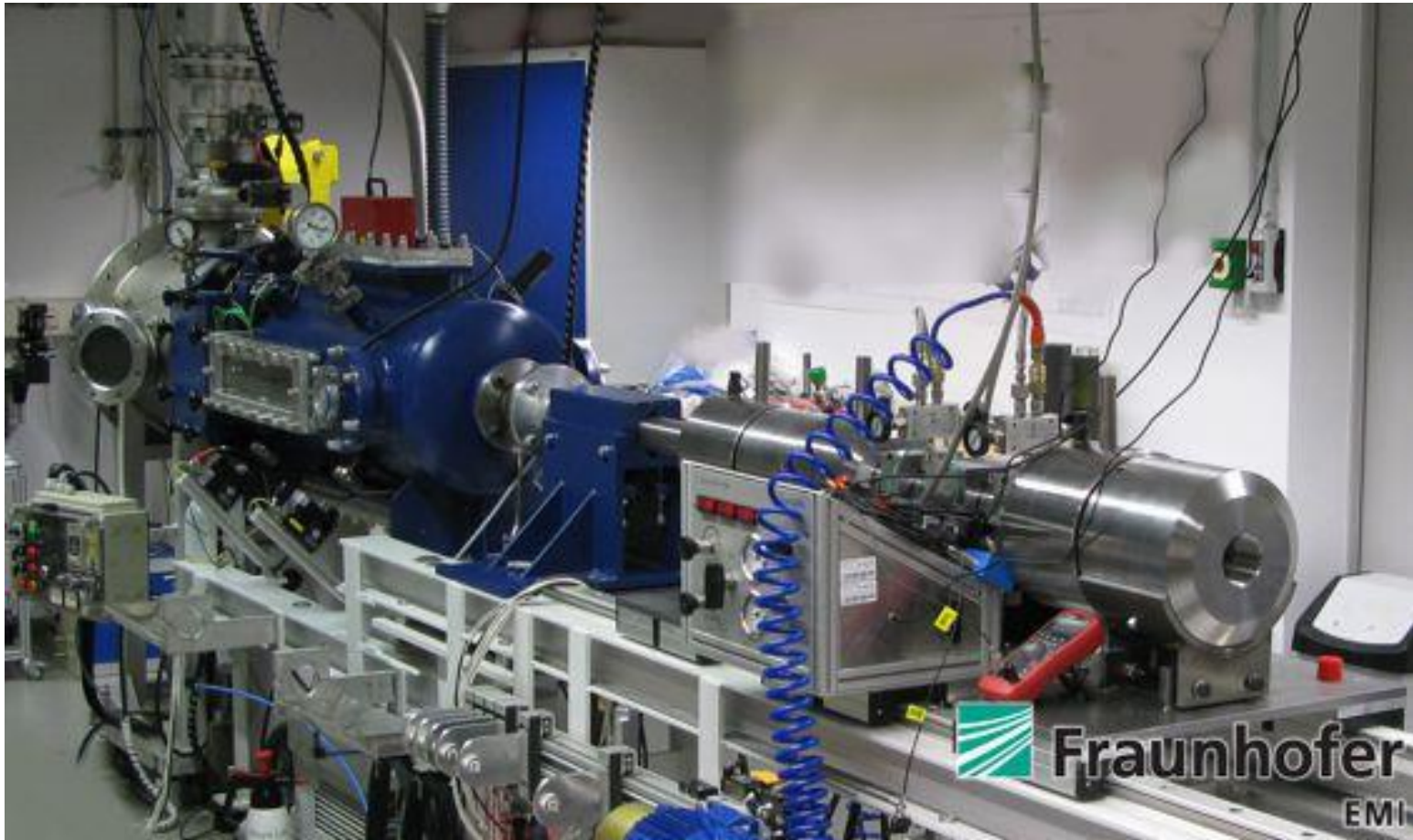
Concept of two-stage light-gas guns



TwinGun – Concept



TwinGun – Facility



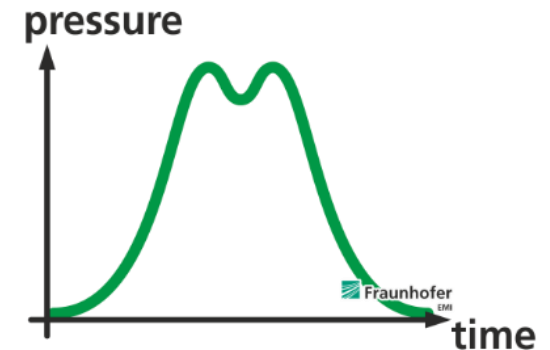
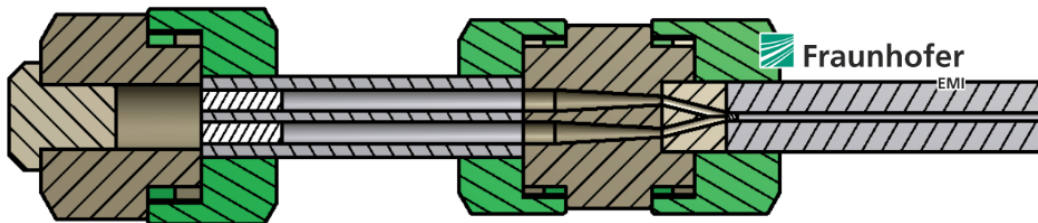
TwinGun – Piston Synchronisation

