CLUSTER OF RESEARCH INFRASTRUCTURES FOR SYNERGIES IN PHYSICS

ESLS-RF

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First power results of the cavity combiner

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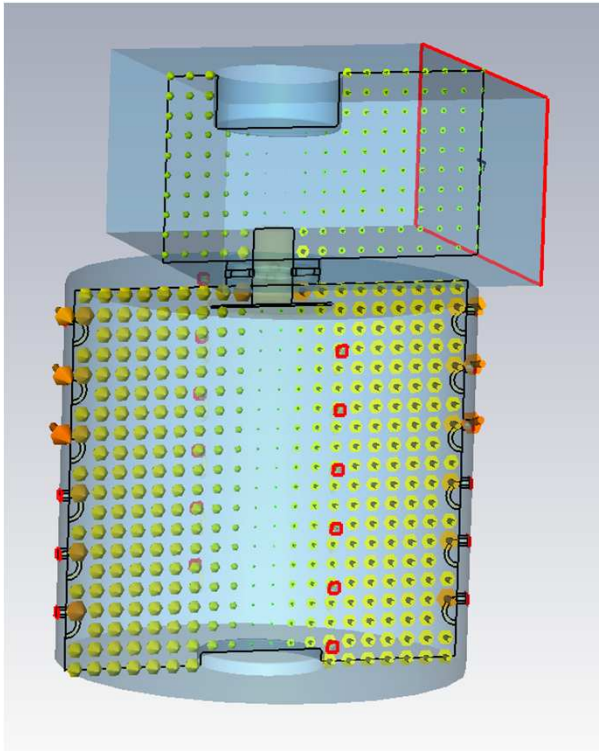
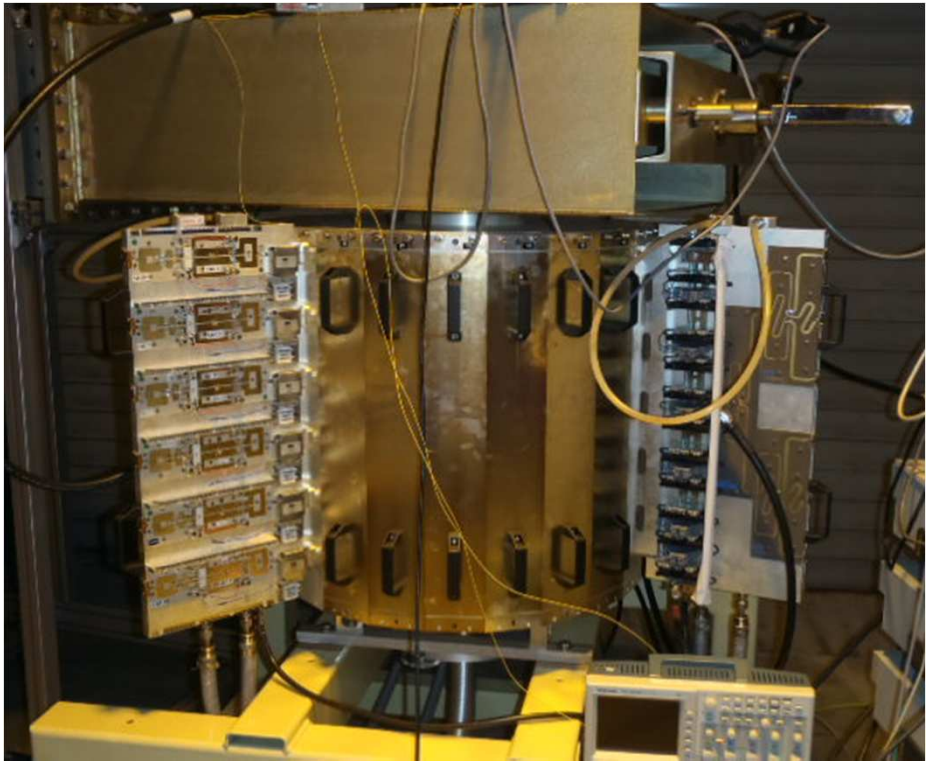
Remember ?



