



von KARMAN INSTITUTE
FOR FLUID DYNAMICS



UNIVERSITÉ
LIBRE
DE BRUXELLES



RE-TWIST : REinforcement TWInning SysTems

From collaborative digital twins to model-based reinforcement learning

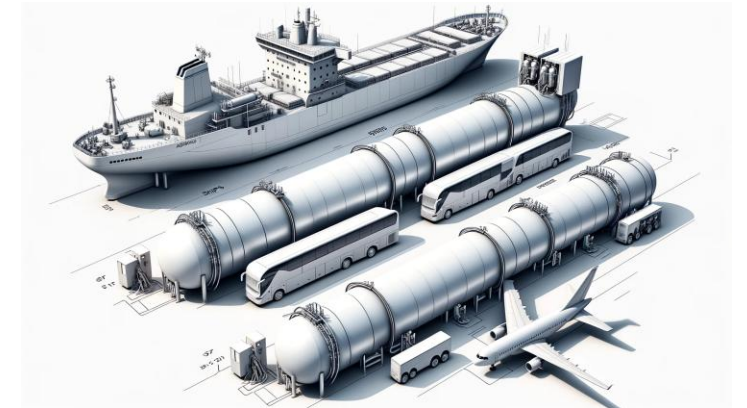
Miguel Alfonso Mendez



Wind Energy

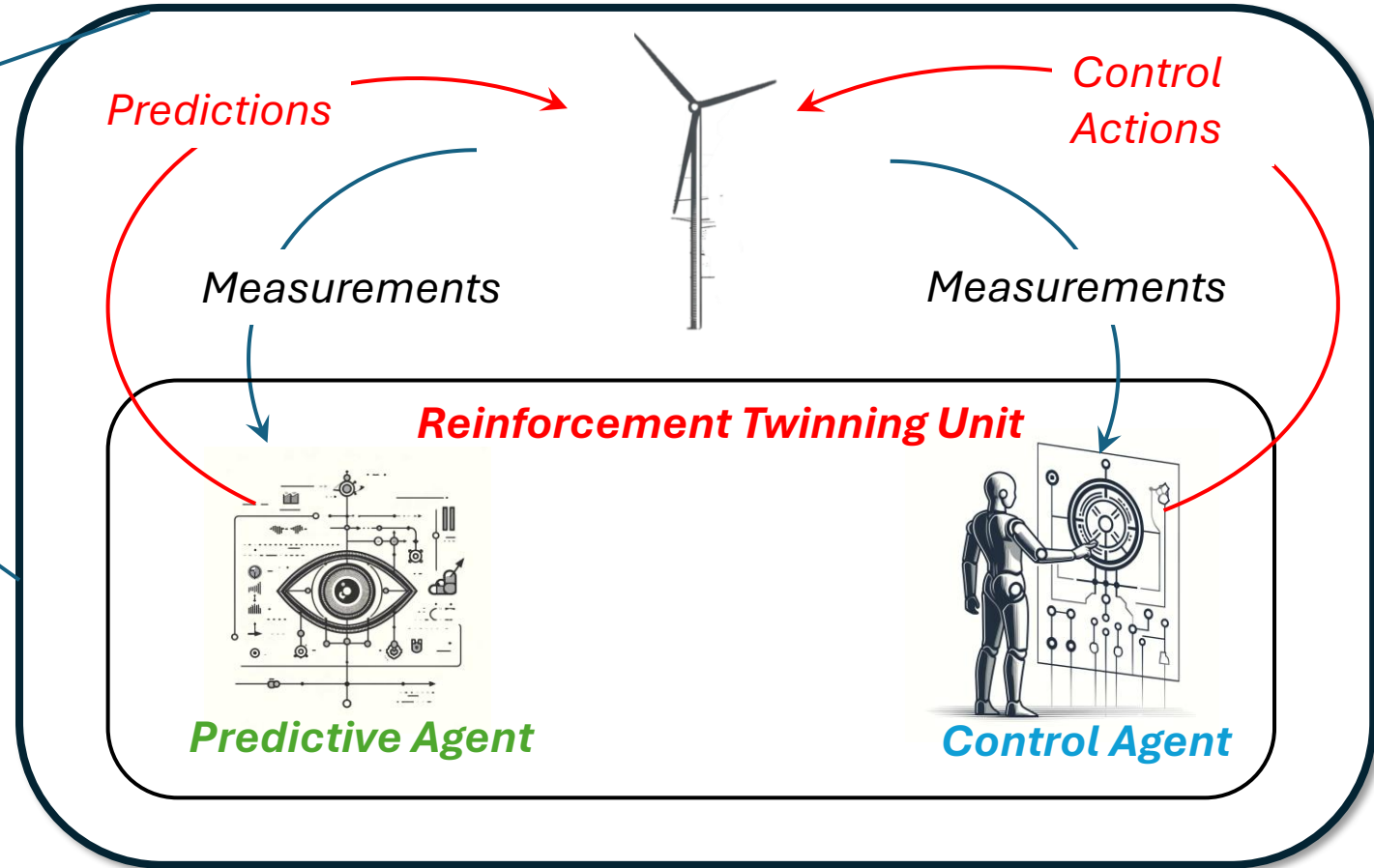
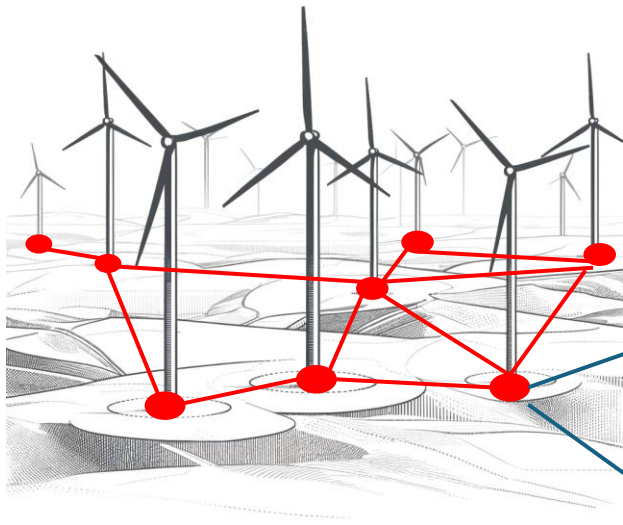


