Application of Sustainable Aviation Fuels in Compression-Ignition Aircraft Engines

Institute of Powertrain
& Automotive Technology

Dipl.-Ing. Florian Kleissner

Agenda

- **Introduction of**
  - **Institute of Powertrain and Automotive Technology (IFA)**
  - **Automotive & Mobility Engineering GmbH (ame)**
- **Background an Motivation**
- **Measurement Setup**
- **Methodology (Fuel Strategy, Test Strategy)**
- **Experimental Results**
- **Summary and Outlook**

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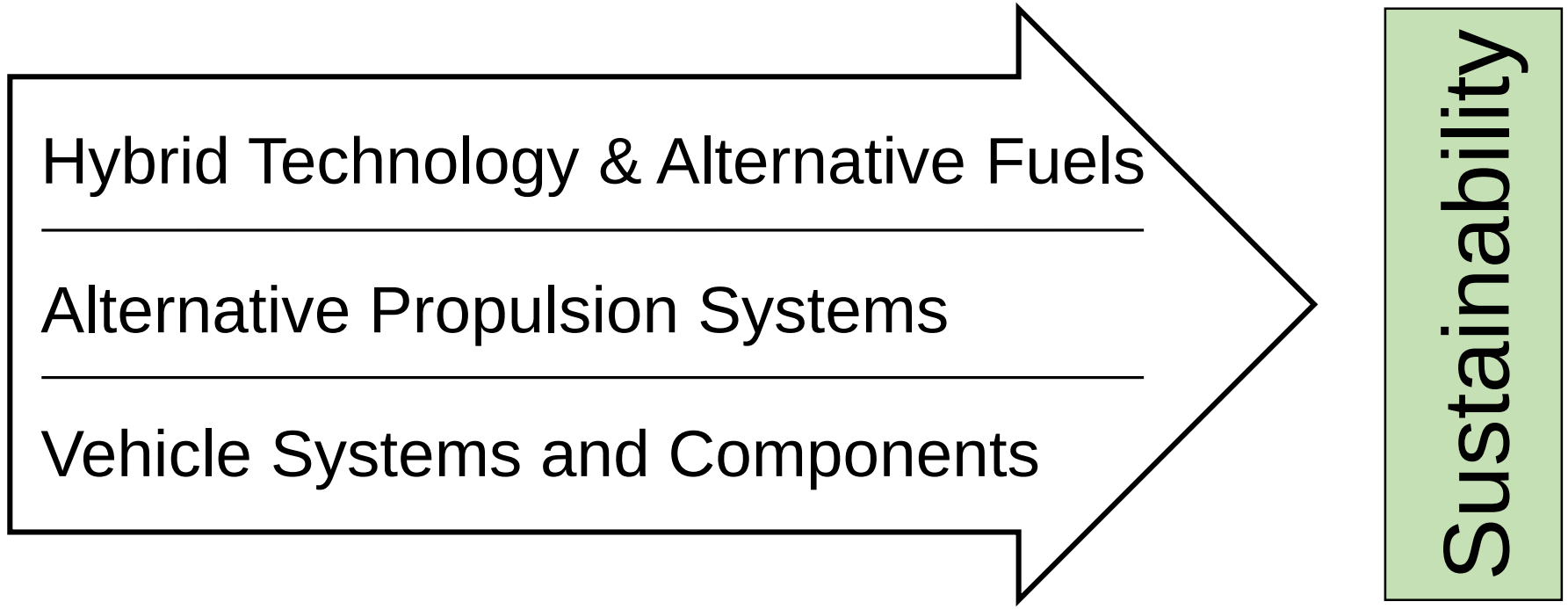
Introduction of: IFA & ame

