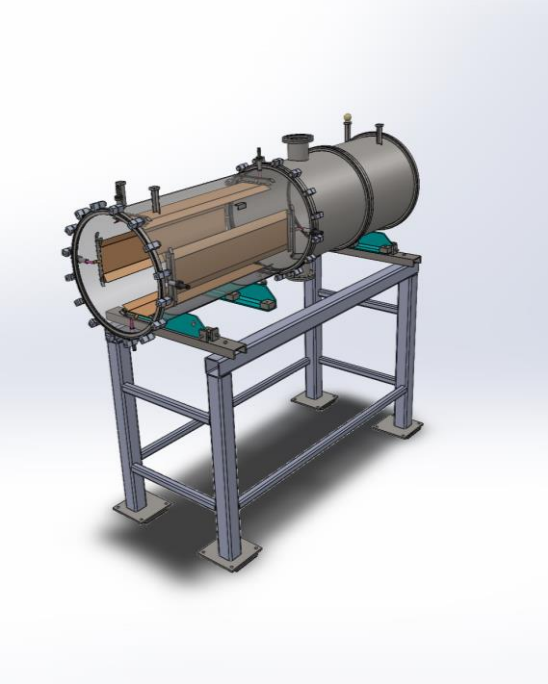
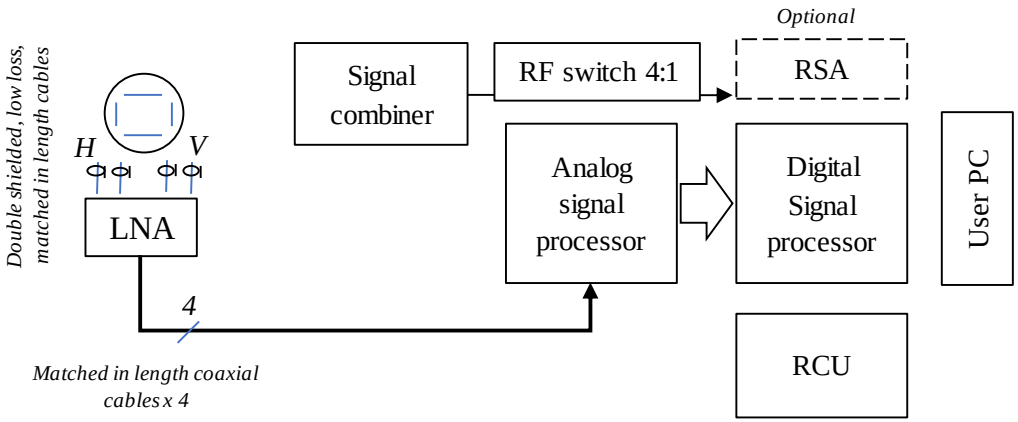
Schottky spectra measurement system

