

The puzzle of the large recombination peak-widths measured during the CeC run

P. Thieberger and M. Minty

8/20/2021

Radiative recombination: $\text{Au } 79^+ + e^- \rightarrow \text{Au } 78^+ + \text{photon}$

$$\sigma_n = 2.10 \times 10^{-22} \text{ cm}^2 \frac{Z^4 E_0^2}{n E_e (Z^2 E_0 + n^2 E_e)}$$

Simple cross-section derived by Bethe and Salpeter. ($E_0 = \text{Rydberg energy}$)

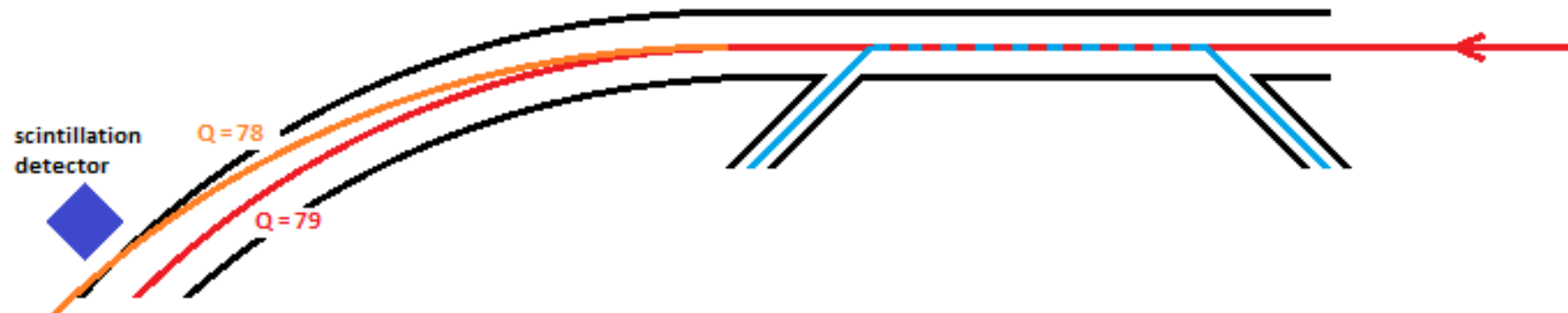
Energy dependence

$$\sigma = A \left(\frac{h\nu_0}{E} \right) \left[\ln \sqrt{\frac{h\nu_0}{E}} + \gamma_1 + \gamma_2 \left(\frac{E}{h\nu_0} \right)^{\frac{1}{3}} \right]$$

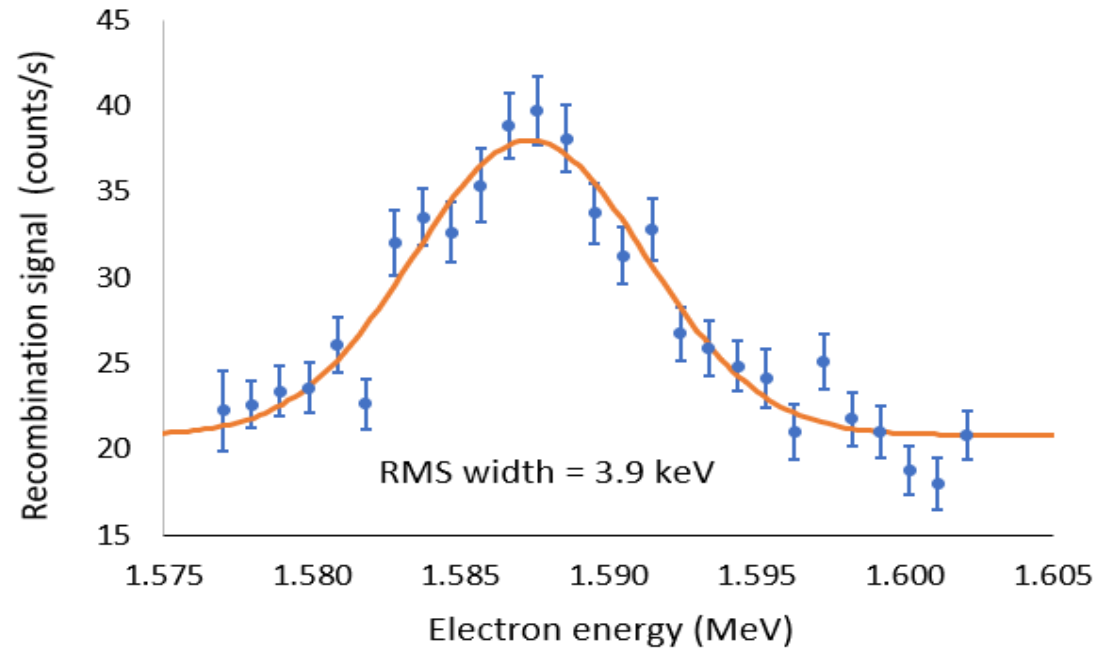
where E is the electron kinetic energy, h is the Planck constant, $A = \frac{4}{3\sqrt{3}\pi} \frac{h e^2}{e_0 m_e^2 c^3} = 2.11 \cdot 10^{-22} \text{ cm}^2$, $h\nu_0 = 13.6 Z^2 \text{ eV}$ is the ground state binding energy and $\gamma_1 = 0.1402$ and $\gamma_2 = 0.525$ are constants.