Institut für Fahrzeugantriebe & Automobiltechnik

&

automotive & mobility engineering



Technological Openness for Mobility Solutions of the Future

Introduction of: IFA & ame

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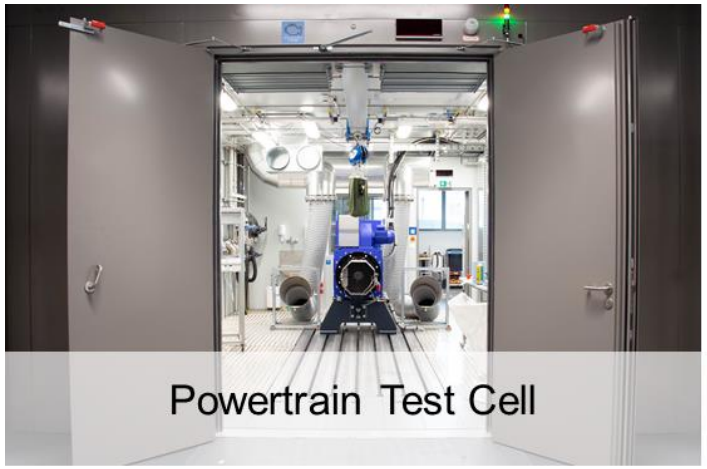
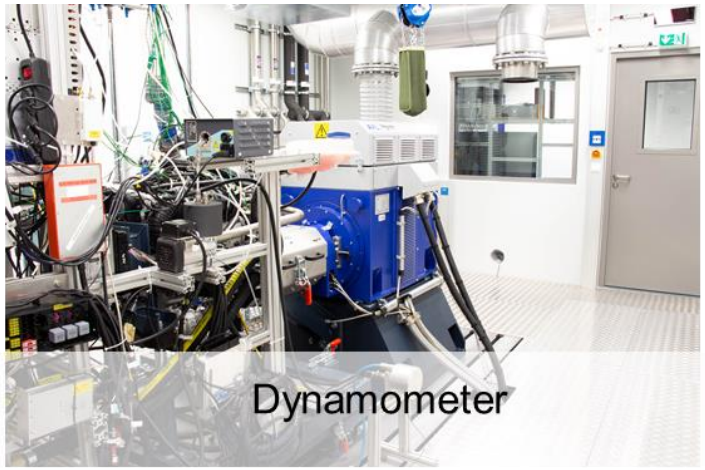
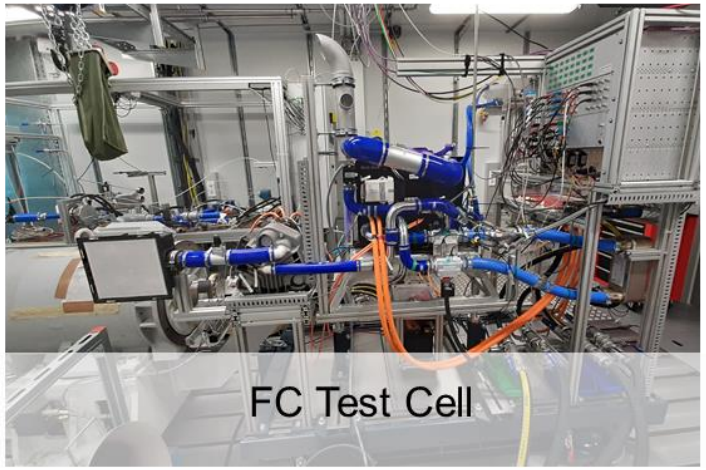
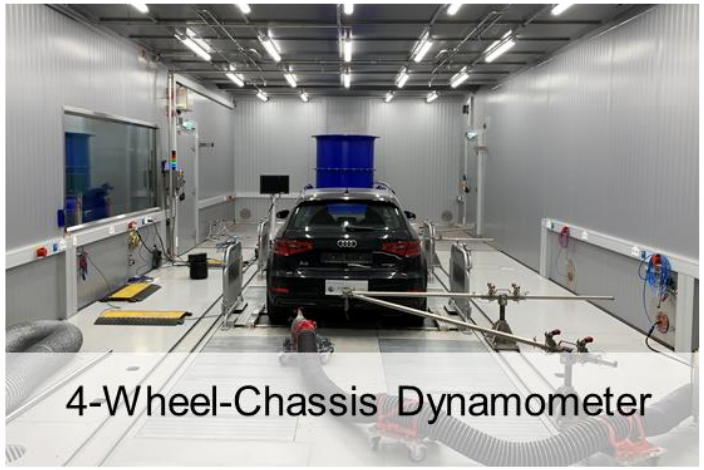

