Special Instrumentation for the 8-Pack Project

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Special Instrumentation: Overview

- Instrumentation which does not clearly fit into other categories
- Primarily used to diagnose problems, and calibrate other systems.
- NOT part of NLC

Note: Budget / Labor not yet approved

**Acoustic Sensors:** Used to Locate RF breakdowns

M+S cost ~35K

**Photomultiplier tubes:** Use to locate RF breakdowns

M+S cost ~12K

**RF Component Temperature Measurements:** General diagnostic

M+S cost ~7K (Conventional system - not discussed further)

**Thermal RF Power Measurement:** Calibrated high power RF power measurement

M+S cost ~11K

“**General purpose**” Lab instruments: Power meters, function generators, etc.

M+S cost - variable, $25K to $100K
Acoustic Sensors

**Function:** Used to locate RF breakdowns. Provides ~few cm resolution.

**Description:** Pulse heating of RF structures generates acoustic signals which have been measured at frequencies from ~1 KHz to ~1MHz, limited by the detection equipment. Pulse heating and measurable acoustic output is produced by normal RF pulses, and increases by a factor of ~10 in amplitude for “breakdown” pulses.

**Hardware:** Nearly identical to operating NLCTA system
Testing new sensors (low cost commercial, SLAC constructed).

**Software:** Identical to operating NLCTA system
Optionally can use SIS 100Ms/s digitizers in place of Joerger 10Ms/s units.
**PMTs**

**Function:** Used to locate breakdowns, optionally for fast interlocking.

**Description:** Photomultiplier tubes (possibly with scintillators) are mounted near high power RF components. X-rays generated during RF breakdowns will be detected and their amplitude and timing measured. Optionally, a discriminated output can be used as a fast RF interlock.

**Hardware:** Integrated PMT modules eliminates HV system. Transient digitizer same as for LLRF system. Fast interlock goes to LLRF system (if needed).

**Software:** Treated as LLRF channel in EPICS. Off line analysis done in Matlab.
**Thermal Power Measurement**

**Description:** An accurate measurement of the thermal power removed by the water to the RF loads is made. This should provide a <5% absolute accuracy RF power measurement.

**System Inputs:** 38Gpm water, 54KW (120Hz) -> 5°C delta T.

Want to measure 60Hz. 50% power = 1.25°C delta T to 2%, need 0.025°C
Need water flow to 2% (0.75Gpm).

**Temperature measurement:** Differential thermocouple, need 1 microvolt stability.
Can use HP3458 voltmeter (existing) with GPIB
Alternately build front end from AD8628 pre-amp (<.005uV/C drift).

**Flow Measurement:** Need 2% accuracy reading
Turbine flow meters provide ~1% absolute accuracy (e.g. Omega FL8305AB).

**Substitution Heater:** Independent calibration.
Need ~30KW water heater (commercial). Use 480V line, measure Vrms and Irms.

**Pulse Profile:** Need RF pulse shape measurement linear to 1%. (LLRF system OK?)
General Purpose Instruments

A variety of general purpose instruments are require, and not costed elsewhere.

**Peak Power Meter:** HP8991. Obsolete, but no substitute available for fast pulse measurements. Invaluable in NLCTA. $14K (used marked).

**Good General Purpose Scope:** Various available. ~15K.

**X-band Synthesizer:** Various. Need to check which units are not allocated. Need one for general measurements. ~$35K

**Miscellaneous RF hardware:** Attenuator, mixers, amplifiers, diodes, etc. ~10K (2002)

**Arbitrary waveform generator:** For special purpose testing of RF modulation schemes. Best to borrow, only needed occasionally. ~$20-60K