CSR Studies at Diamond

Preliminary !

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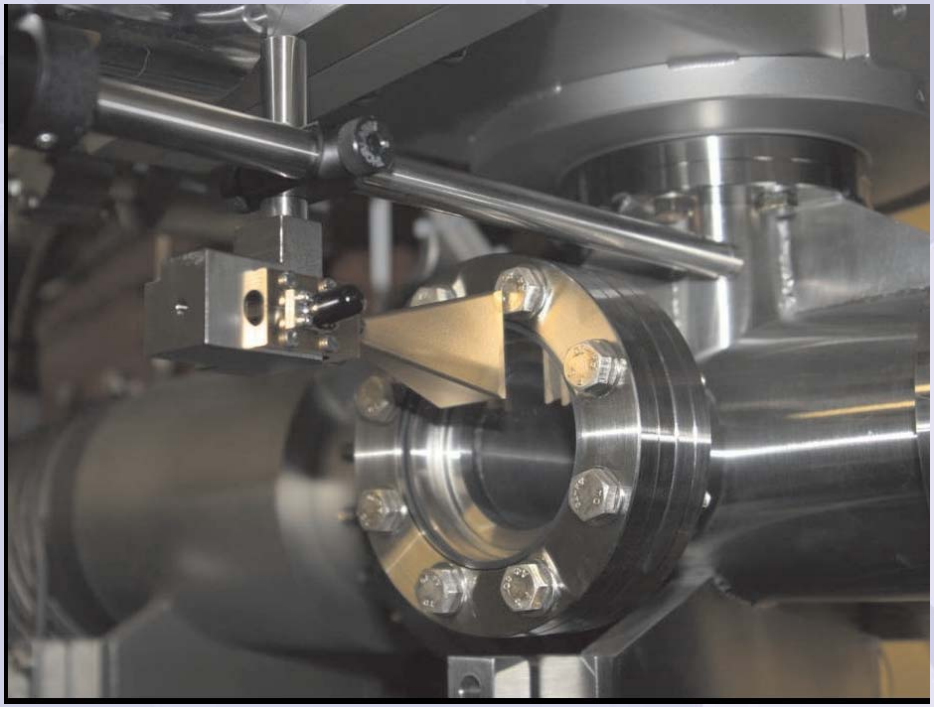
1. mm-wave measurements - steady state
2. mm-wave measurements - bursting
3. sub-mm/FIR/THz measurements

ESLS XVIII, ELETTRA, Nov. 25-26th 2010

diamond

Ultra-fast mm-wave Detector

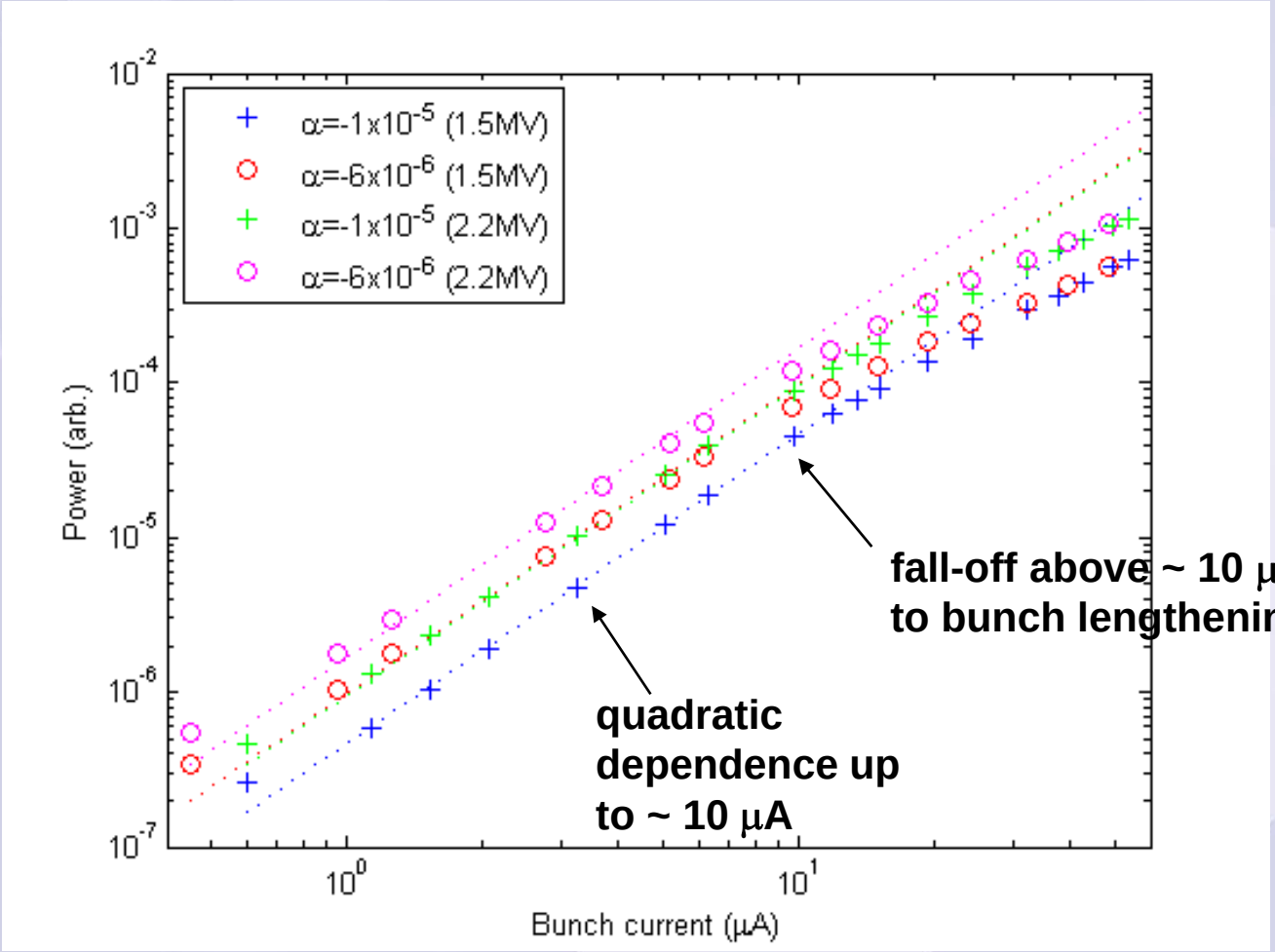
- collaboration with P. Karataev, John Adams Institute (Royal Holloway)



