He hydrodynamic facilities used and in preparation at CERN

Philippe-E. Roche

Institut NEEL, CNRS, Grenoble

GReC's experiment *:*

CERN - CNRS - Grenoble's University - INPG - ENS Lyon

Dauvergne, Lebrun, Pirotte and Bezaguet, Delruelle, Knoops, Pezetti, Tavian, Van Weelderen,… , Bret, Chabaud, Guttin, Hébral, Ladam, Pietropinto, Roche, Baudet, Gagne, Poulain , Castaing

HePipe's experiment *:*

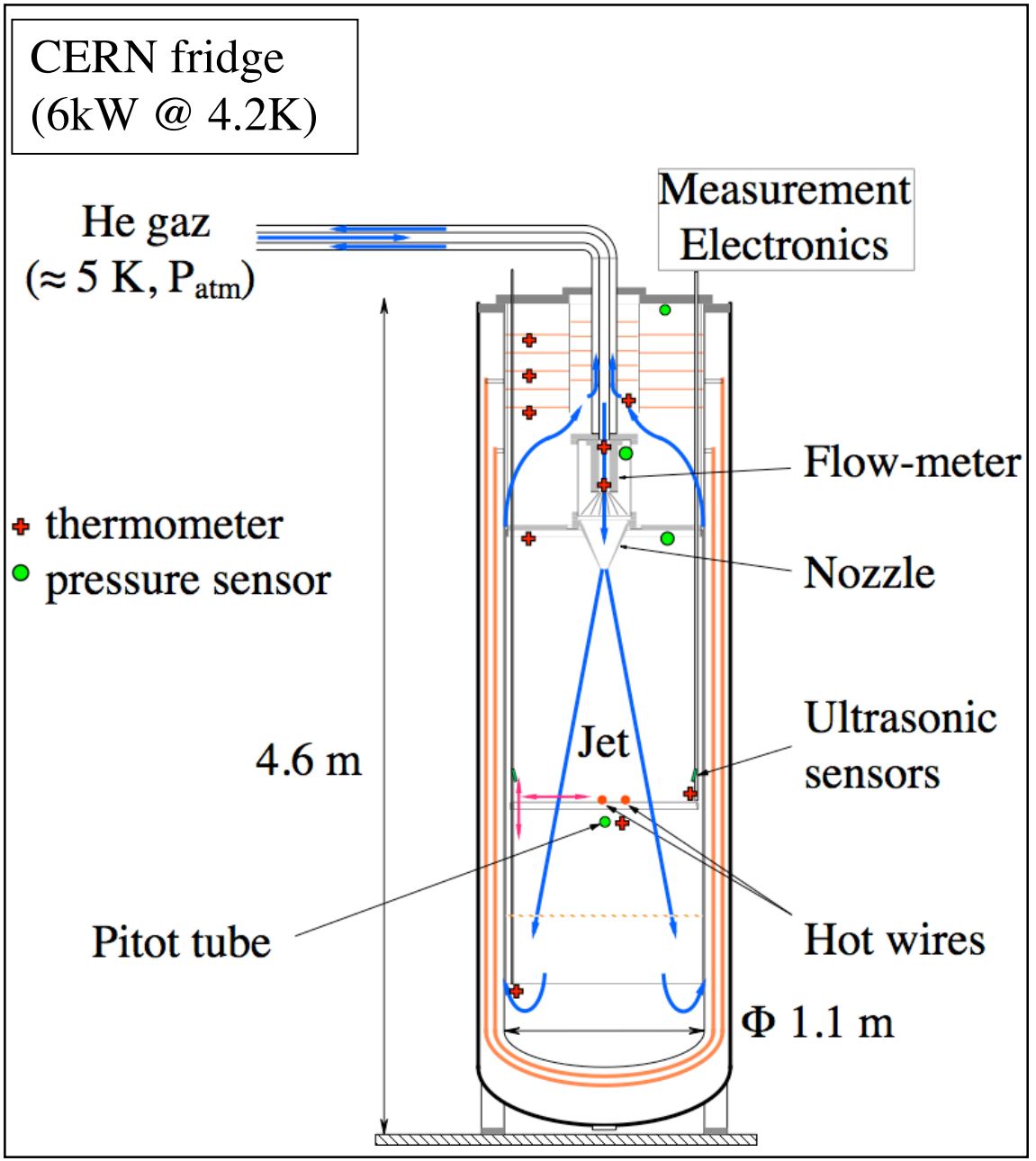
CERN - CNRS - Grenoble's University - INPG - ENS Lyon

