HEIDELBERG UNIVERSITY HOSPITAL

HIT Heidelberg Ion-Beam Therapy Centre

Development of the KO-DDS 2 at HIT and its means for the new amplifier design.

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Meeting I.FAST-REX REsonant eXtraction improvement
17. February 2022

UK HD

Experimental Setup

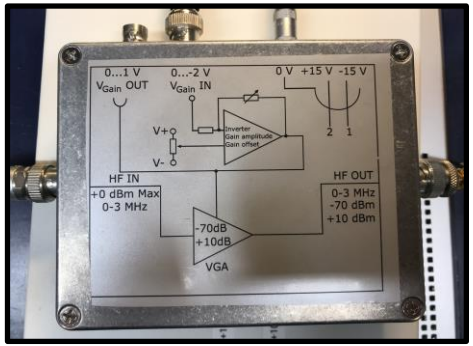
signal generation

Universal Software Radio N210

f: 0 - 30 MHz

P: < +7 dBm

amplitude modulation

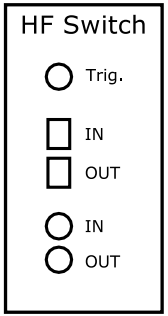


Log. variable gain amplifier LMH6502

f: 0 - 130 MHz

A: -60 dB to +10 dB

RF switch



RF switch SW-239

f: 0 – 2 GHz

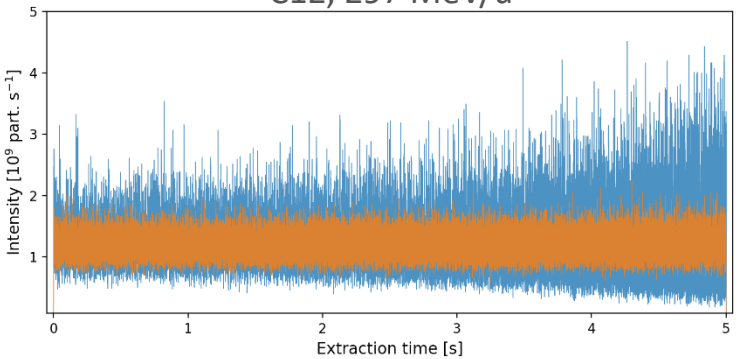
Att: 60 dB

Trise: 2 ns

PA +
KO Exciter

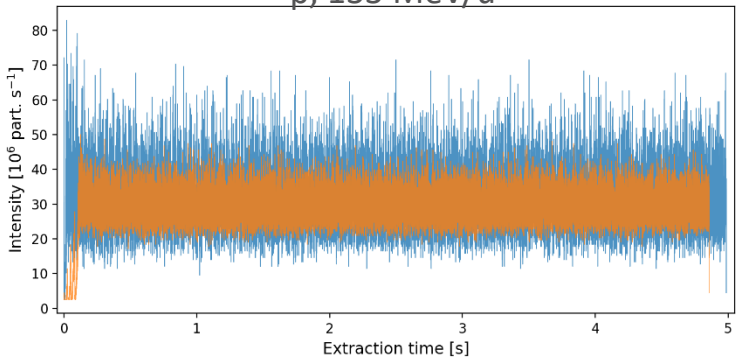
Spillquality improvement

C12, 297 MeV/u



Blue: typical spill, R = 97,6 % (1ms, median)
Orange: Improved spill, R = 99 %

p, 133 MeV/u



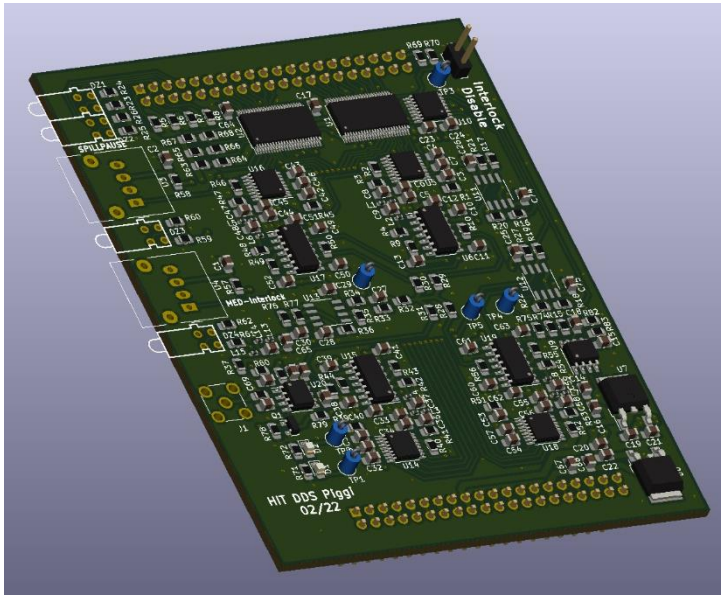
Blue: typical spill, R = 94,4 %
Orange: Improved spill, R = 98,5 %