Powertrain Test Cell


Dynamometer


Control Station

Batterysimulator/-emulator


FC Test Cell


4-Wheel-Chassis Dynamometer

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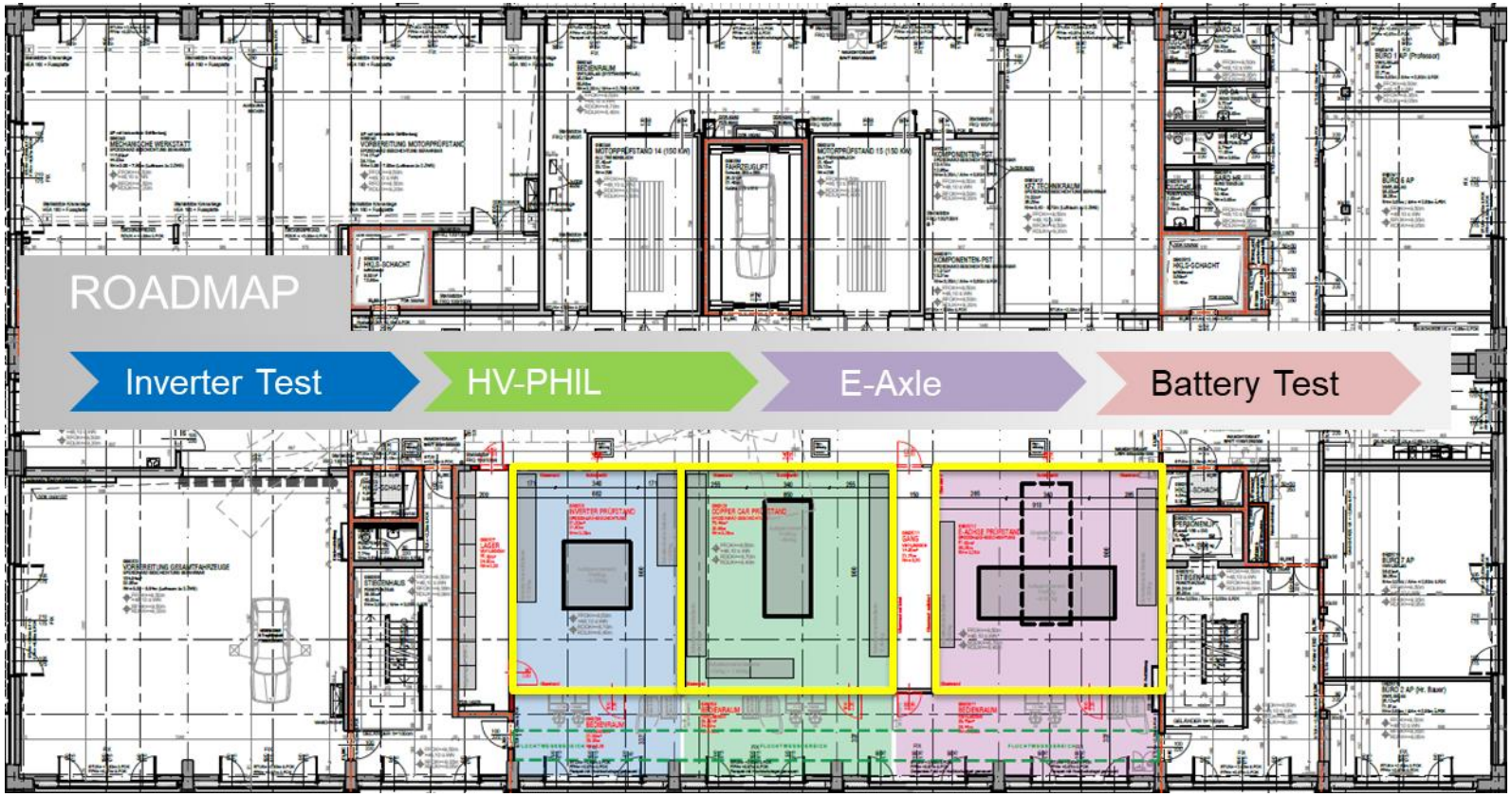

☐ Expansion:

- **Research areas:** Core competence power electronics
- **Hollistic approach:** From low to high TRL
- **Idea:** From inverter to interaction to system-testing

