Noise study of charge measuring system in PITZ

- **Composition of the charge measurement error**
- **Noise study of the ICTs: strange 300kHz ripple**
- **Solution of the 300kHz noise**

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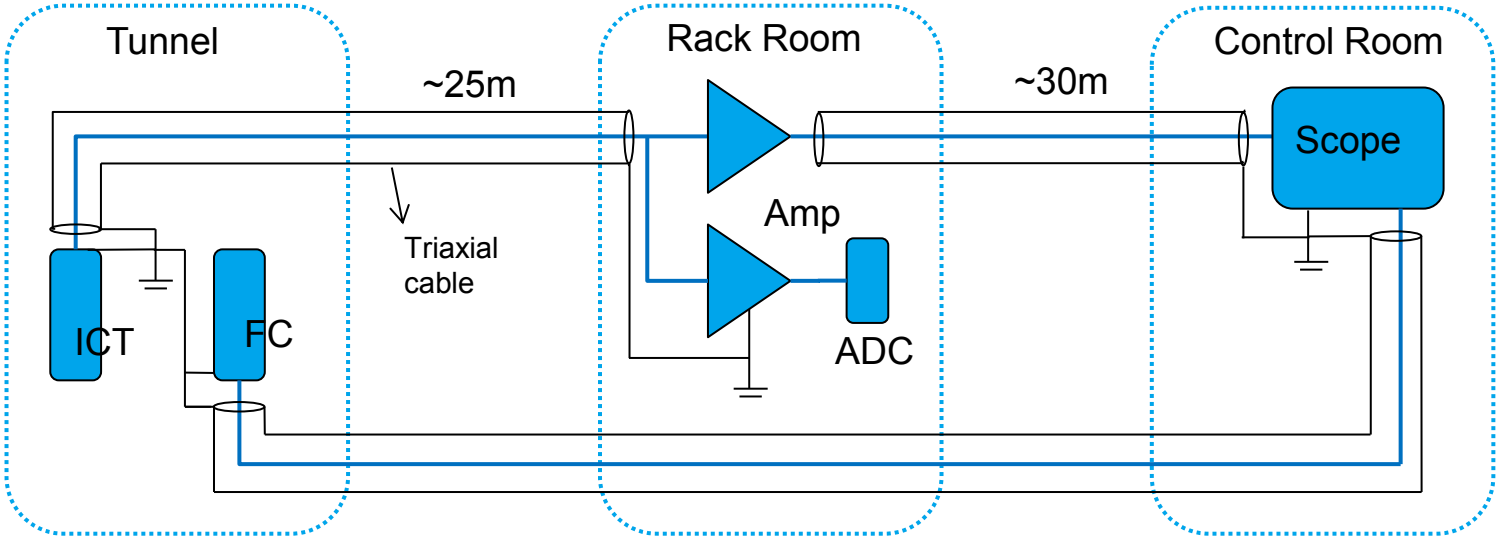
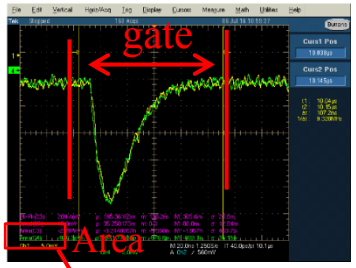
DESY

Measurement Error of Charge measuring system in PITZ





ICT:

$$Q = \frac{A_R - A_B}{50} \times 40 \times Cal = \frac{A_R - A_B}{1.15}$$

FC:

$$Q = \frac{A_R - A_B}{50} \times Cal$$

Charge is presented by:

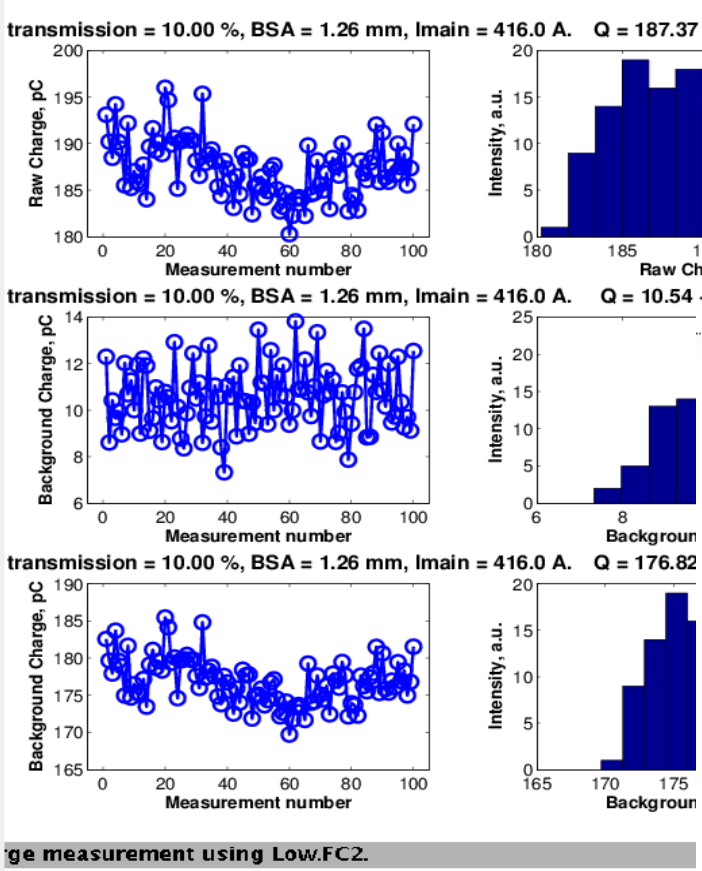
$$Q = \langle Q \rangle \pm \sigma_Q = \langle Q_R \rangle - \langle Q_B \rangle \pm \sigma_{Q_R}$$ **Overall error**

This overall error σ_{Q_R} is caused by two kinds of factors:

- Stability of laser, RF, …
- Charge measuring system, e.g, measurement error of the oscilloscope, electronic noise ⟹ Background error σ_{Q_B}