Major requirement for successful operation:

- Defined offset between the two pistons

Infers two operation requirements:

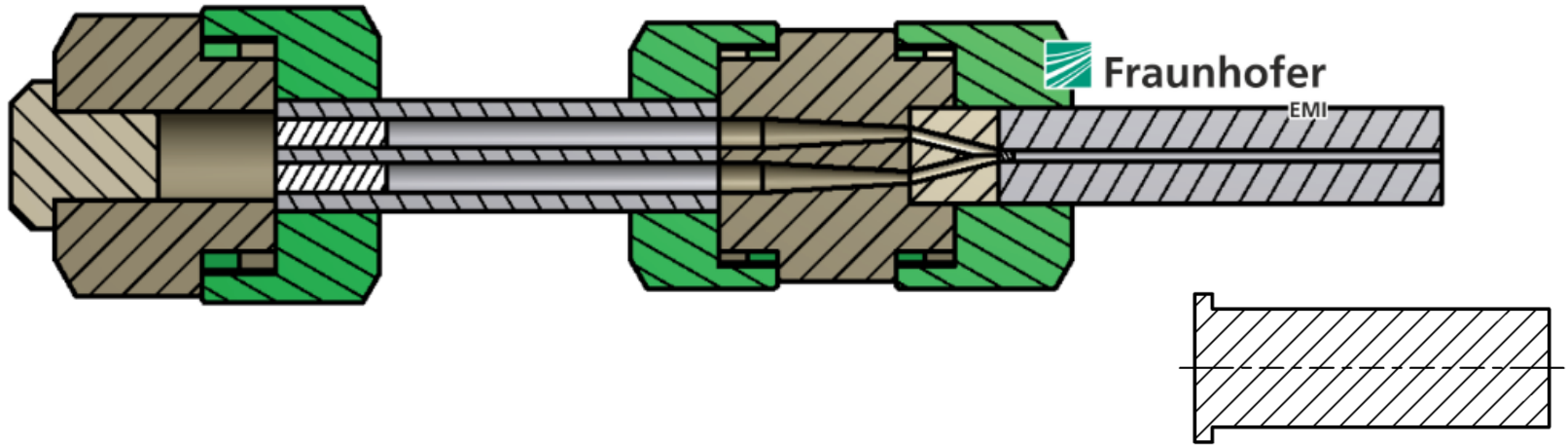
- Reproducibility of piston motion
- Effective manipulation of piston motion



CONTENTS

1. Introduction
2. Reproducibility of piston motion
3. Effective manipulation of piston motion
4. Concluding Remarks

Reproducibility



■ Piston motion sequence

- Motion initiation, shearing of lip
- Acceleration by powder gas pressure, dynamic friction in pump tube
- Deformation in accelerated reservoir

Chronological reproducibility
important for TwinGun

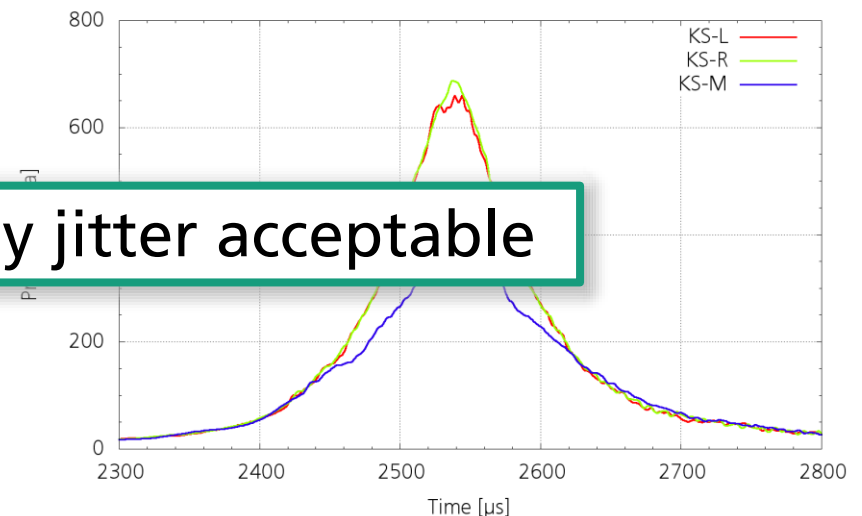
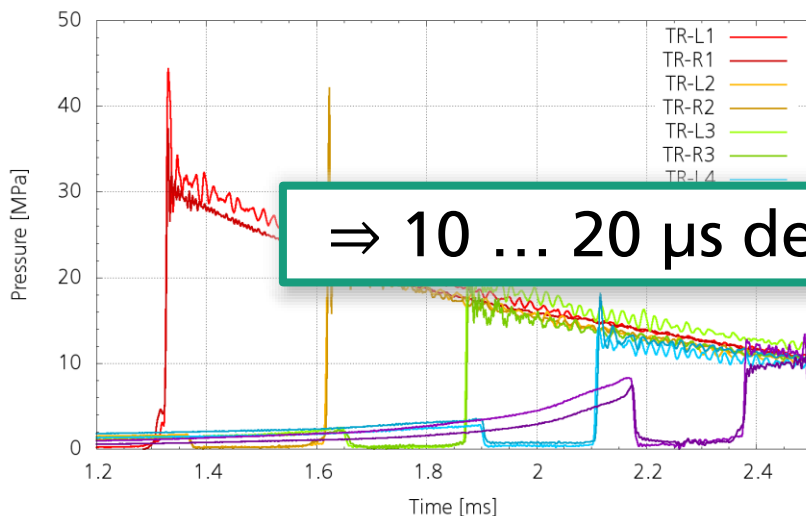
Reproducibility