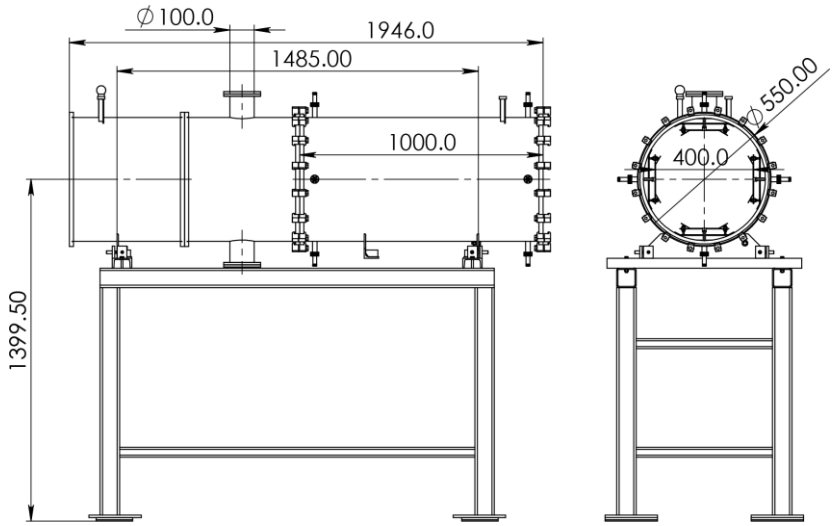
Conceptual Design stage

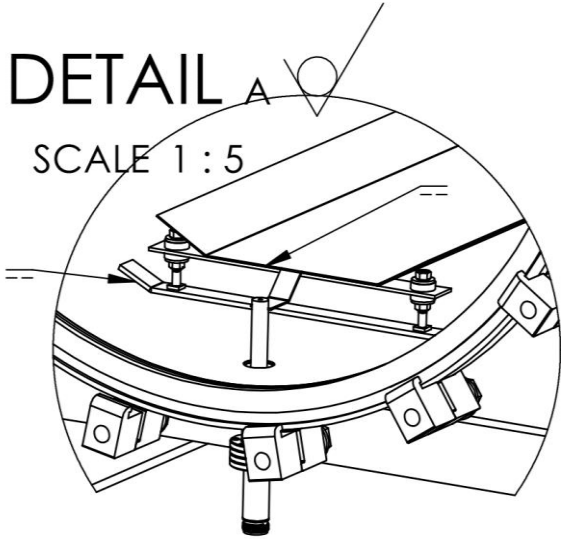
The structure of the measurement system





General view and adjustment schemes

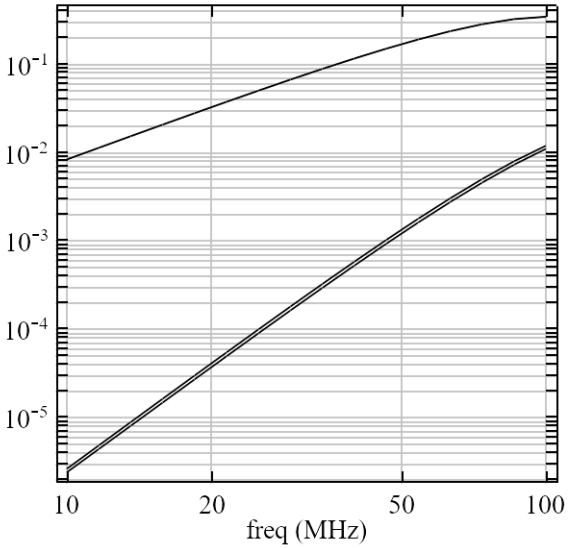




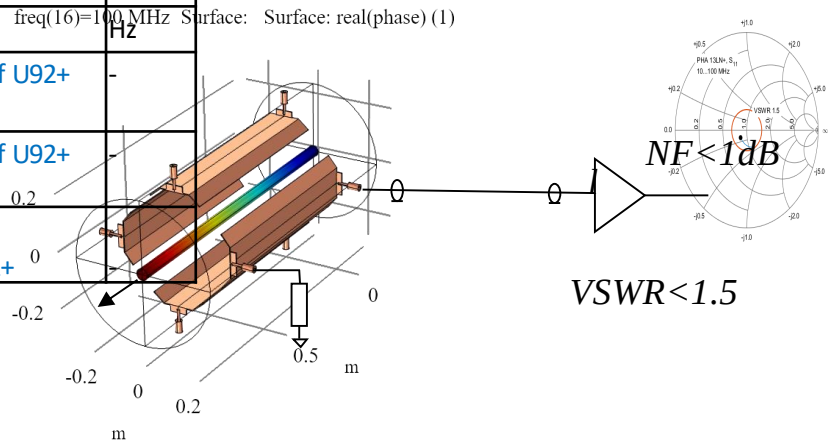
- The general tolerance is 1 mm

Specifications

- The electrodes behave as a high-pass filter



Parameter	Value	Units
Schottky pickup CR		
total length flange-to-flange	1000	mm
horizontal aperture	350-400	mm
vertical apperture	150-200	mm
pickup load impedance	50 (± 2)	Ohm
frequency range	10-100	MHz
Signal analysis		
resolution "tune"	10^-4	-
relative frequency resolution (up to 100 points per bandwidth)	10^-6	-
frequency accuracy	100	Hz
Longitudinal measur. detection threshold of injected / cooled beam	10^5/10^4 ions of U92+	-
Transverse measur. detection threshold of injected / cooled beam	10^6/10^7 ions of U92+	-
reference maximum intensity for the system design	10^10 ions of U92+	