H field E010 mode

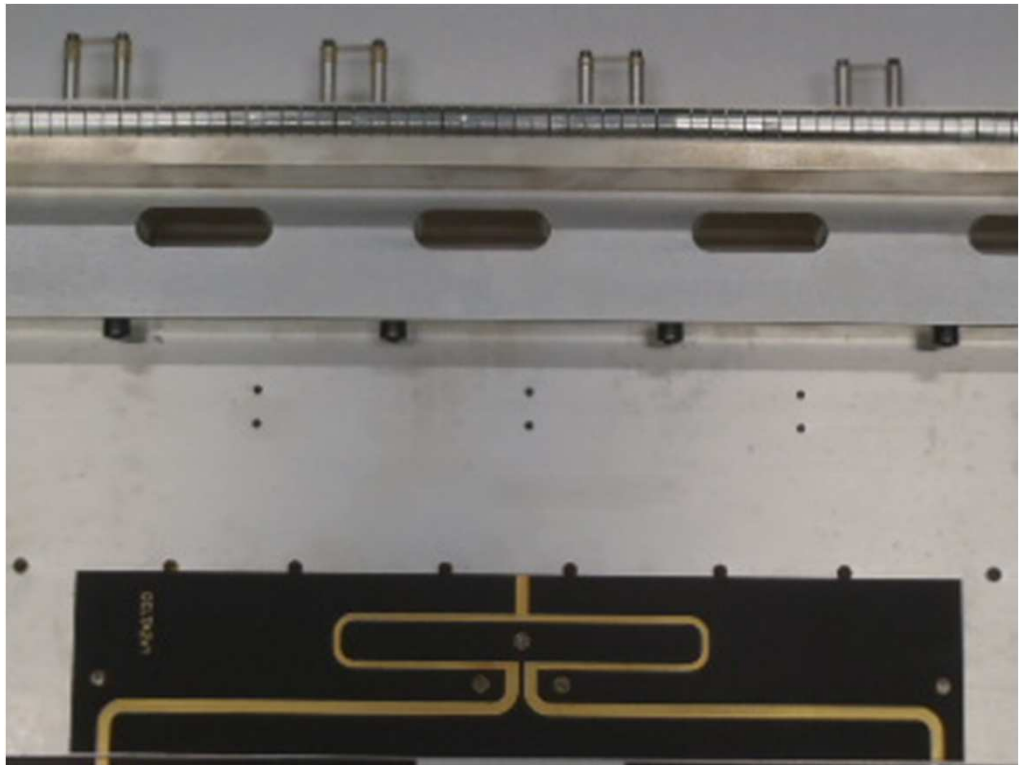


10 kW prototype:

- Only 3 active water cooled wings:
  3 x 6 modules with up to 700 W / module

RF drive split

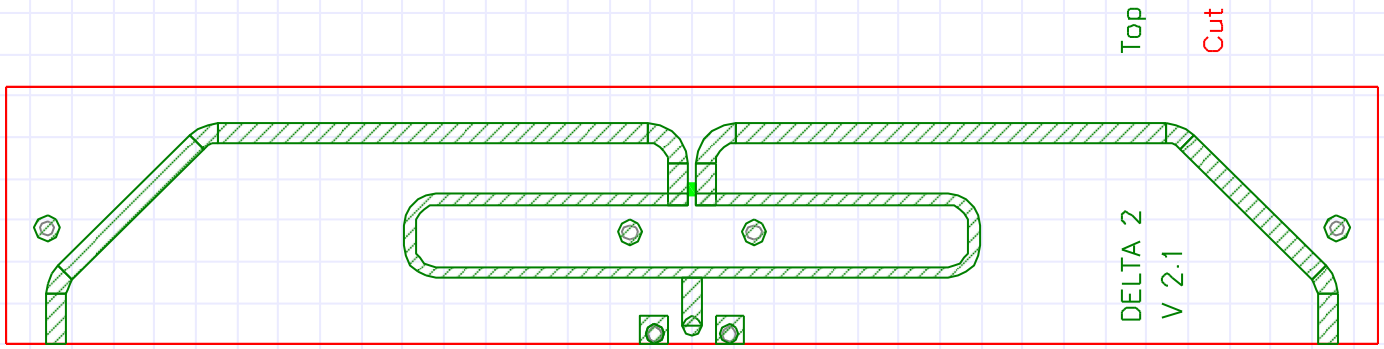
As there are 6 modules per wing, the input signal on each wing has to be split in 6 with equal amplitude and phase.
The first stage is a Wilkinson delta .It divides the signal by two.



V1 is too large and interferes with the holes for the drain DC filters.

item	|S21| dB	|S31| dB	Δmax dB	φ(S21) °	φ(S31) °	Δmax °	|S11| dB	|S32| dB
DELTA A	-3.11	-3.1	0.01	148.5	148.7	0.2	-23.6	-28.5
DELTA B	-3.11	-3.11	0	148.9	149	0.1	-23	-27.9
DELTA C	-3.11	-3.11	0	148.9	149.3	0.4	-22.4	-28.2

The approximate input match is partly due to the N connection.



The N connector stands on a spacer grounded with via holes.
It does no longer interfere with the DC distribution.

RF drive split

The second stage is a Wilkinson divider with 3 branches, star connected.

The resistors are not shown on this picture.