Frequency range	**60 – 90 GHz**
Wavelength range	**3.3 – 5 mm**
Frequency response	**~ 250 ps**

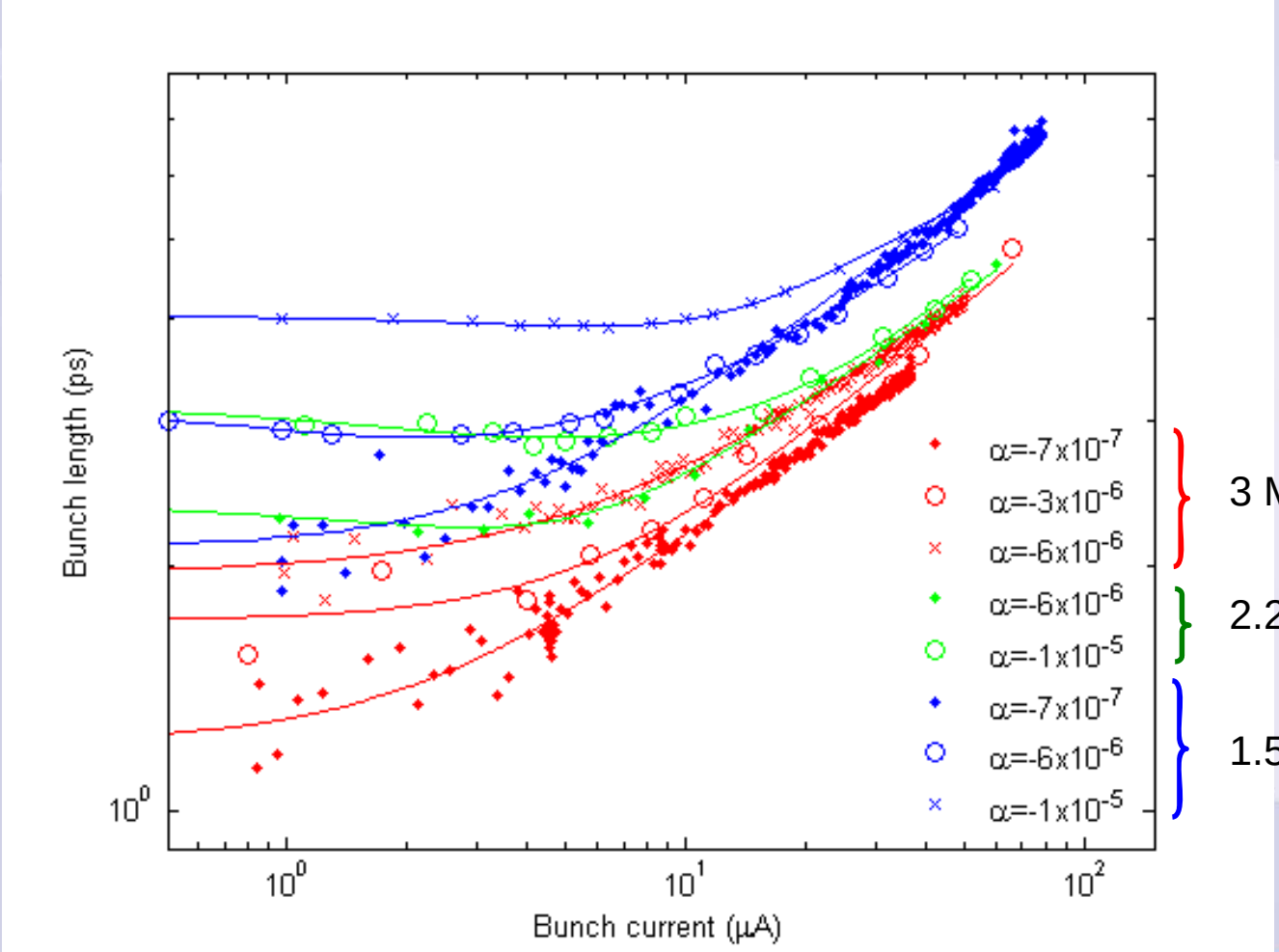
G. Rehm et al., "*Ultra-fast mm-Wave Detectors for Observation of Microbunching Instabilities in the Diamond Storage Ring*", Proc. DIPAC 2009