Measurement Error of Charge measuring system in PITZ

~200pC

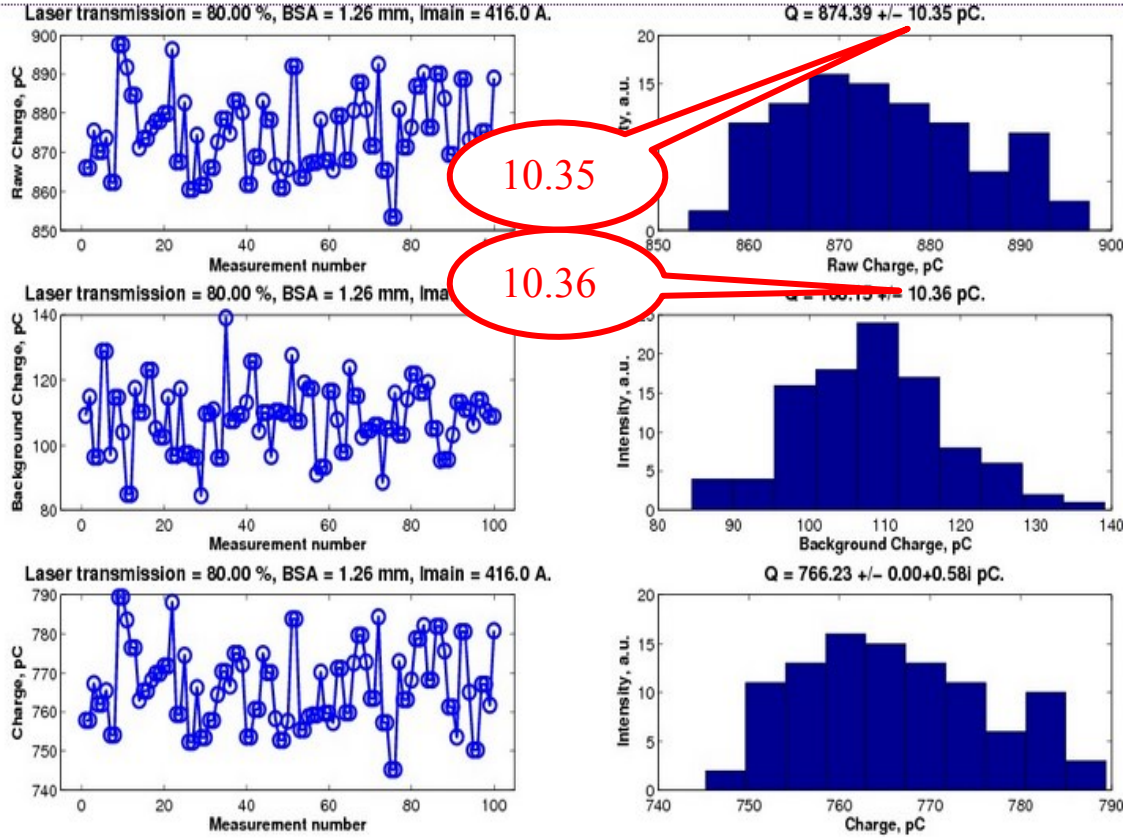


Low.FC2

3.08

1.37

~800pC



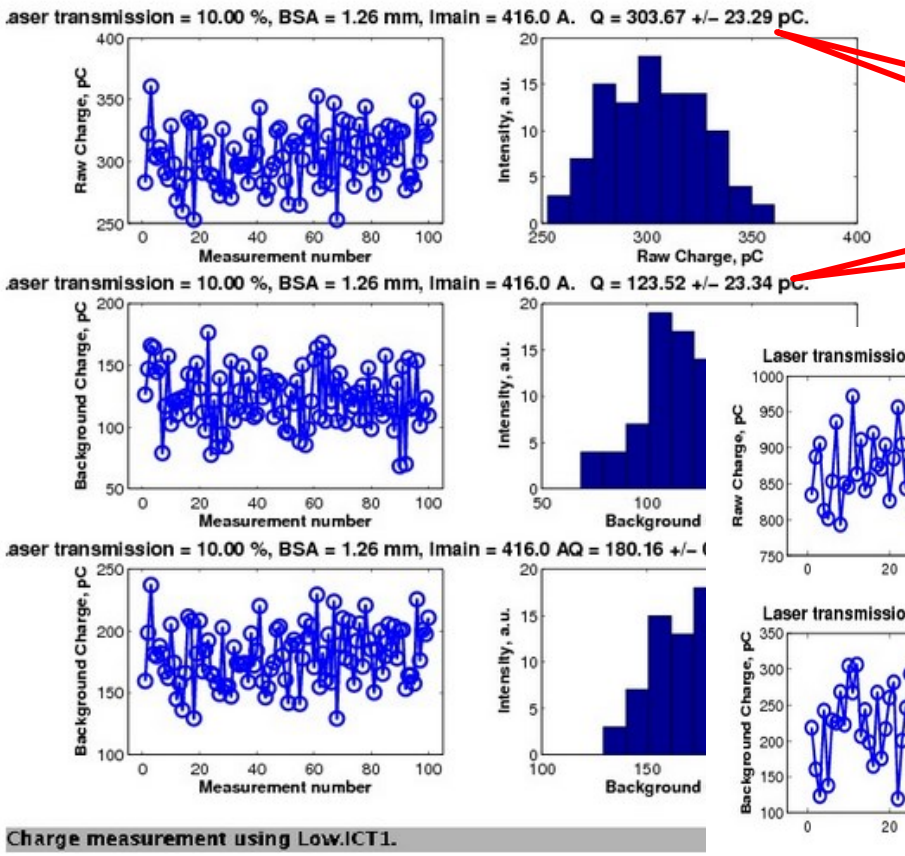
10.35

10.36

$$\sigma_{Q_R} \approx \sigma_{Q_B}$$

Measurement Error of Charge measuring system in PITZ

~200pC

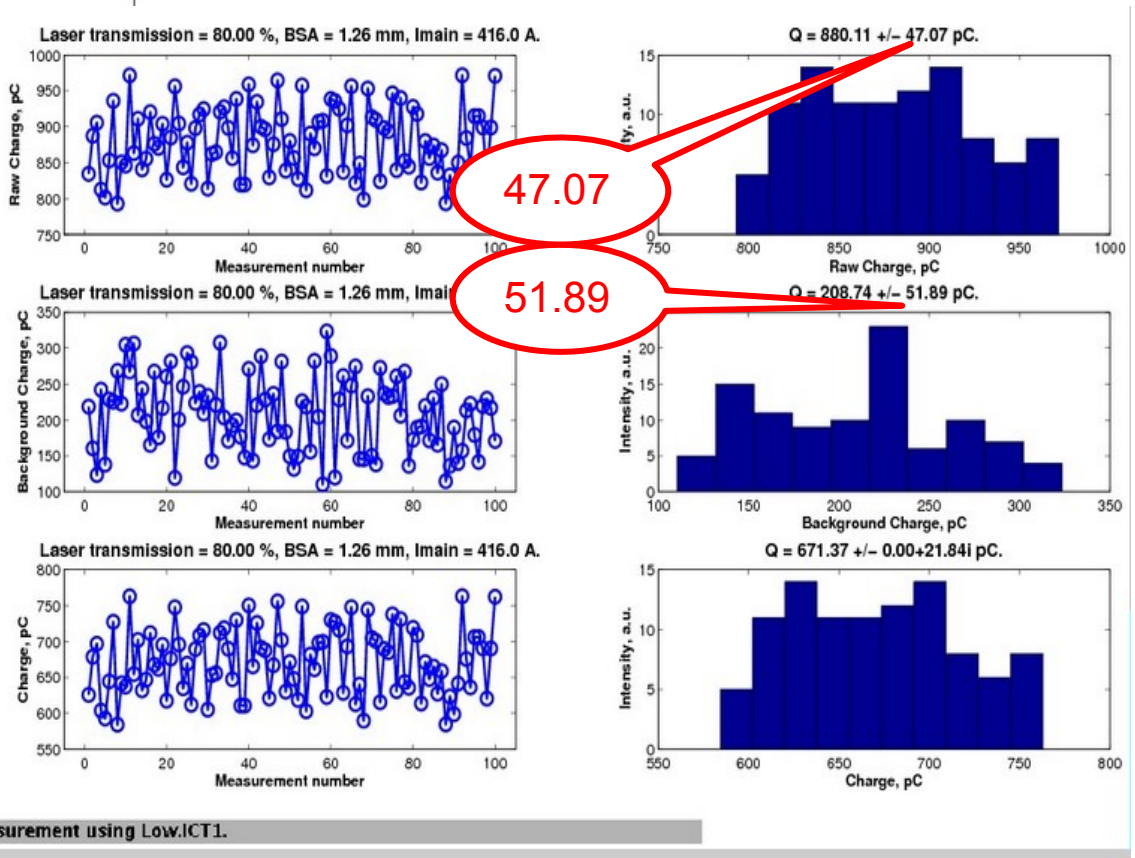


23.29

23.34

Low.ICT1

~800pC



47.07

51.89

$$\sigma_{Q_R} \approx \sigma_{Q_B}$$

Measurement error caused by electronic noise

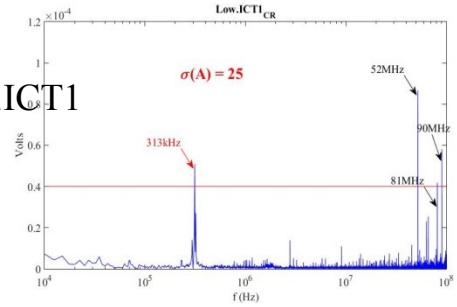
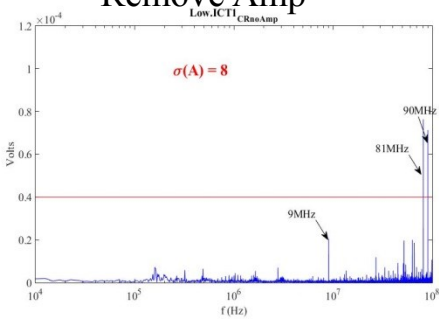
