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, Zeuthen, 16.02.2017





Measurement Error of Charge measuring system in PITZ



$$Q = \langle Q \rangle \pm \sigma_Q = \langle Q_R \rangle - \langle Q_B \rangle \pm \sigma_{Q_R}$$
 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 \implies Background error σ_{Q_B}



Measurement Error of Charge measuring system in PITZ

~200pC



Measurement Error of Charge measuring system in PITZ

~200pC



Measurement error caused by electronic noise

. 1

0

1.00

$\sigma_{\!A_B}$	for differe	nt device	Unit: pVs	ICT: $\sigma_{Q_B} = \sigma_{A_B}/1.15$ FC: $\sigma_{Q_B} = \sigma_{A_E}$									
	scale	Low.FC1	Low.FC2	Low.ICT1	High1.ICT1	High2.ICT1							
	1mV	6	6	20	17	10							
IOT	5mV	6	6	18	19	10							
ICI	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							
	500mV	150	140	150	120	155							
FC	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; Xin Li| Noise study of charge measuring system in PITZ| 16.02.2017| Page 5



Strange 300KHz noise of ICT



This 300kHz noise contributes most to $\sigma_{Q_{BLi}}$ Noise study of charge measuring system in PITZ| 16.02.2017| Page 6

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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.



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 $\sigma_{A_B} = 18$

Trace: Clear/Write Detect: Auto Peak Hz -73.6 dBm			
Detect: Auto Peak Hz -73.6 dBm			
Hz -73.6 dBm			
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M3			
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Stop: 100 MHz			
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Effect of the short cable

Before

$\sigma_{A_B} = 40$

Spectrum of background signal of High1.ICT1



After $\sigma_{A_B} = 15$

Spectrum 11/01/17 15:42								Spectr	pectrum 11/01/17 15:43 Spectrum									11/01/17 15:40													
✐	Ref	: -20.0	dBm	RBV	/: 10 kH	z SW	T: 45 m	s Tra	ce: Cle	ear/Write		Ref:	-20.0 d	Bm	RBW	/: 300 k	Iz SW	T: 20 ms	Trac	ce: Cl	ear/Write		Ref: -20.	0 dBm	RBW	: 1 MH	z SW	T: 20 m	s Tra	ice: Cl	ear/Write
V	Att	: 0 dB		VBV	V: 10 kH	z Trig	: Free I	Run De	tect: Au	ito Peak	V?	Att:	0 dB		VBW	/: 300 k	Iz Trig:	: Free Ru	n Dete	ect: Au	uto Peak	V	Att: 0 dE	}	VBW	: 1 MH;	z Trig	: Free R	un De	tect: A	uto Peak
M1		317.1	l kHz	-75.1	dBm						M1	9	.0825	MHz	-81.1	dBm						M1	66.080	5 MHz	-63.2	dBm	M2	81.7143	MHz	-72.6	dBm
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Effect of the short cable

Before

$\sigma_{A_B} = 9$

Spectrum of background signal of High2.ICT1



After $\sigma_{A_B} = 15$



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DE

Charge measured @Low.ICT1

~1500pC





After





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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.