RF drive split

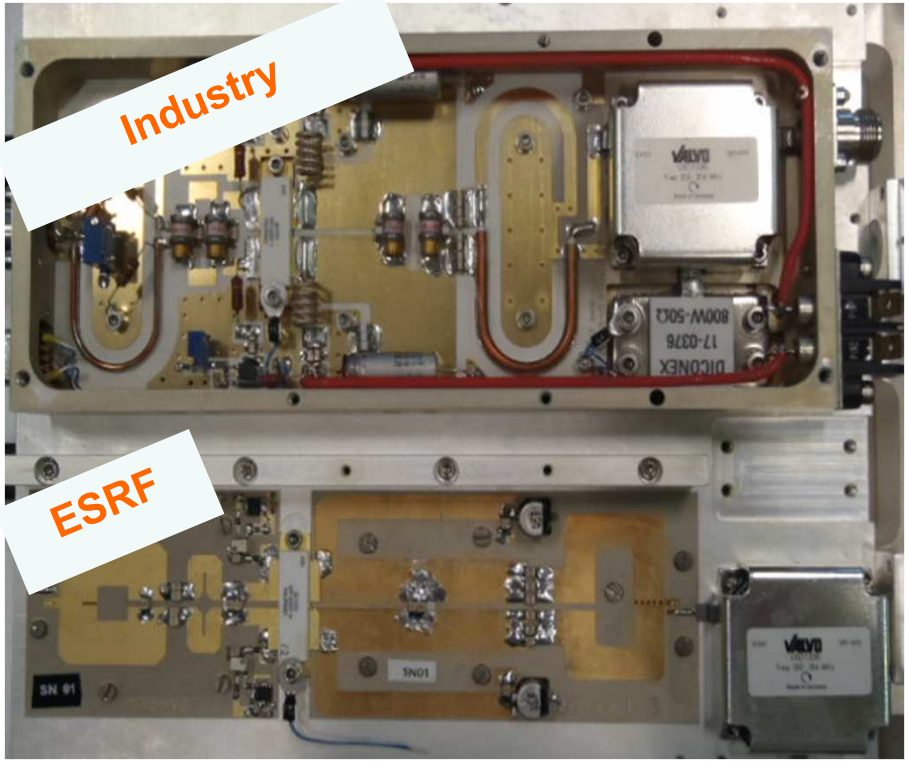
Overall splitter data

	|Si1| dB	Δmax dB	φ(Si1) º	Δmax º	|S11| dB	|Sij| dB
wing A	-7.94	0.06	-25.1	1.3	-23.1	-26
wing B	-7.95	0.09	-24	1.2	-23	-26.3
wing C	-7.95	0.04	-24.2	0.9	-22.7	-26.1

NB: -7.95dB=1/6.2

• RF modules : the bet

All trimmers were avoided, making tuning very difficult. The idea was to suppress hand made components, thus making tuning unnecessary.



- Printed circuit baluns
- RF drain chokes replaced with “quarter wave” transmission lines.
- Very few components left, all of them SMD and prone to automated manufacturing in Europe.
- The biggest bet was the reproducibility of the push-pull MOSFET.

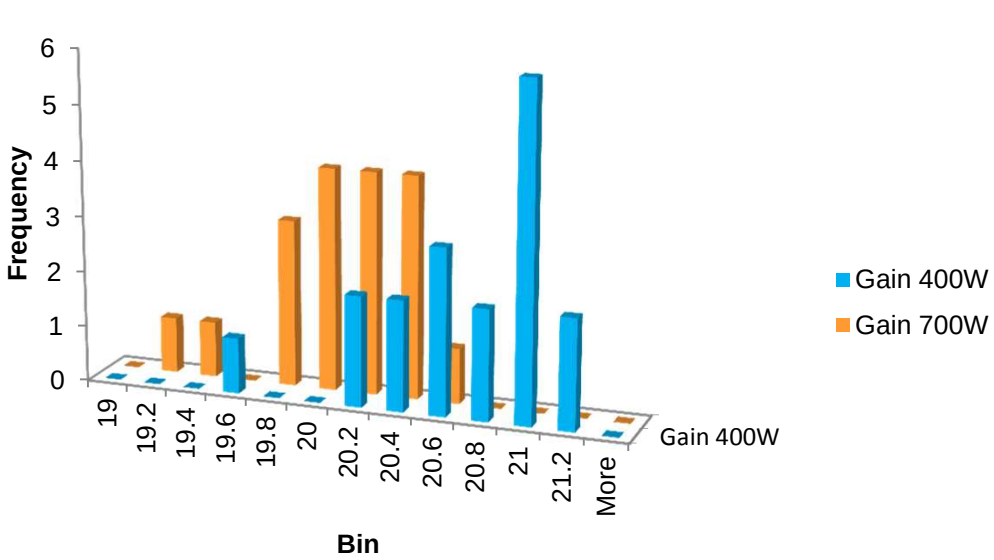
BILL OF MATERIAL:
(quantity 22 *6 modules)
Circulator and MOSFET included

€€ 390 €€€!