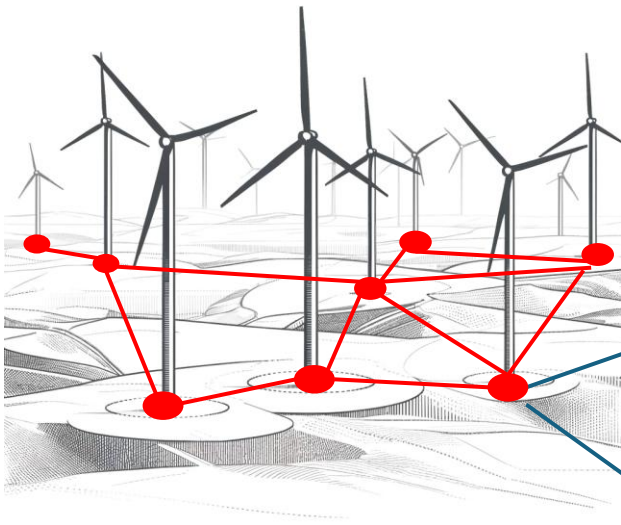
Remote Inspection



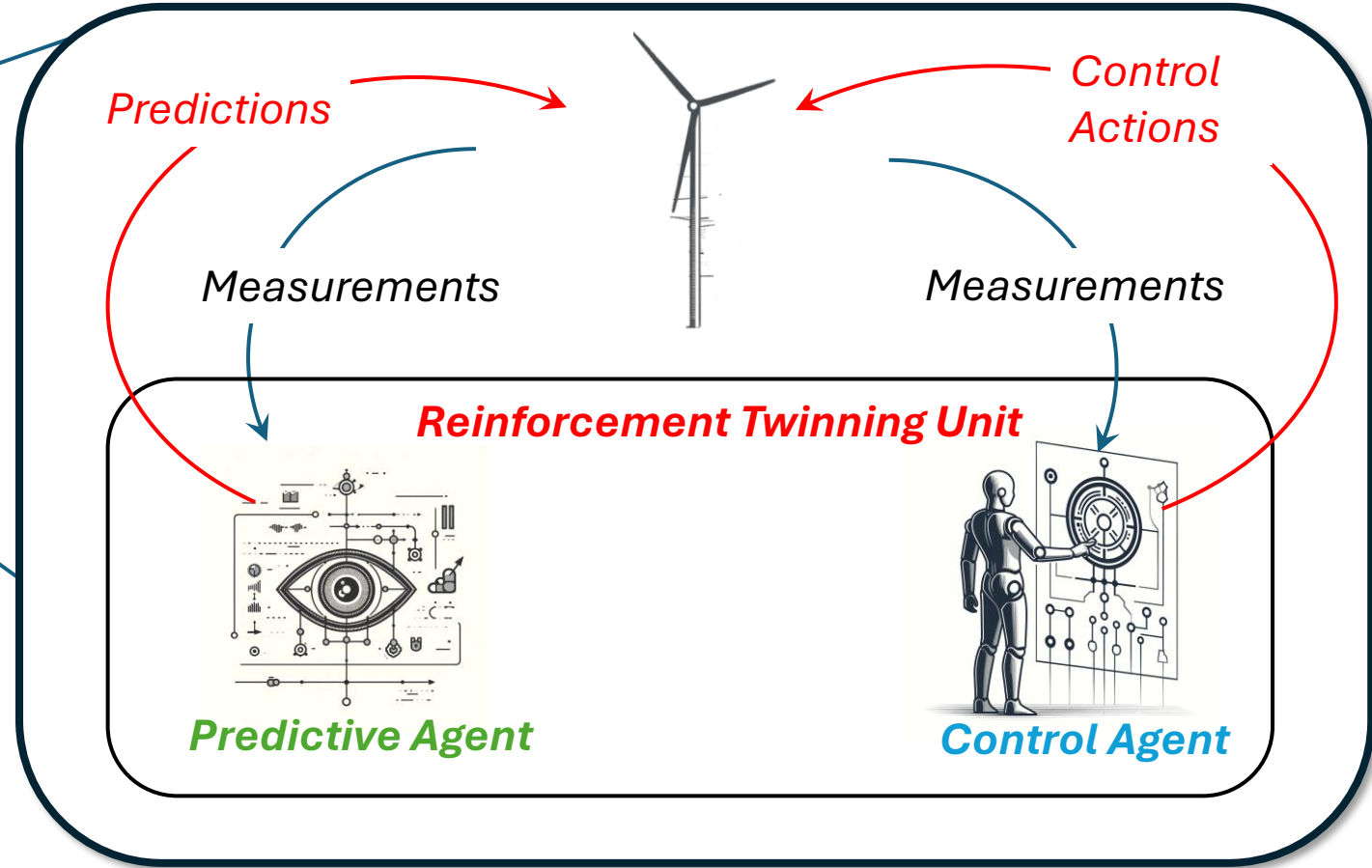
Transportation of cryo fuels
(LNG or LH2)