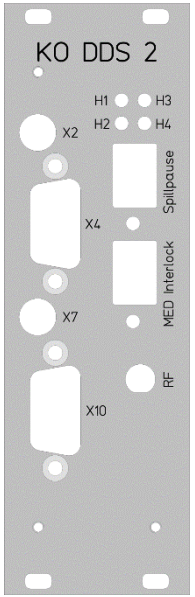
courtesy of Cristopher Cortés
from his Master thesis 2022

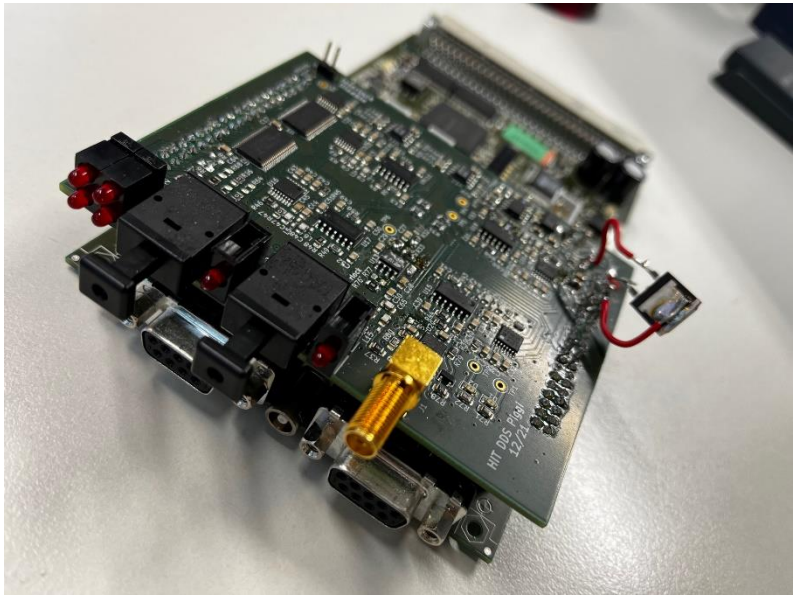
Data supply for the new KO DDS in the Control system

- ✓ Specification
- ✓ Programming of the new functions
- ✓ Customizing of the corresponing User Interfaces (GUI)
- ✓ Implementation in the operational control system
- ✓ Checking of all requirements for the QA and clinical use
- Tests with the new KO DDS

