Sidewall Waveguide Slot Antenna for High Power

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For radiating high-power hypoband (narrow band) microwaves, one is faced with significant electrical breakdown problems. One approach involves dividing a rectangular waveguide with metal septa perpendicular to the electric field of the basic $H_{1,0}$ mode. This ideally avoids large electric-field enhancements. Each subguide so formed is then expanded to a large aperture with lower electric field. The set of subguides then leads to a large compound aperture with appropriate control of the phase across the compound aperture to control the direction of the antenna radiation (or radiation pattern). This can be called a split-waveguide antenna.

The polarization of the radiated field is in the plane containing the waveguide axis. One might then ask if there is some kind of design for similar high powers, but with polarization perpendicular to this plane containing the waveguide axis.

The general class of waveguide arrays includes slot arrays, which have found many applications. A general problem for gigawatt applications concerns electrical breakdown at the slots, even with high-dielectric-strength media (vacuum, SF6) in and around the waveguide, due to electric-field enhancement near the slots. We need to consider designs which minimize this problem. However, it may be difficult to approach the high-power performance of the split-waveguide antenna.

This general design concept leaves various pieces for detailed consideration. The slot shapes (with sharp edges removed, etc.) need to be optimized. The slots, in turn, need to be appropriately transitioned to the external environment.

As the slots become larger, eventually they become large perturbations of the waveguide, making analysis more difficult, and possibly introducing electrical breakdown due to the large electric fields. In this case, the techniques with septa become more attractive. In this case the subguides make H-plane instead of E-plane bends. Then bend radius and overall size need to be considered.