STR

Station for testing streak tubes

Fig. 1. Photo of STR test station

BASIC INFORMATION:

Streak tubes are the most important modules of streak cameras used for the study of ultra fast optical phenomena. The latter cameras are tools of critical importance in many areas of science and technology like studies of plasma/electric discharge/ combustion/laser ablation/ condensed matter phenomenon, in optical communications, electron beam acceleration technology, photochemistry, medicine, biology etc. Streak cameras have made possible a series of important scientific discoveries in earlier mentioned areas of science and technology.

Precision information about parameters of streak tubes is needed both by manufacturer of such tubes in improve tube design and by users of these tubes to correct data generated by the tubes and make possible more accurate interpretation of output images.

Images generated by streak tubes are always spatially and temporally distorted. Spatial resolution give information about minimal size of targets that can be analyzed, and temporal resolution - about shortest temporal phenomenon. Next, distortion give information about displacement of parts of image relative to original targets and knowledge means possibility to correct these image imperfections.

Brightness of screen of streak tube depends on intensity and wavelength of light incoming to tube photocathode. Knowledge about relationship between screen radiance and photocathode irradiance at different wavelengths makes possible absolute radiometric evaluation of images generated by streak tubes.

STR station is quasi universal system for testing streak tubes. The station enables measurement of virtually all parameters of streak tubes: radiometric parameters, spatial parameters, and temporal parameters.

Next, the station is delivered in a form of stand alone, computerized station capable to enable semi-automatic testing of streak tubes.

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HOW IT WORKS:

The station is built using a concept of three semi-independent channels: a)radiometric channel; b)imaging channel, c)temporal channel (Fig.2).

The radiometric channel is built as a system built from three main modules: broadband halogen light source, spectral selector, and a set of radiometric probes. This channel first irradiate tube photocathode and later measures intensity of light emitted by tube screen. Radiometric parameters of tested streak tubes are determined on the basis of relationship between irradiance of tube photocathode and radiance of tube screen.

The imaging channel is built as electronically controlled LED light source integrated with high resolution image image projector and a target slider. The image projector projects image of a series of standard targets onto photocathode of tested tube. Image quality of images of these targets generated at screen of tested tube is analysed using a set of two electronic cameras. Analysis of captured images deliver information about imaging parameters of tested streak tube.

The temporal channel is built as a PC controlled pulsed light source that illuminate tube photocathode cooperating with a fast light probe that captures temporal profiles of pulses generated at screen of tested tube.

