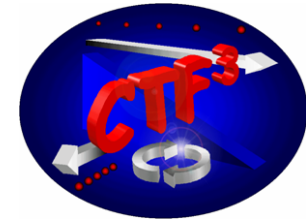


# Power and pulse length possibilities in CTF3

G.Geschonke

# Base line design of CTF3



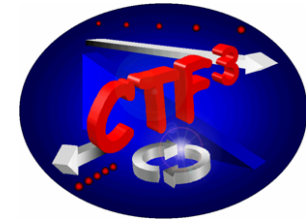
1) demonstrate 30 GHz RF power source for CLIC

design parameters **30 GHz and 140 ns** RF pulse length  
other frequencies than 30 GHz ?  
different pulse length ?

2) Power source for 30 GHz tests

- a) PETS line
- b) 2-beam test stand

# Other frequencies after CR



## PETS line:

- Virtually all harmonics of 3 GHz would be accessible
- Current limited to a maximum of 5 A (  $\sim$  200 ns pulse length)

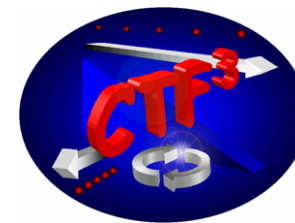
## after Combiner Ring

- Using the nominal combination factor (5), the basic bunch frequency is 15 GHz
- Accessible frequencies: 15 GHz , 30 GHz & 45 GHz
- Current limited to 35 A (140 ns pulse length)
- Different combination factors can in principle be used (from 2 to 5 ?):

• CF = 2	$\nu_0 = 6 \text{ GHz}$	6, 12, 18, 24, 30, 36 ...	14 A
• CF = 3	$\nu_0 = 9 \text{ GHz}$	9, 18, 27, 36 ...	21 A
• CF = 4	$\nu_0 = 12 \text{ GHz}$	12, 24, 36 ...	28 A
• CF = 5	$\nu_0 = 15 \text{ GHz}$	15, 30, 45 ...	35 A

Roberto Corsini

# Other frequencies after CR



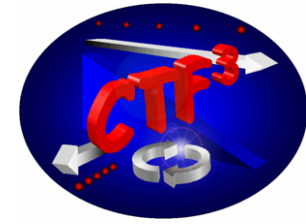
- In order to cover a range from 2 to 5 in CF, both path length and frequency must be changed - Example:

FX =	$\delta f(\text{FX}) =$	$\delta C_{\text{CR}}(\text{FX})$	$\delta L_{\text{DL}}(\text{FX})$
2	-238	-10	3.3
3	0	0	0
4	119	5	-1.7
5	190	8	-2.7

kHz                                      mm

N.B.: Nominal ring length set around CF = 3

## Other pulse lengths after CR



Pulse length:

140 ns given by SHB phase switching

Delay Loop length = 140 ns

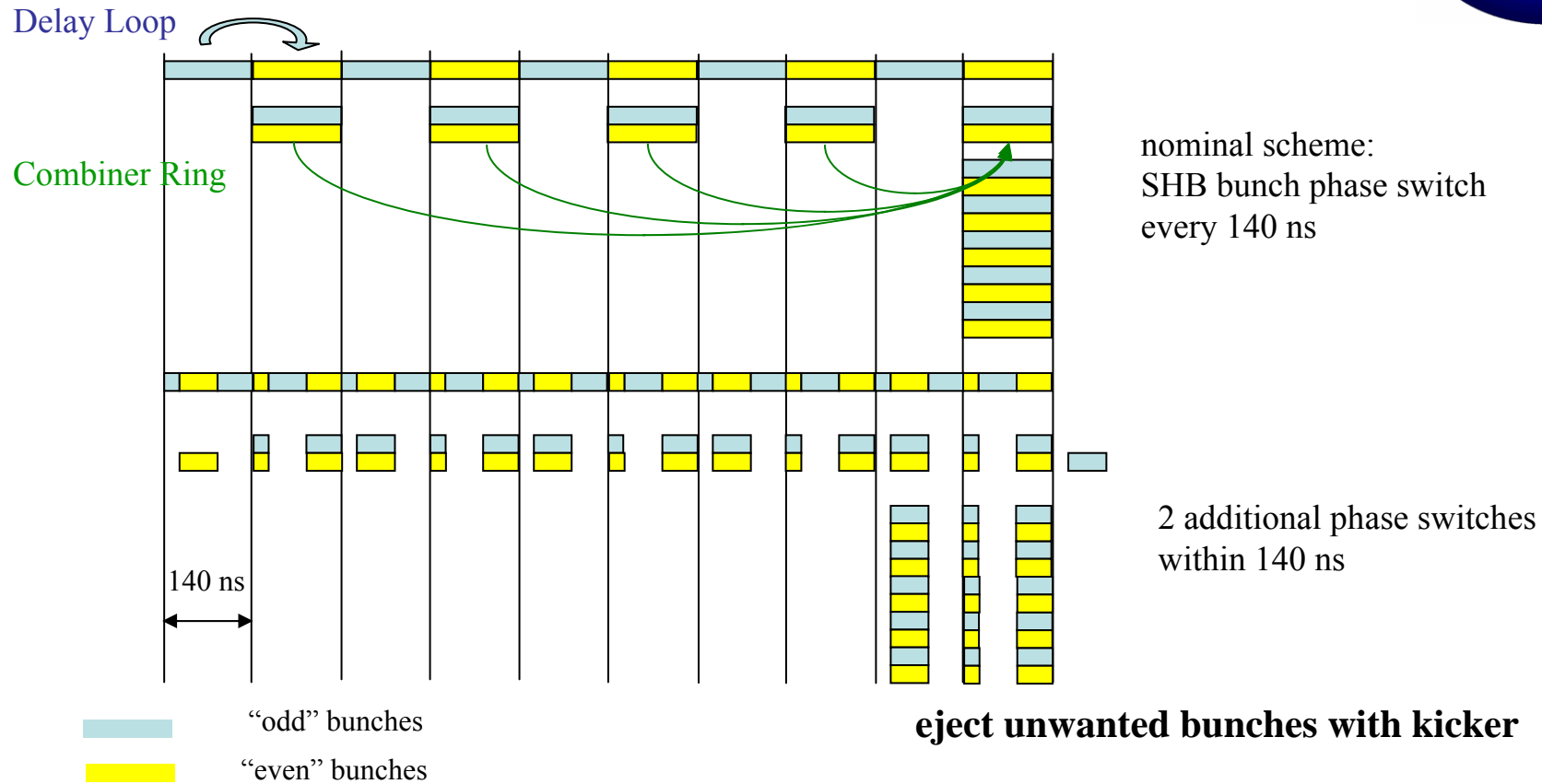
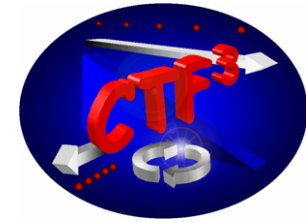
eject bunches with kicker after Combiner Ring.

15 GHz rep. rate => 67 ps

kicker rise time 20 ns

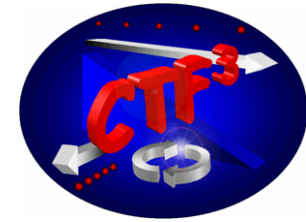
3 ns development for ILC

# Other pulse lengths after CR



any pulse length possible,  
however switching transient ~ 5 ns

# Power after CR



35 A beam available at pulse length adjustable

	CTF3 vs. CLIC	
Current, A	35	176
$\sigma$ , mm	0.4	0.4
Energy, GeV	0.15	2.37
Power, MW	25.4	642
Frequency, GHz	15.	15.

