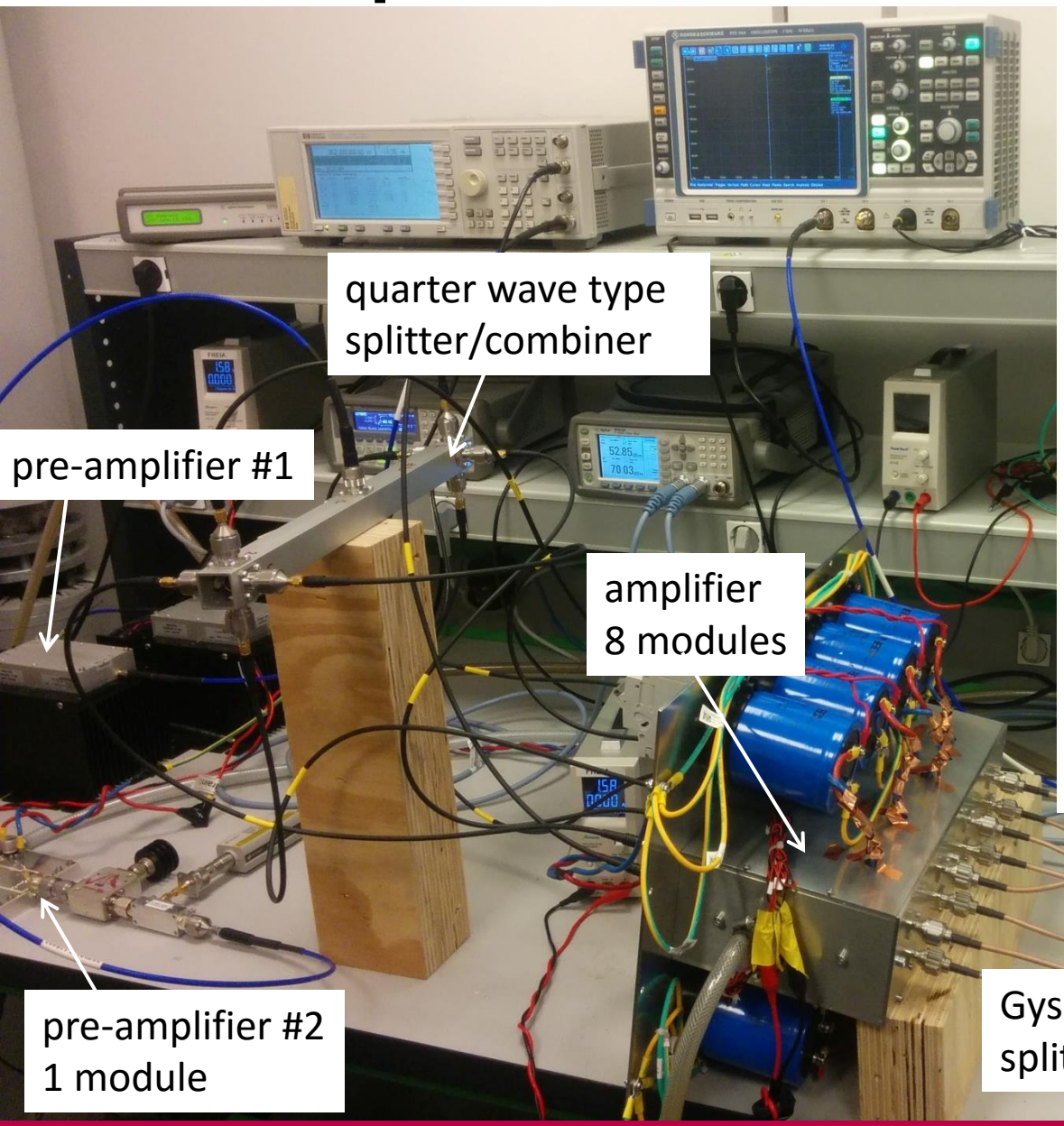
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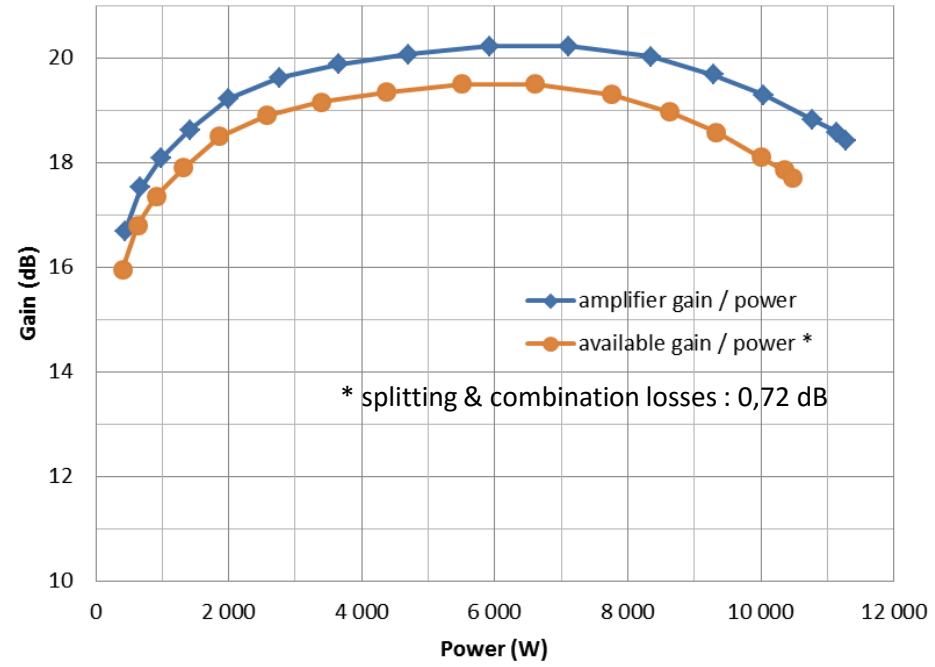
10 kW 352 MHz amplifier at FREIA - final demonstration

