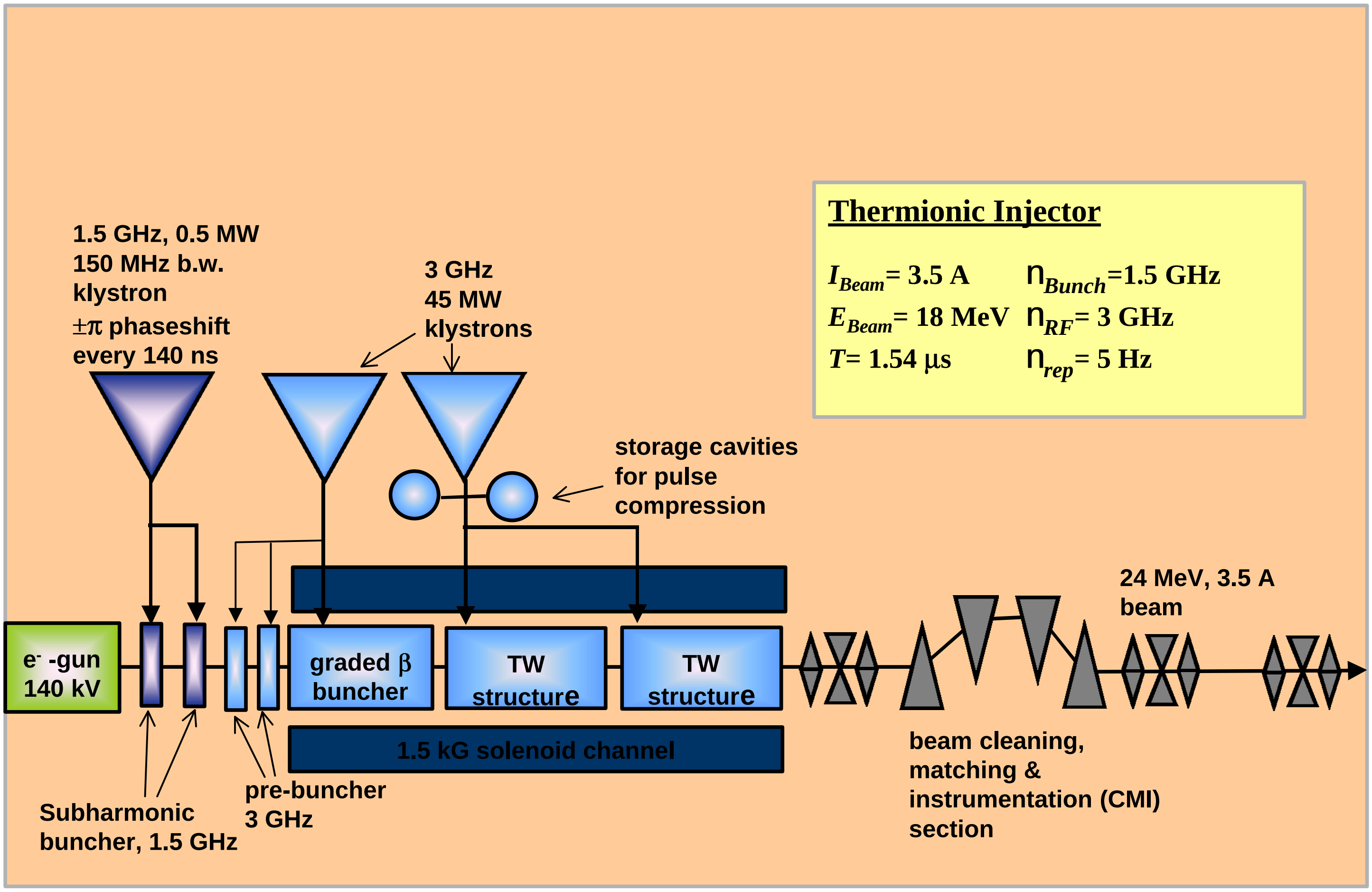
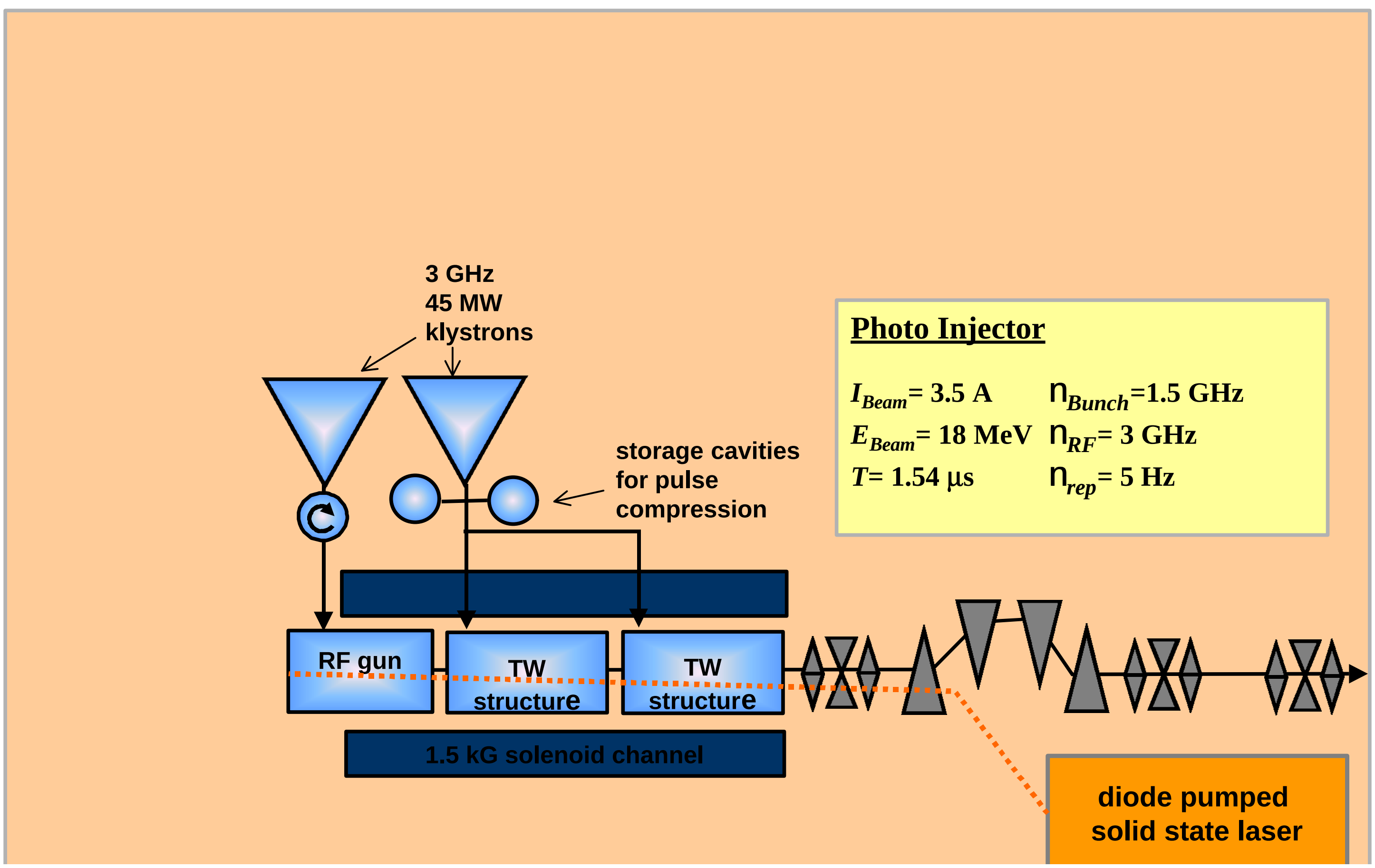
PILOT (=photo-injector long train) **experiment in CTF II**

