Reflectivity Test Station for the Low Threshold Cerenkov Counter

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This note discusses the Reflectivity Test Station (RTS), which was developed to measure the reflectance of the Winston cones of Hall B's CLAS12 Low Threshold Cerenkov Counter (LTCC).

The LTCC, designed to discriminate pions from kaons in the 3.5 GeV to 9 GeV range, consists of six sectors, each filled with C_4F_{10} and instrumented with 36 sets of lightweight mirrors, Winston cones, and 5" PMTs with magnetic shields.

RTS hardware, Fig.1, consists of a desktop computer, Oriel monochromator, dark box with two photodiodes (labeled *A* and *B*), Keithley model 6571B electrometer with a 6521 low current scanner card, and a National Instruments USB-to-GPIB interface.

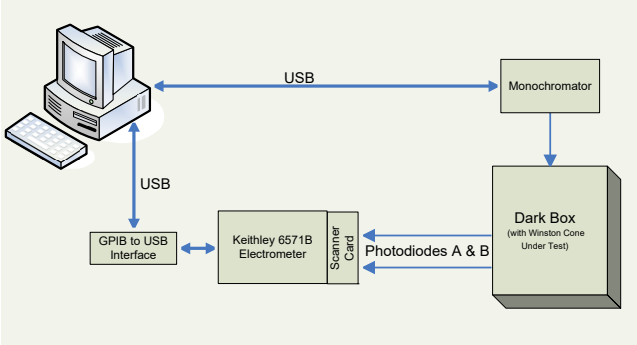

FIG. 1. Block diagram of RTS.

Two LabVIEW programs, *Mono_UT* and *LTCC Test Station,* provide operator interface, control instrumentation, and record and plot acquired data.

Mono_UT communicates with the monochromator via a USB port and its operator front panel, Fig. 2, enabling selection and control of monochromator settings (shutter, filter, and grading), and testing parameters (starting and ending wavelength, step size, and pause time).

LTCC Test Station communicates with the electrometer via a GPIB-to-USB converter connected to the computer's USB port. Since the electrometer can read the current from only one photodiode at a time, a scanner card that allows each photodiode to be read simultaneously was installed in the electrometer. Acquired data are recorded and plotted.

The *LTCC Test Station's User Interface* front panel tab has two parts: *Test Settings* and *Test Readback Data*.

Test Settings provides access to parameters, such as selecting a calibration or test run, wavelength range, number of sets of measurements, test number, filename of the default Excel workbook, and acquisition delay settings for synchronization.

Test Readback Data displays the current data point, corresponding readback currents of the photodiodes, and the timestamp of the measurements. It has error indicators for communication problems with the electrometer and Excel data file-write failures; output data file name is set in this part.

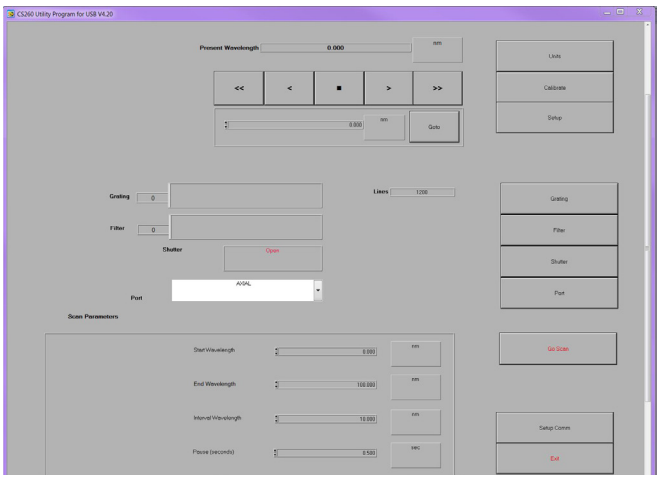

FIG. 2. Operator front panel of monochromator program.