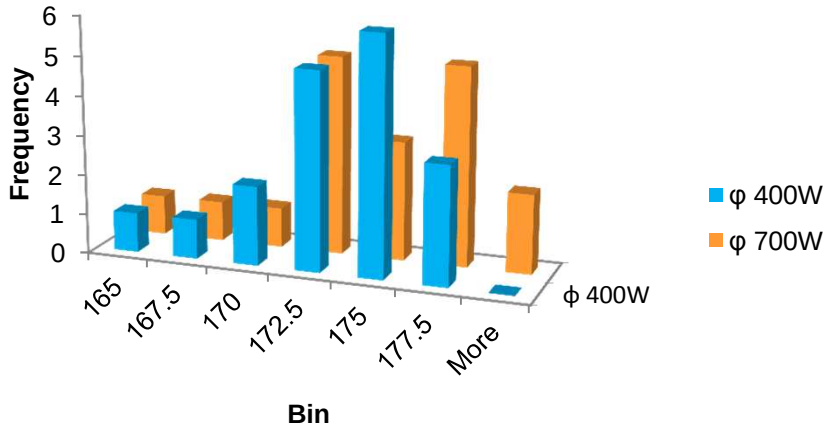
• RF modules : the bet

All modules could be tested separately after being installed on their wing.

