Plan for testing VEGAS

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A block diagram of VEGAS is shown in Fig. 1 As shown in Fig. 1, VEGAS has an analog subsystem to amplify and filter the signals from the converter rack, which is followed by ADC and digital signal processing subsystems. Each of these subsystems will be tested separately. The plan for testing each subsystem is listed below. After the completion of subsystem test, the system as a whole will be tested which is then followed by commissioning VEGAS for GBT observations. The plan for system testing and commissioning is also described below.

1 Subsystem and System testing

- **Analog subsystem :** Measure (a) gain as a function of freq, (b) 1 dB compression point, (c) cross coupling between polarization and (d) performance of the noise source in the analog system. The gain will be measured with a network analyzer. 1 dB compression point will be measured using a tone of freq 750 MHz injected from a synthesizer at the input of the analog subsystem. A spectrum analyzer will be used to measure the output power. Cross coupling between the polarization channels will be measured using network analyzer. The performance of noise source will be checked using VEGAS itself after completion of System test. The test will be repeated for all the 8 analog subsystem. The result of the test will be compared with the specification (`http://www.gb.nrao.edu/vegas/report/analog.pdf`).

- **ADC subsystem :** Measure (a) dynamic range and (b) phase noise. The sampling frequency will be set to about 3.072 GHz for these test. Dynamic range will be measured using a 'bin centered' tone of frequencies near 100, 700, 1400 MHz generated using the synthesizer and injected directly at the input of the ADC. The power level of the tone will be set to 6 dBm so that after the 6 dB attenuator used for impedance matching the power level at the input of the ADC will be 0 dBm. All the bits of the ADC will be toggling for an input sine wave at this power level. The synthesizer will be locked to the 10 MHz reference. Power spectrum will be obtained using the 16 K ADC samples obtained from VEGAS manager sampler output. The noise power relative to 1400 MHz tone at an offset of 1 KHz will be measure to estimate the phase noise. For cross coupling measurements, ADC inputs will be terminated and self and cross spectra are obtained from the 16 K samples. These spectra will be used to estimate the cross coupling. For further details of ADC testing see Roshi & Bussa (2012). These measurements are repeated for ADCs in all the 8 banks. The results will be compared with those obtained earlier by Roshi & Bussa (2012).

- **Time stamping :** The spectra produced by VEGAS are time stamped. The time stamp is introduced using a counter in the FPGA. The counter is incremented by FPGA clock. It is

