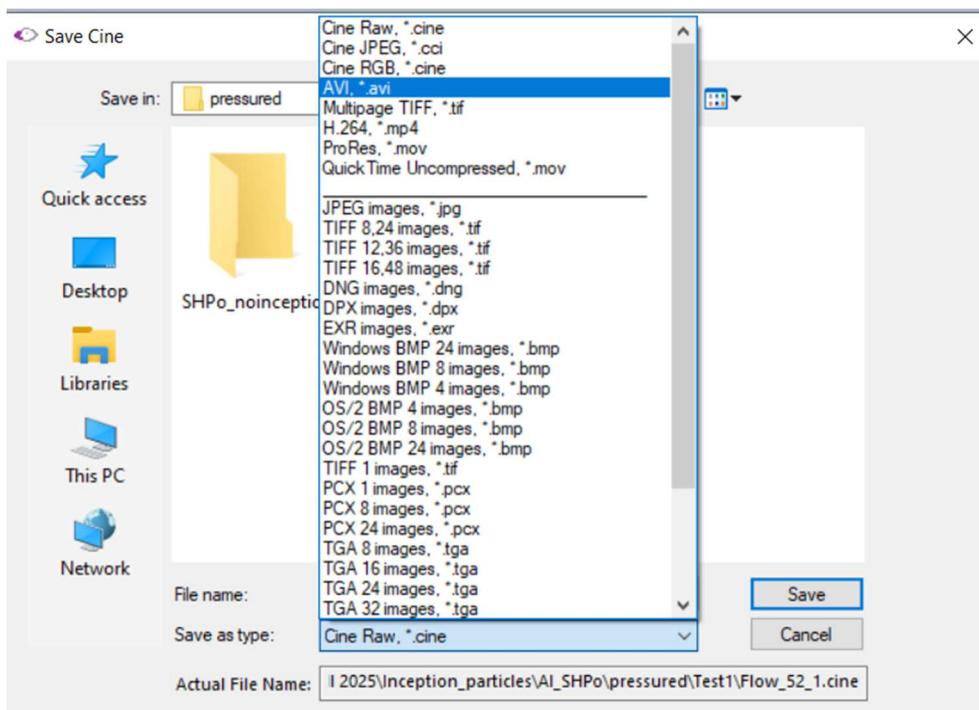


# HOW TO USE ARC FOR OPTICAL FLOW ANALYSIS (USING MATLAB)

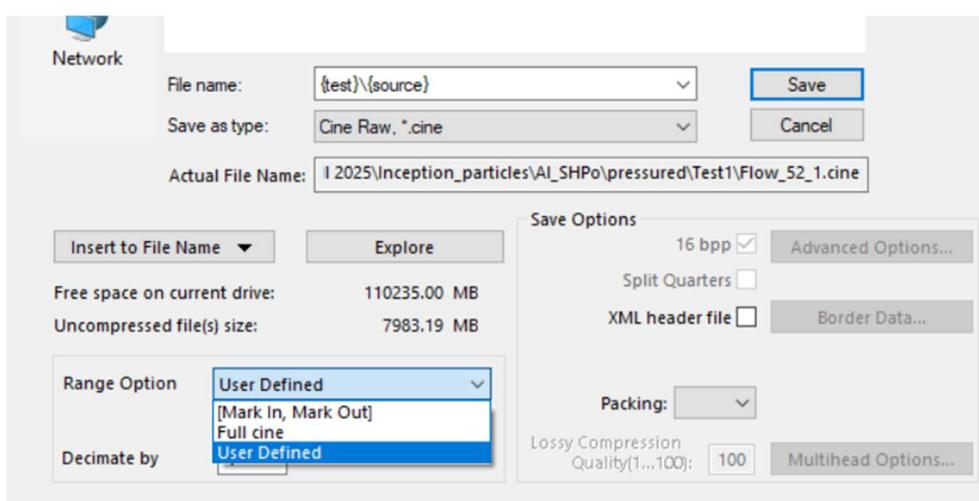
- SWATHIGA DEVI CHANDRASEKARAN

## STEP 1 - VIDEOS

- 1) Save all the videos from phantom camera software as .avi file. You can open the saved cine file in camera software, choose Save as (.avi) file.