Lebrun, Pengo, Pirotte , Chabaud, Gauthier, Hébral, Roche , Gagne , Castaing

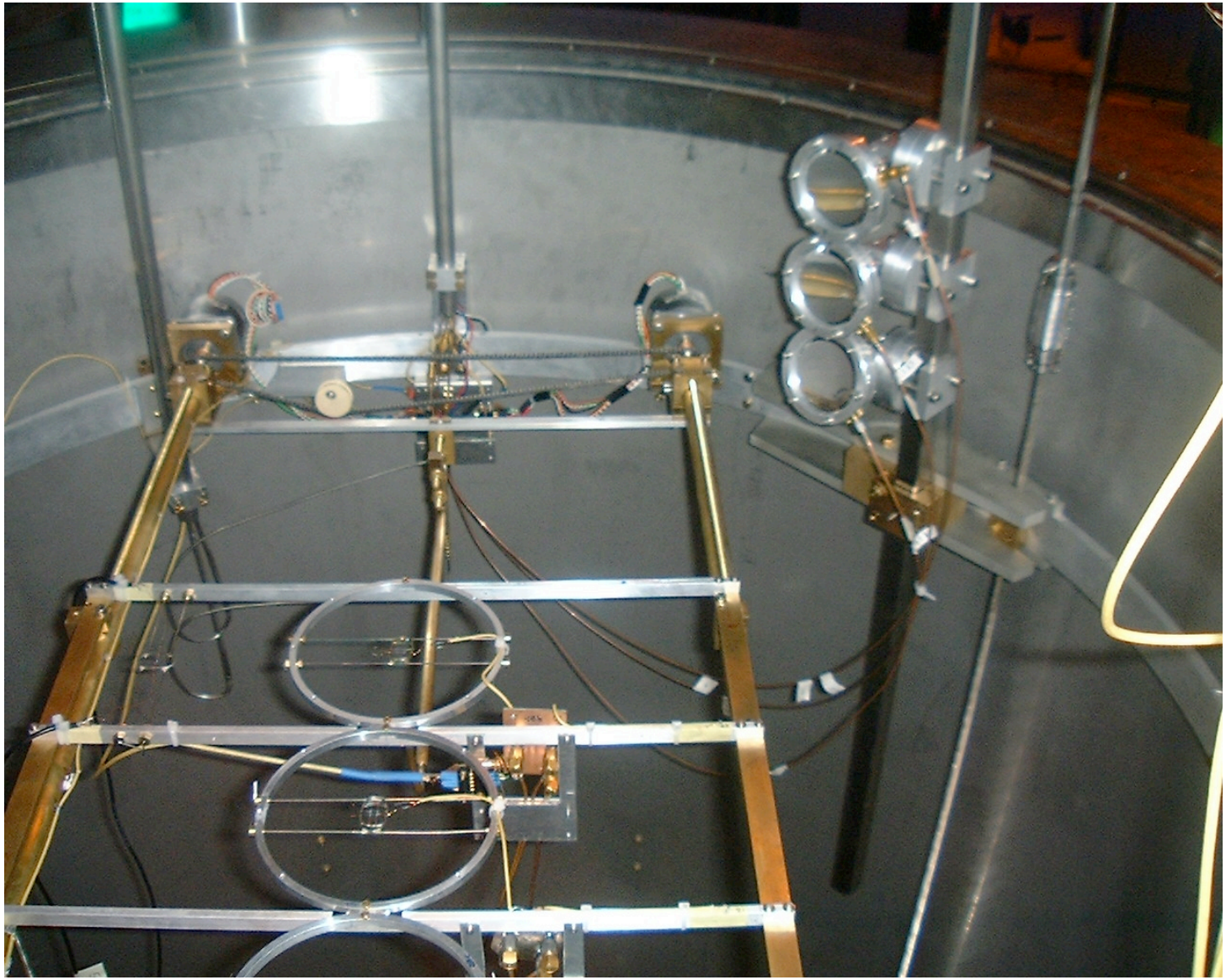
The GReC jet…

- *Validated operation:*
  - *3 mean flow meters*
  - *Mechanical displacement*
  - *no dropplets,… etc*
- *Temperature stability*
  < ±1 % over hours
- *Pressure stability*
  < ±1 % over hours
- *Mean flow stability :*
  < ± 5 % over 10 min
  ~ ±10% over hours
- *Stable Jet direction*

- *Mass flow :* 20 - 260 *g/s*
- *Velocity @50Φ :* 0.32 - 4.4 *m/s*
- Re_{Φ} : $7.6\ 10^5$ - 10^7
  Re_{λ} : 1750 - 6000

