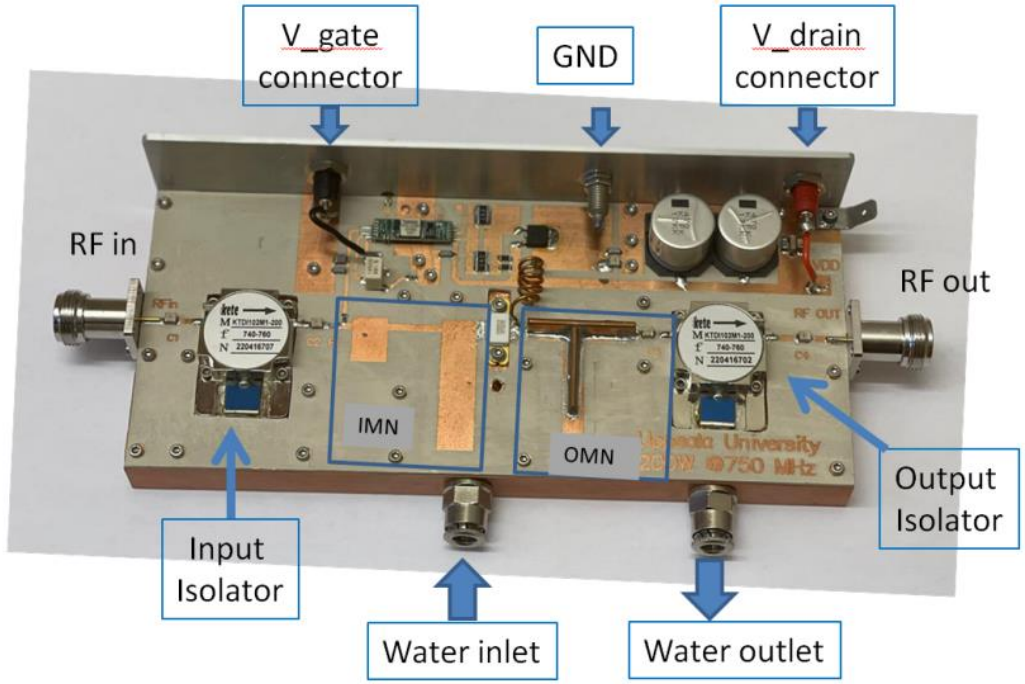
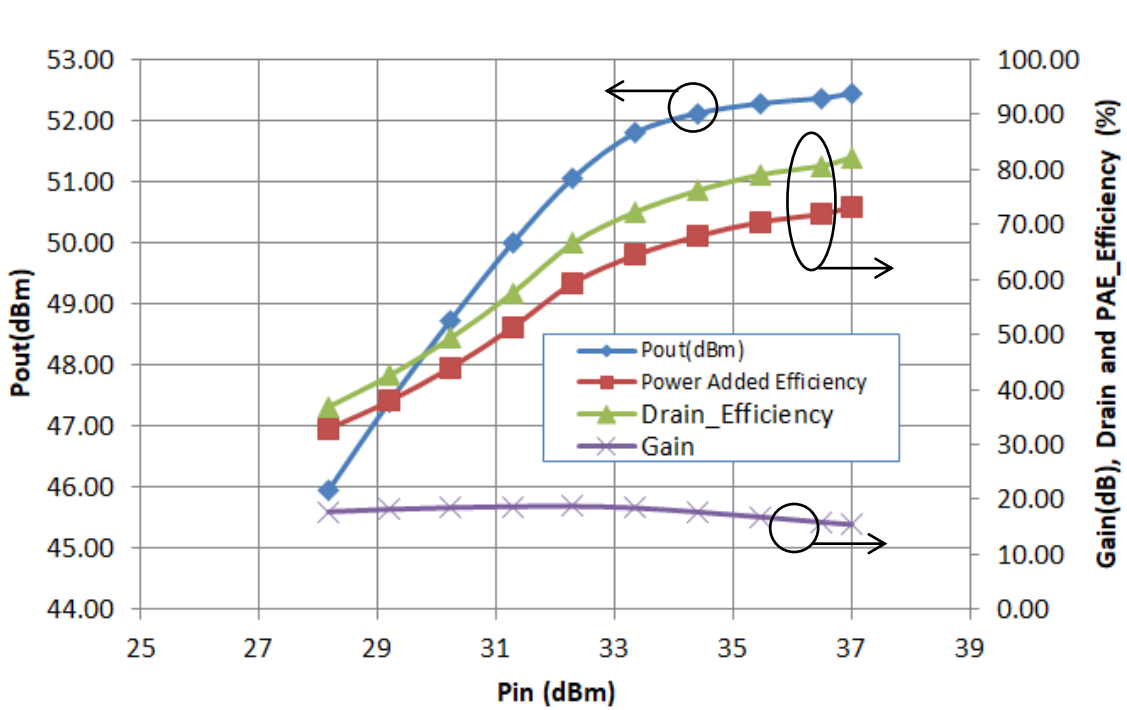
Outline

