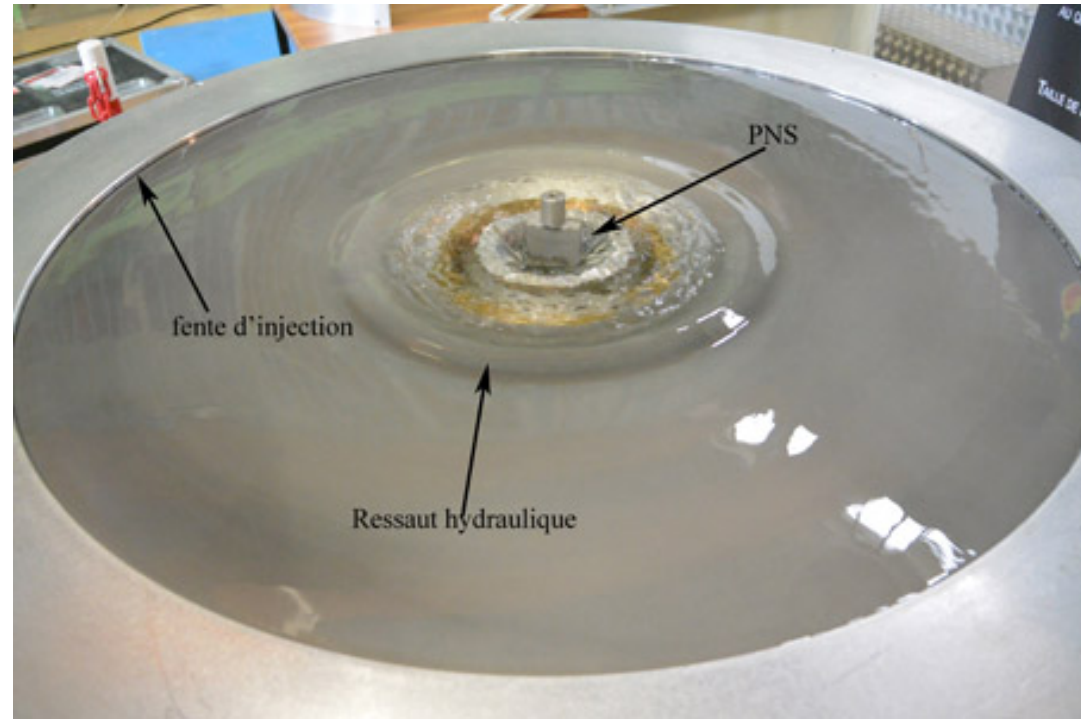


# Rapport de stage L3 FIP

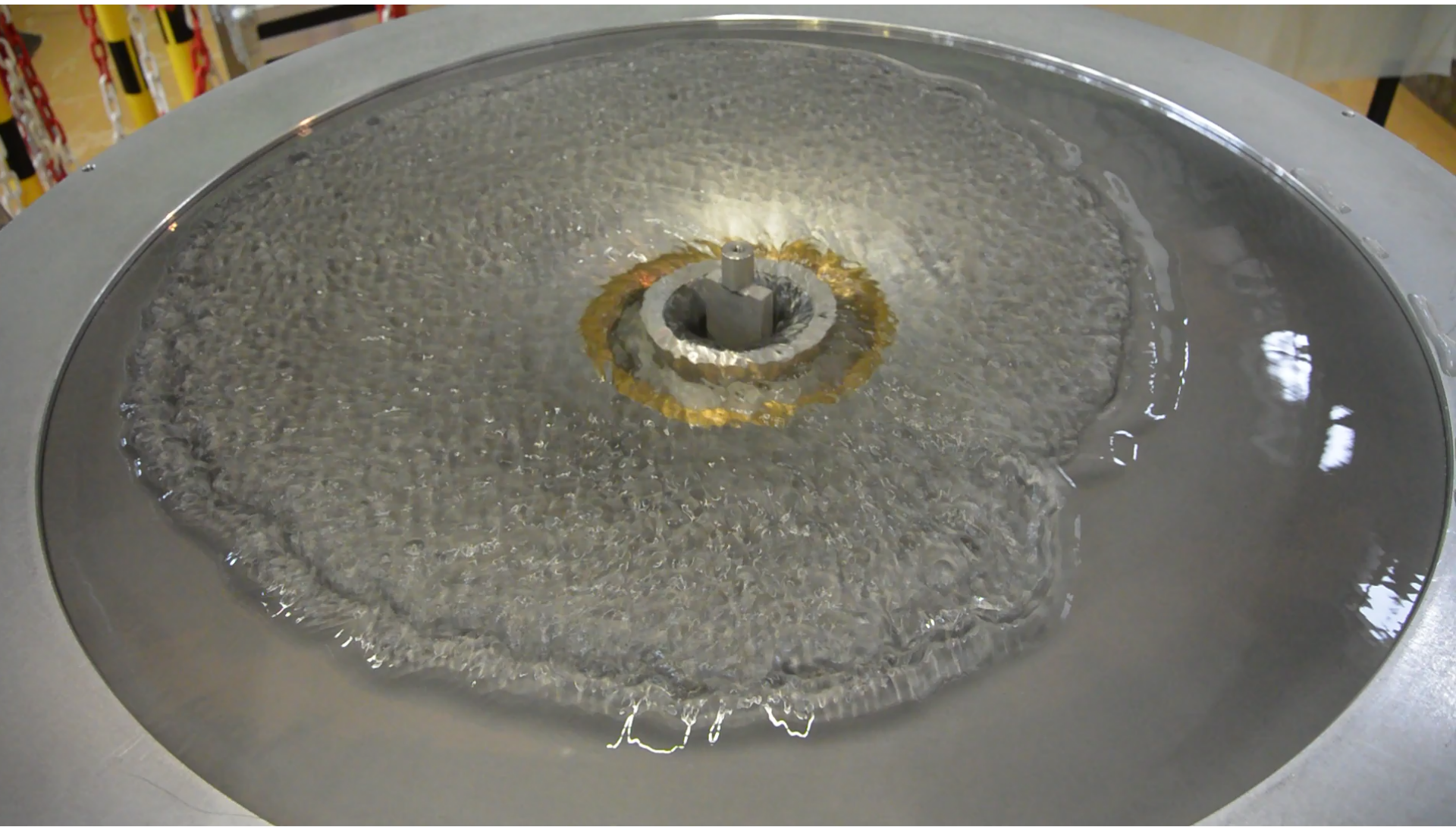
Etude des instabilités hydrodynamiques  
du dispositif SWASI et conséquences  
astrophysiques