Q: What is synchronously?

- indicated by experiments with very synchronous piston motion
- Exp. 77: piston delay @ sensor 5: 2 – 3 μ s
 - FWHM of pressure at coupling section is 96 – 98 μ s (left & right)
- other experiments: typical FWHM is 90 ... 120 μ s

FWHM = full width half maximum



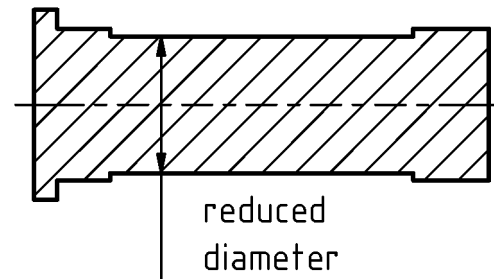
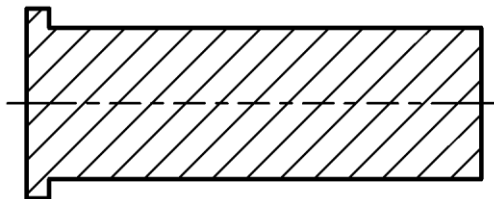
Reproducibility – Experiments

Modifications investigated

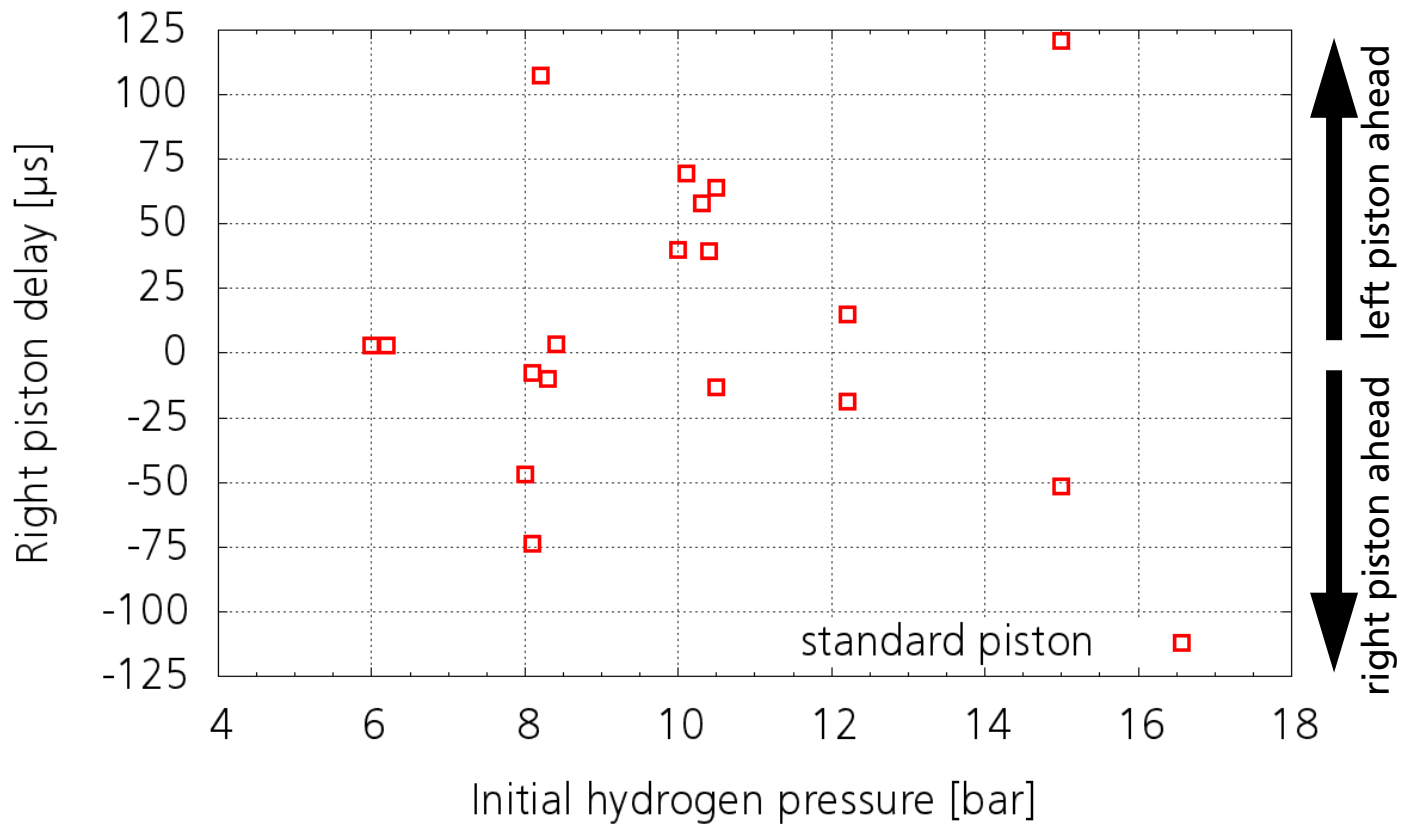
- arrangement of gun powder in the powder chamber
- adjustment of the interior pump tube diameter
- shear lip thickness of the piston
- friction between piston and pump tube
- operation parameters (powder charge mass, initial H₂ pressure)