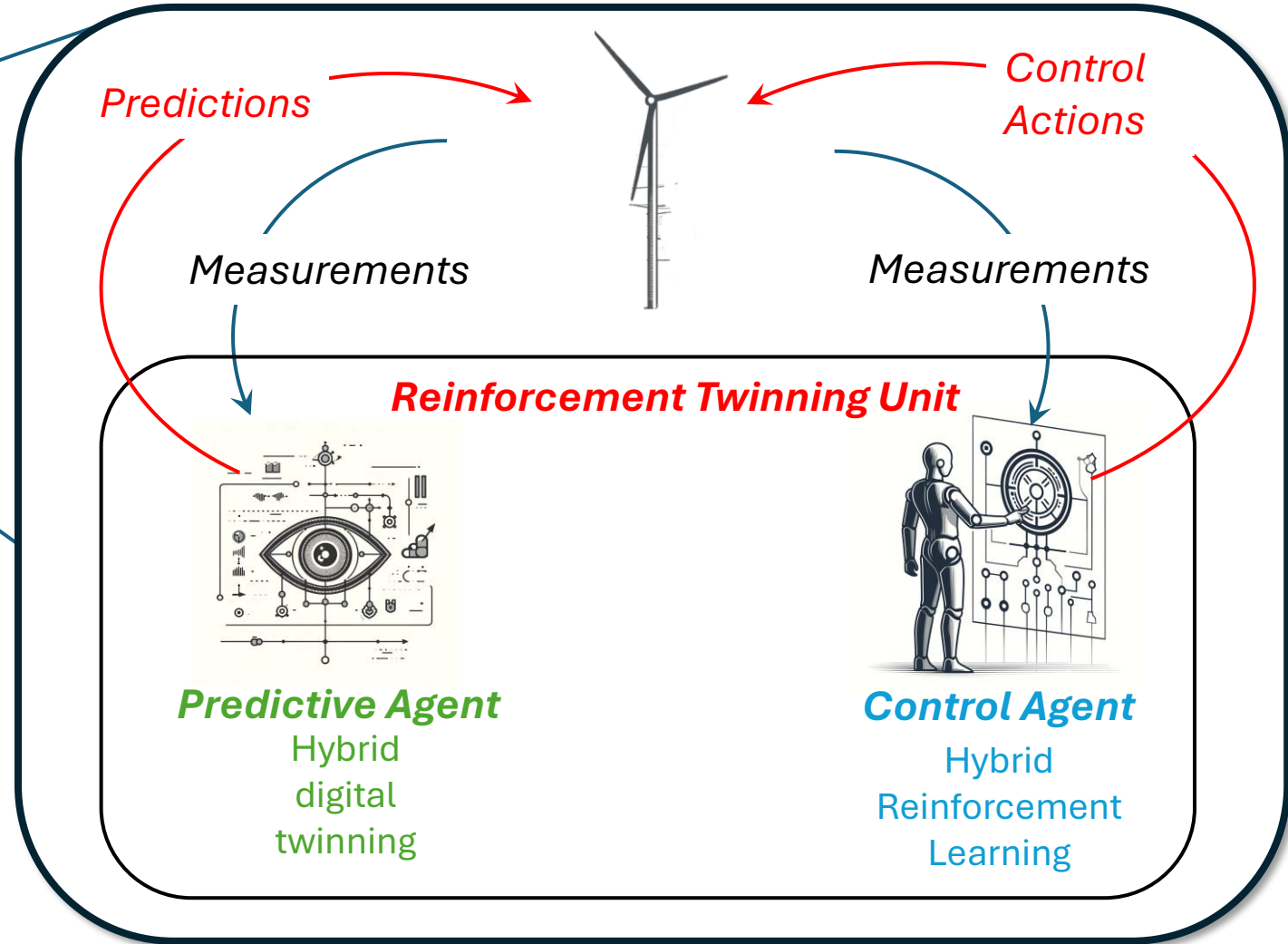
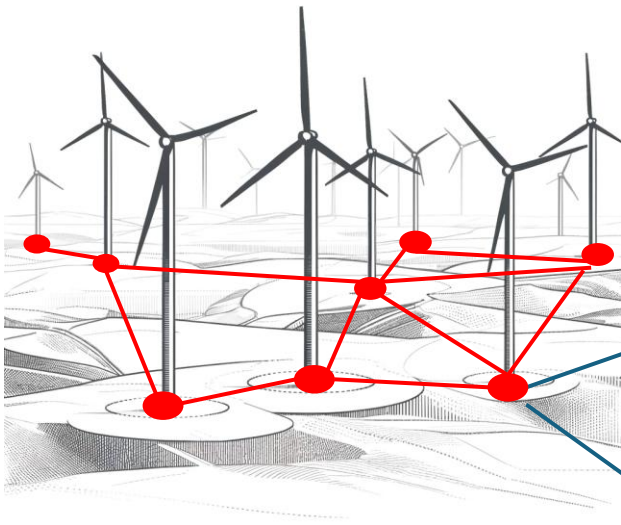
The goal: Make these systems “intelligent” self-learners and self-controlling