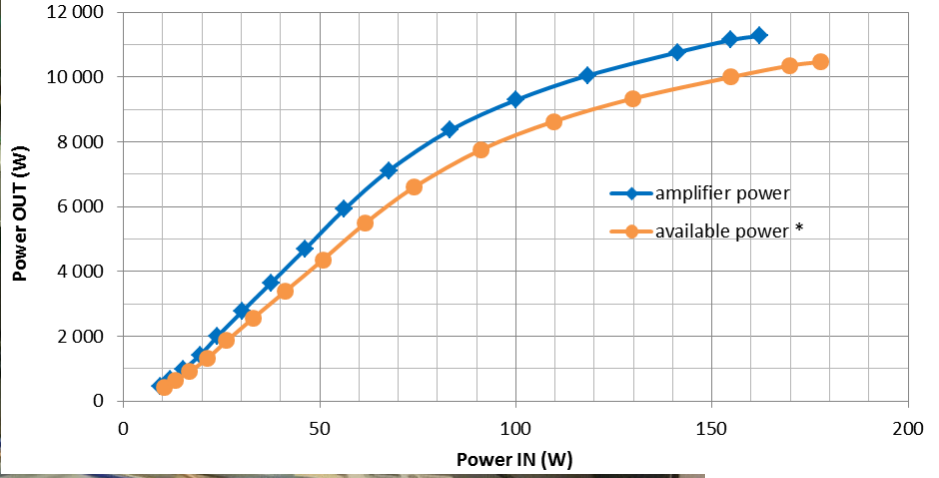
Dragos Dancila, Long Hoang Duc, Magnus Jobs

