

Title: Innovative SETI using the KLT [Pesek Invited Lecture]

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Abstract: SETI searches are, by definition, the extraction of very weak radio signals out of the cosmic background noise. When SETI was born in 1959, it was “natural” to attempt this extraction by virtue of the only detection algorithm well known at the time: the Fourier Transform (FT). In fact:

1. SETI radioastronomers had adopted the viewpoint that a candidate ET signal would necessarily be a sinusoidal carrier, i.e. a very narrow-band signal. Over such a narrow band, the background noise is necessarily white. And so, the basic mathematical assumption behind the FT that the background noise must be white was “perfectly matched” to SETI for the next fifty years!

2. In addition, the Americans J. W. Cooley and J. W. Tukey discovered in April, 1965 that all FT computations could be speeded up by a factor of  $N/\ln(N)$  ( $N$  is the number of numbers to be processed) by replacing the old FT with their own Fast Fourier Transform (FFT) algorithm. Then, SETI radioastronomers all over the world gladly, and unquestioningly, adopted the new FFT.

But in 1982, the French SETI radioastronomer François Biraud dared to challenge this view. He argued that we only can make guesses about ET’s telecommunication systems, and that the shifting trend on Earth was from narrow-band to wide-band telecommunications. Thus, a new transform was needed that could detect signals over both narrow and wide bands, regardless of the colored noise distribution over this finite bandwidth. Such a transform had actually been pointed out as early as 1946 by the Finnish mathematician, Kari Karhunen and the French mathematician, Maurice Loève, and is thus named KLT for them. In conclusion, François Biraud suggested to “look for the unknown in SETI” by adopting the KLT rather than the FFT.

Starting in 1990, the author also was “preaching the KLT” at the Italian CNR SETI facilities at Medicina, near Bologna. Their director, Stelio Montebugnoli, was willing to pay attention to him. Little by little, bright students succeeded in programming the KLT algorithm for the Medicina radio telescopes. Finally, by the year 2000, the advent of programmable cards, mastered by Montebugnoli, made the “miracle” happen. The KLT for SETI is now a reality at the SETI-Italia facilities. This paper describes how the KLT breakthrough was finally achieved.