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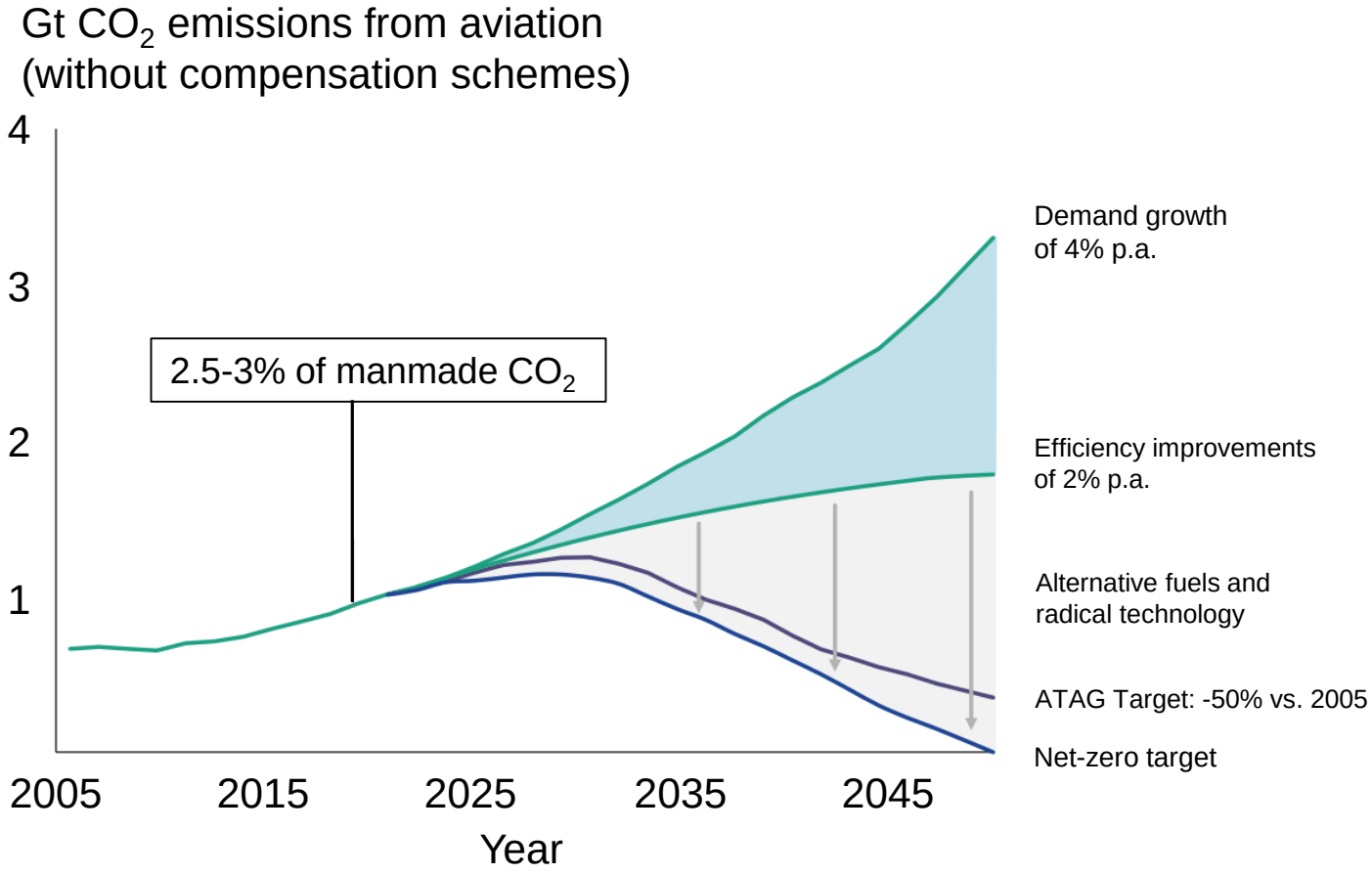
Background and Motivation

- **Aviation** contributes **significantly** to **global CO_2** emissions (≈ 2 % of global greenhouse gas emissions)
- **Fuel demand increasing** → Alternative propulsion technologies/fuels necessary for CO_2 reduction
- **Sustainable Aviation Fuels** (SAF) and **hydrogen** (H_2) are seen as **key enablers** for defossilization of aviation sector

→**Challenge**: Wide variety of fuel properties



Project Objectives: Investigation of the **suitability of SAF** in **CI aviation engines** utilizing **cylinder pressure based combustion control** in **flight investigations**

