

Finite Element Analysis of Accelerating Projectile Inside Vacuum Bazooka

Amir Shakouri, PhD

Nanyang Technological University

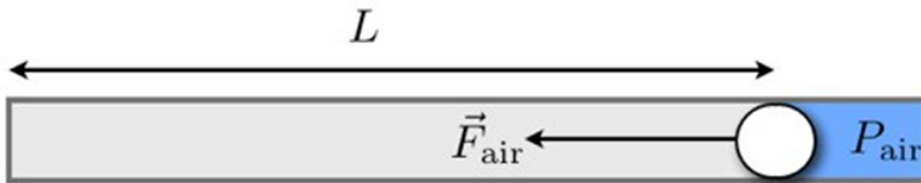


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2017 SINGAPORE

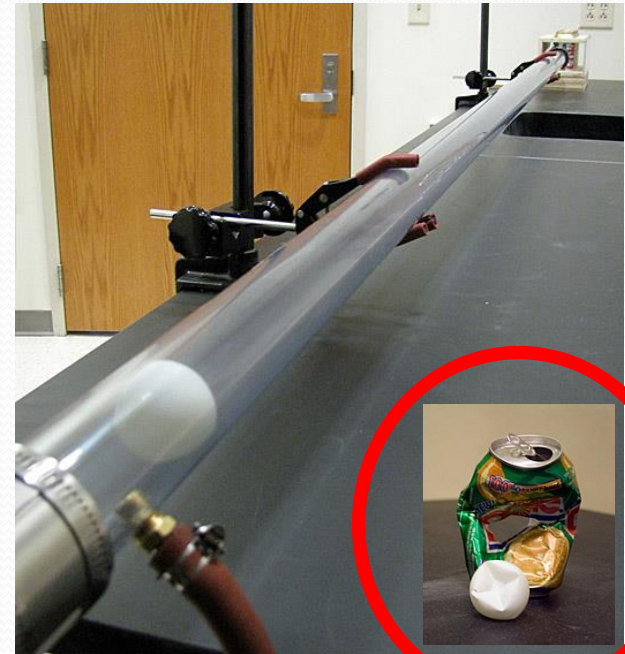
About:

- Myself & My Institute, SPMS NTU:
 - In-house FEM application consultancy
 - Education
 - Making & Tinkering Lab: Student project targeting interesting physics: Helium-filled flying objects, Tesla Valve, **Vacuum Bazooka**, Curie Engine, etc.
- COMSOL®
 - Understanding interplay of different physics involved
 - Academic oriented:
 - Online resources e.g. “Blog”, “Application Gallery”, etc.
 - Transparent software structure
 - +/- Module-based

Background:

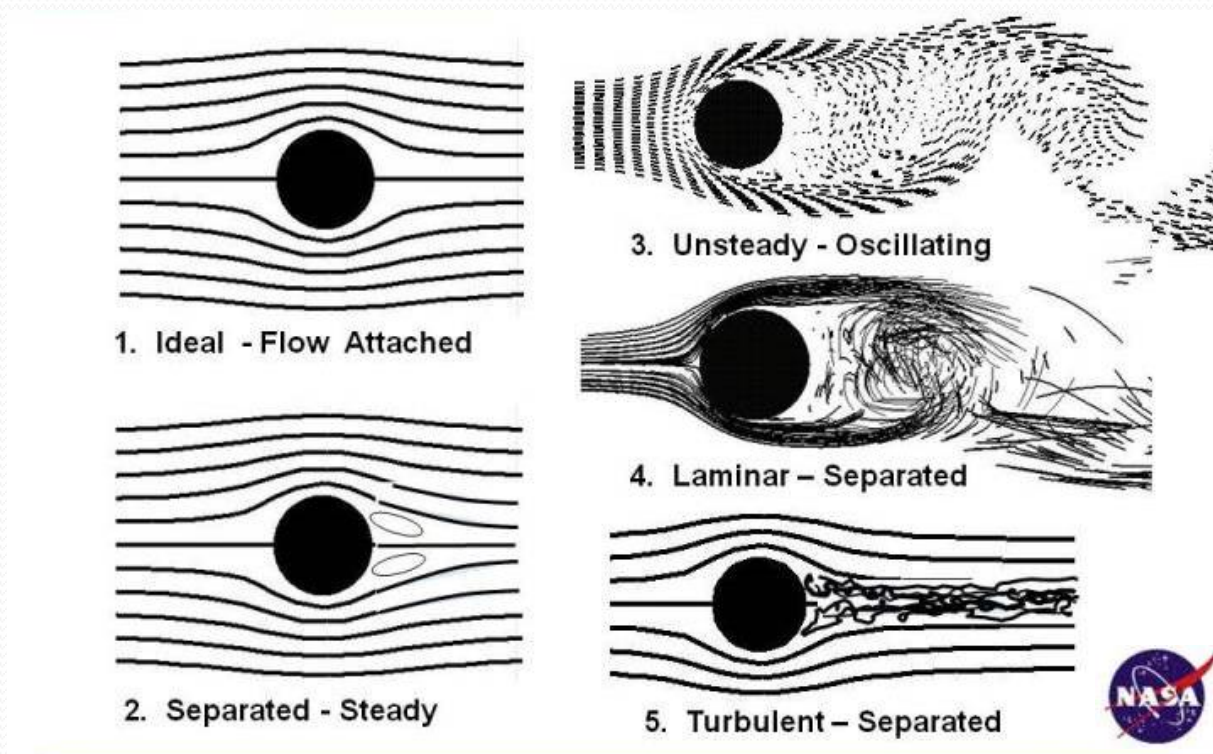


Whole-length accelerating ?!
Perfect fitting?!



