Frequency analysis

- Quasi-periodic approximation (NAFF algorithm)

$$f'_j(t) = \sum_{k=1}^{N} a_{j,k} e^{i\omega_{jk} t} \text{ with } f'_j(t), a_{j,k} \in \mathbb{C} \text{ and } j = 1, \ldots, n,$$

of a complex function $f_j(t) = q_j(t) + ip_j(t)$, for $t = \tau$

- Very accurate determination of the frequency $\approx 1/\tau^4$.

a. Determine approximate location of power spectrum maximum (FFT)

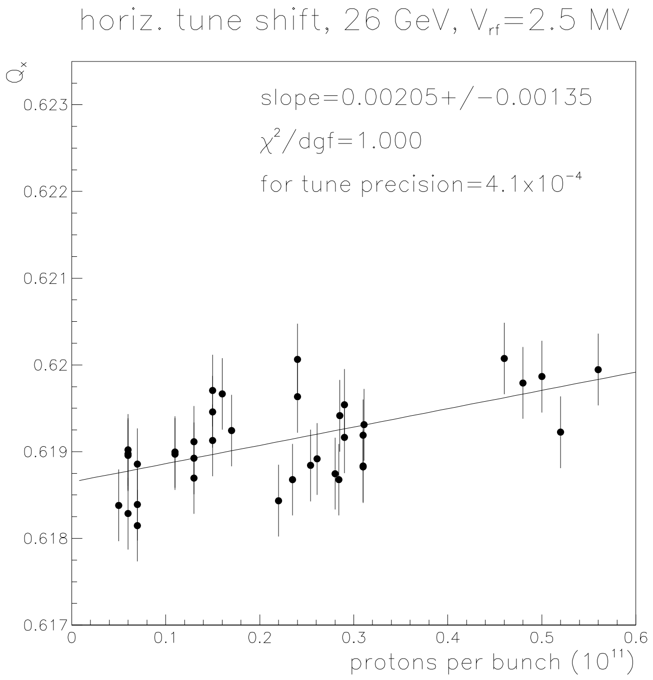
b. Precise calculation of the tune ω_1 which gives the maximum of $\phi(\omega) = 1/2\tau \int_{-\tau}^{\tau} f(t) e^{-i\omega t} \chi(t) dt$ (with Hardy method) where $\chi(t) = 1 + cos(\pi t/\tau)$, the Hanning filter.

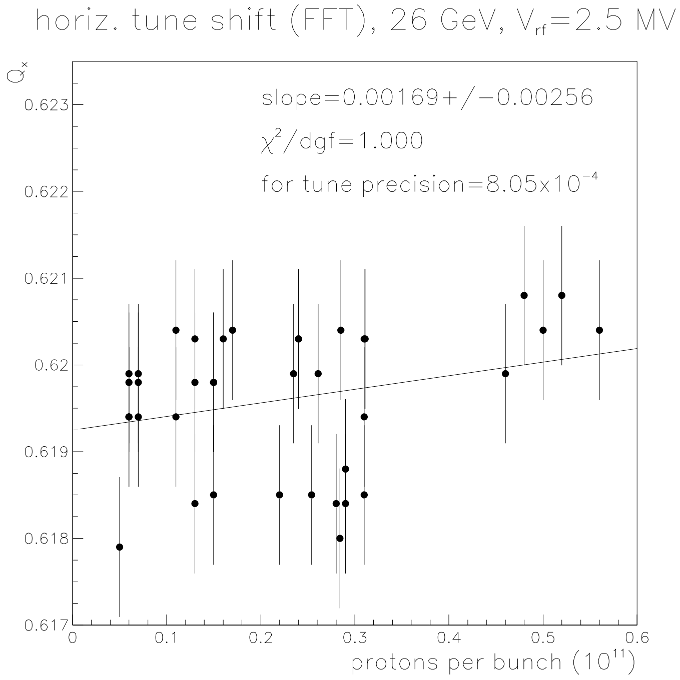
c. Calculate the amplitude a_1

d. Remove the first term $a_1 e^{-i\omega_1 t}$ of the signal $f(t)$ and reiterate.

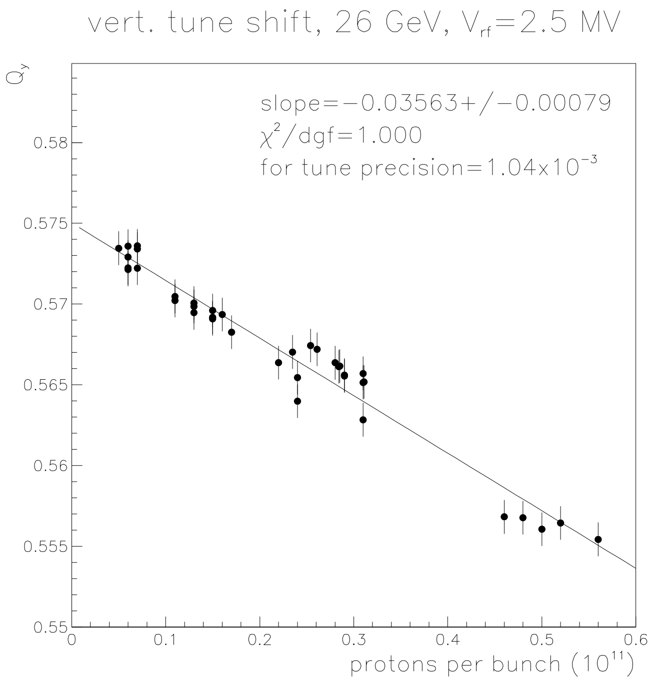
Coherent tune shift versus beam current on SPS

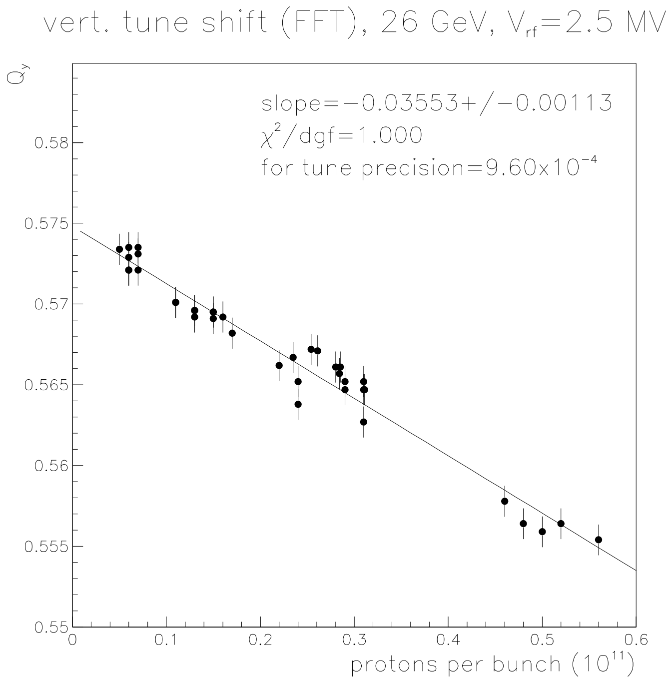
- Horizontal tune





- Vertical tune





Perspectives

- Harmonic decomposition of the signal
- Determination of other tunes (synchnotron, etc.)
- Growth rate, damping rate