- **why**
- **where**
- **what**
- **when**

CTF3 injector variants for nominal phase





RF Photo-Injector option for CTF3 drive beam

Advantages of such an solution:

+ **absence of low charge parasite bunches**
+ **no phase/energy tails as produced in conventional bunching systems**
+ **easy 180^0 phase switching**
+ **design of RF gun for CTF3 parameters straight forward**
+ **RF gun and photo-cathode technology well established at CERN**
+ **smaller beam emittances in all three phase space planes**
+ **much less parameters (2 RF ampl. & phases compared with 6)**
+ **possibility of single bunch operation for beam monitor development, wakefield, CSR,...**

But:

– **laser requirements for producing the long drive beam train very demanding**
– **past experience with CTF II laser system not very encouraging**
– **Unprecedented average current requirement for photo-cathodes**

⇒ **High current tests of cathodes in PS photo-cathode lab. last winter demonstrated feasibility of cathodes**

⇒ **R&D program in collaboration with RAL/CLF and Strathclyde University for the development of an all diode pumped, solid state laser system**

Photo injector option needs a convincing proof of principle experiment for the laser system.

The most convincing experiment is a working photo-injector demonstrating the main features on a reduced scale.

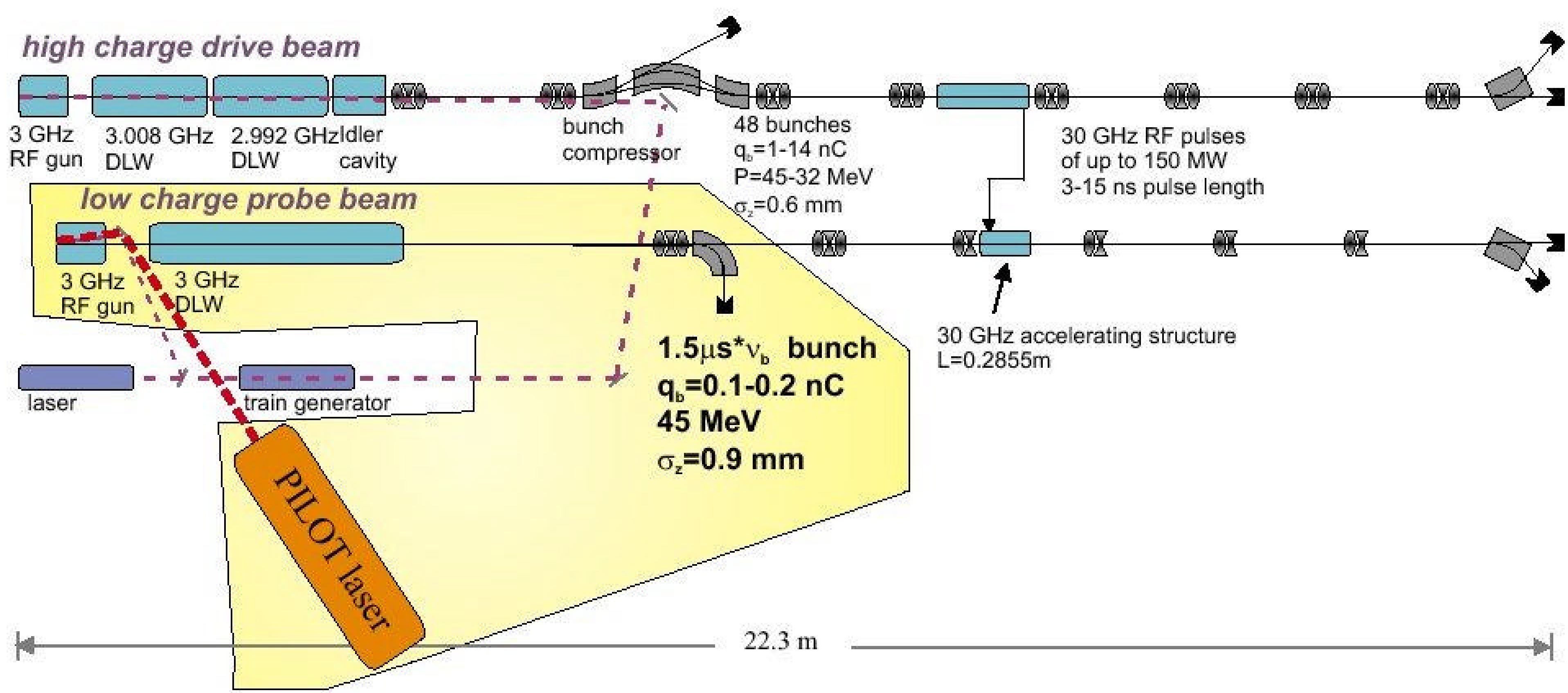
Those features are (in order of importance)

- **long bunch train phase locked with RF**
- **reliable operation for many hours**
- **laser power stability during train & stability pulse to pulse**
- **phase switching every 140 ns**

If this can be shown the photo-injector option for CTF3 will be followed up.

