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*Effects of Bearing Material Choice and
Engine Oil Viscosity on Journal Bearing Durability
in Stop-Start Environments*

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Performance you can rely on.



- **Introduction**

- Importance and significance of stop-start technology for HDD
- Trends in oil viscosity reduction
- Impact on key wear contacts in HDD engine

- **Results**

- Bearing test rig developed
- Effect of start-stop technology and reduced viscosity on bearing wear for:
 - Different lubricant oil viscosities
 - Different bearing materials

- **Summary and future challenges**

Tighter legislation for on-highway emissions

2020



China: Introduced HD fuel consumption limits in 2012 (Phase 2); require 15% reduction (Phase 3)

2025



EU: 15% reduction in CO₂ emissions for new trucks and buses

2027



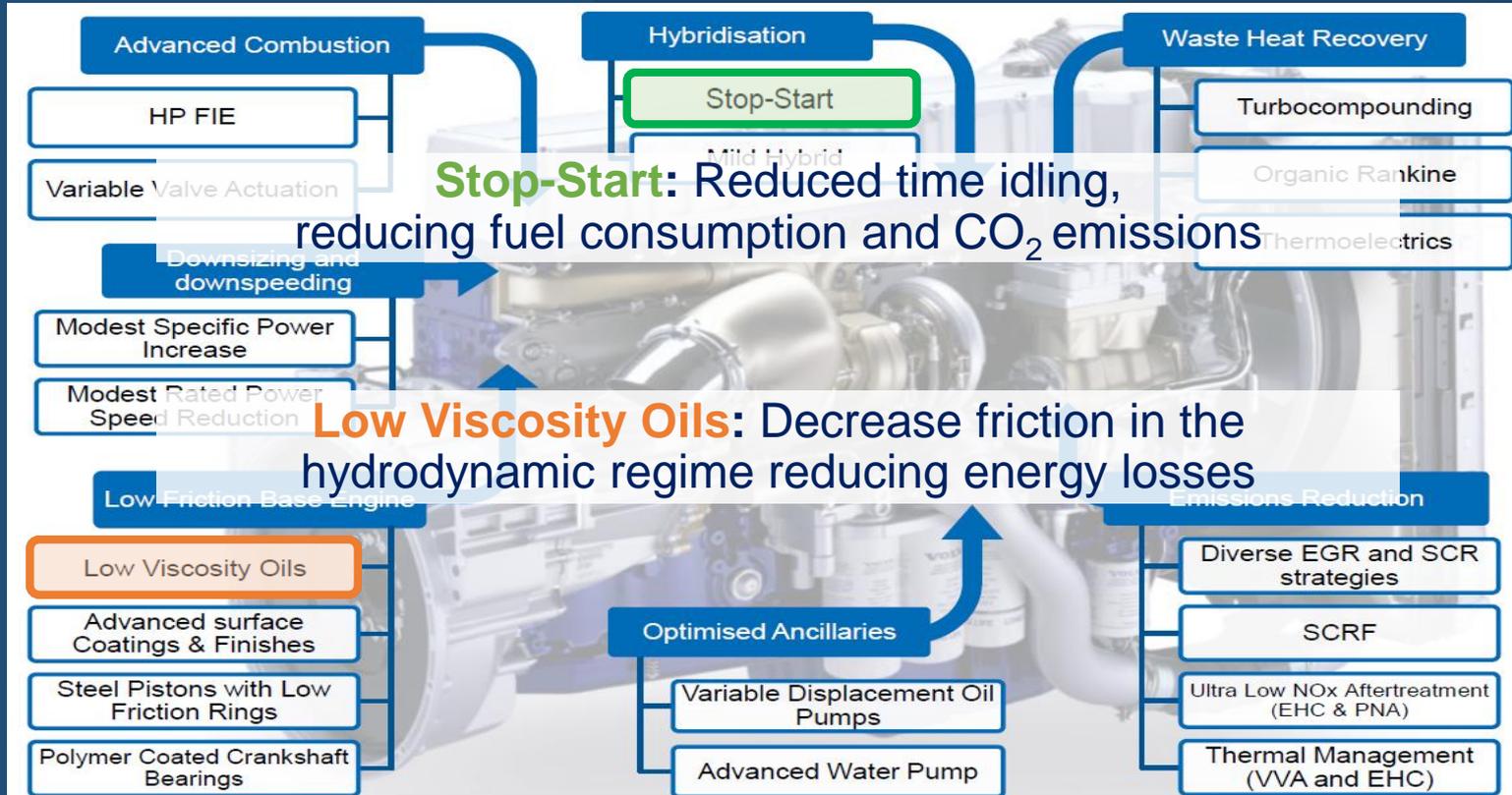
US: Defined HD legislation for 2030, requiring 4-9% engine fuel consumption reduction

