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Supervisor Expression of Interest
MSCA - Marie Sklodowska Curie Action - (PF) Postdoctoral Fellowship 2021

Supervisor name:	Roberto Fedele
Email address:	roberto.fedele@polimi.it
Link pagina docente:	Pagina docente in **http://www.dica.polimi.it/**
Department Name:	Department of Civil and Environmental Engineering (DICA)
Research topic: (https://www.polimi.it/en/scientific-research/research-at-the-politecnico/departments/)	**Computational methods for 3D Diffused Vortex Hydrodynamics**
MSCA-PF Research Area Panels:	☐ CHE_Chemistry ☐ ECO_Economic Sciences ☐ **X** ENG_Information Science and Engineering ☐ ENV_Environmental and Geosciences ☐ LIF_Life Sciences ☐ MAT_Mathematics ☐ PHY_Physics ☐ SOC_Social Sciences and Humanities
Politecnico di Milano Areas:	☐ Cultural Heritage ☐ Smart Cities ☐ Horizon Europe Missions ☐ Health ☐ **X** Industry 4.0
Title and brief description of the Department and Research Group (including URL if applicable):	DICA is the 7th Department of Civil and Structural Engineering in the world, the first in Italy, according to "QS world ranking 2019", with 2 doctoral schools, about 100 members of permanent staff and 80 as non-permanent staff. With its 8 inner sections DICA covers all topics of civil and environmental engineering, with a peculiar expertise in experimental (both in laboratory and in situ) and numerical activities, for the following areas: structural, geotechnical and earthquake engineering, transport infrastructures, water research, geomatics, environmental engineering. DICA is an excellent scientific institution devoted to innovative research,

	education, and to commitments from public and private entities in all aforementioned disciplines. **http://www.dica.polimi.it/.** Prof. Roberto Fedele is responsible for the laboratory of "Full-field measurements" at Dept. DICA; he is in the scientific commission of "AMALA" interdipartimental lab.

Brief project description: (max 1 page)	In the last decades an increasing attention has been given in studying particle methods for fluid flows and, in particular, a renewed attention to vortex particle methods is arising, thanks to their ability in simulating complex vortical flows and long wakes. In recent years, several studies were focused on the deep comprehension of the physics related to biological locomotion, as well as, in recent years due to Covid-19 pandemic, an increasing interest in studying the dynamics of sneezing or coughing processes, that can be modelled as air jet flow with suspended water particles, has begun. The project aim is to develop the 3D Diffused Vortex Hydrodynamics (3D DVH) method not only for the pure Lagrangian approach that set the 3D DVH on the edge of the vortex method research, but to answer the challenging questions related to the study of flow completely driven by the evolution of the vorticity field. The starting point to design the 3D DVH is the 3D Navier-Stokes equations written in vorticity for viscous incompressible flow. To solve this equation, the evolution of the vorticity field will be based on three main steps: the advective, governed by the Euler equation, the vortex stretching, were the vorticity field change in intensity and direction due to the local strain rate tensor, and the diffusive, governed by the heat equation. These steps will be developed and implemented following a pure Lagrangian approach, introducing novelties related to vortex stretching, a pure Lagrangian vortex stretching, and diffusion, designing an algorithm which avoids the use of any remeshing scheme, based on the 2D DVH Regular Point Distribution, while others will be specifically designed, developed and implemented. In order to apply 3D DVH in aerodynamic as well as hydrodynamic fields, a body should be introduced in the fluid domain. No slip Boundary Conditions will be enforced generating vorticity on solid boundaries using an ad-hoc 3D Boundary Element Method.