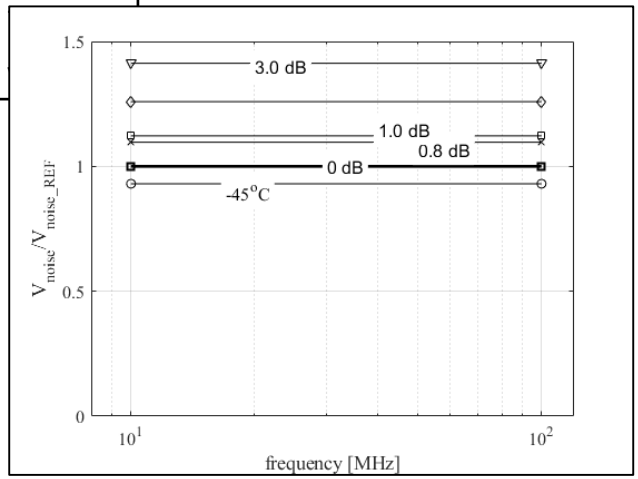


Specifications

Parameter	Value	Units
Vacuum chamber		
Flange of type	CR-K DN 500 ISO	
Complete length of the Pickup	1000	mm
Inner pipe diameter	500	mm
Tolerances for Vacuum chamber		
Length	< 1	mm
Cross-section	< 1	mm
Pickup		
Single plate length	> 800	mm
Plate-to-plate capacitances	< 10	pF
Tolerances plates		
length, width and bending radius along plate,	< 0.5	mm
longitudinal deviation along chamber	< 1	mm
Feedthrough capacitance	< 5	pF

Specifications. Low-noise stage.

Parameter	Value	Units
Input impedance	50	Ohm
Max. gain	40	dB
Power-off state	bypass	-
Bypass attenuation	<0.5	dB
Noise figure @10-100MHz	< 1	dB
Gain Flatness @10-100MHz	< 2	dB
amplifier input matching VSWR	< 1.5	-
amplifier output matching VSWR	< 1.5	
Max input voltage	+- 1	

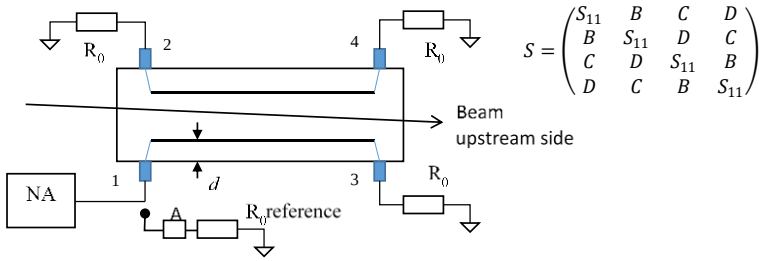


- Noise voltage versus noise figure. 3dB NF add 40% to the noise voltage

Simulations

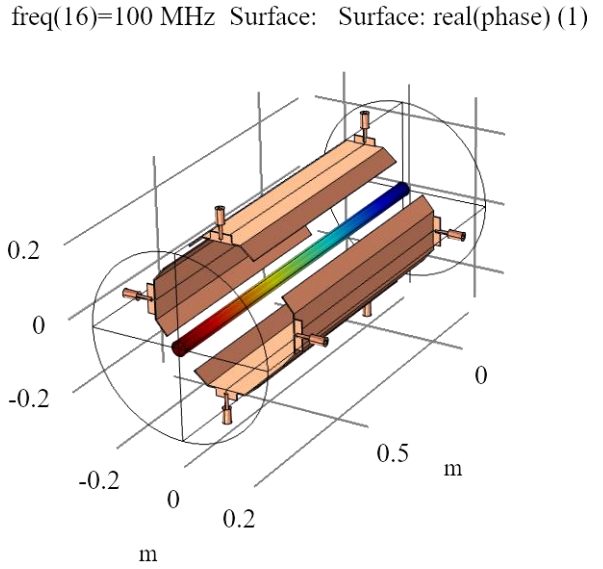
- The simulations estimate useful properties of the system of electrodes and allow to design an optimal geometry of the electrodes.