2030



EU: 30% reduction in CO₂ emissions for new trucks and buses

Tighter legislation for on-highway emissions



Source: Ricardo plc

Tighter legislation for on-highway emissions



Tighter legislation drives
HDD towards **stop-start** technology
and reduced **oil viscosity**

Source: Ricardo plc

Stop-start anticipated for all HDD vehicles by 2030

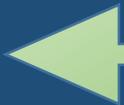


City-type operation:
Greater emphasis on fuel economy

Off-highway:
Greater emphasis
on durability



Increasing benefit and propensity for stop/start



Stop-start anticipated for all HDD vehicles by 2030

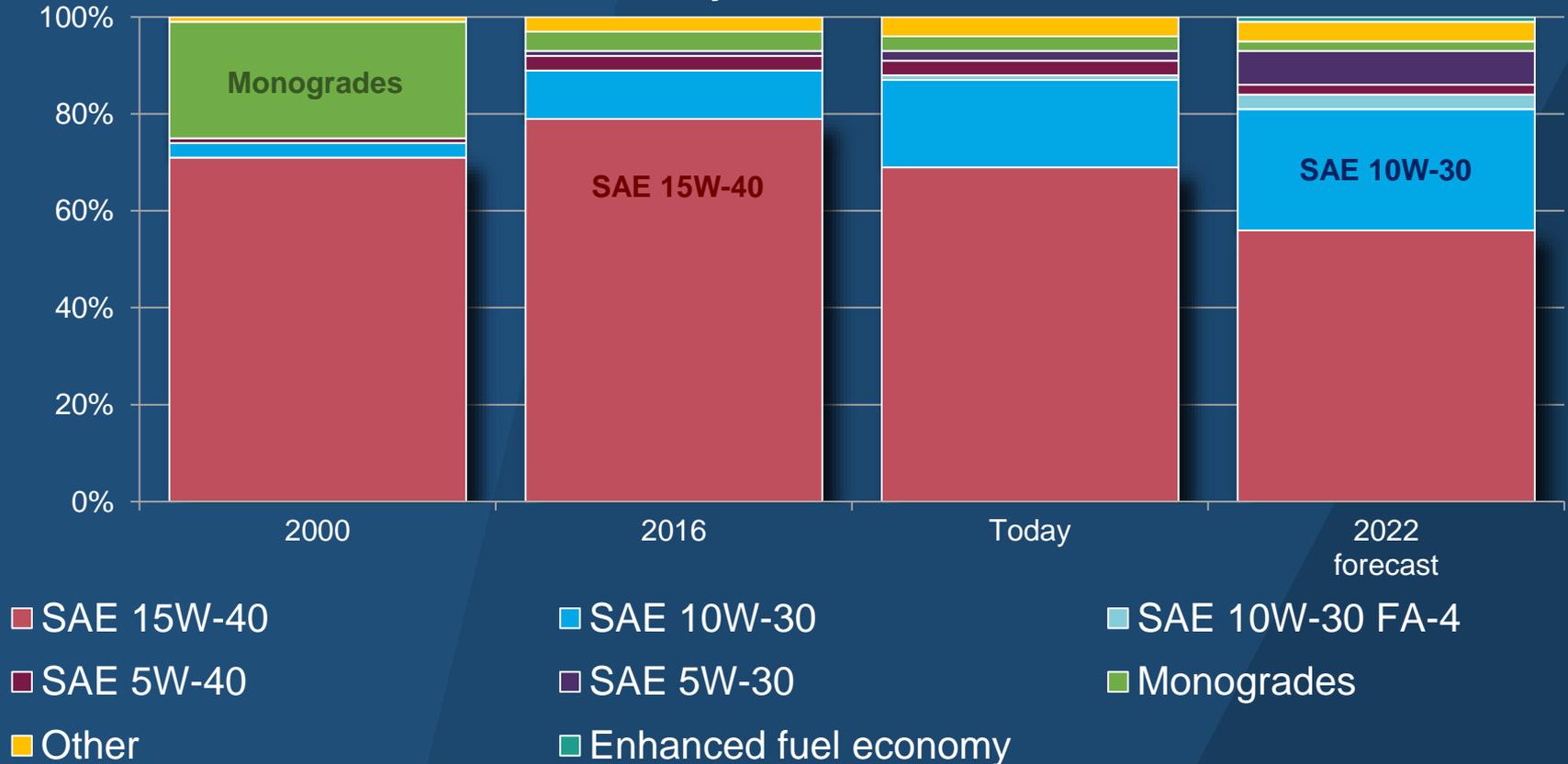


Wide differentiation depending
on vehicle application

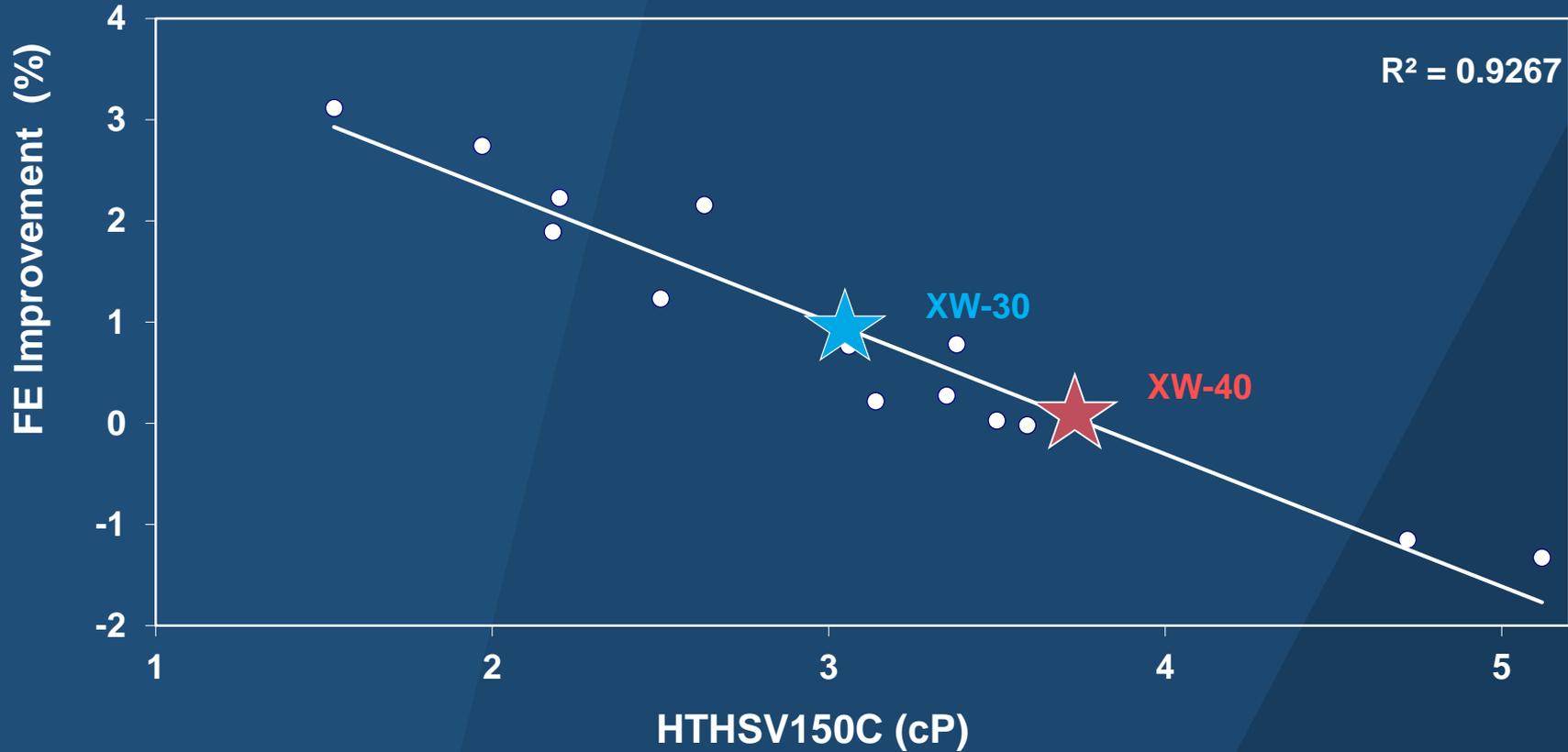
Moving to lower SAE J300 viscosity grade oils



