

# Rolls Royce 2017

## Mechanical Test Operations Centre

Dahlewitz, Brandenburg

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# High Speed Gun Testing

High speed projectile impact testing for civil large & medium full fan rotor assemblies – A capability of the LSSF at Rolls Royce - MTOC

Tobias Hack,

23<sup>rd</sup>/24<sup>th</sup> February 2017

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# Content

- The Large Specialist Spinning Facility (LSSF)
- Ballistic High Speed Impact Testing
- High Speed Gun System in RR – MTOC
  - *Functionality*
  - *Achieved Accuracy*
- Future



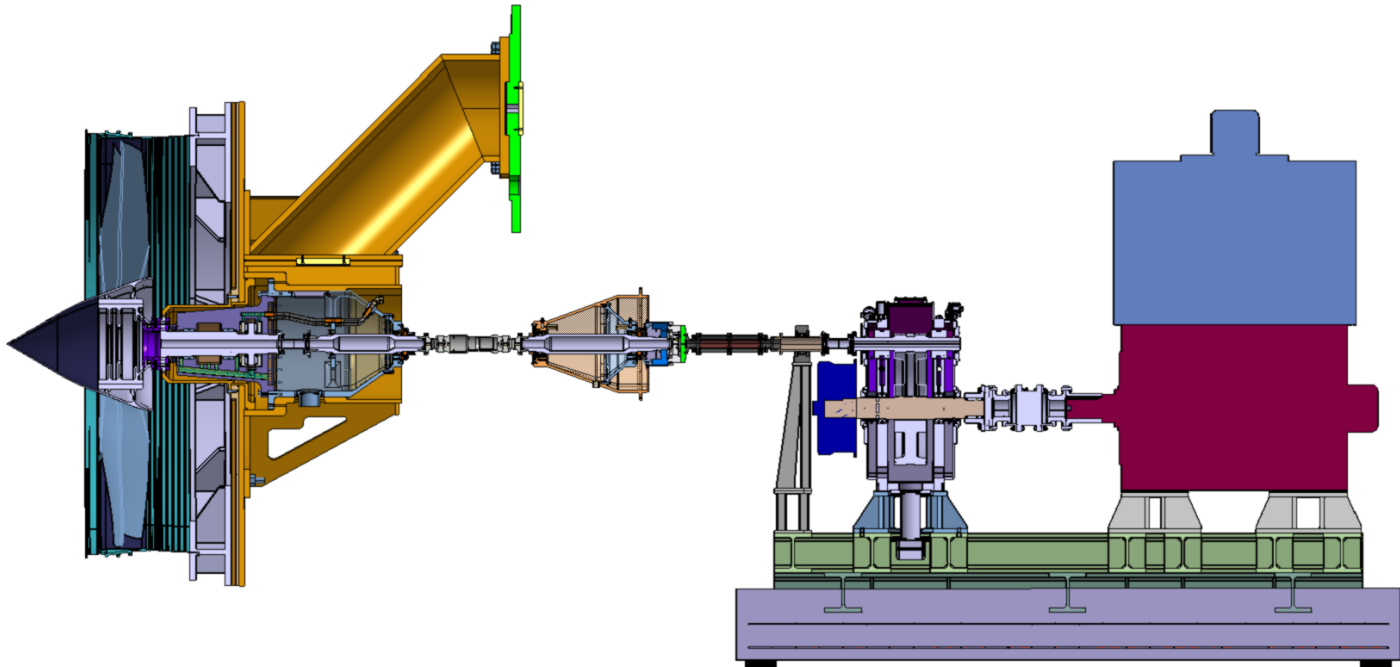
# The LSSF – Large Specialist Spinning Facility

- Largest rig test facility in RR MTOC (∅ 6.45 m / 14 m length)
- Spin tests for rotating engine parts
- Test type capabilities:
  - LCF - Low Cycle Fatigue
  - OS - Over Speed
  - FBO - Fan Blade Off
  - TBI - Trailing Blade Integrity
  - Ballistic Impact Tests (Low & High Speed)
- All test types performed in vacuum condition down to max. 0.5 mbar

# The LSSF – Large Specialist Spinning Facility

- Test piece speed range: 240 – 12.000 rpm
- Drive: 3 MW electrical motor

- Te
- Va
- Te



# Ballistic High Speed Impact Testing

- **Objectives:**
  - Validation of rotor design
  - Validation of impact models to support design of engine parts
  - Analysis of case – rotor interaction
  - Analysis of projectile-residuals trajectory (core/bypass ratio)
  - De-risking of expensive full engine certification tests



