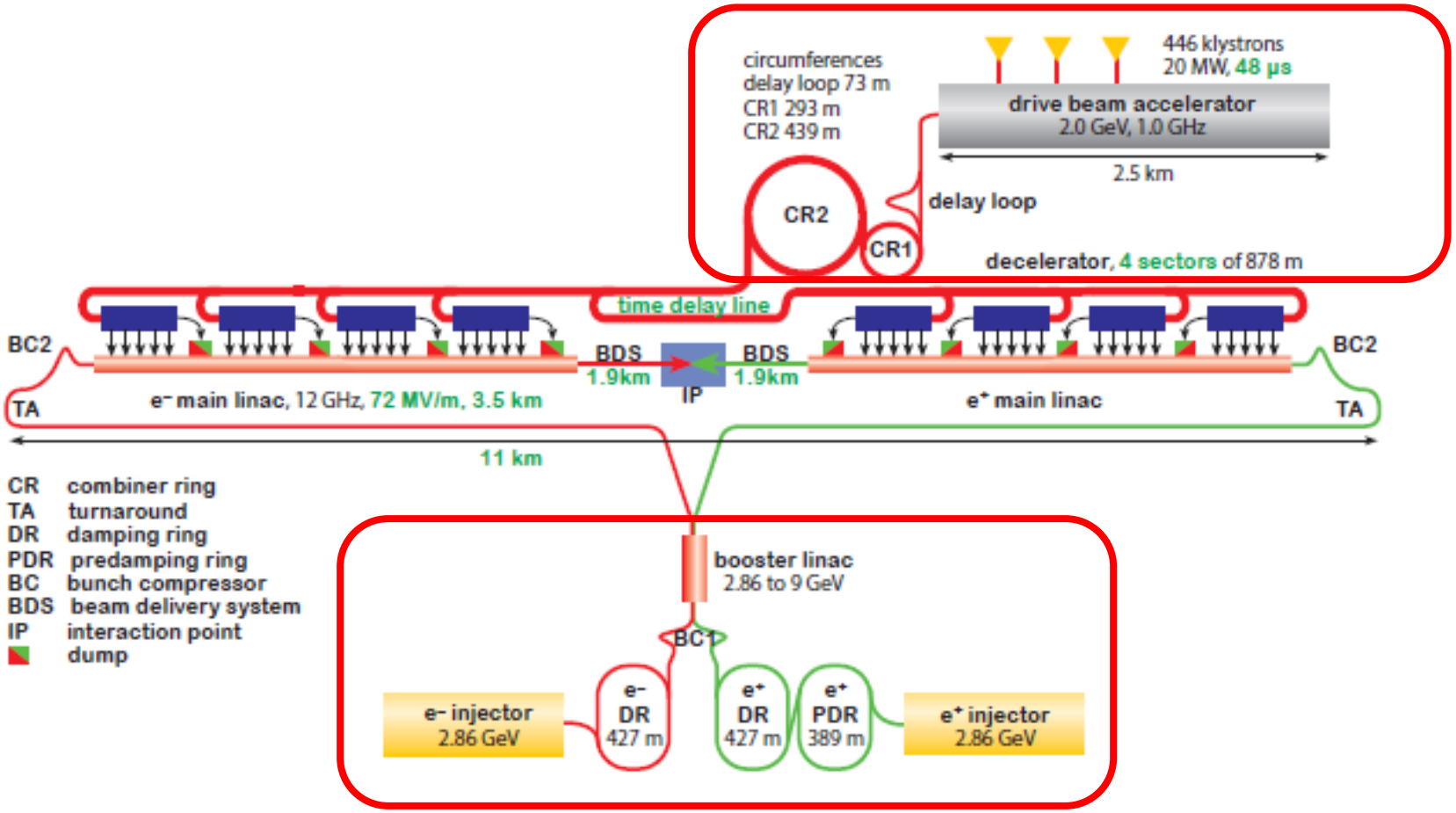
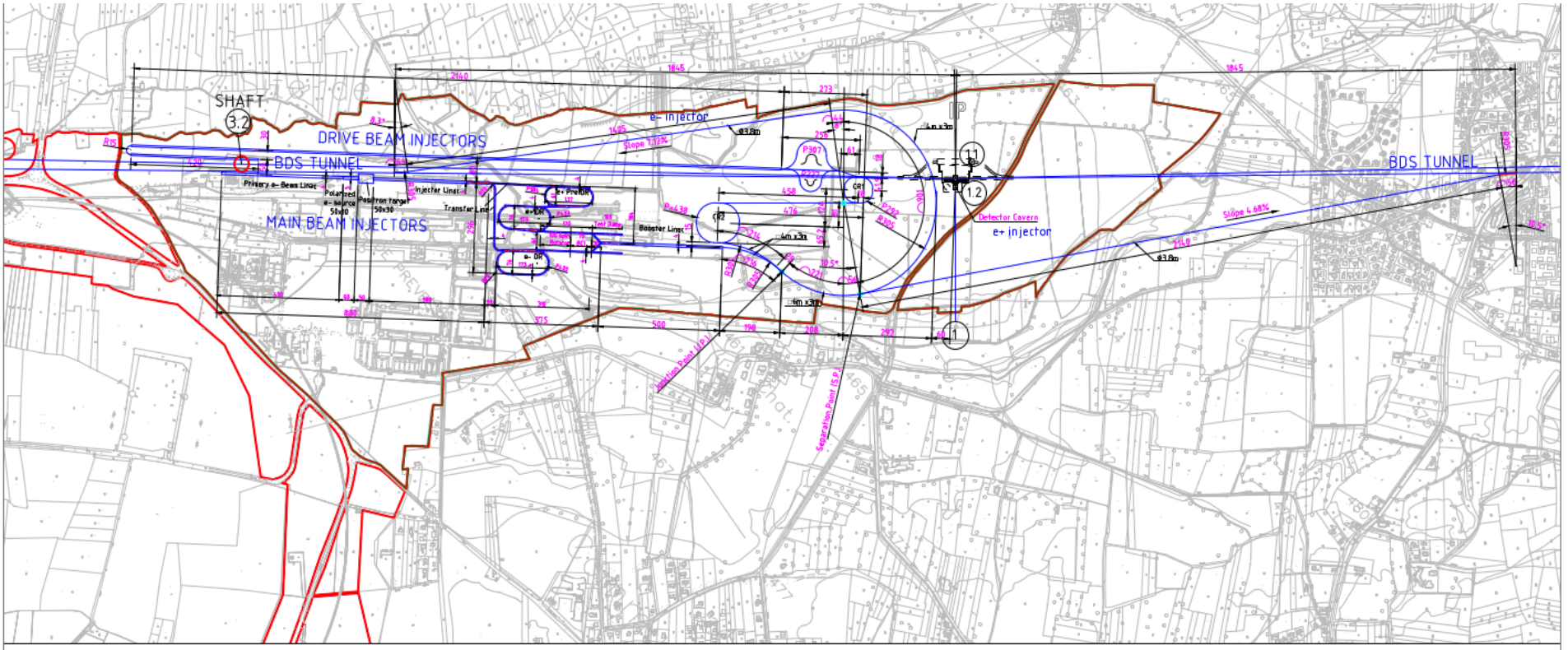
CLIC layout 380 GeV

