Cryovolcano model and Autonomy challenges

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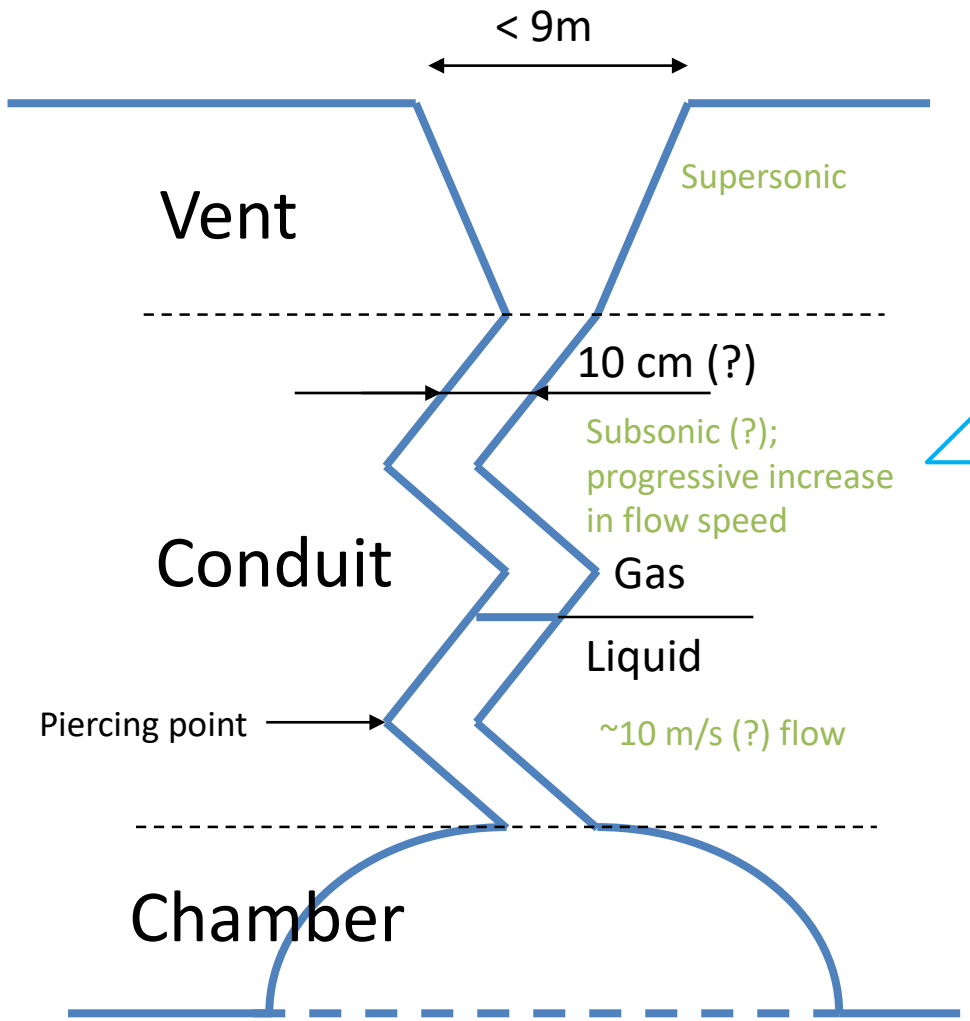
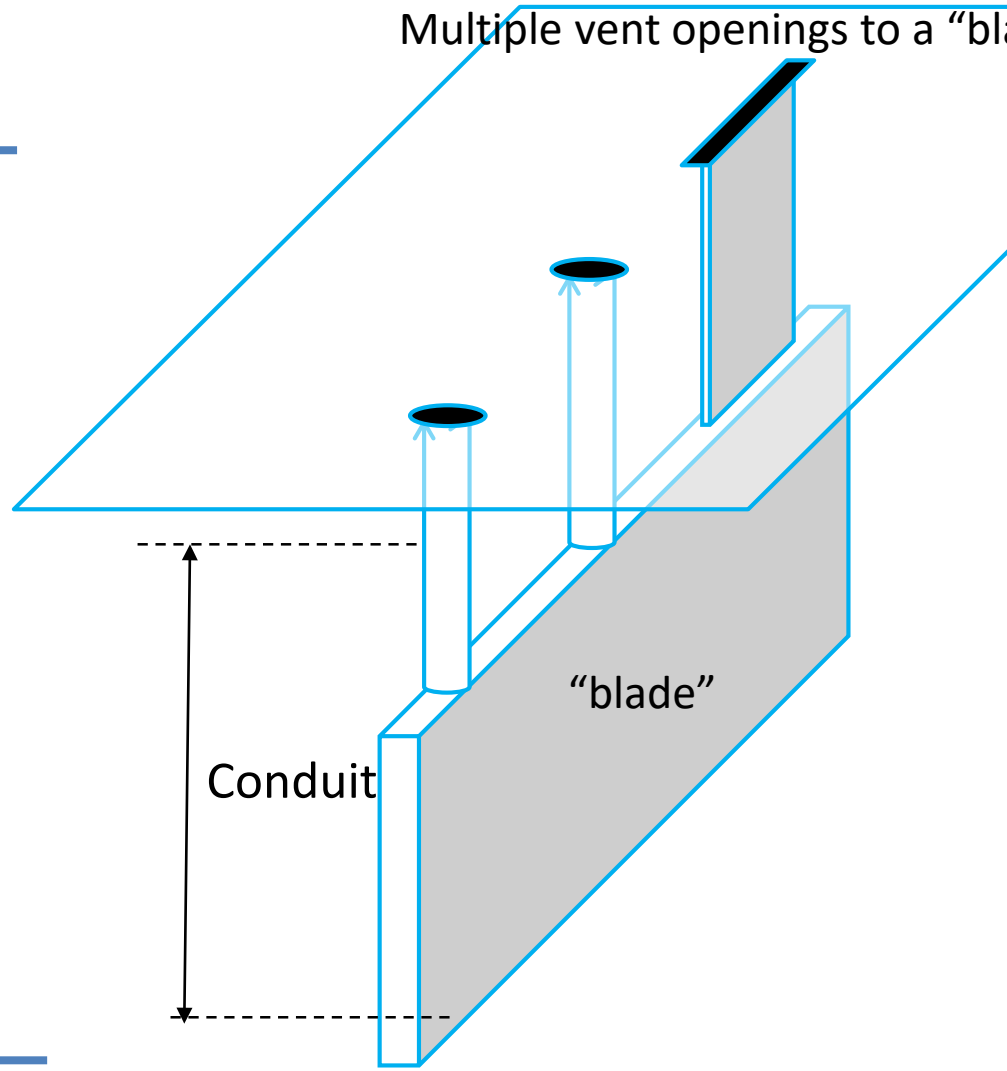
Cryovolcano model





