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Custom Configured PIV and High Speed Imaging System for Multiphase Flows

A non-intrusive **PIV & HS imaging system** for conducting controlled melting/ solidification experiments on salt-water solution at our lab. The system is a **two-phase (solid-liquid) flow during melting/solidification**. The application area is melting/solidification of salt water. A typical test cell size is 10 cm x 10 cm x 1cm for PIV. PIV should be able to be used for multiphase (liquid and solid phase) flow during melting/solidification. For the PIV, we are interested to obtain **both liquid and solid phase velocity measurement, and Shape, Size measurements on solid particle flow**. The acquired PIV & HS images can then be analyzed using ensemble correlation analysis, background removal and related technology to obtain **Shape, Size & velocity measurements (simultaneous measurement)**. For the second application using HS imaging the system is **visualization of droplet impact and spreading on surface**. A typical test cell size is 2 cm x 1 cm x 1cm.

The specifications of main components are given below:

- 1. Laser Source:** Dual cavity Nd:YAG PIV laser, 532nm wavelength laser or equivalent. Energy: ~ 200mJ (x2), Repetition rate: 15Hz, Lamp Life (pulses) ~100 million shots, Pulse Width (ns) < 10.
- 2. Laser Light guide arm & accessories:** Light arm: ~1.8m, Alignment accessories including 10m spherical lens, bread board and compatible laser feet.
- 3. Light sheet optics:** Light sheet optics with continuously adjustable focal length: ~ 0.30 m to 4.0 m. Cylindrical lenses: -15 mm, -25 mm and -50 mm. Also a collimated light sheet probe to give 100 mm high parallel light sheet.
- 4. Shadowgraphy optics:** Backlit shadowgraphy optical system. The system must include Beam expansion optics and diffusion plate to expand the light/laser beam coming out of the illuminator/laser and to uniformly distribute across the entire FOV area.
- 5. CCD Camera** for PIV image acquisition: Max. Resolution: 8MP, Frame rate: ~8 fps @ 8MP resolution, Max. frame rate: ~70 fps @ reduced resolution, Inter-frame time ≤ 300ns, Pixel size < 6 μm, Necessary interface card and cables, Bit depth: 12 bit.
- 6. CMOS HS Camera** for High speed image acquisition: Max. Resolution: 4MP, Frame rate: ~1400 fps @ 4MP resolution, Max. frame rate: ~2,00,000 fps @ reduced resolution, Inter-frame time ≤ 1.5μs, Pixel size ≤ 10 μm, Bit depth: 12 Bit, Exposure time: Minimum 1 μs, Throughput: ~ 6 Gpx/sec, Necessary interface card and cables, Triggering options: Software and Hardware Trigger, Internal storage: 16 GB , PIV compatibility: The HS Camera must be PIV compatible.
- 7. Camera Lenses:** 50mm/F1.8, 100mm/F2.8, and 135mm/F2.0
- 8. Filters:** 550 nm long wave pass filter (for temperature measurement), and 650 nm +/- 20 nm bandpass (for concentration measurement)
- 9. External LED Illuminator** (with projection lens and power source)
Weight: Less than 3 kg and handheld. Luminous Flux: ~2500 Lumen for CW and ~15000 Lumen for Pulsed (green). Heat Dissipation: Heat Sink with temperature controlled fan. Environmental Protection: IP 20. Projection lens 180mm diameter from a distance of 1m.

- 10. Tripod:** Two Flexible Tripod with suitable Head for mounting the CCD Camera and the HS camera. One more mid-size Flexible Tripod for mounting lighting etc.
- 11. Synchronizer:** Output channels: 8, Input channels: 2, Resolution: < 0.5 ns, Trigger: External, Communication: USB/RS 232.
- 12. Software:** Necessary software for image acquisition, processing and analysis. Distributed processing of captured PIV Image, Analysis and parallel processing capability, Normal/Hart Correlation analysis, Analysis of uncertainty of PIV Processing, Dynamic masking of object in the image field captured by PIV, Integrated Tecplot data presentation, Software modules to provide processing of 2D-PIV, Shape, Size and Velocity image capture, analysis and display, Upgradable to stereo PIV and volumetric PIV in future.
- 13. Computer to be supplied:** Dual Intel Xeon Quad-Core 2.40Ghz processors, 128 GB DDR3 RAM, 1TB HDD, 22" monitor, Windows 7 64-bit Enterprise Edition. or Equivalent computer.
- 14. Seed particles and Dyes:** Hollow glass, Silver coated particles, Rhodamine B, Rhodamine 6G Dyes.
- 15. Cables and power supply should conform the Indian standard**

Installation, Commissioning and Training

- The delivery of the equipment should be considered complete only after successful commissioning of the instrument.
- The pre-installation requirements should be communicated to IIT Kanpur well in advance of the installation.
- The supplier should provide training to at least two candidates at the installation site to make them familiar with smooth operation of the instrument.

Terms and Conditions:

1. Prices should be on FOB and CIF (IIT Kanpur).
2. Prices should include installation and training cost, and all additional charges including freight, insurance etc.
3. Discount: maximum educational-discount to be provided.
4. Provide pricing for individual items listed above.
5. Normal payment terms for the Institute will be applicable (90% on delivery of the items and the remaining 10% after satisfactory installation/ inspection)
6. Warranty: no less than three (03) years after installation.
7. Quotation validity: no less than 90 days from the date of quotation submission.
8. Quotations should carry proper certifications such as, agency certificates, proprietary certificates, printed company profile, detail technical specification, detailed user-list for similar equipment (PIV, HS camera etc) with phone numbers.
9. Demonstration is required, if asked by the party.
10. An undertaking that the vendor will supply all the spares and services for the equipment for at least 5 years from the date of commissioning.
11. Delivery must be within 4 months.
12. Availability of after sales service and support in India: Supplier has to compulsorily indicate details of facilities/ expertise/ qualification / cost (after guarantee period) of support in India. Factory trained engineers should be available in India for complete product support.

The prospective suppliers are required to send quotation in two parts in sealed envelopes, as “**Technical Bid**” and “**Financial Bid**”.

The **Technical Bid** should contain detailed technical specification of the product being offered and should not mention any price. The **Financial Bid** should include the detailed price quotation clearly including the cost of the equipment, taxes, service charges if any, shipping and handling charges. The two envelopes should reach the following address **on or before 20th February, 2015**. Kindly mention "**PIV: IITK/ME/AK/2015/01**" on the sealed envelopes.

Any questions, technical or otherwise should be directed to the undersigned via phone, fax, and/or e-mail.

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