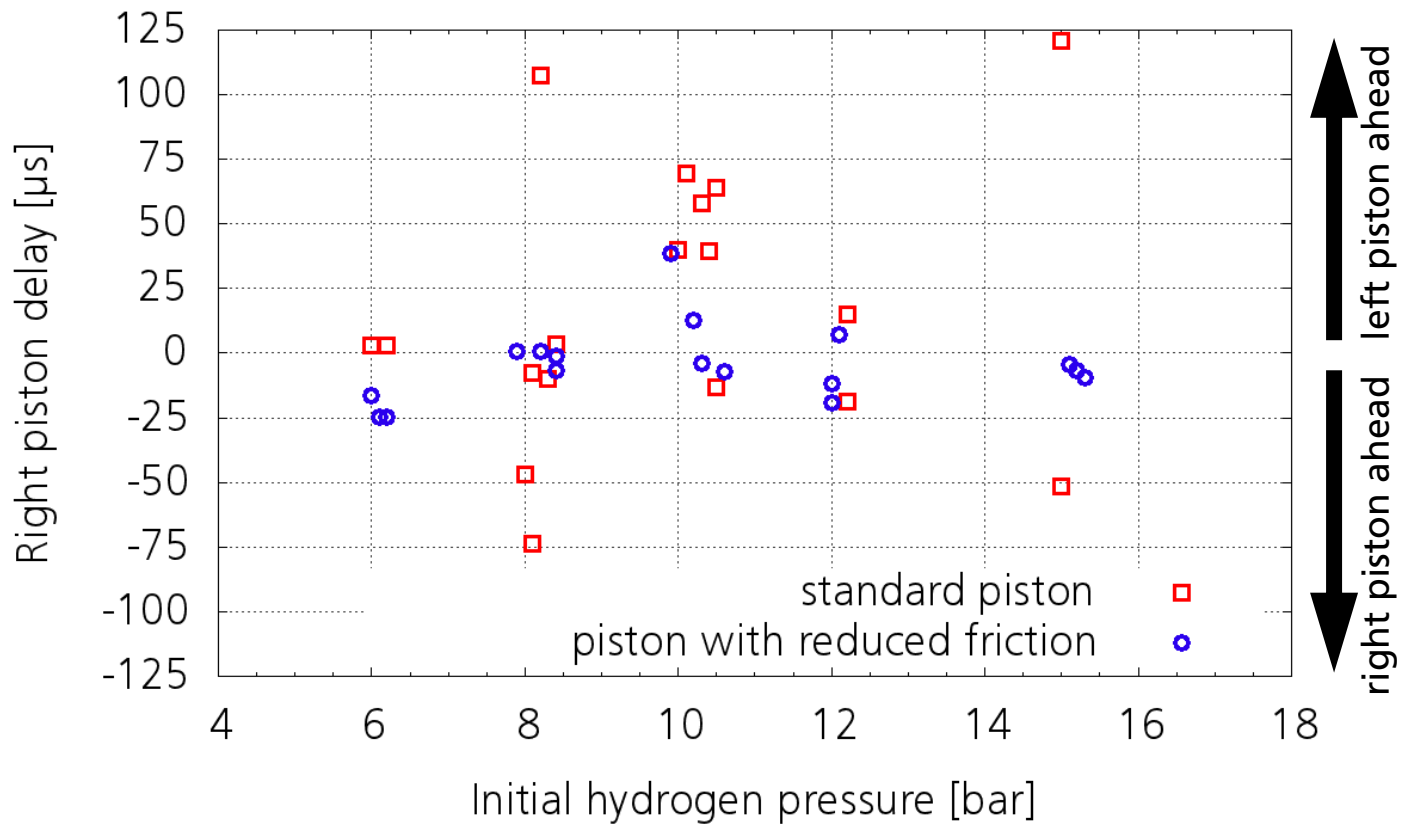
most effective



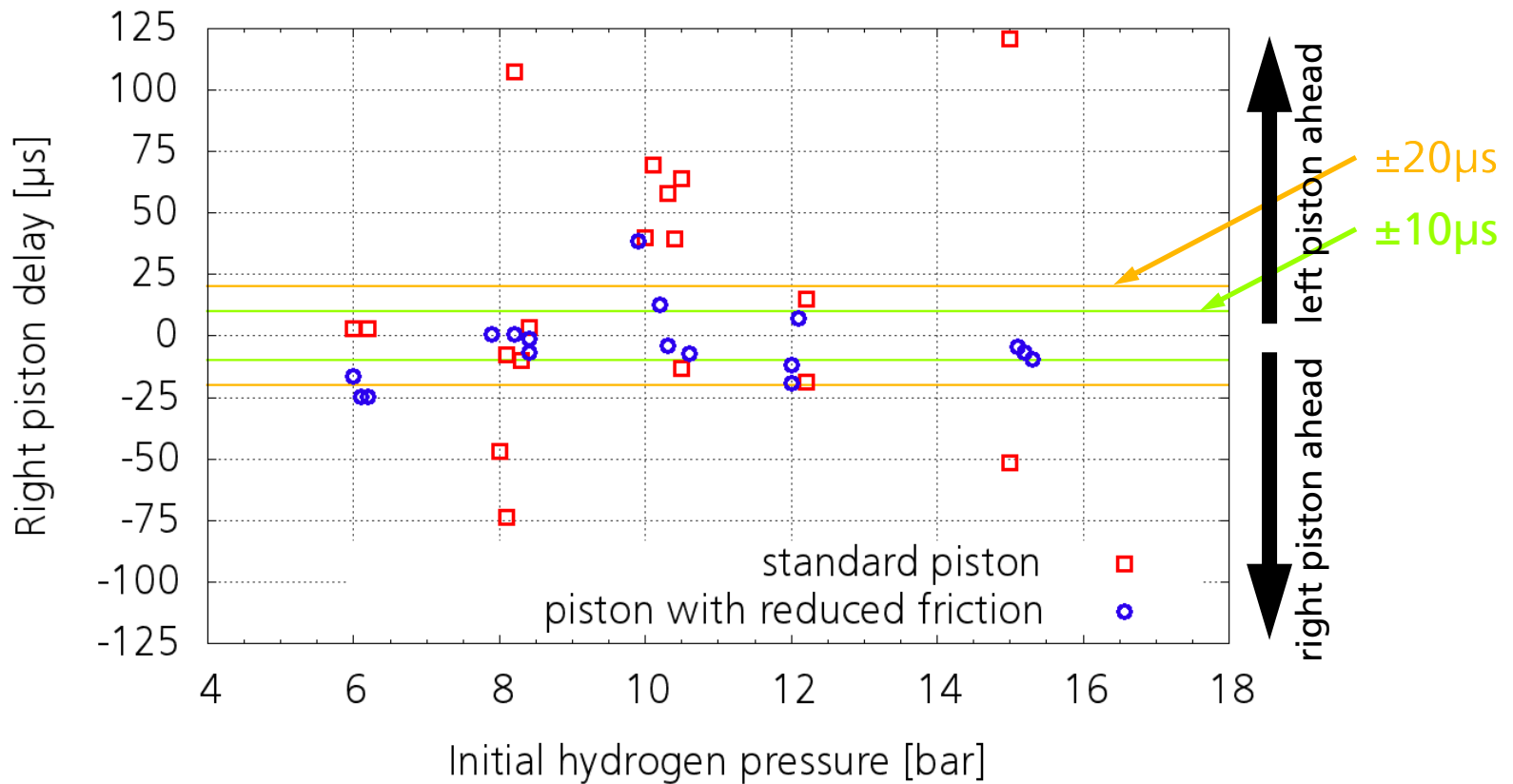
Reproducibility – Experiments with nominal identical pistons



Reproducibility – Experiments with nominal identical pistons

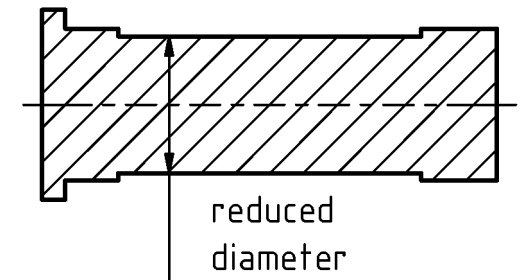


Reproducibility – Experiments with nominal identical pistons



Reproducibility – Summary

- Piston motion in TwinGun now reproducible
- Satisfactory synchronization of piston motion
 - Experiments with nominal identical pistons presented
 - New piston: 14 out of 17 experiments within $\pm 20 \mu\text{s}$