Gain histogram



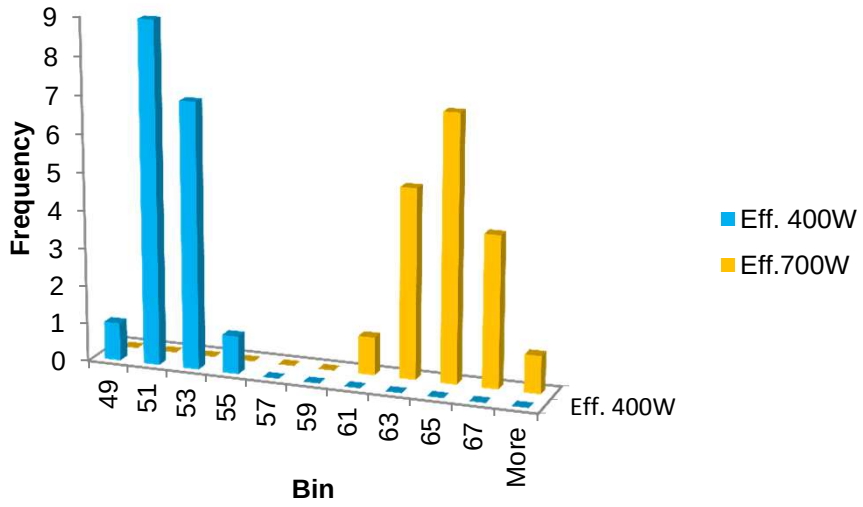
Phase histogram



	Average gain	σ	Average phase	σ
400W	20.61	0.38	171.9	3.5
700W	19.95	0.39	173.2	4

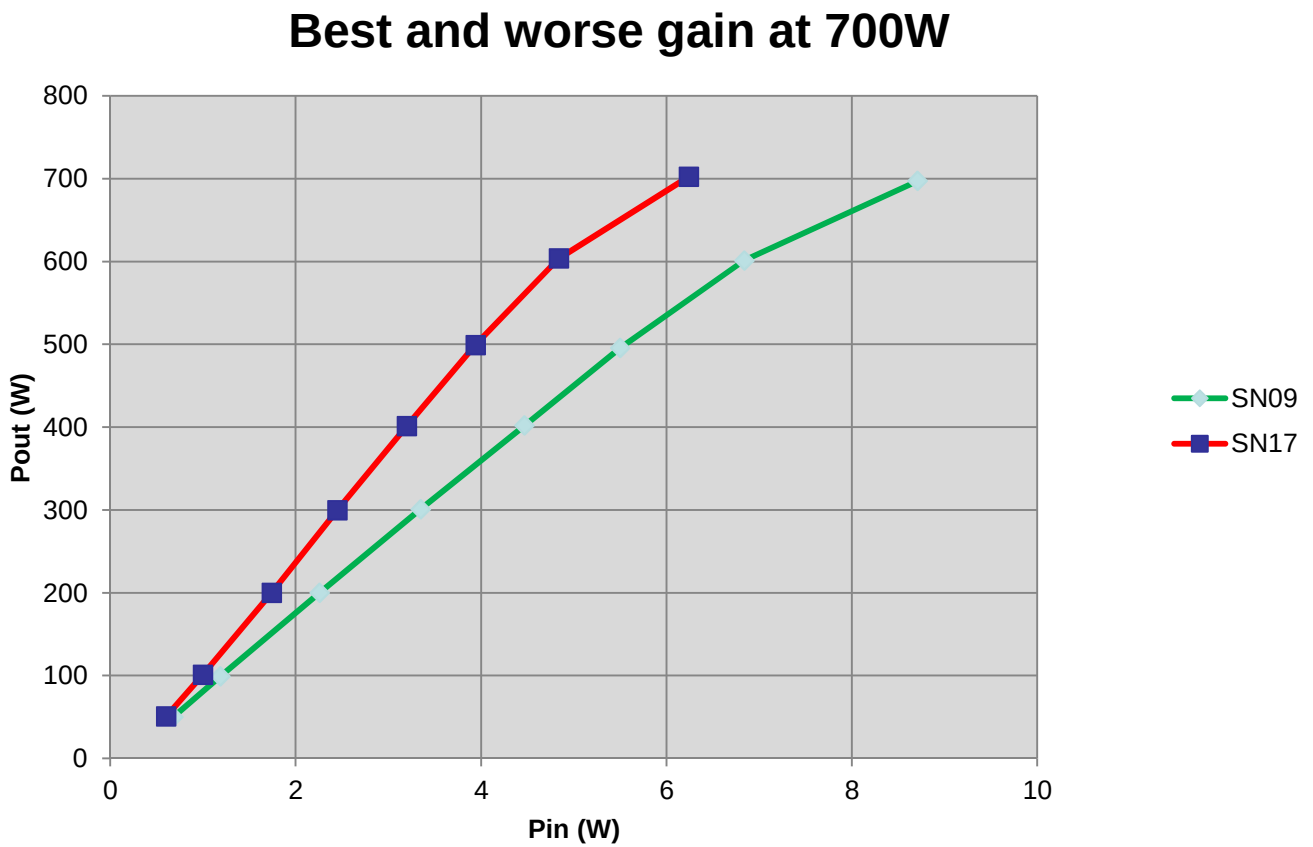
• RF modules : the bet

Efficiency histogram

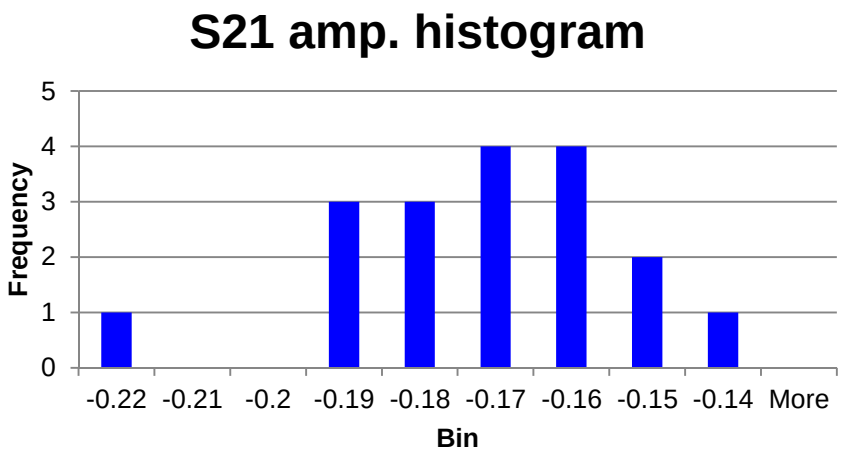


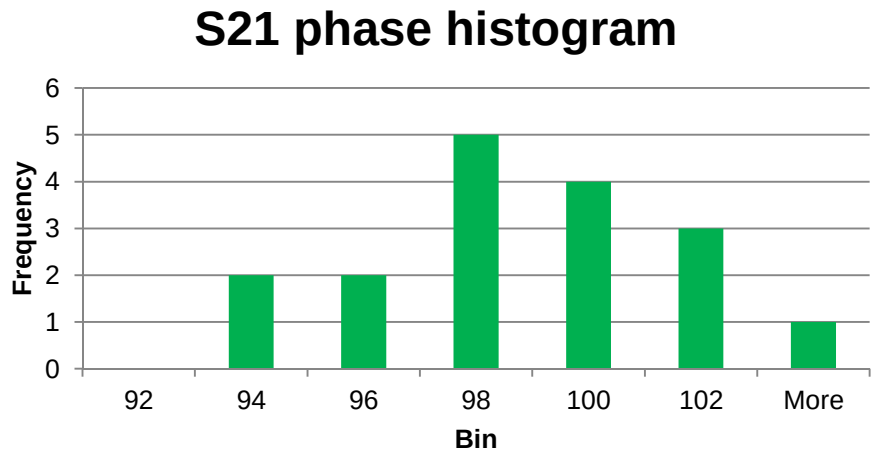
	Average eff.	σ
400W	50.8	1.5
700W	64.1	1.7

