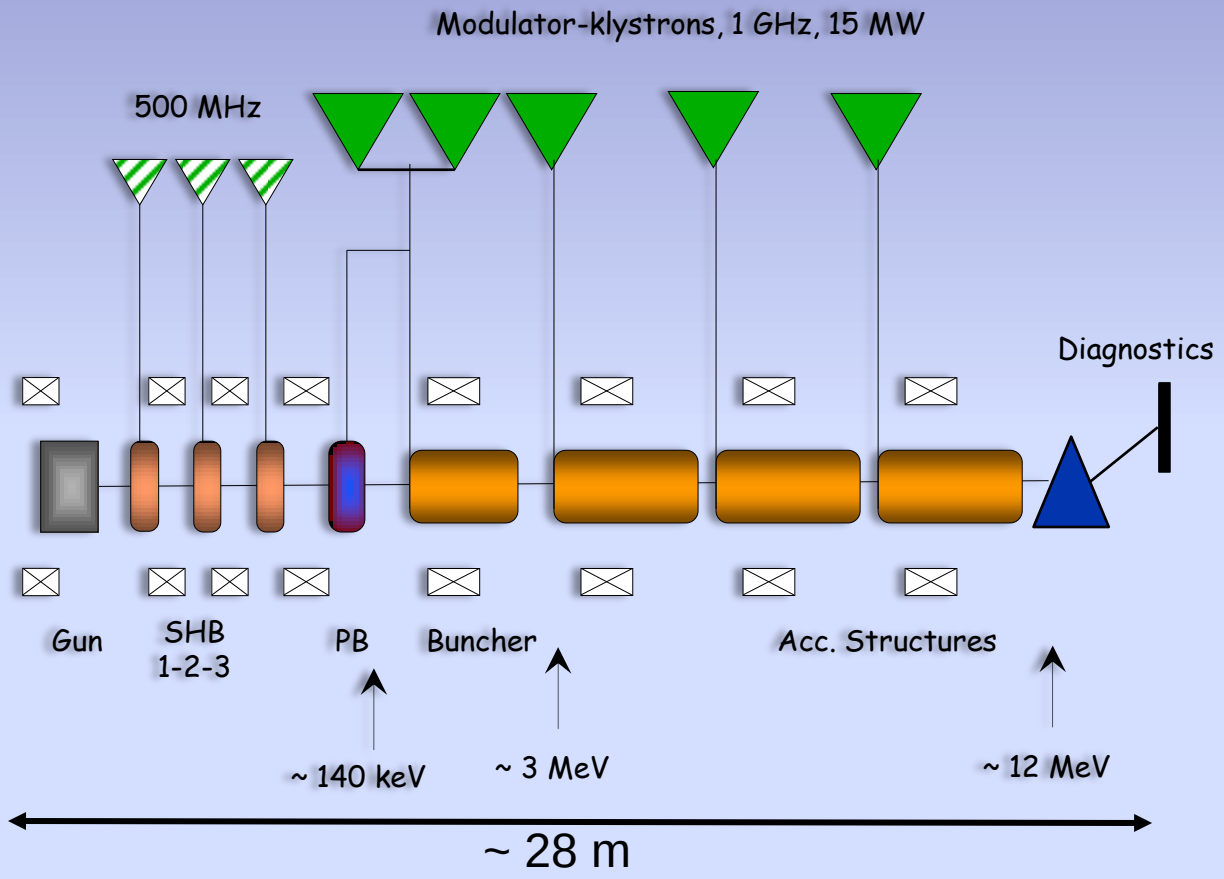
CTF3 what's next ?