M. Bell and John Stewart Bell. Capture of cooling electrons by cool protons. Part. Accel., 12(CERN-TH-3054):49–52. 10 p, Mar 1981

Recombination monitor cartoon

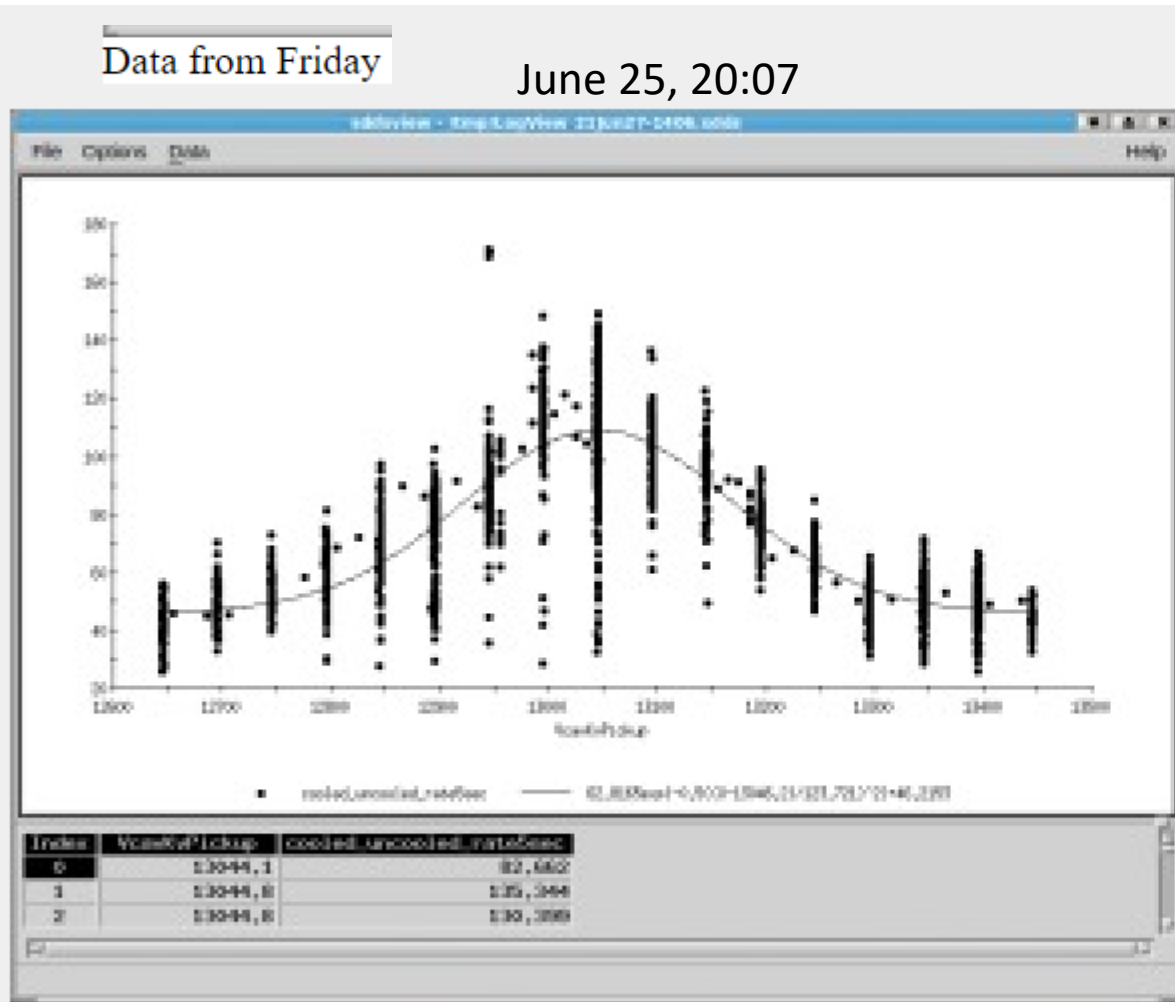