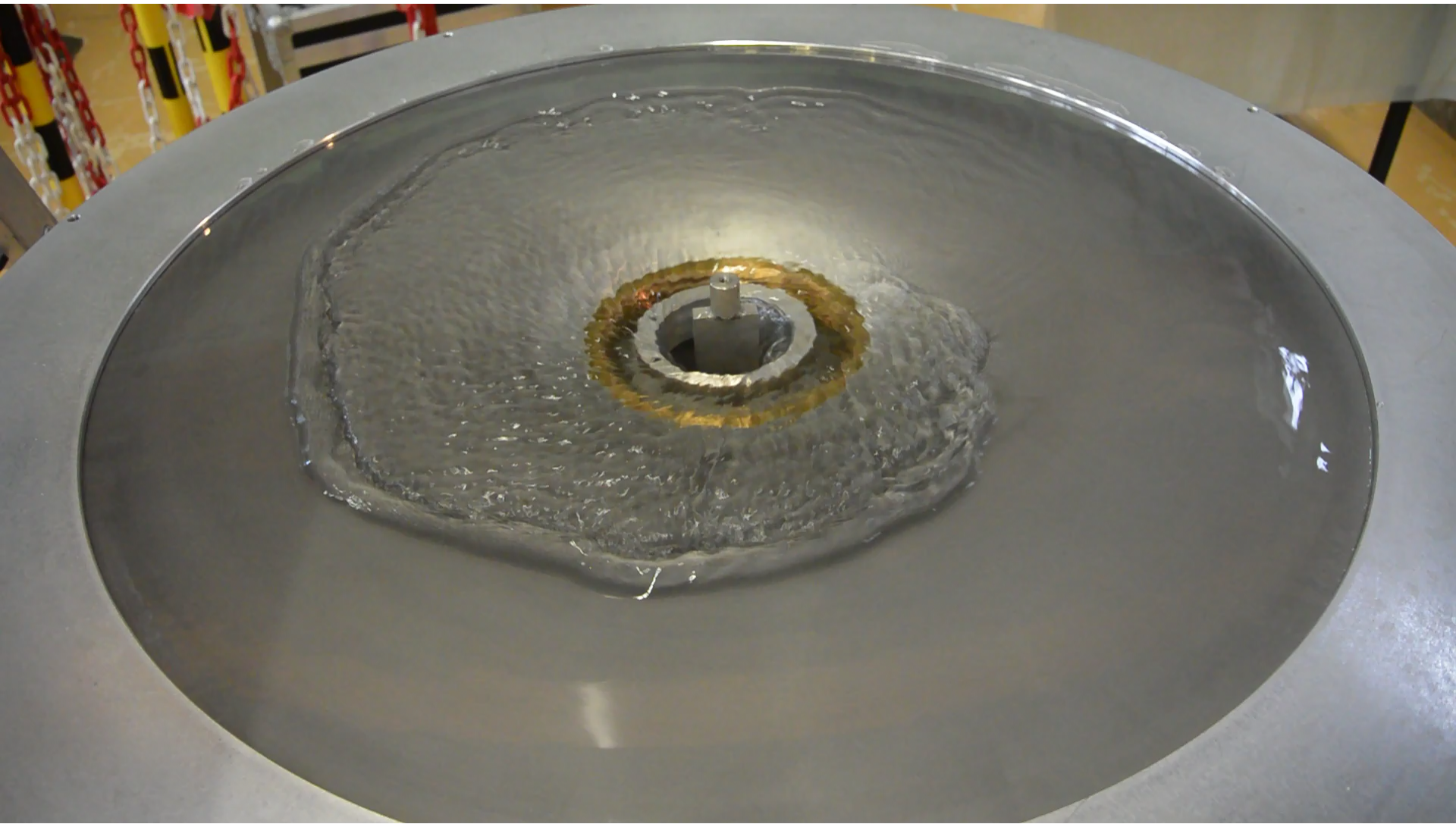
# SASI : Standing Accretion Shock Instability

## SWASI : Shallow Water Analogue to a Shock Instability



	Cas astrophysique	Saint-Venant
Conservation de la masse	$\frac{\partial \rho}{\partial t} + \operatorname{div}(\rho \cdot \vec{v}) = 0$	$\frac{\partial h}{\partial t} + \operatorname{div}(h \cdot \vec{v}) = 0$
Equation d'Euler	$\frac{\partial \vec{v}}{\partial t} + (\overrightarrow{\operatorname{rot}} \vec{v}) \wedge \vec{v} + \nabla \left( \frac{v^2}{2} + \frac{c^2}{\gamma - 1} - \frac{GM}{r} \right) = \frac{c^2}{\gamma} \nabla S$	$\frac{\partial \vec{v}}{\partial t} + (\overrightarrow{\operatorname{rot}} \vec{v}) \wedge \vec{v} + \nabla \left( \frac{v^2}{2} + c^2 - gH(r) \right) = 0$
Bilan d'entropie	$\frac{\partial S}{\partial t} + \vec{v} \cdot \nabla S = \frac{L}{P}$	$\emptyset$