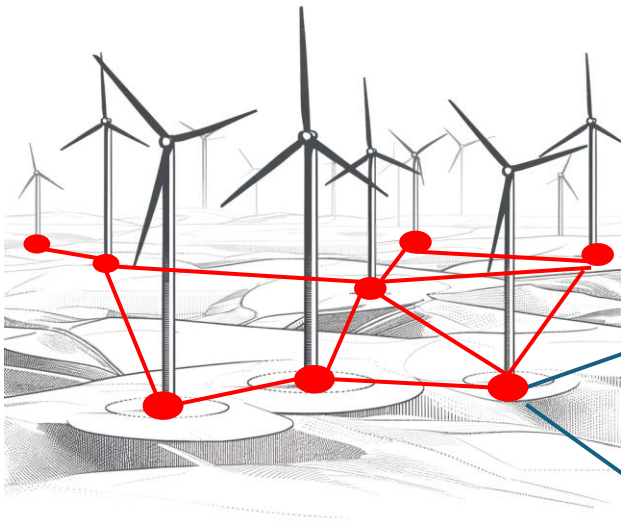
Two Key Innovations:





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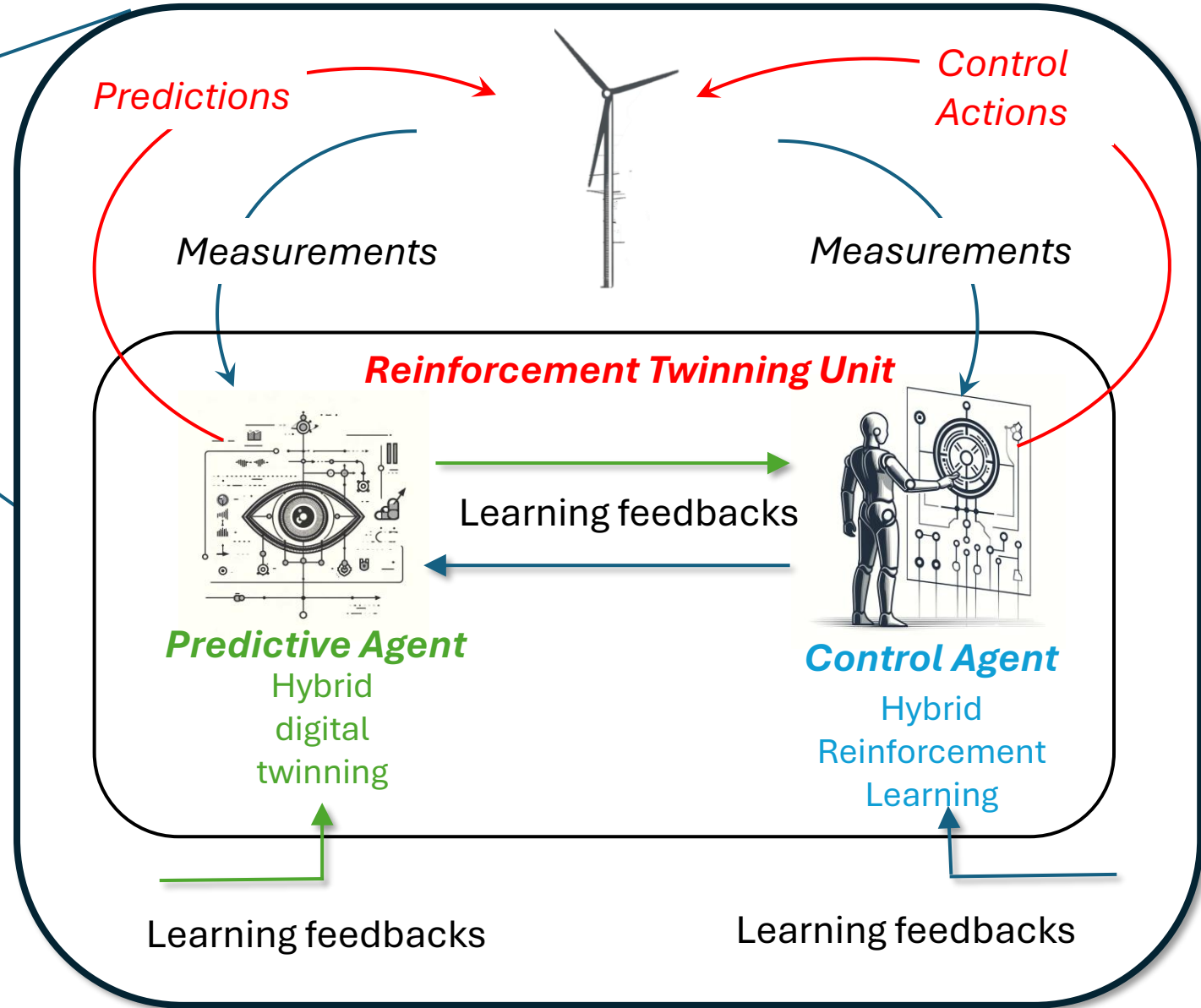
1. Hybrid assimilation



Two Key Innovations

1. Hybrid assimilation

2. Collective learning and control





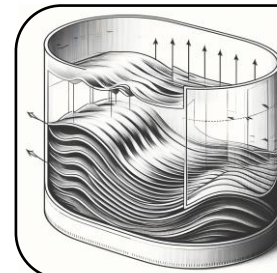
WP1: *Reinforcement Twinning algorithm development*



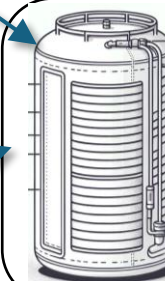
WP2: *Wind turbine and wind farm control*



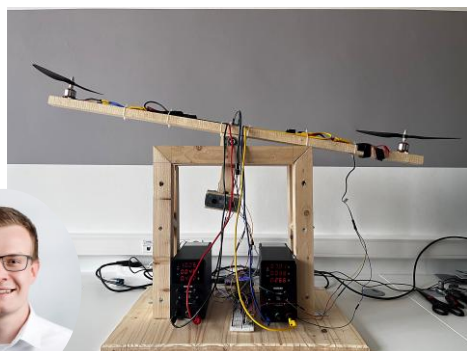
WP3: *Propeller and UAVs control*

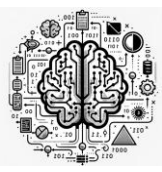


WP4: *Sloshing Control*



