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"VLBI2010 Digital Processing Requirements"

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The purpose of this memo is to propose the basic functionality for a VLBI2010 digital back end (DBE). For orientation, Fig.1 puts the DBE into the context of the VLBI2010 station electronics where it lies between the n-bit samplers and the Data Output Module (DOM).

The proposal for the VLBI2010 DBE is summarized in Fig.2. This is not intended as a final statement of requirements. It is more the opening of discussion. I have included all functionality that I could think of. The modules in the block diagram are discussed briefly below:

Translation from Linear to Circular Polarization. [Polarization issues were discussed in some detail by Brian Corey at the Haystack V2C f2f meeting. I think it would be useful (at least to me) if the talk could be submitted as an IVS memo so that it would be possible to find the information and refer to it in the future.] Since broadband feeds naturally produce linear polarized data, and VLBI works best with circularly polarized data, one approach to handling the linear polarized data is, at some point in the VLBI2010 system, to make the conversion from linear to circular polarization. Conceptually, this could be done at any of three points of the system, e.g.: in hardware prior to the sampler; as part of the station digital processing; or post-correlation. I believe that Brian concluded that it could be done effectively in the station digital processing (and perhaps that that was the best place to do it). He also provided equations and some discussion of difficulties such as gain balance, etc. As a result, I have included this functionality as part of the VLBI2010 digital processing.

Data Analysis Functions such as autocorrelation, PCAL extraction and radiometry. These are important functions both for evaluating the quality of the input data and for calibrating the correlator output. I think it would be useful to have the capability to extract this data both before and after the polarization conversion.

Polyphase Filter and FFT. Channelization of the data is a common feature of DBE's. Often, the primary intent is to convert the wide bandwidth sampled IF into channels that can be handled by a correlator. A side-benefit is that it protects against the possibility of narrow band RFI completely destroying the entire sampled IF band through quantization losses, which is what would happen if the typical VLBI truncation to 2-bit data were performed directly on the broadband sampled data. The protection against narrow band RFI improves (with respect to the total amount of data lost or degraded by the RFI) as the bandwidth of the output channels decreases. However, at some point, the diminishing benefit of narrowing the channel further no longer justifies the added effort. This sort of system is similar to an FX system where the F is done at the station and the X at the correlator. The main difference is the location where the conversion to 2-bit data occurs. At this point, I'm not sure of the impact of this difference, but think it needs to be studied further before deciding on a system like this.

Model. This box represents the application of the usual interferometry delay and phase models. This function is shown in a dashed box since the delay model is normally applied at the correlator. There may, however, be benefits to applying the model here. First, the data at this point is multi-bit. As a result, the delay and phase tracking losses will be negligible and also the VLBI low fringe rate degradation will be handled more naturally. There may be concerns with placing the delay and phase tracking here to do with reliability, multiple phase centers, etc.—so, this decision needs to be considered further.

Truncation to 2-bit Data. VLBI data is transmitted most efficiently in either 1-bit or 2-bit form. In order to do this effectively, an optimum threshold needs to be determined based on the statistics of the n-bit signal.

Burst Mode. Burst mode involves writing data quickly to RAM and then reading it out more slowly to a disk storage device or e-VLBI connection. This makes it possible to shorten the length of time on a source, which is one of the factors required to increase the number of observations in a day.

DOM Interface. This module is required to put the output data into a standard form so that it can be sent to a VSI-compatible Data Output Module (DOM).