- 2) You can manually alter the number of frames to be saved.



**Great! You have the right video format.**

## STEP 2 – MATLAB CODE

To run the analysis, make sure to have all these MATLAB codes and the script for ARC.

raftmatlasideview_sanjay	13-11-2025 15:38	MATLAB Code	18 KB
ROI_and_throatloader	13-11-2025 15:38	MATLAB Code	3 KB
testraft	13-11-2025 15:38	Shell Script	2 KB
timeaveragedvelmagnitude	13-11-2025 15:38	MATLAB Code	8 KB
Velocity_profile_comparison	18-11-2025 11:41	MATLAB Code	8 KB

### Run this code - ROI and throatloader code ???

- You can run this code in MATLAB (laptop/computer, not ARC).
- When you run this code, it will ask you to select a video file.
- Select the .avi file you want to analyze.
- Now, the interactive session will ask you to select the Region of Interest (ROI). Select the region you wish to analyze (ex: Neglecting Venturi). Double-tap.
- Now, it will ask you to select the throat. Mark the throat, press Enter.
- Two .mat files will be saved in the same folder as the input file.

**Cool! You have ROI and throat data.**

## STEP 3 – WHAT IS ARC? HOW TO USE IT?

Using MATLAB on your laptop works, but it takes so much time to process. To make the process quicker, we are using ARC (Advanced Research Computing) VT. To access ARC VT

- 1) You need to create an account using your VT email ID. Also, the Professor should add you to the cavitation project in ARC. Once your account is created, you will get an email like this →

Advanced Research Computing Account Created [Summarize](#)

Your account on the ARC clusters has been created. Please follow the instructions below. You can review the [ARC documentation website](#) for additional information. If you have any issues please open a ticket at [Help](#) or drop by [office hours](#).

**1. Setting up VT VPN when off-campus:**

You need to establish a VPN connection when off-campus to access the clusters. Information on installing and using the VT VPN is available on the [VT VPN website](#).

**2. Accessing the clusters:**

Option 1) Web interface via Open OnDemand:

Go to <https://ood.arc.vt.edu> to access the clusters through a web interface providing a graphical user interface for the most commonly used applications including Matlab, RStudio, Sage, Jupyter, VS Code.

Option 2) SSH and SFTP access:

Access to the clusters is facilitated through Secure Shell (SSH) and Secure File Transfer (SFTP) clients. Windows, MacOS, and Linux users can utilize these commands via their terminal. You may also use FileZilla for SFTP file transfers.

Connect to the clusters using your VT username and password. For command-line SSH clients, log in with:

```
ssh yourVTusername@clusterLoginNode
```

Cluster	Login Nodes (use any)
TinkerCliffs	tinkercliffs1.arc.vt.edu or tinkercliffs2.arc.vt.edu
Owl	owl1.arc.vt.edu or owl2.arc.vt.edu or owl3.arc.vt.edu
Falcon	falcon1.arc.vt.edu or falcon2.arc.vt.edu

- 2) ARC cannot be accessed without VPN outside the campus. So, if you intend to use it off campus, download VT VPN (Ivanti), as mentioned in the email.
- 3) To access the clusters (ARC), use <https://ood.arc.vt.edu>. When you go to this link, you will see this →

The screenshot shows the ARC Open OnDemand interface. At the top, there's a navigation bar with links for Help, Log in, and Log Out. Below the navigation bar is the Virginia Tech logo and the "OPEN OnDemand" branding. The main area displays a 2x4 grid of application icons. Each icon has a blue border and a small description below it:

- Jupyter
- RStudio
- VS Code
- Large Language Model
- 3D Slicer
- IGV
- QGIS
- Ansys

- 4) You will have your own directory with your name once the account is created. Click Files to see the documents in your directory. You can upload and download the files you want to work with in your directory.