WP5: *Thermal management and boil off control*





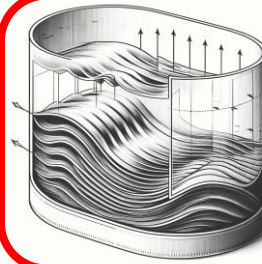
WP1: Reinforcement Twinning algorithm development



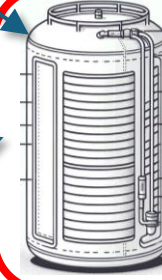
NP2: Wind turbine and wind farm control



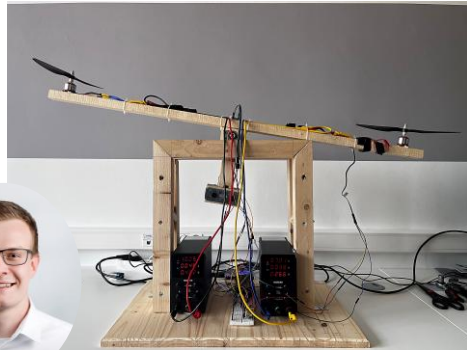
WP3: Propeller and UAVs control



WP4: Sloshing Control



WP5: Thermal management and boil off control



Strong Points (feasibility wise):

- Students already training on the test cases
- Preliminary prototypes under development
- We know these systems well: hands-on familiarity
- **Novelty:** these platforms weren't built for twinning — to be repurposed!



