# More precise method for the gun stability measurements
(proposals)

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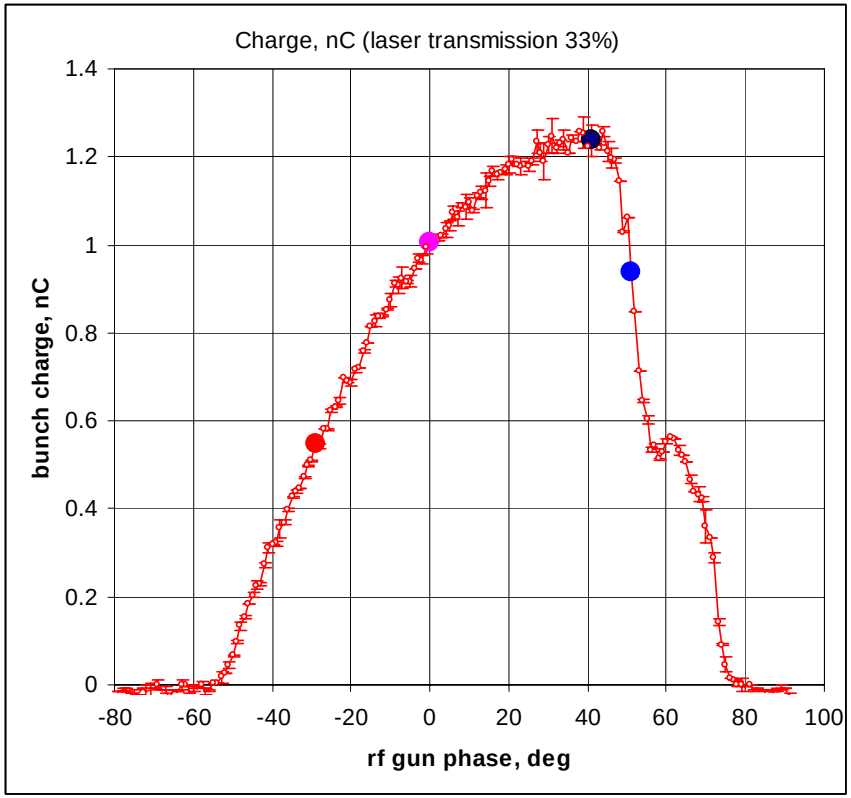
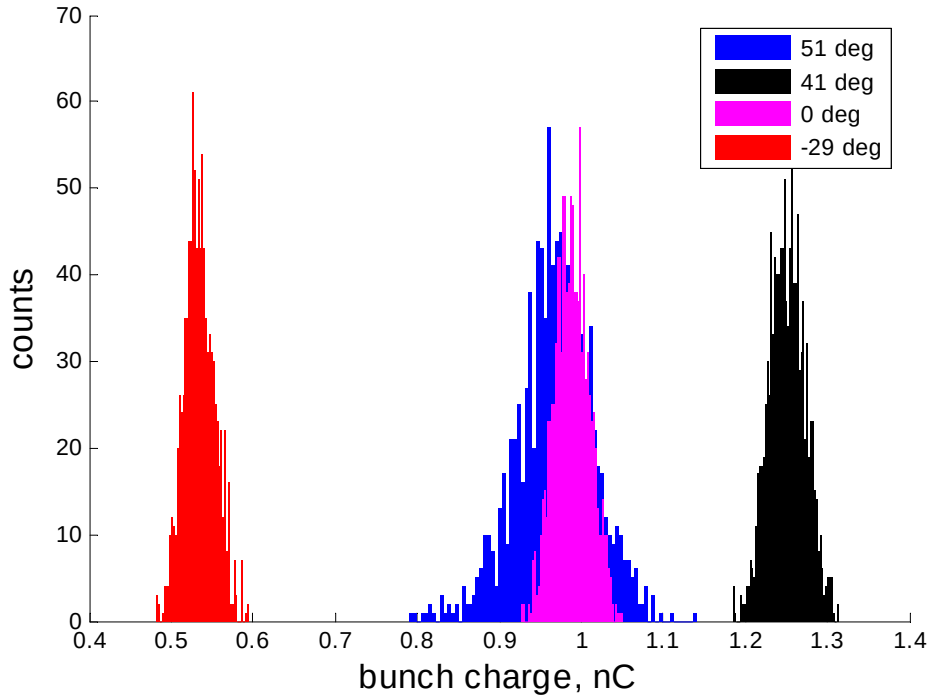
*PPS, 09.02.2010*