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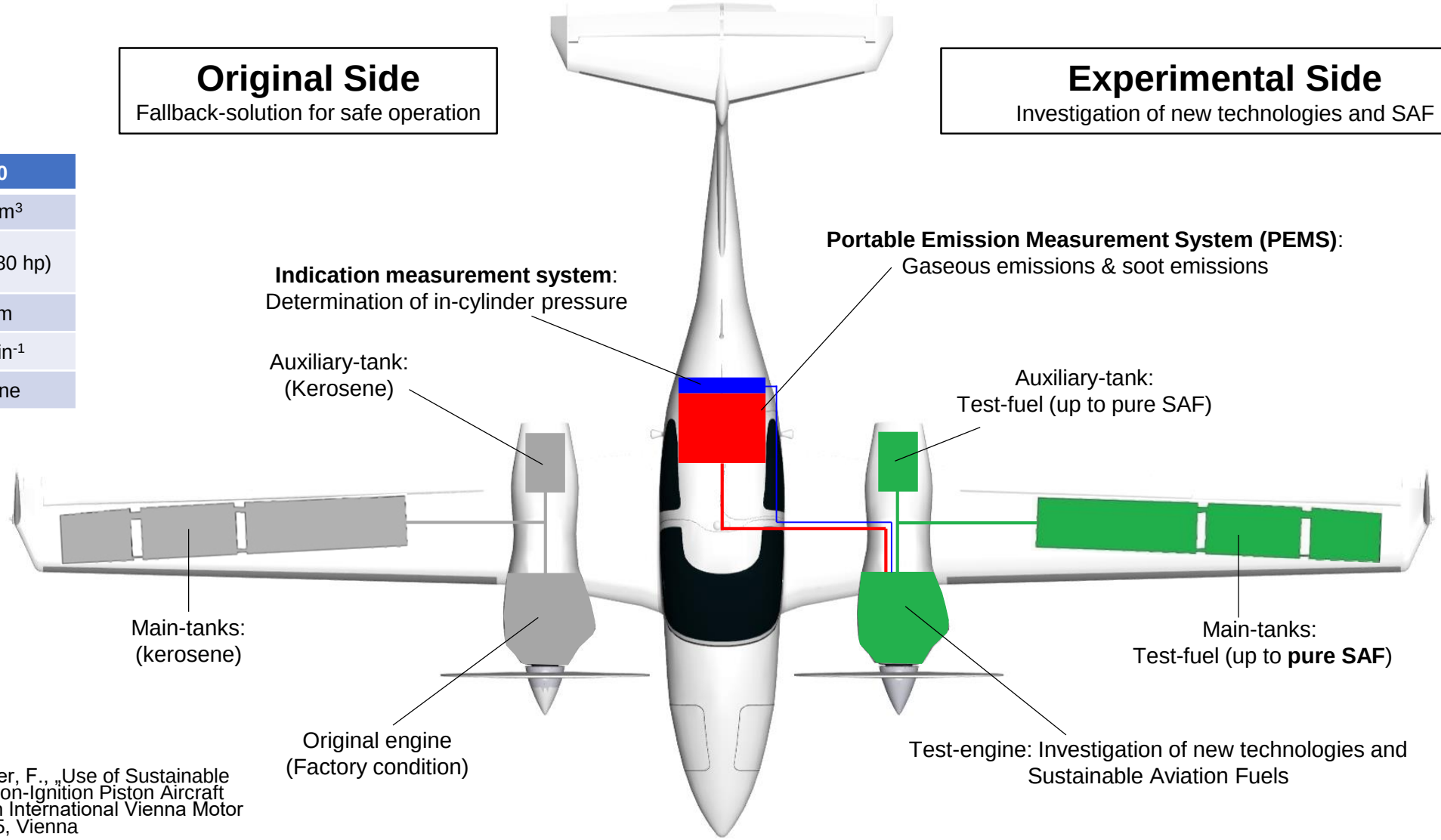
Measurement Setup

Specifications	AE330
Displacement	1,991 cm^3
Max. take off power	132 kW (180 hp)
Max. torque	325 Nm
Max. RPM	3887 min^{-1}
Fuel	Kerosene

Original Side
Fallback-solution for safe operation

Experimental Side
Investigation of new technologies and SAF



Source: Reitmayr, C., Kleissner, F., „Use of Sustainable Aviation Fuels in a Compression-Ignition Piston Aircraft Engine," presented at the 46th International Vienna Motor Symposium, 14th of May 2025, Vienna

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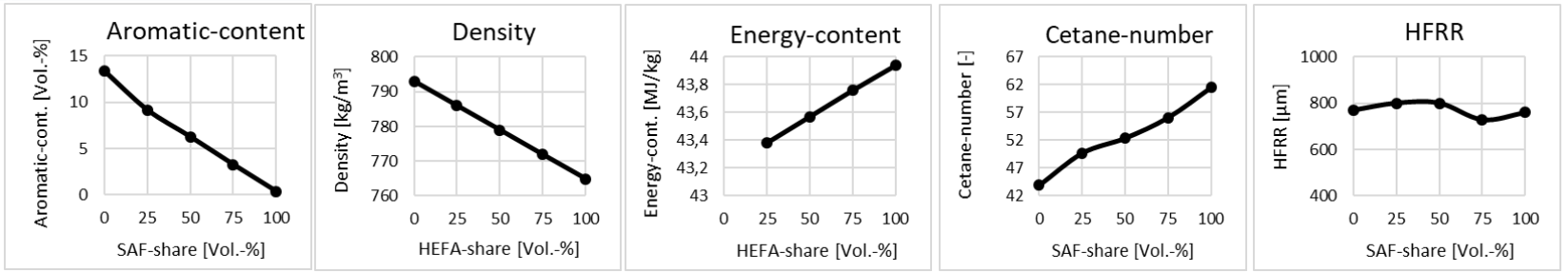
Methodology – Fuel Strategy