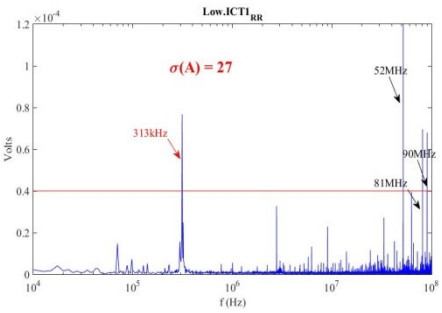
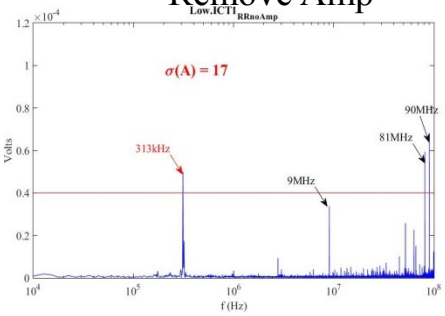
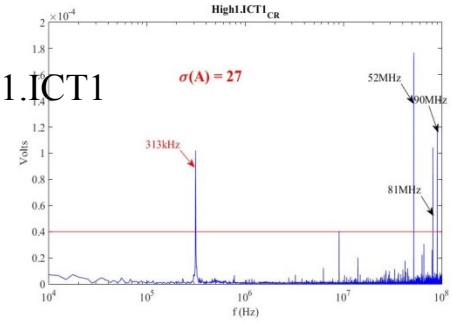
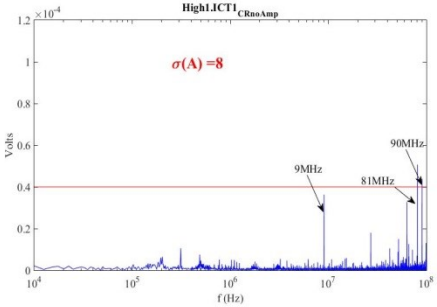
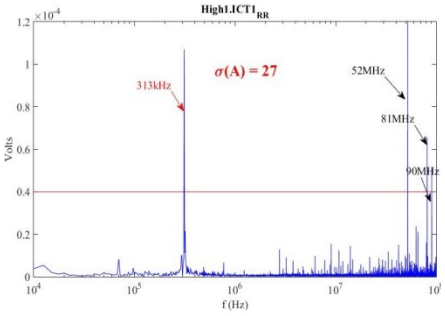
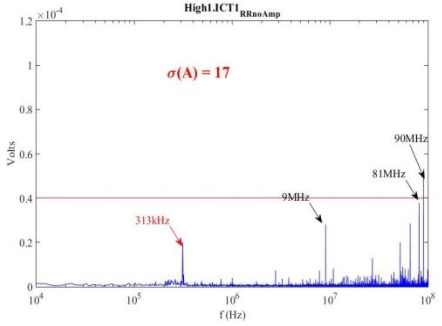
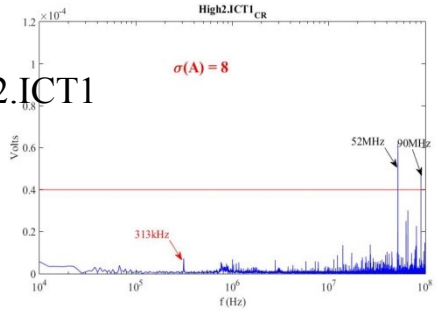
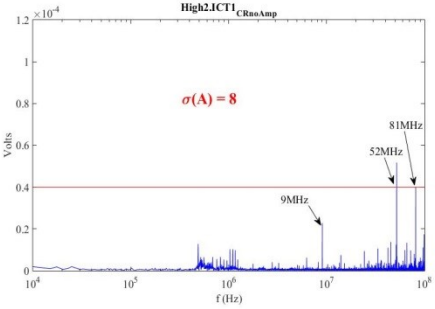
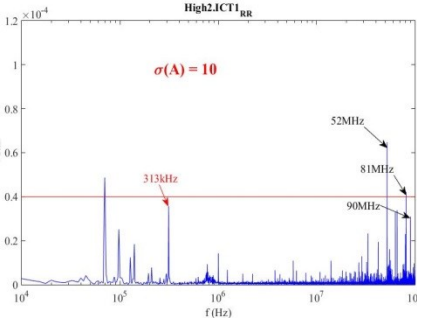
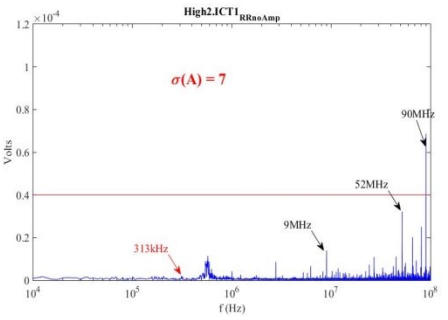
σ_{A_B} for different device Unit: pVs ICT: $\sigma_{Q_B} = \sigma_{A_B}/1.15$ FC: $\sigma_{Q_B} = \sigma_{A_B}/50$