# High Speed Gun System in RR MTOC

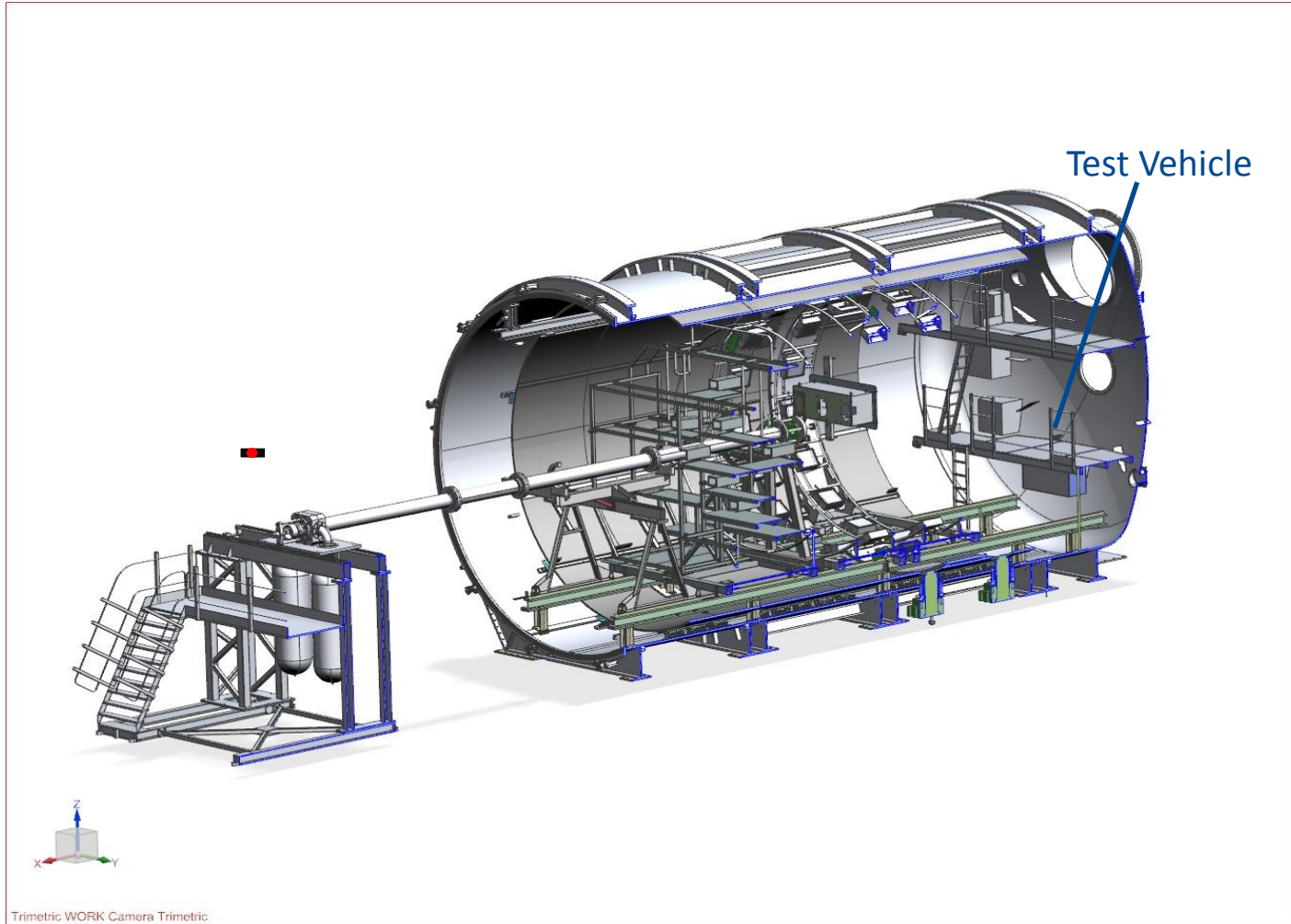
## *Principle*

- **Projectile carrier (sabot) accelerated with pressurised air**
- **Arrester hard stops sabot on barrel end**
- **Main projectile continues flying to target**
- **Capability:**
  - Speed Range: 25 – 140 m/s
  - Projectile Mass Range: 0.45 – 3.65 kg
  - Max. Shooting Pressure: 4 bar (differential)