In-flight investigations with **HEFA/Kerosene blends**:

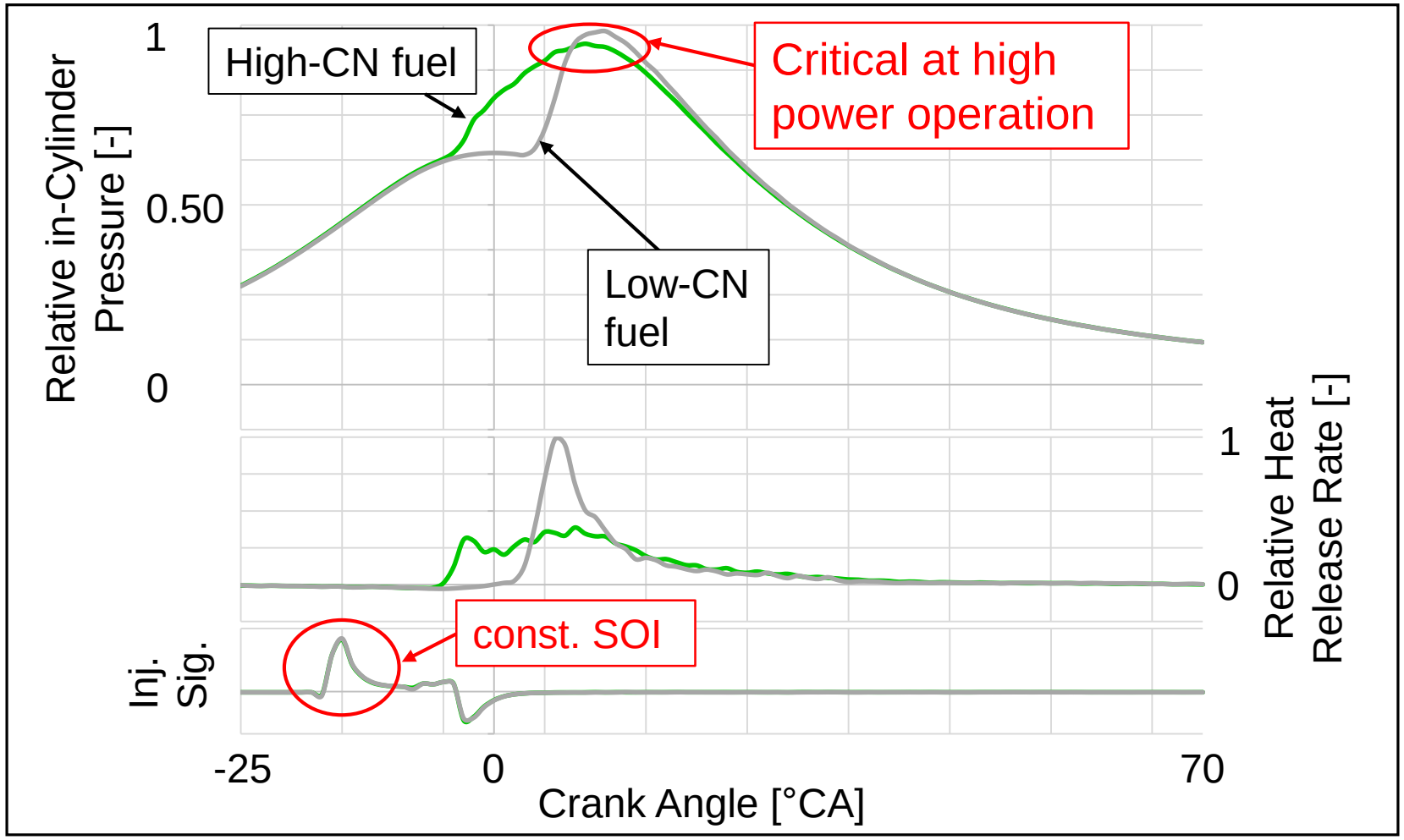
Fuel-Designation	Aromatics content
	[Vol.-%]
Kerosene	13,4
HEFA25	ca. 9,2
HEFA50	ca. 6,3
HEFA75	ca. 3,3
HEFA100	0,4



Potential of **Cylinder Pressure based Combustion Control** to counteract ignition behavior?