- *This presentation outlines the design and implementation of a 1 kW Gallium Nitride (GaN) RF solid-state power amplifier operating at 750 MHz. It builds upon the 200 W solid-state amplifier. Six 200 W amplifiers are combined to achieve a 1 kW output, requiring a low loss combiner.*
- *The designs of a binary 6:1 power combiner and a 1:6 power splitter are also presented in this presentation today.*
- *A comprehensive testing show 82.45% drain Efficiency at 1148 W output power.*
- *This amplifier will be used as a driver amplifier for the CFA amplifier. The whole chain could serve as an RF power generator for the RFQ at 750 MHz that was developed at CERN.*

D13.3: GaN RF Amplifier Module at kW level

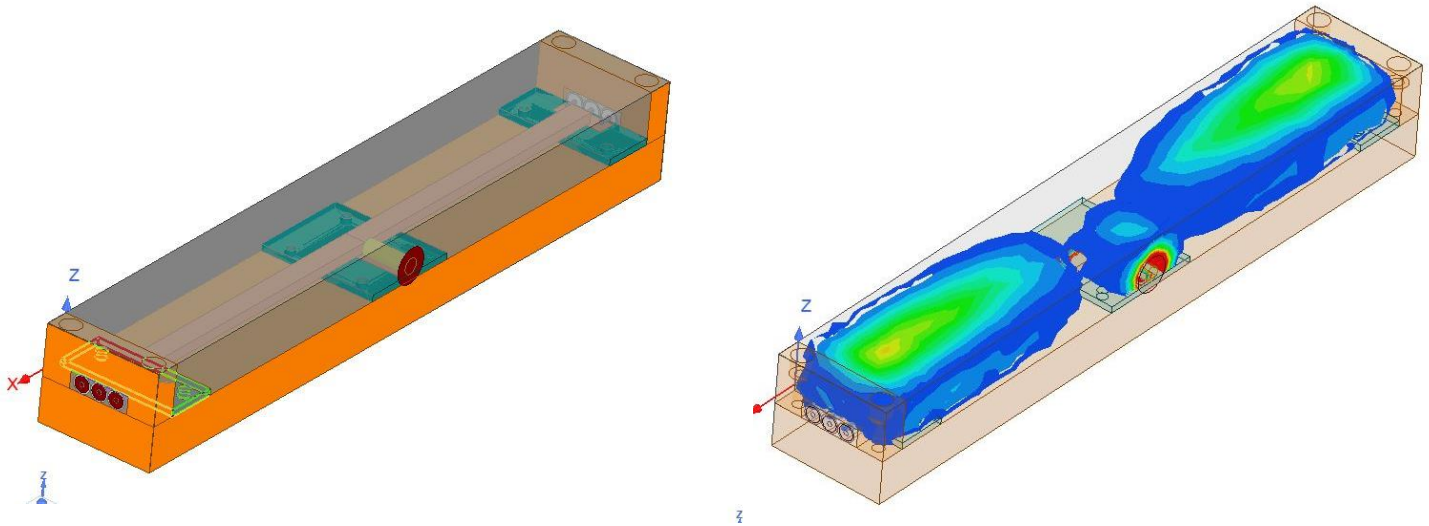


Fabricated 200W solid-state RF power amplifier at 750-MHz

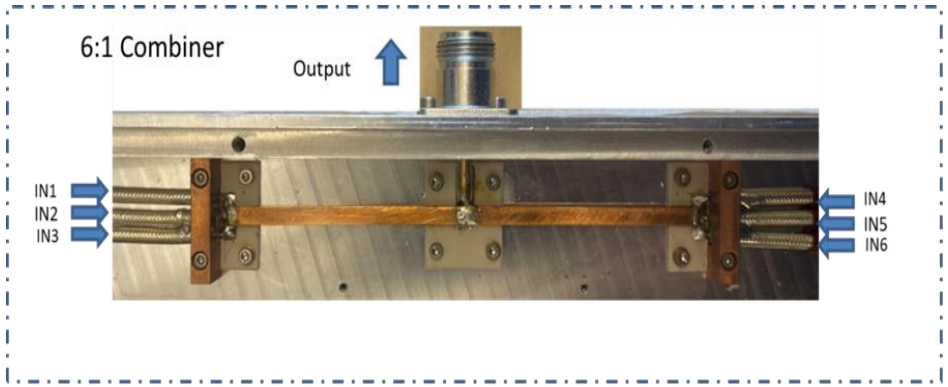


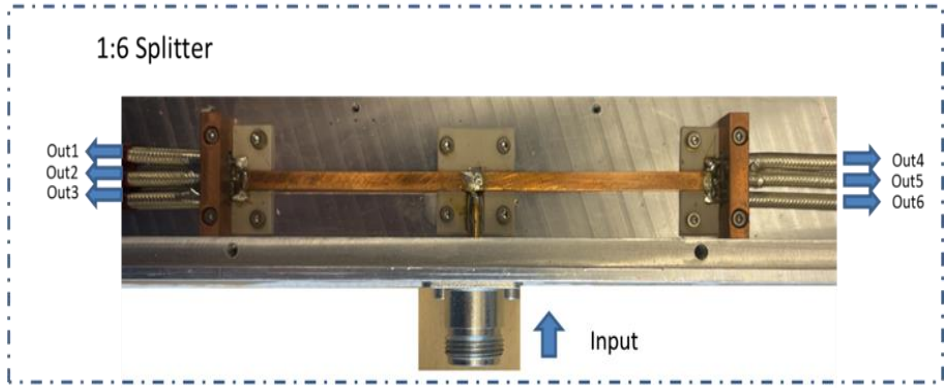
Measurement results of 200W solid-state RF power amplifier at 750 MHz