The injector variant which will be most successful in CTF3 will be the one for the CLIC drive beam

CTF II, configuration for PILOT experiment



Two photo injectors are running in CTF II

boundary conditions

- **drive beam cannot produce trains >20ns because of two frequency beam loading compensation.Therefore it is not suited for this experiment.**
- **probe beam photo cathodes system less sophisticated quantum efficiency limited to ≈0.3%**
- **CTF II will be dismantled in December 2002**
- **experimental program of CTF II until then heavily loaded, in particular for the drive beam. The impact of a new experiment on this program has to be minimised**
- **all CTF II RF frequencies and timings are synchronised with a 249.88 MHz master oscillator. Presently available frequencies are 7.809, 15.62, 249.88, 499.76, 2998.6 MHz.**
- **the probe beam is designed to accelerate a single bunch of 1 nC to an energy of 45 MeV. Acceleration of a 1.5µs long train is possible for a total train charge which is limited ≈75nC by beam loading (energy spread). Present instrumentation can measure charge $q_b \geq 0.1$nC.**

These constraints imply for the PILOT experiment:

- **installation on the CTF II probe beam**
- **impact on the operation of CTF II laser system has to be minimised**
- **experiment has to be ready for October 2002 at the latest**
- **parameters for the laser system**

		A	B
ν_B	MHz	249.88	499.76
q_B	nC	0.2	0.1
W_B on cathode @264 nm	μJ	0.32	0.16
P_{LASER} on cathode @264 nm	W	80	
ν_{REP}	Hz	5	
T_{PULS}	μs	1.5	

Schedule

2001	Build laser configuration for PILOT
2002	
	PILOT experiment to demonstrate stable long train operation
	Decision on CTF3 photo-injector
2003	Upgrade/Rebuild laser to meet CTF3 Injector specification Build RF gun
2004	
	Install laser and RF gun in CTF3
2005	
	Commission & operate

Interfaces laser/CTFII to be defined for PILOT:

- **Trigger signal**
- **Frequencies**
- **Cooling water requirements**
- **Electric requirements**
- **Space requirement**
- **Instruments needed for setting up**
- **…**

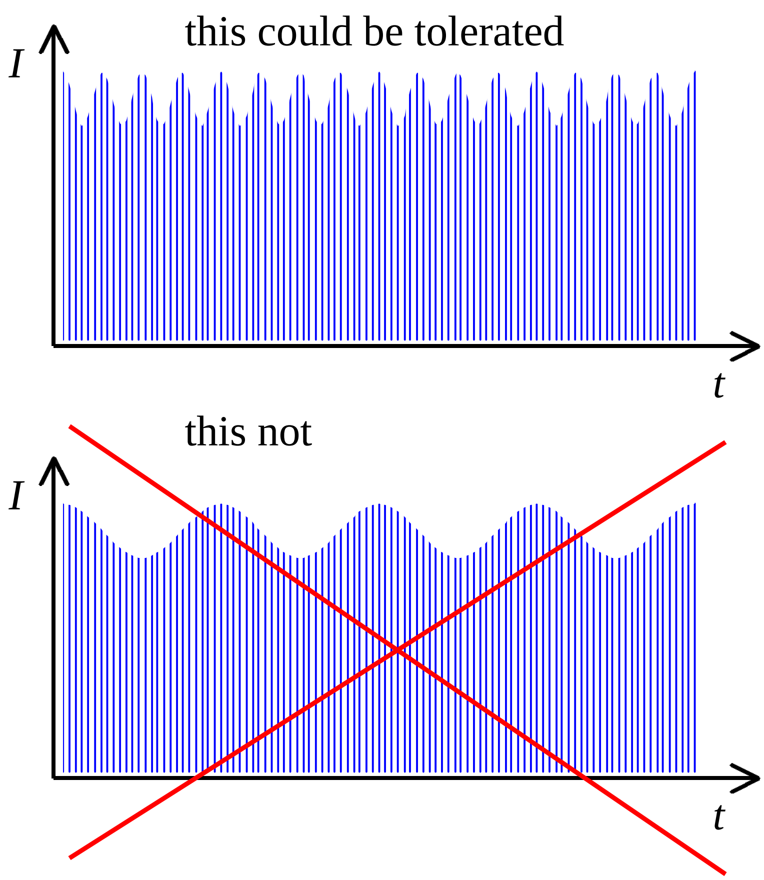
Other aspects to be defined

- **Responsibilities for system components**
- **Costs & Funds**
- **Project management**
- **…**