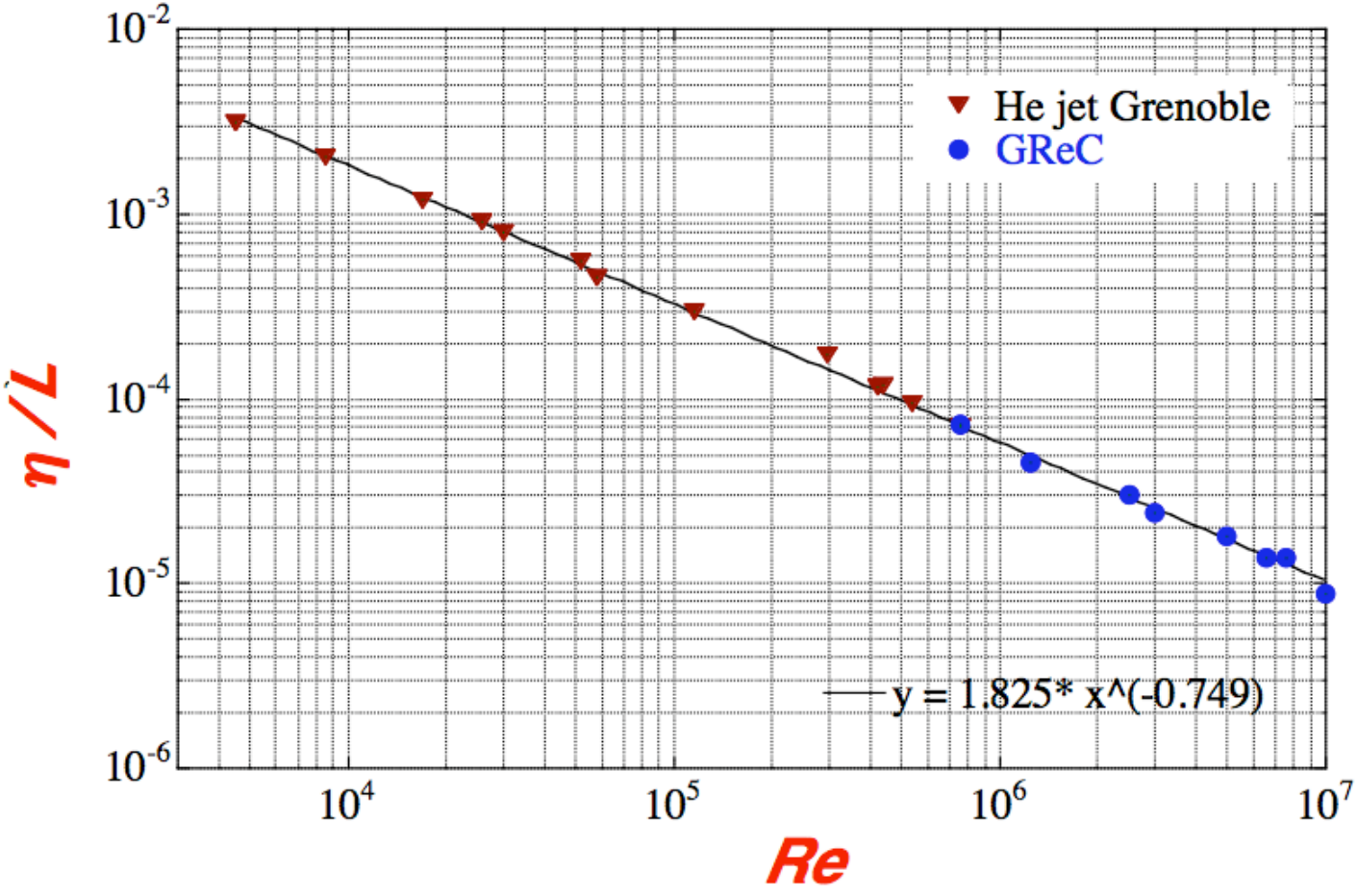


⇒ a clean validated ultra high Re flow



Ratio : Kolmogorov scale / Integral scale

- The Kolmogorov length **η** is deduced from the dissipation **ε** , which is calculated from the 3rd moment of the velocity increments
- The Integral scale **L** is defined as a decorrelation length for the velocity fluctuations