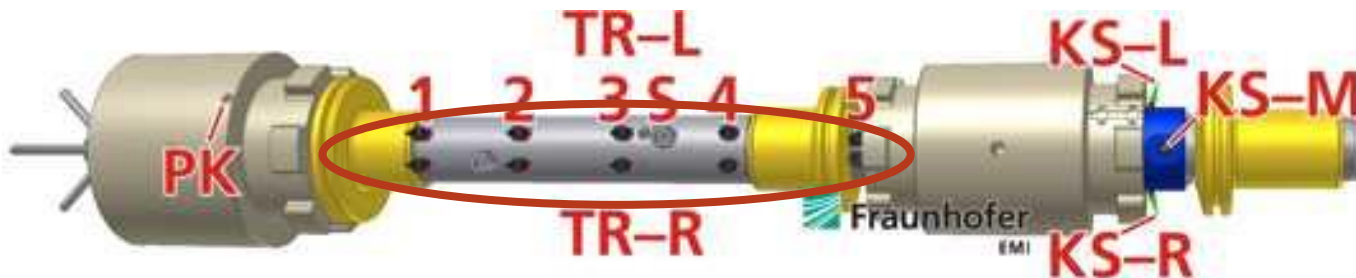


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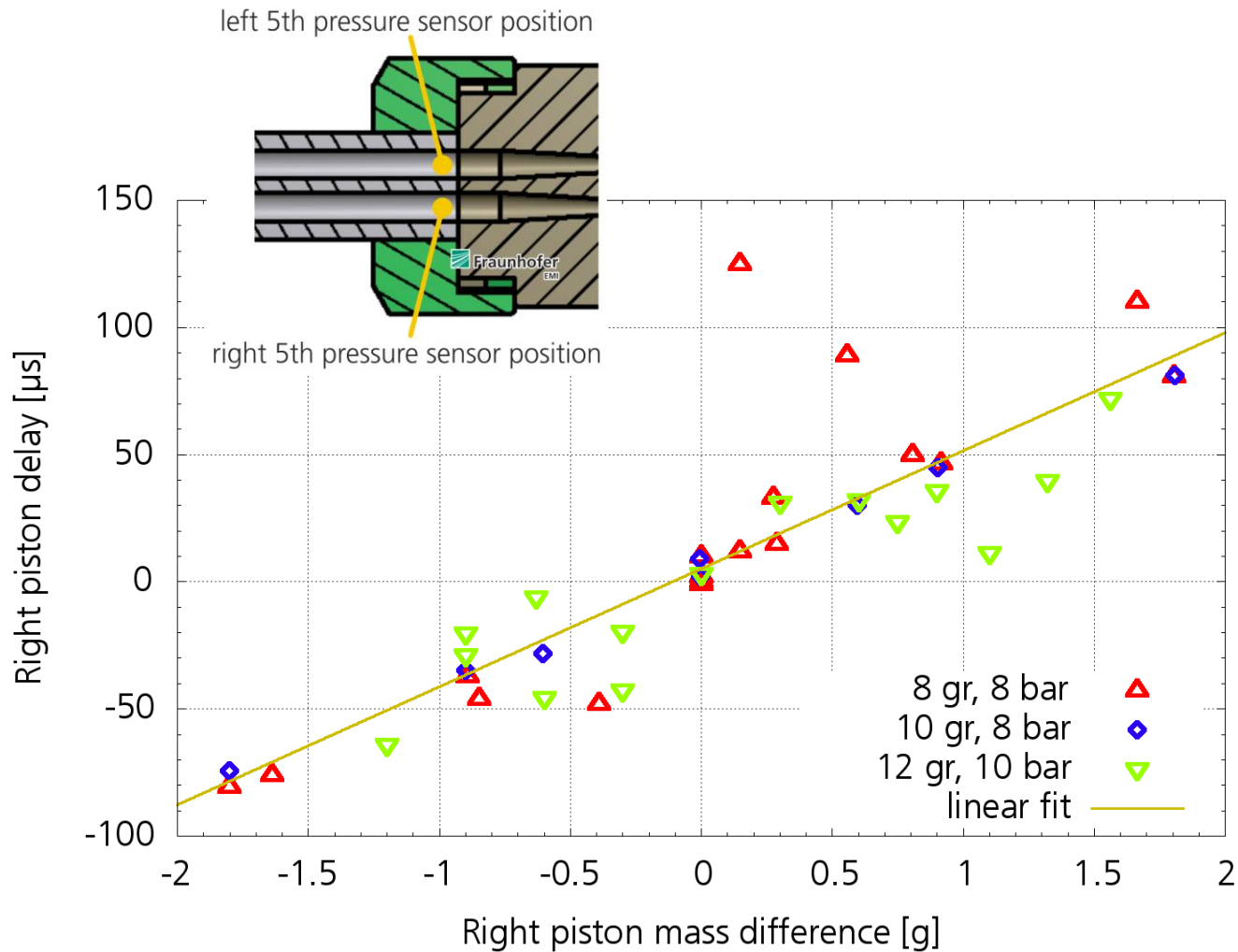
1. Introduction
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Effective manipulation

