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The 88-Inch Cyclotron at Lawrence Berkeley National Laboratory is a sector-focused cyclotron that has light- and heavy-ion capabilities and supports a local research program in Nuclear Science and is the home of the Berkeley Accelerator Space Effects Facility, which studies effects of radiation on microelectronics, optics, materials, and cells. The cyclotron utilizes several vacuum electron devices (VEDs) in different systems, mainly to convey plasma heating, high power RF generation, and high-voltage and current DC power generation.

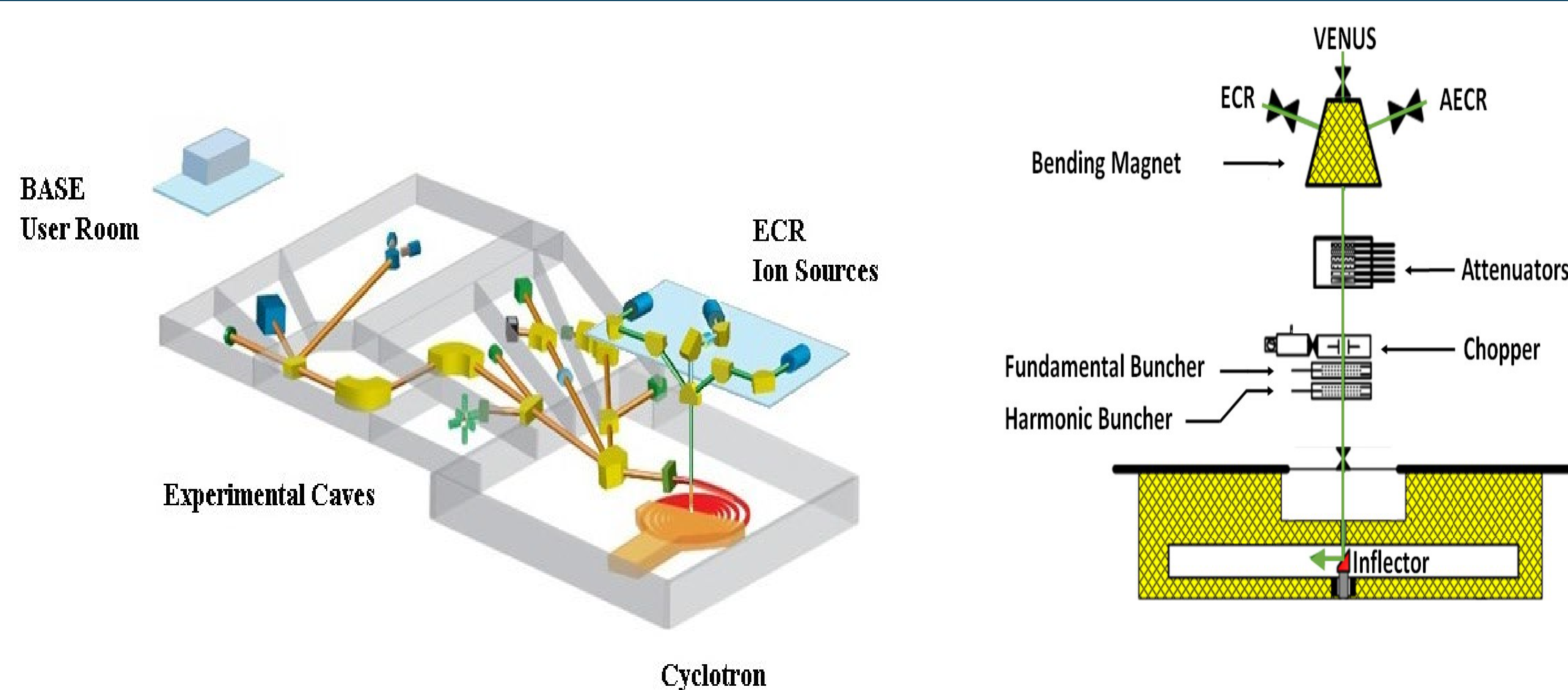
VEDs have been proven reliable, robust, and radiation resistant. They also have wide range, good response against transients, and stable operation with load mismatch during system tuning, instabilities, or breakdowns.