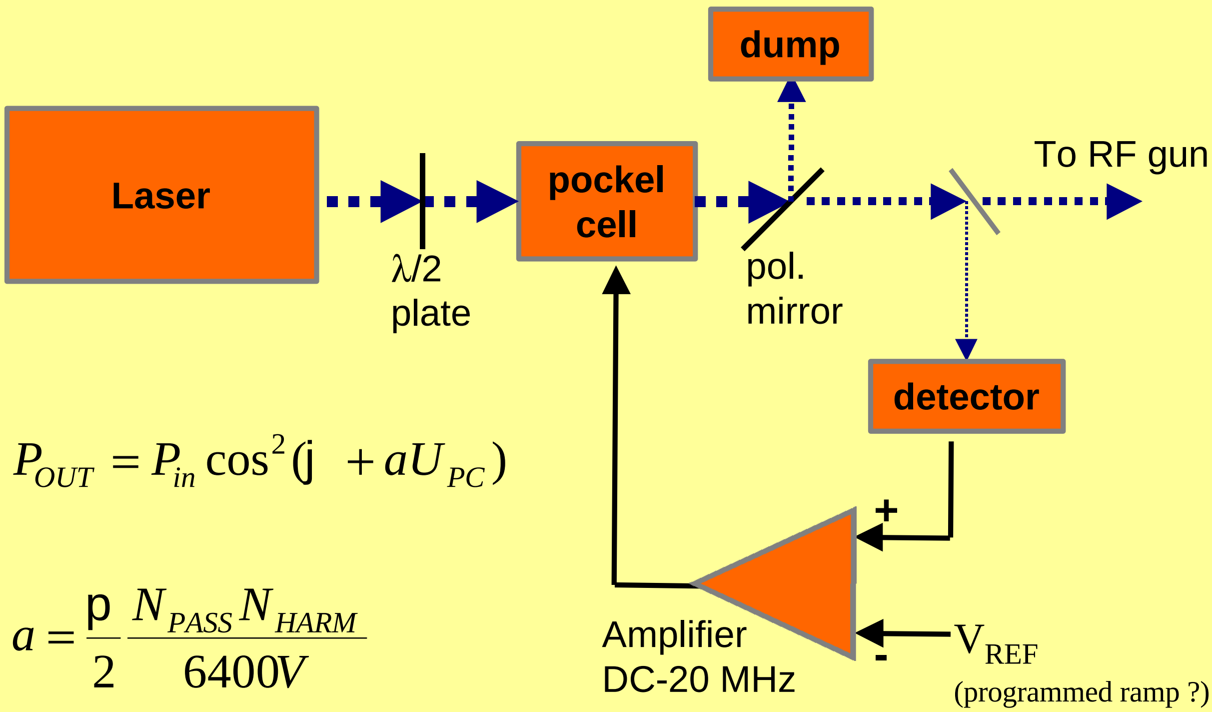
<u>Feedback for laser power</u>

requirement of CTF3:

$$\frac{dI}{I} < 0.1\% \quad \text{for variations slower than 20 MHz}$$



Laser power feedback system



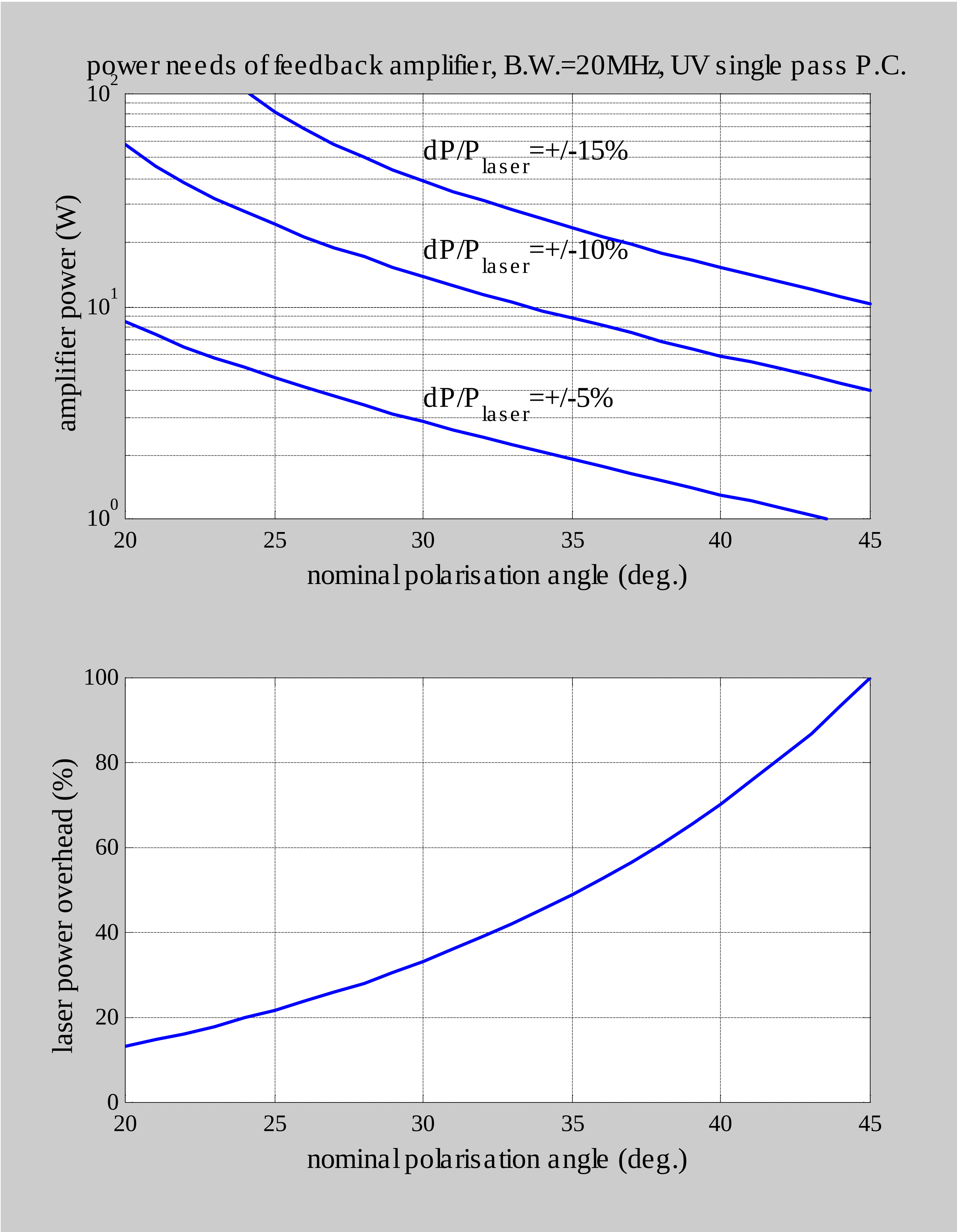
$$P_{OUT} = P_{in}\cos^2(\varphi + aU_{PC})$$

$$a = \frac{\pi}{2}\frac{N_{PASS}N_{HARM}}{6400V}$$

Thefeedback signal should ideally be from a beam current monitor, however cable delays would imply feedback in tunnel without access during operation, therefore laser power sensing seems more adapted for PILOT

issues to be addressed:

- **pockel cell where (1064, 532 or 266 nm?)**
- **single/double pass pockel cell ?**
- **expected laser power variation**
- **laser power overhead**
- **amplifier parameters**


power needs of feedback amplifier, B.W.=20MHz, UV single pass P.C.
amplifier power (W)
10^2
10^1
10^0
dP/P_{laser}=+/-15%
dP/P_{laser}=+/-10%
dP/P_{laser}=+/-5%
20
25
30
35
40
45
nominal polarisation angle (deg.)
laser power overhead (%)
100
80
60
40
20
0
20
25
30
35
40
45
nominal polarisation angle (deg.)