# High Speed Gun System in RR MTOC

## Main Components



Trimetric WORK Camera Trimetric

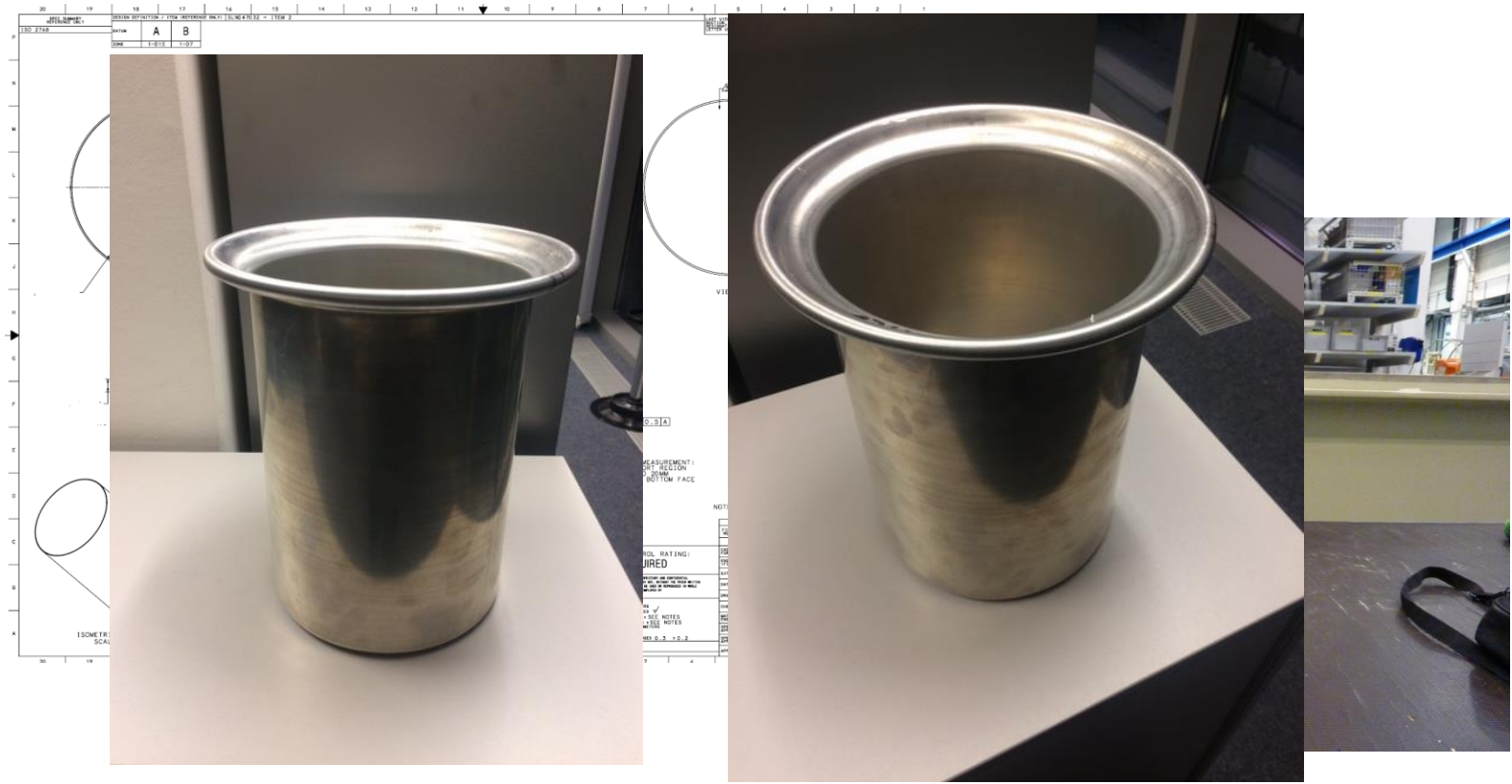


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# High Speed Gun System in RR MTOC *Projectile Carrier - Sabot*

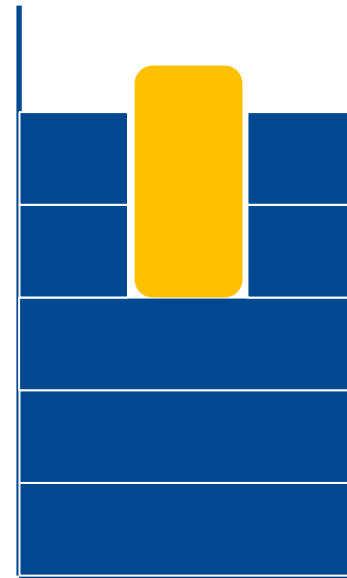
- **Aluminium spun sabot**



# High Speed Gun System in RR MTOC

## *Projectile Carrier - Sabot*

- **Projectile Packing**



# High Speed Gun System in RR MTOC *Valve*

- **Electro Magnetic Valve**

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Data**



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# High Speed Gun System in RR MTOC

