RÉPUBLIQUE FRANÇAISE
Liberté Égalité Fraternité

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Cité de l'espace, Toulouse

cnes CENTRE NATIONAL D'ÉTUDES SPATIALES

Experimental analysis of cavitation instabilities on spatial inducer

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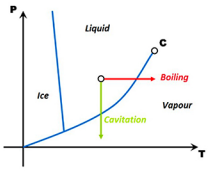
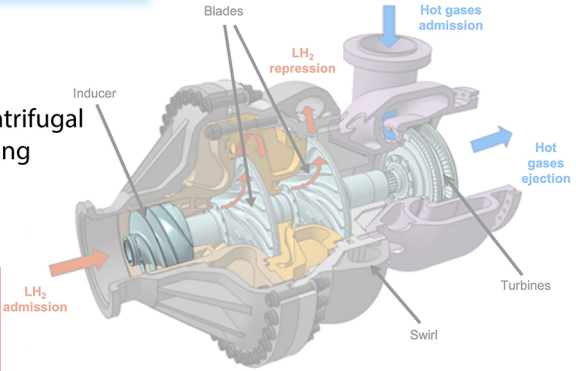
1 - Overview

- Cavitation



- Risks
  - Performance drop
  - Erosion
  - Instabilities
  - POGO
  - Overspeed
- Inducer aims
  - First overspressure
  - Avoid cavitation in centrifugal
  - Allow low inlet operating



Objective:
Build some tools to identify cavitating regime dynamics and the impact on the launcher (efforts, vibrations, performance, ...)

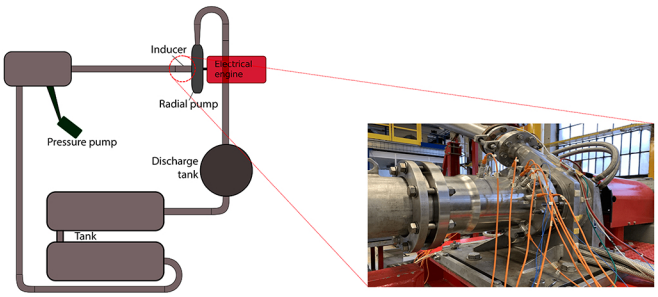
2 - Test-rig (SESAME)

Closed loop of water driven by an electrical engine (200 kW)

- Temperature
- Acceleration
- Flow rate
- Pressure (unsteady) at the carter
- Force / moment (rotating frame)

Sampling rate: 2048Hz

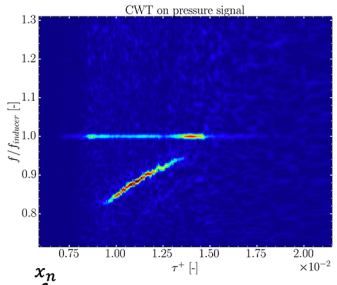
Similitude laws to know the hydrogen behaviour



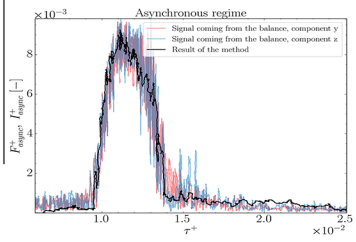
3 - Radial efforts estimation

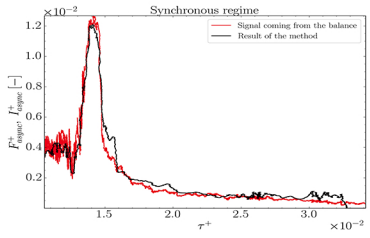
Quantification of **radial efforts** on the shaft's turbopump

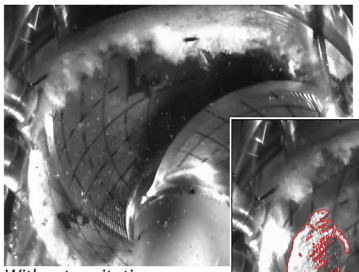
Pressure signals - P(τ)
↓
Continuous Wavelet Transform
↓
Denoising
↓
Inverse Continuous Wavelet Transform - P'(τ)

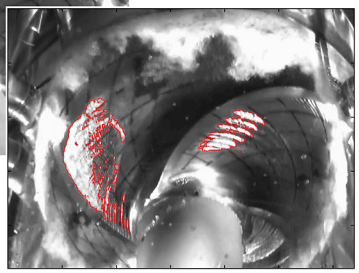


$$I_{async}, I_{sync}(\tau) = \pi R \int_{x_1}^{x_n} P'(\tau).\Delta x \, dx$$






Without cavitation


With cavitation

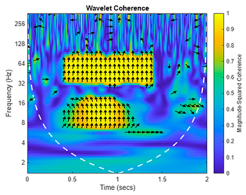
Contours detection with strobostropic light and camera.

Estimation of the cavitation surface.

- Visualization test campaign with **high speed camera**

4 - Perspectives

- Improvement of forces estimation method
- Understand phenomenon behavior using **Cross Wavelet Analysis**



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