	scale	Low.FC1	Low.FC2	Low.ICT1	High1.ICT1	High2.ICT1
ICT	1mV	6	6	20	17	10
	5mV	6	6	18	19	10
	10mV	7	6	18	17	10
	20mV	9	8	21	19	12
	50mV	13	15	25	22	18
	100mV	45	40	50	63	44
	200mV	70	60	70	70	70
FC	500mV	150	140	150	120	155
	1V	600	500	520	480	480
	2V	600	700	700	650	700

FC: σ_{Q_B} is dominated by the measurement of oscilloscope;

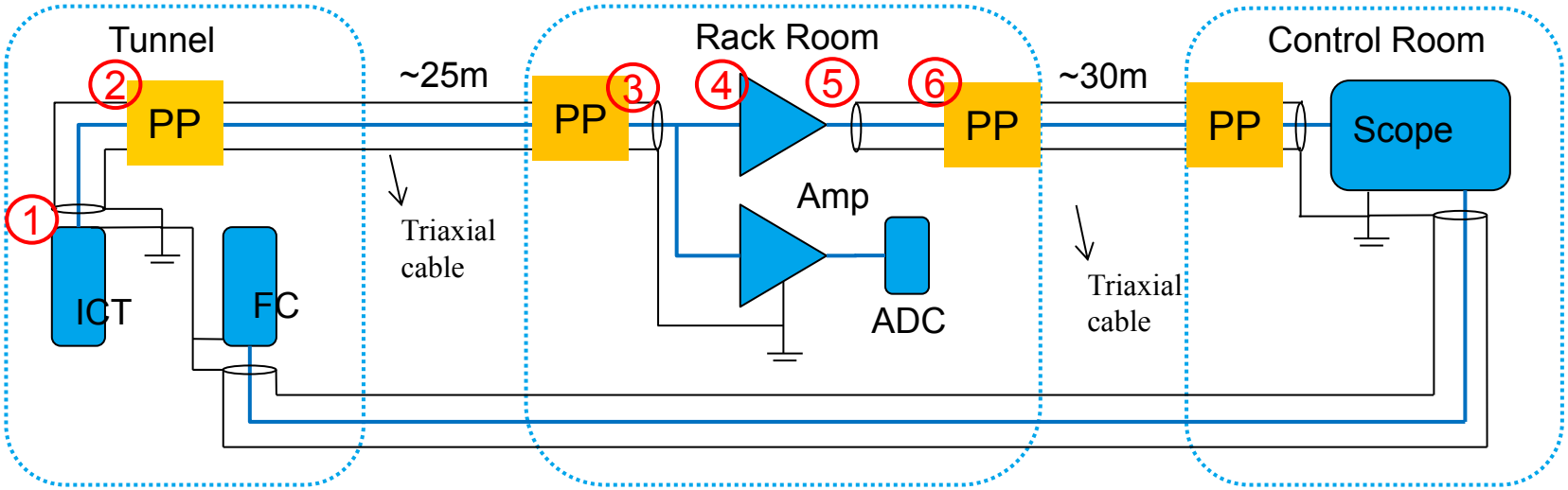
ICT: σ_{Q_B} is dominated by the electronic noise;

Strange 300KHz noise of ICT

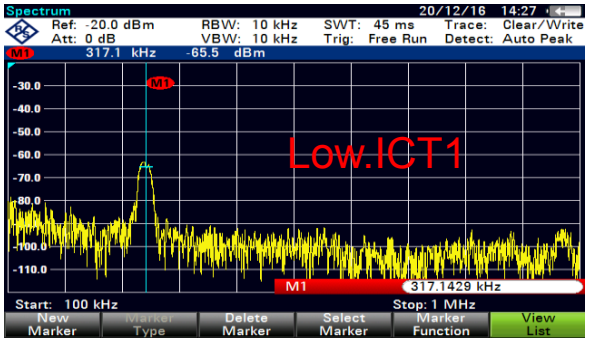
	CR	CR Remove Amp	RR	RR Remove Amp
Low.ICT1				
High1.ICT1				
High2.ICT1				

This 300kHz noise contributes most to σ_{Q_B}

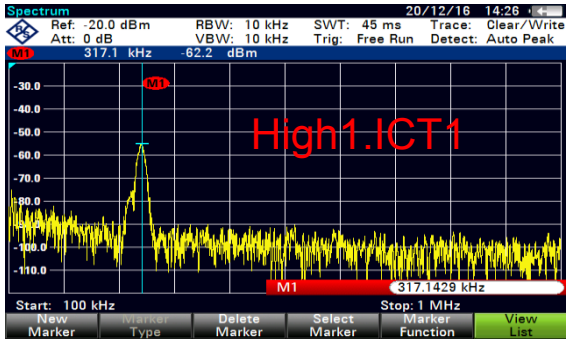
Strange 300KHz noise of ICT



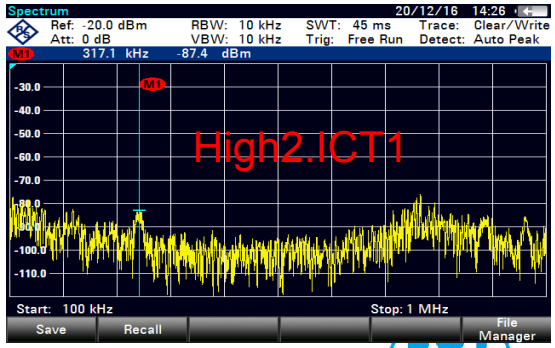
- All of the 3 ICTs share the same patch panel in the rack room, and the AMP are powered by the same power supply.
- They are connected to different patch panel in the tunnel.
- Low.FC1, Low.FC2 and Low.ICT1 share the same patch panel in the tunnel.