D13.3: GaN RF Amplifier Module at kW level



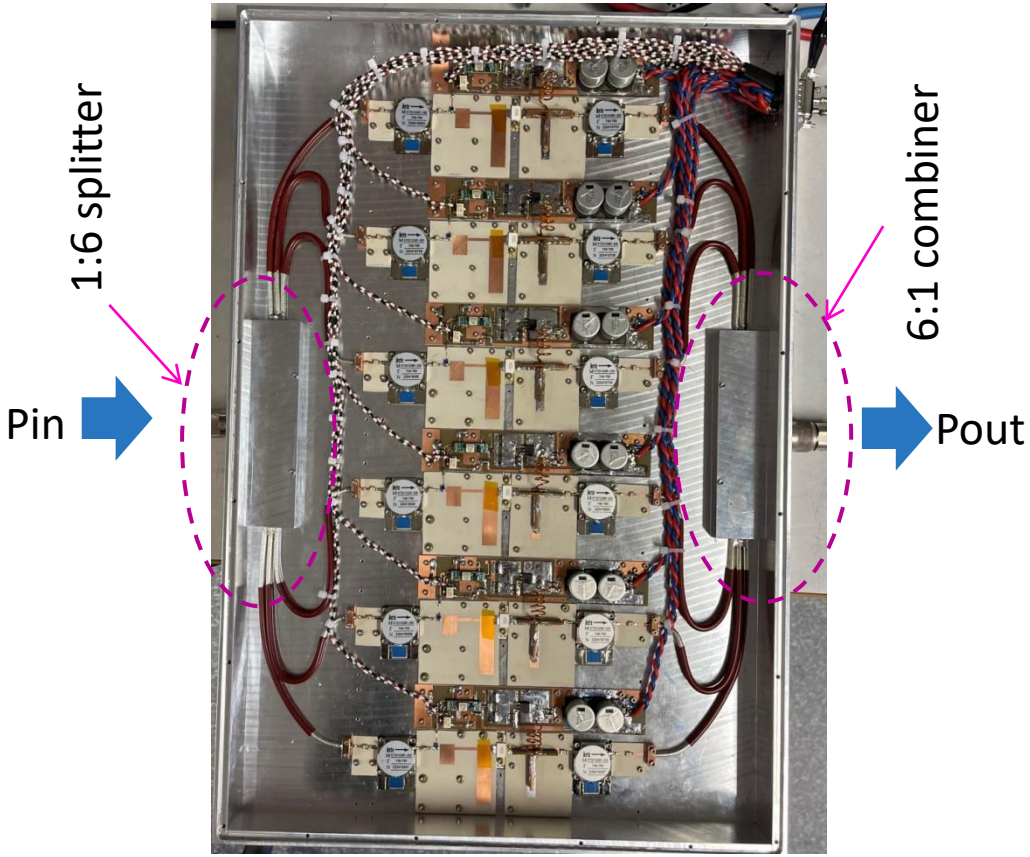
Simulated high power 1:6:1 splitter/combiner at 750 MHz.



