rectifier with capacitive storage, which is essentially an AC-to-DC converter. The SINUS machines have a typical efficiency of $\eta_S = 0.69$, and a power conditioning efficiency of $\eta_{PC} = 88\%$ in the case of three-phase prime power input. The *average* power required from the prime power system is therefore given in terms of the radiated microwave power, $P_{RAD} = 400$ MW, the electron beam pulse length, and the pulse repetition rate (PRR) by the expression

$$\langle P_{PRIME} \rangle = \frac{P_{RAD}\tau_{RF}PRR}{\eta_A \eta_M \eta_{BWO} \eta_S \eta_{PC}} = \frac{(4\times10^8)(5\times10^{-9})(150)}{0.85\times0.95\times0.083\times0.69\times0.88} = 7.4\ \text{kW} \quad (2.3)$$

The difference between the 5-nsec microwave pulse length and the 10-nsec electron beam pulse length is taken account of in Equation 2.3.

The layout of the NAGIRA system within the transmitter cabin is shown in Figure 2.16. The portion of the system on the right, pulse-forming line, high power switch, and impedance transformer, comprise the SINUS pulsed power generator. Note that it takes up a substantial fraction of the length of the container, so that the transmission line is bent upward to the BWO, which is surrounded by a cryostat for its superconducting magnet. The quasi-optic feed couples the BWO output to the transmitting dish antenna through open air. Although not labeled, it would appear that the motor generator supplying prime power is located at the back of the container, opposite the pulse former.

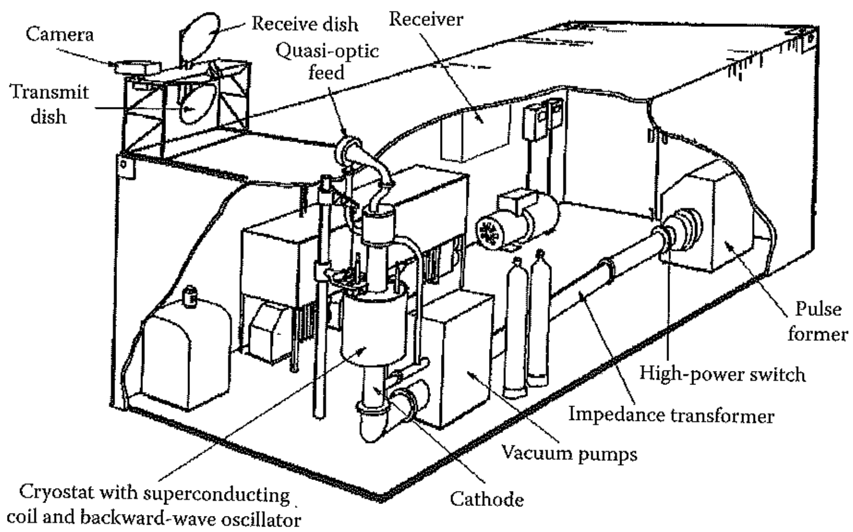

FIGURE 2.16
Schematic of the transmitter cabin of the NAGIRA system. (From Clunie, D. et al., The design, construction and testing of an experimental high power short-pulse radar, in *Strong Microwaves in Plasmas*, Litvak, A.G., Ed., Novgorod University Press, Nizhny Novgorod, Russia, 1997. With permission.)

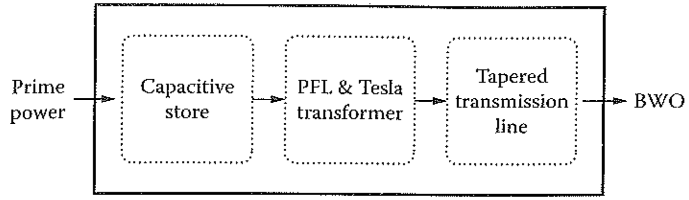

FIGURE 2.17
Top-level schematic of the SuperSystem. (From Clunie, D. et al., The design, construction and testing of an experimental high power short-pulse radar, in *Strong Microwaves in Plasmas*, Litvak, A.G., Ed., Novgorod University Press, Nizhny Novgorod, Russia, 1997. With permission.)

2.5.2 Constructing a SuperSystem

Using information for other NAGIRA-like systems, as well as models for the individual components of the NAGIRA system, we can construct a model of the SuperSystem itself. To define the performance required of the components of the SuperSystem, we work backward through the system, from the microwave output requirements to the prime power. A top-level schematic for the SuperSystem is shown in Figure 2.17. We include the effect of the parameters τ_B and τ_{TB} only on the prime power, which implies that we ignore the effect of these parameters on the mass and volume of the cooling system required for the pulsed power and BWO. Since both elements of the system will probably only just reach their equilibrium temperature during a burst, this assumption is justified.

In the following, we will rely on phenomenological models with assumed parameters. For example, we will assume an efficiency for conversion of electron beam power to microwave power at the output of the microwave source; no attempt will be made to compute or even estimate that efficiency from first principles. Rather, it is an independent input parameter; we will choose a value in line with those observed in actual experiments. We can vary it to uncover the effect on SuperSystem. This is one of the key elements of the process of scoping a system using a systems modeling approach.

2.5.3 Antenna and Mode Converter

Returning to Table 2.1, we see that the system is to operate in the X-band, so we choose a frequency of 10 GHz. The gain of the system antenna is to be 45 to 50 dB. Denote this gain, measured in decibels, G_{dB}. This value actually corresponds to an actual numerical value of (see Section 5.5)

$$G = 10^{G_{dB}/10} \quad (2.4)$$

For G_{dB} between 45 and 50 dB, G lies between about 3.2×10^4 and 10^5. In terms of the antenna diameter D and the frequency and wavelength of the microwave output, f and λ, G is given for a parabolic dish antenna by