Drive Beam + Injector



Main Beam Injector Complex

Injector infrastructure



INJECTORS TUNNELS	DRIVE BEAM INJECTORS COMPLEX							MAIN BEAM INJECTORS COMPLEX									COMMON TRANSFER TUNNEL J.P. to S.P.	FINAL TRANSFER TUNNELS ((From Separation Point)		
	LINAC	DL1	DL2	CR 1	CR 2	Transfer Lines	TT to Junction Point	Preliminary e- beam LINAC	Polarized e- source	Positron Target	Transfer Lines	e+ Pre DR	e+/e- DR	SpinRotator +BC1+TD	Booster LINAC	TT to Junction Point		e- TT		e+ TT
Length (l) m	2140 +48+420	227	307	292	438	518	239	400	50	50	482	384	2x433	2 x 313	500	216	277	945	1449	2196
Section (w x h) m	6 x 3	4 x 3	4 x 3	4 x 3	4 x 3	4 x 3	4 x 3	4 x 3	5 x 3	30 x 3	4 x 3	4 x 3	4 x 3	4x 3	4 x 3	4 x 3	6 x 3	4 x 3	ϕ 3.8	ϕ 3.8
Surface Buildings (l x w x h) m	2560 x 30 xh 9	-	-	30x30 x h 5	30x30 x h 5	-	-	400 x 7 x h 3	ComptonR. 30x30x h3	Linac1+2. 30x30xh5(x2)	-	30x30 xh5(x2)	30x30 xh5(x2)	-	500 x 5 x h 3	-	Inject.Hall 30x30xh5	delta e-/e+ = 198m		