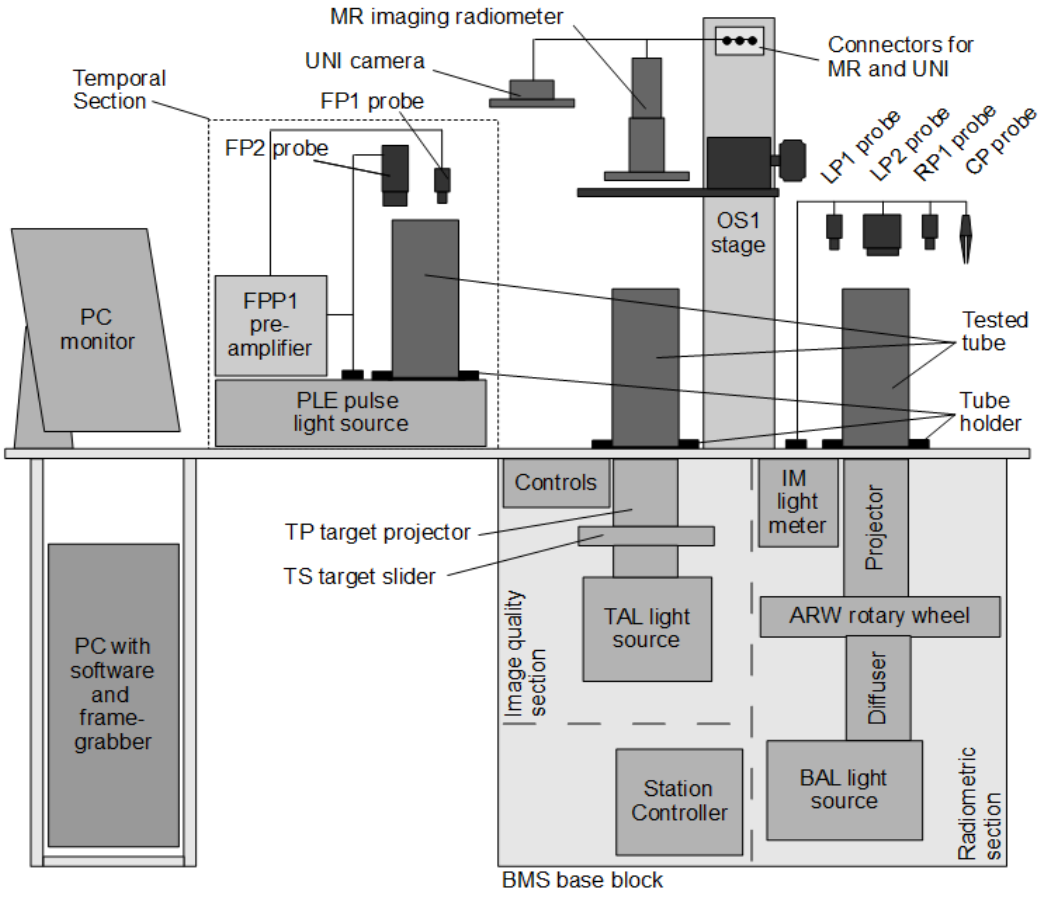

Fig.2. Block diagram of STR test station

Modules of the radiometric channel and modules of the imaging channel excluding light probes and imagers are integrated in a common big mechanical case that works also as a platform tested tubes, light probes, cameras and keyboard of PC. All these modules integrated within the big mechanical case as a single unit are coded as BMS base block. As shown in Fig.2 the BMS block can be divided into two sections: radiometric section and imaging section.

BAL light source is the hearth of radiometric section. It is a polychromatic halogen light source (spectral band from at least 400nm to 1000nm) of ultra high dynamic (over 10^{10}). The latter feature is important and needed to enable measurement of EBI (simulation of very low light levels) and to measure tube dynamic (simulation of

very light light levels). Color temperature of BAL light source equals 2856K as recommended by MIL standards for testing image intensifier tubes of similar design as streak tubes.

BAL light source is integrated with ARW rotary wheel with a set of spectral filters. This wheel enables spectral filtering and conversion of polychromatic light emitted directly by BAL source into monochromatic light at a set of ten discrete wavelengths in range from 400nm to 850 nm. This feature enables measurement of radiometric parameters of tested tube at 10 different wavelengths.

Light intensity of BAL light source and position of ARW wheel (wavelength) are controlled from PC enabling easy control of irradiance and spectrum of light at photocathode plane of tested tube.

The imaging section of BMS base block is built as a set of three modules: TAL light source, TS slider, TP image projector. The TAL light source is an electronically controlled LED area light source that illuminate targets inserted into TS target slider. There is here a set of targets: three linear targets to test resolution of streak tubes (the largest of linear targets can work also as an edge target needed during MTF measurement), USAF 1951 targets to test resolution of frame tubes, uniform target, edge target and FOV target. Image of an active test target is projected to photocathode plane of tested tube by TP target projector built using a special macro objective of ultra high resolution of resolution over 256 lp/mm. The latter feature is needed to eliminate influence of TP projector on image quality of projected images and eliminate possible decrease of resolution and MTF measurement results.

Light intensity at screen of the streak tube tested in radiometric mode is to be analysed by a set of four probes:

1. LP1- high sensitivity luminance probe needed to measure luminance of tube screen. This probe is needed during measurement of luminance gain and dynamic. Practically this probe can be used only for phosphors of spectrum similar to sensitivity of human eye (P20, P22, P43, P45 phosphors),
2. RP1 - high sensitivity radiometric probe needed to measure radiance of tube screen (can be used for any phosphor),
3. LP2 - an ultra high sensitivity probe needed to enable measurement of EBI at very low light level,
4. CP is a ultra high sensitivity current probe to measurement of current flowing through photocathode (measurement of luminous sensitivity and radiometric sensitivity).

Output image generated by a tube tested in imaging mode is to be analyzed by a set of three tools:

1. MR1 imaging radiometer,
2. MR2 imaging radiometer,
3. UNI camera.

MR1 is an imaging radiometer of ultra narrow field of view. It is needed to capture images of resolution targets and to enable measurement of spatial resolution (human subjective evaluation of captured images) and MTF (software determines MTF on basis of captured image of edge target).

MR2 is an imaging radiometer of narrow field of view. It is needed during measurement of magnification and distortion.

UNI is a camera of wide field of view. It is needed to capture image of uniform target during measurement of Output non-uniformity.

Height and horizontal position of MR imagers and UNI camera is regulated using OS1 stage.

Temporal channel is built as a set of modules: PLE pulsed light source/analyser, FP1 fast probe, FPP1 preamplifier, FP2 ulfrafast probe. .

PLE pulsed light source/analyser is the hearth of the temporal channel. It is PC controlled light source based on ultra fast LED. The PLE source emits light pulses in form of rectangle wave of regulated frequency. Light power can be regulated, too. At the same time PLE module can be used to capture and analyze fast electrical pulses generated by FP probes.

