PIV Cameras and time resolved PIV measurement.

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In the late 1980s, the video cameras progressively replaced the double exposed photographic records used for auto-correlation PIV technique. The optical auto-correlation map or directly the double exposed particle fields were recorded in digital format using video camera. The transition towards a fully digital PIV system has been more and more pronounced in the beginning of nineties, when the developments of CCD sensor had made possible separated images recording in short time delay (< 10 μs) using the frame-straddling synchronisation[2,3]. Even if at that time, the CCD resolutions were very low (720x580 in CCIR Standard), and that the two separated images were distributed on the even and odd fields of interlined CCD device, the advantages of the cross-correlation approach (non directional ambiguity, high particle density, large range of velocity measurement,.no self correlation-peak..) compared to difficulties and limitations of auto-correlation technique, have strongly contributed to the definitive transition of the photographic film towards the video cameras. That transition has been enforced by the sub-pixel technique, which compensated the lost of measurement accuracy induced by the low resolution of images and by the significant increasing of computer power permitting to consider fully-digital image processing approaches. From that time, the camera improvements have never stopped and nowadays, devices able to record up to 4kx4k double images with inter-frame delay smaller than one microsecond become more or less standard cameras for PIV applications.

For time resolved PIV measurement in high speed flows (> 1 m/s), namely when the video frame rate has to reach more than 1000 frames/s, the transition to digital acquisition devices has been done around ten years later than for the low framing-rate systems (< 100 Hz). During the 90s, more or less the only way to access to time resolved PIV measurements was to combine high-speed photographic camera with a coper vapour laser[4]. The photographic films were then digitized with many precautions thanks to high resolution film scanner to allow the correlation between images recorded at different positions on the photographic film. The first high speed video cameras able to record more than 1000 frames/s had very low resolution (< 256x256 pixels) and could not be synchronised in frame-straddling mode for short inter-frame delay. Nevertheless, these cameras have quickly replaced photographic film recording due to more flexible and simpler operating conditions. During the last ten years, performances of high speed video cameras have been extensively developed and improved in term of resolution, sensitivity and frame rate. Nowadays, time resolve PIV measurement reaches accuracies close to those obtained from classical PIV system.

In this lecture, the different historical evolution and transition of recording systems for PIV measurement will be presented and discussed.

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