



**POLITECNICO**  
MILANO 1863

DIPARTIMENTO DI SCIENZE  
E TECNOLOGIE AEROSPAZIALI

# CFD e flussi nasali

---

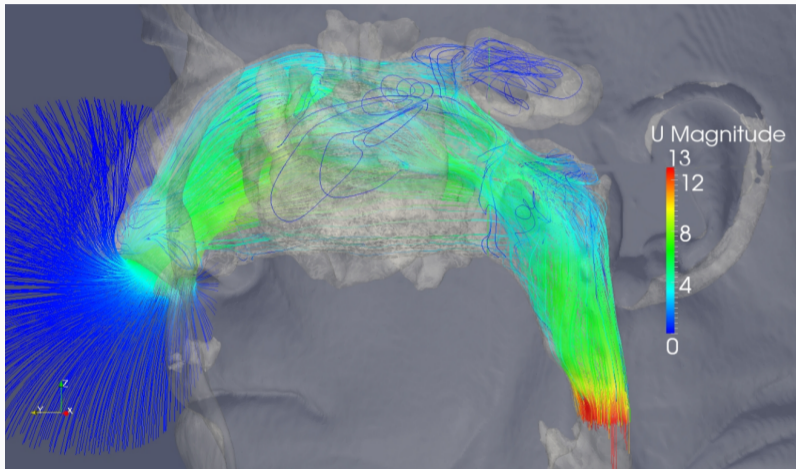
Maurizio Quadrio

GLO, Milano, 23 marzo 2019

# Introduzione

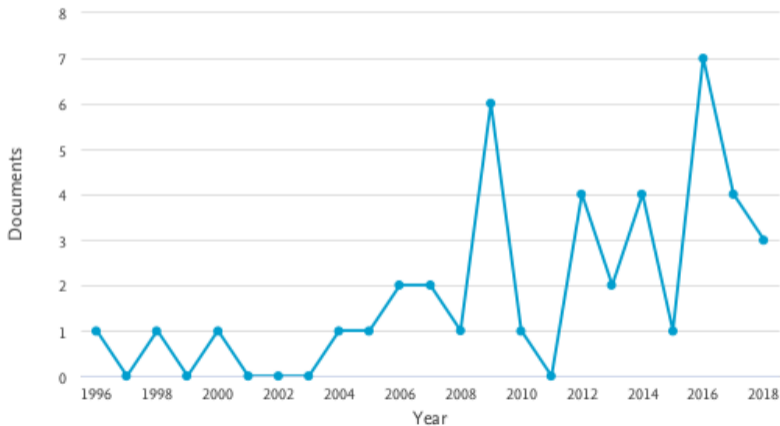
---

# Un tipico risultato CFD (e 3 messaggi)



Scopus query: title, +"CFD", +"nasal"

Documents by year

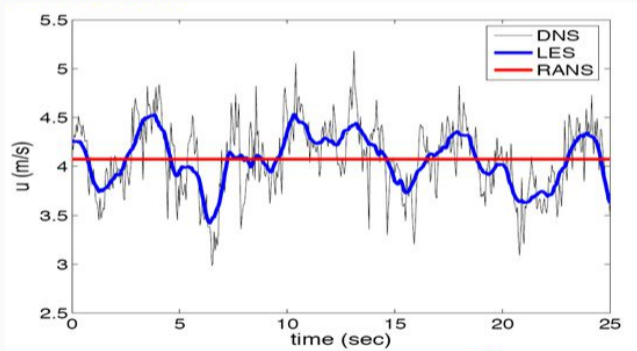


Key word 1: Accuratezza

---

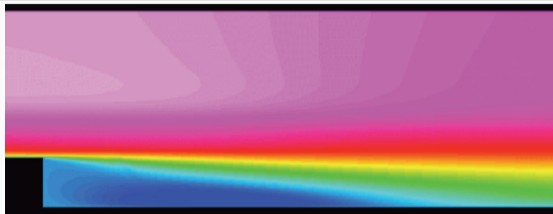
# Dalla RANS alla DNS

Differenza fra CFD **elementare**, **più informativa** e **completa**

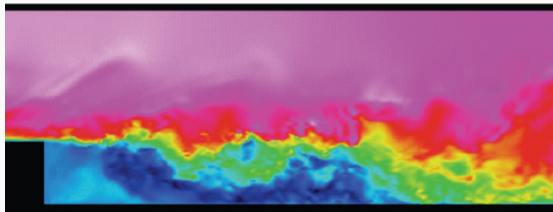


# Differenze informative!

"CFD"