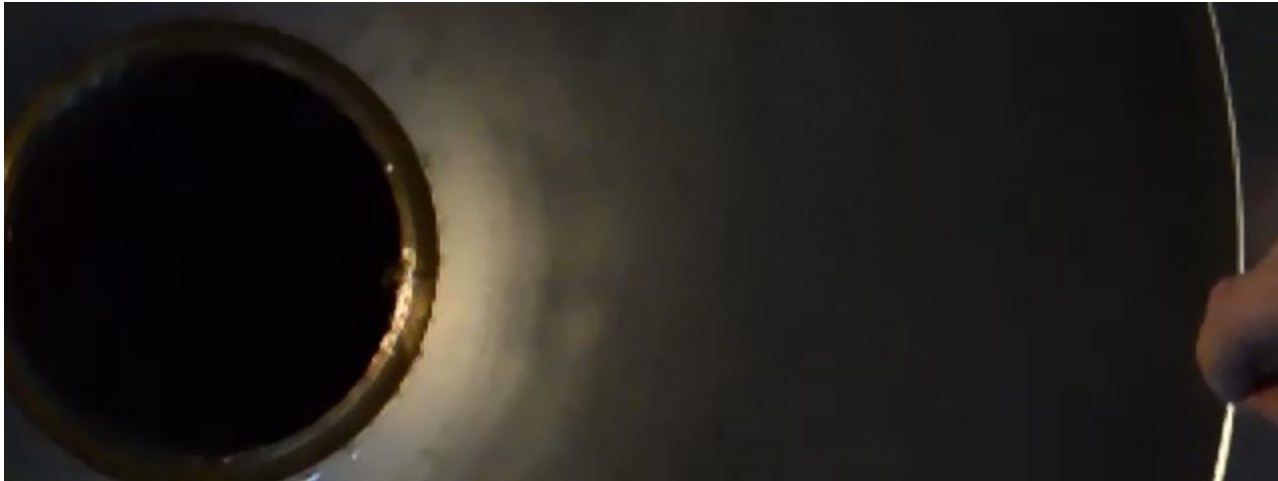




# Nos objectifs

1. La viscosité
2. La spirale

# La viscosité



# La viscosité

- Forces visqueuses :

$$\vec{F}_{lam} = \alpha \nu \frac{\vec{v}}{h^2} \quad \vec{F}_{turb} = \beta \frac{\nu}{h} \cdot \vec{v}$$

- Equations utilisées :

Débit

$$Q = 2\pi r h v_r = Cste$$

Bernouilli

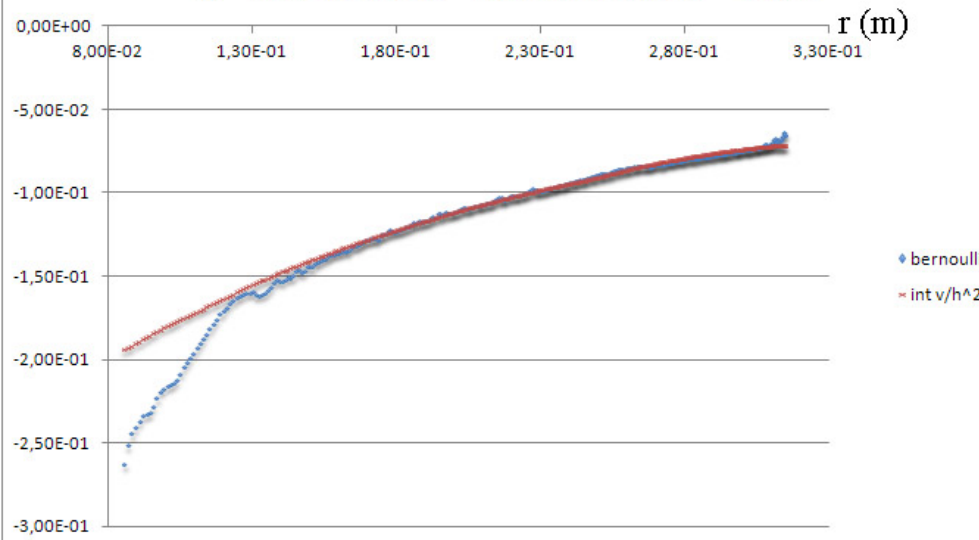
$$\frac{v_r^2}{2} + gh - gH(r) = \int_{r_{int}}^r \left( \alpha \nu \frac{v_r}{h^2} + \frac{v_\theta^2}{r} \right) dr + Cste$$

Moment cinétique

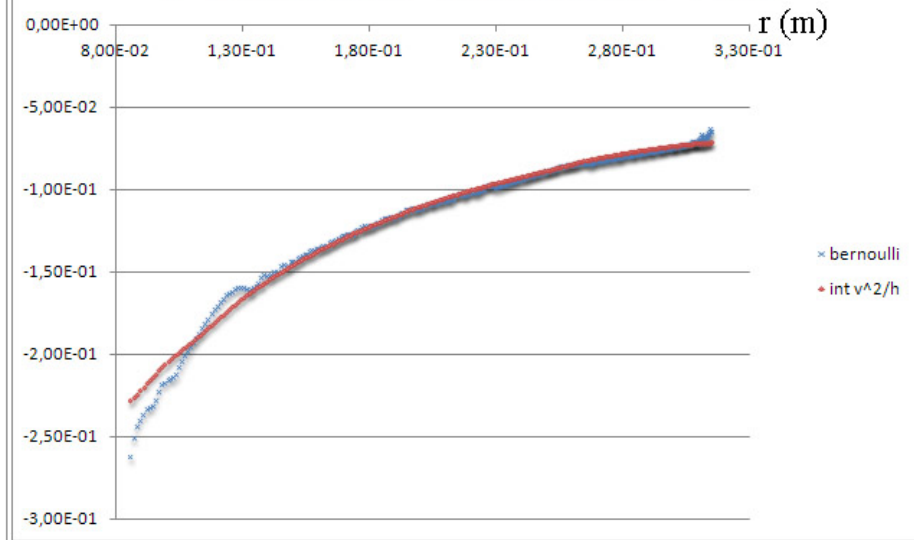
$$r v_\theta = \alpha \nu \int_{r_{int}}^r \frac{r(v_\theta - r\Omega)}{h^2 v_r} dr + Cste$$