Methodology – Fuel Strategy

Impact of **cetane rating** on combustion behavior at typical **low load** operation:



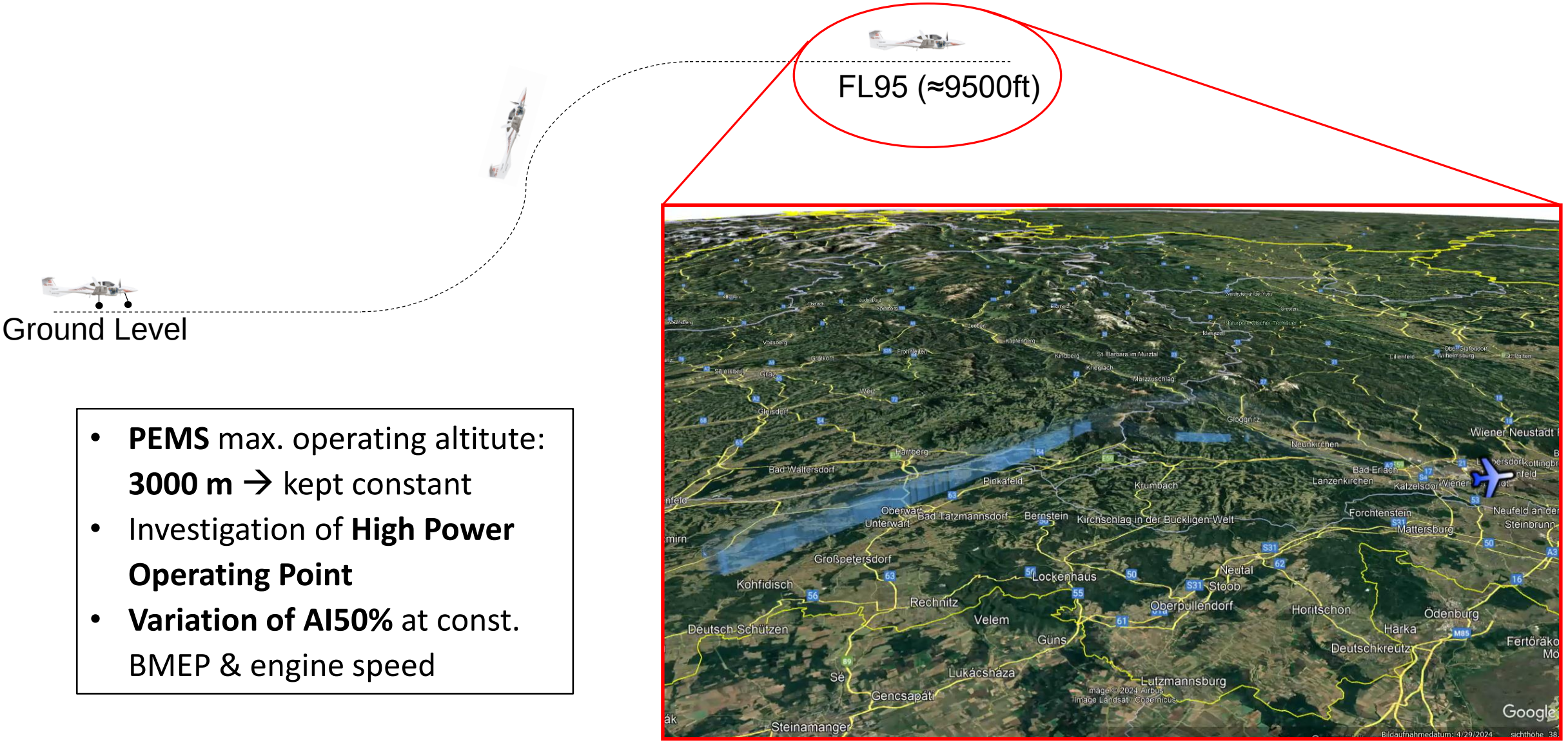
At constant SOI, different CN influences:

- Start of combustion
- Pressure gradient
- Max. in-cylinder pressure

Cylinder pressure based combustion control (SOI adjustment):

- Stay within max. permitted pressure
- Adjust towards **maximum efficiency**

Methodology – Test Strategy



- **PEMS** max. operating altitute: **3000 m** → kept constant
- Investigation of **High Power Operating Point**
- **Variation of AI50%** at const. BMEP & engine speed