Temporal profiles of light pulses generated at tube screen are measured using FP1 fast probe integrated with FPP1 preamplifier is used n case of standard phosphors of moderate speed (like P20, P22, P30, P43 or P45). If tube with screen covered using ultra fast phosphors like P46 or P47 is to be tested then ultrafast FP2 probe is to be connected to PLE source/analyser.

Measurement of parameters of streak tubes is supported using a set of computer programs:

1. STR Control,
2. STR Display,
3. STRIM,
4. STR Time.

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STR Control is a computer program that enables control of light irradiance and spectrum at photocathode plane of tested streak tube and measurement of radiance/luminance/current at tube output on basis of signals generated by LP1/LP2/RP1/CP probes. This program enables also fast calculation of radiometric parameters on basis of data from BAL light source and the LP1/LP2/RP1/CP probes.

STR Display enables reading and presentation of illuminance at photocathode of tested tube in imaging channel.

STRIM program enables acquisition and semi-automatic analysis of images generated by MR1 imaging radiometer, MR2 imaging radiometer and UNI camera.

STR Time is a computer program that enables control of parameters of light pulses emitted by LPE light source/analyser and analysis of recorded temporal profiles of electronic signals from FP1/FP2 fast probes.

TEST CAPABILITIES:

STR test station enables measurement of all important parameters of streak tubes:

Radiometric parameters:

1. Photocathode luminous sensitivity,
2. Photocathode radiant sensitivity,
3. EBI (equivalent background input),
4. Radiant power gain,
5. Luminance Gain,
6. Dynamic range.

Imaging parameters:

1. Spatial resolution,
2. MTF,
3. Magnification,
4. Distortion.

Temporal parameters:

1. Phosphor decay time
2. Temporal resolution (option).

Streak tubes of parameters specified below can be tested:

- Photocathode diameter: 5-40mm
- Max tube height: <480mm
- Max screen diameter: <56 mm
- Spectral band: 400 -850nm (typical) - can be extended
- Photocathode type: any photocathode sensitive in earlier mentioned spectral band
- Phosphors: P20, P22, P30, P43 (typical), P46, P47 (option)
- External mechanical diameter: <150mm
- Spatial resolution: 16 lp/mm to 81 lp/mm (up to 114 lp/mm - option)
- Tubes with MCP and without MCP

Test conditions:

1. The customer is responsible to deliver sample streak tubes with electronics to power and control of tested tubes.
2. Two types of streak tubes and control electronics can be delivered A)fully operational streak tubes capable to work in streak mode and frame mode, B) streak tubes working only in static mode like image converter tubes
3. Control electronics of tubes type A should fulfill these conditions:
   tubes working in streak mode and frame mode should be triggered by external electrical pulses with frequency not lower than 500 Hz (recommended value 1 kHz), maximal sweep time (that can be used during tests) of tested streak tubes is not lower than 10 microseconds (recommended value is 1 ms), maximal opening time (that can be used during tests) of tested frame tubes is not lower than 1 microseconds.
4. Control electronics of tubes type B should fulfill these conditions: to power tube and enable tube to generate image at screen

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LIST OF MODULES

STR station is built from the following modules:

1. BMS base block,
2. Set of probes for radiometric mode: LP1 luminance probe, LP2 luminance probe, RP1 radiometric probe, CP current probe
3. Set of imagers for imaging mode: MR1 imaging radiometer, MR2 imaging radiometer, UNI camera
4. Set of blocks for temporal mode: PLE pulse light source/analyser, FP1 fast probe, FPP1 preamplifier, FP2 probe,
5. PC integrated with an analog frame grabber
6. Set of computer programs: STR control, STR Display, STRIM, STR Time
7. Mechanical supports modules: OS1 stage, set of mechanical adapters
8. PS power supply

SUMMARY:

STR station is a first commercially available station for testing streak tubes offered at international market. It presents a sophisticated test system based on years of experience of Inframet research team in field of imaging tube technology.

Several technical points should be particularly emphasized:

- Computerized test station. Semi-automatic easy measurement of the all important parameters of streak tubes,
- Modern compact design (not a collection of different laboratory modules to be assembled on a table),
- All types of streak tubes can be tested: tubes working in streak mode, framing mode, synchronous mode; tubes with different photocathodes, of different size, height; having screens with different phosphors,
- Light sources of ultra high dynamic and stability,
- Image projector of ultra high resolution,

All these features make STR station and ideal metrological tool for manufacturers of streak tubes, manufacturers of streak cameras, or any scientific team using or developing streak tube technology.

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