Recombination rate as function of electron energy measured in LEReC



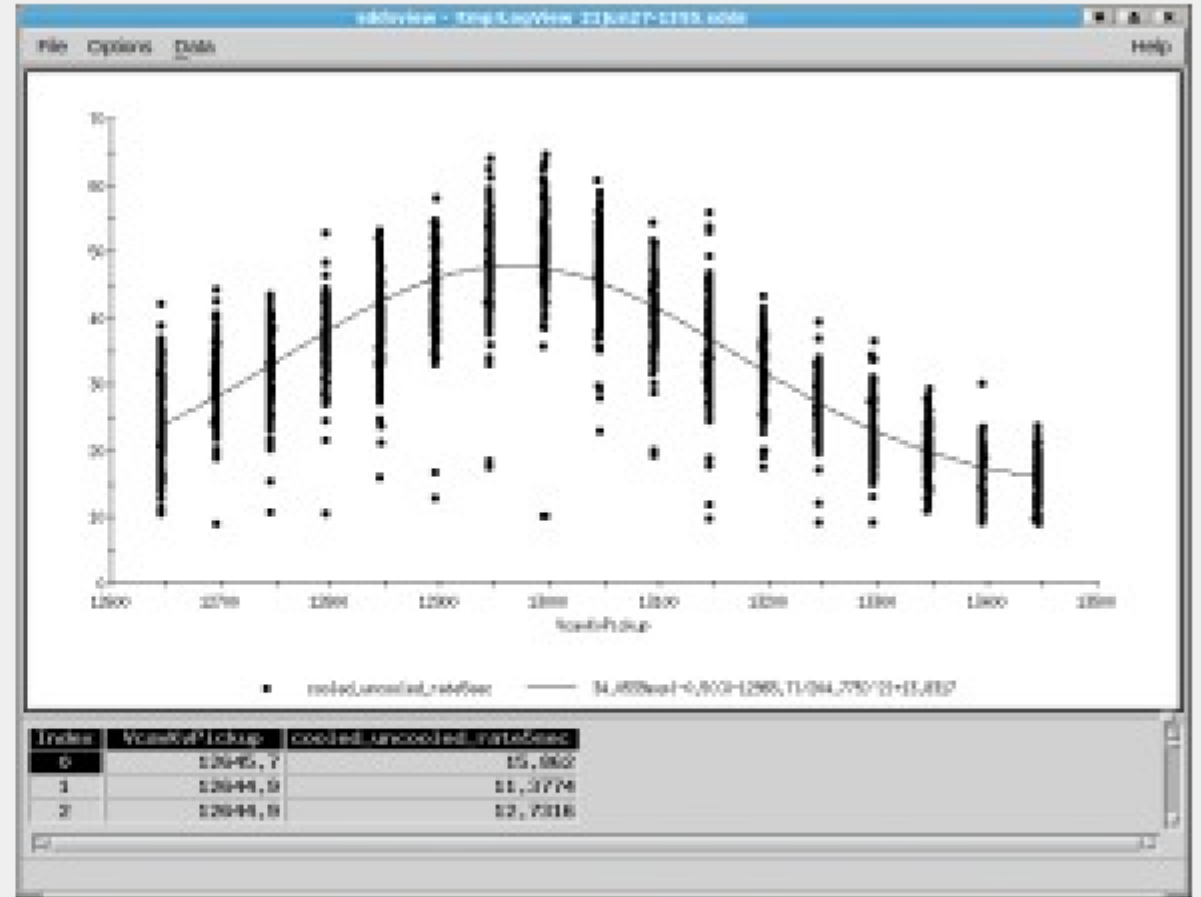
Recombination rates from the CeC e-log

Normal PCA solenoid settings.



