

I. INTRODUCTION

Transmission line technology has developed considerably since high power gyrotrons first became available for electron cyclotron heating (ECH) experiments in the late 1970s and early 1980s.

Except for some experiments at Moscow's Kurchatov Institute, most ECH experiments began in the 28 to 70 GHz range. The available gyrotrons at these relatively low frequencies typically produced output power in TE_{0n} modes, for which smooth-wall waveguides were suitable. Power levels of up to 200 kW could be transported at atmospheric pressure in these waveguides.

Various techniques were used at the end of the transmission lines to transform the TE_{0n} fields into fields that radiated better into plasmas. Some of these techniques were quasi-optical, using specially shaped mirrors. Waveguide mode converters were also developed to produce the HE_{11} waveguide mode, which was known from antenna theory to have good radiation characteristics.

Curved waveguide bends propagating TE_{0n} modes require corrugated waveguide walls to minimize mode conversion losses, so techniques for making corrugated waveguide were developed. It was soon discovered that low-loss corrugated waveguide bends propagating HE_{11} could be more compact than those propagating TE_{0n} modes. Since corrugated waveguides could also be used for propagating HE_{11} in straight