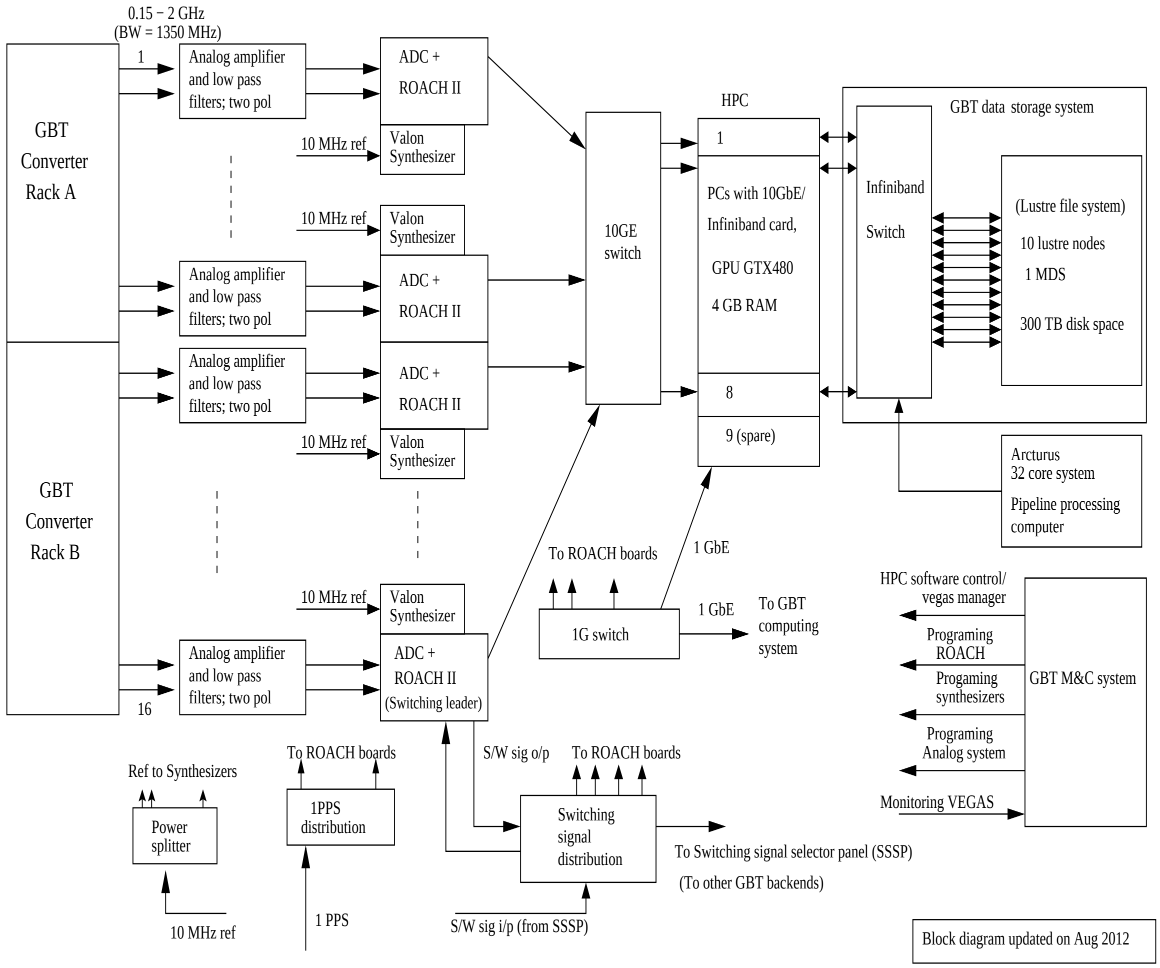

Figure 1: VEGAS block diagram

initialized by the 1 PPS signal from the observatory clock after the VEGAS manager issues a start command. The manager converts this counts to an offset from 1 PSS in UTC, which is referred to as UTCDELTA. The stability of the system will be examined by monitoring the time stamping on the data for 1 hr or so. This will be done for each mode of VEGAS after configuring the system for one switching state.

- **Polyphase Filter Bank (PFB) and Digital Filters :** Measure (a) dynamic range (b) cross coupling between polarizations and (c) filter response function. Dynamic range will be measured as for the ADC but now using the PFB output. Cross coupling will be measured using an uncorrelated noise source. The PFB filter response will be measured for modes 1, 2 and 3. For the rest of the modes, the digital filter response implemented in the FPGA will be measured. Filter response will be measured by injecting a sinewave at the input of the ADC and sweeping its frequency between $f_0 \pm 10 \times \Delta f$ with a step size of $\Delta f/10$, where f_0 is the center of a frequency channel and Δf is the frequency resolution. VEGAS will be configured for one switching state for these tests. The measurement results will be compared with the specification (`http://www.gb.nrao.edu/vegas/report/specific.pdf`).

- **State Integration :** Switching signals are used for frequency and noise switching for observations with GBT. The spectra corresponding to each state of the switching signal are integrated in different accumulators. To check whether these state integration are taking place properly, we plan to use the Artificial Pulsar (AP). The AP output will be connected to the ADC inputs. The pulsed noise of AP will be modulated with one of switching signals. The VEGAS spectra will be examined for power variation at the expected state. The stability of the system will be examined by monitoring the time stamping of the spectra and integration time recorded by VEGAS. These test will be repeated by connecting the LO blanking signal to the switching signal distributor. The functioning of LO blanking is assessed by examining the integration time for different states. This test will be repeated using a tone generated with LO1B after VEGAS is integrated with the GBT receiver.

2 Commissioning Plan

There are basically 4 GBT observing modes that are widely used by observers. They are (1)single beam position switching, (2) single beam frequency switching, (3) single beam mapping with and without frequency switching, (4) dual beam nodding. We plan to test items 1 to 3 using L-band receiver and item 4 using K-band receiver. The test will be done in two stages. In the first stage, data is collected without any antenna motion. This data will be used to examine the proper switching of cal and frequency in GBTIDL. For testing the frequency switching we plan to use an injected tone using LO1B. In the second stage, we plan to observe a region of the sky and try to detect HI (a strong signal) and recombination lines (a weak signal). The decrease of RMS noise with time is compared with the $\sqrt{t}$ dependence. The test will be repeated for all VEGAS modes. Testing of the observing modes for all receivers other than L and K bands will be done by working with scientist who has shared risk observing time with VEGAS.