Online Supplement for *Pendant drop rotation in vertical, turbulent, shearing flows*

We perform a mesh sensitivity study by varying the base cell size from 1.0 mm to 3.0 mm and monitoring the centerline axial velocity along the height of the tunnel for the case where $U_S = 2.0$ m/s and $r_U = 0.2$, as shown in **Fig.S1**. The inner potential core collapse location is extracted from each velocity profile as a representative scalar metric and is summarized in **Table S1**. The solution exhibits monotonic convergence across all mesh levels, with successively smaller changes as the mesh is refined.

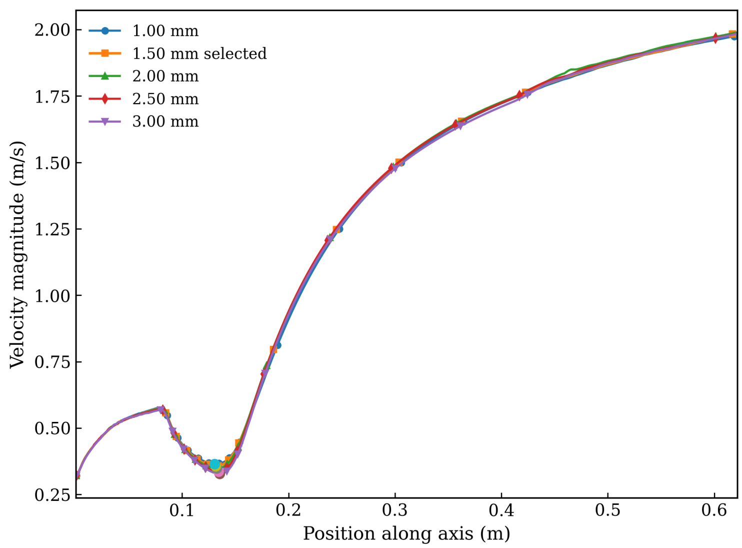

Figure S1: Grid independence study showing the axial velocity magnitude along the centerline for the case where $U_S = 2.0$ m/s and $r_U = 0.2$ for mesh base sizes ranging from 1.0 mm to 3.0 mm. The velocity profiles exhibit close agreement across the refined meshes, particularly between the 1.0 mm and 1.5 mm cases. The selected 1.5 mm mesh captures the inner potential core collapse location with only a 0.71% deviation from the finest mesh while reducing computational cost.

Table S1: Inner potential core collapse location for different mesh base sizes. The relative difference is computed with respect to the finest mesh (1.0 mm base size).

Mesh base size	Collapse location (m)	Difference from 1.0 mm (mm)	Relative difference (%)
3.0 mm	0.135102	4.50	3.45
2.5 mm	0.134123	3.53	2.70
2.0 mm	0.132600	2.00	1.53
1.5 mm	0.131519	0.92	0.71
1.0 mm	0.130598	0.00	0.00

To formally quantify discretization uncertainty, a Grid Convergence Index (GCI) analysis is performed following the procedure of Celik *et al.*[?] , using the three finest meshes (1.0, 1.5, and 2.0 mm). The refinement ratios are $r_{21} = 1.500$ and $r_{32} = 1.333$. The apparent order of convergence, computed iteratively, is $p = 1.47$, consistent with the second-order spatial discretization we employ. The Richardson-extrapolated collapse location is $f_{\text{ext}} = 0.129398$ m. The resulting fine-grid GCI for the 1.5 mm mesh is $\text{GCI}^{21}_{\text{fine}} 1.08\%$, which is within the accepted threshold for engineering CFD applications. The asymptotic convergence ratio, defined as $\text{GCI}_{32}/(r^p_{21} \cdot \text{GCI}_{21})$, evaluates to $0.994 \approx 1$, confirming that the solution resides in the asymptotic convergence regime. The GCI parameters are summarized in **Table S2**. Therefore, the 1.5 mm base size is considered sufficient to achieve grid-independent results while maintaining reasonable computational cost. The final mesh consisted of 220,045 cells.

Table S2: Grid Convergence Index (GCI) analysis following Celik *et al.*[?] , using the inner potential core collapse location as the solution variable.

Parameter	Value
Mesh sizes h_1, h_2, h_3 (mm)	1.0, 1.5, 2.0
Collapse locations f_1, f_2, f_3 (m)	0.130598, 0.131519, 0.132600
Refinement ratios r_{21}, r_{32}	1.500, 1.333
Apparent order p	1.47
Extrapolated value f_{ext} (m)	0.1294
Approximate relative error e^{21}_a	0.7052%
Extrapolated relative error e^{21}_{ext}	0.8701%
Fine-grid $\text{GCI}^{21}_{\text{fine}}$	1.0782%
Asymptotic convergence check	$0.9929 \approx 1$