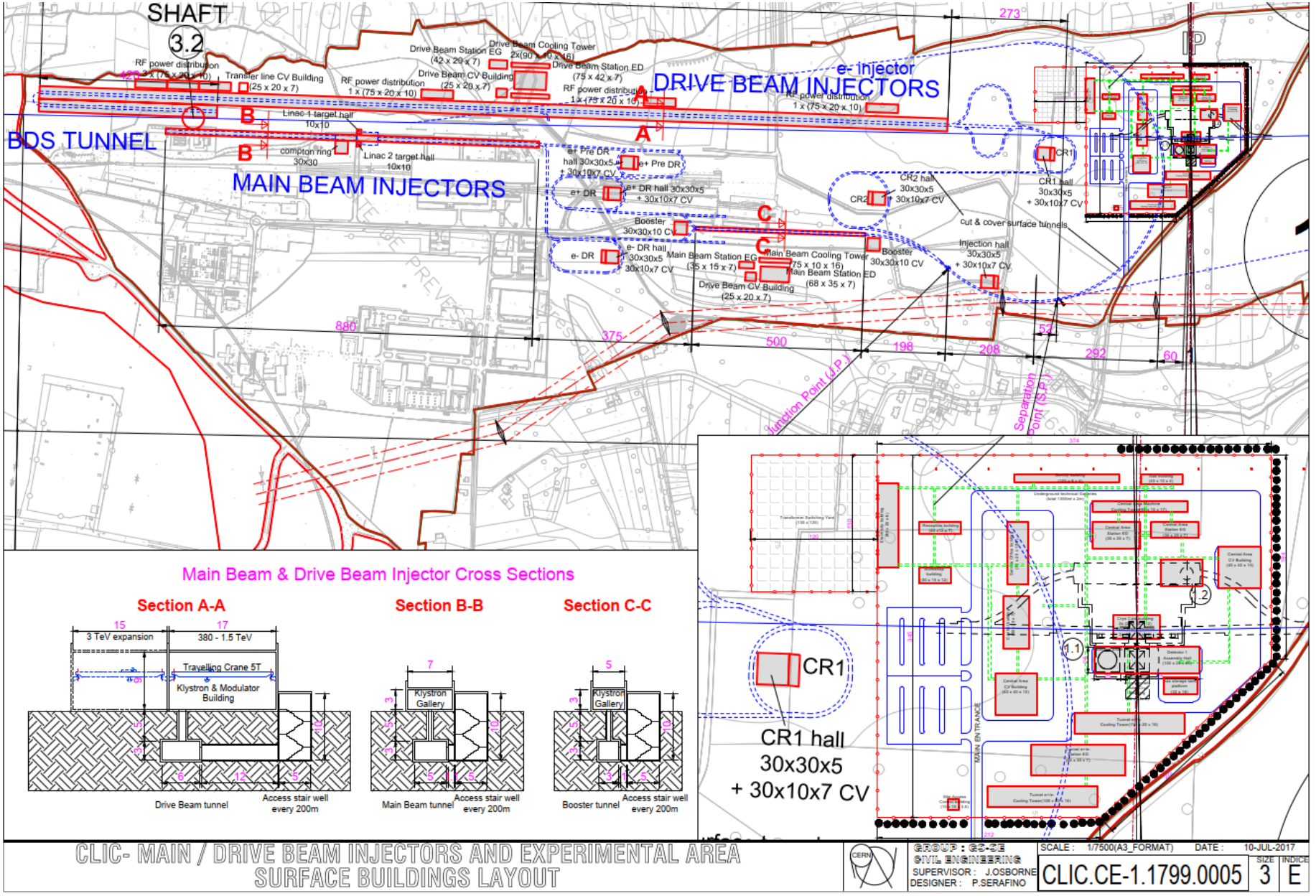
CLIC- MAIN / DRIVE BEAM INJECTORS AND EXPERIMENTAL AREA LAYOUT

CERN

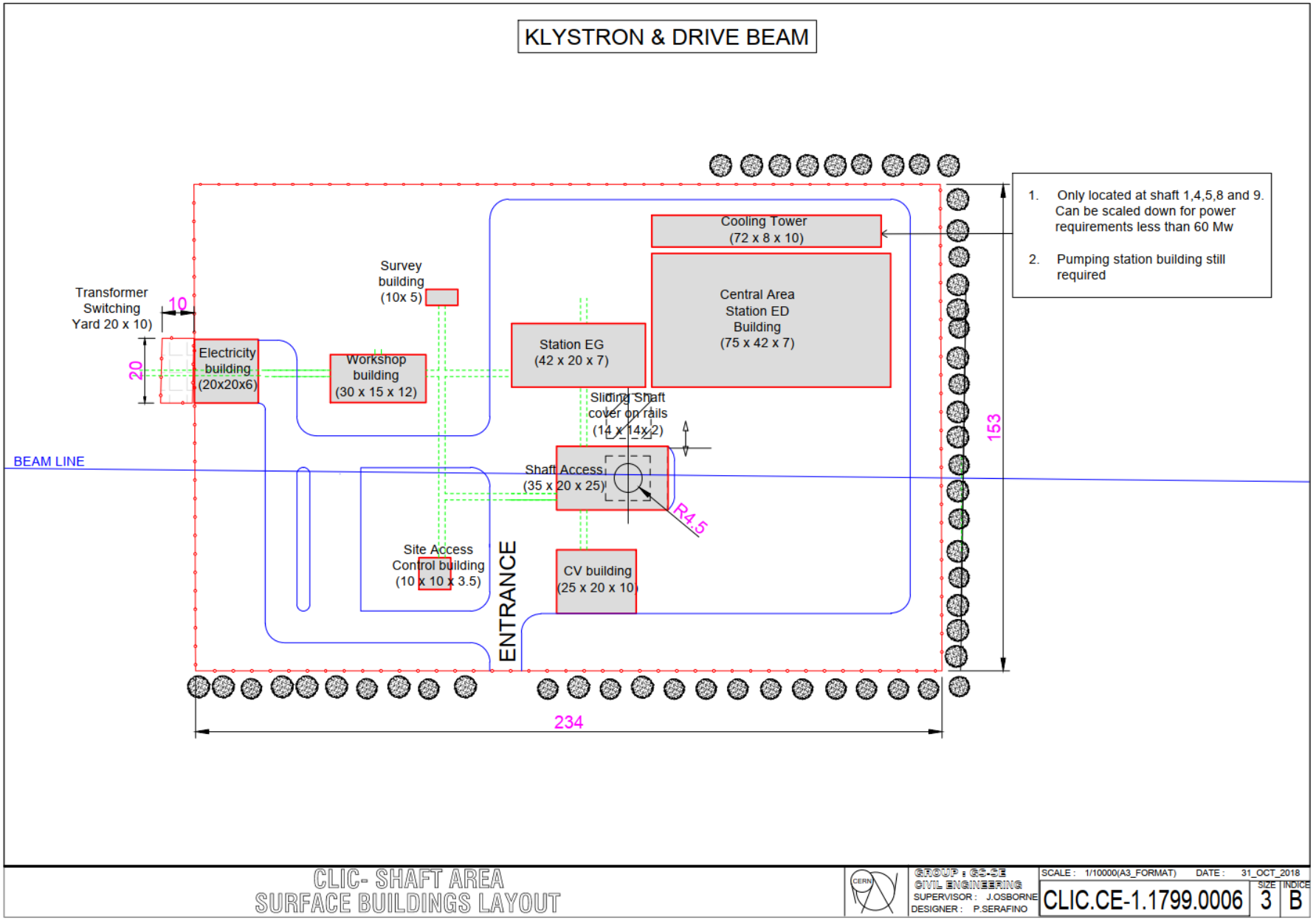
GROUP : GS-CE
CIVIL ENGINEERING
SUPERVISOR : J.OSBORNE
DESIGNER : P.SERAFINO

SCALE : 1/8000(A3_FORMAT) DATE : 02-JUN-2017
CLIC.CE-1.1799.0002 | SIZE 3 | INDICE L

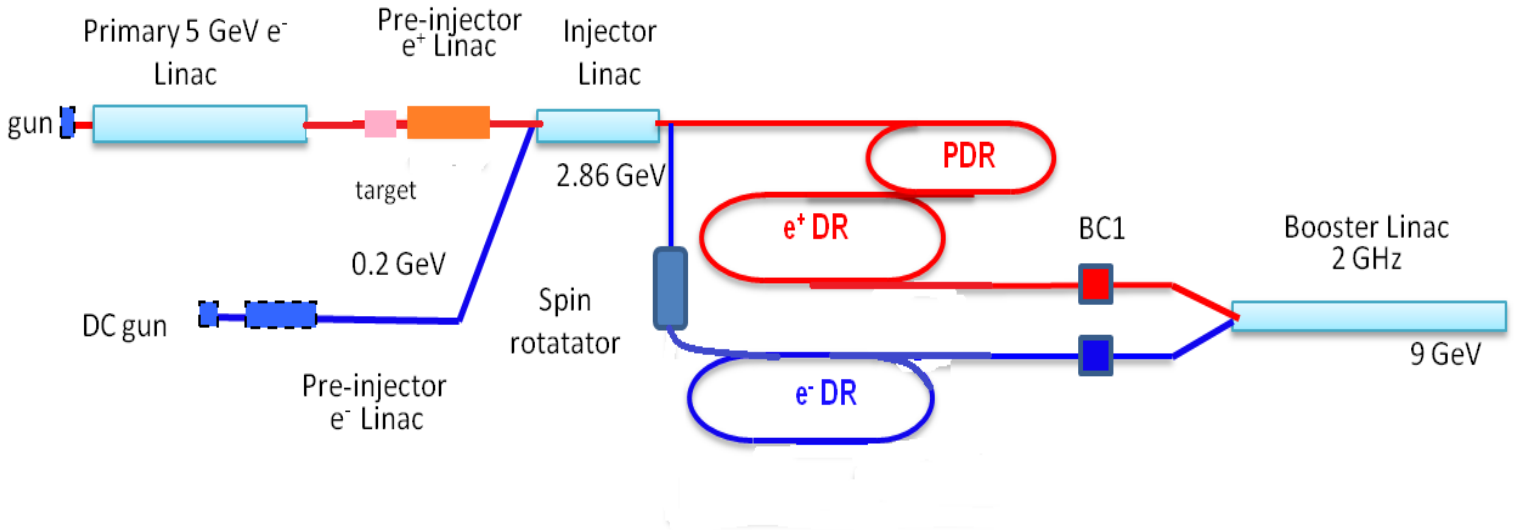
Zoom into the injectors



Infrastructure close to shafts

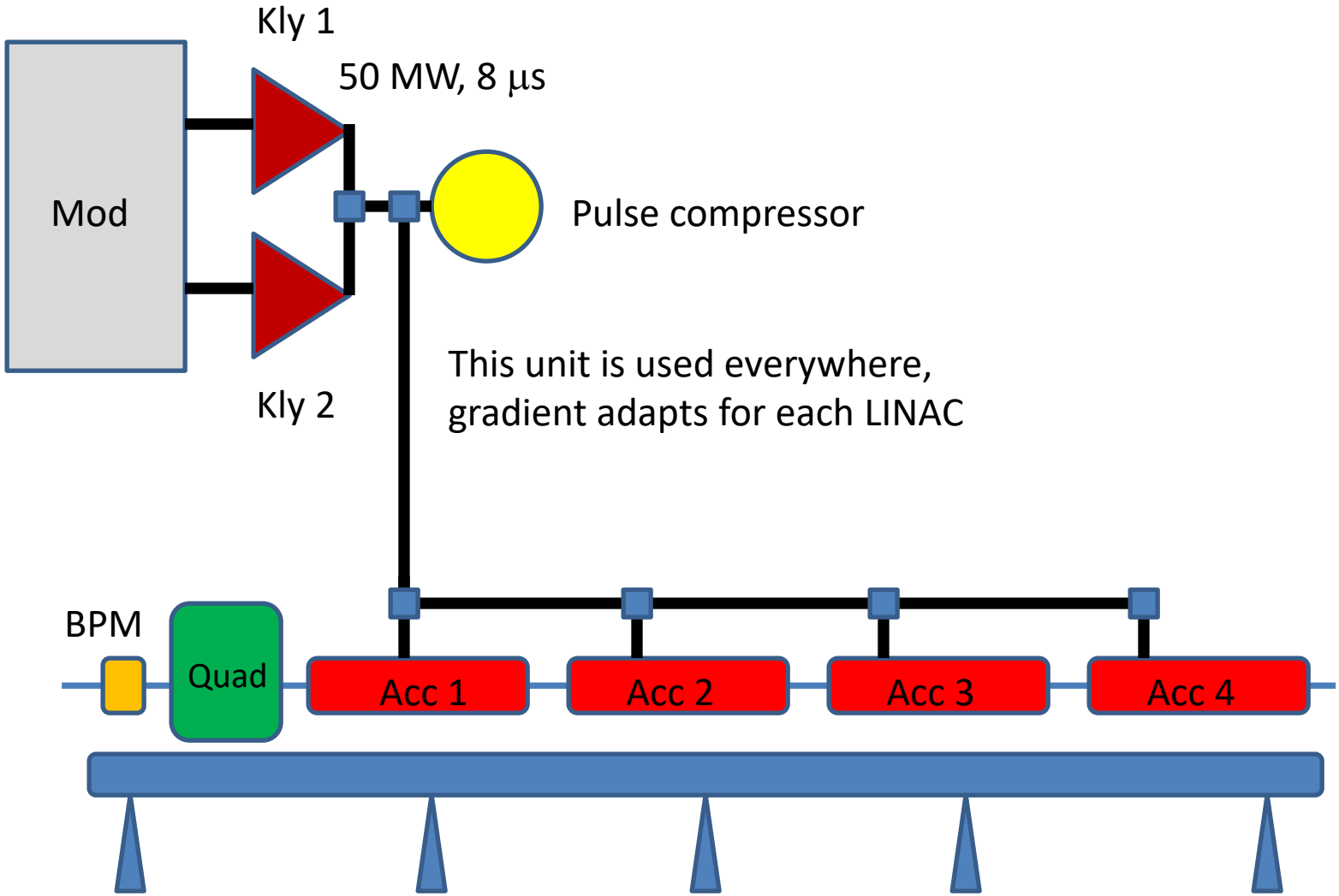


Schematic layout



Rf-module cost model

Typical 2 GHz rf module including accelerators and beam line



Generic transfer line

Infra structure ?
Cooling, ventilation, cable trays ?

Cost per linac updated 380 GeV

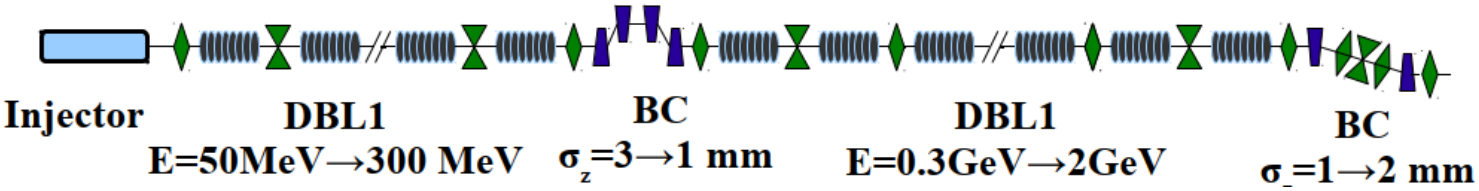
380 GeV parameters												