~ -60 dbm



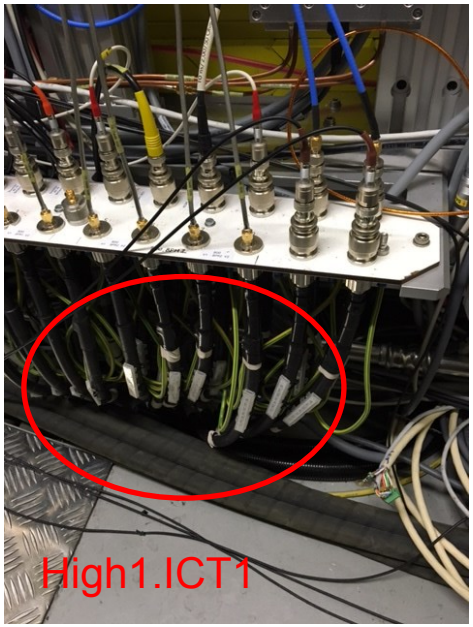
~ -60 dbm

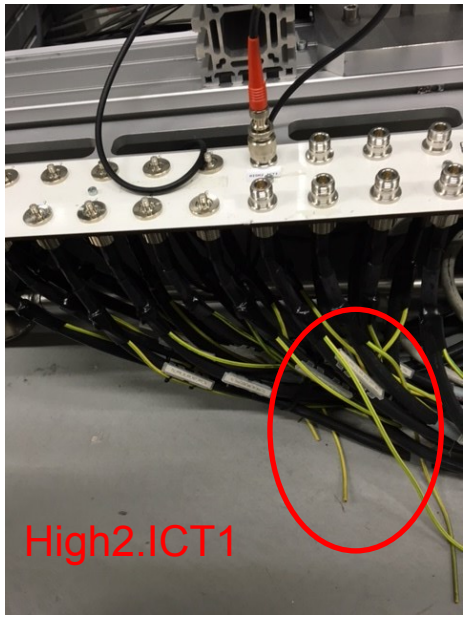


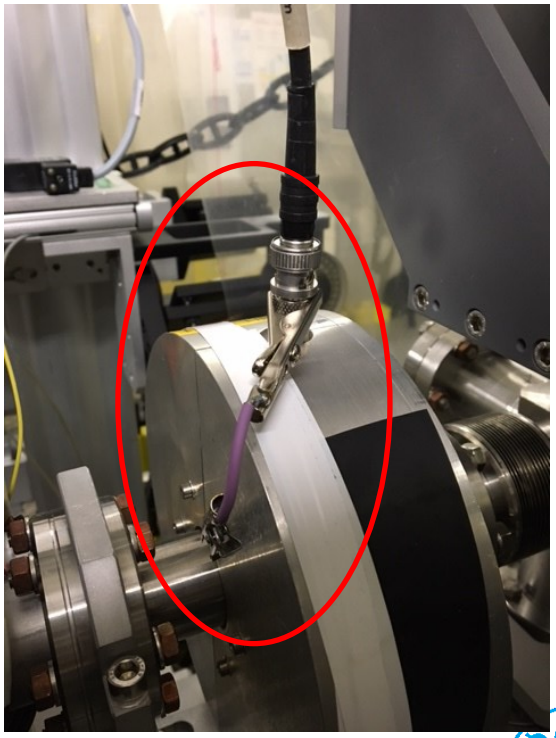
~ 80 dbm

Strange 300KHz noise of ICT

- For Low1.ICT and High1.ICT1, the inner part, which the coaxial cable is connected, is isolated to the outer shell which is grounded in the tunnel. But the inner part of High2.ICT1 is not isolated.
- The long cable from tunnel to rack room has second shielding. For Low1.ICT and High1.ICT1 the second shielding is grounded in the tunnel but ungrounded in the rack room. For High2.ICT1, both ends are ungrounded.