Measured mm-wave power in low-alpha mode at different RF voltages – steady state:

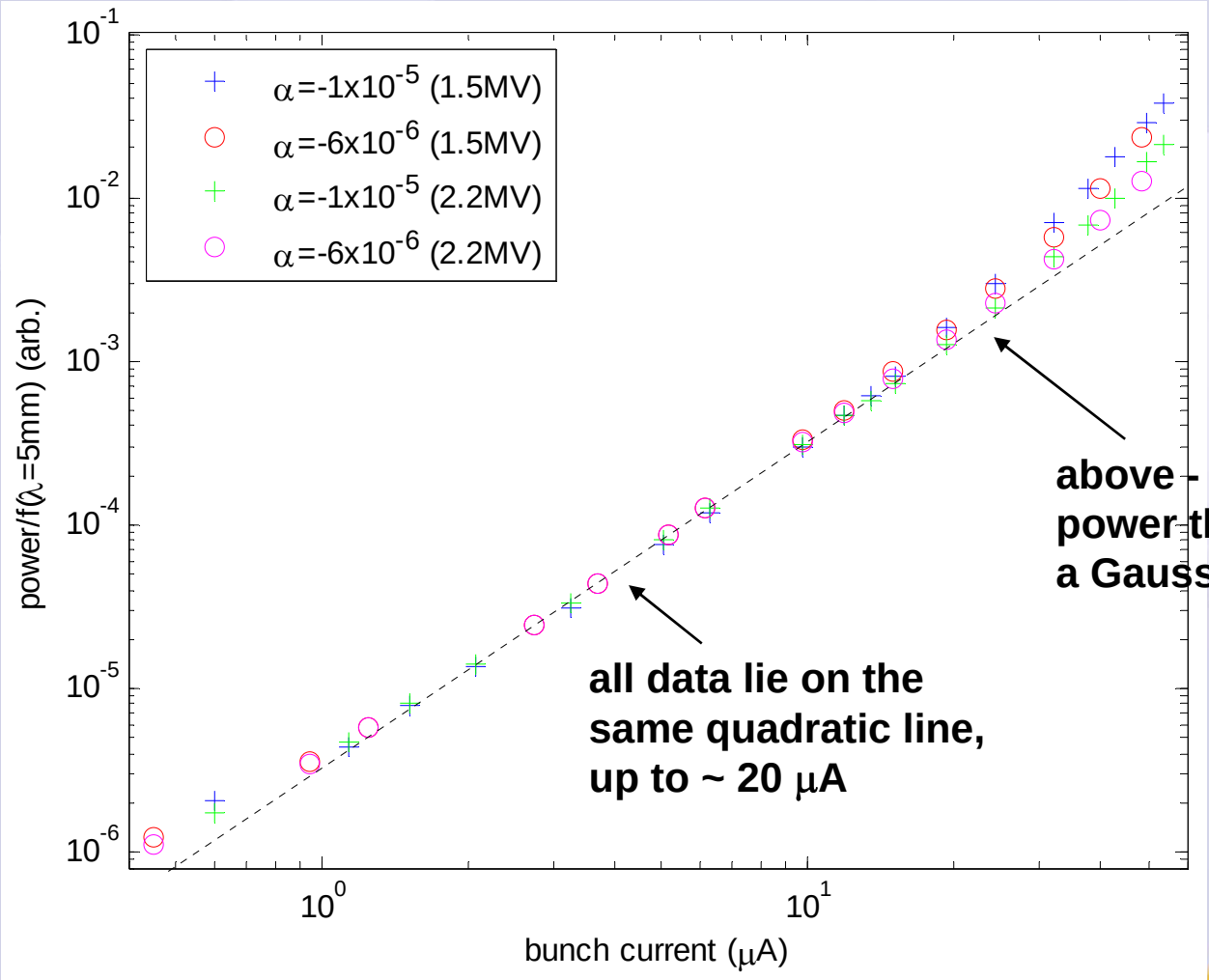


I.P.S. Martin et al., "Low Alpha Operation of the Diamond Storage Ring", Proc. IPAC'10