LINAC	Energy Gain (MeV)	Bunch charge (10^9)	rf pulse length (ns)	Power per structure (MW)	Loaded gradient (MV/m)	Configuration (structure/ 2 klystrons)	No of rf modules	pulse compressor gain	No of structures	Length (m)	Energy gain per module	Cost
e- pre-injector	200	6	600	75	16.7	4	2	4.4	8.0	15.6	100.2	4910
e+ pre-injector	200	20	600	87	8.3	4	6	4.4	17.0	22.1	33.2	14730
injector linac	2660	7	2x600	77	17	4	26	3.7	105.0	204.75	102	63830
positron drive linac	5000	7	600	90	19	4	44	4.4	176.0	343.2	114	108020
booster linac	6140	5.6	2x600	75	18.2	4	56	3.7	225.0	438.75	109.2	137480

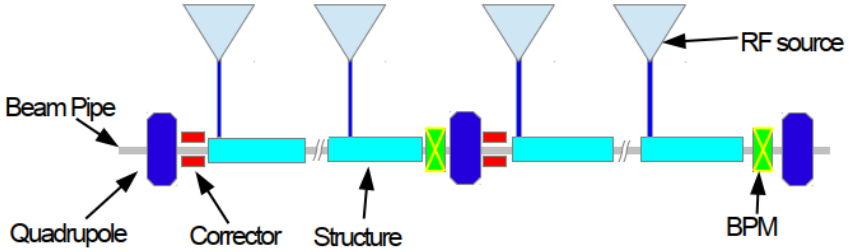
Total injector costs in PBS

	PBS 380 GeV PP				Generated :
cmd	wu	pbs	pbs description	relative start	duration
cmd	Mxx			pv	unit
cmd	Pxx			pv	unit
	wu	1.1.1.	Thermoionic gun unpolarized e-	0y	0y
	MP			1000000	CHF
	wu	1.1.2.	Primary e- Beam Linac for e+	0y	0y
	MP			108020	kCHF
	wu	1.1.3.	e-/e+ Target	0y	0y