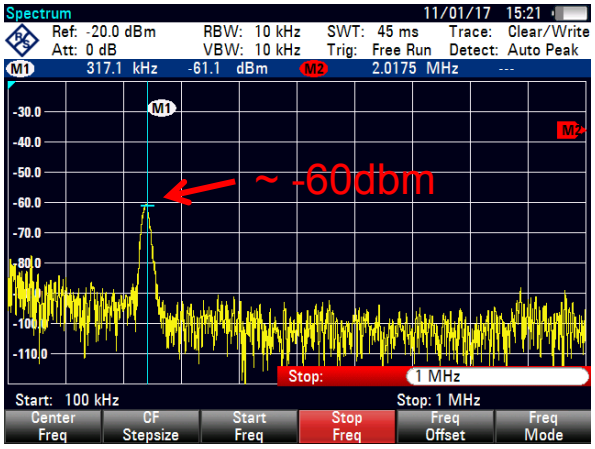


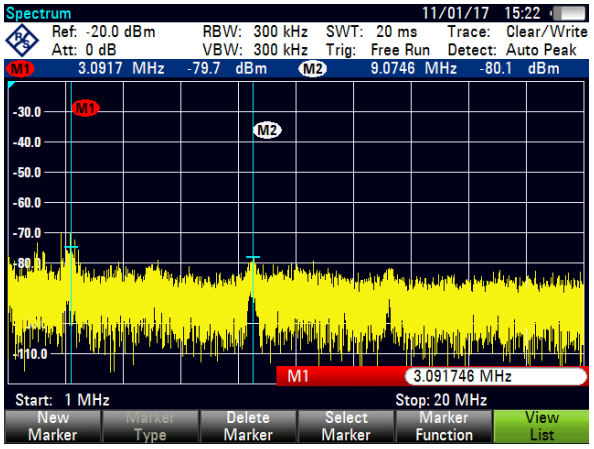


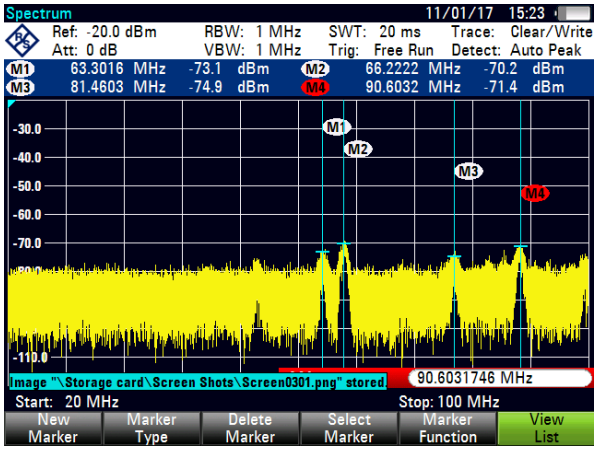
Result of the short cable

Before $\sigma_{A_B} = 35$

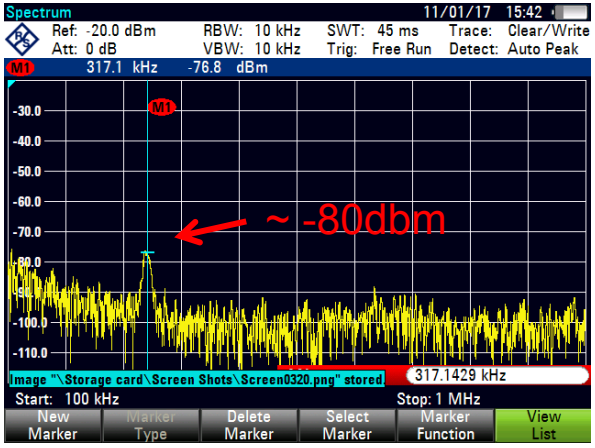
Spectrum of background signal of **Low.ICT1**

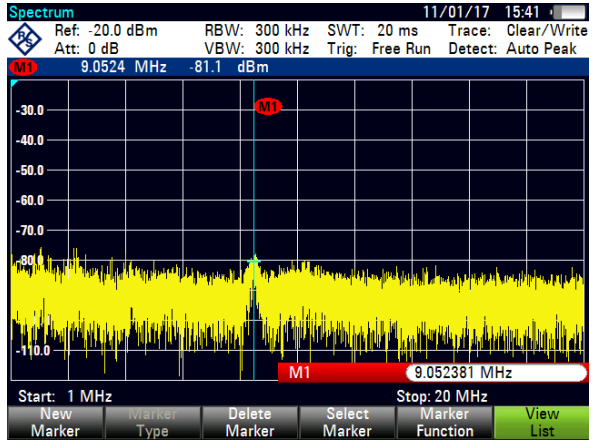


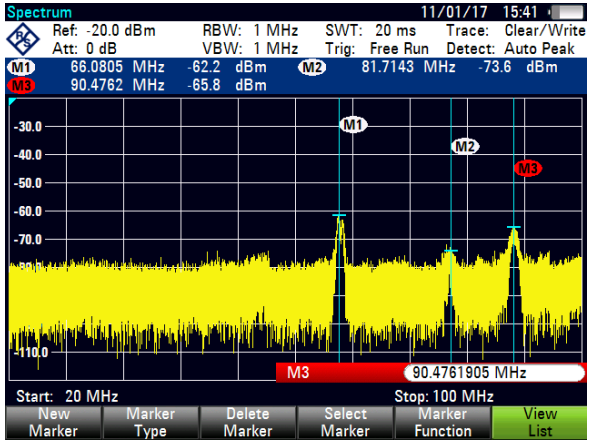




After $\sigma_{A_B} = 18$



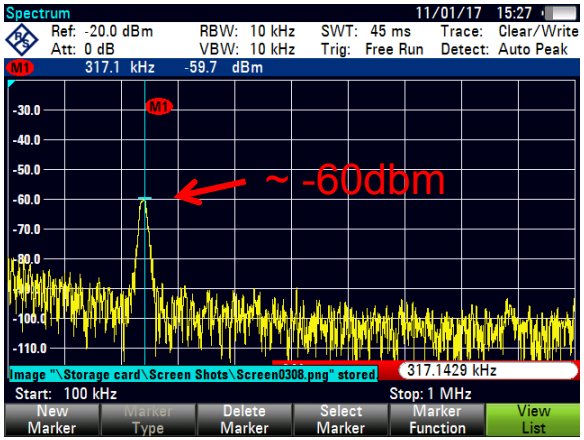


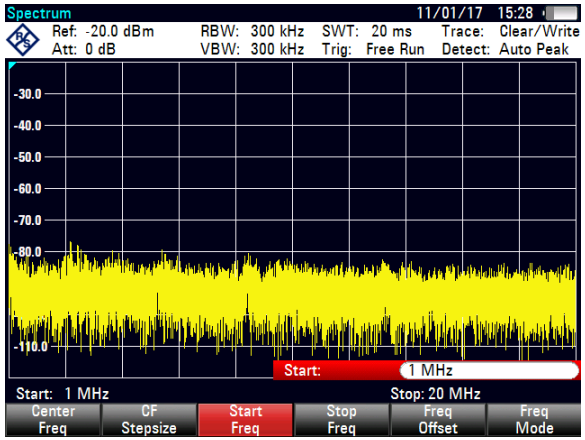


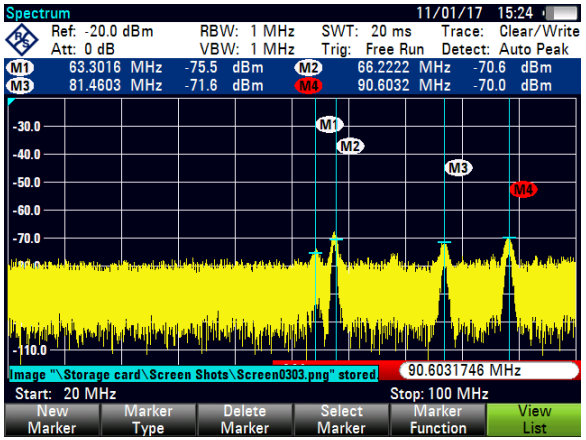
Effect of the short cable

Before σ_{A_B} =40

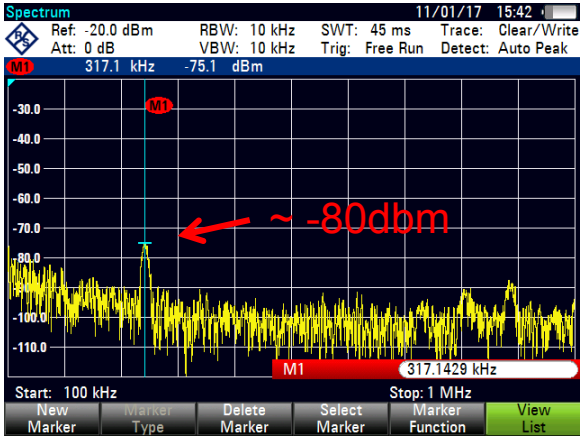
Spectrum of background signal of **High1.ICT1**