Drive Beam front end
and
Contribution to AWAKE

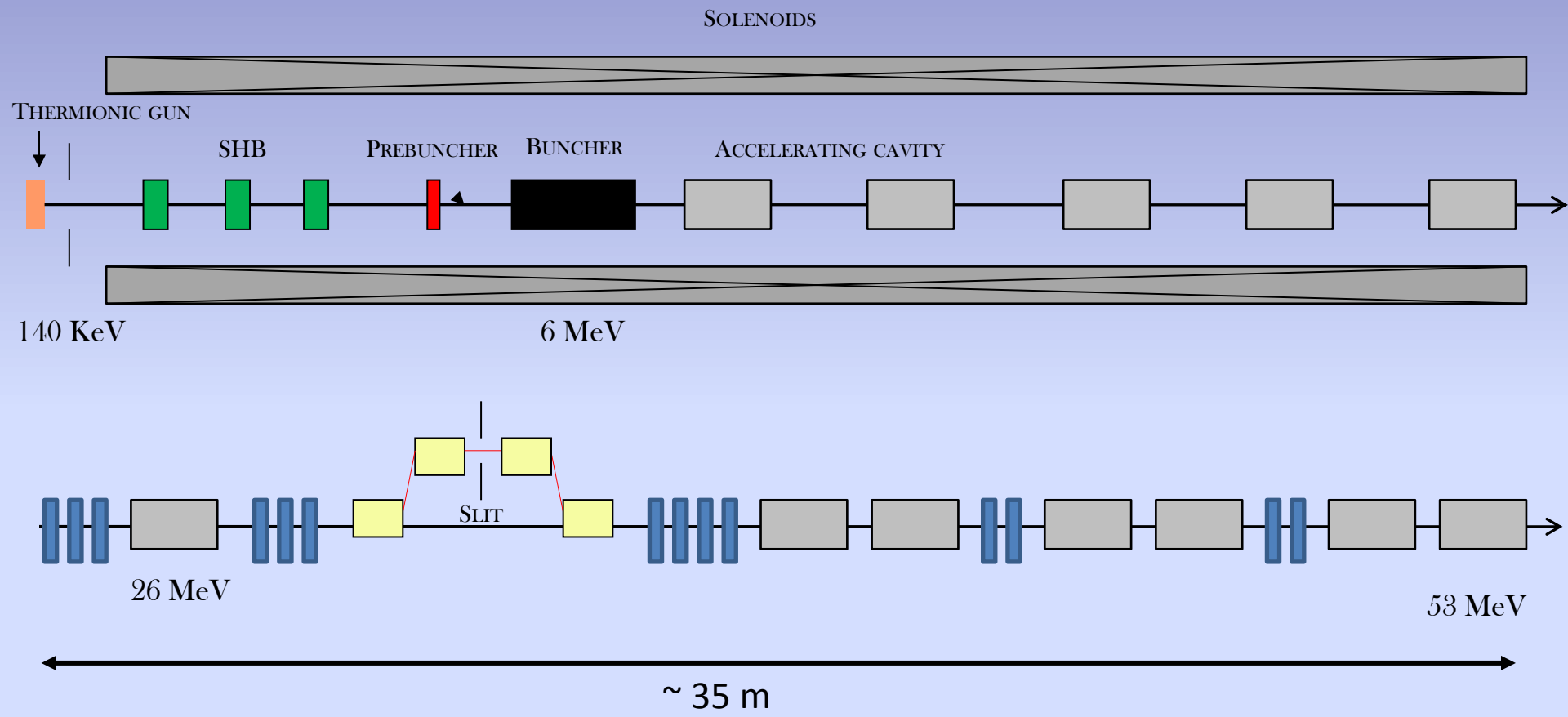
Steffen Döbert, BE-RF

CLIC DB front end, Post CDR Project



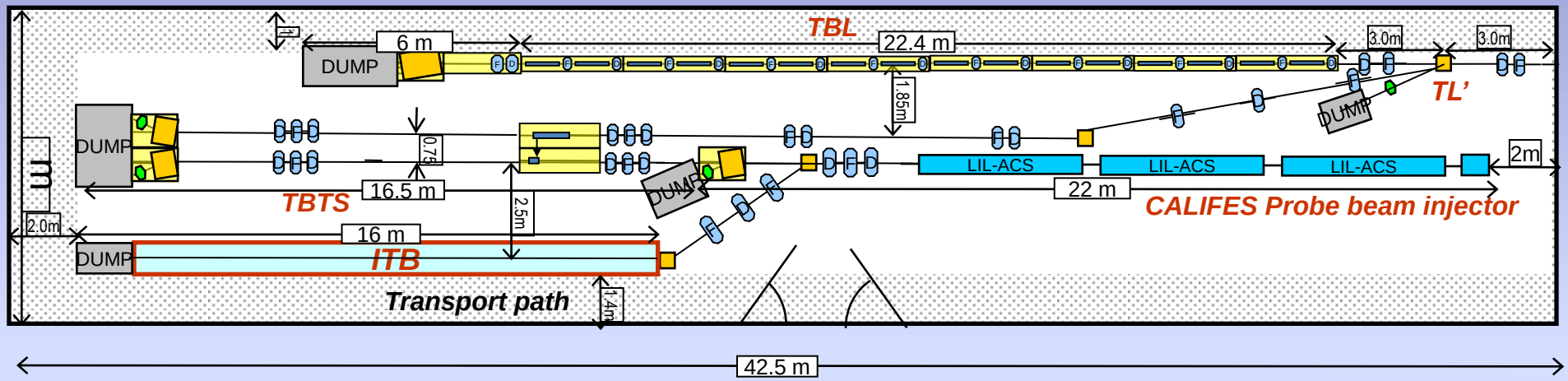
For time being only major component development:
GUN, SHB, high bandwidth 500 MHz source, 1 GHZ MBK, modulator and fully loaded accelerating structure

CLIC drive beam injector layout



Total length 70-80 m

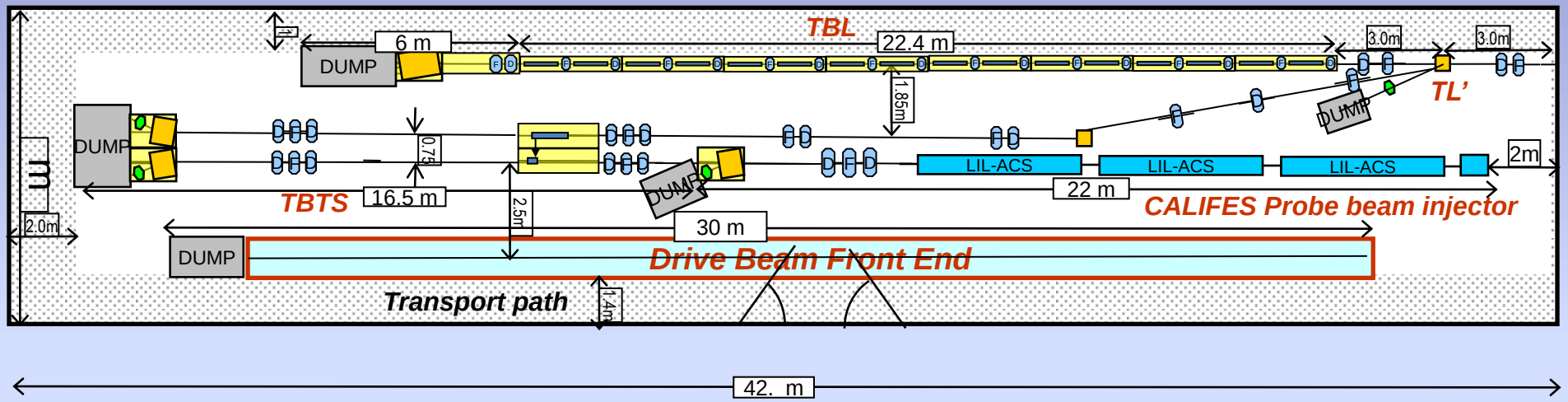
CLEX layout



Space reservations

CALIFES	**22.0 m from cathode preparation chamber to end of spectrometer**
TBTS	**16.5 m from output spectrometer to end of beam dump**
TBL	**31.4 m from dogleg bend to end of beam dump**
ITB	**16.0 m from 2nd dogleg magnet to end of beam dump**

Drive Beam front end in CLEX



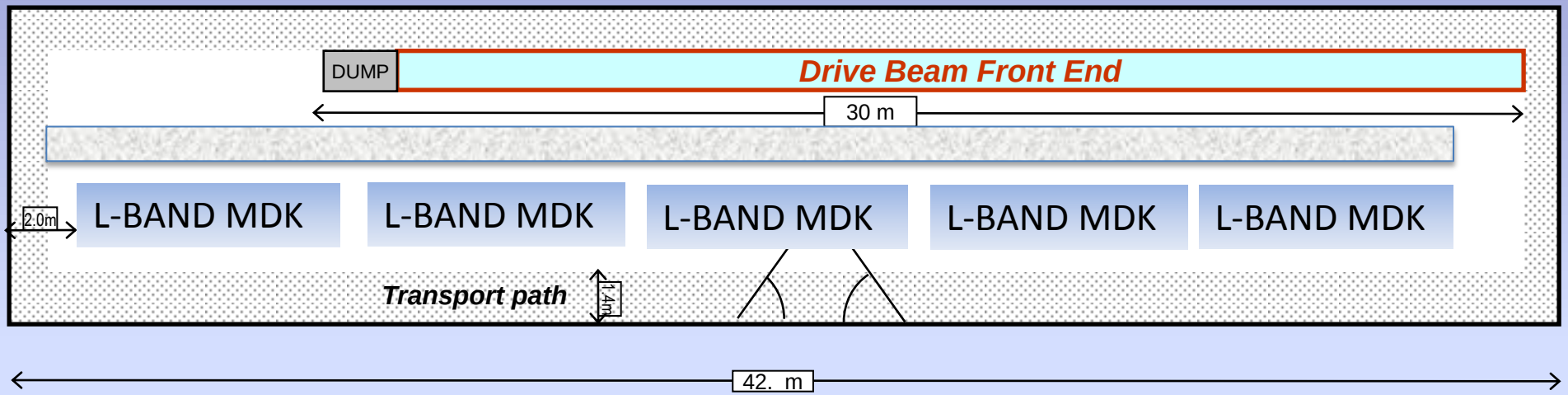
Drive Beam Front End: **~ 30 m**

Concerns:

Shielding likely not sufficient for full beam power operation (350 KW)

Extra Space for modulators and klystrons needed if not exclusively used for the front end