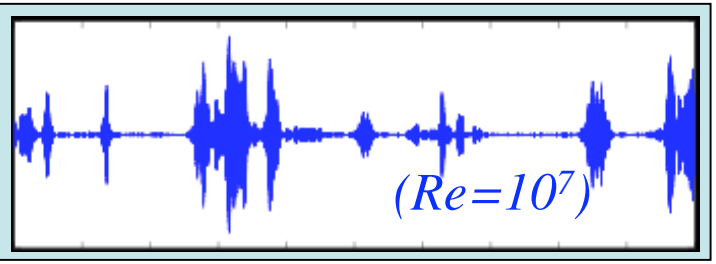


GReC's challenge : probing the local velocity

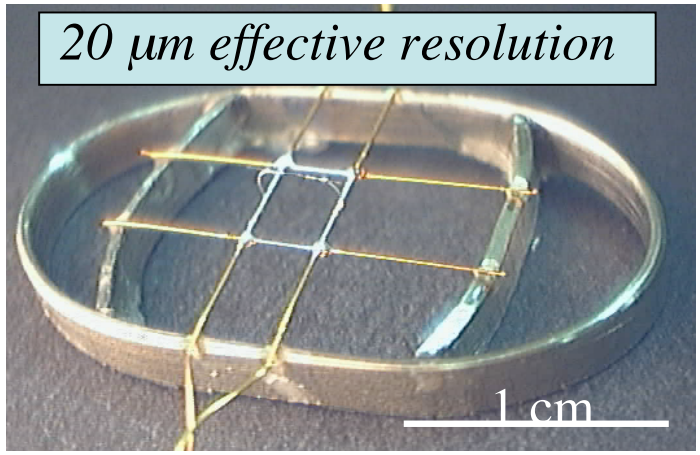
- Requirements for hot wires :
  - Kolmogorov length : $\eta \geq 3\ \mu m$ ⇒ micromachined probe
  - Frequency scale : $V_0/\eta \leq 1.5$ MHz ⇒ wide-band electronics
  - Velocity dynamic range $V_0/V_\eta \leq 135$ ⇒ low noise electronics