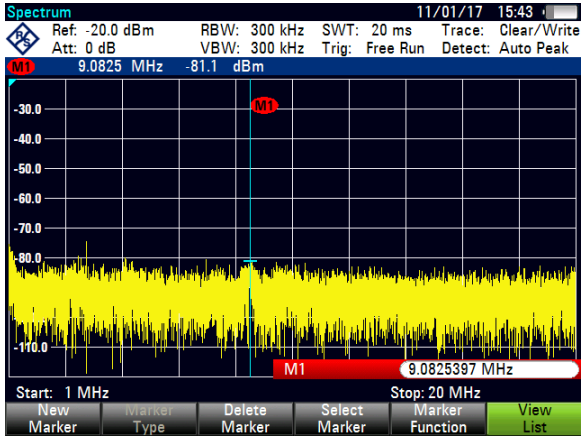


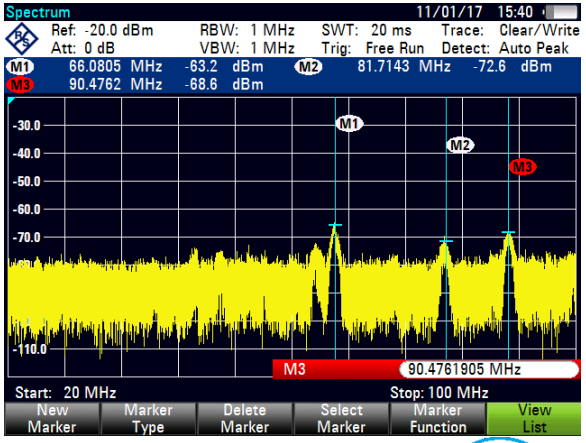




After $\sigma_{A_B} = 15$



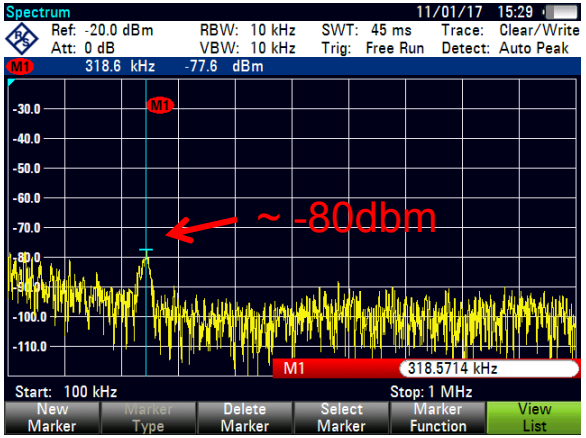


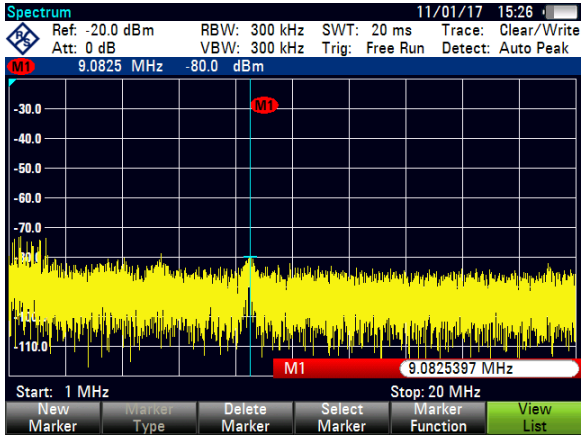


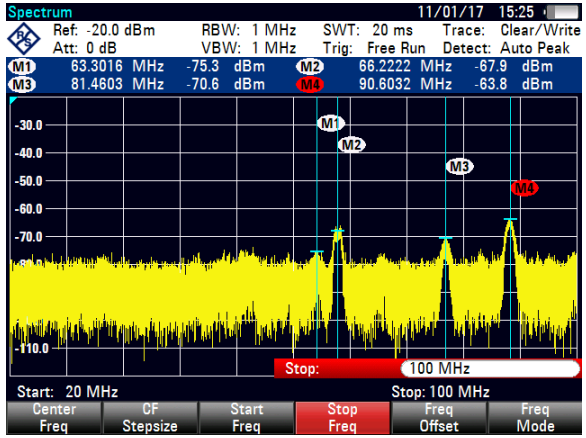
Effect of the short cable

Before $\sigma_{A_B} = 9$

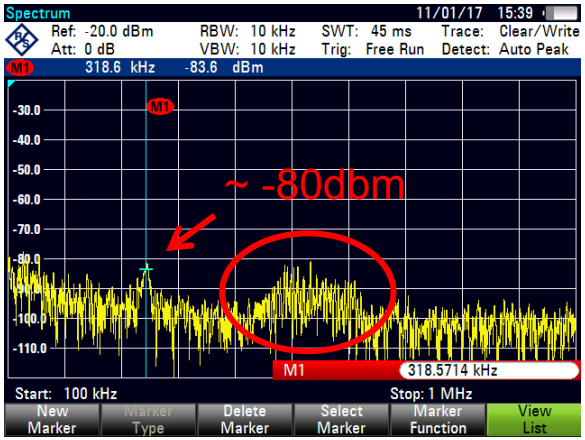
Spectrum of background signal of **High2.ICT1**