Drive Beam front end in CLEX



Drive Beam Front End: **~ 30 m**

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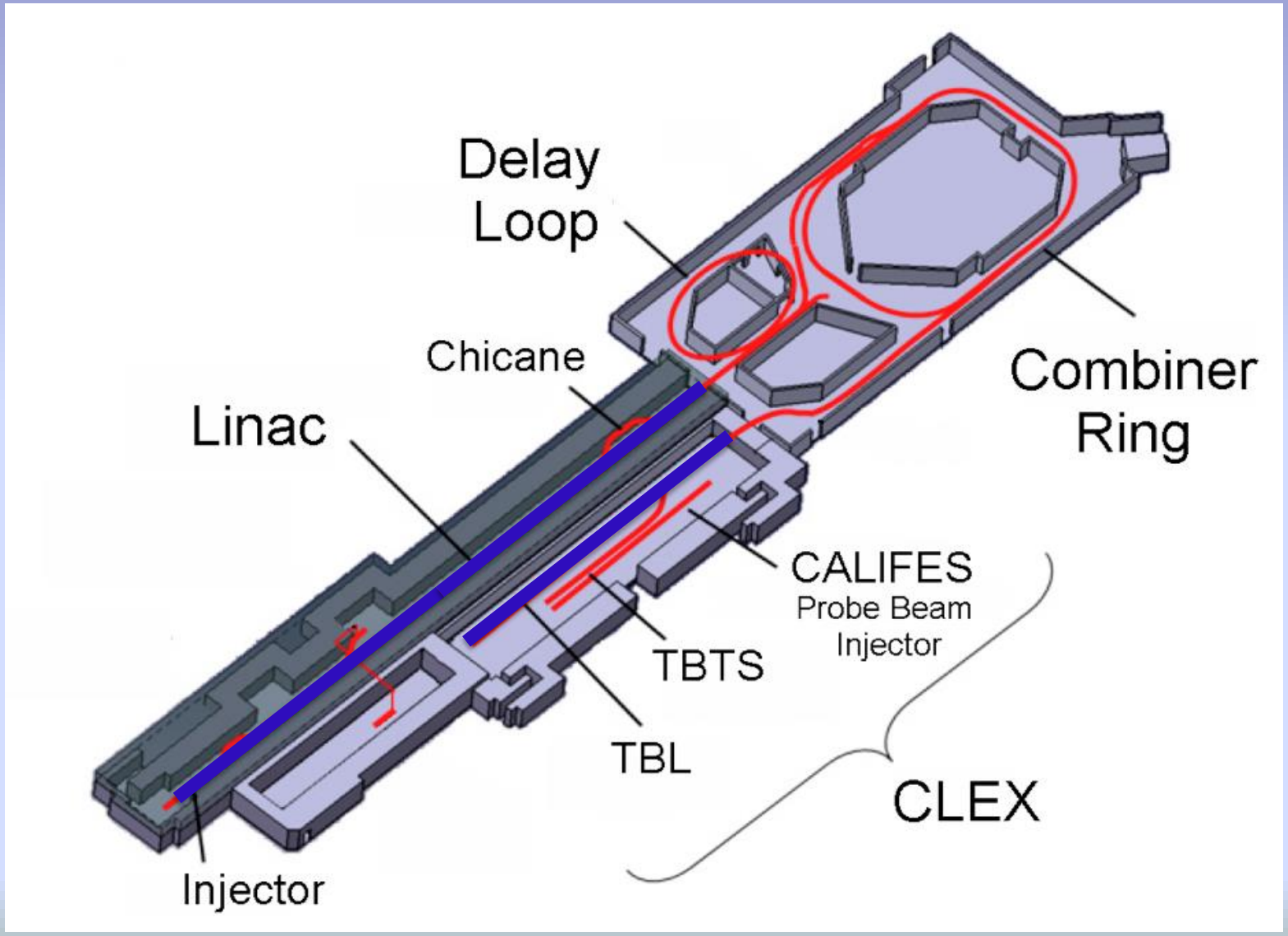
CLIC DB injector specifications

Parameter	Nominal value	Unit
Beam Energy	50	MeV
Pulse Length	**140.3** / 243.7	μs / ns
Beam current	4.2	A
Bunch charge	**8.4**	nC
Number of bunches	70128	
Total charge per pulse	**590**	μC
Bunch spacing	**1.992**	ns
Emittance at 50 MeV	100	mm mrad
Repetition rate	100	Hz
Energy spread at 50 MeV	1	% FWHM
Bunch length at 50 MeV	3	mm rms
Charge variation shot to shot	**0.1**	%
Charge flatness on flat top	**0.1**	%
Allowed satellite charge	< 7	%
Allowed switching time	5	ns

Drive Beam Front End in CTF3

The linac tunnel could house the entire CLIC0 injector



CLIC-Contribution to AWAKE

- Awake needs 20 MeV electron source with low charge, small emittance and possibly short bunches

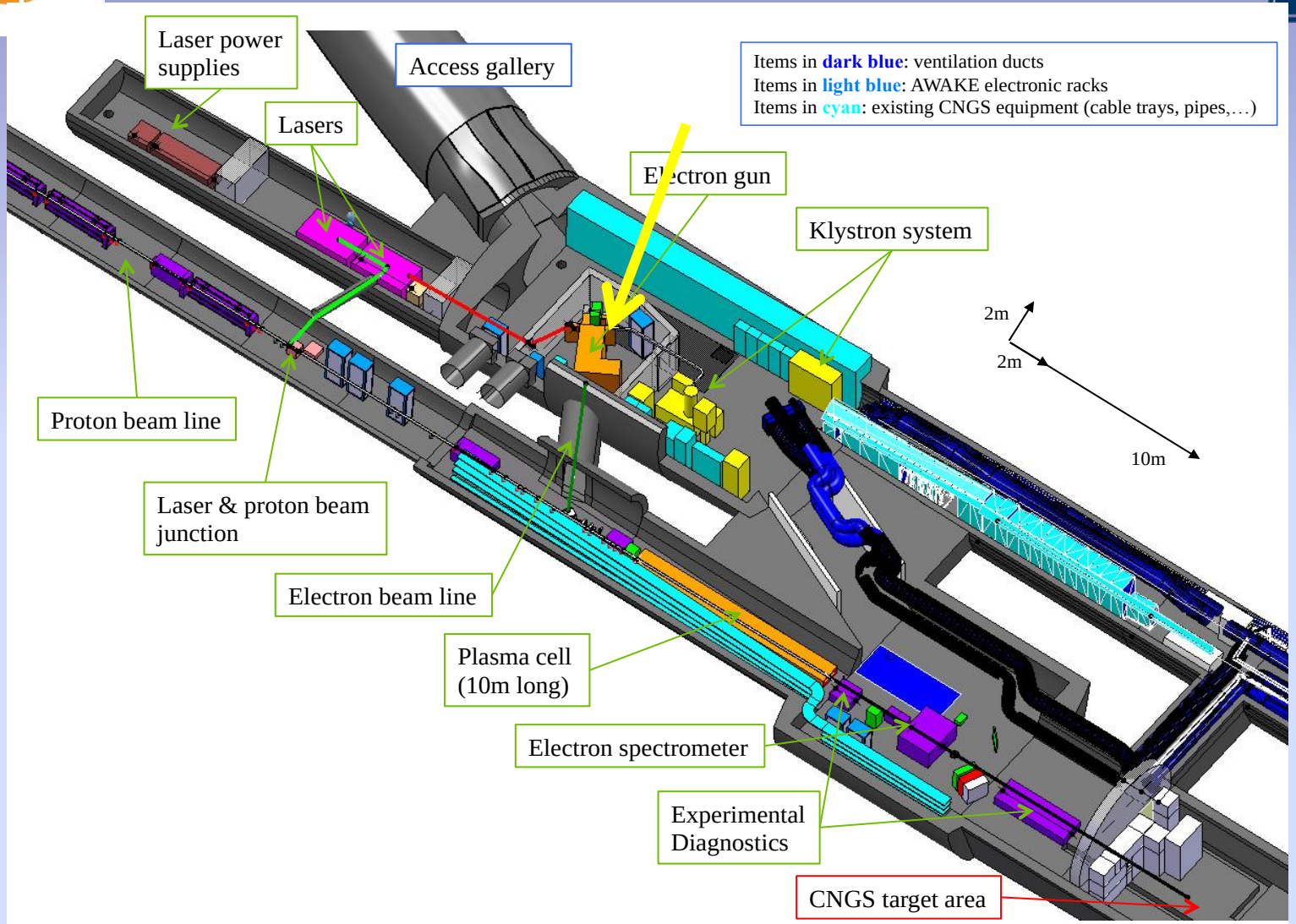
- One CTF3-type Klystron-Modulator would be needed to power the injector
- PHIN type gun could be used
- Some diagnostics, vacuum equipment and magnets might be useful