# Gun3.2: Phase Scan and Charge Stability (MK, PPS, 04.12.2007)

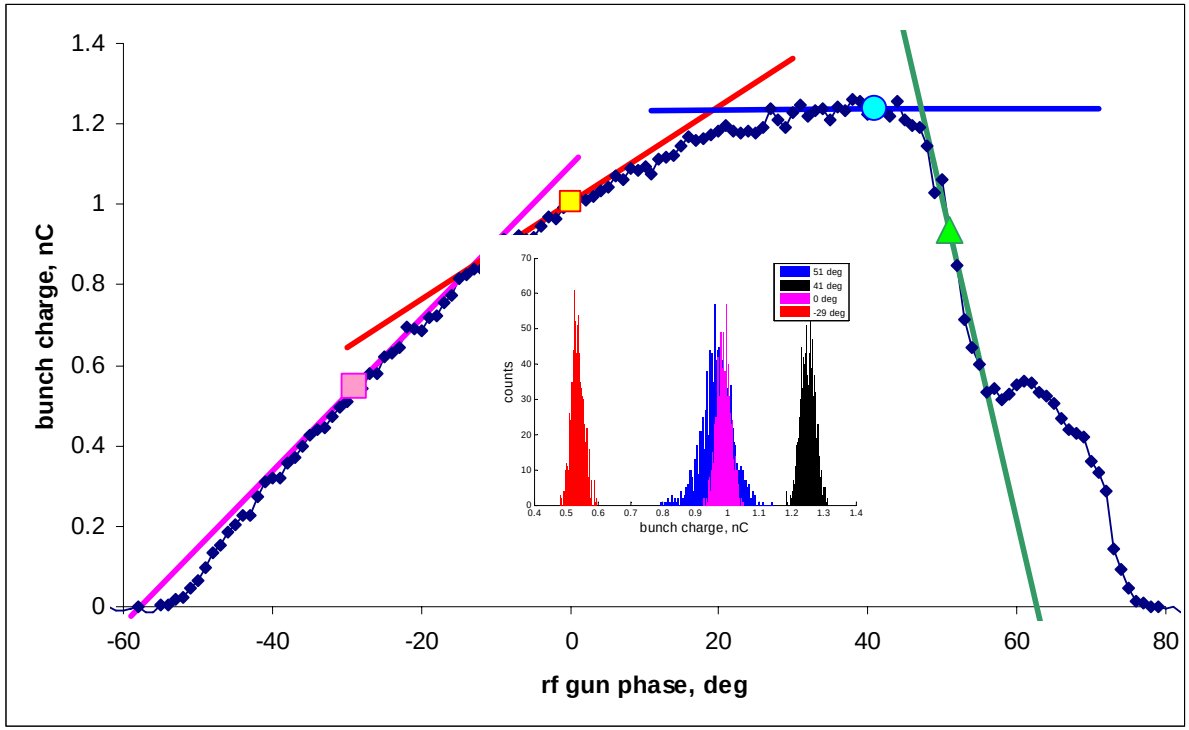



Measurements of the night shift 18.08.2007




| Phase, deg | <Q>, nC | dQ/<Q>,% |
|---|---|---|
| -29 | 0.547 | 3.6% |
| 0 | 1.005 | 2.1% |
| 41 | 1.237 | 1.8% |
| 51 | 0.937 | 4.9% |

# Charge stability studies: laser energy and rf phase jitter




$\delta Q$ – charge jitter

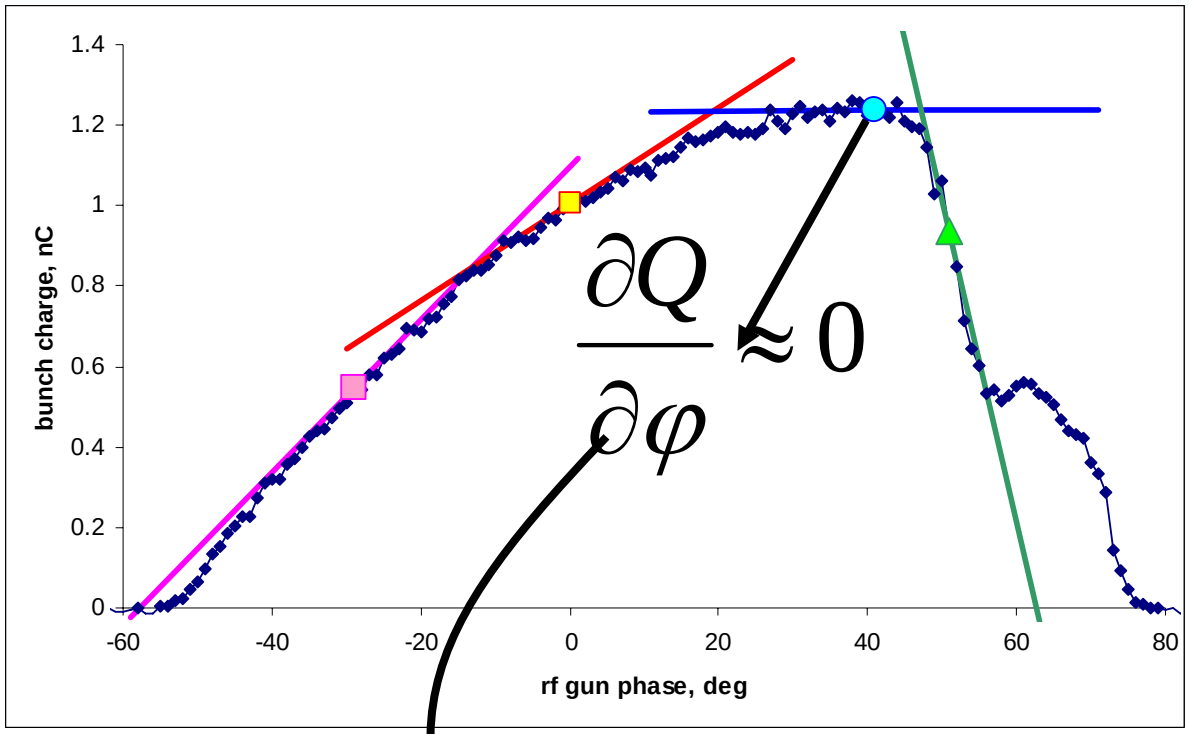
$\delta Q_E$ – charge jitter due to laser energy jitter