	MP			7000000	CHF
	wu	1.1.4.	Pre-injector Linac for e+	0y	0y
	MP			14730	kCHF
	wu	1.1.5.	DC gun Polarised e-	0y	0y
	MP			3000000	CHF
	wu	1.1.6.	Pre-injector Linac for e-	0y	0y
	MP			4910	kCHF
	wu	1.1.7.	Injector Linac	0y	0y
	MP			63830	kCHF
	wu	1.1.8.	Bunching System e- for e+	0y	0y
	MP			500000	CHF
	wu	1.1.9.	Transfer Lines e- to Single Targets Station	0y	0y
	MP			100000	CHF
	wu	1.1.10.	Transfer Lines e+ to Injector Linac	0y	0y
	MP			100000	CHF
	wu	1.1.11.	Bunching System e- for e-	0y	0y
	MP			300000	CHF
	wu	1.1.12.	Pre-injector to Injector Linac Transfer Line	0y	0y
	MP			100000	CHF
	wu	1.1.14.	Spin Rotator e- before PDR	0y	0y
	MP			500000	CHF
			Booster linac		

Drive Beam Linac and Injector

Avni Aksoy, CLIC WS 2018





Sh.S. Hajari et al. / Nuclear Instruments and Methods in Physics Research A 799 (2015) 172–186