- CTF- team experience would be likely helpful as well
- Test facility and pre-commissioning in CTF2 ?

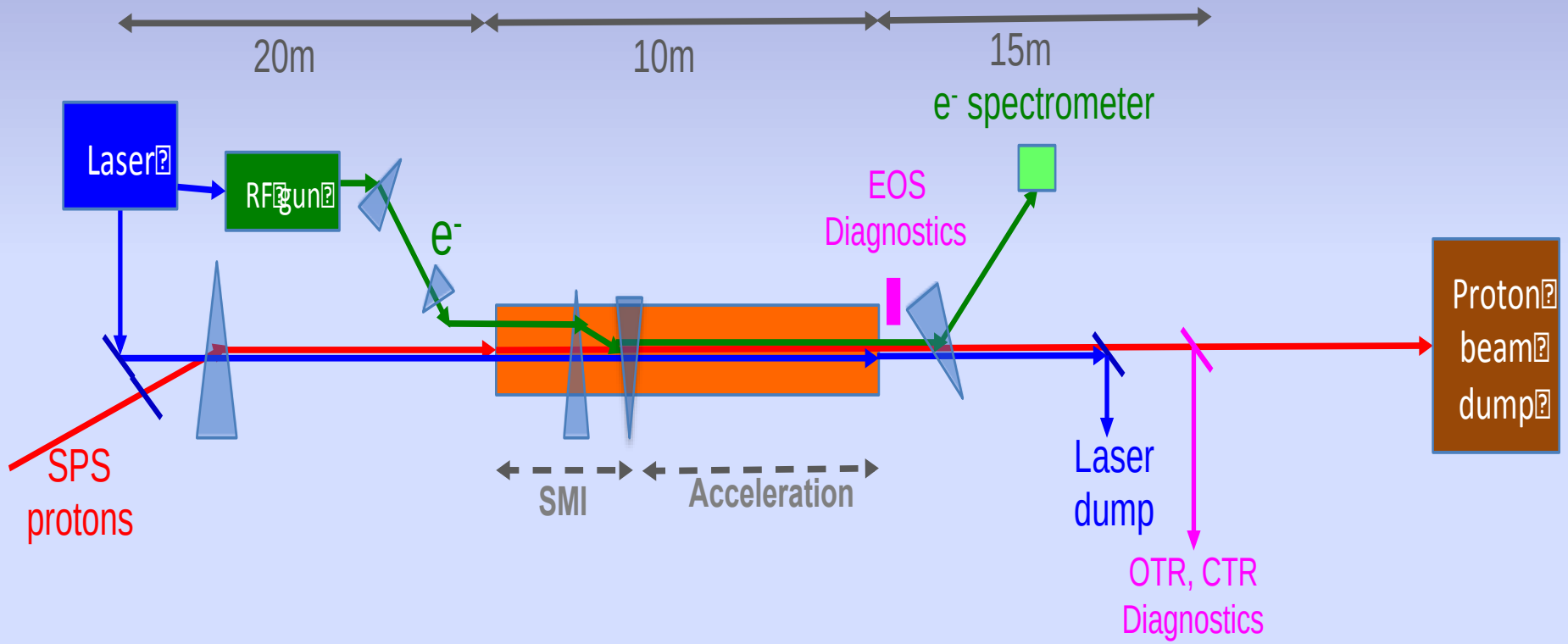
Awake electron beam requirements

Parameter	Side injection	Collinear injection
Beam Energy	13-16 MeV	20 MeV
Energy spread (rms)	0.1 %	
Bunch Length	~ 4 ps	< 1 ps
Laser/Rf synchronization	1 ps	0.1 ps
Free Repetition Rate	10 Hz	
Synchronized repetition rate	0.03 Hz	
Beam Focus Size	< 250 μm	
Divergence	< 3 mrad	
Normalized Emittance	2-5 mm mmrad	0.5 mm mrad
Bunch Charge	0.2 nC	1 nC