- GReC's State of the Art :

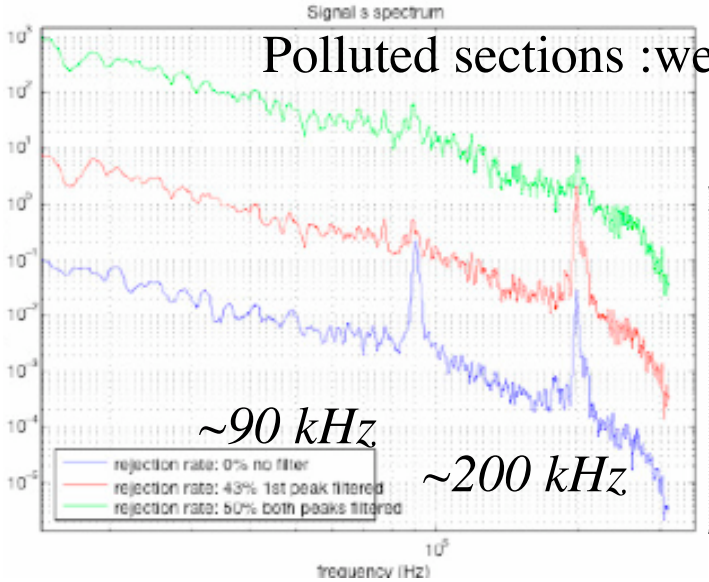
Sample of the time signal windowed between 190 and 210 kHz



20 μm effective resolution



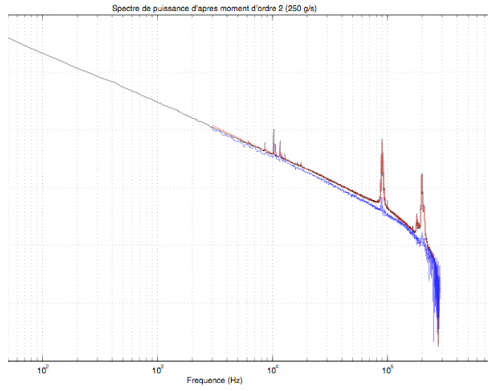
Constant Temp. Regulation : DC-2MHz / very low noise



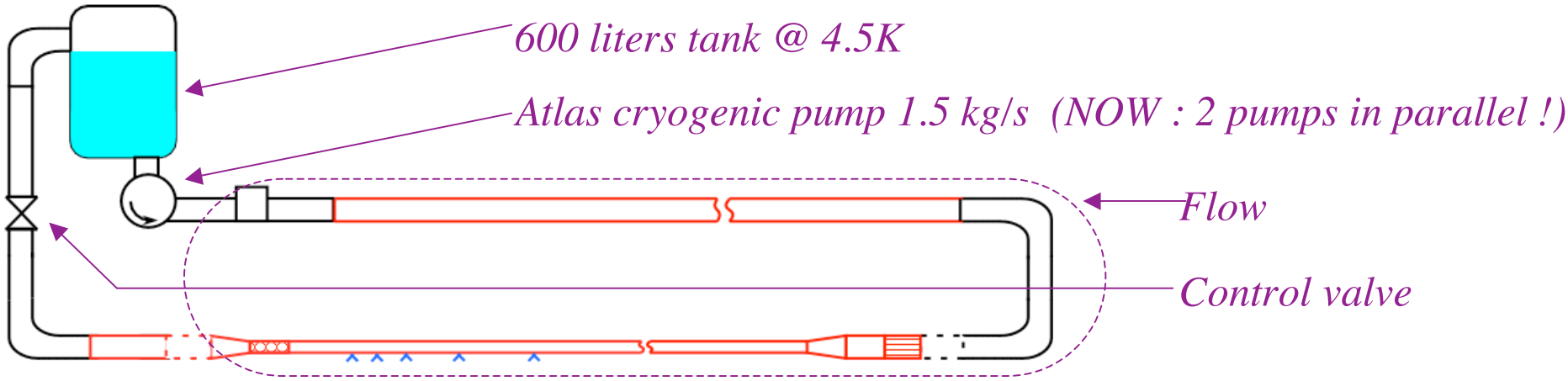
Polluted sections :well-defined oscillations