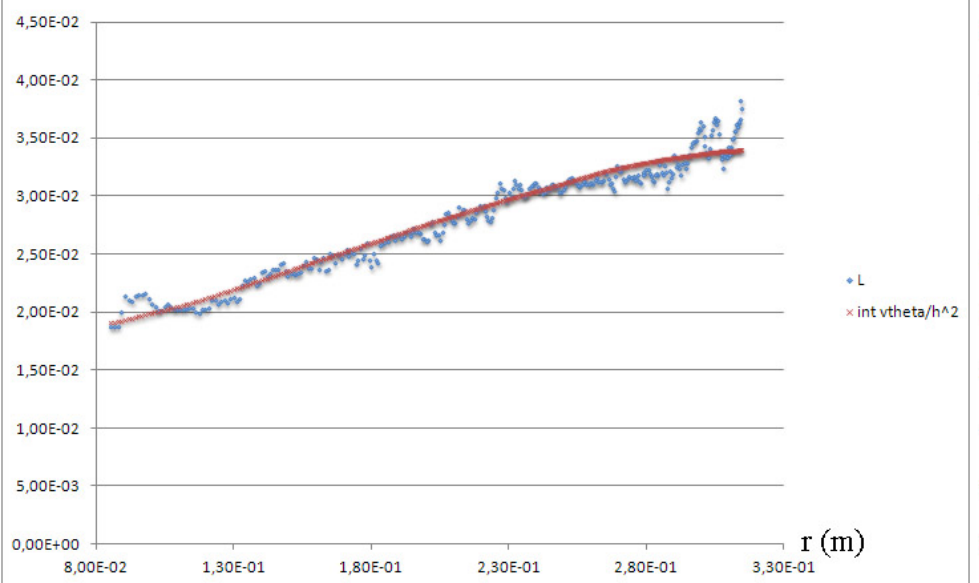
Q = 0,49 L/s fente = 1,7mm rotation = 22,1s



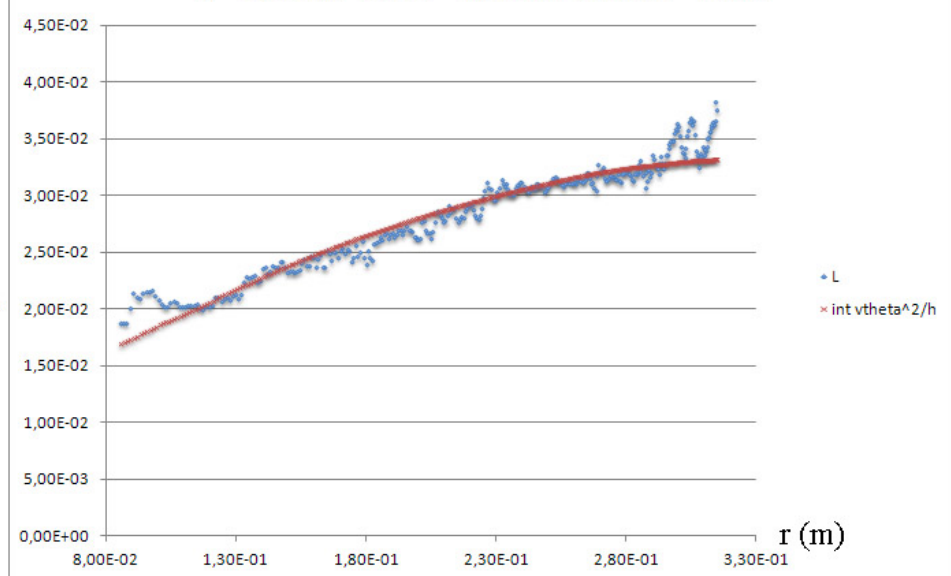
Q = 0,49 L/s fente = 1,7mm rotation = 22,1s