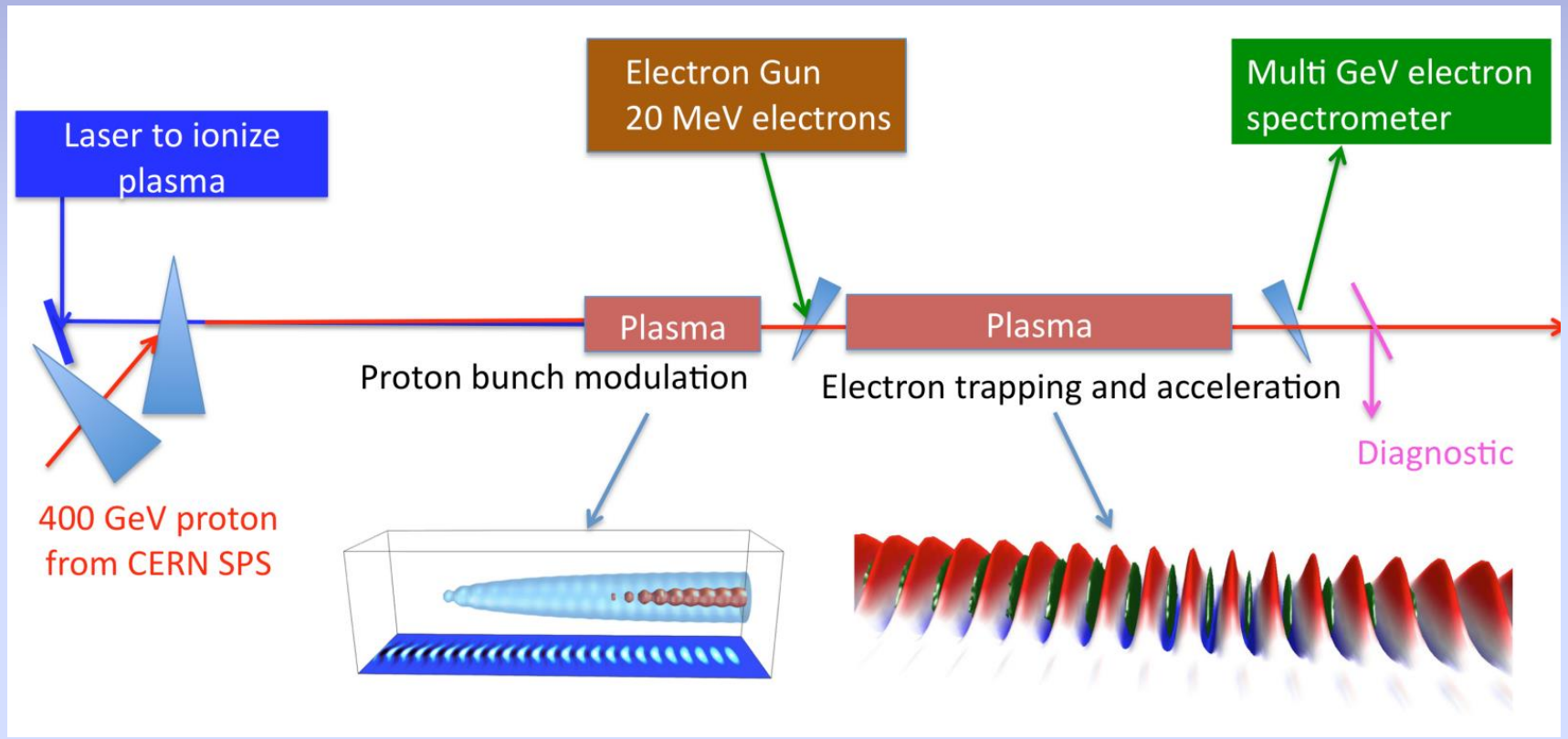
Layout of AWAKE Experiment



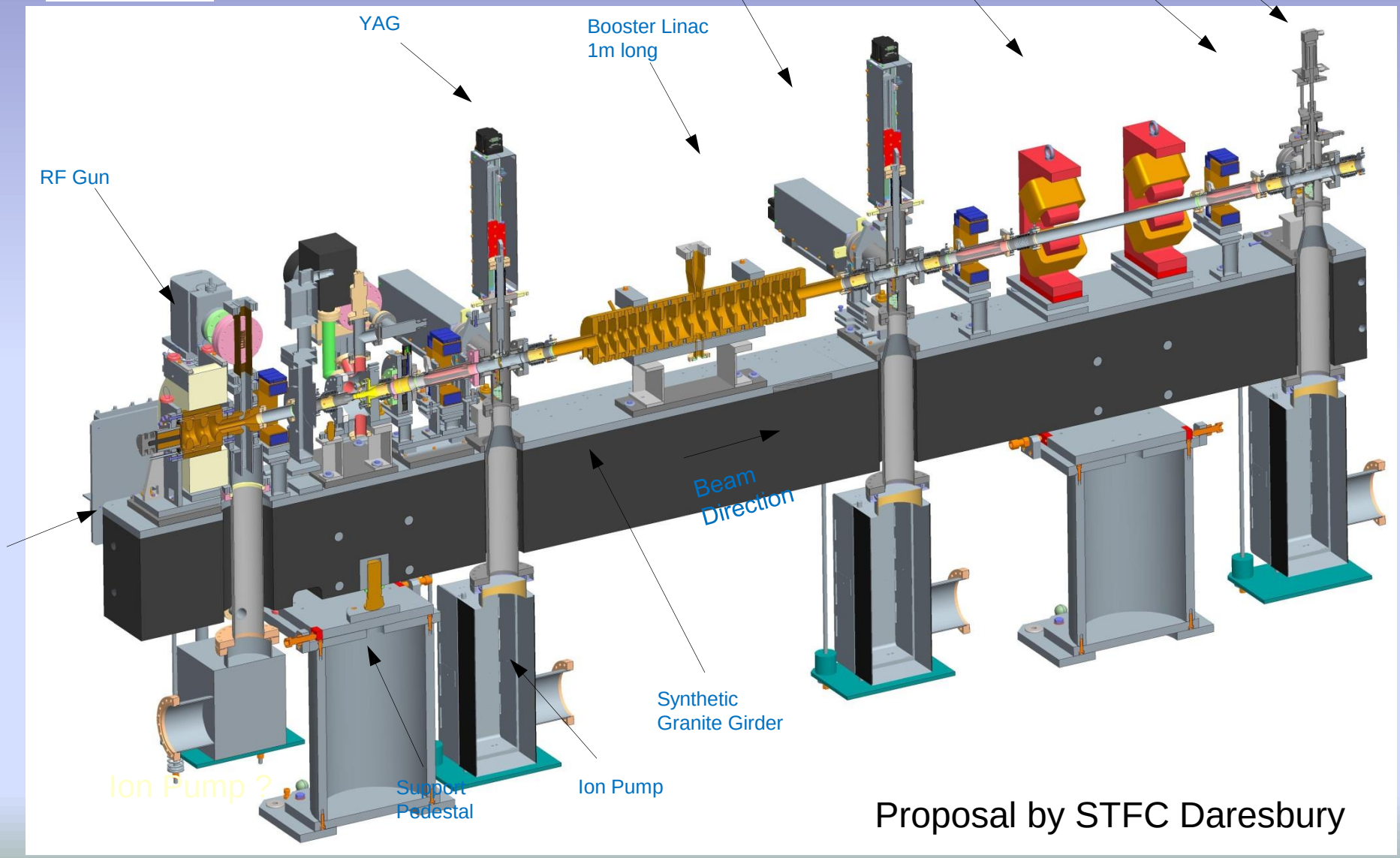
Single plasma cell @side injection



2 plasma cells/on-axis injection

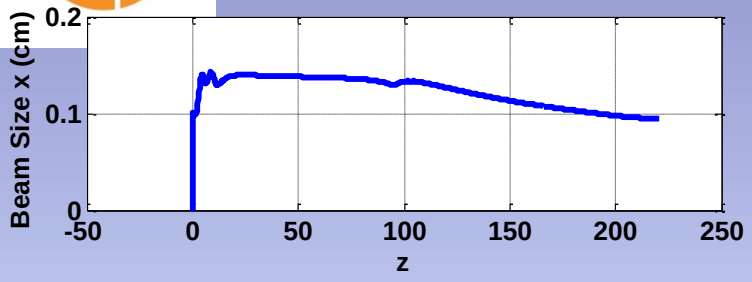


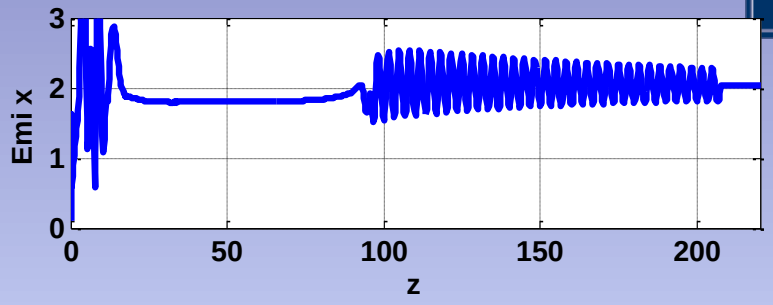
AWAKE – INJECTOR MODULE

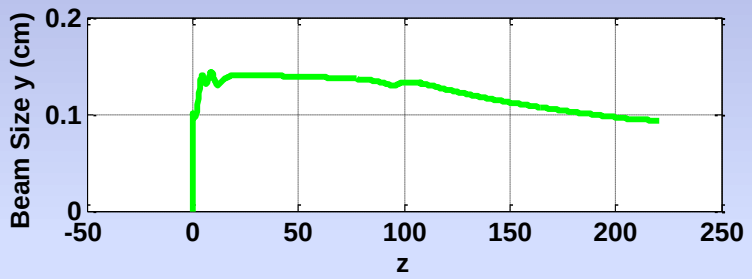


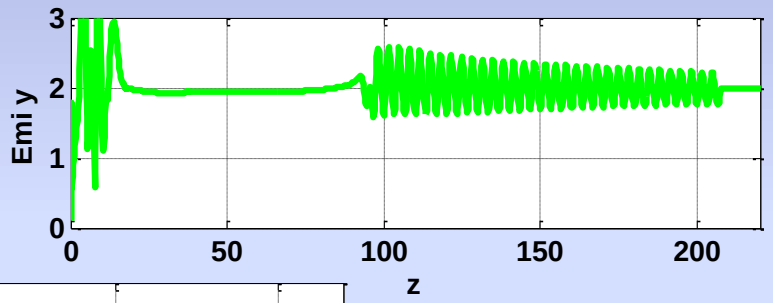
Proposal by STFC Daresbury