The screenshot shows the ARC Open OnDemand interface with the 'Files' tab selected. At the top, there's a navigation bar with links for Help, Log in, and Log Out. Below the navigation bar is a toolbar with various file operations: Open in Terminal, Refresh, New File, New Directory, Upload, Download, Copy/Move, and Delete. The main area is a file browser showing a list of files in the directory '/home/swathigadevc/SanjayCode\_New'. The files listed are:

- raftmatlabsideview\_sanjay
- testraft
- timeaveragedvelmagnitude
- Velocity\_profile\_comparison

Below the file list are several filter options: Show Owner/Mode, Show Dotfiles, Filter:, and a note indicating 'Showing 50 rows - 10 rows selected'.

## STEP 4 – USING ARC FOR OUR ANALYSIS

- 1) Upload these code files to your directory. These are common for all test runs.

	raftmatlabsideview_sanjay	13-11-2025 15:38	MATLAB Code	18 KB
	testraft	13-11-2025 15:38	Shell Script	2 KB
	timeaveragedvelmagnitude	13-11-2025 15:38	MATLAB Code	8 KB
	Velocity_profile_comparison	18-11-2025 11:41	MATLAB Code	8 KB

- 2) Upload the video (.avi file) to be analyzed in ARC
- 3) Also, upload the output .mat files from the ROI and throatloader code for each case.

**Example:** For a video file named: AI\_noinception.avi. The ROI and throat data would look like this →

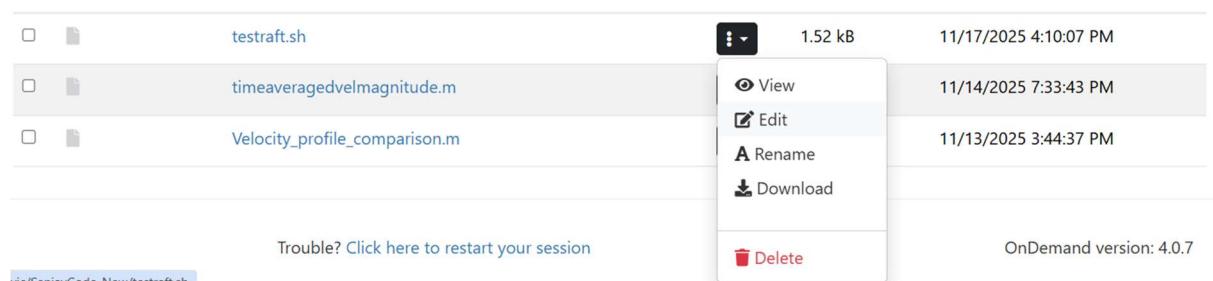
 AI_noinception_ROI	16-11-2025 15:33	MATLAB Data	5 KB
 AI_noinception_throat	16-11-2025 15:33	MATLAB Data	1 KB

- 4) Now, you have the ROI data, throat location data, and the MATLAB codes to run on the ARC.

## WHAT TO BE MODIFIED FOR EACH TEST CASE?

### 1) testraft.sh

This is a script given to the ARC to run the job. For each test case, the file name should be modified. To edit the file, choose the three dots, click edit.



The screenshot shows a file list with the following entries:

- testraft.sh (1.52 kB, 11/17/2025 4:10:07 PM)
- timeaveragedvelmagnitude.m (11/14/2025 7:33:43 PM)
- Velocity\_profile\_comparison.m (11/13/2025 3:44:37 PM)

A context menu is open over the 'testraft.sh' entry, showing options: View, Edit (highlighted with a blue border), Rename, Download, and Delete. At the bottom of the screen, there is a message: "Trouble? Click here to restart your session" and "OnDemand version: 4.0.7".