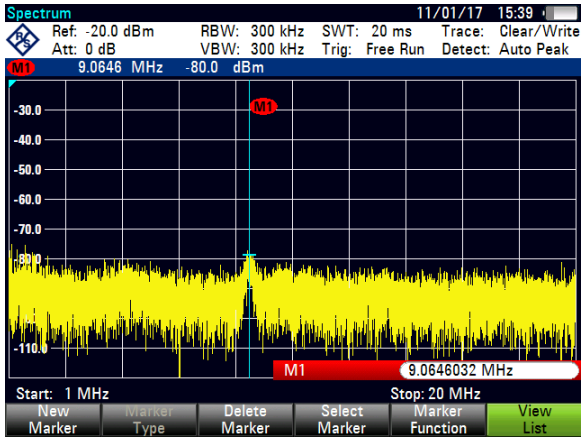


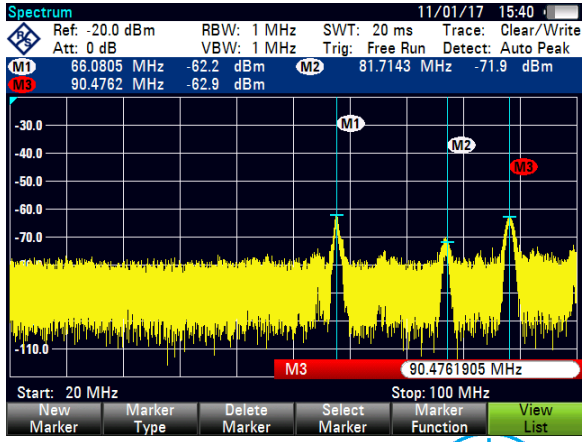




After $\sigma_{A_B} = 15$



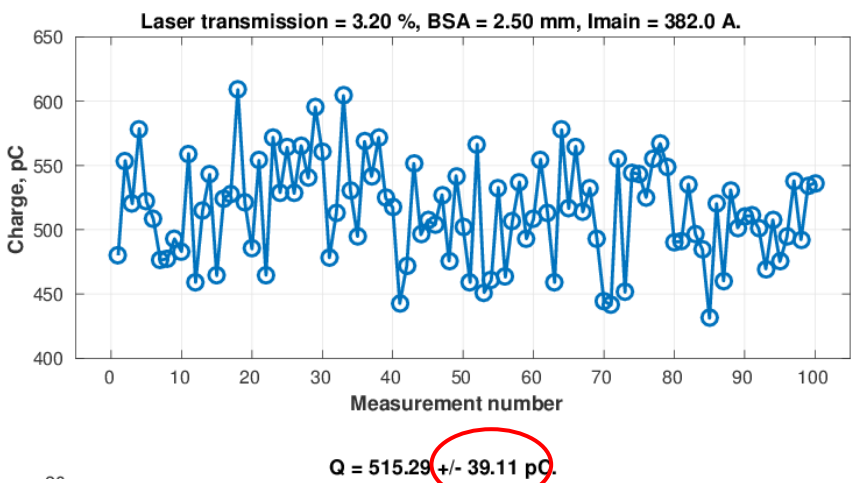




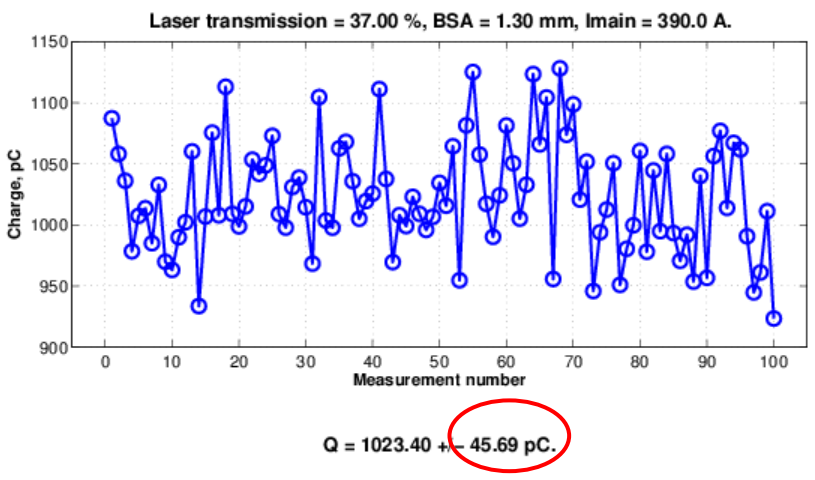
Charge measured @Low.ICT1

Before

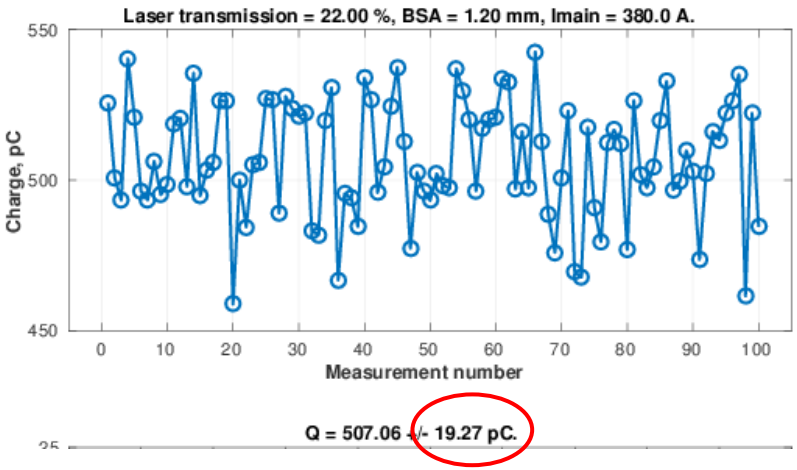
~500pC

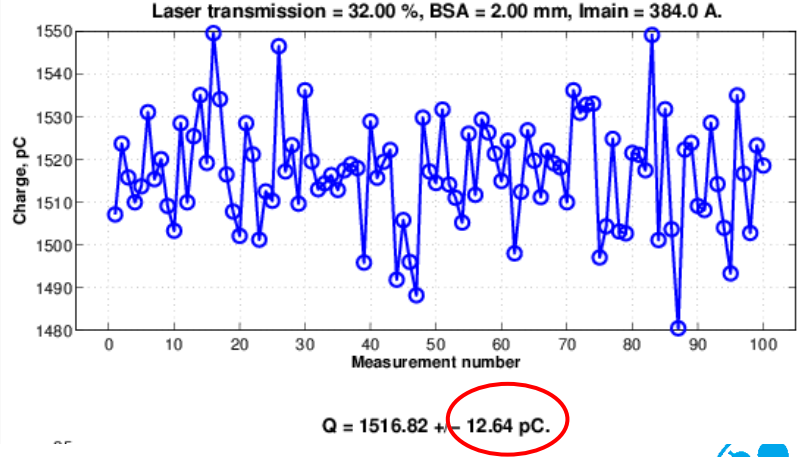


~1500pC



After





Summary

- The 300kHz noise contributes much to the charge measurement error of ICTs.
- The inner part of ICTs should be grounded. With such grounding, the 300kHz ripple is decreased from -60dbm to -80dbm, the charge measurement error of Low.ICT1 and High1.ICT1 is reduced about 50%.
- Compared with High2.ICT1, grounding the inner part of Low.ICT1 and High1.ICT1 with short cable is useful, but not a proper way, it can be improved.