The paper will describe applications of these devices in the 88-Inch Cyclotron.

* Work supported by the U.S. Department of Energy, Office of Science, Office of Nuclear Physics under Contract No. DE-AC02-05CH11231.

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88-Inch Cyclotron¹

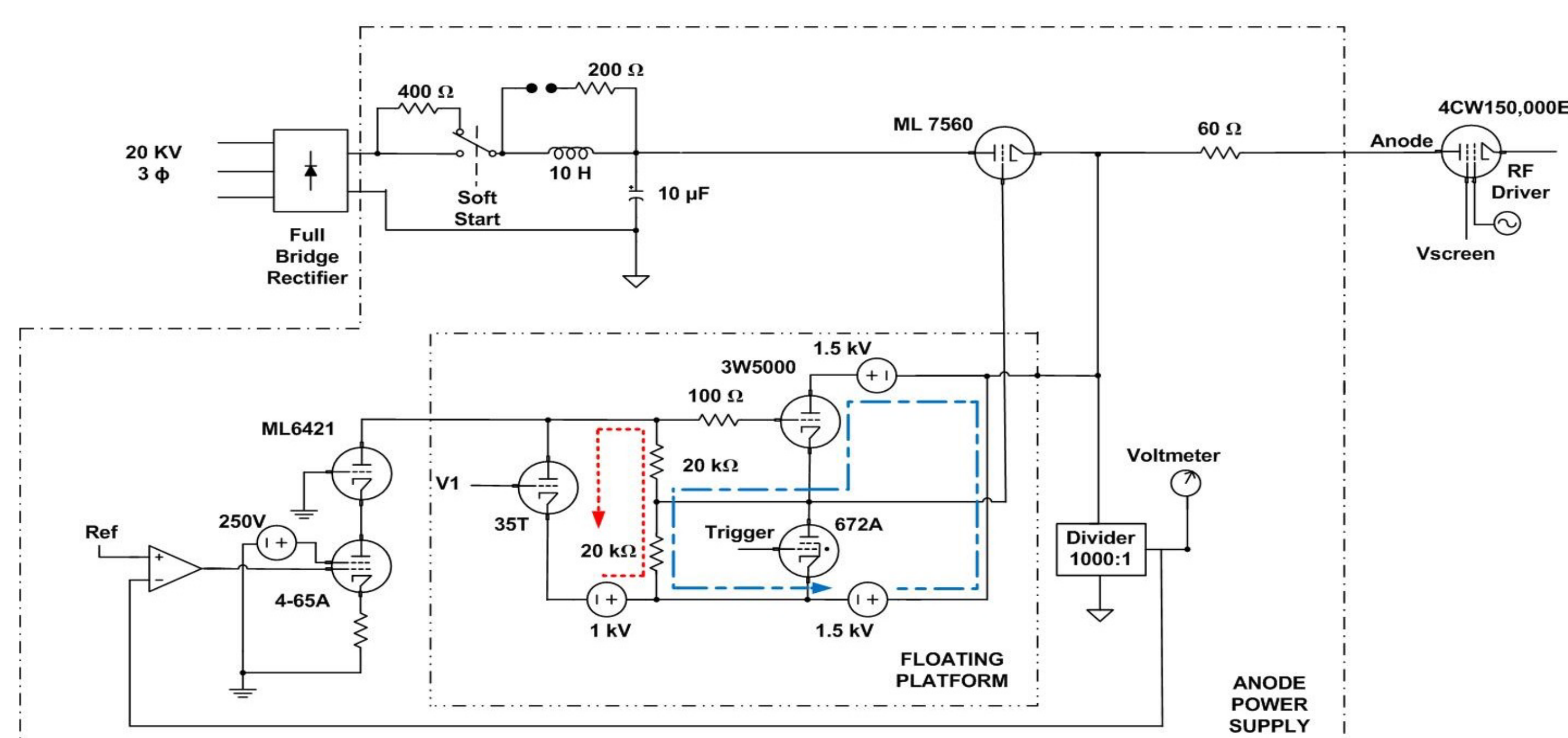


¹ M. Kireeff Covo et al, "The 88-Inch Cyclotron: A One-Stop Facility for Electronics Radiation and Detector Testing", Measurement (2017), doi: <https://doi.org/10.1016/j.measurement.2017.10.018>.