In here,

- Change the email ID (**Line 13**) to yours. This will notify you about the start and end of each job.

```

1 #!/bin/bash
2 #SBATCH --output=RAFT_SideView_%j.out
3 #SBATCH --error=RAFT_SideView_%j.err
4 #SBATCH --time=08:00:00
5 #SBATCH --account=cavitation
6 #SBATCH --nodes=1
7 #SBATCH --ntasks=1
8 #SBATCH --cpus-per-task=48
9 #SBATCH --gres=gpu:2
10 #SBATCH --mem=380G
11 #SBATCH --partition=l40s_normal_q
12 #SBATCH --mail-type=BEGIN,END,FAIL
13 #SBATCH --mail-user=swathigadevic@vt.edu
14 #SBATCH --job-name=Cavitation
15
16 module reset
17 module load MATLAB
..
```

- Change the directory (**Line 35**)

```

22 echo "=====
23 echo " SLURM Job ID:      $SLURM_JOB_ID"
24 echo " Node:              $HOSTNAME"
25 echo " Submitted from:    $SLURM_SUBMIT_DIR"
26 echo " Start time:        $(date)"
27 echo "====="
28
29 # GPU monitoring (every 300 seconds)
30 nvidia-smi --query-gpu=timestamp,name,pci.bus_id,driver_version,temperature.gpu,utilization.gpu,utilization.memory,memory.free,memory.used
31
32 # -----
33 # Launch MATLAB (non-interactive batch mode)
34 #
35 matlab -nodisplay -nosplash -nodesktop -batch "run('/home/swathigadevic/SanjayCode_New/raftmatlasideview_sanjay.m')"

```

→ Save it.

## 2) raftmatlasideview\_sanjay

Similarly, edit this code as well.

→ Change the file path (**Line 21**)

```

1 %% -----
2 % Optical Flow RAFT + ROI (roiPoly) + Calibrated Velocity in m/s
3 % Time-averaged velocity + vertical profiles with axes in mm (origin at lower-left)
4 %
5 clear all; clc; close all;
6
7 % --- Load your personal toolbox path safely ---
8 userPathFile = fullfile(getenv('HOME'), 'matlab', 'pathdef.m');
9 if isfile(userPathFile)
10     addpath(genpath(fileparts(userPathFile))); % add folder containing pathdef.m
11     run(userPathFile); % execute your saved pathdef.m
12     fprintf('Loaded custom MATLAB path: %s\n', userPathFile);
13 else
14     warning('Custom pathdef.m not found. Using default MATLAB path.');
15 end
16
17
18 try
19     %% --- Specify video path ---
20     videoPath = '/home/swathigadevic/SanjayCode_New/CB_noInception.avi'; % <- Adjust if needed
21     [filepath, filename, ~] = fileparts(char(videoPath));
22
23     if ~isfile(videoPath)
24         error('Video file not found at: %s', videoPath);
25     end
26
27     v = VideoReader(videoPath);
28     fprintf('Loaded video: %s\n', filename);

```

→ Change the mm/pixel (Line 32) and fps (Line 33), if needed (Based on your case)

```

27 v = VideoReader(videoPath);
28 fprintf('Loaded video: %s\n', filename);
29
30 %% --- Calibration parameters ---
31 mm_per_pixel = 0.00388514345; % [mm/pixel]
32 fps          = 110000;          % [frames per second]
33 m_per_pixel  = mm_per_pixel / 1000; % [m/pixel]
34 fprintf('Calibration: %.9f m/pixel | Frame rate: %.1f fps\n', m_per_pixel, fps);
35
36 %% -----
37 % Load existing ROI mask if available, else select and save a new one
38 %
39 fprintf('Checking for existing ROI...\\n');
40 roiFile = fullfile(filepath, [filename '_ROI.mat']); % Default ROI filename
41
42

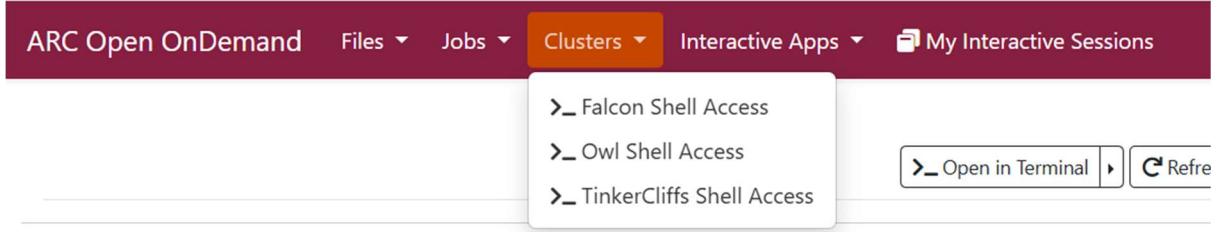
```

→ Save it.