Measured rms bunch-length (streak camera) in low-alpha mode at different RF voltages:



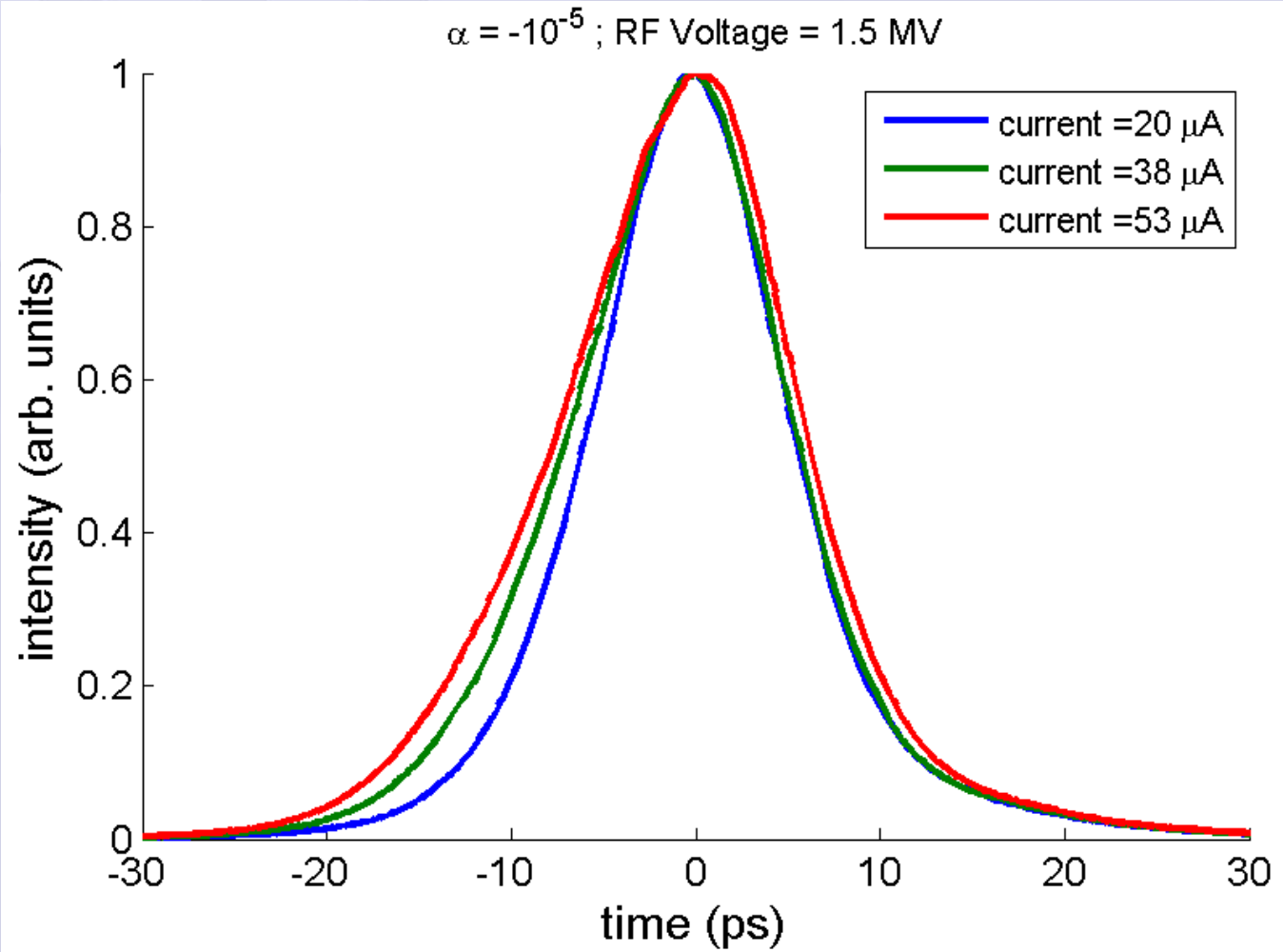
Measured mm-wave power normalised by the calculated form factor at λ=5 mm, using measured rms bunch length, assuming Gaussian shaped):