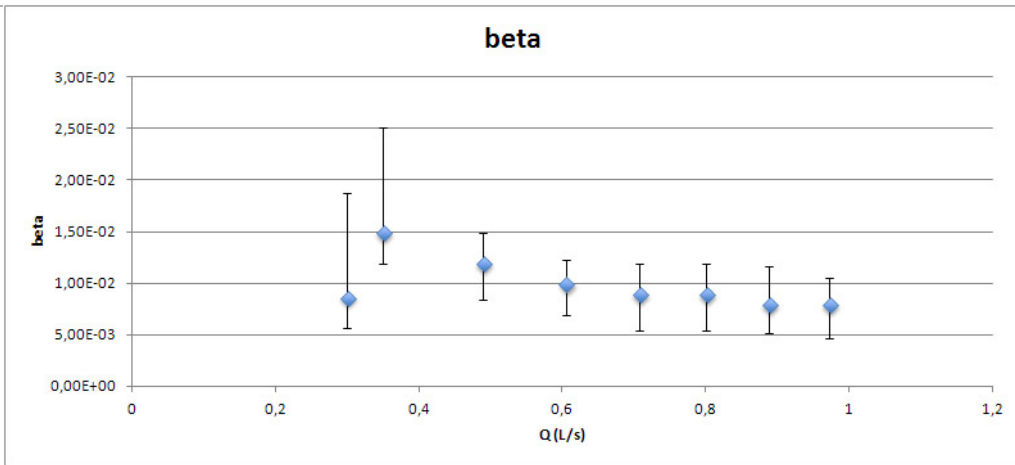
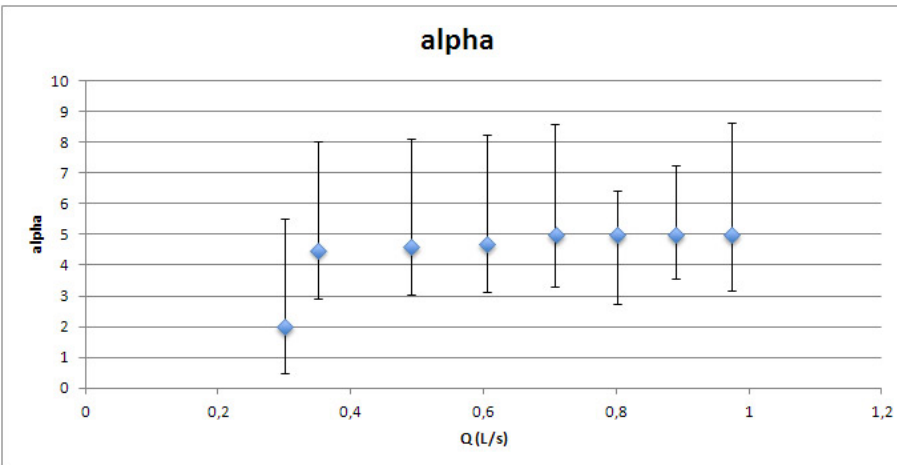
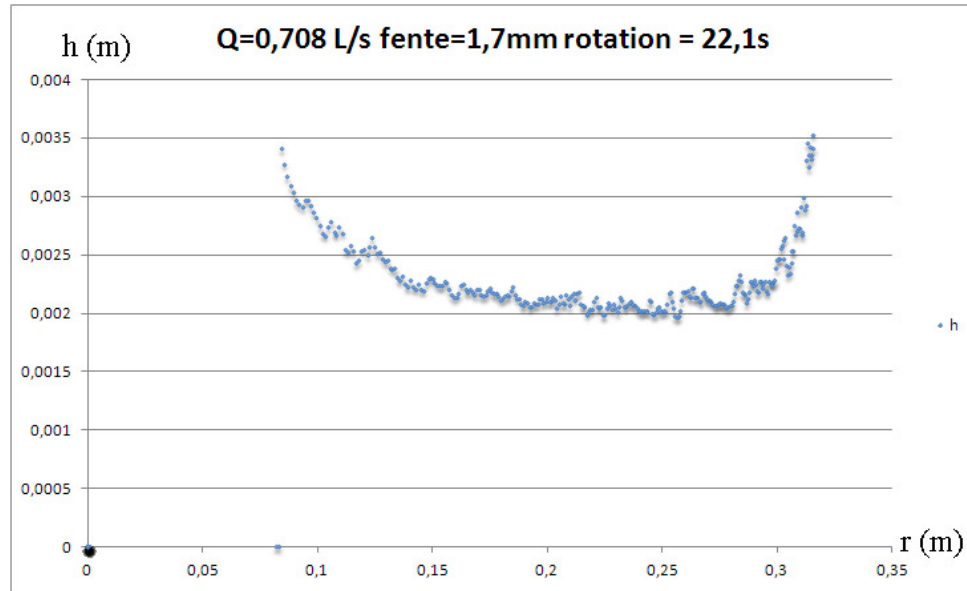