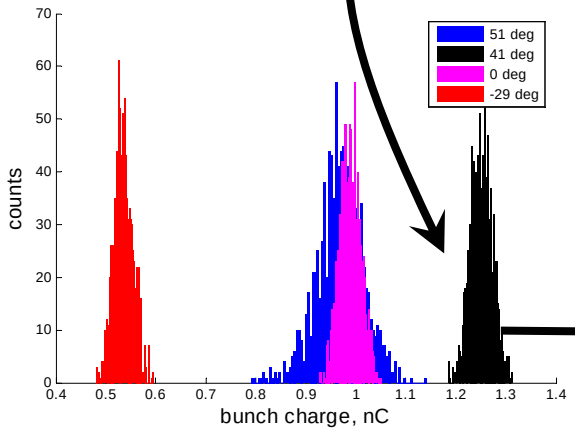
$\delta Q_{RF}$ – charge jitter due to rf phase jitter

$$\delta Q^2 \approx \delta Q_E^2 + \delta Q_{RF}^2$$

$$\delta Q_E = \frac{\partial Q}{\partial E}\delta E \qquad \delta Q_{RF} = \frac{\partial Q}{\partial \varphi}\delta \varphi$$

# Charge stability studies: laser energy and rf phase jitter

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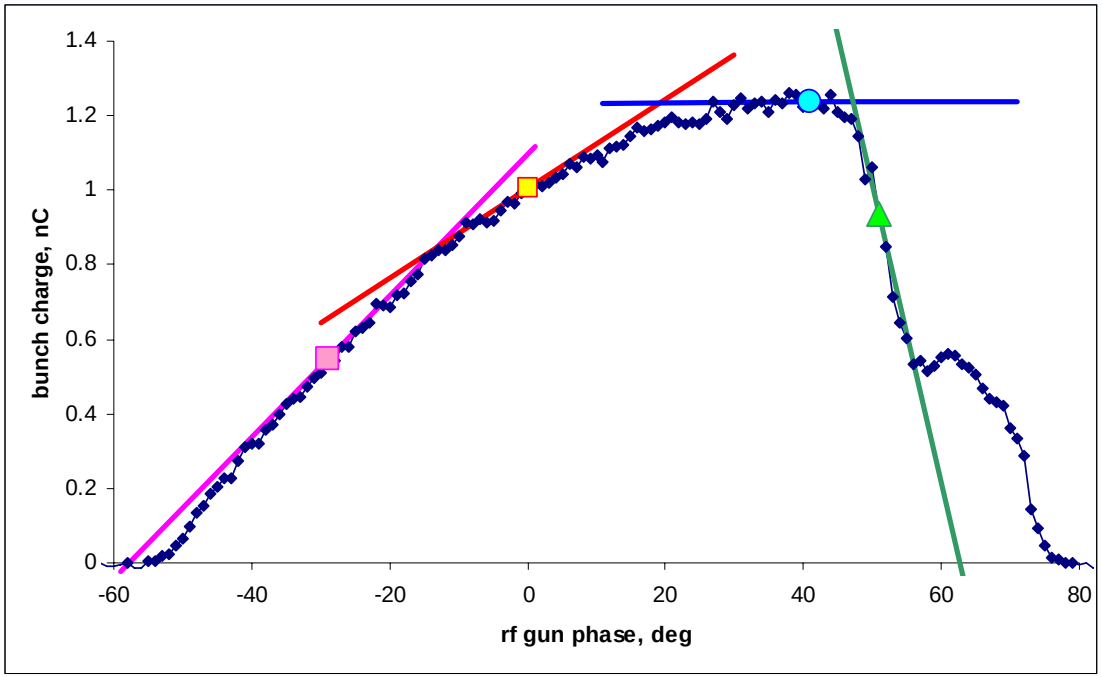
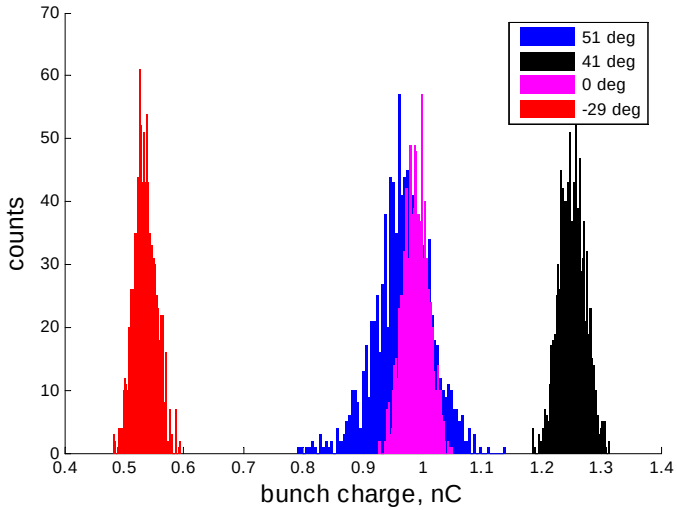
?laser energy jitter 1.8%???