- **RF modules : the bet**



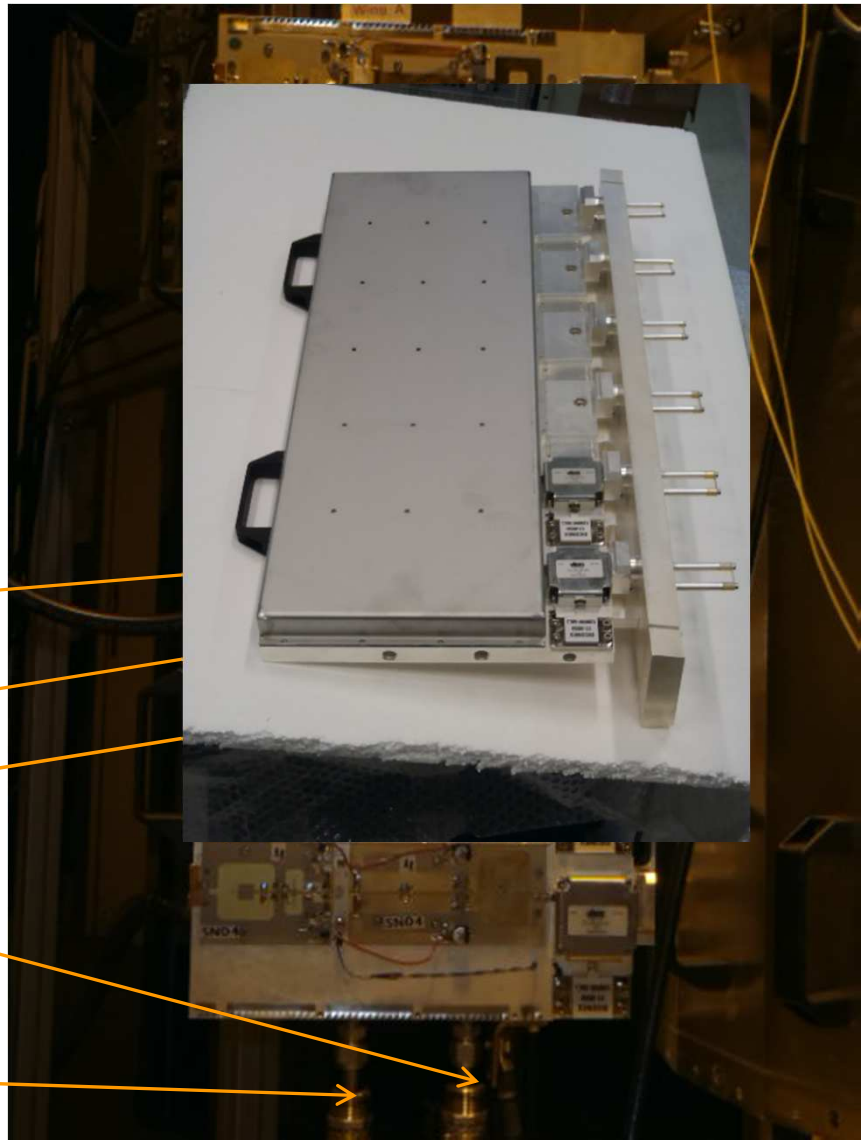
- **Circulators (the same as implemented by Soleil in ESRF amplifiers)**





The complete wing

4 parameters can be measured for each RF module:
- Both drain currents
- Transistor sole temperature
- Load case temperature