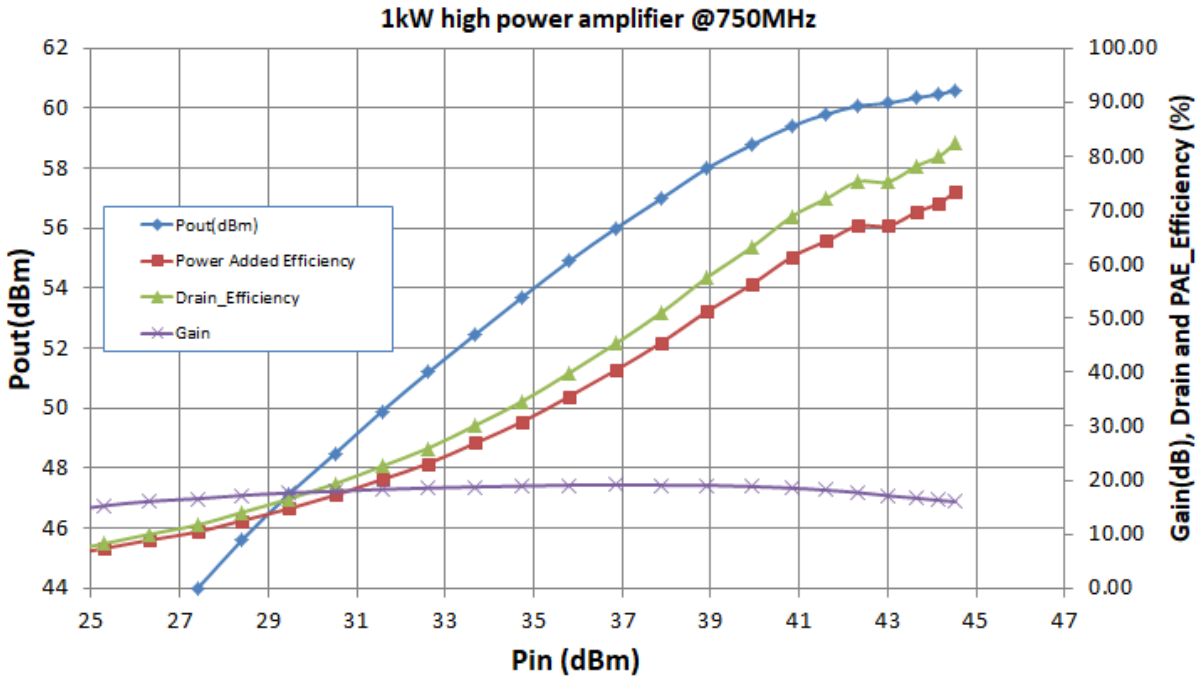


Implemented high power 1:6:1 splitter/combiner at 750 MHz with 0.15 dB insertion loss.

D13.3: GaN RF Amplifier Module at kW level



Implemented 1kW RF high power solid-state amplifier including DC bias circuits, 6 200-w RF power amplifiers, and the RF splitter and combiner.



$P_{in(dBm)}$	Pout(dBm)	Pout (W)	PAE(%)	I_Drain (A)	DE (%)	Gain
43.02	60.17	1039.92	67.09	31	75.28	17.15
43.66	60.35	1083.93	69.71	31.1	78.21	16.69
44.16	60.46	1111.73	71.26	31.2	79.96	16.30
44.53	60.60	1148.15	73.48	31.25	82.45	16.07

Measurement Results including Signal Gain, Output Power, Drain Efficiency, and Power Added Efficiency at 750MHz.

Comparison and conclusion

Reference	Operating class	F_{min} (MHz)	F_{max} (MHz)	P_{out} (dBm)	Gain (dB)	PAE_{min} (%)	Package/Die	Technology	Institution
2023 [This work]	Class B	750	-	60.60	16.07	73.48	packaged	GaN	FREIA – Uppsala U.
2020[1]	Push pull	24.5	27	59.8	25	83	packaged	LDMOS	FREIA – Uppsala U.
2019[2]	Class AB	400	450	60	15	-	Packaged	GaN	SSPL - Delhi
2018[3]	Class AB	UHF	-	67.2	-	55	Packaged	GaN	CETC - Nanjing
2017[4]	Class AB	1200	1400	64	16.7	55	packaged	LDMOS	USTB - Beijing
2016[5]	Class AB	352	-	60.9	20.5	71	Packaged	LDMOS	FREIA – Uppsala U.
2016[6]	Class AB	200	500	40	18	71	packaged	GaN	CESAT - Islamabad
