Effects of simple generic configuration *(SWIM)* on *near to far field* wake using *3D Vortex Filament Method*

Fluid Mechanics Institute of Toulouse

D. Margerit

A. Giovannini and P.Brancher

Objectives

- ***Validation*** of the EZ-vortex code against linear stability studies
- ***Parametric study*** :
  - ◆ NLR wind tunnel results (LST/ LLF): 6 model configurations.
  - ◆ Initial conditions of EZ-Vortex
  - ◆ EZ-Vortex computation

Partner	Activity	2000				2001				2002			
		I	II	III	IV	I	II	III	IV	I	II	III	IV
DLR-PA	Adaptation of vortex filament method			�▬	▽								
	Configuration investigation				▬▬▬	▬▬	▬▬	▽					
DA	Development of fast vortex method	▬▬	▽										
	Validation						▬▽						
	Parametric study									▬			
UPS	Adaptation of vortex filament method			▬▬	▽								
	Acceleration method				▬								
	Validation						▬▽						
	Parametric study							▬▬					
NTUA	Validation with existing data			▬▽									
	Parametric investigation				▬								
	Comparison with LES					▬▬	▽						
	Application to selected configuration								▬▬				
	Project Milestones					R1 ◈				R2 ◈			EOP ◈

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# Validation of EZ-Vortex

➡ *Validation*: 4-wake vortex model

Growth rate / Shape of linear mode

◆ Linear Stability (Fabre - Jacquin 2000)

◆ EZ-Vortex computation (linear regime)

⇓

➡ *Slender Vortex Filament Simulation:*
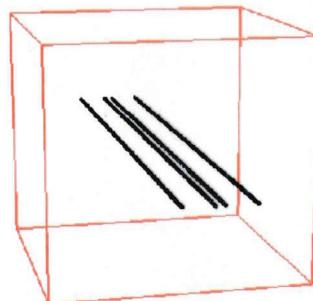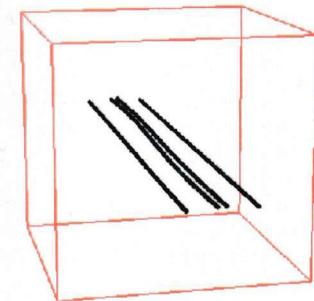
t=0   t=2.375   t=3.135
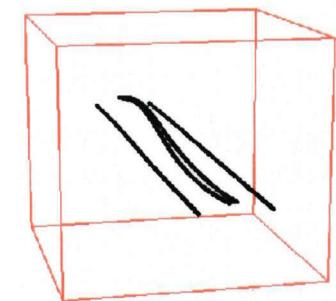
non-linear regime

Parametric study

- Inputs of EZ-Vortex (Initial condition)

  Position, Circulation Γ, Radius δ , Axial flux m_0

- NLR report : only some of these parameters are available

  $\Rightarrow$ we need to complete the analysis of NLR

Experimental NLR data: *Our analysis of the data files:*

Vorticity contour lines
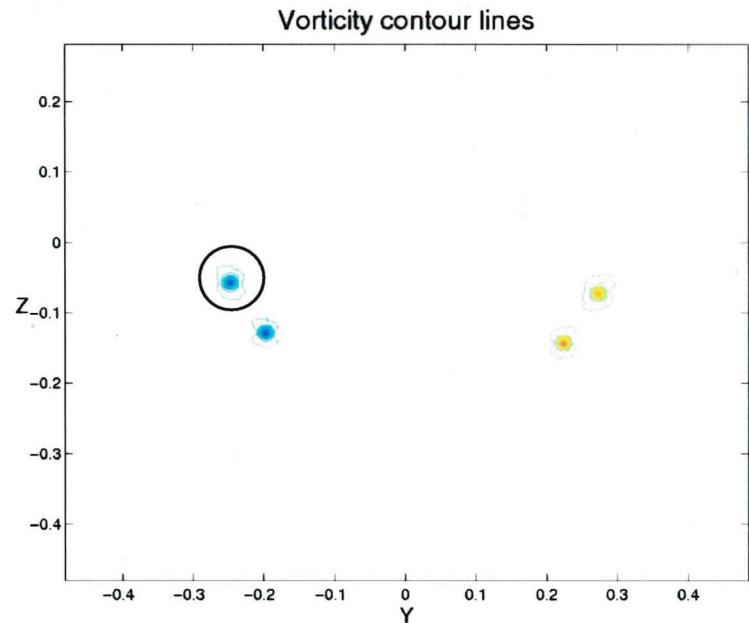
➤ Axi-symmetric average over the circle:

$\Rightarrow$

$\Rightarrow$ radial profile of vorticity

➤ Analysis of this profile:

(least square method)

$\Rightarrow$ position, Γ , δ , m_0

Analysis

$$\Downarrow$$

Position of vortices
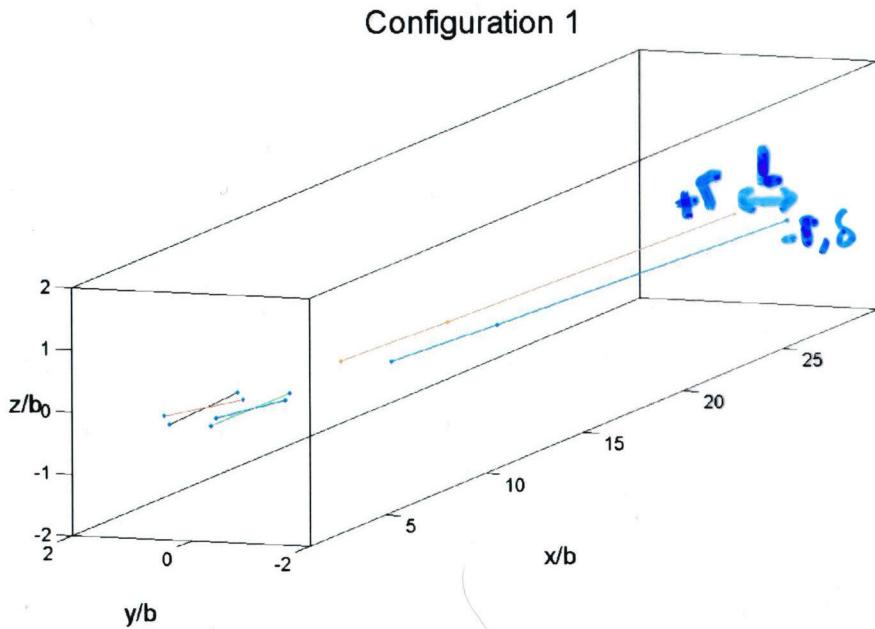
$$x/b > 30 \; :$$

Configuration 1

- 3D dynamics, curvature effects
- Initial condition for EZ-Vortex from station
$$x/b = 30$$

$$\Rightarrow \quad x/b < 30 \; : 2\text{D dynamics for motion and merging}$$

Initial Conditions for EZ Vortex

(Wing span b=0.6 m, V0=60 m/s)

IC from our analysis at $x/b = 30$:

Configuration 1:

- 2 vortices
- Distance of vortices $L = 0.5m$
- Circulation $\Gamma = +/- 2.4 m^2/s$
- Radius $\delta/L = \varepsilon = 0.046$ $\Rightarrow$ <u>Slender vortex</u>
- Viscosity $v/\varepsilon^2 = 0.01 m^2/s$
- Axial flux $m0 = -0.0 m^3/s$

$\Rightarrow$ **EZ-Vortex code** $\Rightarrow$ **Time of 3d collision:**

$t = 0$ $t = 0.6365s$ $t = 1.273s$
$$t_{collision} = 1.273s$$

Linear stability time:
$$t_{linear} = 1/\beta = 0.78s$$
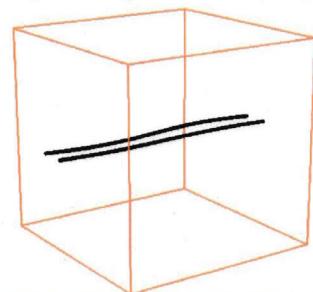
Criteria of collision:
$$d_{min}/L = 4\varepsilon$$
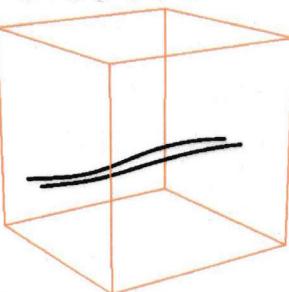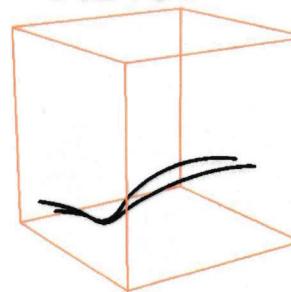
$\Lambda = 4.57965m$ (most unstable linear mode)