Shahin Hajari

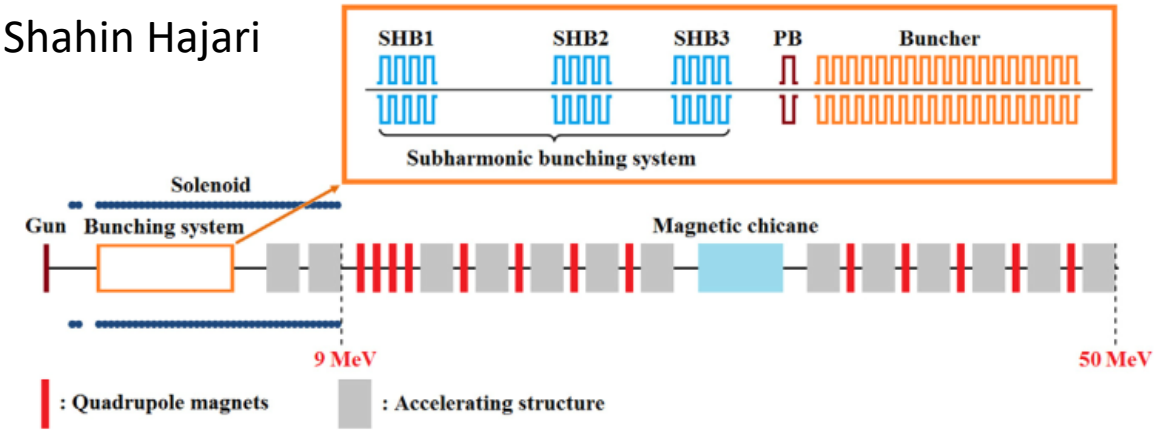


Fig. 6. The general layout of the injector complex.

Drive Beam Injector and LINAC cost

- Drive Beam Linac uses 470 RF stations (459+ 11 spares), each one powers one structure
- We have 200 quadrupoles, correctors and BPM's
- The injector is costed as a lump sum

DB-Injector:	1 x	40 MCHF
L-band Klystron (MBK):	470 x	380 kCHF
Modulator:	470 x	370 kCHF
LLRF:	470 x	50 kCHF
Acc-structure	470 x	250 kCHF
Waveguides	470 x	30 kCHF
Magnet system:	200 x	50 kCHF
Powering:	200 x	18 kCHF
BI:	200 x	15 kCHF
Vacuum:	470 x	43 kCHF

Klystron and modulators

Unified approach for all systems:
-Bottom up cost model for klystrons (O. Brunner) benchmarked with known prices and discussed with Industry to determine prototype price.
-Apply learning curve of 0.92 for number of units
-Determine average unit price.

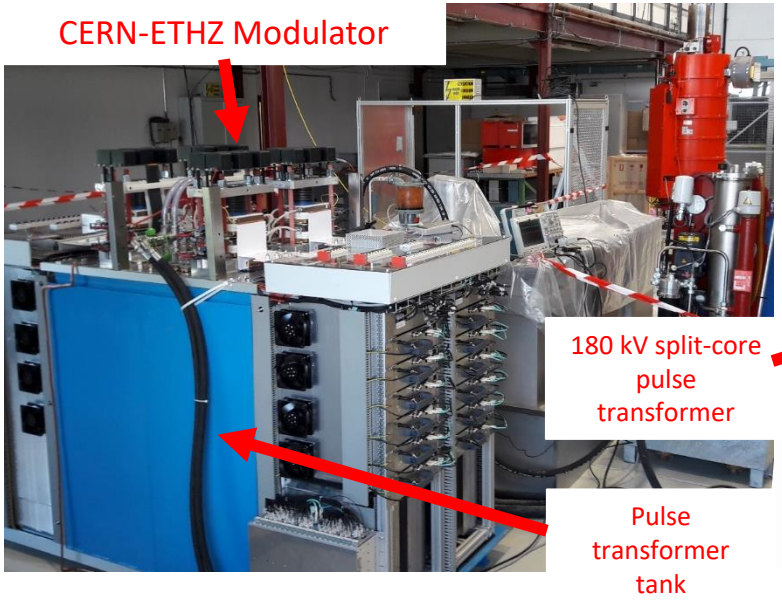
Klystron	L-band	2 GHz	X-band
Prototype price	685 k	454 k	595k
Number of units	470	300	5800
Average price	380 k	260 k	240 k (see Carlo's talk)

