I. Introduction

In collaboration with members of the Atomic Weapons Establishment (AWE), the Advanced Radiographic Technologies Dept. 1645 is conducting research on the development of X-ray sources for flash core-punch radiography. The source development is conducted on the Radiographic Integrated Test Stand (RITS-6) [1,2].

RITS-6 is an Inductive Voltage Adder (IVA) accelerator developed at Sandia National Laboratories for driving high brightness flash x-ray radiographic sources. In its present configuration six induction cells are each driven by an 8Ω parallel water dielectric pulse forming line. The individual induction cells are joined in series by a vacuum coaxial Magnetically Insulated Transmission Line (MITL) which delivers power from the cells to a diode region, where the electron beam is created. The geometry of the accelerator and diode region is shown in Fig. 1a. It is capable of delivering greater than 10-MV, 125-kA, 75-ns pulses to high impedance (> 200 Ω) electron beam diodes. Flexibility in the architecture via changes to the MITL operating point and or geometry also allows for the ability to deliver ~ 7.5-MV, 180-kA, 75-ns pulses to lower impedance (~ 50 Ω) diodes.

A field shaping "knob" is attached (Fig. 1b) at the end of the MITL, just upstream of the diode anode-cathode (A-K) gap. The knob serves to shed excess flow current from the MITL and shield accelerator components from debris generated by the diode. In the diode region, the electron beam is generated at the cathode, accelerated across the A-K gap and impinges the anode. The anode is usually a 1/3 electron-range thick high atomic number (Z) target (e.g. Tantalum) The stopping of the e-beam in the anode/target generates bremsstrahlung radiation. The radiation is extracted in the forward direction and used for imaging dense material via point projection X-ray radiography.

IV. Conclusions

Experiments conducted on the RITS-6 accelerator with a low impedance (40 Ω) MITL and a Self-Magnetic Pinch diode have demonstrated the capability to create 6.5 MeV endpoint energy bremsstrahlung X-rays with radiation output in excess of 350 rads@m and spot sizes in the range of 2.5-3 mm. This specification meets a near term requirement for scaled core-punch radiography and provides the U.S. with the brightest Pulsed Power driven X-ray source developed to date. The results involved both an optimization of the source geometry and the accelerator to drive the source. The radiographic source figure of merit (FOM), defined as the radiation output divided by the square of the spot-size

$$FOM = \frac{dose}{spot^2} \quad (3)$$

is ~ 50 (rads@m/mm^2). For comparison, this source is a factor of 15 times brighter than the Cygnus [16] sources, fielded at the Nevada Test Site and only a factor of 2.5 times less bright than the DAHRT 1[17] source at Los Alamos National Labs.