TEQIP SUMMER INTERNSHIP REPORT 2019

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- **INTERNSHIP DURATION** – 1 month (1^{st} -30^{th} june 2019)
- **SUBJECT-** IC Engines

- **RESEARCH TOPIC -** Particle Image Velocimetry

- **INTRODUCTION-**2-D Particle Image Velocimetry is an optical method to measure the in-plane 2-dimensional velocity component irradiated on a laser light sheet. It comprises a class of flow measuring techniques that is characterized by recording the displacement of small particles embedded in a region of fluid. STEREO-PIV is a straightforward extension of 2-D PIV which enables the measurements of 3 velocity components inside a light sheet using two cameras.

- **PRINCIPLE OF OPERATION-** The fluid is seeded with tracer particles which, for sufficiently small particles, are assumed to faithfully follow the flow dynamics. These particles have to be illuminated in a plane of flow at least twice within a short interval of time. The light scattered by the particles have to be recorded on a single frame or a sequence of frames. The displacement of the particle images between the light pulses have to be determined through evaluation of PIV recordings. For evaluation, the digital PIV recording is divided in small sub areas called "interrogation areas". The local displacement vector for the images of the tracer particles of the first and the second illumination is determined for each interrogation area using statistical method (auto- and cross- correlation).Stereo-PIV is based on the principle of stereoscopic imaging: two cameras are arranged to image the illuminated flow particles from different perspectives and Scheimpflug lens arrangements keep both image planes in focus. The combination of both camera projections allows the reconstruction of the true 2D3C-particle displacement inside the measurement area.

- **ELEMENTS-**

  LIGHT SOURCE: Lasers are widely used in PIVs, because of their ability to emit monochromatic light with high energy density, which can easily be bundled into thin light sheets for illuminating and recording the tracer particles. Pulsed lasers are generally used due to its short duration.

  SEEDING PARTICLES: They are the inherently critical component of the PIV system. Depending on the fluid under investigation, the particles must be able to match the fluid properties reasonably well. Ideal particles will have the same density as the fluid system being used, and are spherical. Refractive index of the

seeding particles should be different from the fluid which they are seeding, so that particles and be scattered towards the camera.

CAMERA: Two exposures from the laser light are required upon the camera from the flow. Due to the inability of the cameras to capture multiple frames at high speeds, both exposures were captured on the same frame and this single frame is used to determine the flow. A process called autocorrelation is used for such analysis. But in this case the direction of flow is unclear. To overcome this problem, faster digital cameras using CCD were developed since then that can capture two frames at high speed with a few ns difference between the frames (cross- correlation).

SYNCRONIZER: It can dictate the timing of each frame of the CCD camera's sequence in conjunction with the firing of the laser to within 1 ns precision. Thus the time between each pulse of the laser and the placement of the laser shot in reference to the camera's timing can be accurately controlled.