- It is important to have parameters which could be verified experimentally.



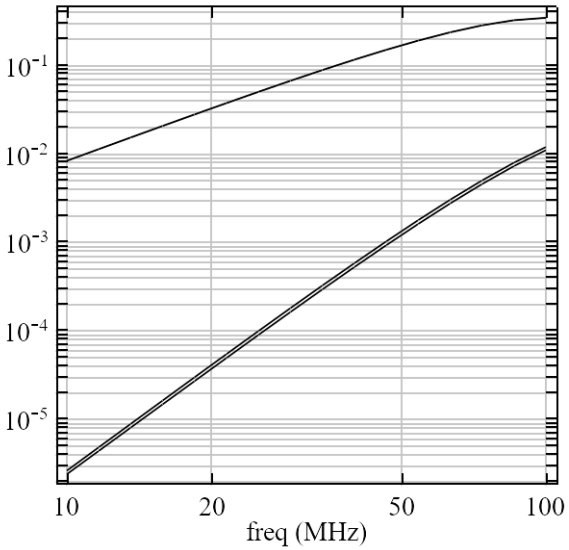
$$S = \begin{pmatrix} S_{11} & B & C & D \\ B & S_{11} & D & C \\ C & D & S_{11} & B \\ D & C & B & S_{11} \end{pmatrix}$$

- The realistic test scheme

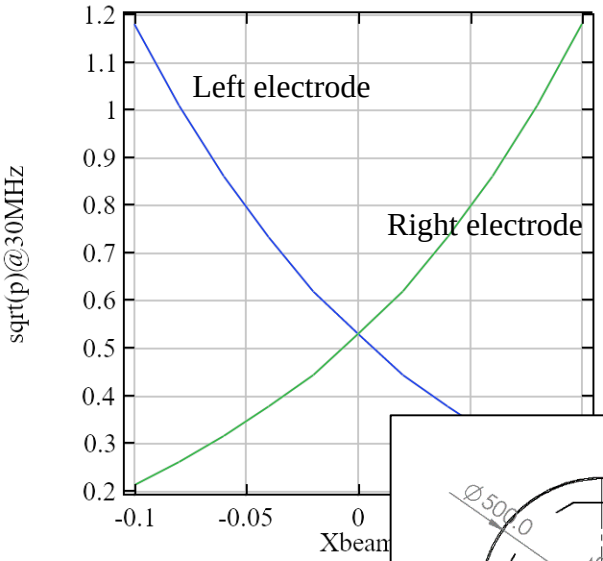


- 3-D models use space distributed beam charge and particle velocities other than speed of light

Simulation results

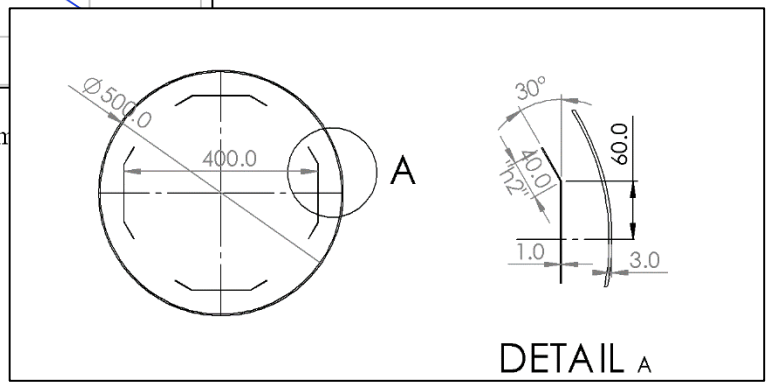


- The signal strength in the cable and in the terminating load.

