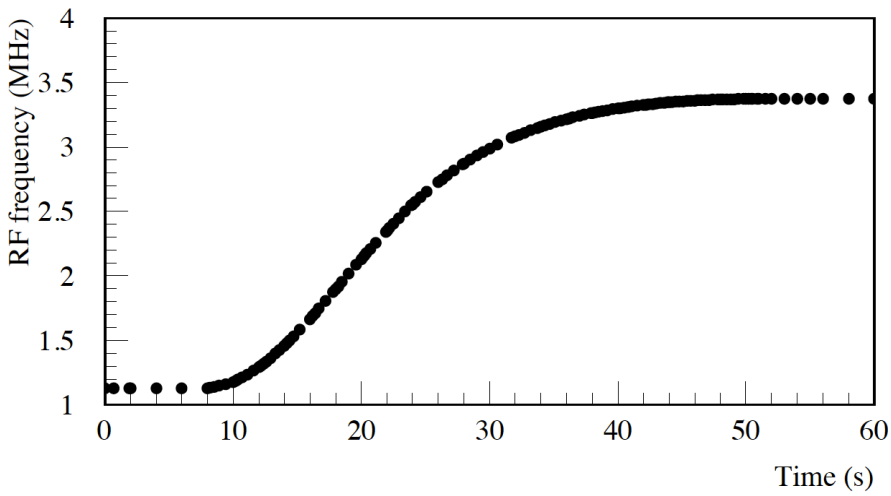
TUTORIAL LONGITUDINAL BEAM DYNAMICS

CAS 2013 – Trondheim

In this problem, we consider the longitudinal and RF parameters of the CELSIUS low-energy proton ring at The Svedberg Laboratory in Uppsala (Sweden). This ring has a circumference of 81.8 m and 40 dipoles are installed along it. Once protons are injected in the ring, they are accelerated up to a kinetic energy of 1460 MeV within about one minute. Meanwhile, the RF frequency goes from 1.130 to 3.372 MHz, as shown below.



1) Calculate the revolution frequency at the end of the energy ramping.
   What is the CELSIUS harmonic number? Round your result to the closest integer.

2) Calculate the kinetic energy of the protons at injection.
   (hint: same harmonic number as in 1)

3) At the end of the energy ramping, the magnetic field in the dipole magnets is 1.052 T.
   What is the magnetic field at injection?

4) What fraction of the ring is covered with dipole magnets?

5) The momentum compaction factor α_p of the CELSIUS ring is equal to 0.123.
   Is it necessary to implement a phase jump system? Why?

6) What is the acceptable range for the synchronous phase ϕ_s during acceleration?