

Specifications of 36 GHz gyroklystron

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on behalf of research teams of

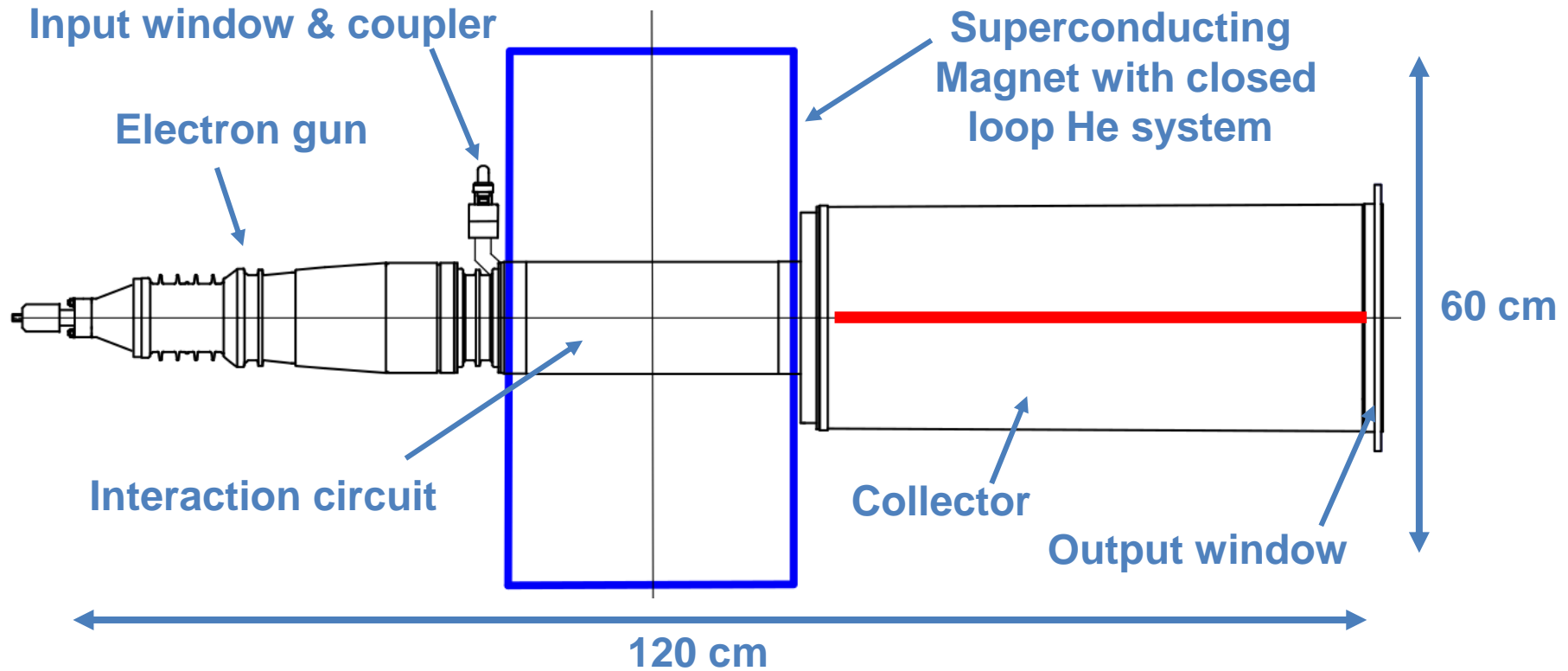
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Dimensions of gyroklystron

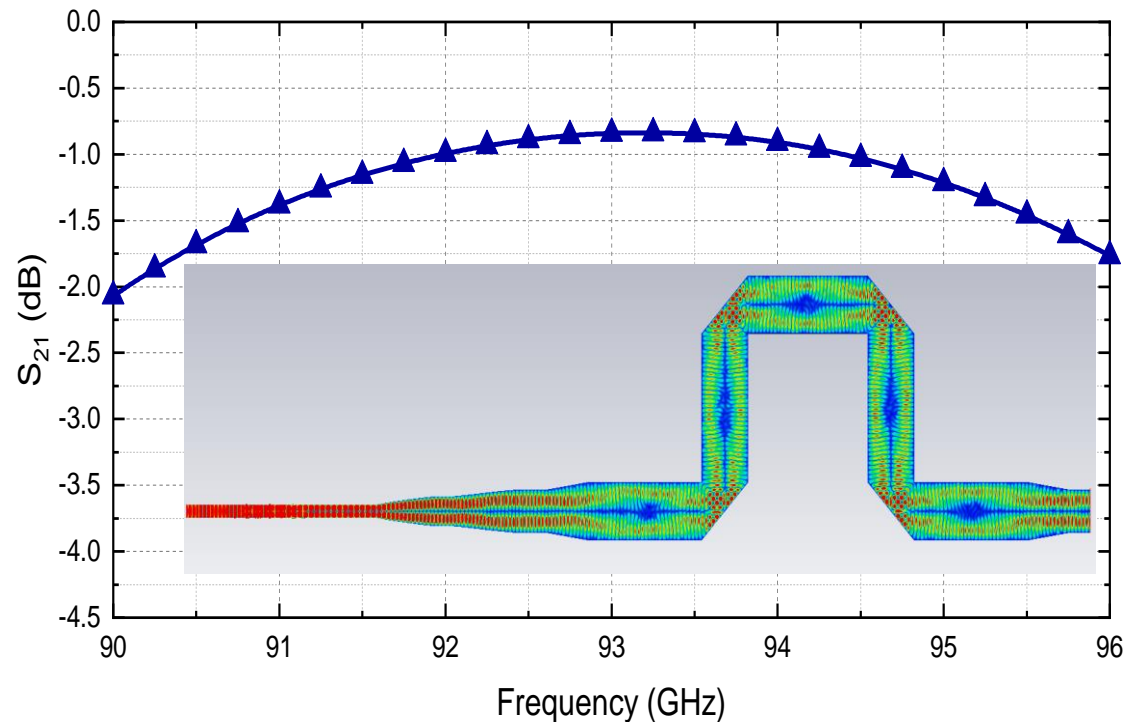
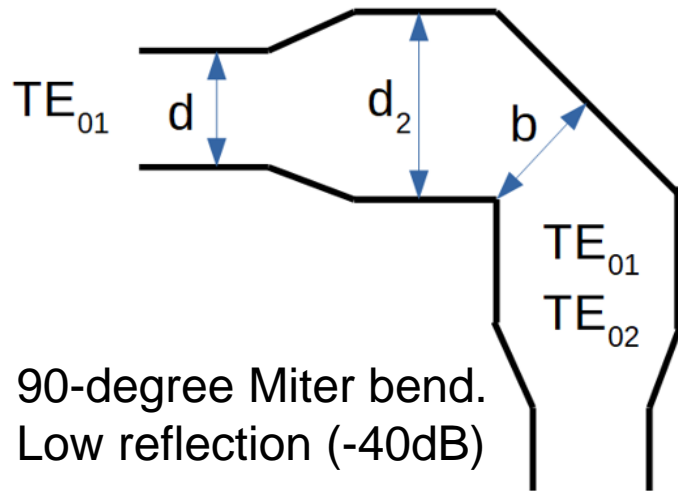