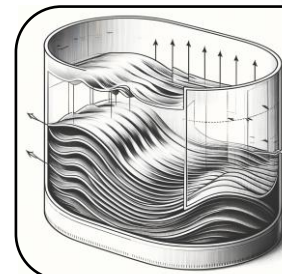
WP1: Reinforcement Twinning algorithm development



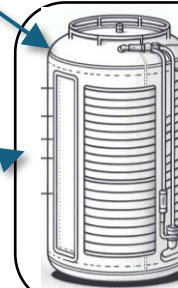
NP2: Wind turbine and wind farm control



WP3: Propeller and UAVs control



WP4: Sloshing Control



WP5: Thermal management and boil off control

P. Marques, S. Ahizi and **M. A. Mendez (2024)**

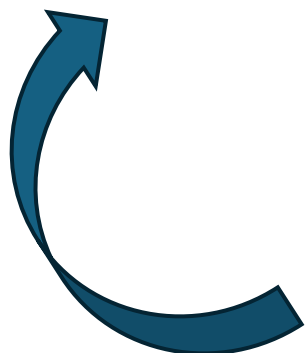
Real-Time Data Assimilation for the thermodynamic modeling of cryogenic storage tanks

arXiv > physics > arXiv:2310.11399

L. Schena, P. Marques, R. Poletti, S. Ahizi, J. van den Berghe, **M.A. Mendez (2024)**

Reinforcement Twinning: from Digital twins to model-based reinforcement learning

arXiv > eess > arXiv:2311.03628



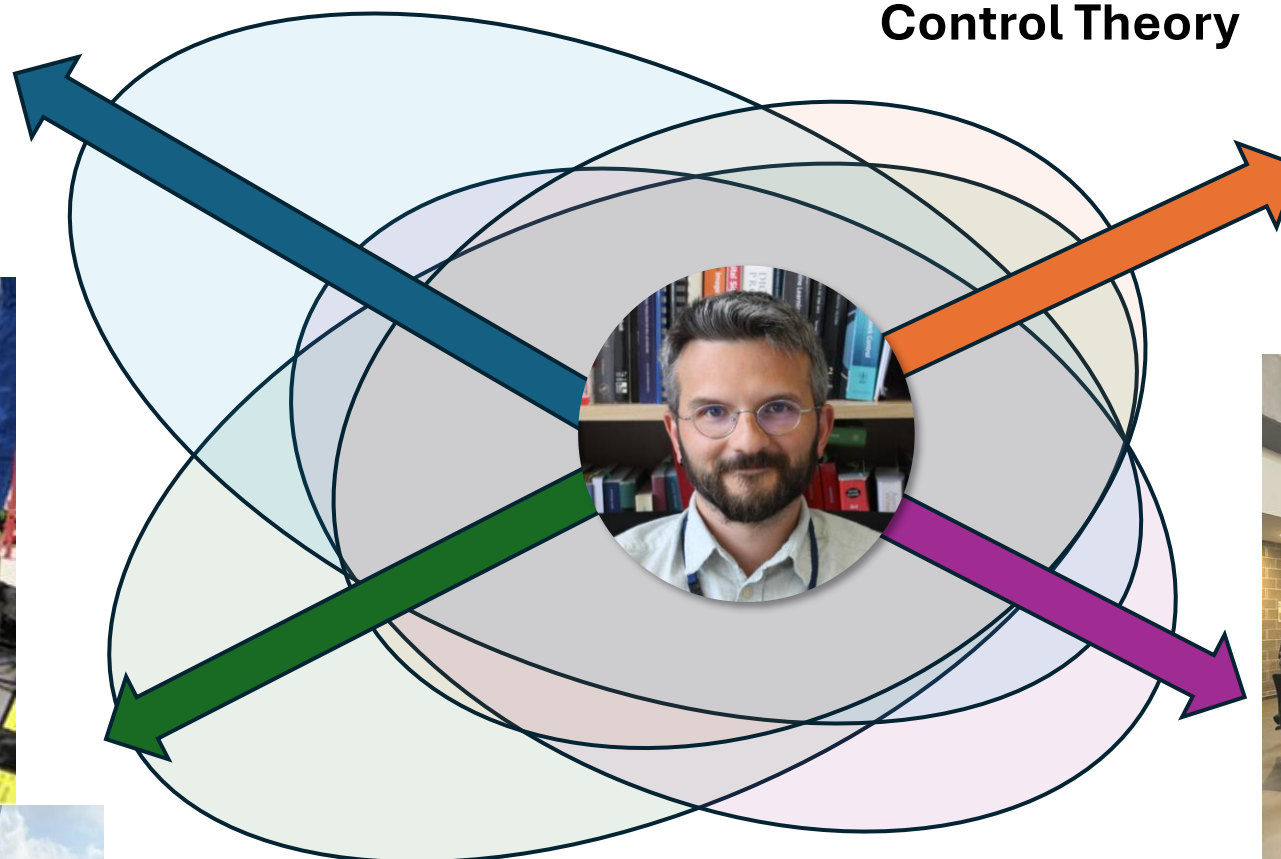
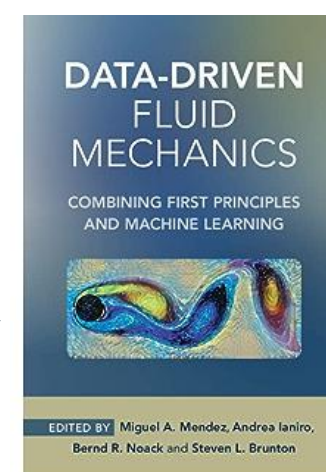
Weak points (too high risk ?):