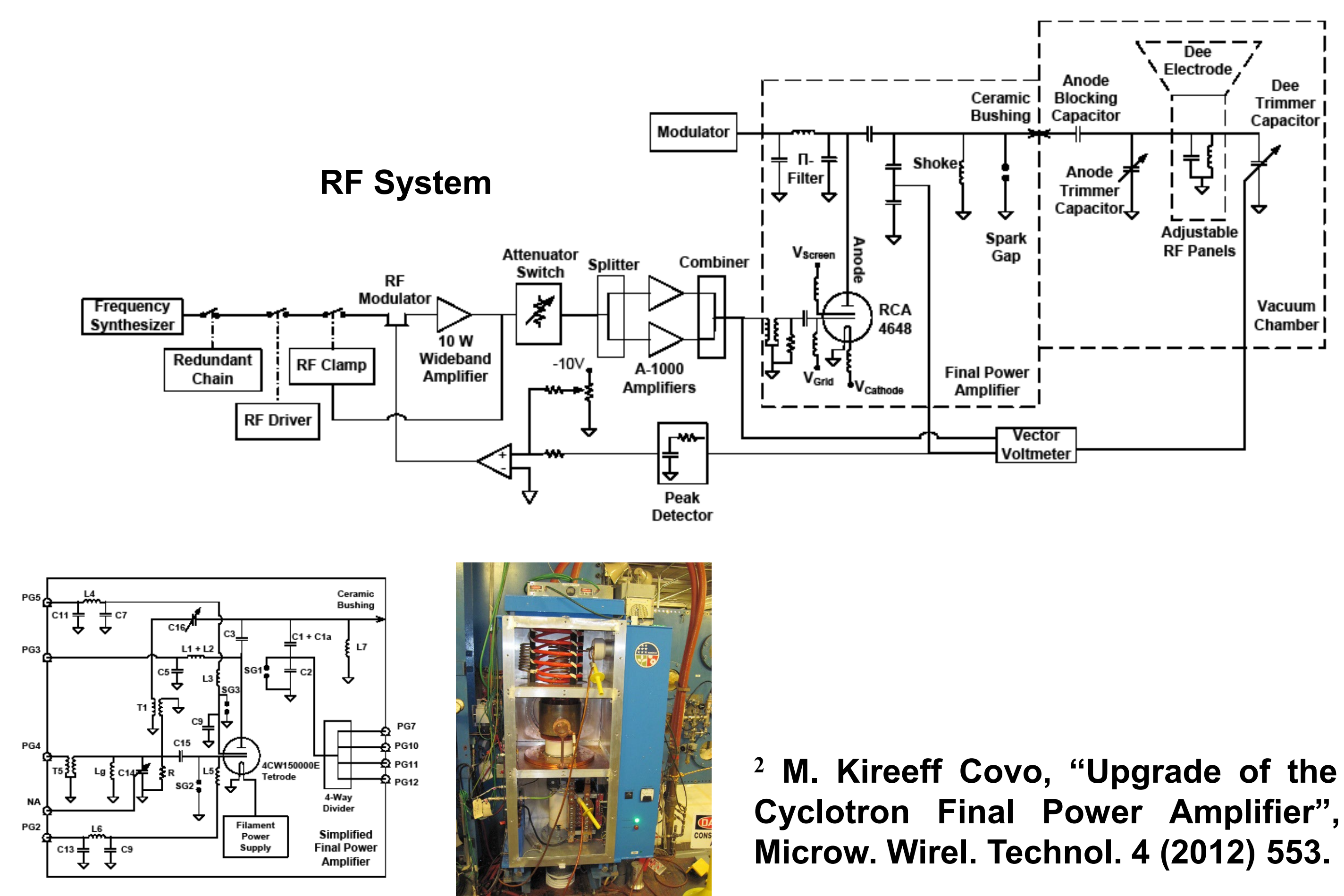
Basic Mechanisms for the Electromagnetic Radiation

1. Cerenkov radiation - when an electromagnetic wave propagates with a phase velocity slower than the speed of the electrons (TWT)
2. Transition radiation - when electrons pass through an inhomogeneous medium (Klystron)
3. Bremsstrahlung radiation - when the electrons are subject to a periodic force created by electric and/or magnetic fields (Gyrotron).