- Output is in the axial direction
- Output mode is TE_{02} in circular waveguide, can be converted to TE_{01} mode easily with a waveguide taper

TE_{01/02} transmission line

Transmission line system is composed of:

- (1) Waveguide taper (conversion between TE₀₁ to TE₀₂ mode)
- (2) Miter bend
- (3) Straight waveguide (low loss ~0.02 dB/meter)



- A complete design has been done at Strathclyde at W-band 94 GHz with -0.75 dB loss for a total length of 20-meters

Specifications

Beam voltage / Beam current	150 kV / 50 A
Output power / 2nd harmonic power	3.2 MW / 2.3%
Output power stability	0.4% @0.5% variation of the modulator voltage
Output frequency / 3dB bandwidth	36 GHz / 108 MHz (0.3%)
Magnetic field and frequency drift	1.46 T and < 1 MHz frequency drift due to the drift of magnetic field
Frequency drift due to beam voltage	24 MHz @0.5% / 4.8MHz @0.1% variation of the modulator voltage
Pulse repetition rate / Duration	1000 Hz / 1.5 us
Drive power / Gain	410 W / 39 dB
Input / output waveguide mode	Input TE ₁₀ (Rectangular) mode, output TE ₀₂ (Circular) mode
Efficiency	43% (without energy recovery), 58.0% (with single stage depressed collector)
Average spent beam power	6.5 kW (mm-waves on), 11.3kW (mm-waves off)
Dimensions	60 cm (W) * 60 cm (L) * 1200 cm (H)
Phase stability	17.0 degree @ 0.5% variation in modulator voltage 3.4 degree @ 0.1% variation in modulator voltage 0.34 degree @ 0.01% variation in modulator voltage

Specifications of the commercial superconducting magnet

Guide magnetic field	1.46 T
Type	Cryogen Free Superconducting Magnet
Candidate vendor	Cryogenic Ltd
Magnetic field accuracy	0.08%
Stability over time	0.002%/hour
Stability over temperature	0.002%/K

Reference:

http://www.cryogenic.co.uk/sites/default/files/product_files/sms_series_sample_users_manual.pdf

Specifications of the power modulator

Operating voltage	150 kV
Operating current	50 A
Candidate vendor	ScandiNova
Product model	K Series K100 (with enhanced option to 1000 Hz)
Typical pulsed voltage range	115 – 190 kV
Typical pulsed current range	90 – 140 A
RMS Voltage stability	0.02%
Dimensions	166 cm * 70 cm * 220 cm

Reference: <https://scandinovasystems.com/content/uploads/2020/04/scandinova-productsheet-k100-200421.pdf>

Meet the requirements of the 36 GHz linearizer

1. Consider a loss of 2% in the TE01 transmission line, the input power at the pulse compressor is $3.2 \text{ MW} * (1 - 2\%) = 3.13 \text{ MW}$
2. For the pulse compressor with 1394 ns pulse length input, the power gain is 7.65
 - The output of the compressor (with 5% loss) is $3.13 \text{ MW} * 7.65 * (1 - 5\%) = 22.7 \text{ MW}$ (larger than required 22 MW)
3. The phase stability is proportional to the variation of the modulator voltage
 - It is 3.4 degree per 0.1% variation on the modulator voltage
 - The phase stability is 0.34 degree at 0.01% voltage variation (less than 0.5 degrees required by lineariser)
4. The output power stability is 0.4% at 0.5% variation of the modulator voltage, which satisfies the requirement of 1%
5. The output mode of the gyroklystron is TE02 in circular waveguide
 - It can be converted to TE01 simply by using a circular waveguide taper

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INTEGRATED CAPABILITY from IDEA to DEMONSTRATOR