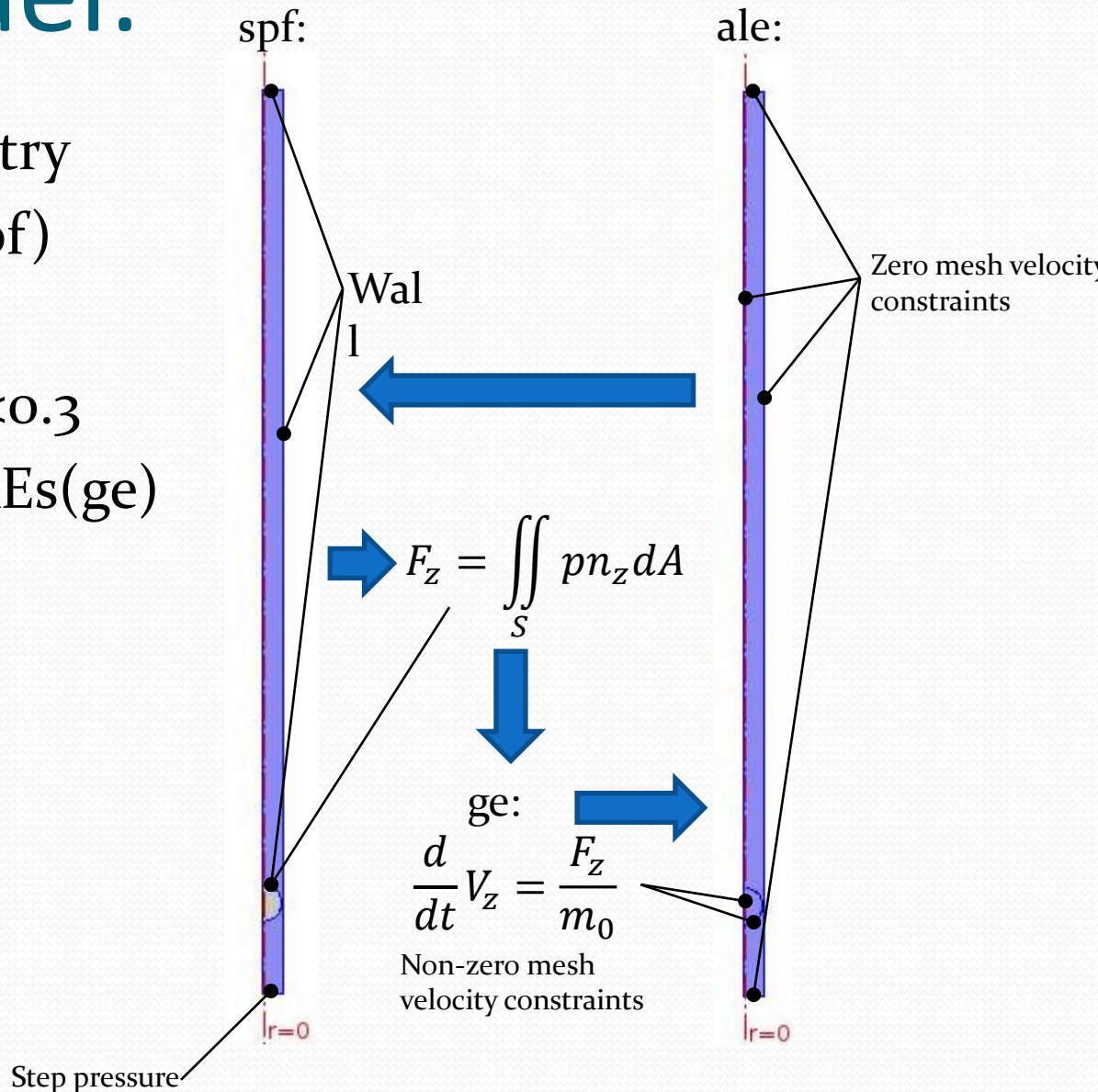
Background:

Within laminar regime drag can be significantly reduced if flow separation (due to adverse pressure) is avoided



FEM Model:

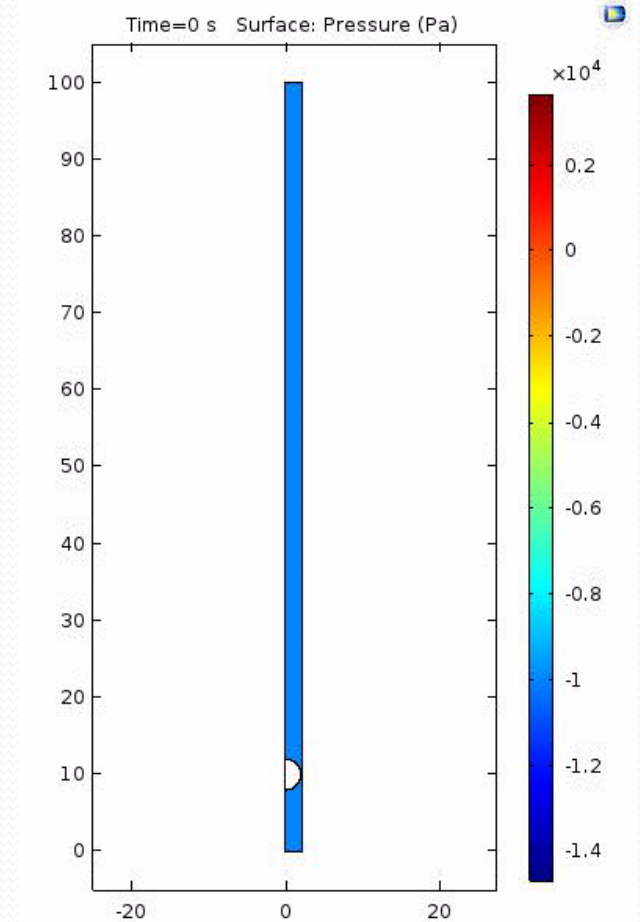
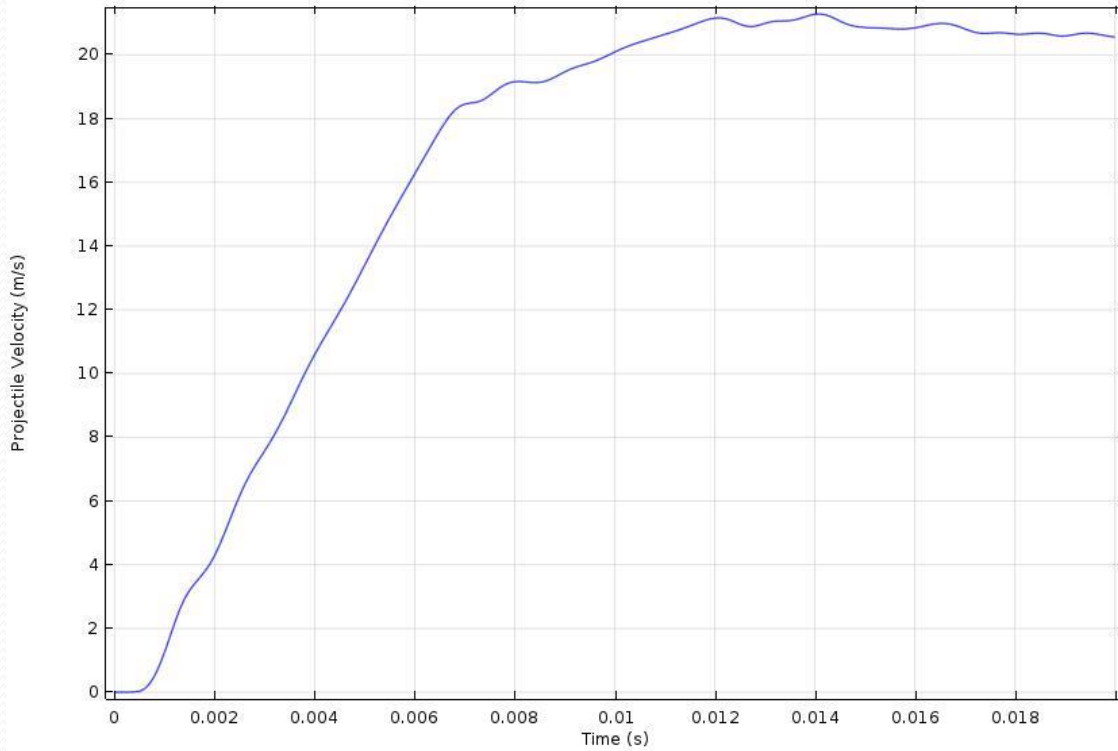
- Axisymmetric geometry
- Single-phase flow (spf)
 - Laminar
 - Compressible $Ma < 0.3$
- Global ODEs and DAEs (ge)
- Moving Mesh (ale)



Model Parameters:

- Ping-Pong ball: 2.7 g, 40 mm diameter
- Vacuum pressure: 10 kPa
- 1 mm gap
- 1 ms pressure step transition

Results:



Conclusion:

- This is a dynamic problem involving both wave propagation and diffusion
- The diffused air through the gap and the interference between the incoming and reflected waves diminishes the pressure difference
- The projectile is being accelerated while pressure difference exists
- By decreasing the step transition, higher rates of accelerating can be achieved (but for studying higher velocity higher Ma flow should be studied)