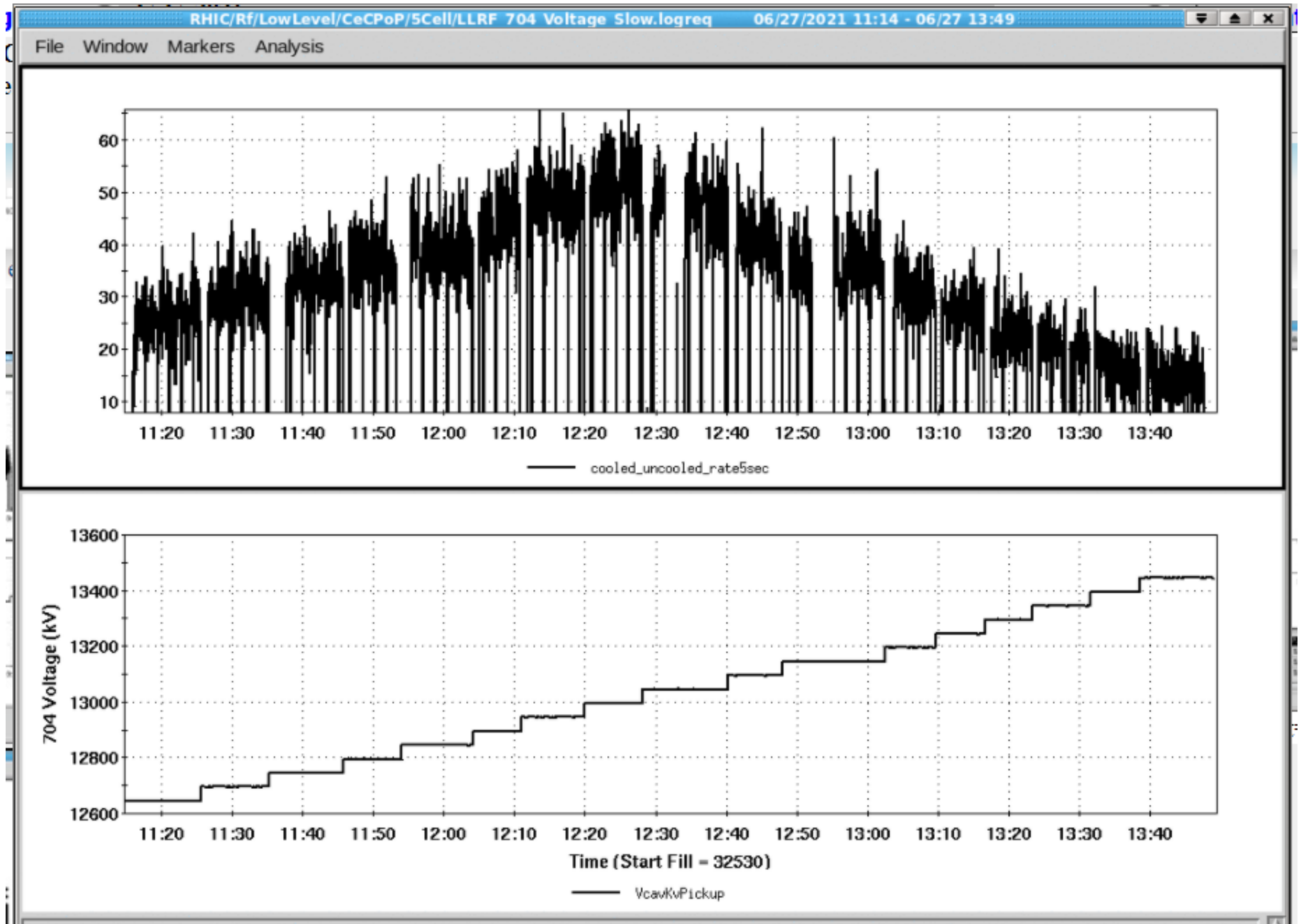
$V_{cent}=13045$, $\sigma=123$ kV

Relaxed solenoid settings



Tofay it is 12965 kV with sigma of 205 kV.
Difference is 80 kV, i.e. 0.55%

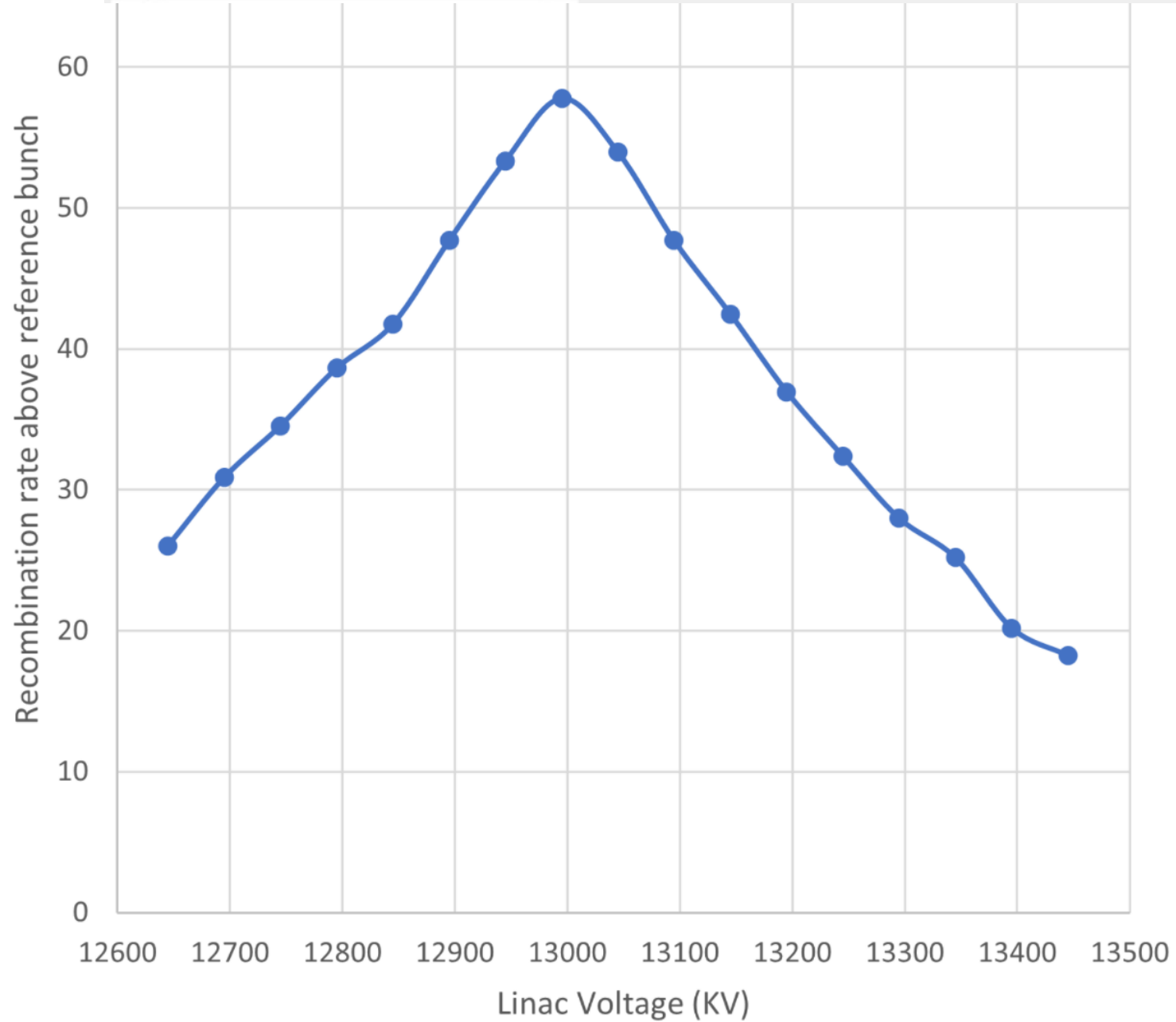
Raw data with relaxed lattice



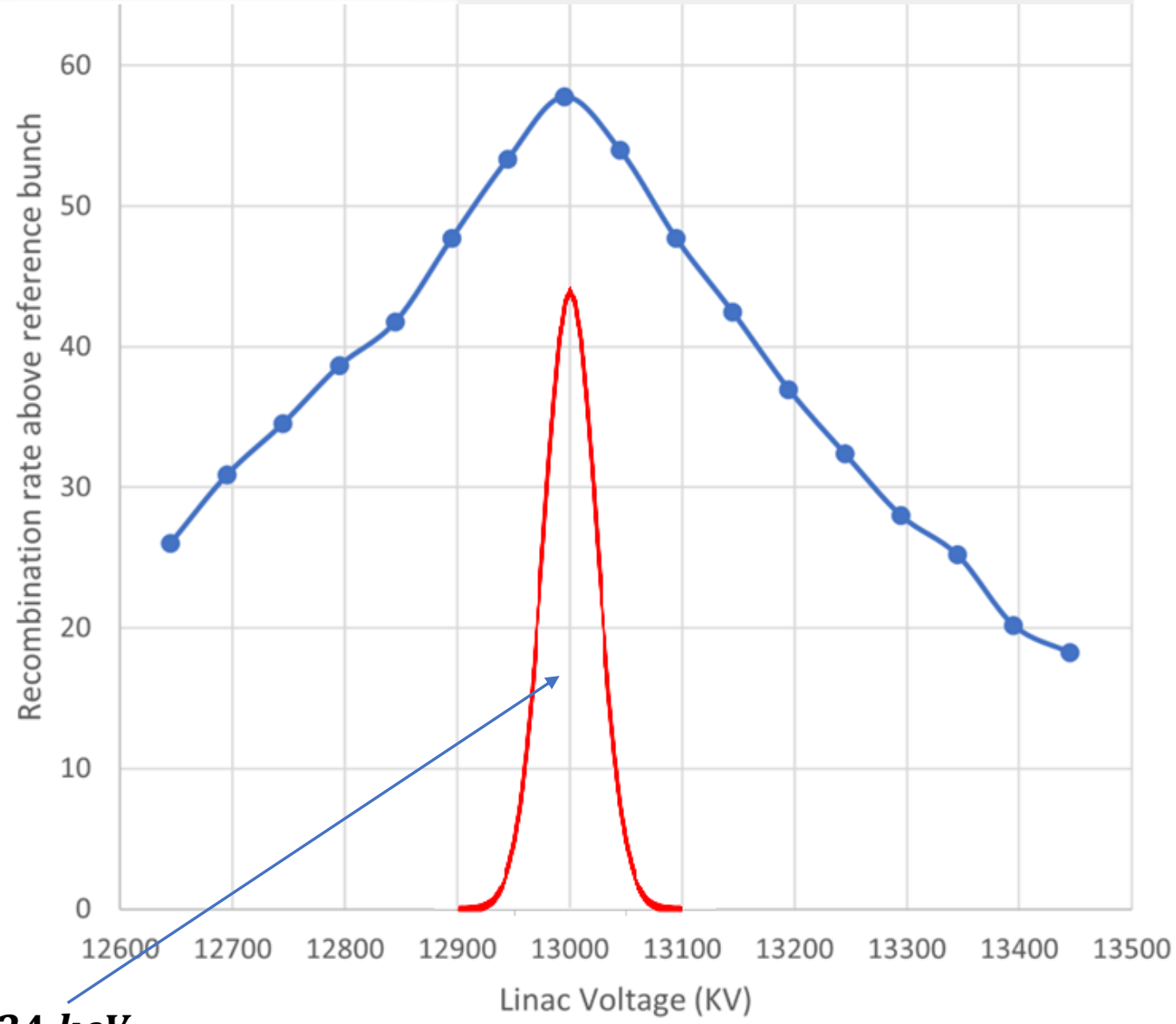
Normalized
recombination rates
with relaxed lattice

70 - Jun 27 13:50 cp Gang [1 edit]

Raw data of normalized recombination rate above reference bunch vs linac voltage.



Raw data of normalized recombination rate above reference bunch vs linac voltage.



Comparison of CeC data with the expected distribution scaled from the LEReC results

Electron energies:

LEReC: 1.6 MeV
CeC: 14.5 MeV

To match electron velocity changes in the rest frame, the beam energies changes are 6.15 time larger for the more relativistic CeC beam

$$\frac{CeC\ width}{LEReC\ width} = 6.15$$

$$CeC\ RMS\ width = 6.15 * 3.9\ keV = 24\ keV$$

6/27/21 recombination monitor scan

CW mode

1 bunch

PUZZLE

The large energy spread observed with the recombination monitor isn't present when looking at the dogleg BPM data. It also isn't present in the diagnostic line.

While there is no room for a diagnostic line after the cooling section, the JAG screen between the last dipole and the DUMP may allow us to verify or rule out the presence of these large energy spreads.

Linac voltage