Very similar for modulators, learning curve 0.92 based on Industry quotation

Unit price L-band (470 units): 370 kCHF
Unit price 2 GHz (150 units): 420 kCHF

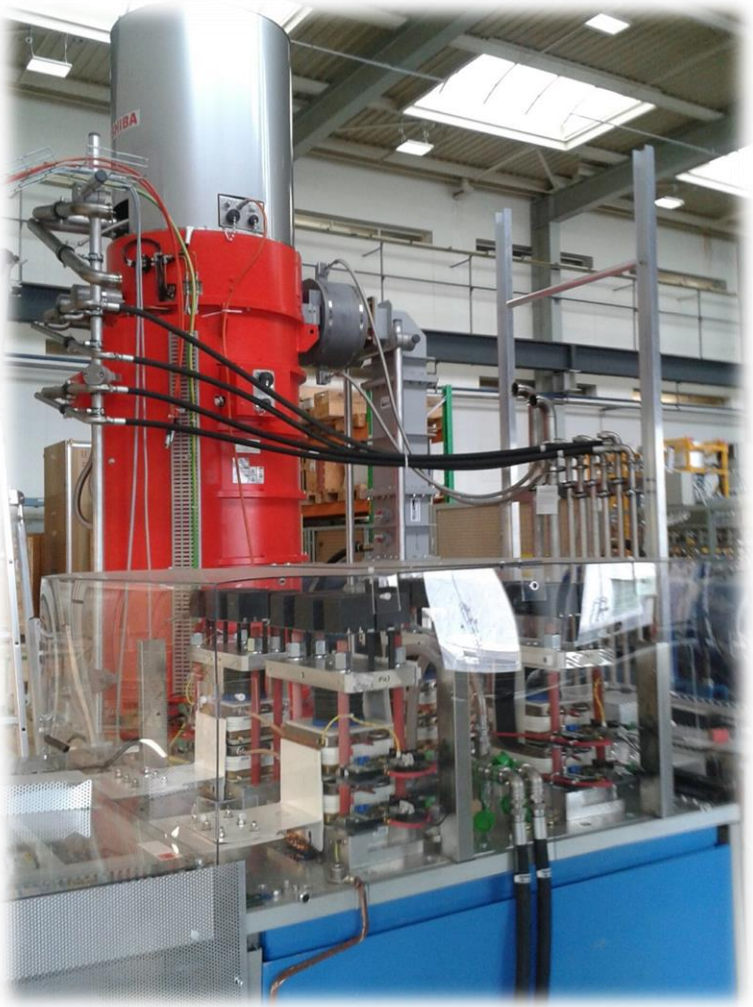
Klystron modulator R&D

- CERN-ETHZ collaboration for design & delivery of a CLIC's Drive Beam klystron modulator
- Modulator installed, tested and ready for commissioning with klystron in building 112
- World *première* for precise 180 kV – 30 MW pulse with 3µs rise/fall times & a "long" flat top (150µs) !
- Pulse stability better than 0.1 % !
- Collaboration with ETHZ successfully ended



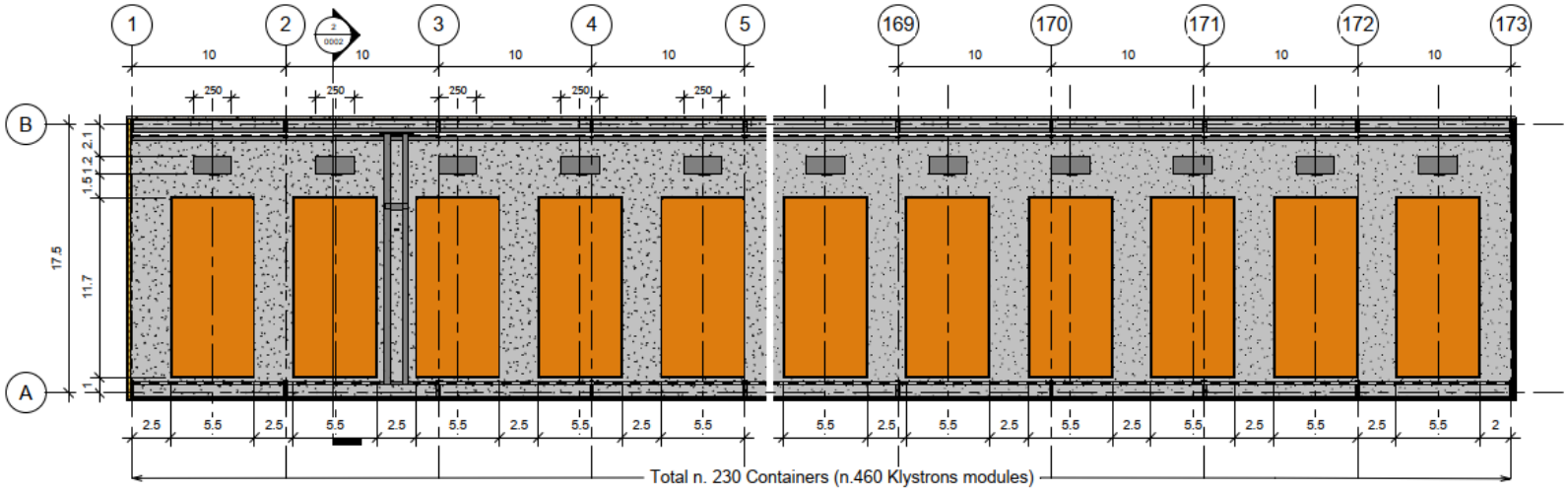
- 4 years of R&D studies achievements:
  - Feasibility to create voltage pulse verified
  - Solutions found to decouple 39 GW of pulsed power from electrical grid
  - Optimal number of powering sectors found (For civil engineering)
  - Optimal grid layout for power distribution proposed
  - Proposal of a new very high repeatable / precise measuring system for high voltage pulses
  - Discovery of excellent R&D partners in Canada, UK, Italy, & Switzerland!