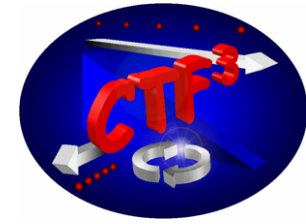
The full power will be generated by CLIC PETS from CTF3 drive beam if extra 430 MW will be used to "prime" it. This could be done using few special booster structures in parallel, so that each of them produces moderate peak power. It is advisable not to exceed the electric surface field level in booster structure compared to that in CLIC PETS. Assuming 90% power transfer efficiency, booster should produce 480 MW.

remark on time scale:

tests can be done as soon as  
CR is commissioned  
→ 2007

**OK for PETS tests with primer**

# PETS line

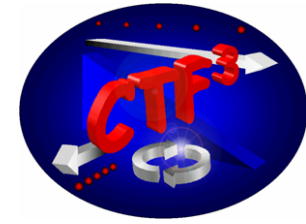


Frequency:  
any multiple of 3 GHz

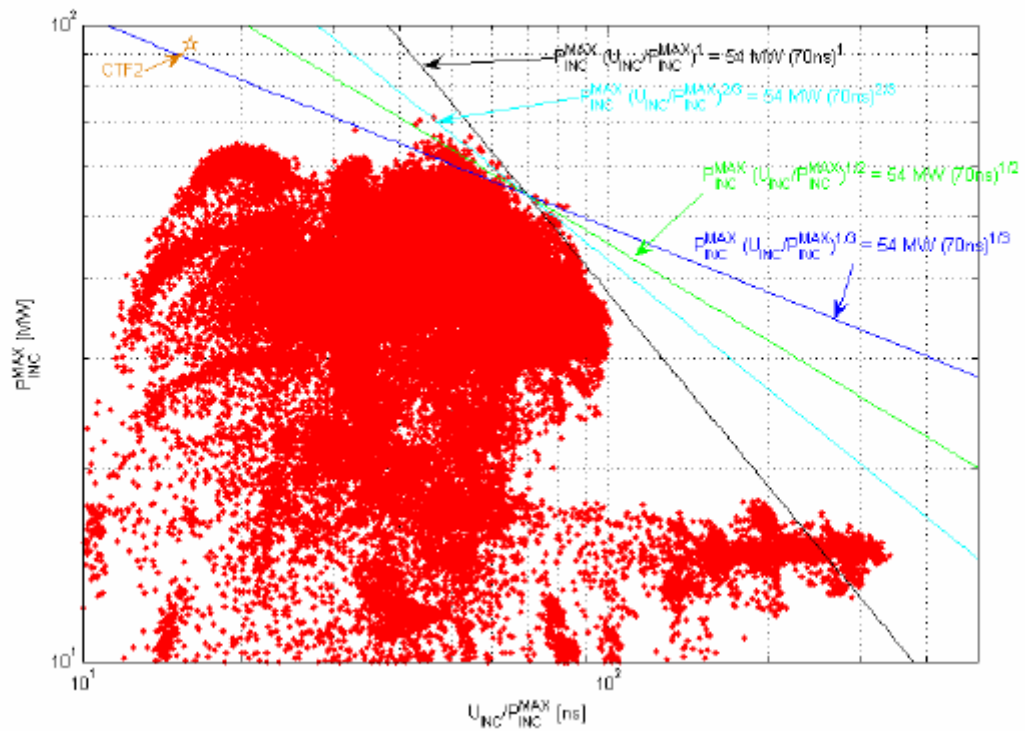
operation in power mode:  
higher beam current 3.5 A → 5 A,  
higher RF power in structures ( reminder: outside their specs)  
typically: 50 – 70 MW instead of 35 MW  
at shorter pulse length 200 ns instead of 1.5  $\mu$ s