Chamber may or may not connected to the ocean

Cryovolcano model

- Some vents could be closed by rocks
  - Open vent can be identified by mass flux
- Conduit could be straight, zig-zag or winding, but not branching (at most two branches)
  - Typically NOT vertical
- Conduit width is not constant
  - Wide part of conduit can be remotely identified by a greater mass flux
- Dynamic changes in vent
  - Vent could open more but not close
  - Sudden, abrupt changes in fluid mechanical conditions in the subsonic region (pressure, flow velocity)

Technical ideas

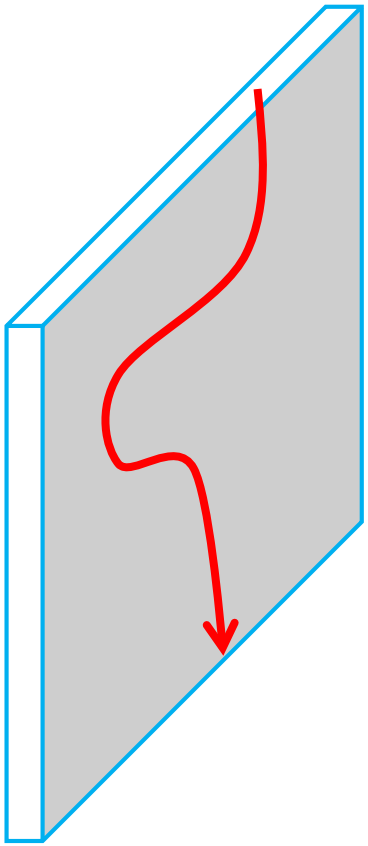
- Multi-robot systems exploring multiple vents and/or multiple places simultaneously
- Wi-Fi through the conduit?
  - The width of conduit is similar to the wave length of Wi-Fi. Conduit could work as an optic cable

Autonomy challenge 1

- Choosing the right vent to get in
  - Open vents = greater mass flux
  - Could be identified by orbital reconnaissance, but would require orbiter instead of flybys
  - Limited lifetime of the robot could be a strong driver for on-board decision making
    - Strong radiation would not allow robot to stay on the surface for an extensive time period
    - Very limited communication
    - Battery driven robot

Autonomy Challenge 2

- Path planning in conduit
  - Choosing the wide part of conduit
  - No global map available - robot's line of sight is extremely limited
    - Exploration vs exploitation
      - Exploration: first move horizontally to find the widest opening of conduit
      - Exploitation: Go down the widest known opening
  - The width of conduit below can be guessed by measuring the mass flux