# Charge stability studies: laser energy and rf phase jitter



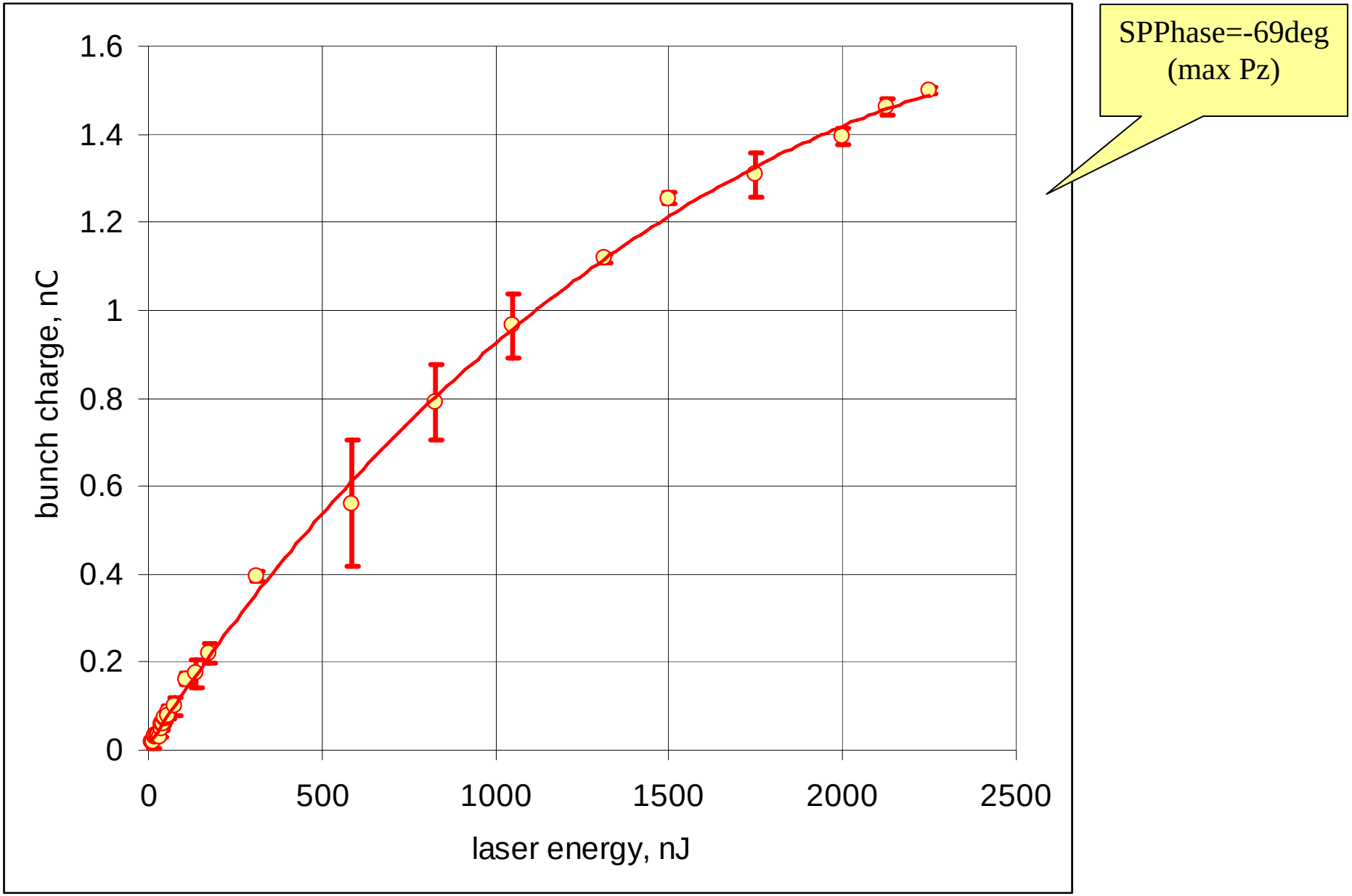




| Phase, deg | <Q>, nC | dQ/dphi nC/deg | DQ(21%) nC | dE/E % | dQ_E | dQ/<Q>,% | dQ, nC | dQ_phi | dphi,deg |
|---|---|---|---|---|---|---|---|---|---|
| -29 | 0.547 | 0.019 | 0.01 | 2.93% | 0.001 | 3.6% | 0.020 | 0.020 | 1.03 |
| 0 | 1.005 | 0.012 | 0.123 | 2.93% | 0.017 | 2.1% | 0.021 | 0.012 | 1.02 |
| 41 | 1.237 | 0.0001 | 0.160 | 2.93% | 0.022 | 1.8% | 0.022 | 0.000 | 1.16 |
| 51 | 0.937 | -0.08 | 0.15 | 2.93% | 0.021 | 4.9% | 0.046 | 0.041 | 0.51* |