Q = 0,49 L/s fente = 1,7mm rotation = 22,1s

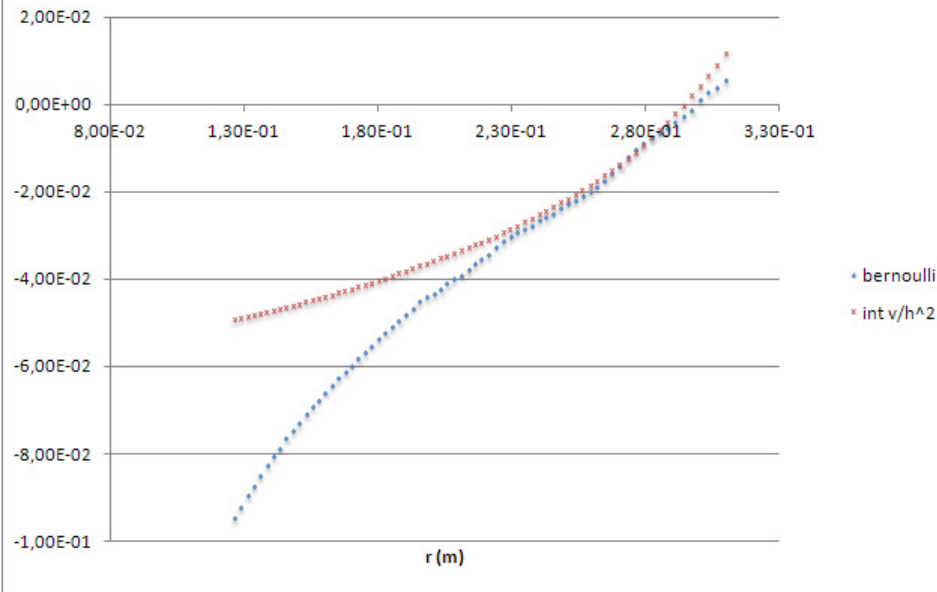


Q = 0,49 L/s fente = 1,7mm rotation = 22,1s

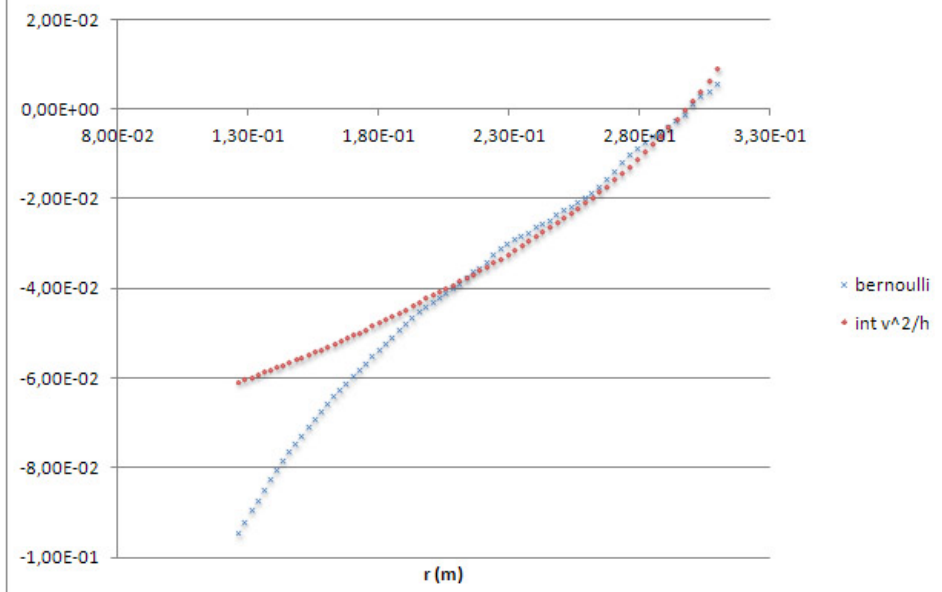




Q = 2,5 L/s, fente = 0,9mm, rotation = 25s

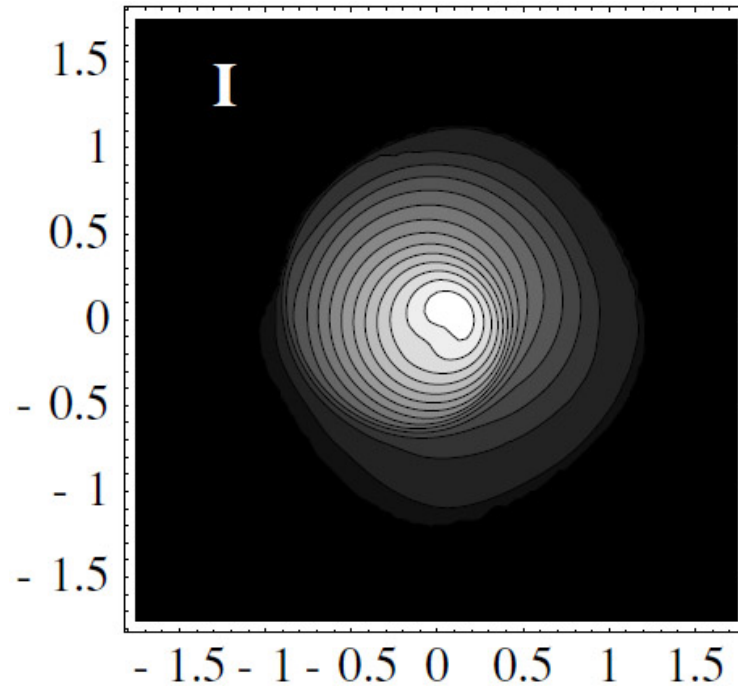


Q = 2,5 L/s, fente = 0,9mm, rotation = 25s



# La spirale ouverte

- Low  $T/W$



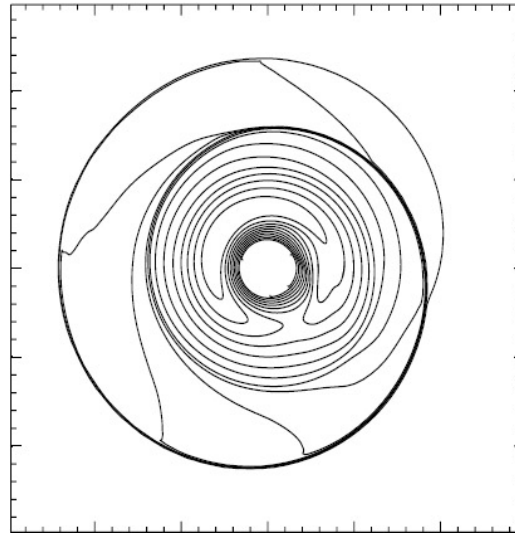
- Instabilité de Papaloizou-Pringle

# Difficulté d'interprétation du low T/W

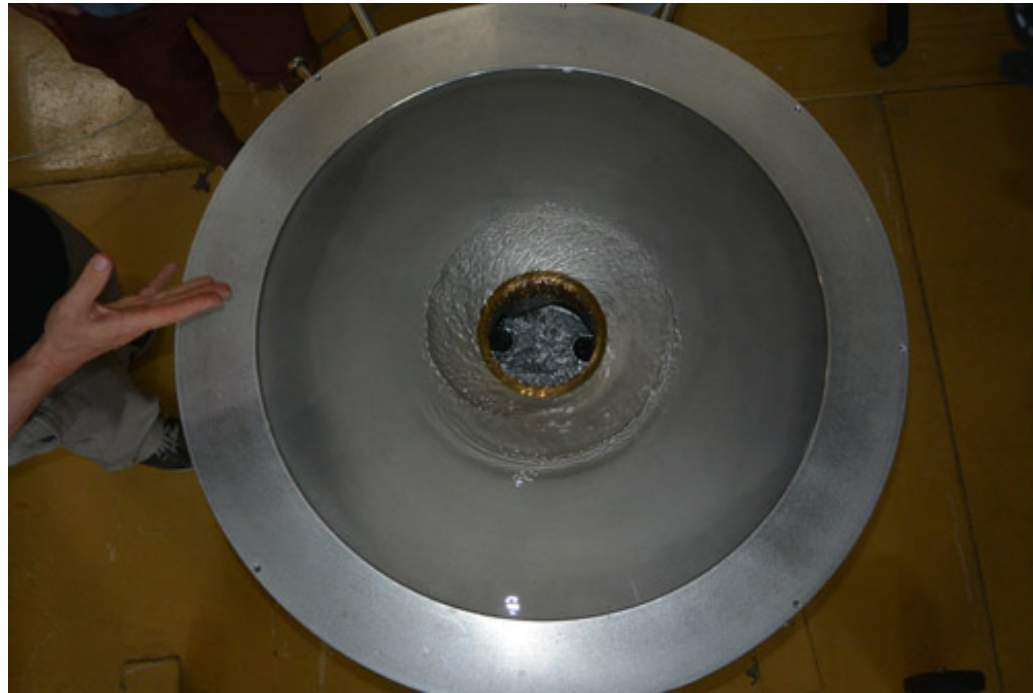
- Etoiles à neutrons sans accrétion
- Vorticité
- Relativité
- Etoile à neutrons en formation : low T/W incertain