Prototype of the new KO DDS for HIT

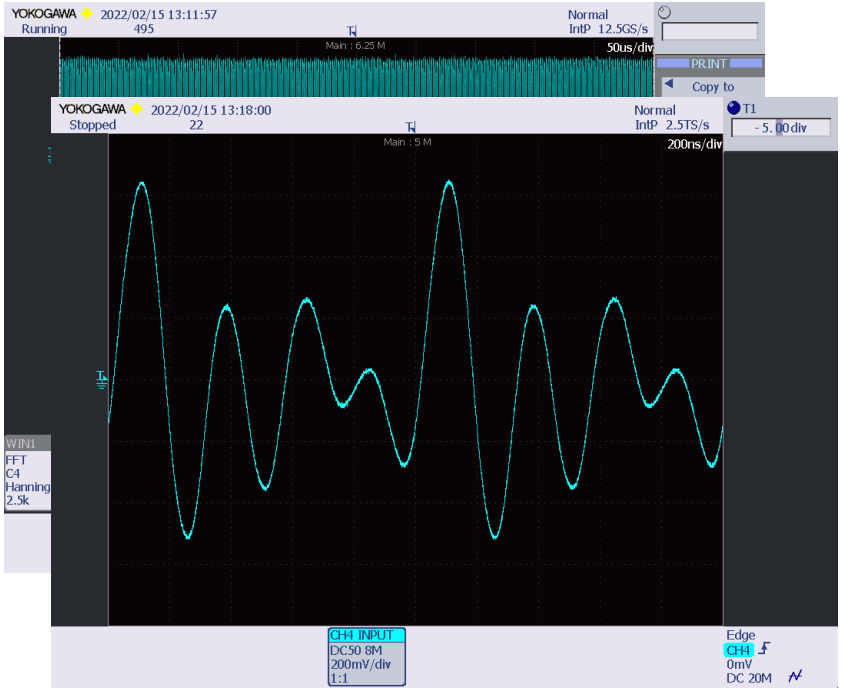


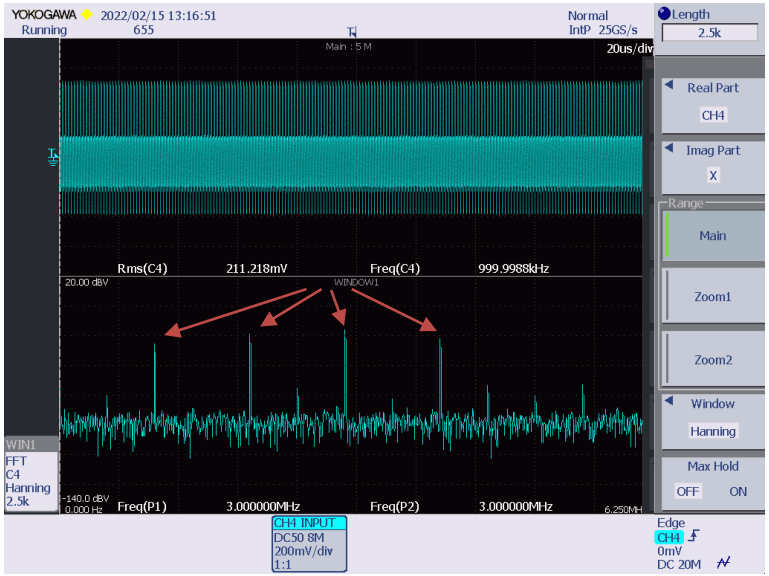




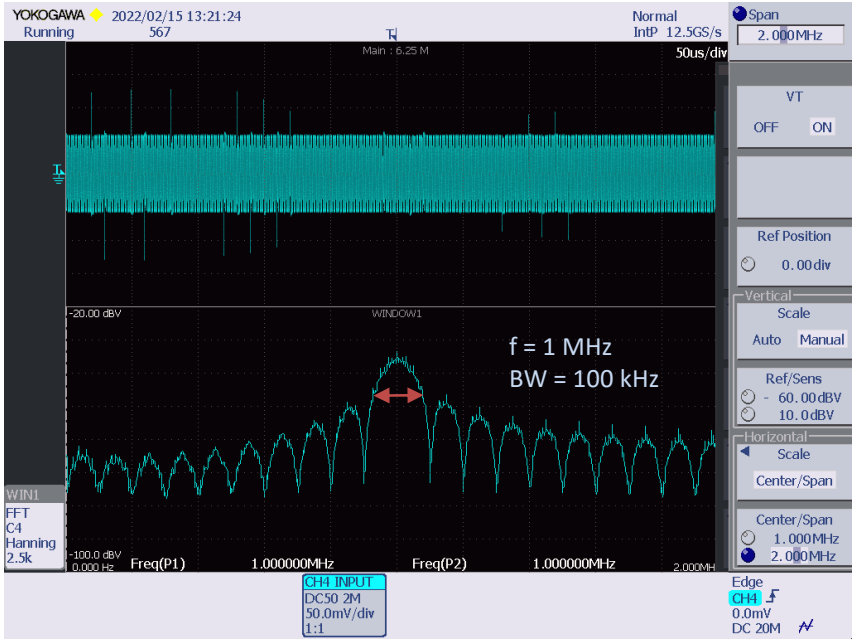
The prototype of the new KODDS2 is now unter testing