above ~ 20 μA see *more* power than expected for a Gaussian bunch

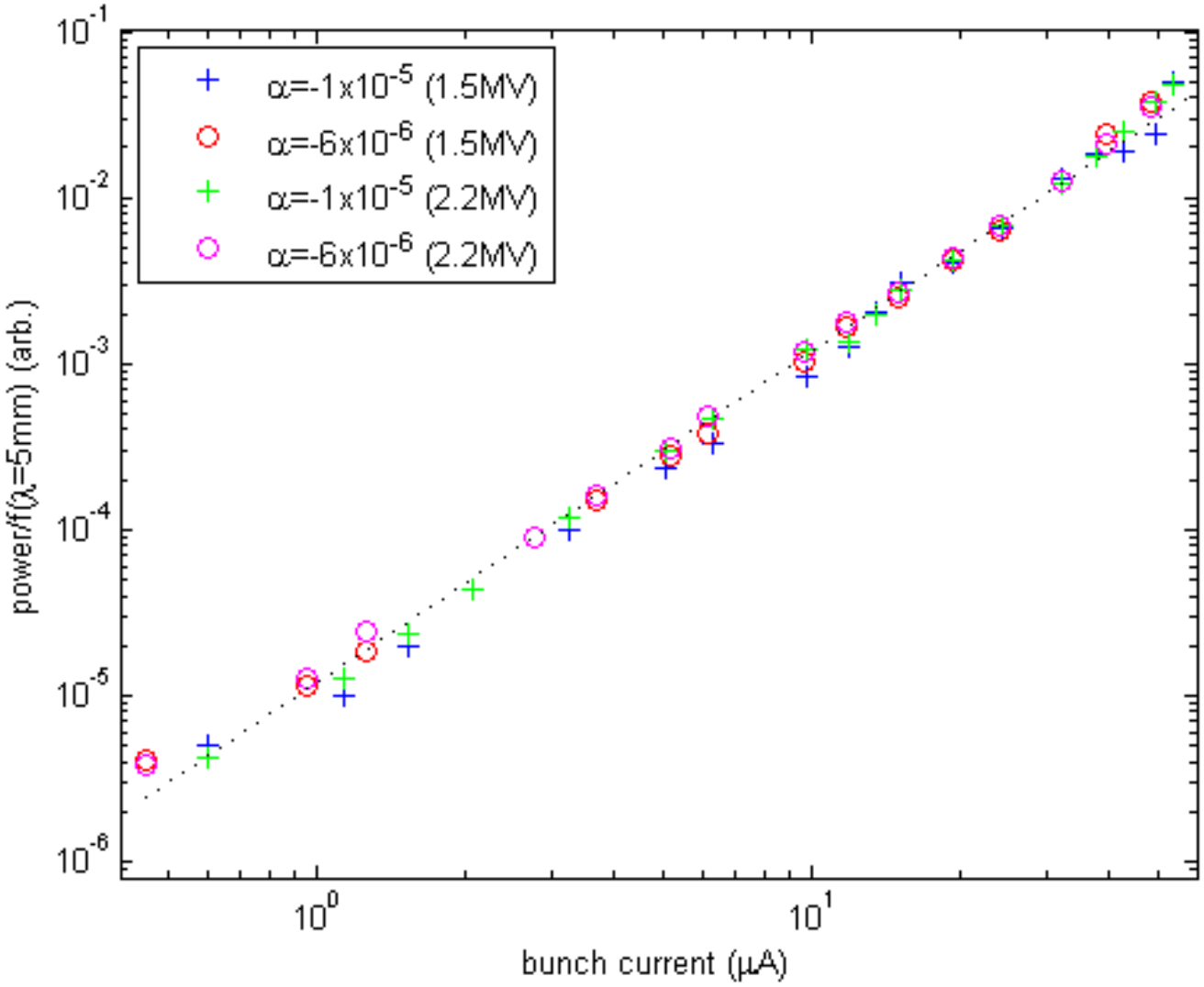
all data lie on the same quadratic line, up to ~ 20 μA

due to bunch shape ?