# Mode « Trou noir »

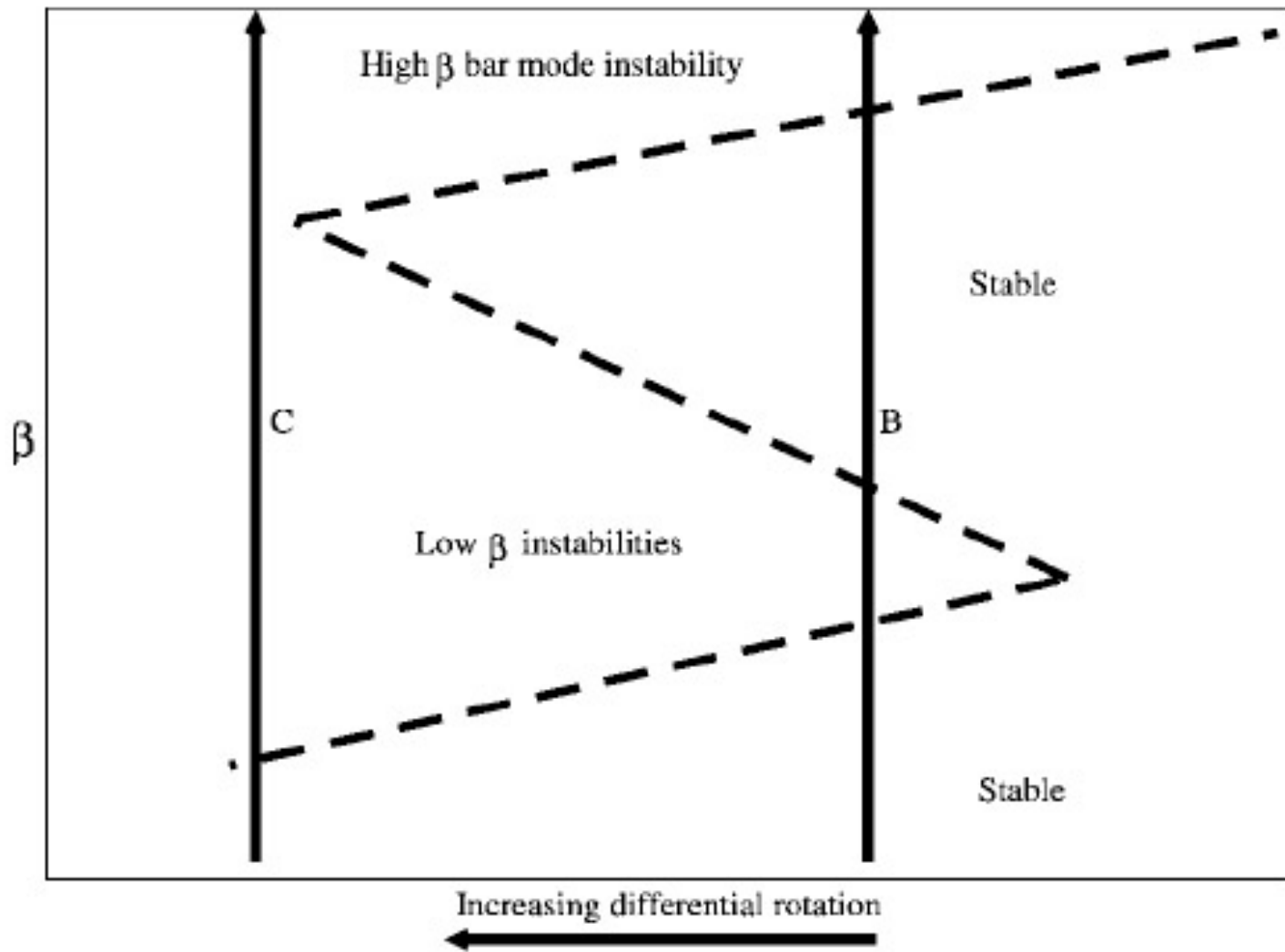
- Molteni :