2016 09 05

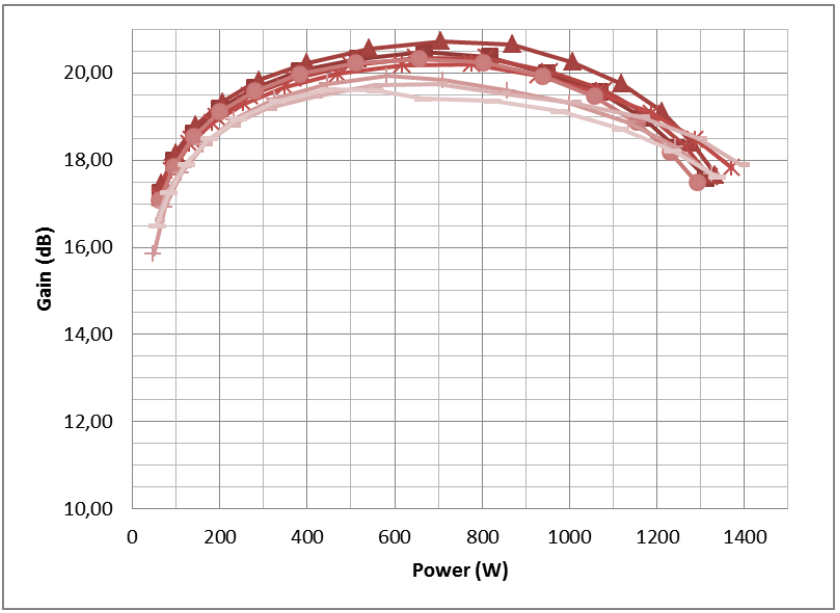
10 kW 352 MHz amplifier at FREIA

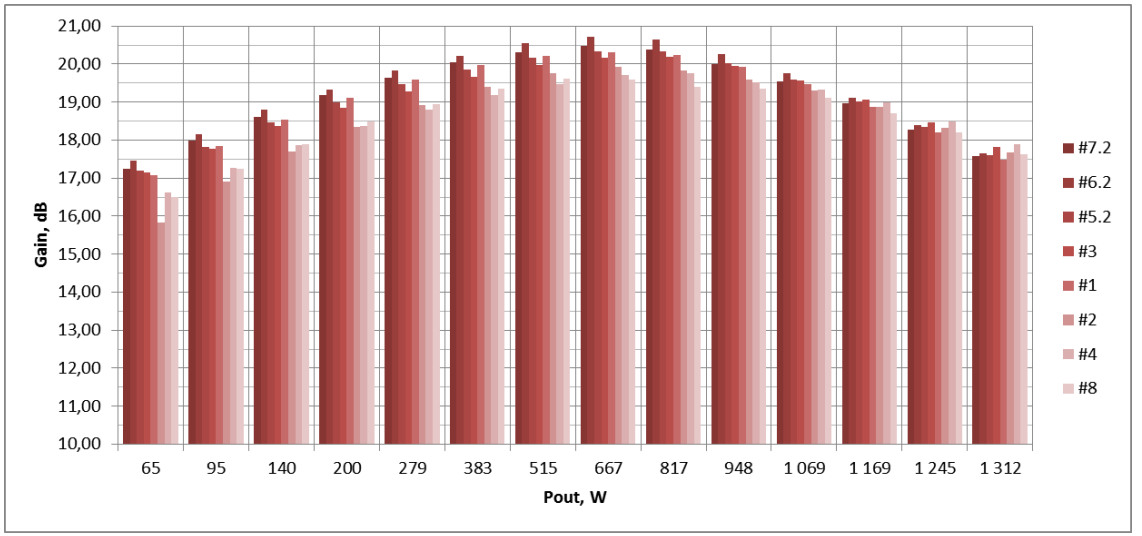


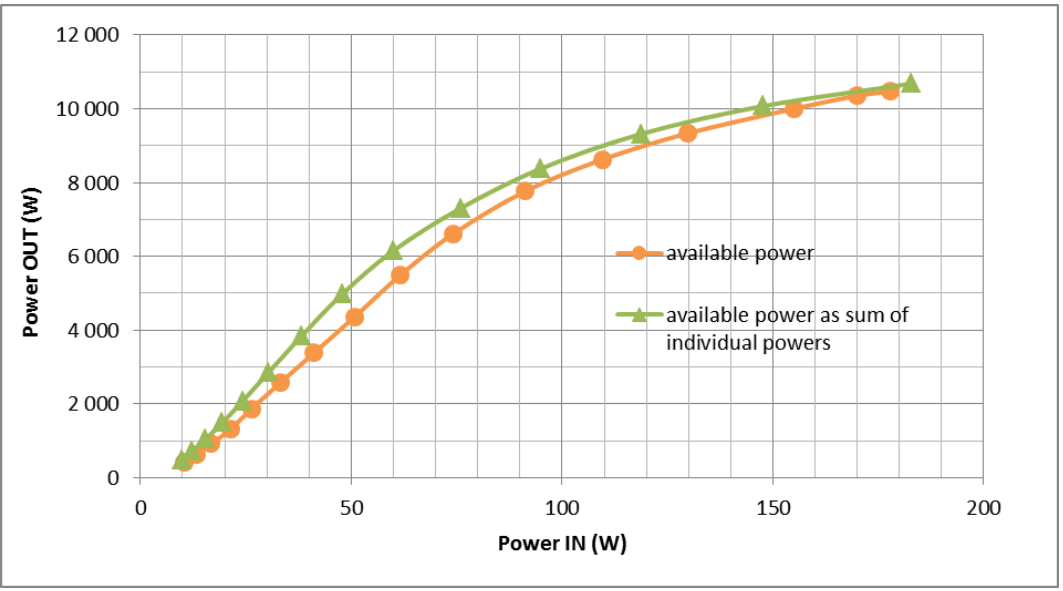


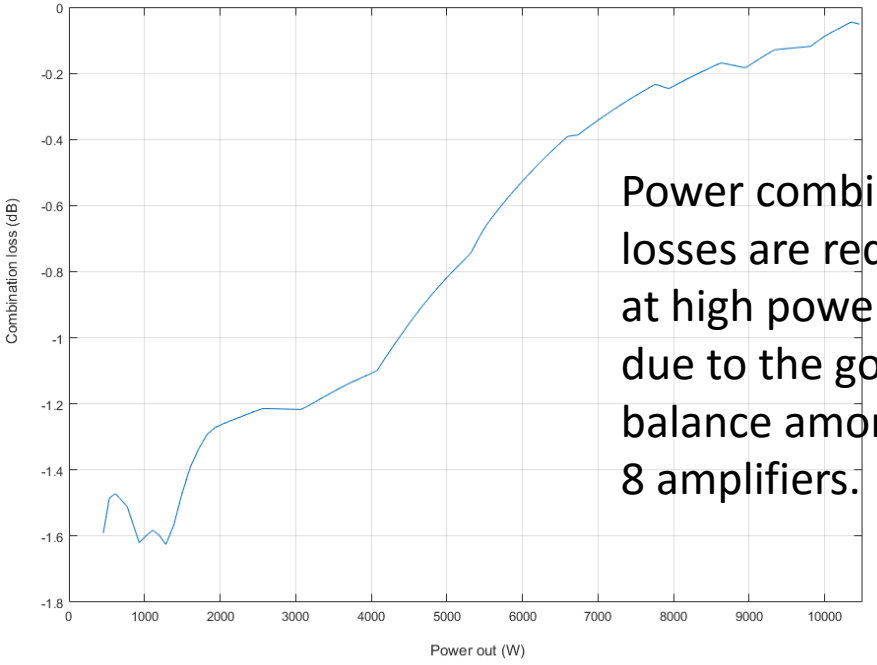


Spread among the 8 amplifiers







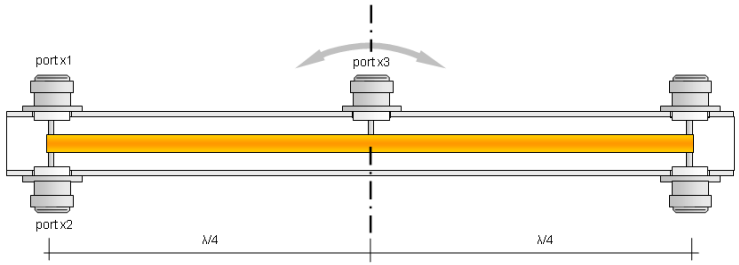


Power combination losses are reduced at high power levels due to the good balance among the 8 amplifiers.