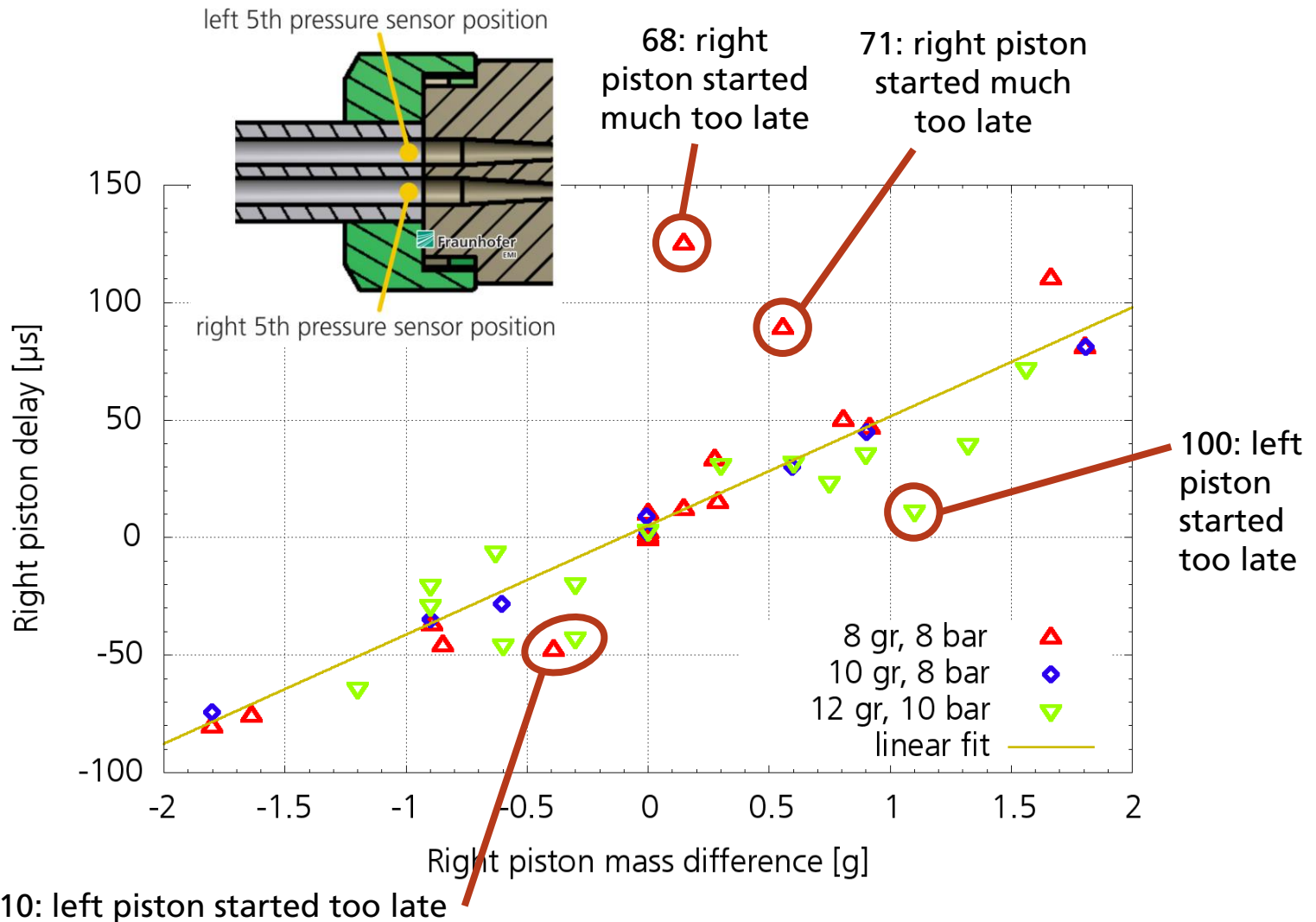
- Aim: effective manipulation of piston delay
 - measured at 5th pressure sensor
- Differing piston masses
 - effective manipulation in numerical simulation
 - therefore 1st choice in experiment