Viscosity Trends for HDD



Moving to lower SAE J300 viscosity grade oils



Moving to **lower SAE J300 viscosity grade oils**



Lower viscosity grade oils reduce friction
leading to improved fuel economy
for the same additive package

Impacts of both **stop-start** and **lower oil viscosity**

Stop-start:

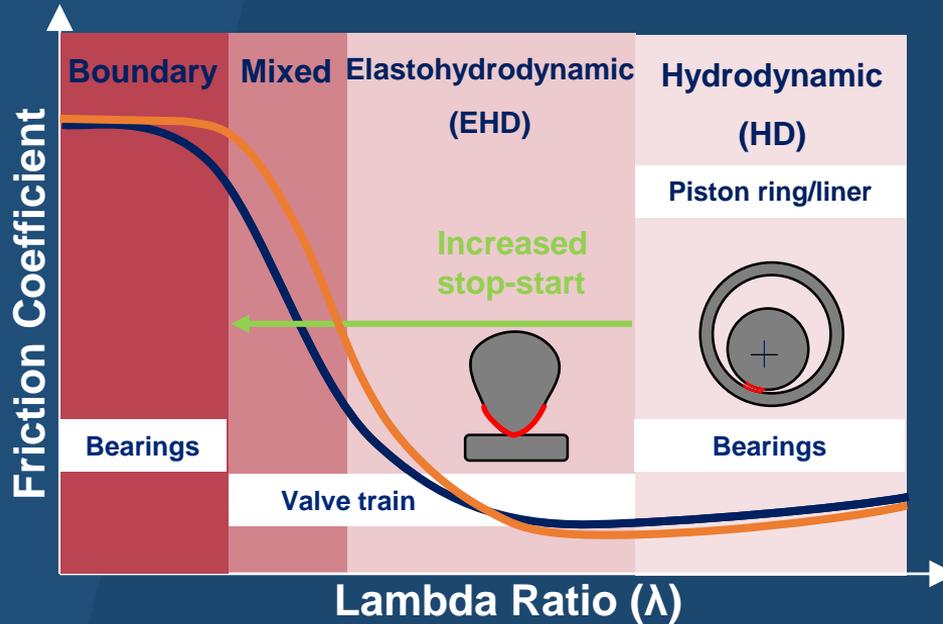
Reduced relative speed of shaft



$$\lambda \propto \frac{\text{speed} \times \text{vis.}}{\text{load}}$$



Increased periods of asperity contact