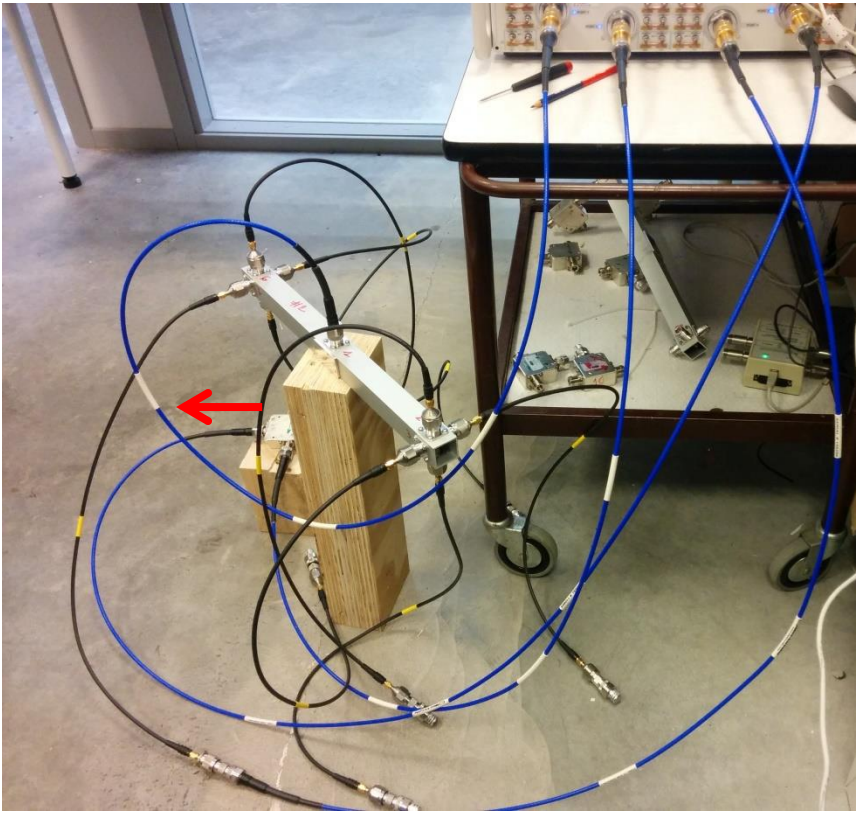
8:1 λ/4 splitter/combiner

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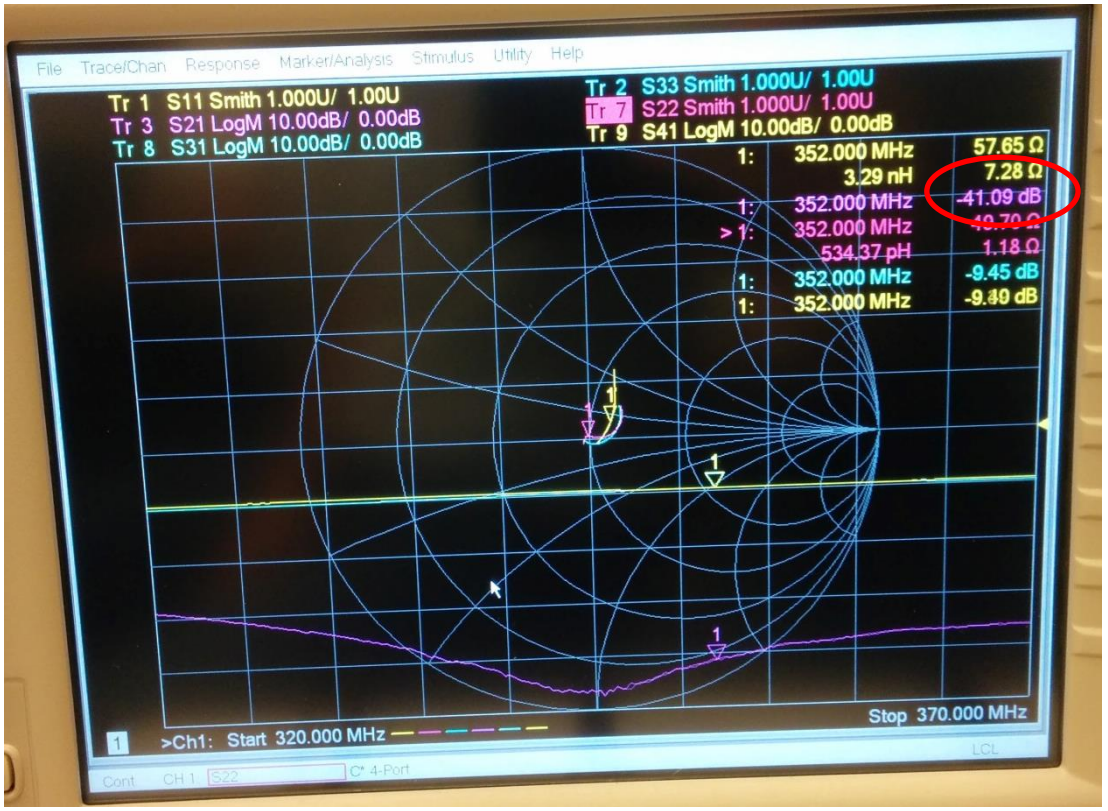
Low cost
Low IL
High power