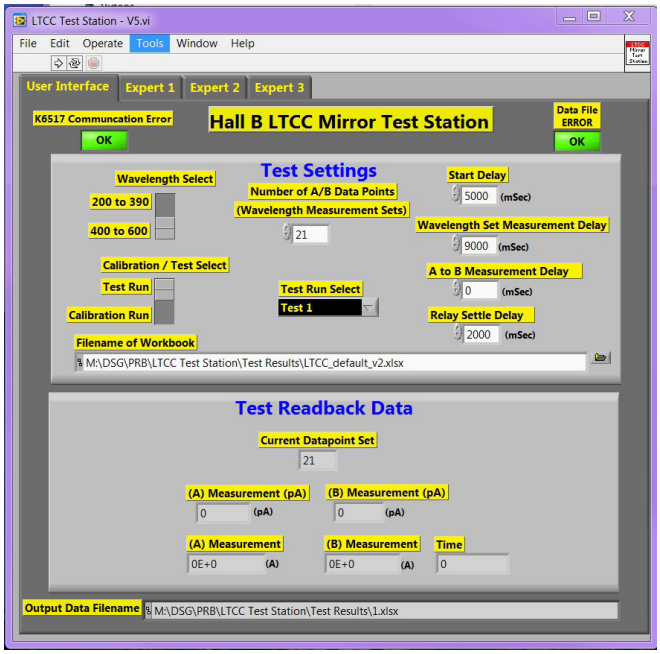

FIG. 3. *LTCC test station User Interface* front panel tab.

Additionally, the *LTCC Test Station* front panel has three tabs labeled *Expert 1-3*. These tabs provide detailed data and error displays for troubleshooting. Figure 4 shows the tab *Expert 1,* detailing an Excel error that occurred during a test run.

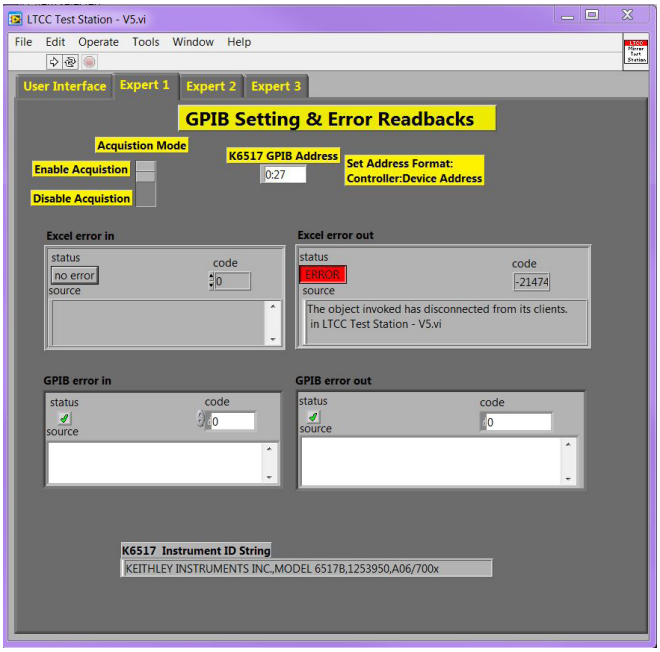

FIG. 4. *Expert 1* tab showing an Excel file error.

Figure 5a shows that data are acquired in steps of 10 nm for wavelengths from 200 nm to 400 nm. Columns *A* and *B* of the calibration set show the current in pA of the photodiodes; their ratio gives the calibration coefficient. For test sets 1 and 2, columns *A* and *B* give the photodiode currents in pA; the last column gives the reflectance.