laser energy jitter $\frac{\delta E}{E} \sim 2.9\%$

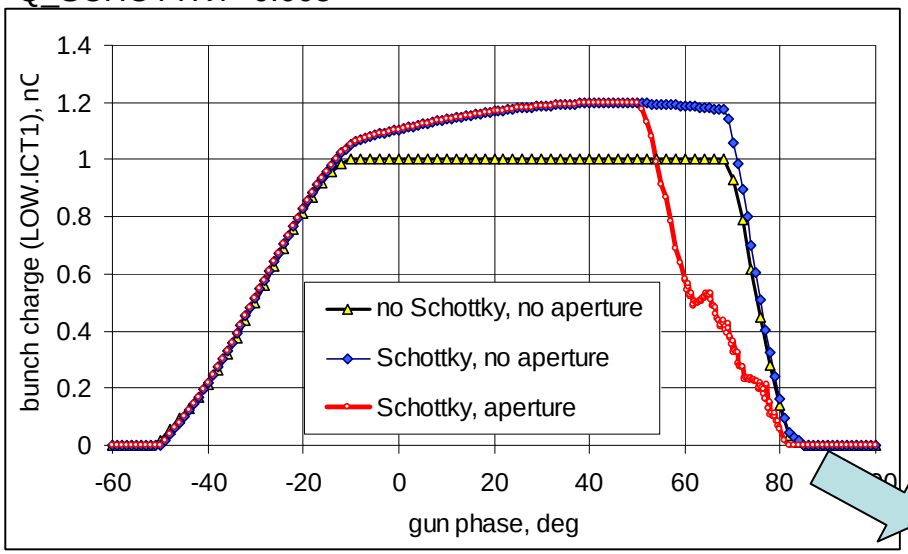
RF phase jitter $\delta\varphi \sim 1\text{deg}$