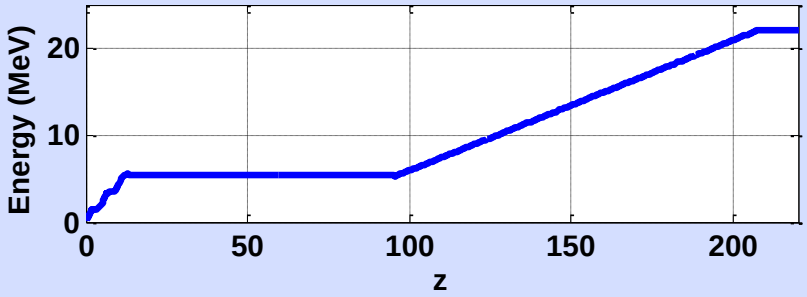
Awake simulations
Phin gun, 20 MV/m structure, 0.1 nC, 1 mm 3 ps laser

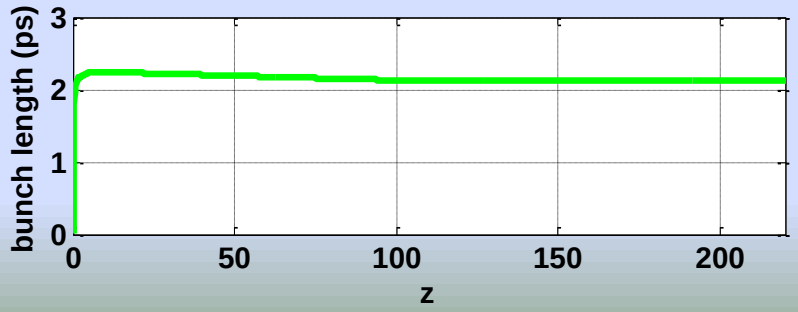




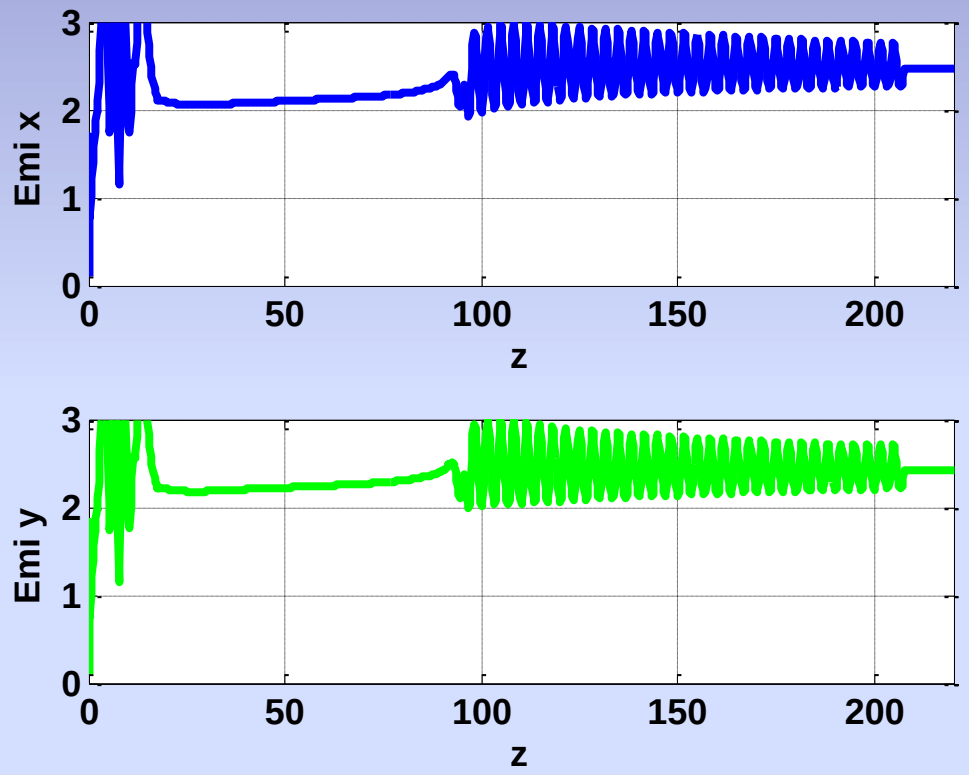




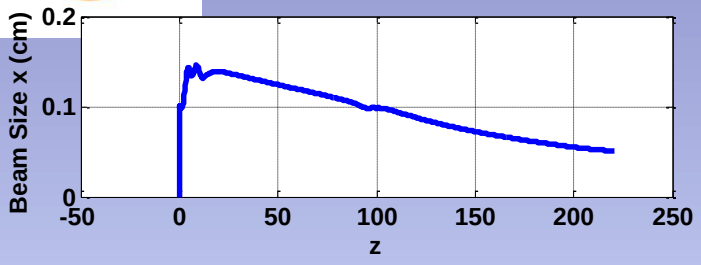


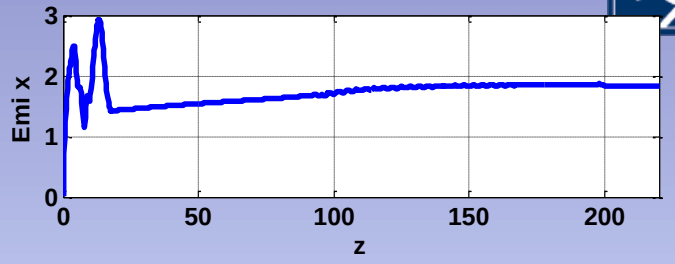


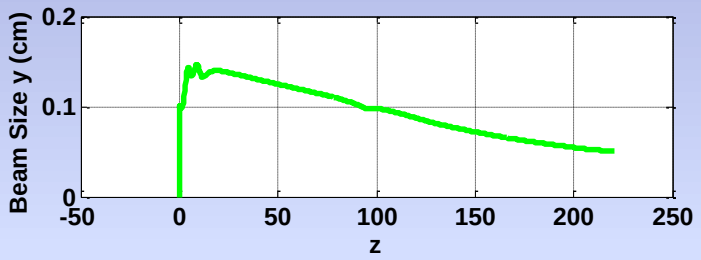
Awake simulations
Phin gun, 20 MV/m structure, 0.2 nC, 1 mm laser