Modulator Power Supply

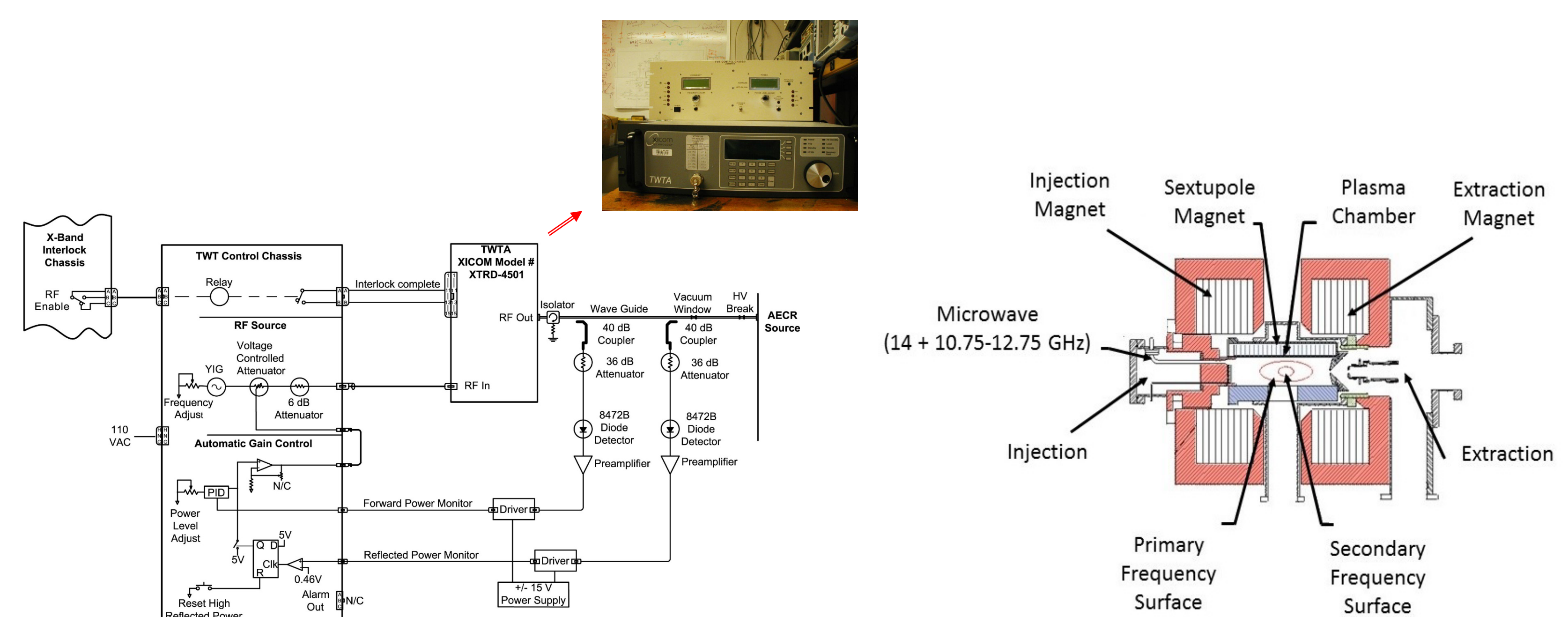


Final Power Amplifier²



² M. Kireeff Covo, "Upgrade of the 88-Inch Cyclotron Final Power Amplifier", Int. J. Microw. Wirel. Technol. 4 (2012) 553.

ECR Ion Source³



³ M. Kireeff Covo et al, "Integrating a Traveling-Wave Tube into an AECR-U Ion Source", IEEE Transactions on Plasma Science (Volume: 39, Issue: 6, June 2011).

Conclusions

VEDs are largely used in the cyclotron because they have been proven reliable and can reach higher RF power than SSDs, besides being tolerant to overloads, voltage spikes, and radiation.