## *Sabot Arrester*

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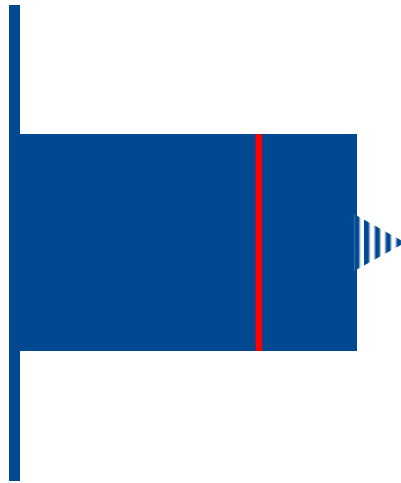
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# High Speed Gun System in RR MTOC

## *Requirements & Achieved Accuracy*



Tumbling Angle  
Speed  
Strike Radius  
Synchronization



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# High Speed Gun System in RR MTOC

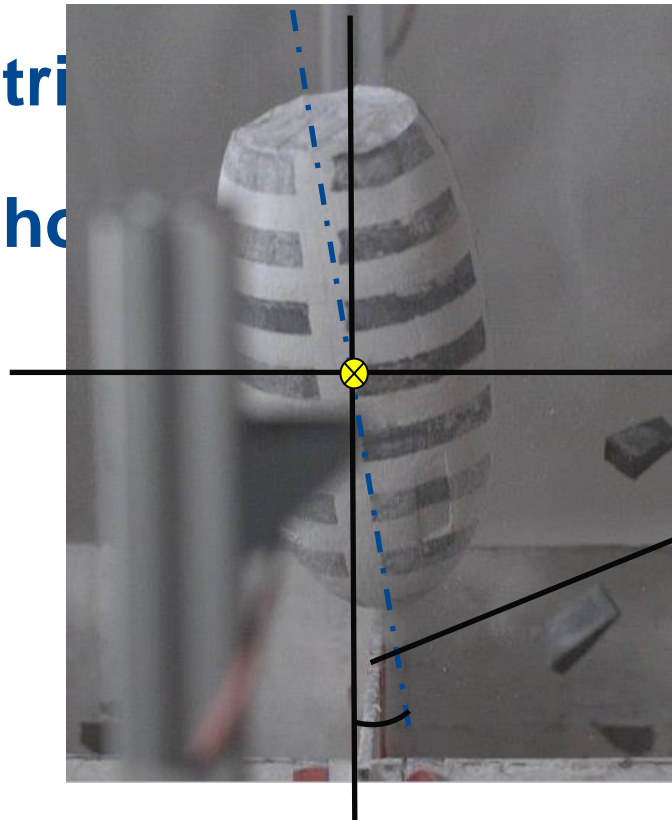
## *Achieved Accuracy*

**Projectile Speed:  $\pm 2.5$  m/s**

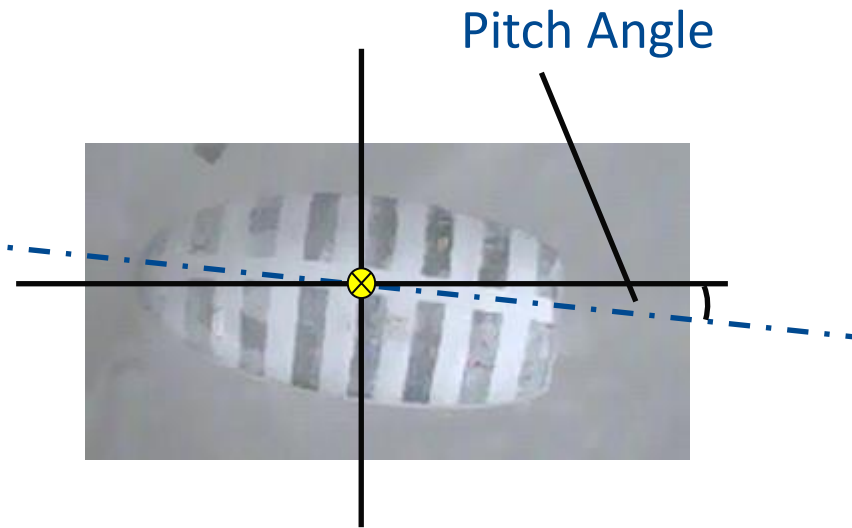
**Projectile Angle:  $\pm 10^\circ$  (pitch & yaw)**

**Strik** m

**Sho** - 1 ms



Yaw Angle



Pitch Angle



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# View into Future

- I. Development of vacuum shot capability & automated arrester reset**
- II. Automated shot pressure setting**
- III. Continuously optimization of the valve – and sabot system in order to improve further synchronization & and projectile trajectory → Higher quality of test data**



# Thank you



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