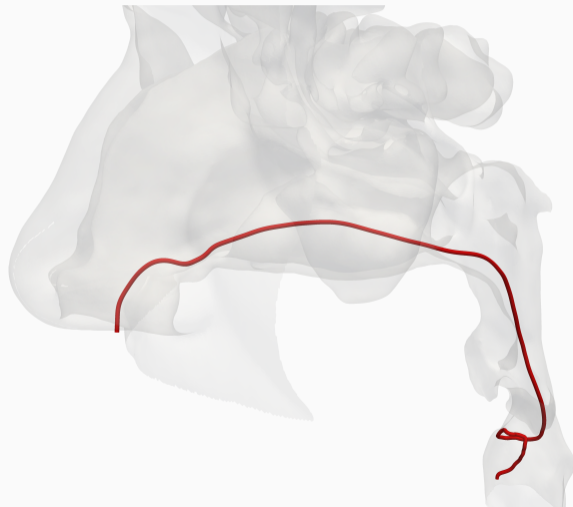


Fluidodinamica  
"vera"



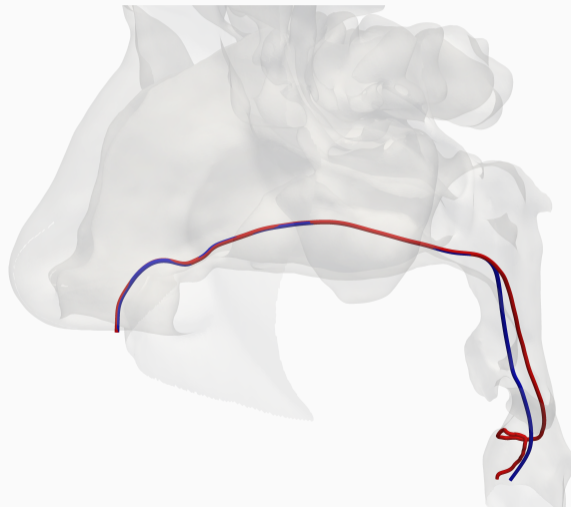
## Flusso nasale: differenze (1)

DNS istantanea



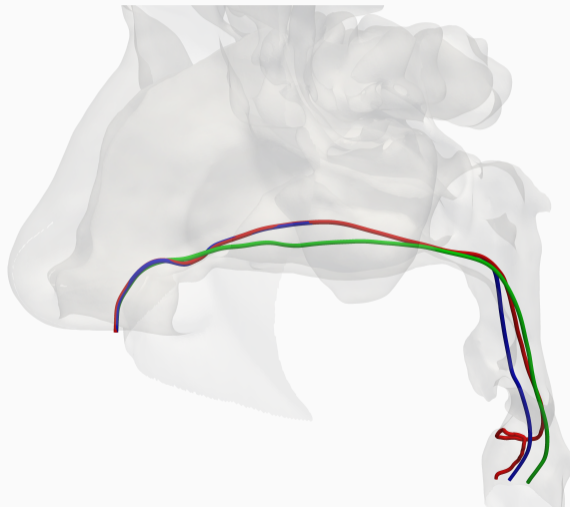
## Flusso nasale: differenze (1)

DNS istantanea + media

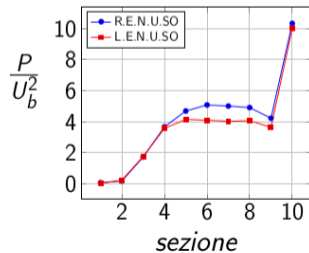
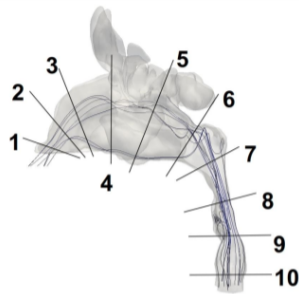
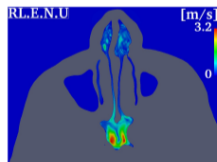
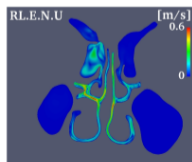
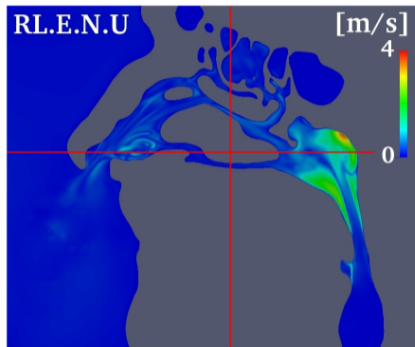