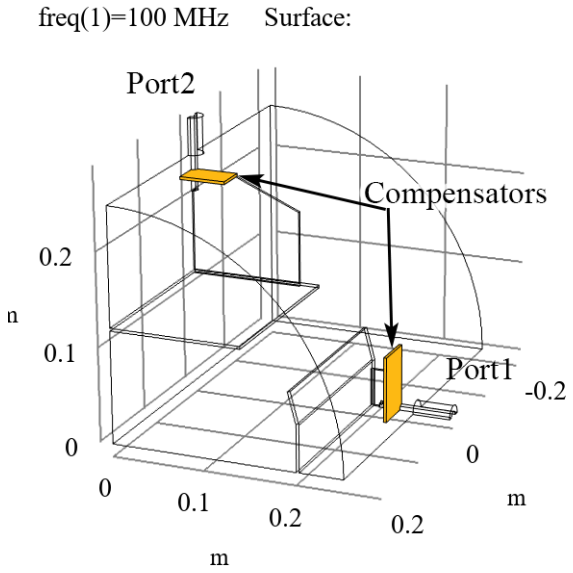


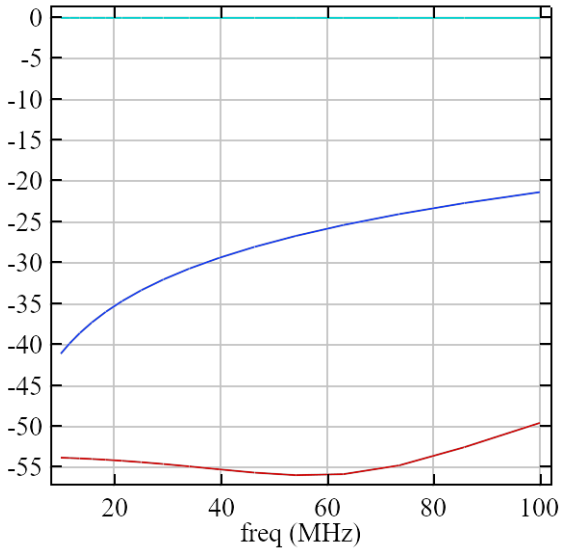
- Position sensitivity characteristics.

- A matched design of the electrodes geometry. *No additional ground plates will be delivered*.



Transition area between the coaxial and strip-line

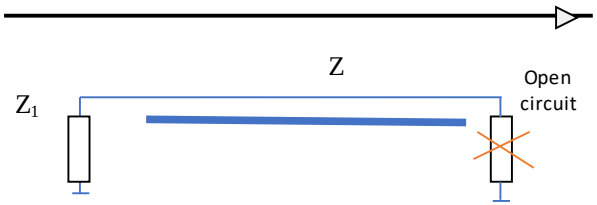




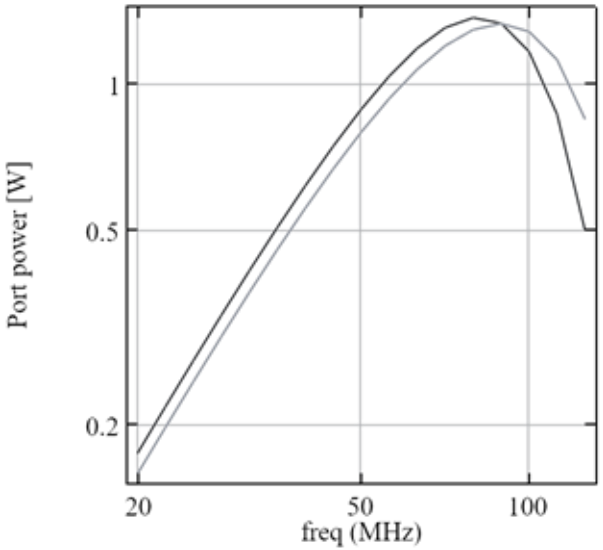
- S11 parameter with and without (VSWR=1.2) compensators

- Use of compensators improve the RF properties of the electrodes.

