GLOBALEM 2022-The JOLT System: A Retrospective

Jane Lehr and Edl Schamiloglu
Department of Electrical & Computer Engineering
University of New Mexico
Albuquerque New Mexico USA
jmlehr@unm.edu

***Abstract*—** Early in the last century, a realized, ultrawideband radiating system was described to the world in a Special Issue of the Proceedings of the IEEE dedicated to the applications of compact pulsed power technology. The Guest Editor of that Special Issue was Edl Schamiloglu, our Summa Foundation President, and Jane Lehr was the Technical Director for the pulsed power system and co-author of the article [**1,2**]. Dr. David Giri was instrumental in the development of that groundbreaking system – known as JOLT - and a co-inventor of the critical system component known as the impulse radiating antenna (IRA). The foundational research, development of the system, and anecdotes will be discussed.

Keywords- Impulse radiating antenna, radiating systems, ultrawideband

I. INTRODUCTION (HEADING 1)

In his memoir, *My Journey with Carl*, Dave Giri wrote, "***Hyperband Systems*:** Carl wrote a concept paper on radiating impulse-like waveforms (100's of ps wide) in 1989. He helped me to implement the concept that resulted, in 1994, of a highly successful prototype IRA. This work was sponsored under SBIR Phase I and II contract awards from the Air Force Research Laboratory, Kirtland AFB, NM. Since completing that pioneering work, many UWB systems that I and others have built are finding applications in military and civilian sectors." In our judgement, this synopsis is insufficient to describe the rich history and the continuing legacy of impulse radiating antennas and the JOLT system.

Transient high power electromagnetic systems generally consist of a pulsed, high peak power source and an antenna capable of radiating a substantial fraction of its spectral content. The category known as ultrawideband (UWB) or more recently "hyperband" sources provides a radiated electromagnetic environment with a fairly flat spectral content over one to two decades – generally from tens of megahertz to several gigahertz. Such systems have found both military and civilian applications [3], but we contend the impact of JOLT is most significant on the approach to integrated design now called *systems thinking.*

For example, the IRA I – also known as the Prototype IRA – was differentially fed from the source by a center-tapped pulse transformer [4,5]. The IRA I, developed and fielded in 1994, used a high-pressure hydrogen switch, a focusing lens, and a four-arm TEM horn to produce an extremely powerful hyperband pulse from a 3.66-m (12 foot) reflector. With a charge of only 60 kV, this system generated a transient signal with a peak electric field of 4.6 kV/m at a 200 Hz repetition rate. The IRA I system was retrofitted with a 2 m reflector and designated the IRA II [6,7]. The source was modified to provide a peak voltage 75 kV and pulse repetition rate of 400 Hz. The radiated spectrum of the 2 m IRA was measured to be flat in the frequency range 200 MHz to 3 GHz with a band ratio of 10. IRA antennas are known as balanced sources.

JOLT was conceived as a deployable system so that the footprint was confined by the size of the truck bed. After a very short consideration, it was concluded that an unbalanced source was needed for packaging as well as the difficulty in making a balun at the required design voltage. Noting the symmetry, the half-IRA [8] over a symmetry plane was conceived so that the high-voltage signal could feed the antenna directly with a coaxial source line. This system architecture makes the high-voltage design more tractable but lacks the uniformly symmetric field pattern of a full parabolic antenna [9]. JOLT is powered by a very compact and highly efficient 1.6-MV resonant transformer that is connected, via an integrated transfer capacitor and an oil peaking switch, into an 85- half-IRA. This unique system delivered a tightly focused radiated field with a FWHM on the order of 100 ps and a field-range product of approximately 5.3 MV at 200 Hz [10,11].

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