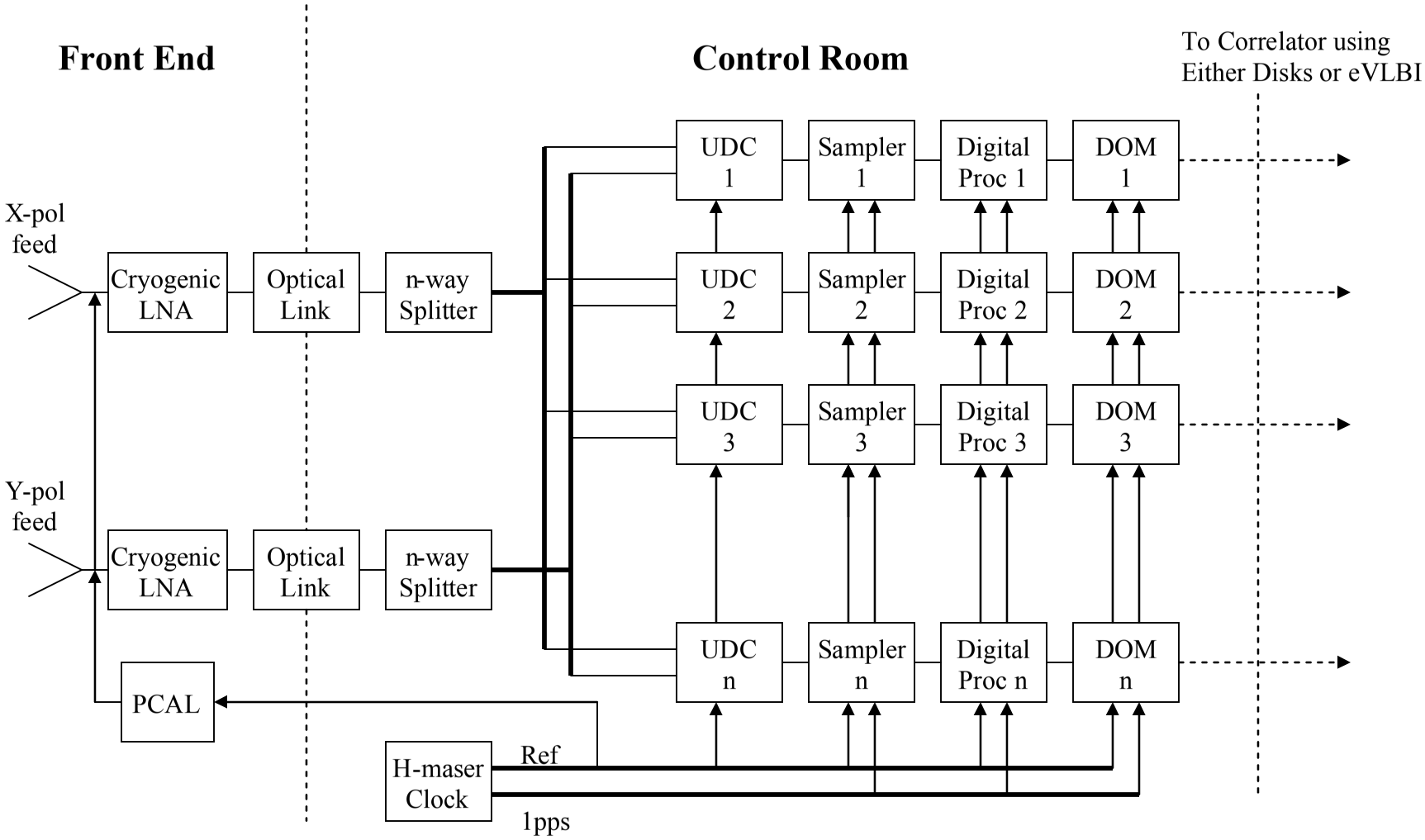

Fig.1 VLBI2010 Station Electronics Block Diagram

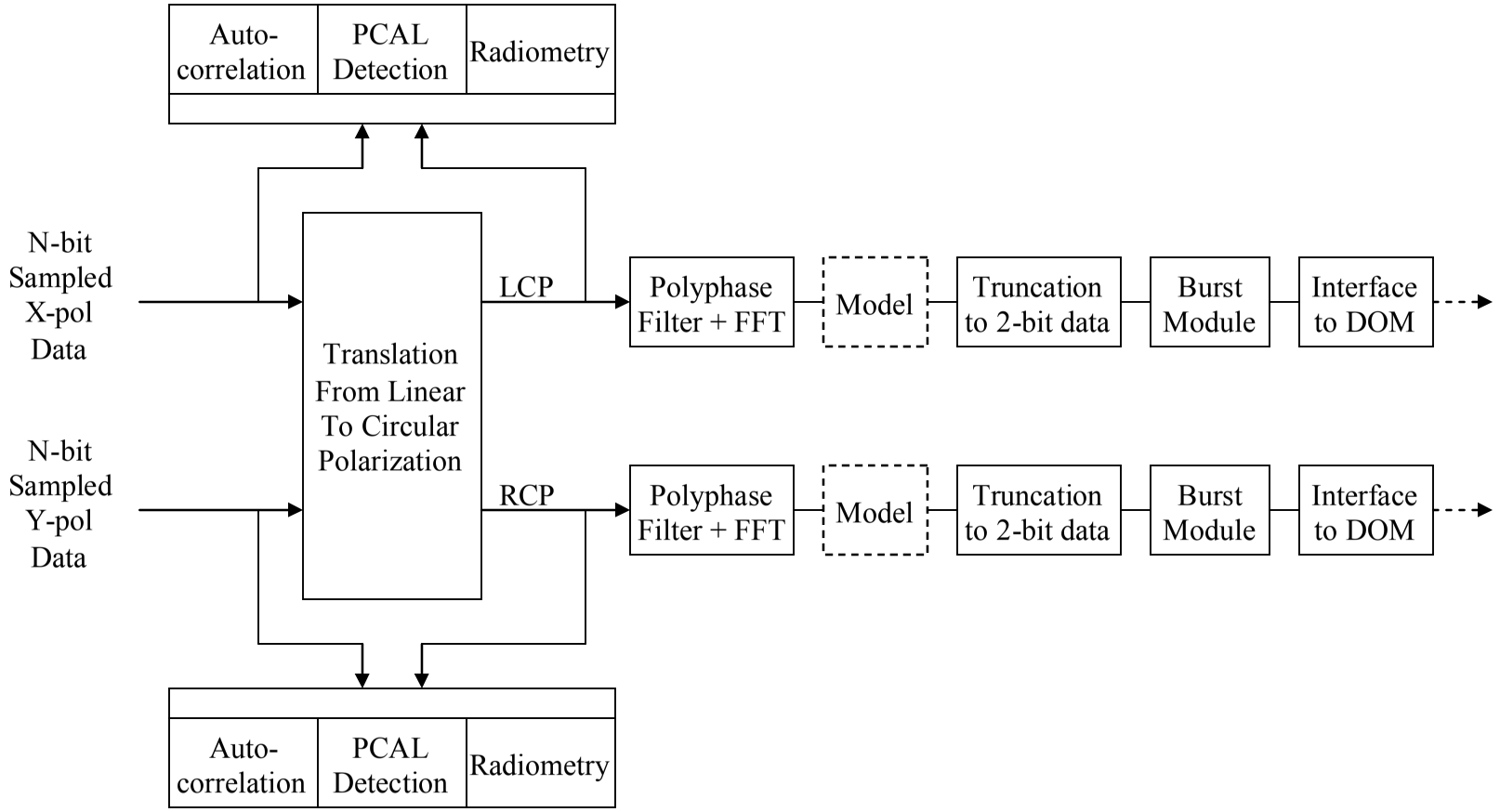

Fig.2 VLBI2010 Digital Processing Unit Block Diagram