# 30 GHz data



Conditioning: Peak power vs. Pulse length

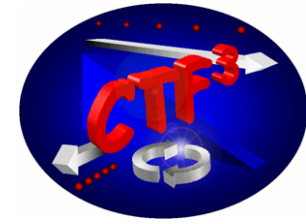


70 MW, 50 ns  
52 MW, 70 ns

Alberto Rodriguez

# Power production with PETS

**S. Doebert**



## Expected

$$(P_{\text{out}} \text{ (MW)}) = 4.762 I^2 \text{ (A)} * F^2$$

3.5 A: 58 MW

4.5 A: 96 MW

5A: 119 MW

95-100% Transmission

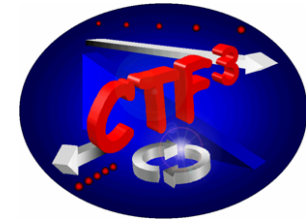
## Achieved

30 MW ,90 %Trans

77 MW

100 MW, 80 % Trans

## now - future



	PETS out	pulse length	DUT
	MW	ns	MW
Hans 2004 coll meeting	74	80	54
		140	40
Steffen 2005	100	70	60
	25	300	15
Alberto's plot		50	70
		70	52
		100	45
Roberto	90	70	70

take: 60 MW @ 70 ns  
power loss PETS – DUT: 30 %

if we need 100 MW in DUT at 70 ns:

reduce losses in RF power line ( different waveguides) +10% → 80 % transfer

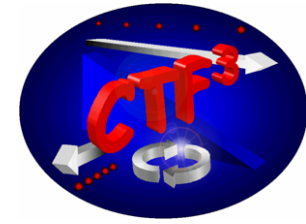
increase beam current from 5 → 6 A : + 30 % Lower energy ?

→ 85 MW in DUT

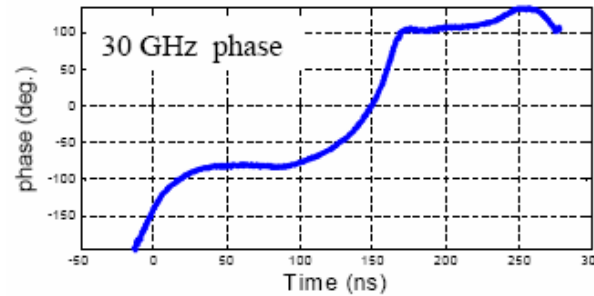
**about 20 % missing.**

**New PETS structure ?**

# RF pulse compression



## 1. bunch phase switch by 18 degrees



(Hans Braun 2004 coll meeting)

Works in principle. If this can be further improved, the PETS line together with a 30 GHz pulse compressor could provide 30 GHz power of  $\approx 300$  MW, covering all the needs for the 30 GHz accelerating structure development programme !

has not been followed up in 2005

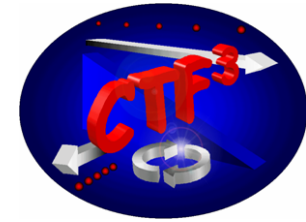
## 2. active switched pulse compressor

still in laboratory stage.  
does it work ?  
reliability, rep rate,

## 3. passive pulse compressor

has not been done in 2005. ,  
potential:

# RF Pulse compression



to reach 100 MW @ 70 ns in DUT:

not switched: factor 2

400 ns @ 60 MW from PETS  
possible ?

switched: factor 4

a ) slow switch

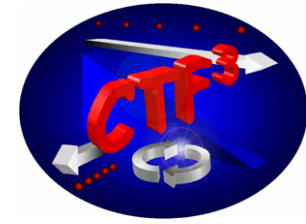
750 ns @ 30 MW  
possible ?

b ) fast switch

360 ns @ 30 MW

**Conclusion : Can we base our test programme on RF pulse compression ?  
my personal opinion: No, at least not in the moment**

# Conclusion



continue business as usual:  
up to 70 ns, 60-70 MW into DUT  
pulse length limited by PETS / RF transmission line

PETS damaged ?  
waveguides damaged ?

upgrade:  
with planned upgrades we can probably achieve 85 MW @ 70 ns  
for more new PETS necessary

SOS scheme:

pulse compression works, long RF pulse necessary (360 - 750 ns, 30 - 60 MW from PETS)

**100 MW probably achievable in routine operation.  
Consequence for CLIC structure parameters ?**