Experimental Measurements on a Novel Rotating Cavity Rig for Hot Gas Ingestion

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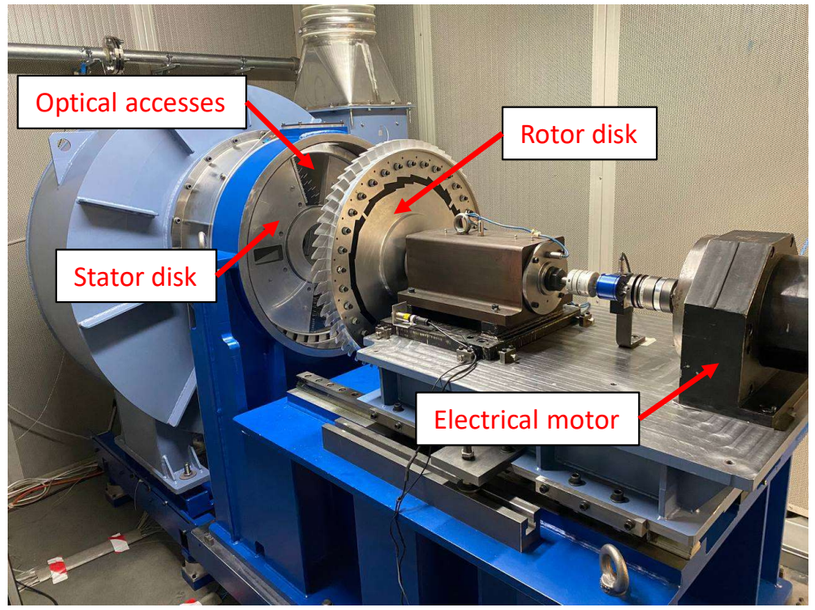
PhD program in Industrial Engineering

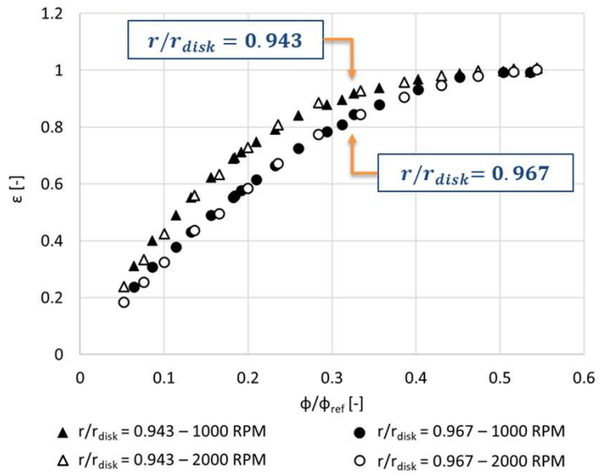
Experimental Facility

- **Test Rig** that simulates the first stage of a **HPT**
- **Optical accesses** for 2D investigations
- Possibility to finely adjust the **stator-rotor axial distance**
- **Electrical motor** to spin the rotor up to **3000 RPM** (variable Re_{ϕ})
- **Interchangeability and modularity** of the stator/rotor covers
- **Adjustable Flowpath** mass flow rate (variable Re_{c_x})
- **Adjustable purge** mass flow rate



Gas Sampling Results

- $\phi - \varepsilon$ curves are **independent** from Re_{ϕ}.
- The **effectiveness** on the **stator side is NOT radially constant**.
- **Asymptotic trend** of the curve at **high Φ**.
- **Progressively more expensive** to reach **higher protection**.



Test Section

$$C_f = \frac{Re_{c_x}}{Re_{\phi}}$$

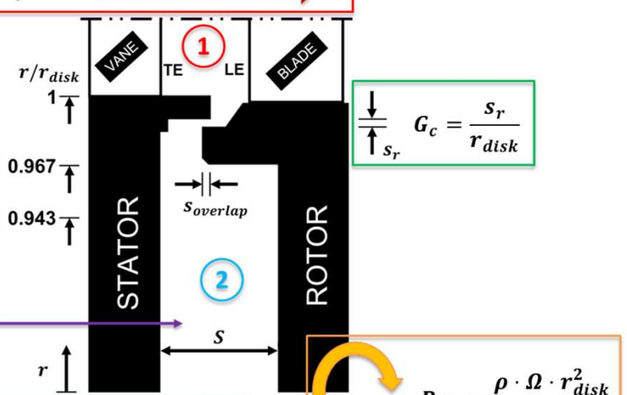
$$\Delta C_p = C_{p,max} - C_{p,min} = \frac{p_{1,max} - p_{1,min}}{\frac{1}{2} \cdot \rho \cdot \Omega^2 \cdot r_{disk}^2}$$

$$Re_{c_x} = \frac{\rho \cdot c_{1,x} \cdot r_{disk}}{\mu}$$

$$v_{\phi} = \sqrt{\frac{p_{tot} - p_s}{\frac{1}{2} \cdot \rho}} \rightarrow \beta = \frac{v_{\phi}}{\Omega \cdot r}$$

$$C_{p,s} = \frac{p_s - p_{s,ref}}{\frac{1}{2} \cdot \rho \cdot \Omega^2 \cdot r_{disk}^2}$$

$$C_{p,tot} = \frac{p_{tot} - p_{tot,ref}}{\frac{1}{2} \cdot \rho \cdot \Omega^2 \cdot r_{disk}^2}$$



$$Re_{\phi} = \frac{\rho \cdot \Omega \cdot r_{disk}^2}{\mu}$$

$$\phi = \frac{\dot{m}_{purge}}{\mu \cdot r_{disk} \cdot 2 \cdot \pi \cdot G_c \cdot Re_{\phi}} = \frac{U}{\Omega \cdot r_{disk}}$$

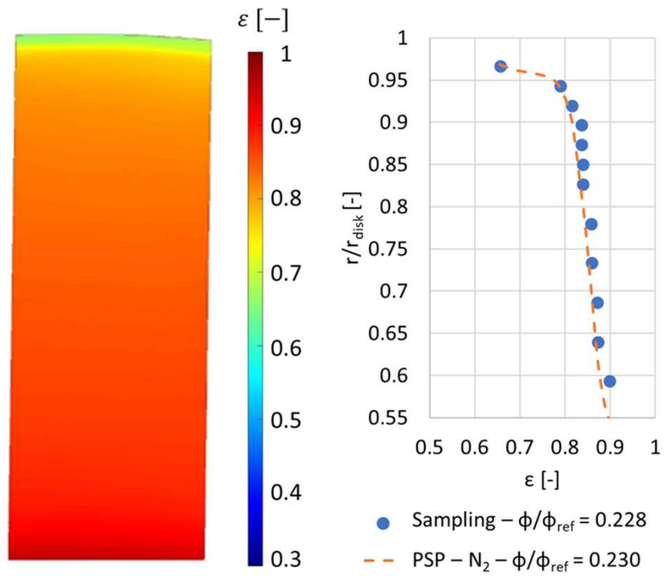
$$\varepsilon = \frac{c_{stator} - c_{an}}{c_0 - c_{an}}$$

$\varepsilon = 1$ → Cavity sealed

$\varepsilon = 0$ → NO sealing

PSP Results

- The **effectiveness** is **uniform** in the **circumferential direction**
- The **comparison** between the **discrete sampling points** and the **PSP** curve is **very good**!
- **First study** in **literature** to address the **hot gas ingestion** problem with **PSP**!



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