~90 kHz

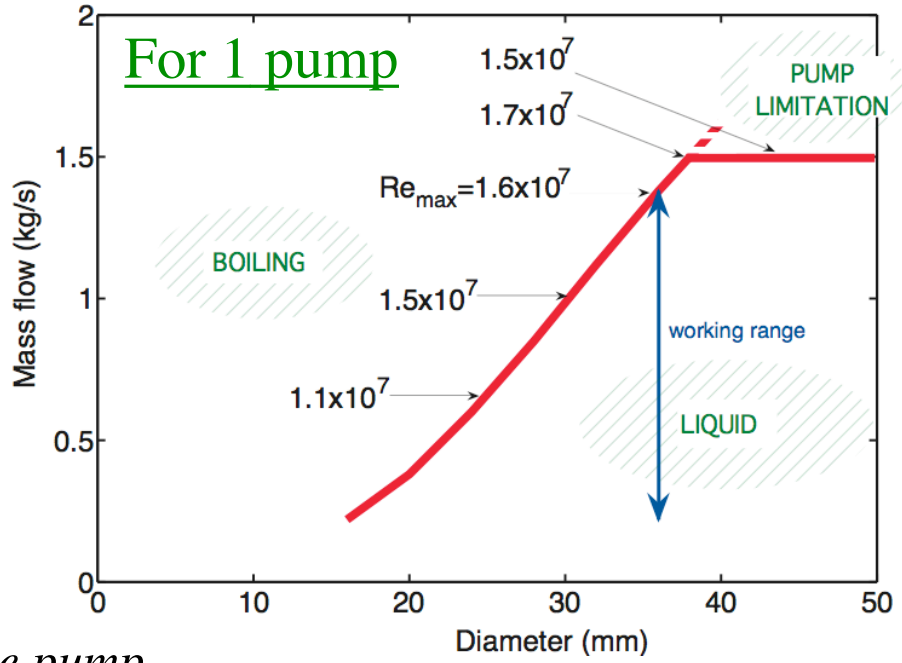
~200 kHz



Atlas test loop : Opportunities for high Re flows



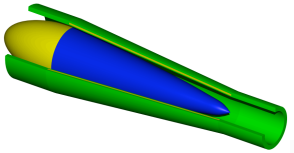
- *Existing He loop facility*
  - *1.2 kW cooling power @ 4.5K*
  - *cryogenic Coriolis mass-flowmeter*
  - *2 Atlas cryogenic pumps (1500 g/s each) + thermosyphon (low velocity)*
  - *Modular design*
  - *Continuous operation*

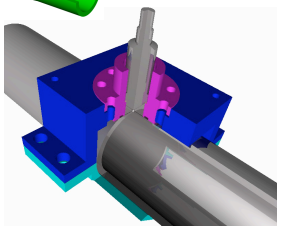


- *Present limitations*
  - *Only 400 mbar pump pressurization → cavitation to watch*
  - *25 bars pressure cycling*
  - *Not yet validated turbulent environnement (EM, vibration & acoustics, bubbles from the pump, fluctuating head loss on the CV, what stability of temperature and flow, …)*

HePipe : a very high Re pipe flow

- Design Study (for one pump)
  - L=6.5 m - Φ=36 mm (L/Φ =180)
  - Smoothness requirement : 0.3 µm
  - **Re up to 2.10^7** (R_+ up to 3.10^5)





- First machining and Tests in Grenoble
  - Void fraction meter
  - Low temperature electronics
  - Polishing
  - Leak free pressure taping
  - …