Homework questions for the CLIC lecture

1.) Pulsed surface heating:

What is the maximum RF pulse length for a normal conducting linac with the following parameters (assume $\Delta T_{max}=50K$)?

$E_{acc} = 100$ MV/m   accelerating gradient
$f = 12$ GHz   RF frequency

What is it for $E_{acc} = 150$ MV/m and $f = 30$ GHz?

2.) Breakdown rate:

Consider a linac with the following parameters:

$E_{acc} = 150$ MV/m   accelerating gradient
$f = 12$ GHz   RF frequency
$E_{cms} = 3$ TeV   centre-of-mass energy
$L_s = 0.5$ m   accelerating structure length
$f_{rep} = 50$ Hz   pulse repetition frequency

Assume that the energy E_{cms} has to be kept within a margin of 0.1% from the effect of RF breakdowns. What is the permissible average rate of breakdowns per structure and hour resulting from this energy margin?
(Treat breakdown occurrence as a stochastic process and take 6σ of the distribution as a save margin. Assume that a breakdown only affects one single machine pulse and that a structure breaking down doesn't give any acceleration.)

3.) Drive beam generation:

Assume you want to generate a 100 A drive beam for a CLIC type collider with a frequency of 12 GHz. Further assume that the initial beam pulse must have a beam current below 5 A (not included!), the initial bunch repetition frequency can be in the range of $0.5 - 2$ GHz.
a) What configuration of Delay Loop (DL) and Combiner Ring(s) (CR) can you use? Remember you need one Delay Loop, and keep the multiplication factor in each $CR \le 5$. (Can you comment on why you have this last restriction?)
b) What is your initial beam current?
c) What is your initial bunch repetition frequency?

The final RF pulses (= bunch train pulse length) are to have a length of $t_p = 200$ ns. (Hint: this determines the length of the DL. If you have more than one CR, keep the highest multiplication factor for the last combination stage. (Do you have an idea why?))
d) What is the length of the DL and the CR(s)?
e) What are the frequencies of the RF deflectors?