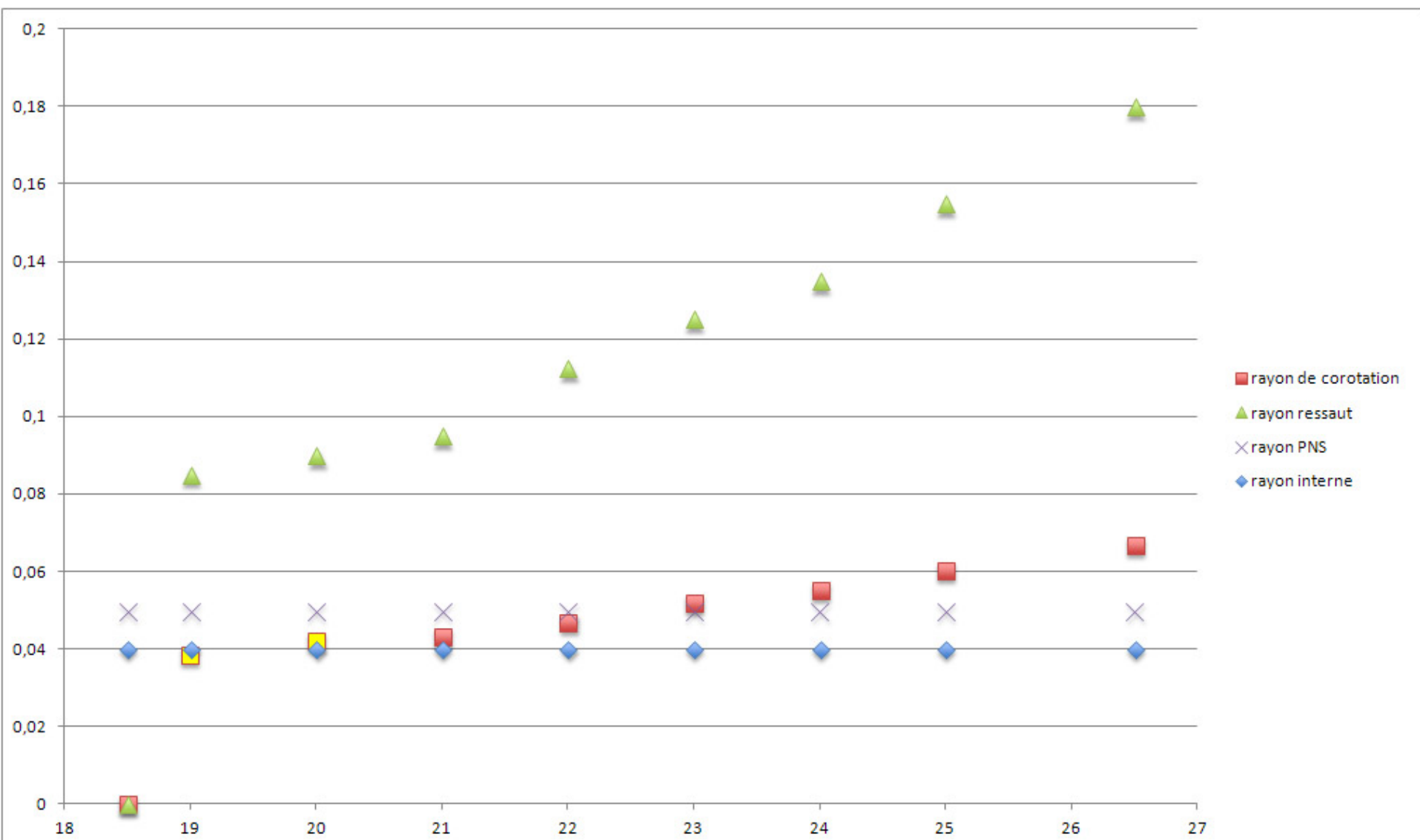


- Fontaine :



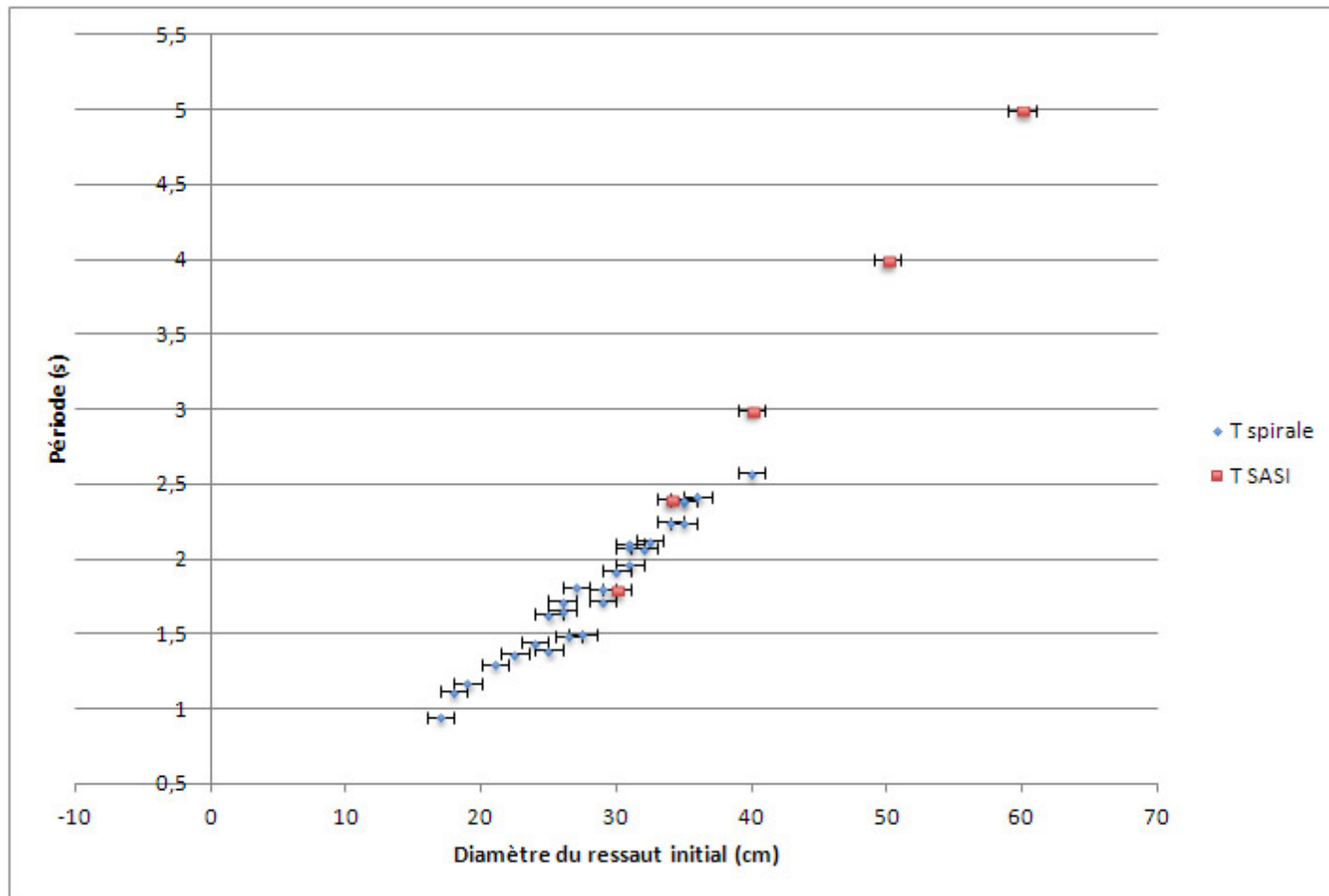
- Watts :







# Analogie avec SASI



# Conclusion

- Viscosité :  $\alpha = 4.5$  mais modèle turbulent plus adapté
- Spirale ouverte :
  - Rôle essentiel du rayon de corotation
  - Cavité résonante entre le rayon de corotation et le ressaut hydraulique
  - Lien inattendu entre SASI et la spirale ouverte