Thanks Tord Peterson



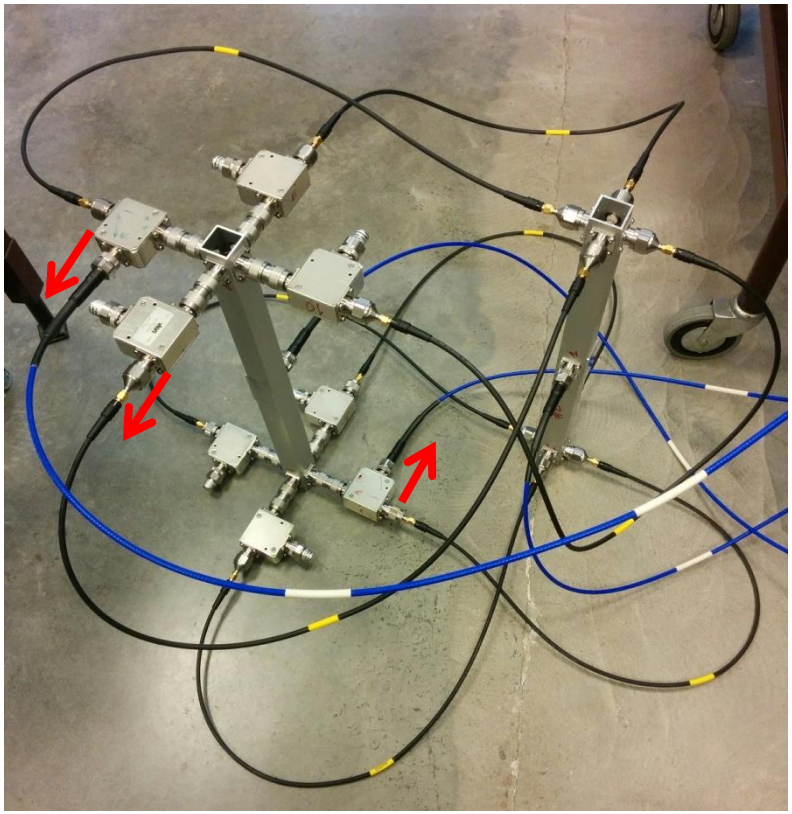
1:8 splitter connected to 8 loads.
Circulator is used to measure RL