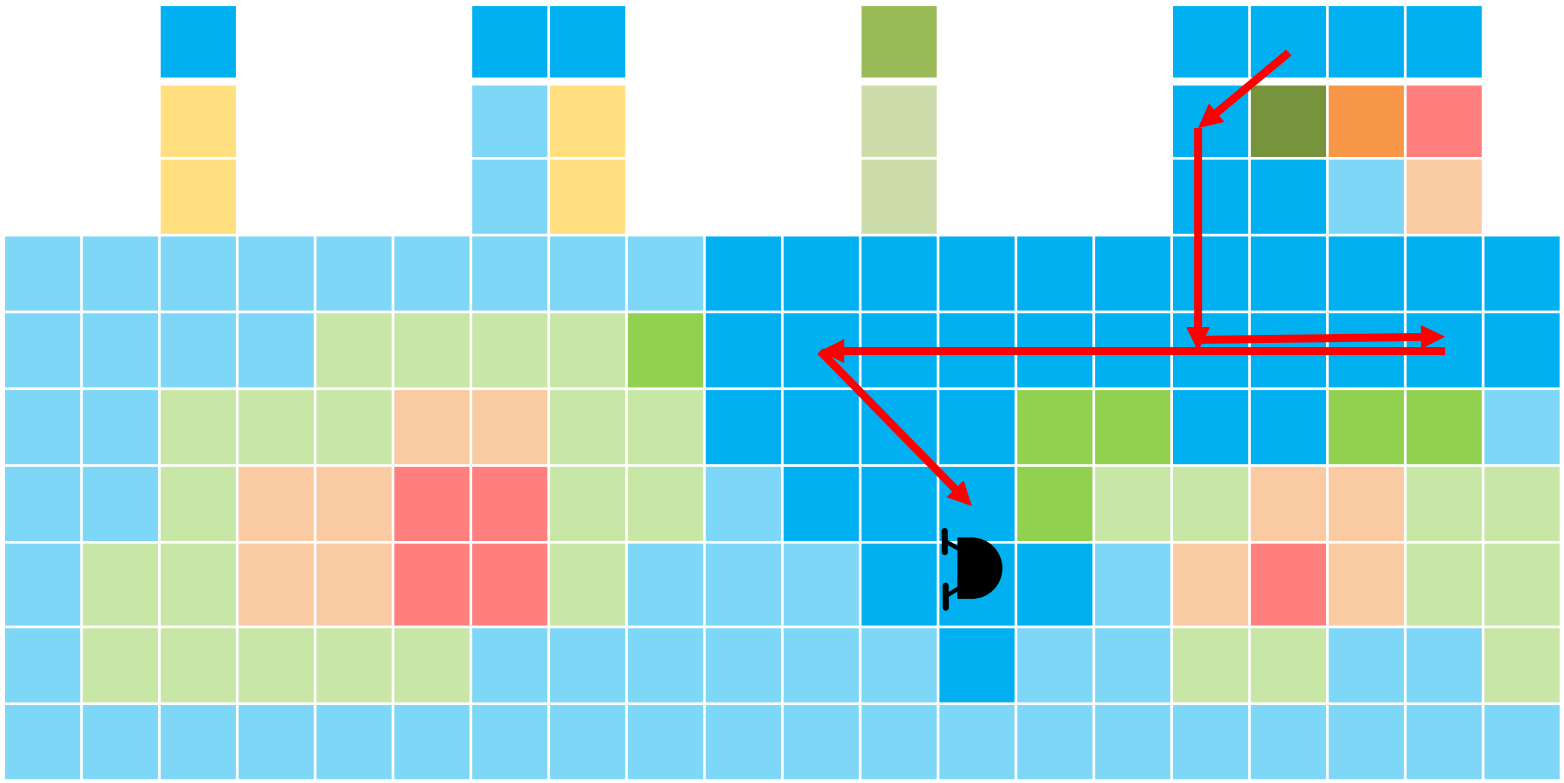


Autonomy Challenge 3

- Resilience against the abrupt change in flow speed/density/dynamic pressure
  - Dynamically changes in time and place
  - Hard to sense a priori
  - Flow speed within the line of sight could be measured by Doppler (with particles in the flow)
  - Idea: switch the mobility mode (slow and strongly attached v.s. fast and weakly attached)

Simulator 1

- 2D sim
  - X along the length of blade, z vertical
  - Similar to DEM – each grid has the width value
  - Example below
    - Color = width
    - Transparency = explored or not



Simulator 2

- 3D sim
  - Imports .obj file from VolcanoBot
  - Useful for Ravi's Gaussian karnel interpolation