- Limited publication record in reinforcement learning
- Few peer-reviewed results on flow control implementation
- Most past work focused on modeling, not control synthesis



**Experimental Testing
and modeling**

Control Theory



Data Assimilation

Machine Learning

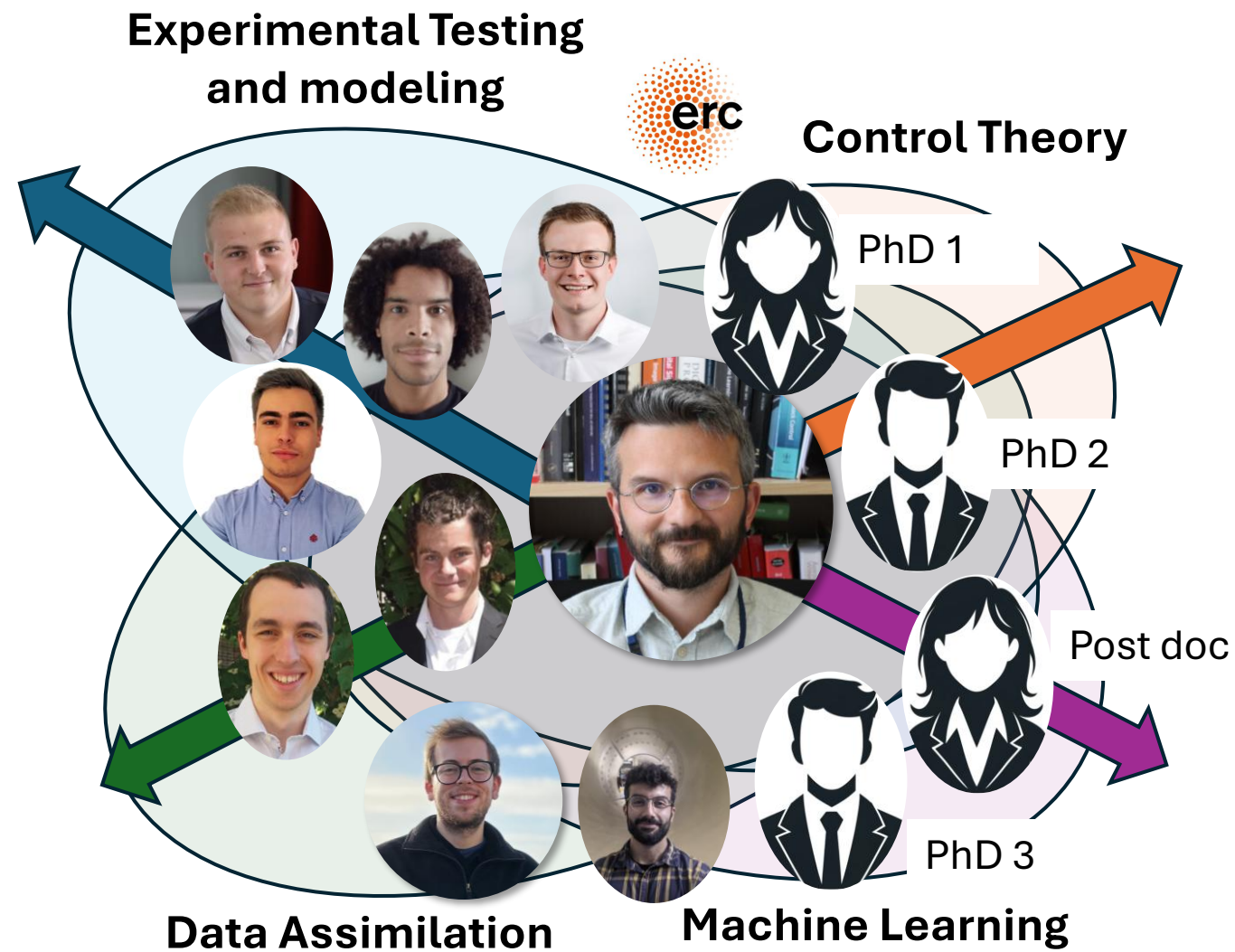
**PhD Defended in 2018, applied
in 2023 (5 years after)**