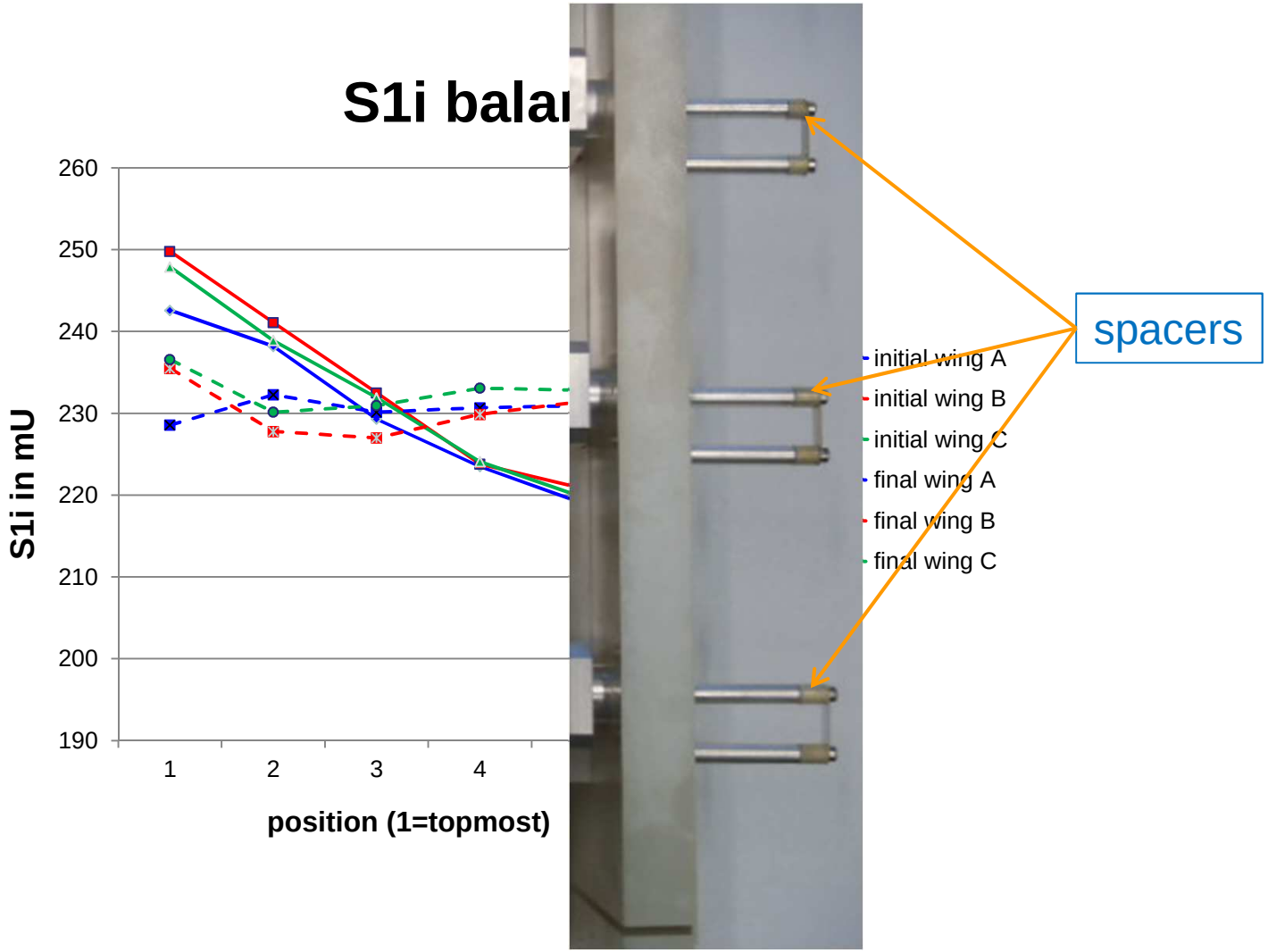


DC supplies, pre-amp, cooling

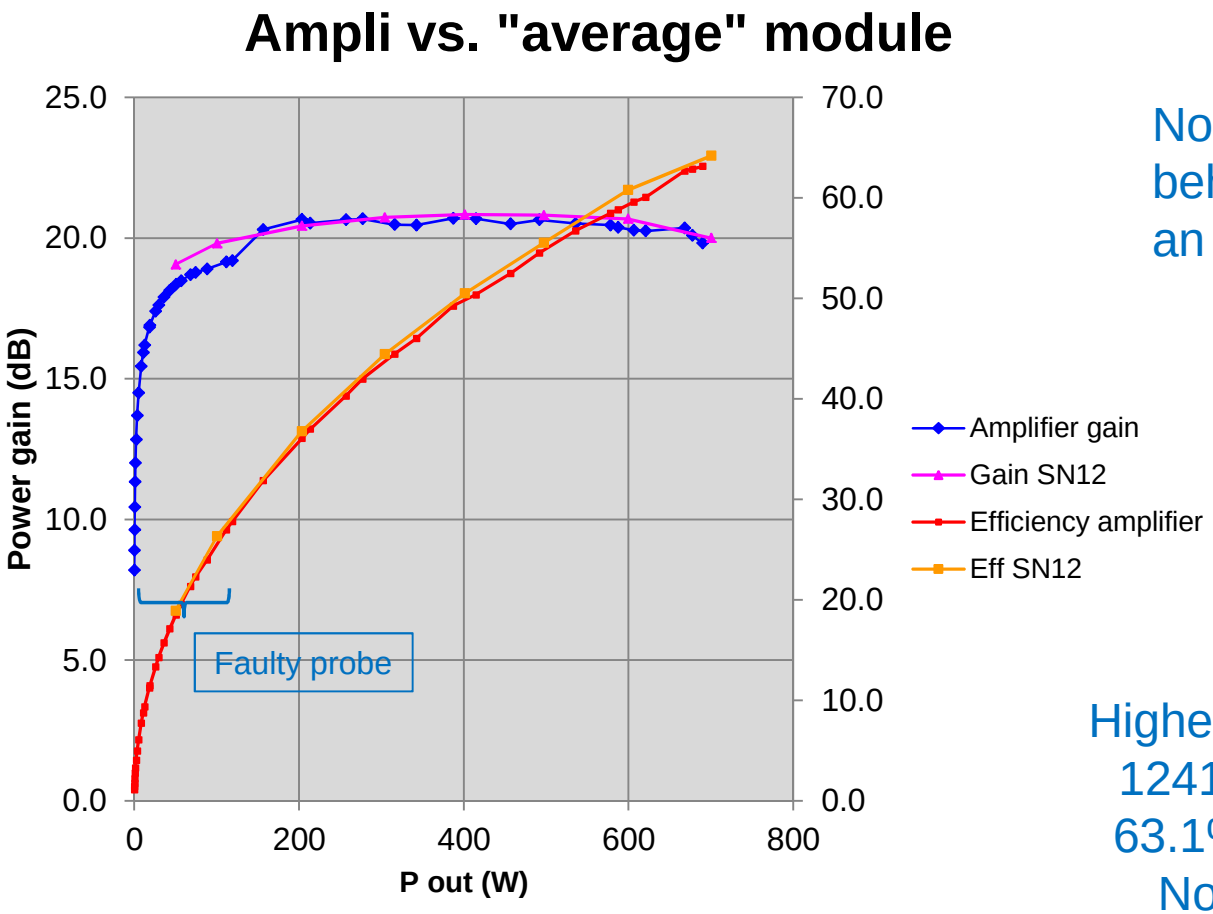
Water temperature and flow indicators
Interlocks
Pre-amp
3 DC supplies 50V/140A