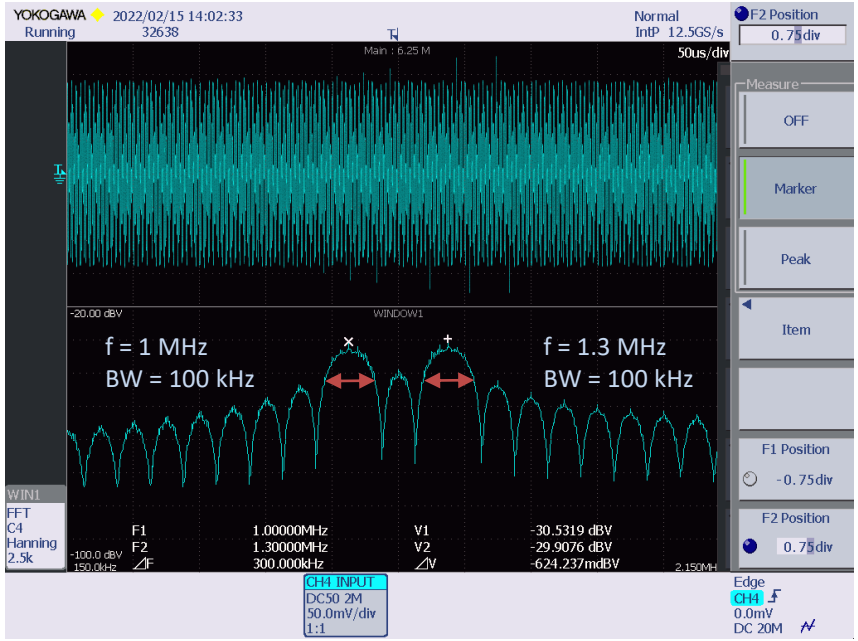
Singleband, Multiband





Singleband, Multiband with adj. Bandwidth

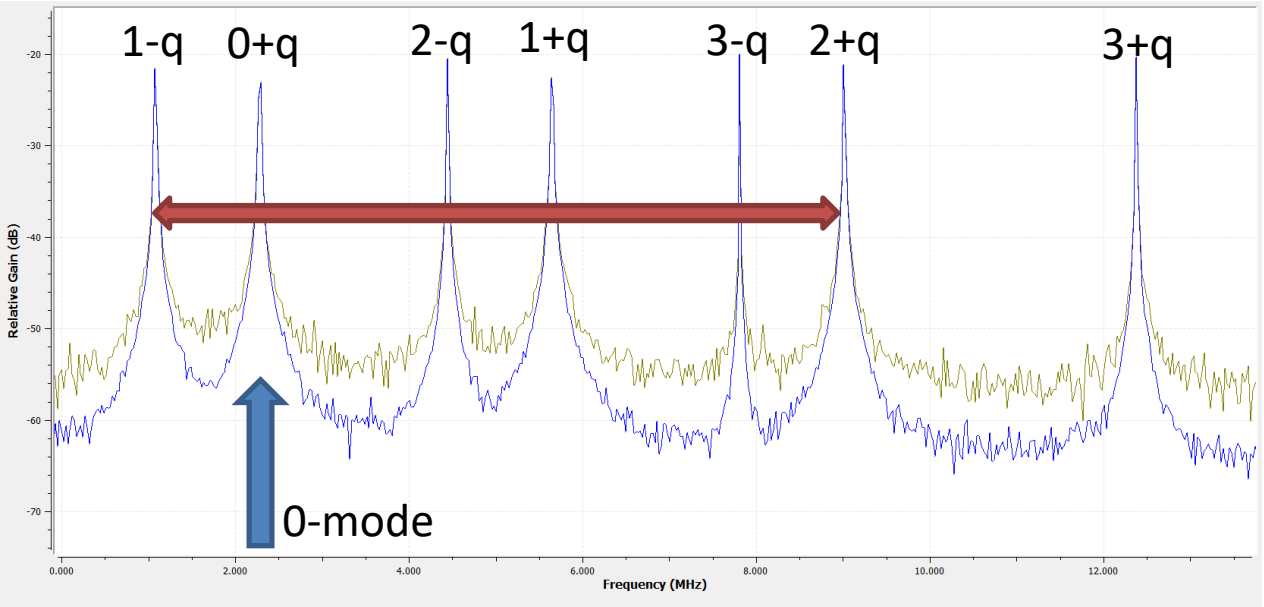




Frequency spectrum of side band excitation

C12 E255: $f_{rev} = 3.36599\,\mathrm{MHz},\ q_{frac} = 0.6785$

$$f_\beta = f_{rev} \cdot (n \pm q_{frac}),\ n = 0, 1, 2, 3$$



~(n +/- q)	f [MHz]
1 – 2/3	1.0822
0 + 2/3	2.2838
2 – 2/3	2.8695
1 + 2/3	5.6498
3 – 2/3	7.8141
2 + 2/3	9.0158
3 + 2/3	12.3818

Frequency calculations for multiband operation

We want to use frequencies from the „1-“-Band up to the „2+“-Band, which lead to the following frequencies:

	lowest freq $f_{KO} = (1 - q) \cdot f_{rev}$	hightest freq $f_{KO} = (2 + q) \cdot f_{rev}$
p	**0.473 MHz**	7.244 MHz
He	0.487 MHz	7.241 MHz
C	0.627 MHz	8.974 MHz
O	0.670 MHz	**9.331 MHz**

Specification for a new KO Power amplifier

Amplifier actual	Amplifier [limit]
Frequency range	0.4 - 20 MHz [0.4 - 10 Mhz]
Duty cycle	CW, but normal < 50%
Output power	P = 1 kW @ 50 Ohm
Input power	+0 dbm
Amplification	+60 dB
Harmonic oscillations	< 20 dBc [< 15 dBc]
Impedance	50 Ohm
Cooling	Air
Noise @ duty cycle 50%, 1m	< 70 dBa