RL is at -41 dB level
we can deduce the RL of the combiner at -32 dB

8:1 λ/4 splitter/combiner

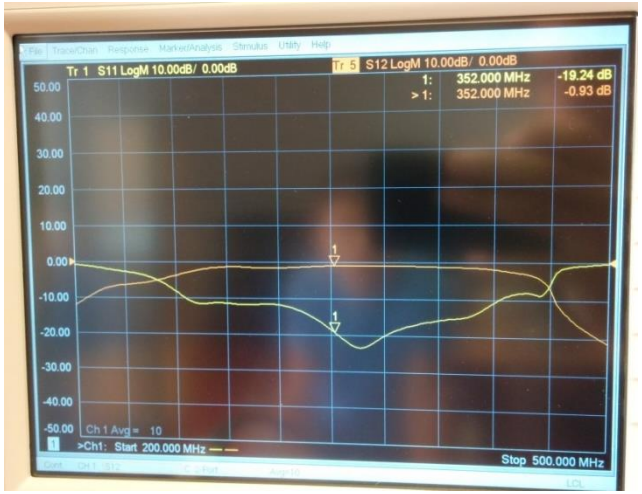




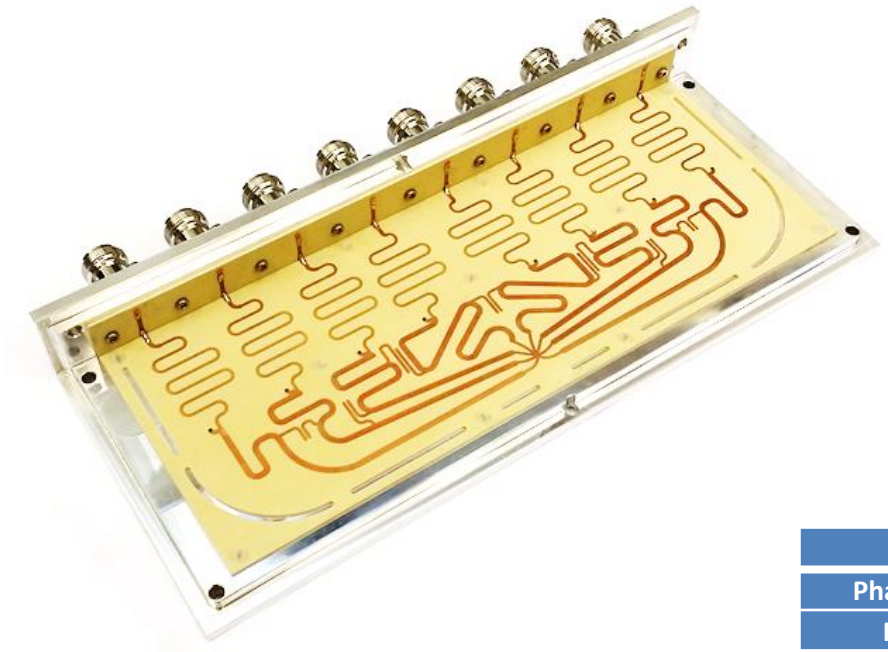
1:8 splitter connected with circulators to the 8:1 combiner

RL is at -28 dB level
considering 1:8 splitting/combination
we can deduce the RL of the combiner at -17 dB
higher RL due to slightly phase and amplitude imbalances

Measured IL 0.93 dB
(with cables 0.3 dB
and circulator 0.2 dB)
We can deduce the
splitter/combiner
IL = 0.2 dB



Gysel Combiner



- Aluminum Casing
- High Integration Factor
- Integrated Loads
- Easily Reproducible
- Average Insertion Loss (IL): 0.2dB
- Peak Power (Tested): 10 kW

Measured Performance

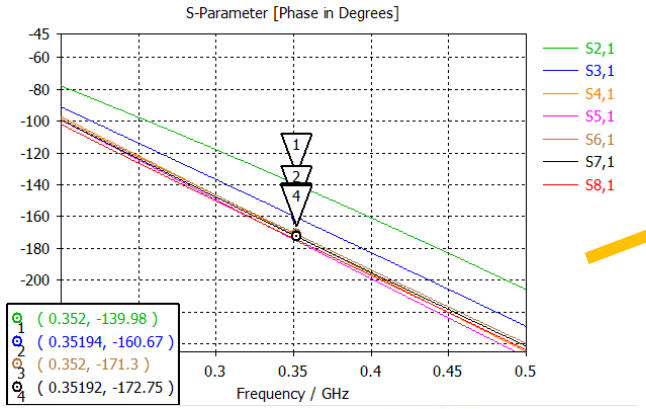
	1	2	3	4	5	6	7	8
Phase [deg]	121	117	117	120	120	117	117	121
Mag [dB]	-9.24	-9.32	-9.24	-9.16	-9.19	-9.27	-9.29	-9.15



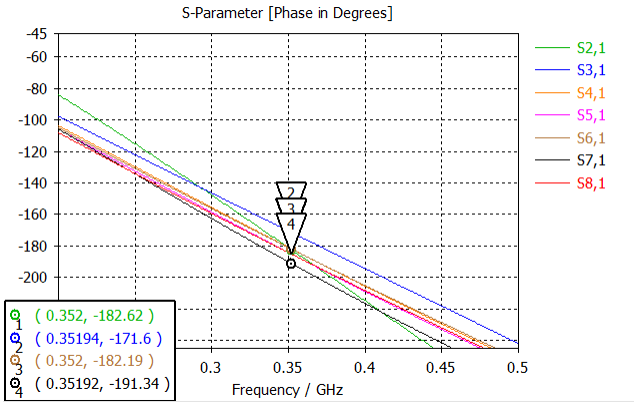
	1	2	3	4	5	6	7	8
1	-21*	-24.7	-23.7	-24.2	-24.1	-23.7	-23.4	-22.7
2		-24*	-27.5	-26.8	-26.3	-24.8	-24.9	-23.6
3			-21*	-26.4	-27.3	-25.2	-24.9	-23.3
4				-23*	-30.6	-27.1	-26.1	-24.1
5					-25*	-26.2	-26.5	-24.2
6						-25*	-27.1	-23.7
7							-26*	-24.9
8								-26*