**All set for analysis now!**

## STEP 5 – SUBMITTING A JOB IN ARC

- 1) To run the analysis, click Clusters → Falcon Shell Access.



ARC Open OnDemand    Files ▾    Jobs ▾    Clusters ▾    Interactive Apps ▾    My Interactive Sessions

Falcon Shell Access  
Owl Shell Access  
TinkerCliffs Shell Access

Open in Terminal    Refresh

```
Host: falcon1.arc.vt.edu

+-----+
| This computer is the property of Virginia Polytechnic Institute and State
| University. Use of this equipment implies agreement to the university
| Acceptable Use Policy (Policy 7000). For more information, please visit:
| https://vt.edu/acceptable-use.html
+-----+
+-----+
| By accessing and using this system, you acknowledge and agree to comply with
| all applicable institutional policies, terms of service, and usage
| guidelines. This system provides access to a wide range of software, each of
| which is subject to its own license agreements and terms of use. By using
| any software or service available on this system, you accept and agree to
| the terms and conditions set forth by the respective software providers and
| licensors. Unauthorized use of this system is strictly prohibited. All
| activity may be monitored and recorded to ensure compliance with
| institutional policies and applicable laws. If you do not agree to these
| terms, you must disconnect immediately.
+-----+
+-----+
| NOTE: VT Enterprise Directory Password authentication requires a DUO second
| factor challenge. After your password is provided, you will receive a
| DUO challenge.
+-----+

Last login: Mon Nov 17 16:53:18 2025 from 2607:b400:9a:0:2:a0b9:c652:f918
[swathigadevic@falcon1 ~]$
```

This will show your directory (/home/yourname). Make sure your videos and codes are in this directory.

→ Type **sbatch testraft.sh**, click enter

```

+-----+
| NOTE: VT Enterprise Directory Password authentication requires a DUO second |
| factor challenge. After your password is provided, you will receive a |
| DUO challenge. |
+-----+
Last login: Mon Nov 17 16:53:18 2025 from 2607:b400:9a:0:2:a0b9:c652:f918
[swathigadevic@falcon1 ~]$ sbatch testraft.sh

```

→ It will show submitted batch job, if successful. You will get an email once the job starts.

### Submitted batch job 124194

→ To check the status of the job, type **squeue** (After successful submission)

JOBID	PARTITION	NAME	USER	ST	TIME	NODES	NODELIST(REAON)
124194	l40s_norm	Cavitation	swathiga	PD	0:00	1	(Priority)

- ST – PD means Pending, hasn't started yet
- ST – R means Running. You will see the time taken for each analysis.
- Once the job is completed, you will receive an email stating "job ended".
- To cancel a job, type **scancel "JOB ID"**

**scancel 124194**

### STEP 6 – OUTPUTS??

<input type="checkbox"/>		AI_noinception_ThroatProfiles.mat		703.58 MB
<input type="checkbox"/>		AI_noinception_TimeAvgVelField.mat		2.90 MB
<input type="checkbox"/>		AI_noinception_TimeAvgVelMag.png		56.69 kB
<input type="checkbox"/>		AI_noinception_VelField_200to300.gif		2.68 MB
<input type="checkbox"/>		AI_noinception_velocity.mat		49.93 GB
<input type="checkbox"/>		AI_noinception_VelProfiles.png		66.68 kB