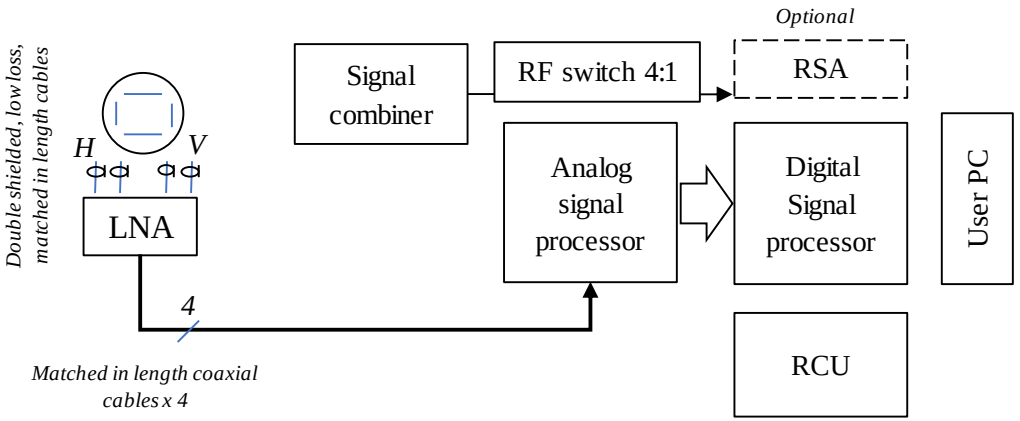
Alternative connection scheme



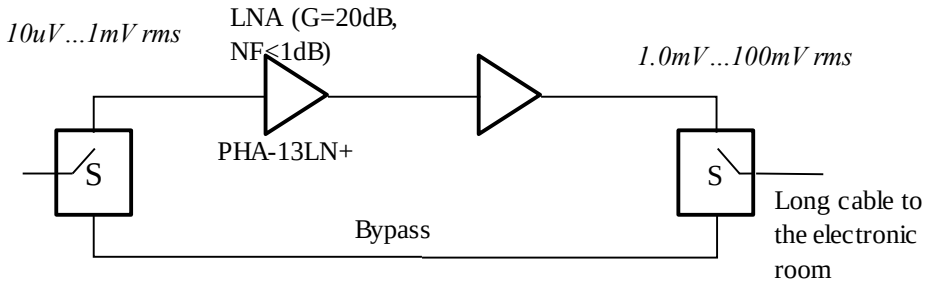
- A non-terminated scheme shown in top has slightly better performance. The transmission function over frequency presented in the right figure.