Cooling skid
Pump
Heat exchanger
Flow meter
Temperature sensors

- **Input coupling of the cavity combiner**



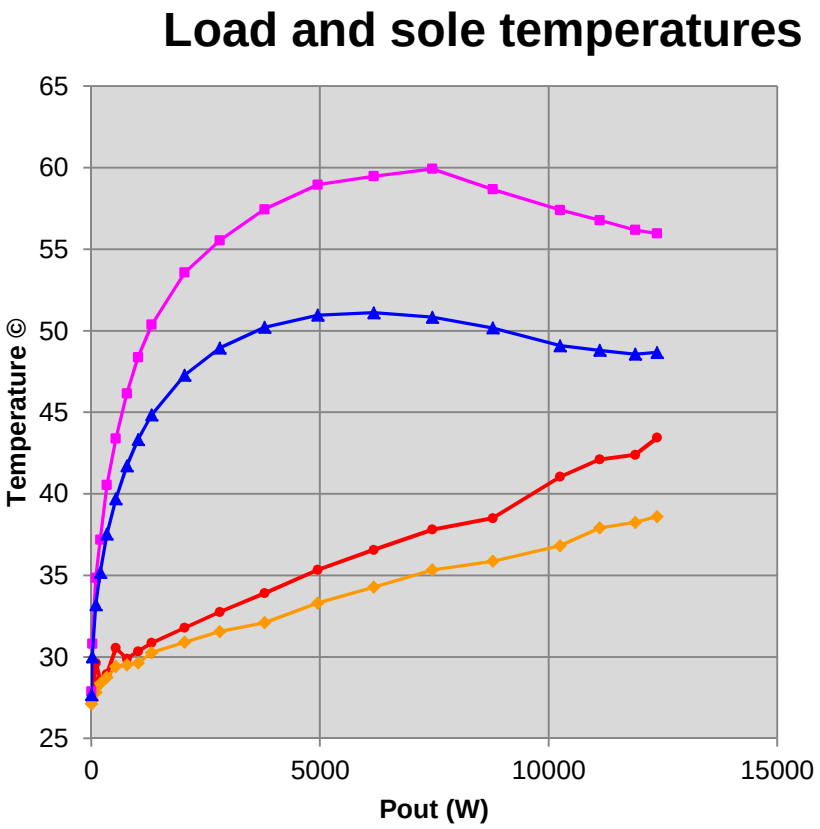
• RF results



No big difference in the behavior of the amplifier and an “average” module.

Highest value reached:
12417W= 690W*18
63.1% drain efficiency
No failure so far!

• RF results (2)



•The transistor temperature follows the usual class B behavior, with maximal dissipation around half power.

•Some power is wasted in the loads, probably due to the cumulated discrepancies of splitters, modules, circulators and cavity input loops.


Thank you !
Special thanks to my colleague
from the ESRF RF group and t
Hans Kartmann (NXP)