Lower oil viscosity



Decreased oil film thickness



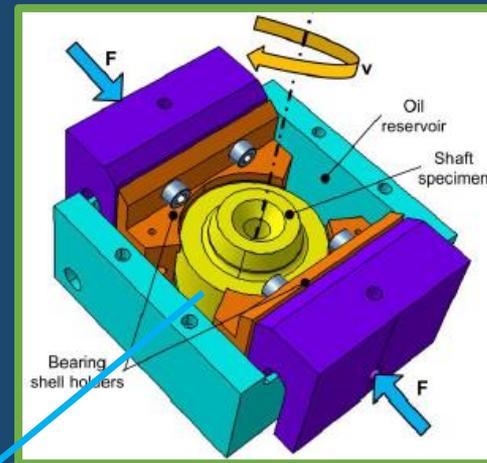
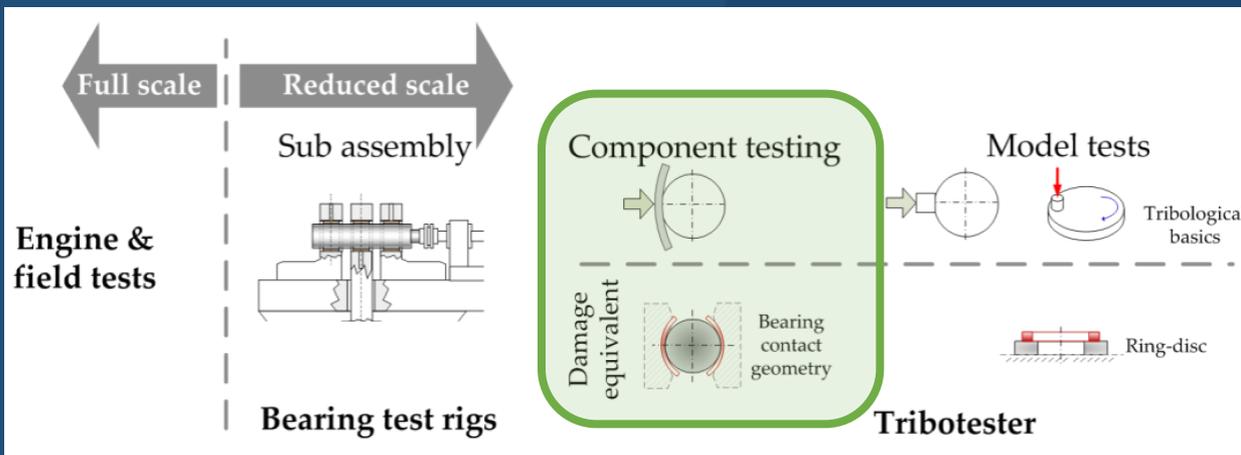
Increases mixed friction



Increased bearing wear



Investigating stop-start and decreased oil viscosity effects



Source: *Lubricants* 2017, 5, 47

Real bearing shells:



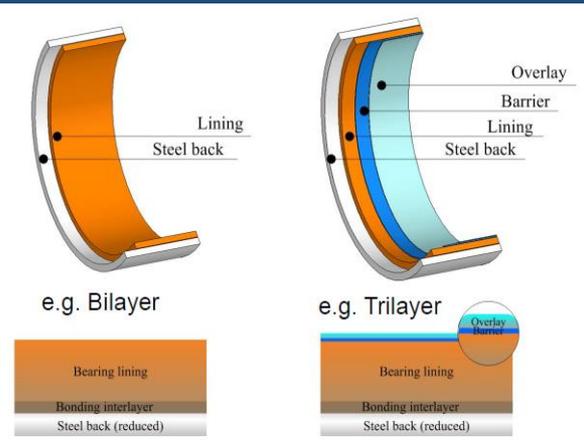
Source: F. Summer *Ecotrib* presentation, 2015

Investigating stop-start and decreased oil viscosity effects

Real bearing shells:

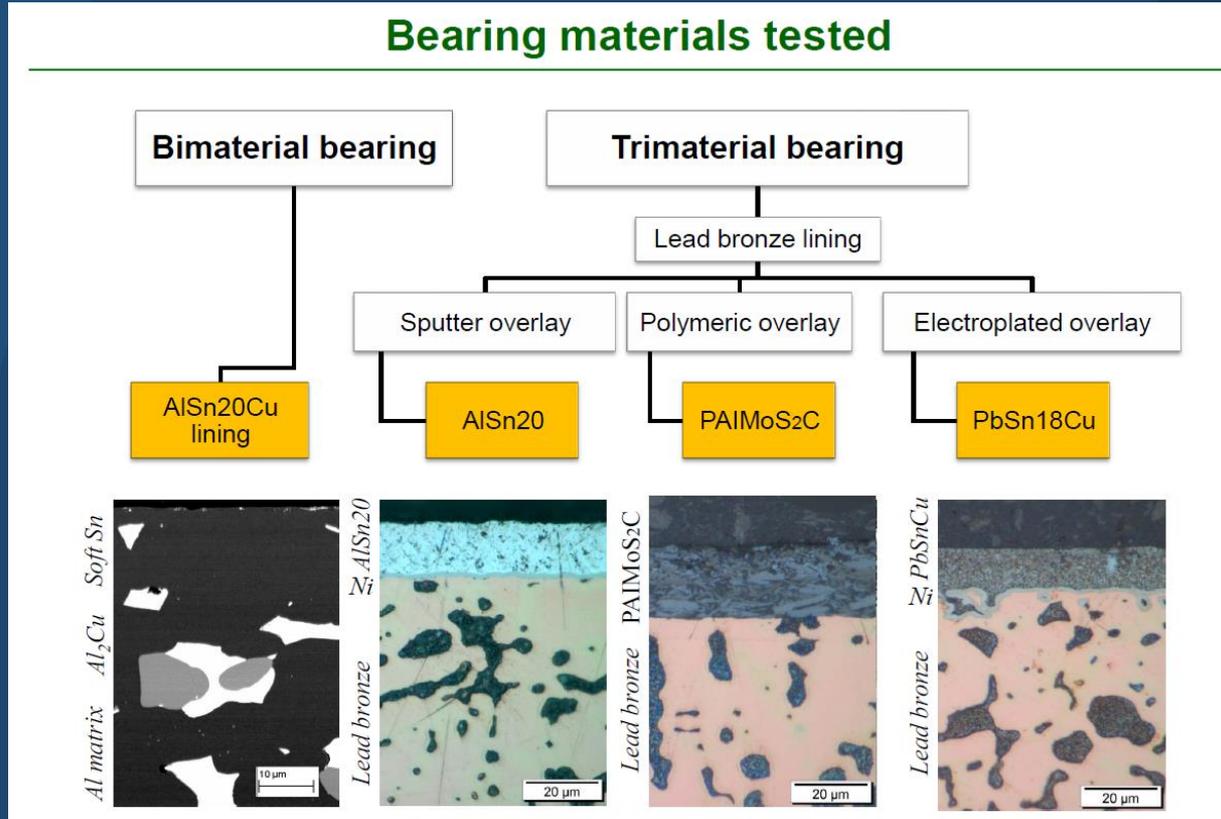


Source: F. Summer *Ecotrib presentation, 2015*



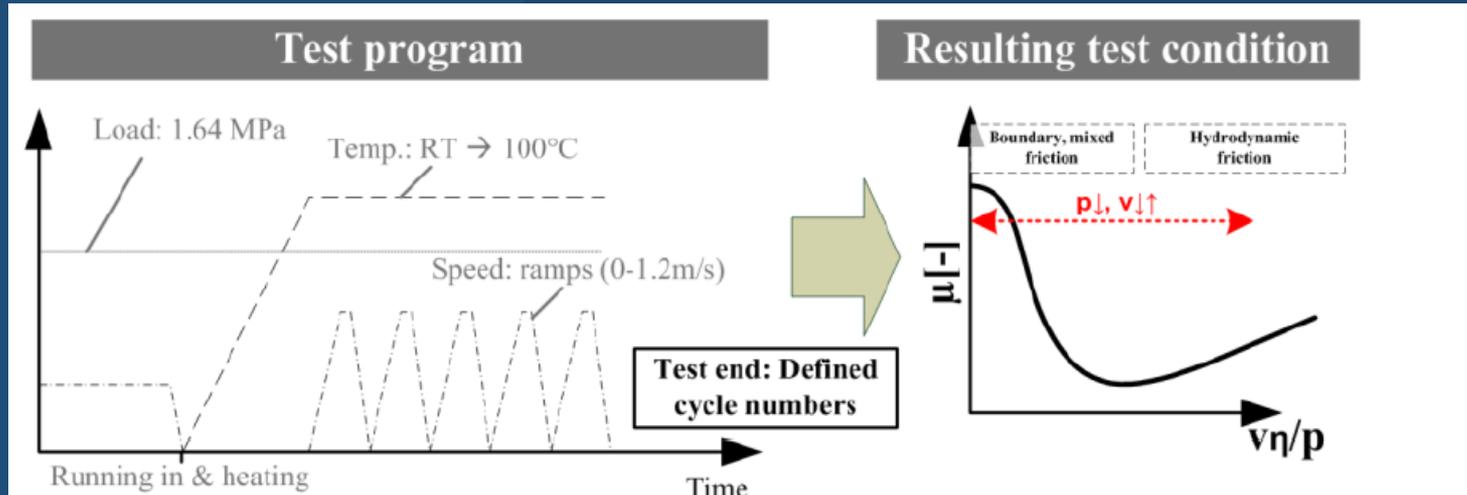
Source: F. Summer thesis, 2016

Bearing materials tested



Source: F. Summer *Ecotrib presentation, 2015*

Investigating stop-start and decreased oil viscosity effects

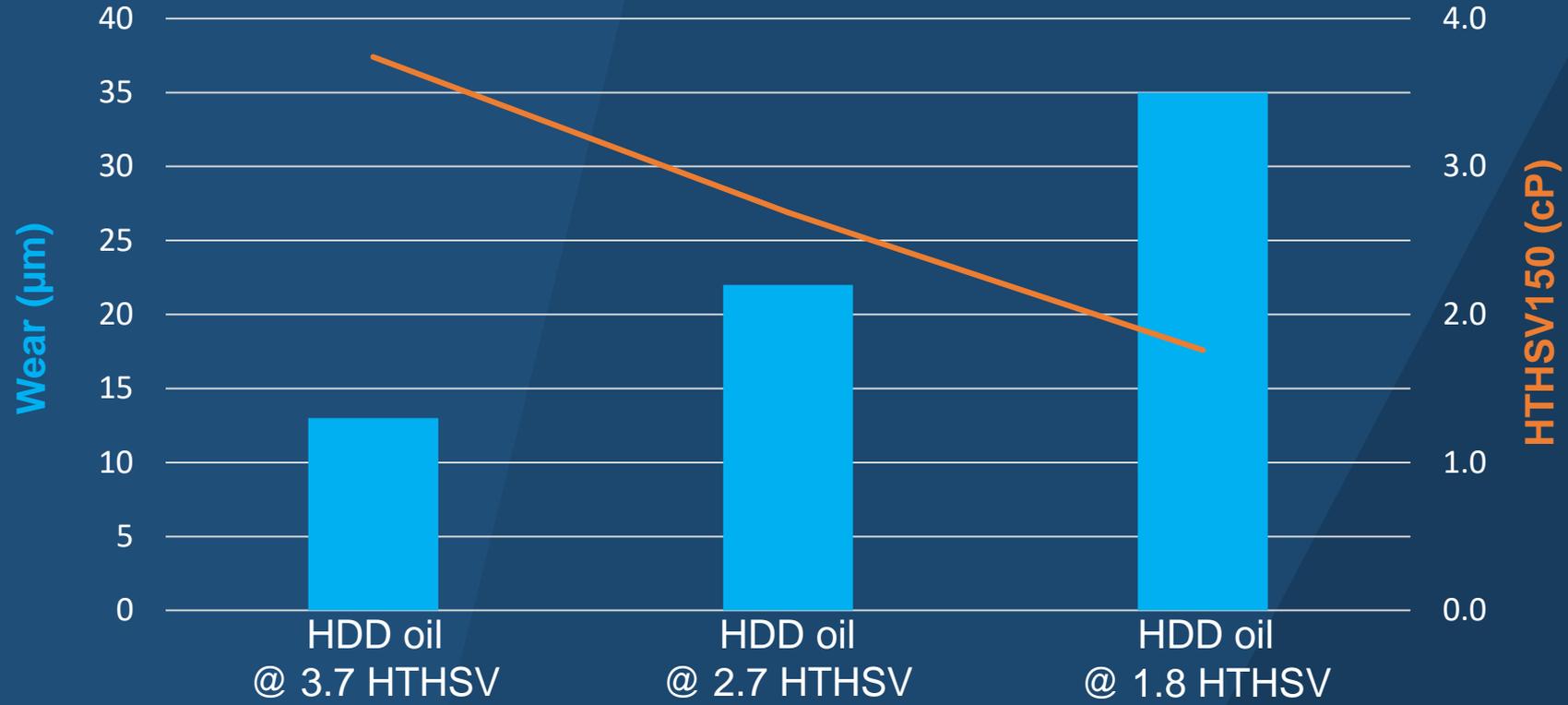


Source: F. Summer OTG Symposium 2016

Thinner oils increases stop-start bearing wear



Wear at 1800 stop-start cycles for AISn bimetel bearing