Calibration			
Wavelength	A	B	A/B
	I (pA)	I (pA)	#
200	13.10	1.43	9.16
210	55.46	8.87	6.25
220	50.70	41.83	1.21
230	88.86	49.64	1.79
240	87.70	59.74	1.47
250	58.60	75.87	0.77
260	61.41	55.57	1.11
270	51.97	44.69	1.16
280	50.66	34.48	1.47
290	41.51	34.46	1.20
300	33.45	34.67	0.96
310	28.76	29.03	0.99
320	24.55	24.17	1.02
330	13.79	21.37	0.65
340	15.44	19.68	0.78
350	12.07	16.91	0.71
360	10.10	13.45	0.75
370	9.45	11.21	0.84
380	10.06	10.99	0.92
390	9.87	10.20	0.97

Test 1		
A	B	Reflectance
I (pA)	I (pA)	#
12.81	0.53	0.38
54.92	2.70	0.31
49.71	13.98	0.34
87.58	17.16	0.35
86.75	22.24	0.38
57.70	30.37	0.41
60.53	24.07	0.44
51.28	20.27	0.46
50.17	16.71	0.49
41.04	18.25	0.54
33.12	19.25	0.56
28.27	16.51	0.58
24.17	14.30	0.60
19.45	13.14	0.44
15.21	12.42	0.64
11.93	10.95	0.65
9.95	8.87	0.67
9.34	7.43	0.67
9.94	7.34	0.68
9.76	6.86	0.68

Test 2		
A	B	Reflectance
I (pA)	I (pA)	#
12.97	0.59	0.42
54.99	3.12	0.36
49.92	15.94	0.39
87.69	19.04	0.39
86.53	24.44	0.41
57.66	32.64	0.44
60.37	25.41	0.47
51.21	21.19	0.48
50.03	17.13	0.50
40.85	18.49	0.55
32.88	19.35	0.57
28.17	16.53	0.58
24.13	14.18	0.60
19.53	13.04	0.43
15.18	12.17	0.63
11.96	10.68	0.64
9.92	8.66	0.66
9.34	7.24	0.65
9.90	7.13	0.66
9.70	6.62	0.66

FIG. 5a. Acquired data for calibration and tests.

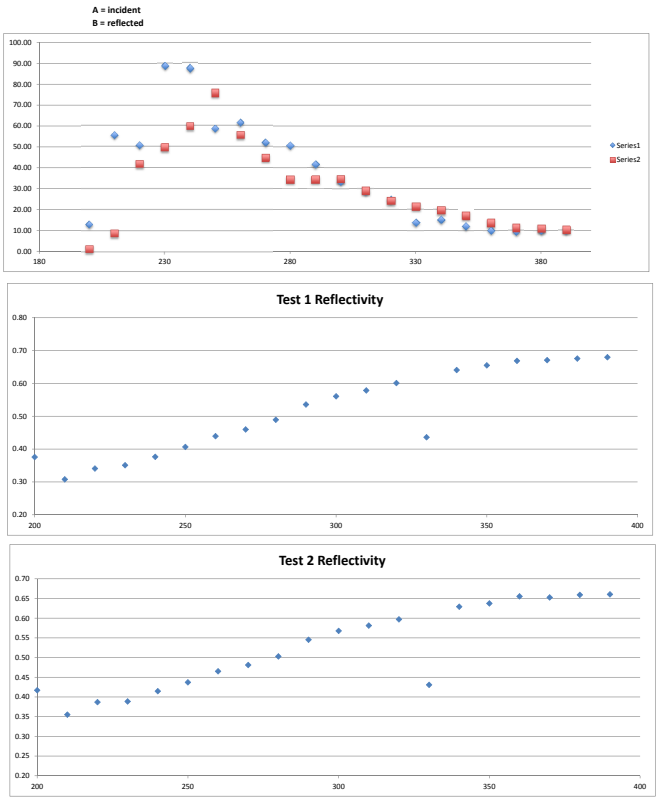

FIG. 5b. Plots of the acquired data and calculated reflectance.

In Fig. 5b, the topmost graph is the plot of the calibration set data of the photodiode current (in pA) of the incident and the reflected light, photodiodes *A* and *B*, as a function of the wavelength. The middle and bottom graphs show the calculated reflectivity as a function of the wavelength for tests 1 and 2 done on that Winston cone.

In conclusion, RTS has been successfully used to determine the quality of the LTCC Winston cones.