Gysel Combiner

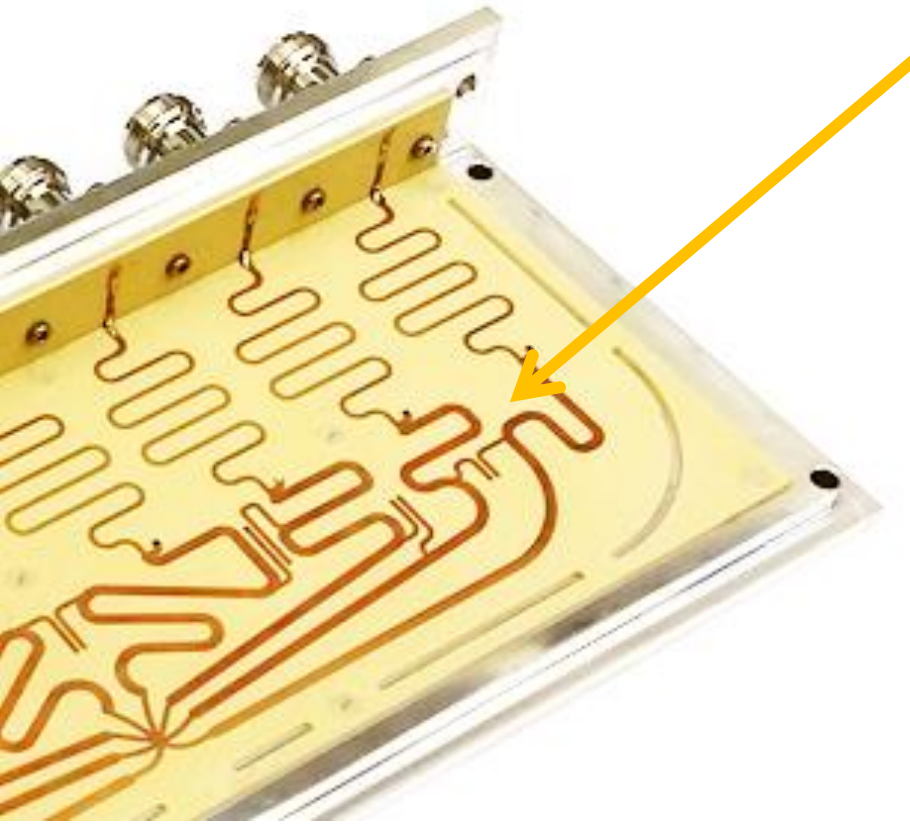
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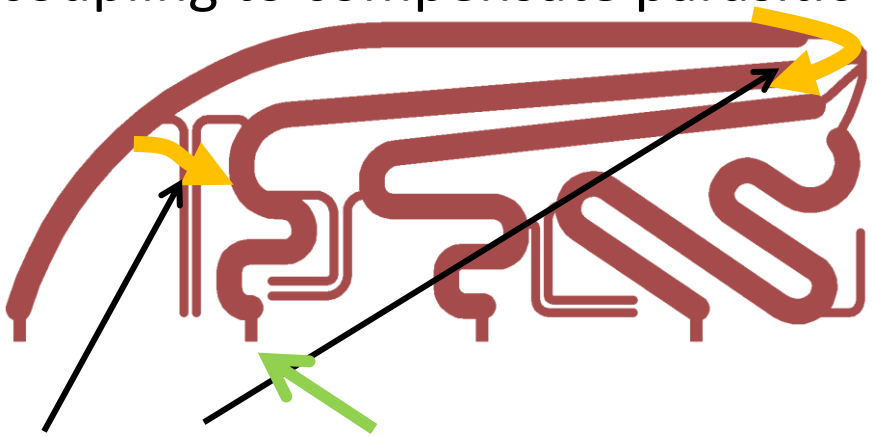


Phase Balancing



Add line coupling to compensate parasitic coupling





$$U_{out}e^{-j(\omega t+\theta)} = U_0e^{-j\omega t} + U_1e^{-j(\omega t+\gamma)}$$

$$efficiency = 1 - (\alpha - \alpha^2) * \sin^2(\frac{\gamma}{2})$$

$$phase = -\text{atan}(\frac{\sin(\gamma)}{(1/\alpha - 1) + \cos(\gamma)})$$