Main Challenges



**Multidisciplinary
and
broad-spectrum**

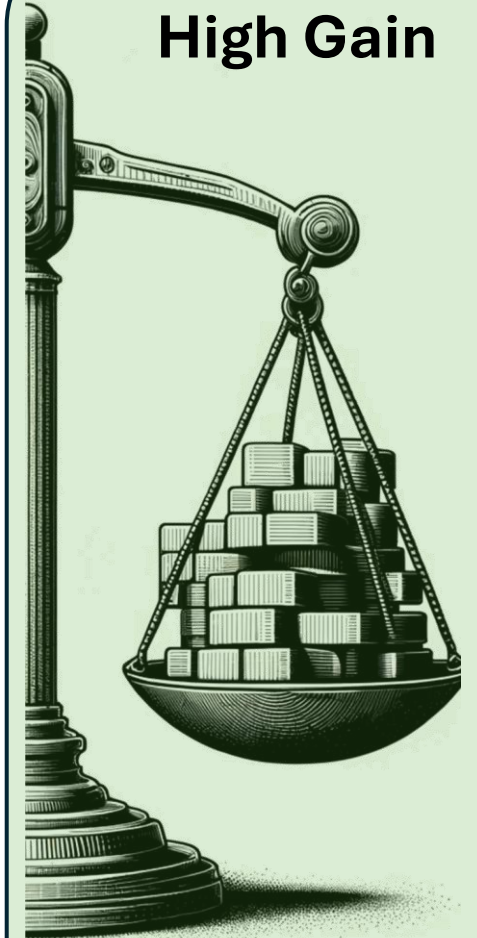


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High Gain



**Self learning,
intelligent
systems in energy
engineering**

The ERC Proposal: Bold, Feasible, and **Yours**



1. **Timing and Approach.** Started writing in June 2023 (submission → 07 November 2023)

It's an iterative process (I wrote about 20 versions of B1...!) B1 -> B2 -> B1

Think of B1 as a grant + a TED talk + a manifesto --> Why this problem? Why now ? Why you ?

Think of B2 as a blueprint + a stress test + a trust-building exercise

2. **Pick the right panel** : in my case PE8 (Products and Processes Engineering) even if there was a lot of overlap with PE6 (Computer Science and Informatics).

In which panel will the core ambition of my proposal be most clearly understood and appreciated — even if some technical parts fall outside their expertise?

3. **To what extent is this a continuation of your previous work ?**

- Showing that your past work **enabled** this new direction (gave you tools, insights, credibility).
- Making it clear that the **new questions you're asking couldn't have been asked before** — even by you.
- Demonstrating that you are now **staking out new territory**, not just extending a previous line.

“What is genuinely new in this proposal — in its ambition, questions, or methods — that I have never attempted before, even though I’m uniquely positioned to try it now?”

The ERC Proposal: Bold, Feasible, and **Yours** (2)



4. Groundbreaking vs feasible

- Showing **preliminary results** or **proof-of-concept steps** that suggest feasibility.
- Breaking the big goal into **clear, testable milestones** or fallback plans.
- Be bold but not vague. Be authentic: what do you are deeply about? **enthusiasm is contagious!**

“If I were reviewing this, would I believe that this ambitious goal has at least one credible path to success — and that failure would still be scientifically valuable?”

5. The emotional roller-coaster

- **Get feedback** → but remember that friends can be your worst allies. **Criticism helps more than encouragement.**
- **Expect self-doubt.** You will often feel the idea is not bold enough or too crazy. That’s a sign you’re in the right zone.
- **Take breaks** — clarity often comes when you step away.

Whether you get the grant or not, you’ll come out stronger, clearer, and more ambitious than when you started — and that’s already a win.

Go for it. It’s hard....but it’s worth it!