# Flusso nasale: differenze (1)

DNS istantanea + media + RANS

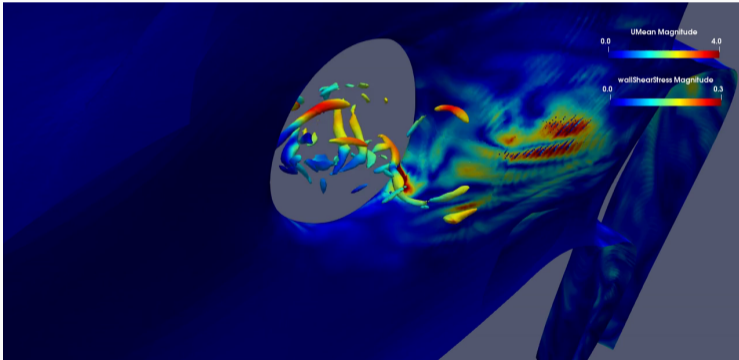


## Flusso nasale: differenze (2)



# Flusso nasale patologico: differenze importanti!

- ENS → Pipolo
- Perforazione settale



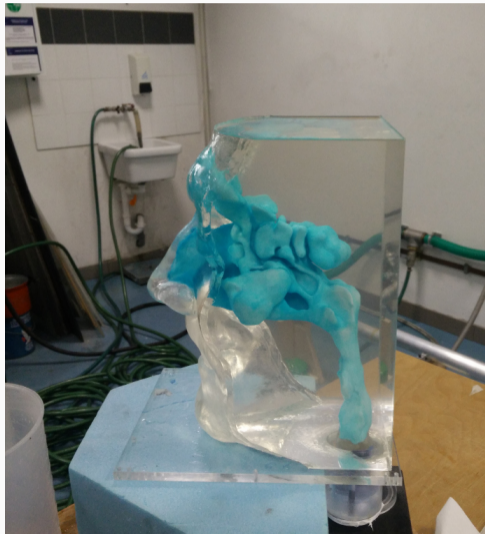
Key word 2: Validazione

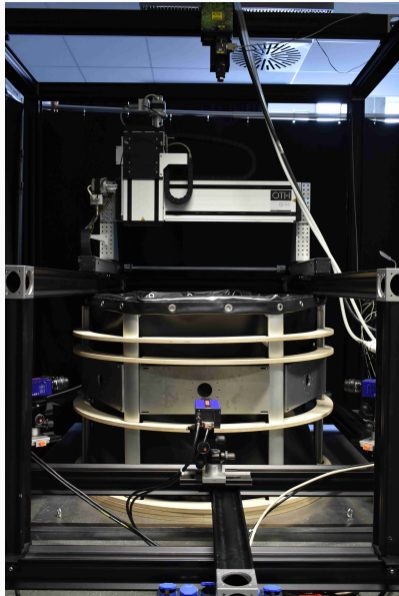
---

## Limite oggi più importante

- Scelte modellistiche non univoche
- Mancanza di metrica condivisa
- Anatomie *patient-specific*
- Fondamentale anche per approccio statistico (UQ)
- Necessaria per certificazione

Un **benchmark aperto** per validare strumenti CFD





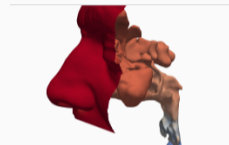
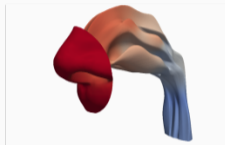
→ Pipolo

CFD :

RANS

LES

DNS



ANATOMY :

CAD

SYNTHETIC

REAL CT

200

200

5000

ML :

HAND-CRAFTED FEATURES

DEEP LEARNING

- Diagnostica del futuro per ENT
- TAC → forma ma CFD → funzione
- Necessari strumenti di qualità e utilizzo consapevole
- Impatto sulla clinica ormai imminente