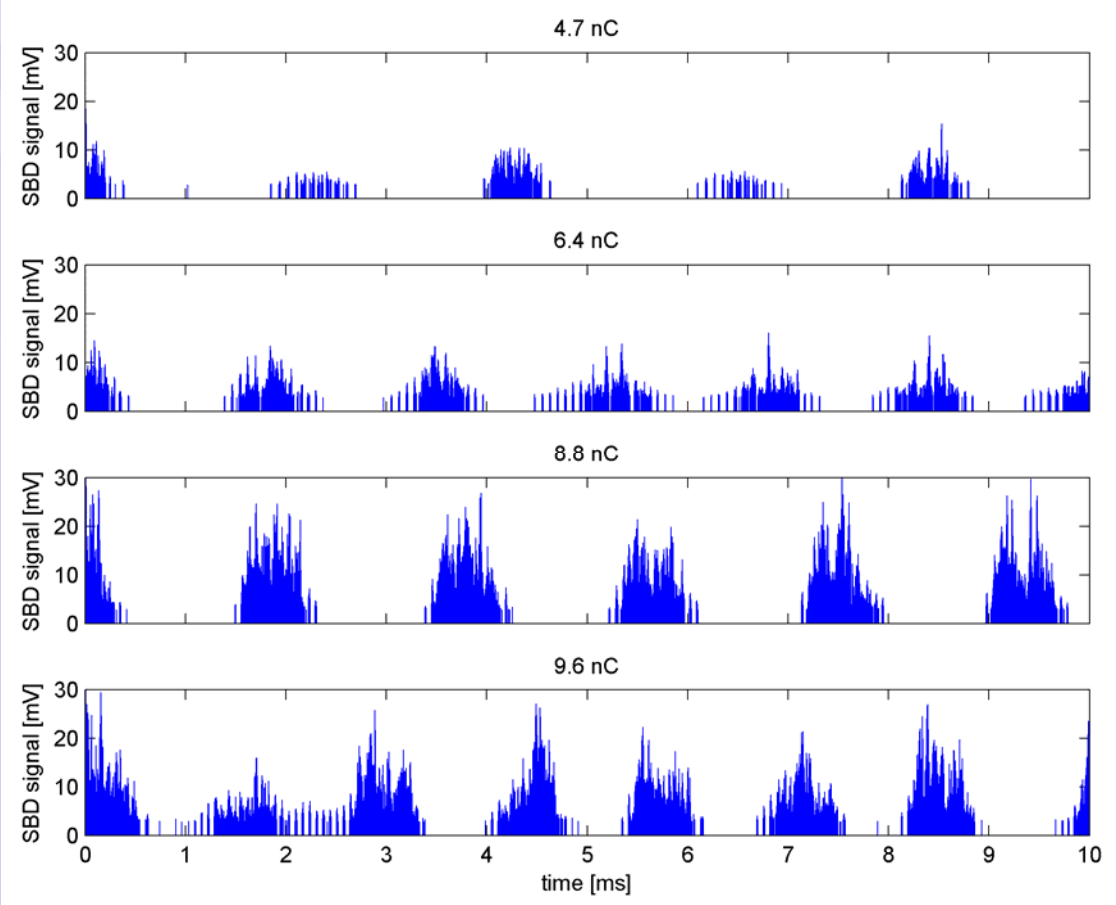
not very obvious, but the form factor is actually decreasing more slowly than for a Gaussian of the same width, so …

.. when include the numerically calculated form factor (λ=5 mm) get much better agreement:



Mm-wave Measurements - Bursting Mode

Normal alpha ($1.7\ 10^{-4}$)



threshold = 3.6 nC (1.9 mA)

bunch length = 26 ps

nat'l bunch length = 11 ps

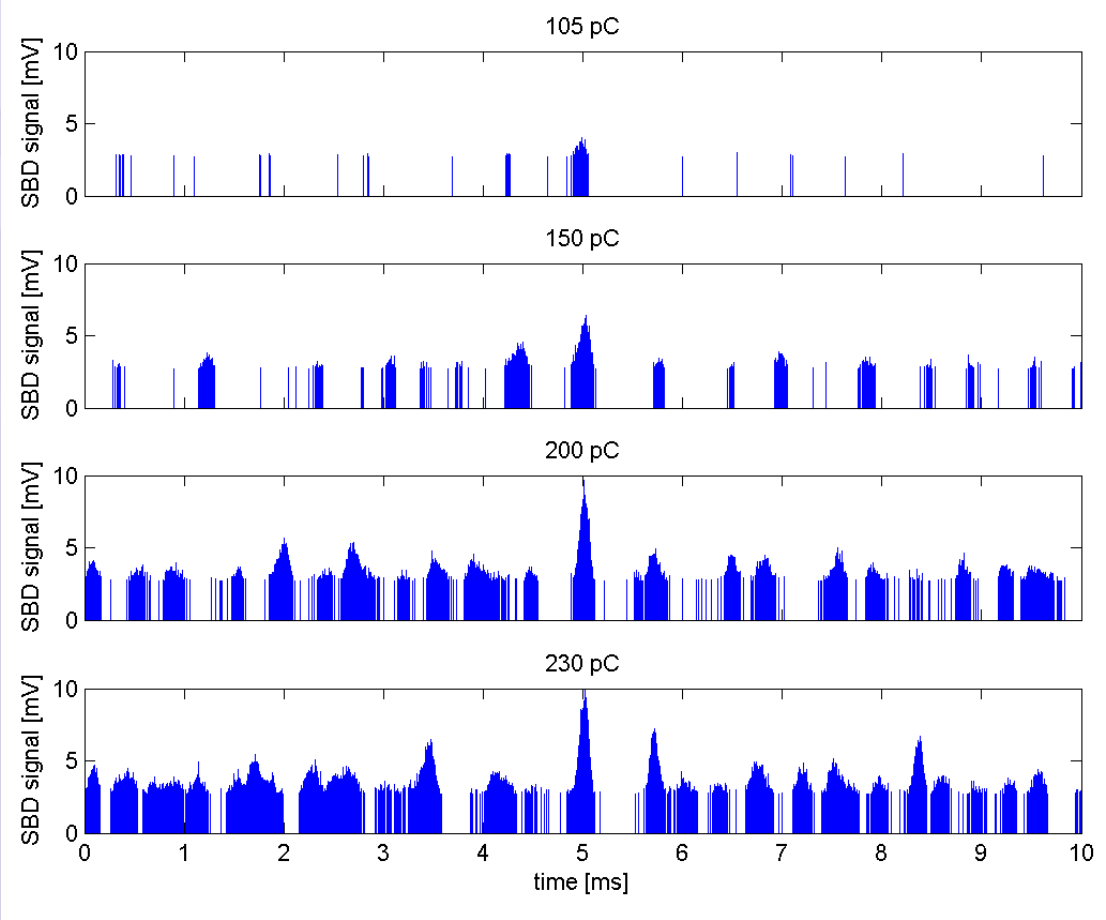
calculated threshold for λ = 5 mm, σ = 26 ps