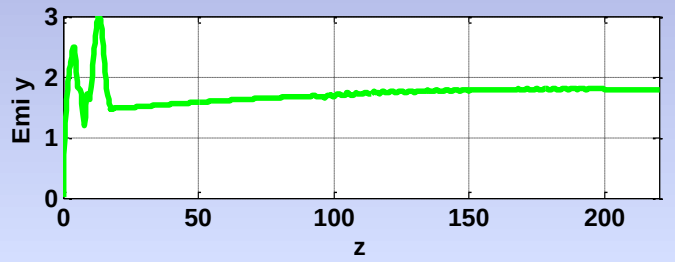


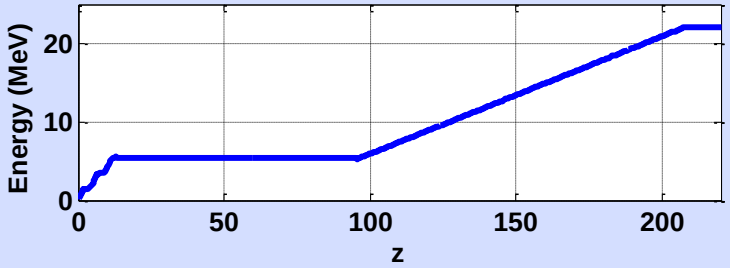
Awake simulations
Phin gun, 20 MV/m structure, 0.2 nC, 1 mm laser, 1 ps laser