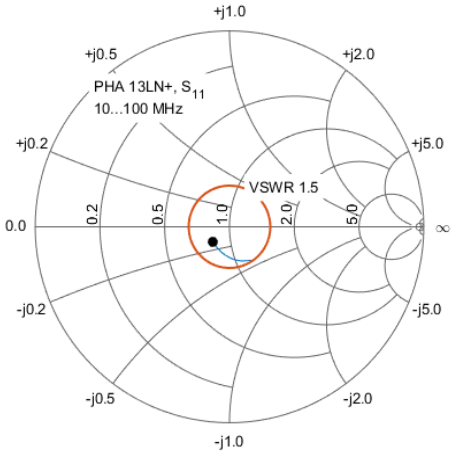


Electronics

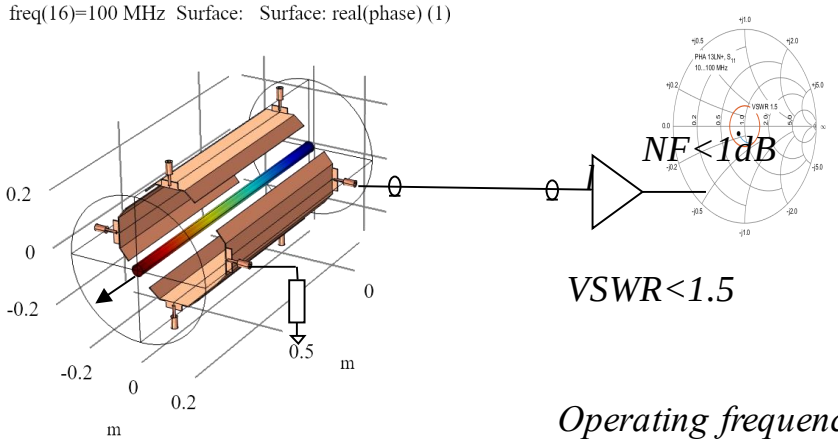


Low-noise amplifier



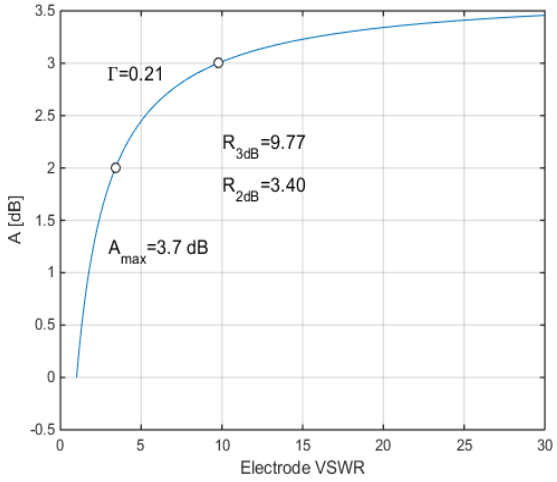


- Front-end module with LNA



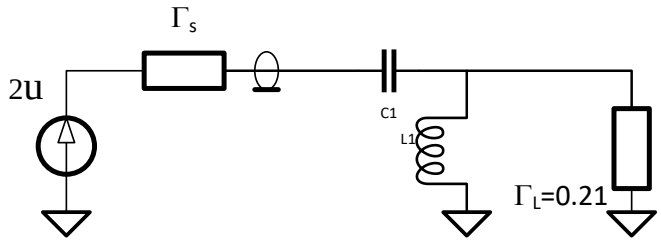
Operating frequency 10…100 MHz

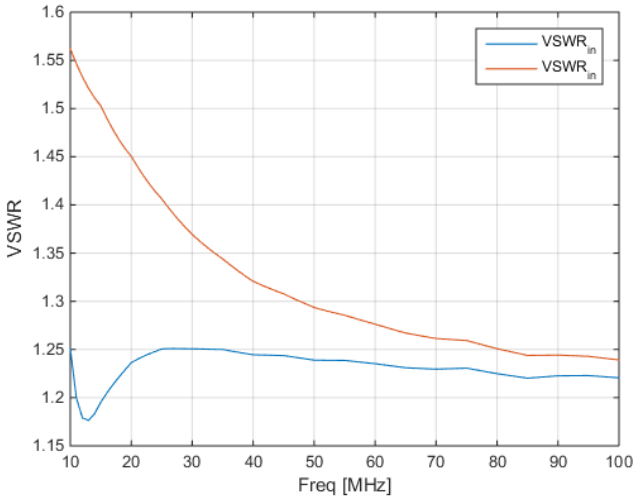
LNA matching



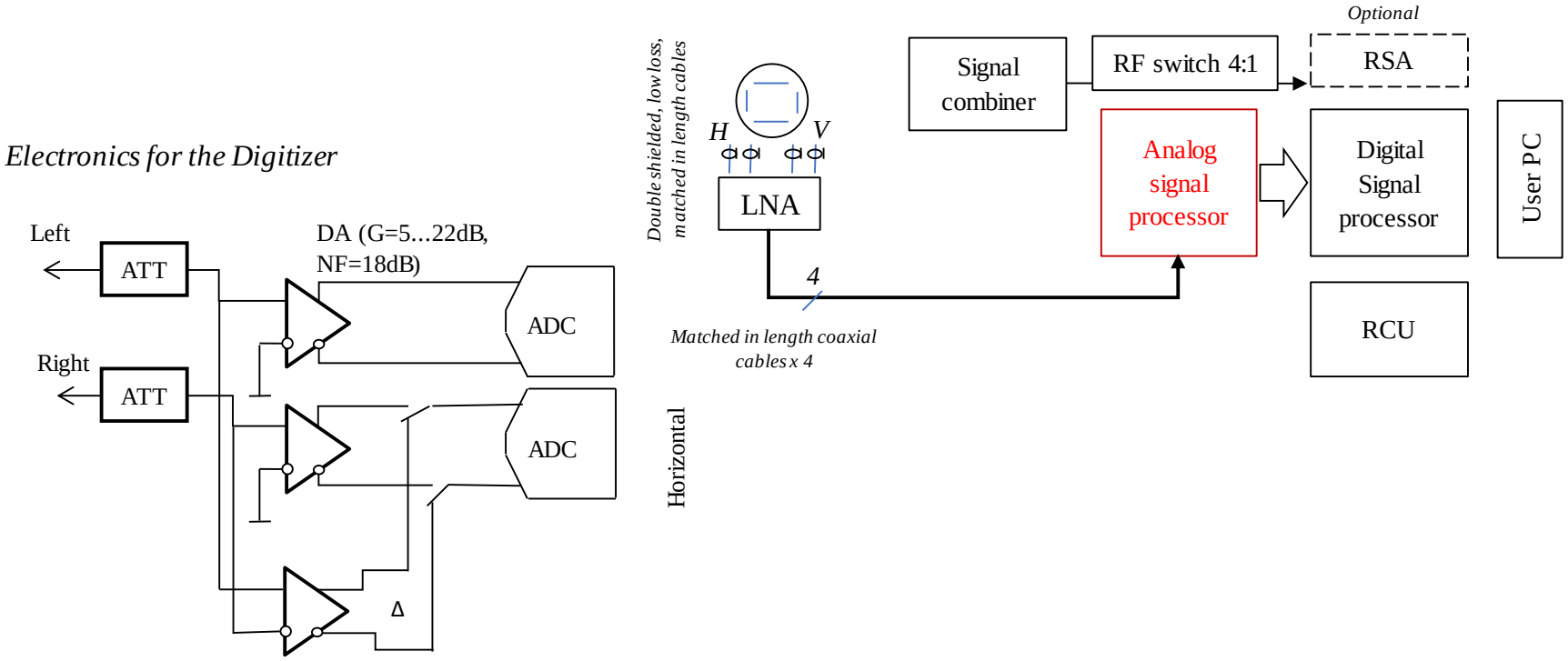
The ripple of the transmission function versus the electrode's output standing wave ratio.

The matching could be improved by use of simple LC-scheme.



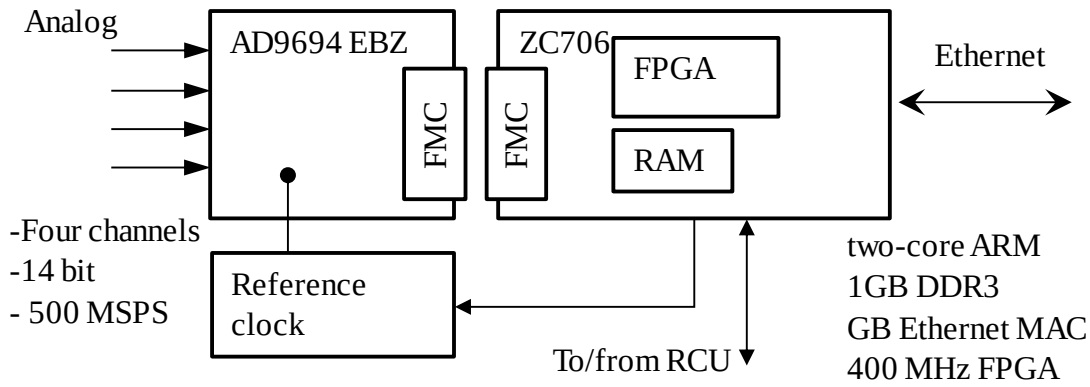


Analog signal processor



- The purpose of this module is a signal normalizing in front of the ADCs. The fine step of the gain allow precise matching to the ADC full-scale operation. For the bunched beam the analog subtraction may be helpful for reduction of the deterministic part of the signal.

The digitizer



- The digitizer samples four channel, therefore, three kind of Schottky spectra are simultaneously available.
- The digitizer uses a commercially available boards with an ADC and high performance SoC (System on Chip) device.

Thank you