2016[7]	Class B	420	450	60	25	73	3 chip Packaged	GaN	Integra Tech. - CA
2020[8]	Class E	400.8	-	63.6	22	70	Die	GaN	Integra Tech. - CA
2018[9]	Class E	680	750	47	-	80	packaged	GaN	U. of Cantabria
2018[10]	Class E	100	-	60.8	-	82	packaged	LDMOS	FREIA – Uppsala U.
2017[11]	Harmonic tuned	420	450	60	40 (two stages)	75	Packaged	GaN	Integra Tech. - CA
2017[12]	Class E	670	900	44.7	-	70	packaged	GaN	U. of Cantabria
2016[13]	Class F	704	-	58	-	79	packaged	GaN	Green Mountain Radio Research
2016[14]	Class F	550	950	40	15	75	packaged	GaN	U. of Calgary
2011[15]	Class F	550	1100	40	10	74	packaged	GaN	Cardiff U.

***Blue for linear classes, Orange for nonlinear classes.**

However, achieving high power efficiency is often a trade-off with other parameters such as bandwidth, linearity, gain, and cost. Nonetheless, the design with an 82.45% power efficiency and 1-kW output power at 750 MHz frequency is a commendable and demonstrates a well-designed and efficient amplifier based on GaN technology. It also shows the feasibility of implementing a high efficiency, high-power solid–state amplifier with high reliability and high MTBF features.

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Thank you for your attention!

This project has received funding from the European Union's Horizon 2020 Research and Innovation programme under GA No 101004730.