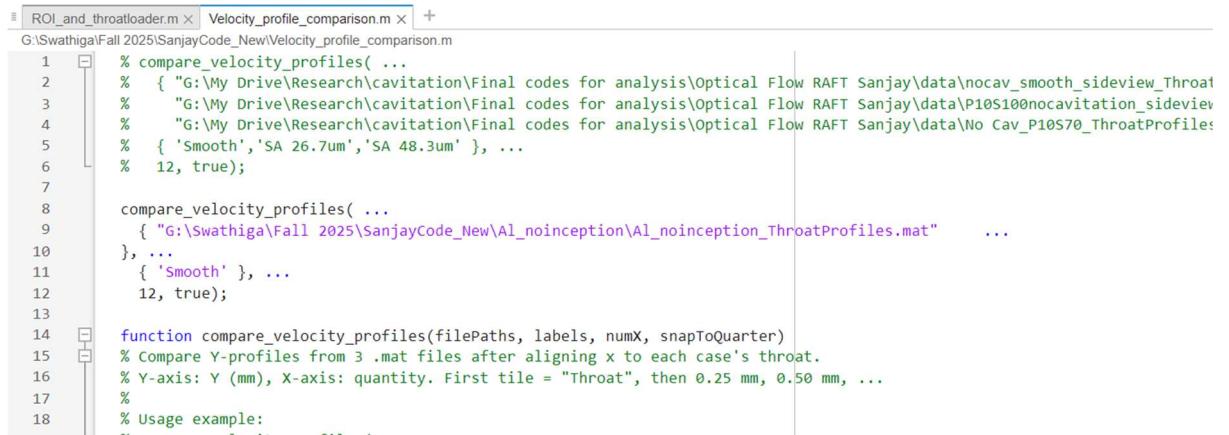
You will be able to see (for reference)

- Time-averaged velocity magnitude plot (.png file) for your case
- Velocity field for 200-300 frames (gif file)
- Velocity profiles (.png)

For further analysis across all frames, you can use →

- 1) ThroatProfiles.mat – You can download this .mat file and run it on your laptop/computer. This gives you the velocity profiles at respective locations from the throat.

→ Run the data in this code – **Velocity\_profile\_comparison**



```

1 % compare_velocity_profiles( ...
2 % { "G:\My Drive\Research\cavitation\Final codes for analysis\Optical Flow RAFT Sanjay\data\nocav_smooth_sideview_Throat
3 % "G:\My Drive\Research\cavitation\Final codes for analysis\Optical Flow RAFT Sanjay\data\P10S100nocavitation_sideview
4 % { "G:\My Drive\Research\cavitation\Final codes for analysis\Optical Flow RAFT Sanjay\data\No Cav_P10S70_ThroatProfiles
5 % { 'Smooth','SA 26.7um','SA 48.3um' }, ...
6 % 12, true);
7
8 compare_velocity_profiles( ...
9 { "G:\Swathiga\Fall 2025\SanjayCode_New\Al_noinception\Al_noinception_ThroatProfiles.mat" ...
10 }, ...
11 { 'Smooth' }, ...
12 12, true);
13
14 function compare_velocity_profiles(filePath, labels, numX, snapToQuarter)
15 % Compare Y-profiles from 3 .mat files after aligning x to each case's throat.
16 % Y-axis: Y (mm), X-axis: quantity. First tile = "Throat", then 0.25 mm, 0.50 mm, ...
17 %
18 % Usage example:

```

→ Modify the file directory in the code

- 2) Velocity.mat – Gives the instantaneous velocity values across all frames (Huge file).

**Code to be written to use this data**

## **SUMMARY**

**For each video (case):**

- 1) Get the video (.avi file)
- 2) Get ROI and throat MATLAB .mat file (**Using ROI\_and\_throatloader code**)
- 3) Upload all the files in ARC (respective case) – Video, ROI & THROAT
- 4) **Edit testraft.sh and raftmatlabsideview\_sanjay** in ARC
- 5) Submit job in Falcon
- 6) Obtain velocity data and plots in ARC
- 7) Download .mat files for further analysis in matlab using **velocity\_profile\_comparison code**

**FOR QUERIES:**

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