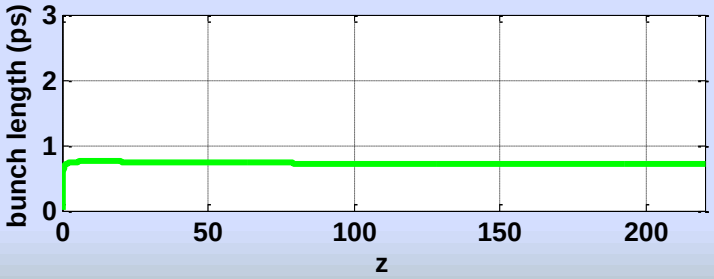




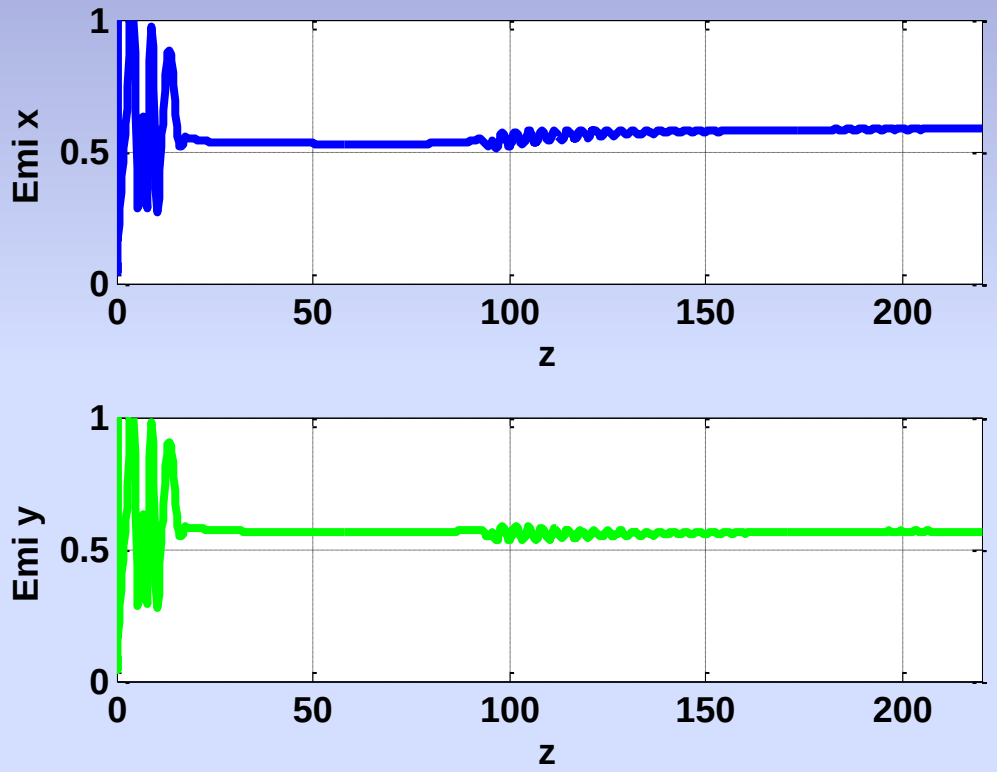




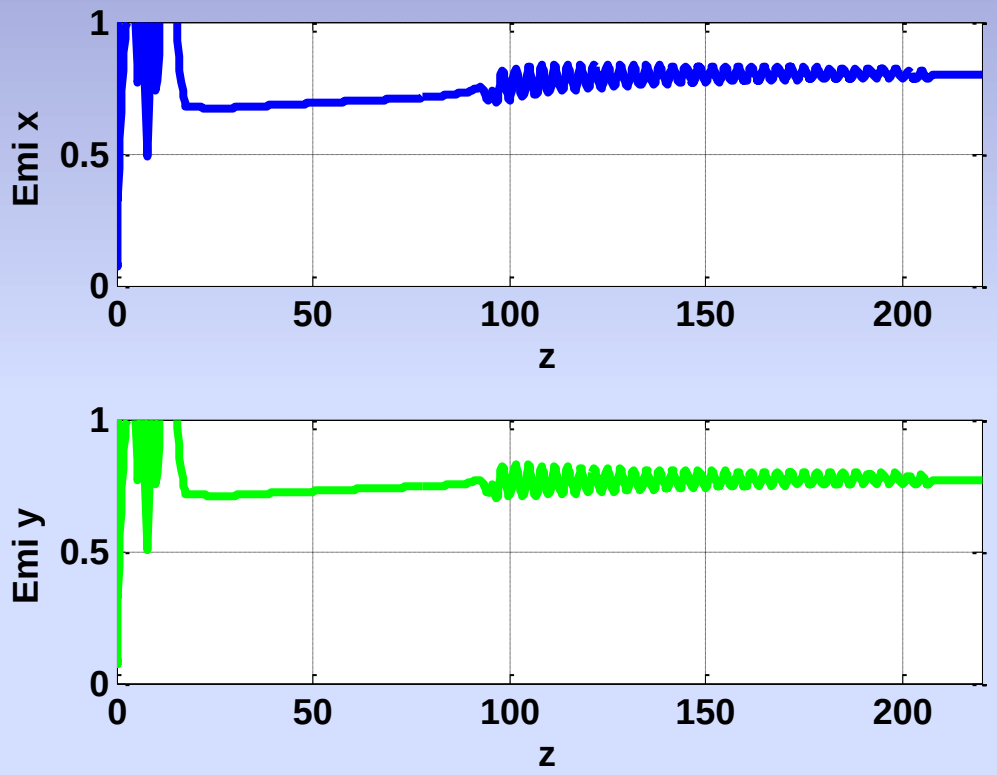




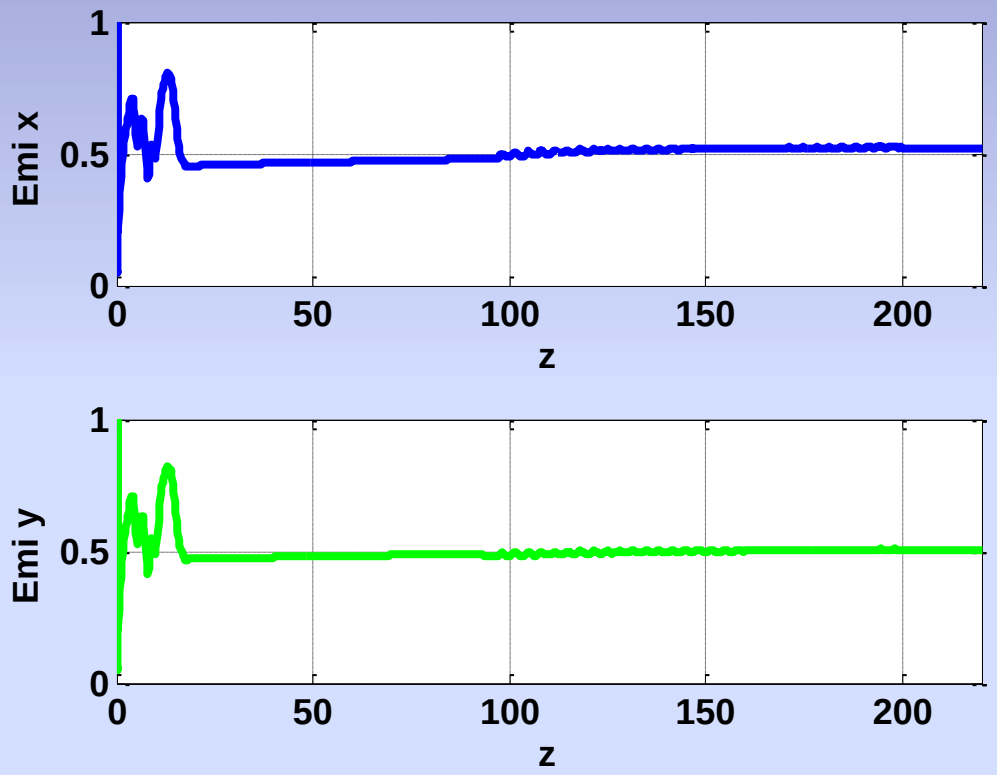
Awake simulations
Phin gun, 20 MV/m structure, 0.01 nC, 0.5 mm laser



Awake simulations
Phin gun, 20 MV/m structure, 0.1 nC, 0.5 mm laser



Awake simulations
Phin gun, 20 MV/m structure, 0.1 nC, 0.25 mm laser



Similar aspects have been studied for a possible implementation of PHIN in CTF3 in 2006.
See EPAC paper: *"INTEGRATION OF THE PHIN RF GUN INTO THE CLIC TEST FACILITY"*

Booster structure

Some rough numbers

1 m long constant gradient structure

f= 2998.55 MHz

Q ~ 15000

r/Q ~ 70 MΩ

ΔV= 15 MV

T_f= 280 ns, 2a ~ 2 cm

Po = 11 MW

PHIN gun needs about 10 MW for 85 MV/m

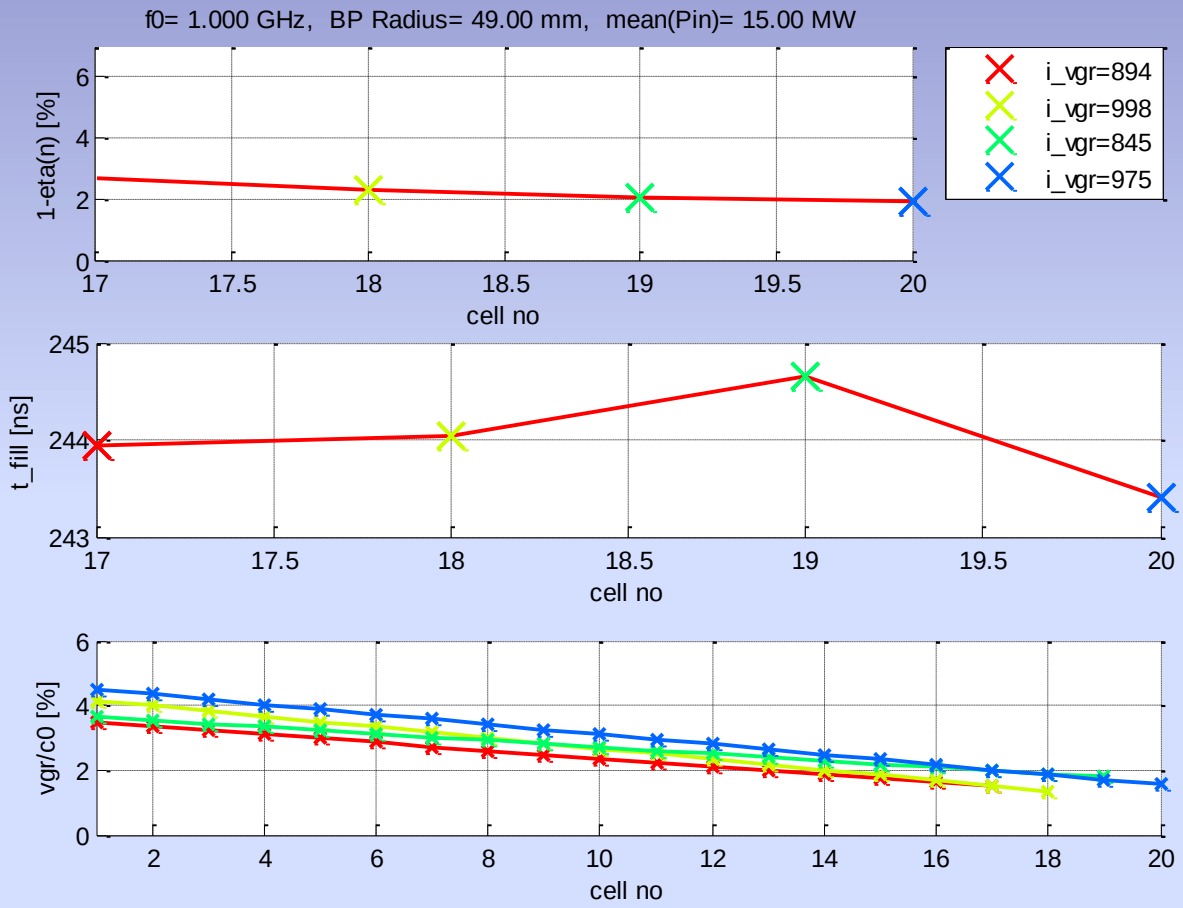
Roughly 30 MW needed to power the injector (one klystron)

Conclusions

- Beam requirements for side injection likely possible with PHIN gun and booster
- Some useful equipment should be available from CTF3
- Need detailed beam and laser specifications
- Requirements for collinear injection challenging to fulfil simultaneously

End

DB-accelerator structure



Parameters:

f = 999.5 MHz

P_{in} = 15 MW

R_B = 49 mm

N = 19 cells

OD= 300 mm

L= 2.4 m

T_{fill} = 245 ns

$\eta_{RF\text{-}Beam}$ = 97.5 %