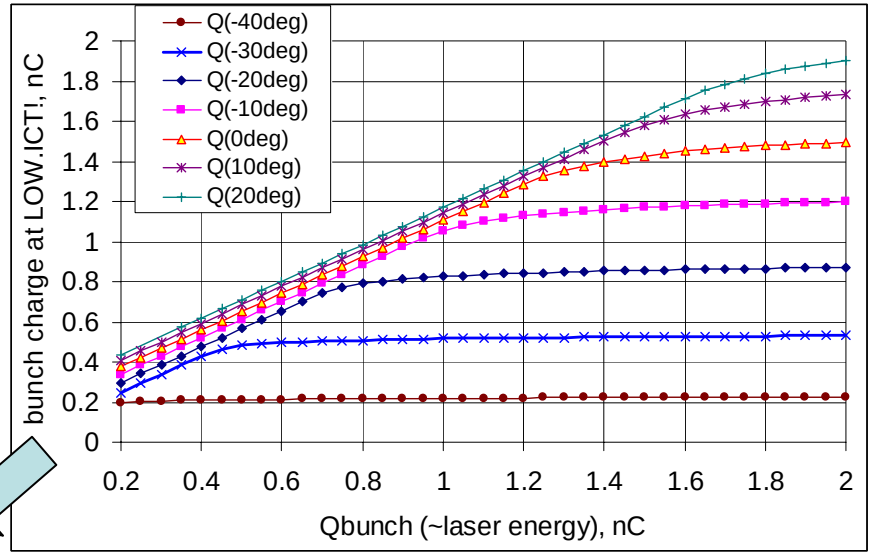
# Charge vs. laser energy

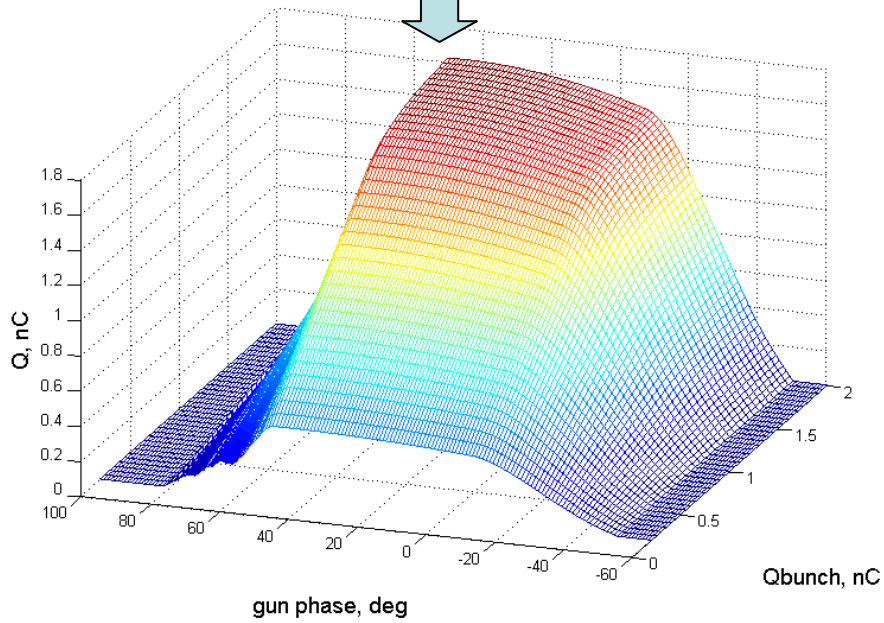


# Simulated (ASTRA) phase (Schottky) scan

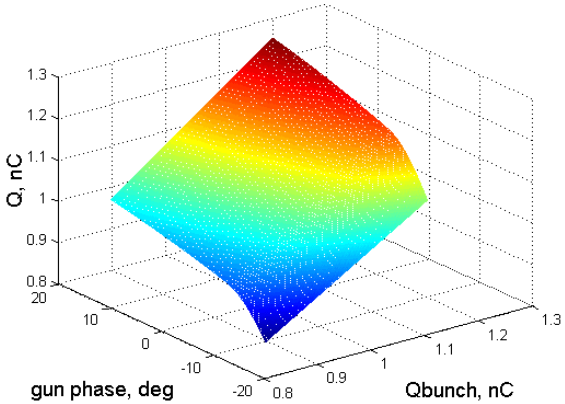
Q_SCHOTTKY=0.005

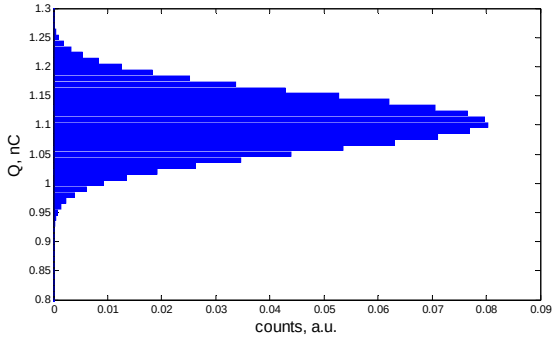


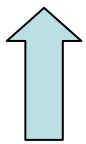



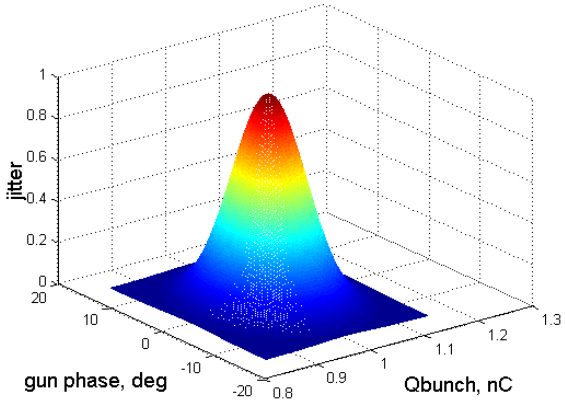



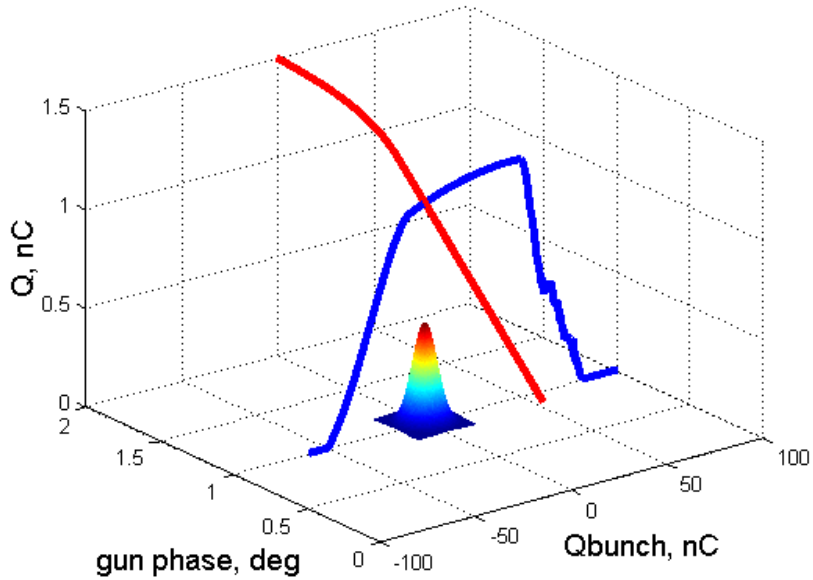
# 2D (phase + laser energy) jitter



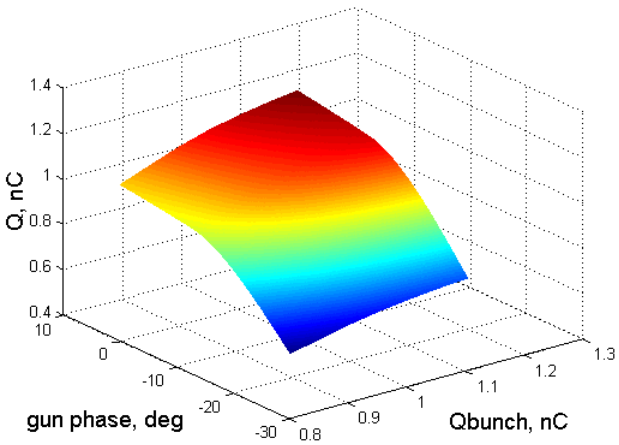



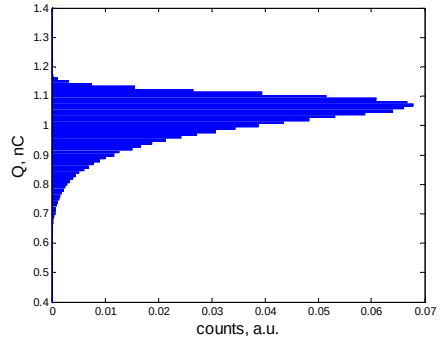


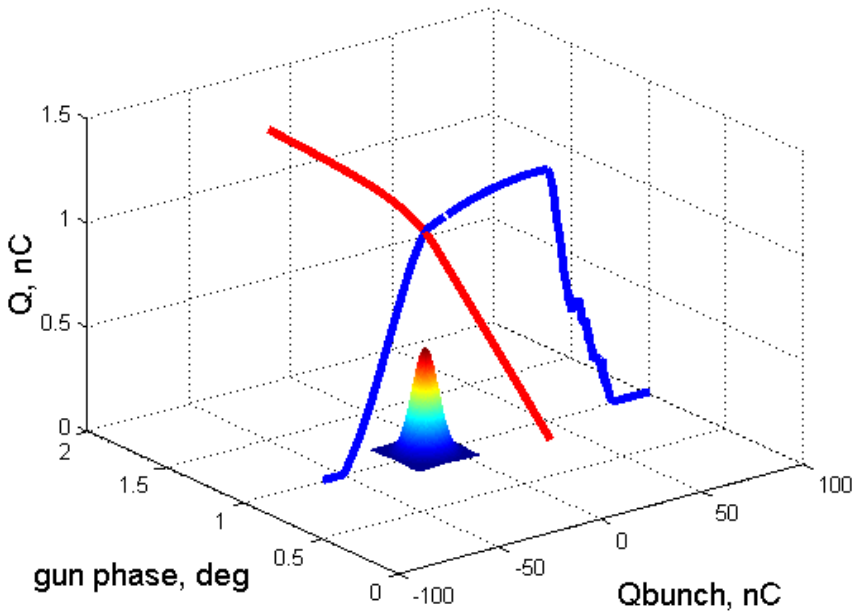



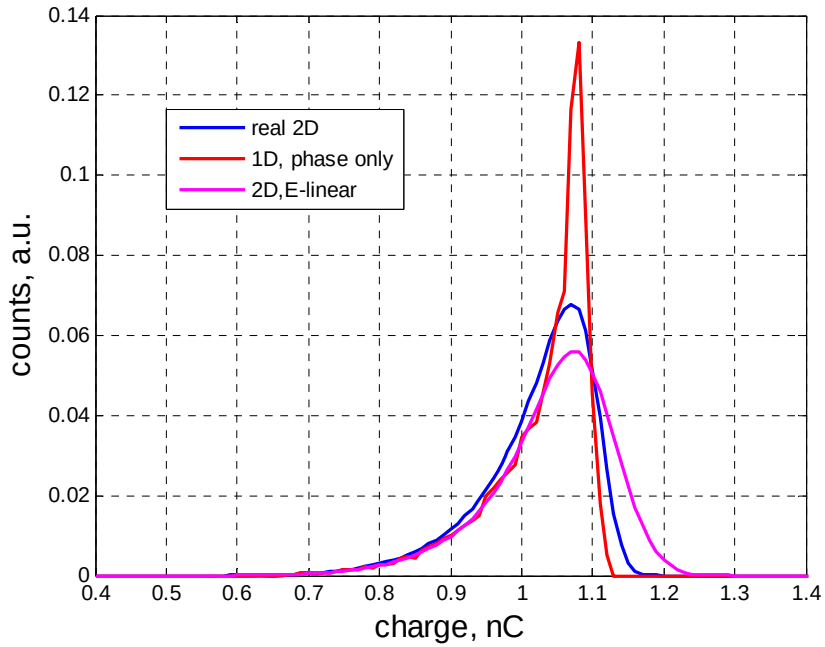