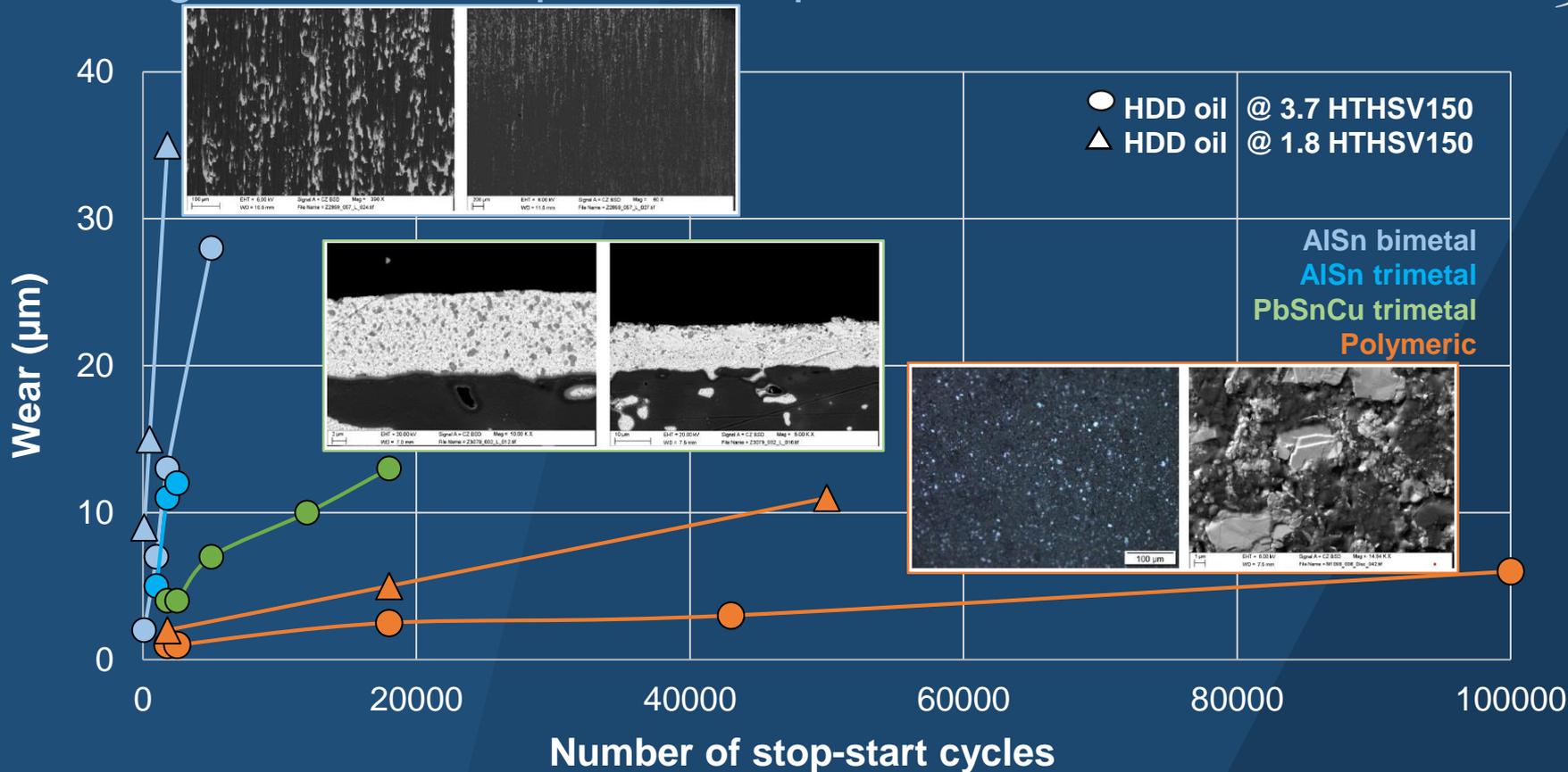


Thinner oils increases stop-start bearing wear



Future reductions in HTHS will have
a negative impact on wear

Bearing choice and impact on stop-start wear



Source: F. Summer *Ecotrib presentation, 2015*

Summary and future challenges



- **Decreasing viscosity** has a negative impact on **stop-start** bearing wear across all material types
- However, impact on higher cost polymeric bearings is lower than for cheaper aluminium bimetal bearings
- Therefore, as OEMs move to lower viscosity oils and stop-start becomes more prevalent in HDD, a cost-effective solution to bearing wear will be required for the 2025-2030 timeframe, via either:
 - More cost effective journal bearing material solutions
 - Additive solutions that deliver bearing durability at lower viscosities, under dynamic stop-start lubrication regimes

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