= 1.85 mA

good agreement, using the actual bunch length

(calculated threshold = 1 mA for λ = 3.3 mm, σ = 11 ps)

Low alpha (-1 10^{-6})



threshold < 100 pC (53 μA) - insufficient sensitivity

bunch length ~ 3 ps

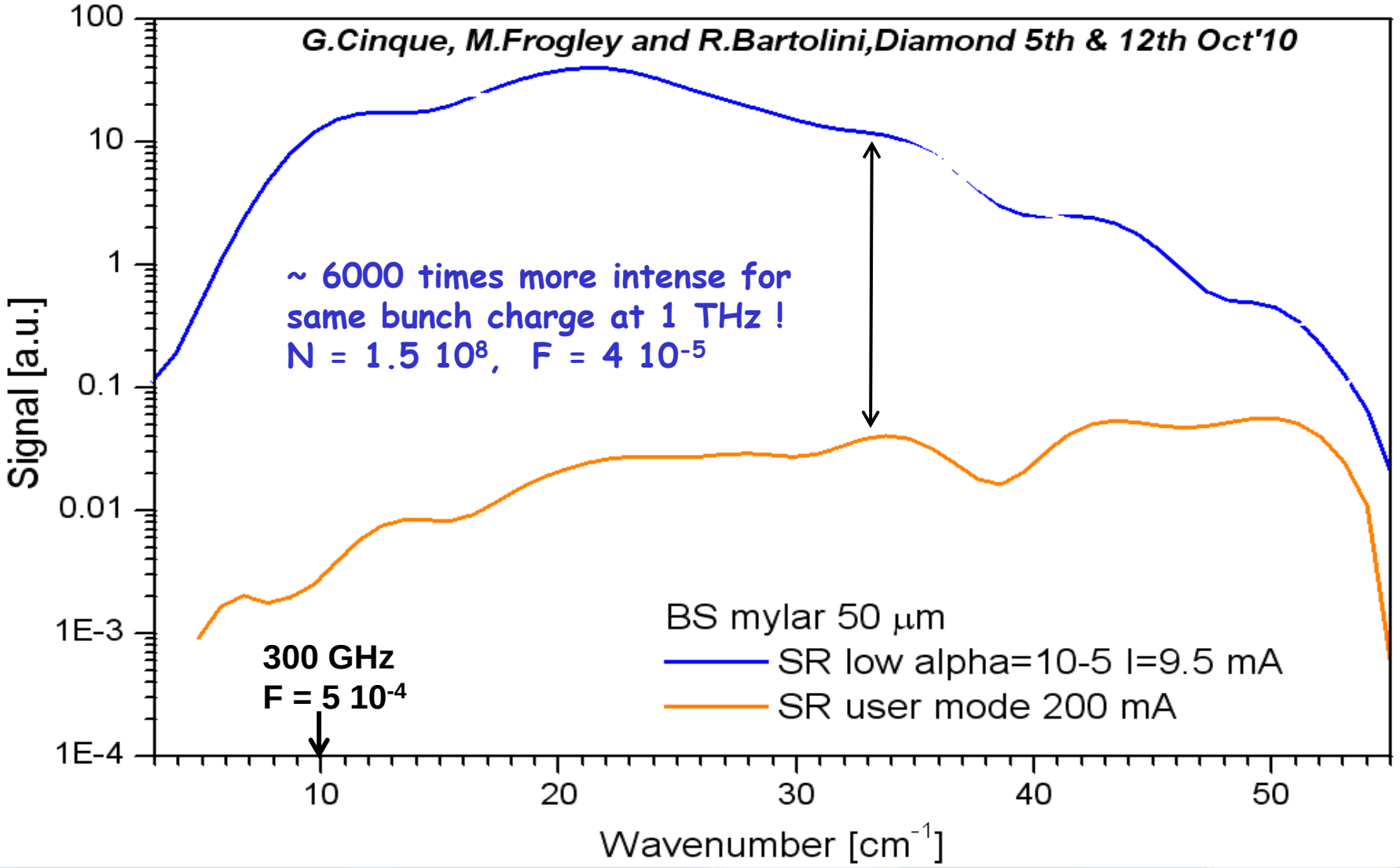
nat'l bunch length = 1 ps

calculated threshold for λ = 5 mm, σ = 3 ps

~ 2 μA ?!

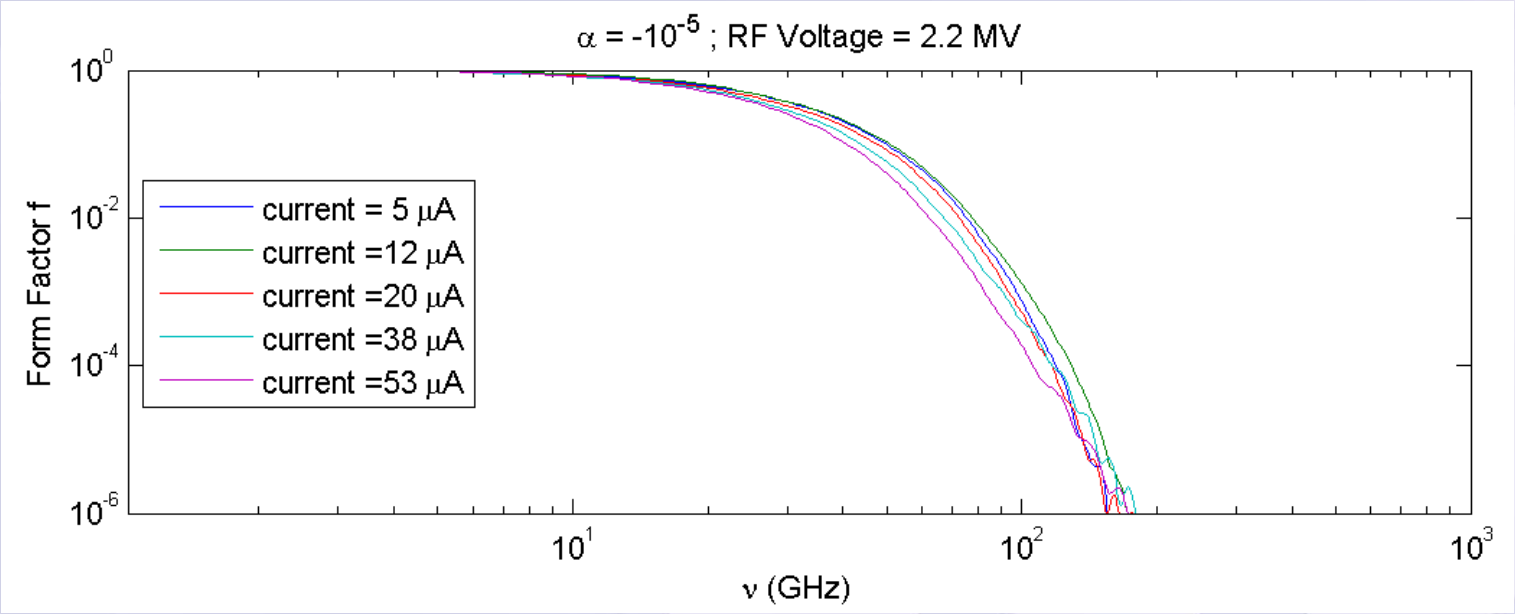
Far-IR/THz Measurements at B22

α ~ 5 10^{-6}, I~10 mA, 800 bunches, 12.5 μA/bunch



Why ?!

- too short a wavelength for coherent emission of the whole bunch, even if slightly non-Gaussian



- bursting ? (detectors not sensitive enough to detect bursting at this current, but is above theoretical threshold at λ=5mm, not λ=1mm)

- higher frequency micro-structure, even if not above bursting threshold ??