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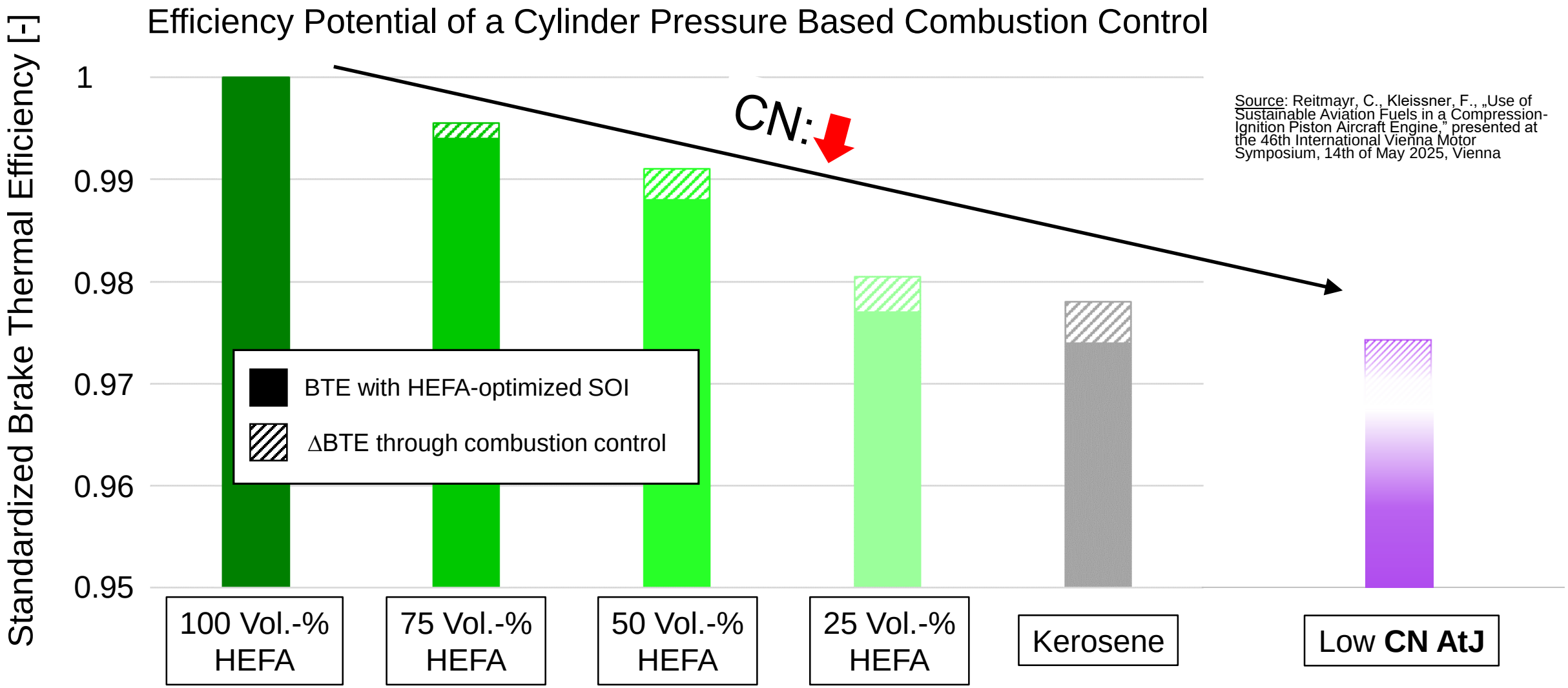
Experimental Results



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Summary and Outlook

- **Summary**:
  - SAF blends (HEFA/kerosene – up to 100% HEFA) successfully tested in real-flight conditions using a DA42 aircraft
  - Cylinder pressure-based combustion control showed up to 0.4% efficiency improvement within a narrow CN range

- **Outlook**:
  - Future SAF work will focus on low-CN fuels (e.g., AtJ), in-flight cold-start behavior, and higher altitude testing

- **Stuttgart International Symposium on Automotive and Engine Technology, 2 to 3 July 2025:**

  Kleissner, F.; Reitmayr, C.; Hofmann, P.: „Application of Sustainable Aviation Fuels in CI Aviation Engines: In-Flight Investigations," presented at the Stuttgart International Symposium on Automotive and Engine Technology, 2nd of July 2025, Stuttgart

- **Sustainable Energy and Powetrains, 25 to 26 November 2025:**

  Kleissner, F.; Hofmann, P.; et al.: „In-Flight Evaluation of Sustainable Hydrocarbon Fuels in Compression Ignition Aircraft Engines," presented at the Sustainable Energy & Powertrains, 25th – 26th of November 2025, Stuttgart

Thank you for your attention.

The presented achievements were obtained in the research project “SAF Air Lab”.

The project is supported with funds from the Austrian Research Promotion Agency (FFG).

Institute of Powertrain
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