**phi0=0; sigphi=5; E0=1.0; sigE=0.05;**

# 2D (phase + laser energy) jitter



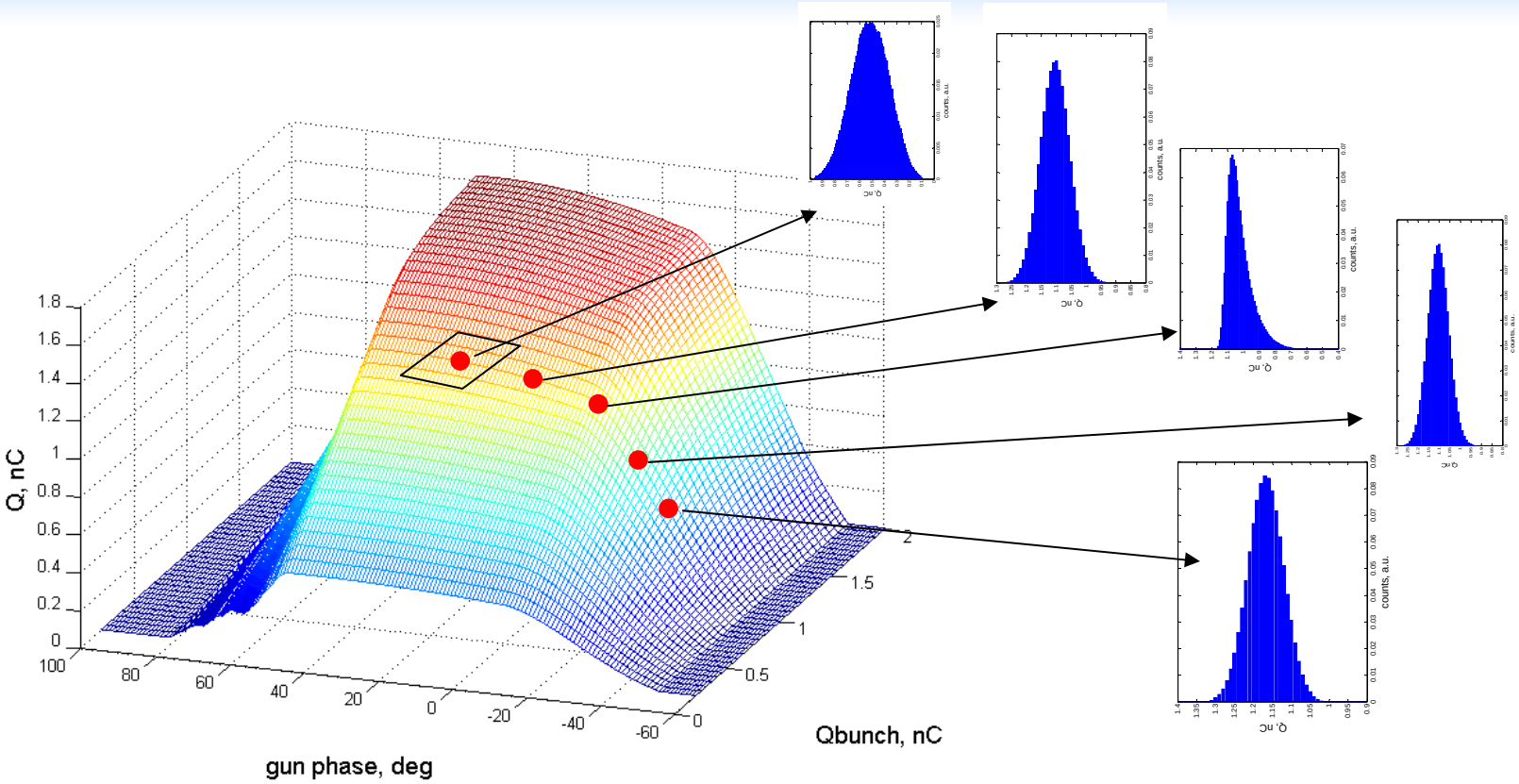




**phi0=-10; sigphi=5; E0=1.0; sigE=0.05;**

# Simultaneous rf gun phase and laser energy jitter determination




- Detailed measurements: Q(SPPhase, LasAtten) x n
- Q-histogram for the centre point
- Fit 2D Gaussian jitter distribution x measured surfaces to the measured Q-histograms:

$$\Phi(\sigma_\phi, \sigma_E) = \sum_n w_n \cdot \int \left(QH_{meas} - QH_{calc}\right) dq \rightarrow \min$$

# Simultaneous rf gun phase and laser energy jitter determination

Main assumptions:

- normal distribution of rf gun phase and laser energy jitter
- rf gun phase and laser energy jitter are independent
- no other source of the charge jitter:
  - Dark current (bkg) fluctuations
  - Dependence of the bunch charge on the gun gradient?
  - Noise of the ICT (FC?) measurements
  - Charge losses due to beam position (steering)
- …

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- Rather simple measurements (LOW.ICT1 or LOW.FC1)
- Provides simultaneously phase and laser rms jitter

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- Could be time consuming (needs some automation)
- Reconstruction algorithm to be implemented and tested

# 2D phase scan (ASTRA simulations)