Effective manipulation – Experiments

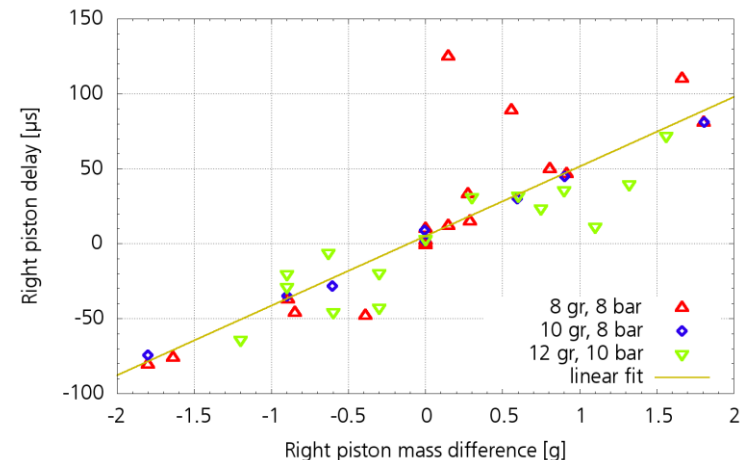
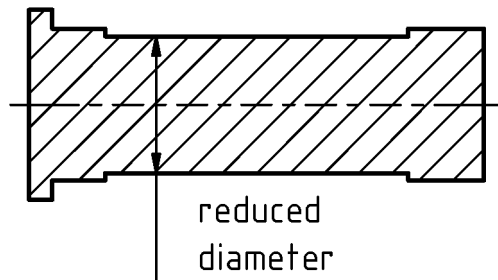


Effective manipulation – Experiments

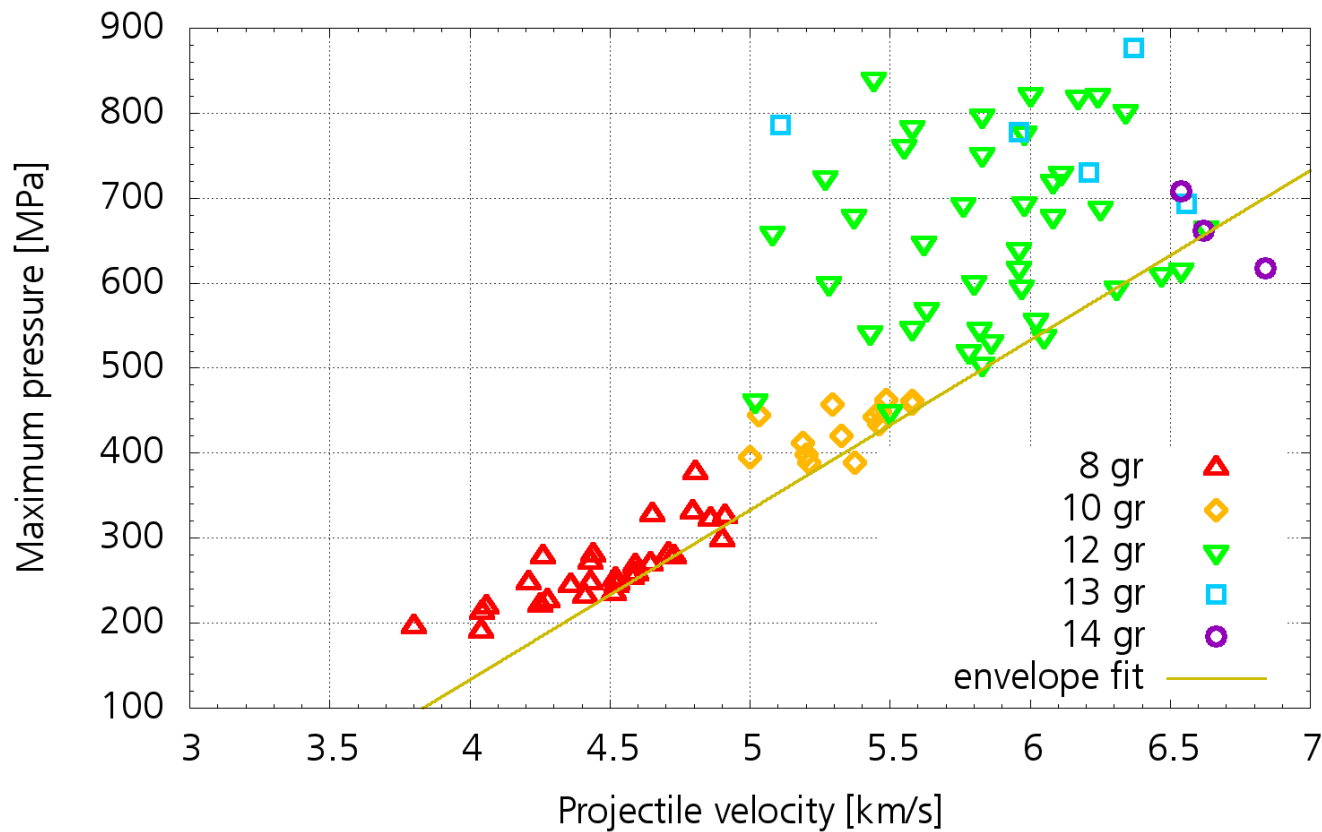


Effective manipulation – Summary

- Piston delay is linear depending on piston mass difference
- Discrepancies can be explained by delayed piston motion initiation
- Reasons for delayed piston motion initiation remains unclear
- Possibilities
 - Static friction
 - Inhomogeneous piston material



Current Performance



Concluding Remarks

- Achieved reproducible piston motion in TwinGun
- Achieved effective manipulation of piston delay
 - Piston mass difference
- Current performance at 7 km/s with acceptable load to gun components

Outlook

- Increase performance while maintaining acceptable gun load