Klystron Test Stand

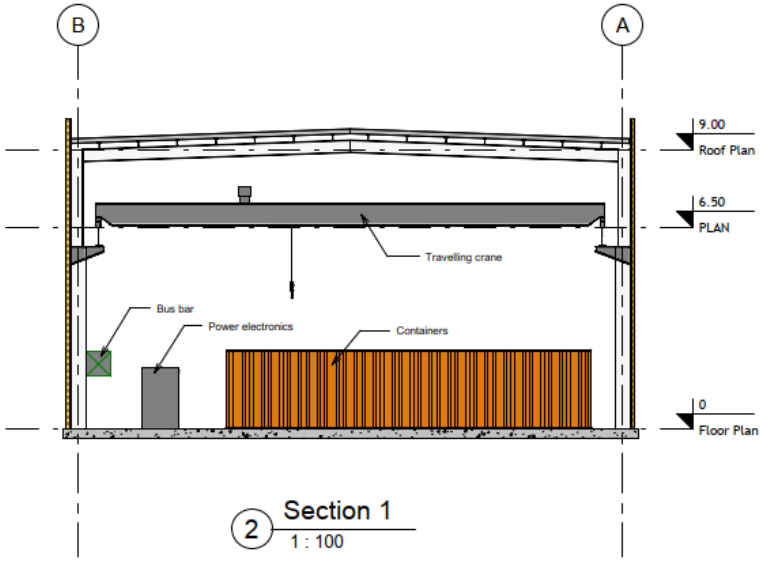


Location: CERN Bldg: 112

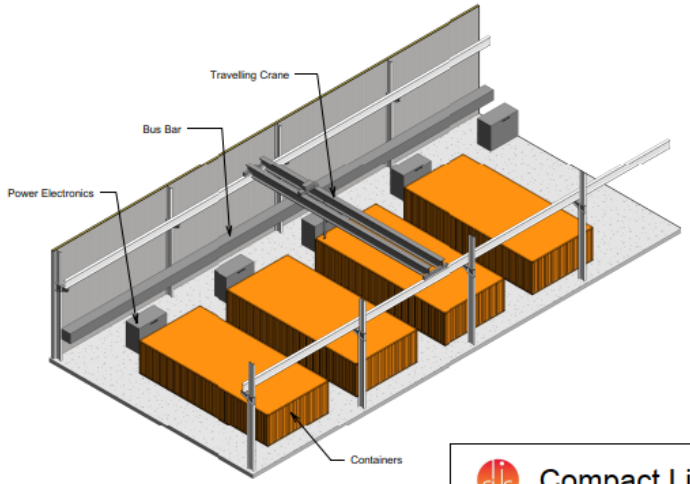
DB LINAC klystron gallery layout



1 PLAN
1 : 200



2 Section 1
1 : 100



3 3D VIEW

Compact Linear Collider

CLIC - DB BUILDING

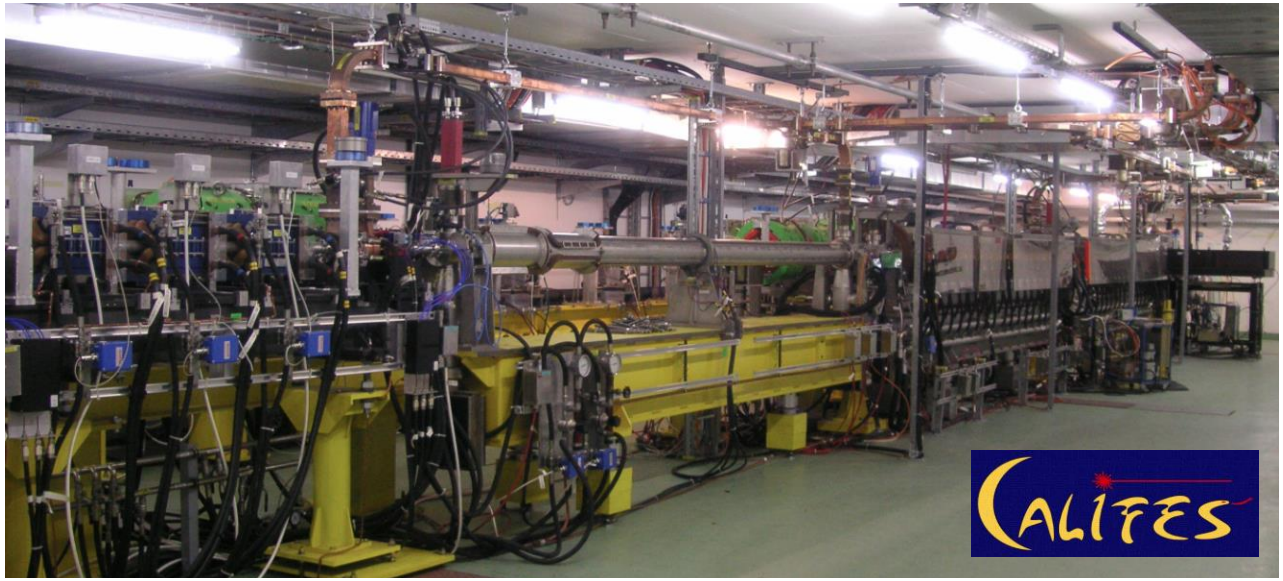
PAOLO SERAFINO
SMB-SE-DOP

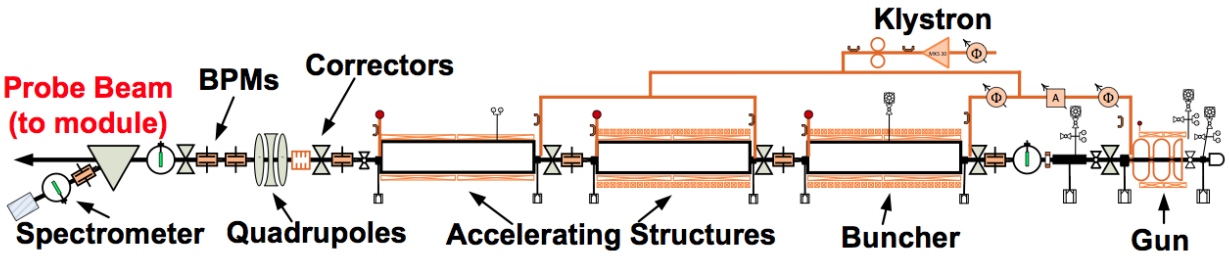
Sc : 1:200/100
V1 - 24/07/2018

Typical injector modulator/klystron system

Contacted company for input to this study
(Integrated system value or material breakdown)

Example of an injector unit





Example of a CLIC main linac module (see Benno talk)

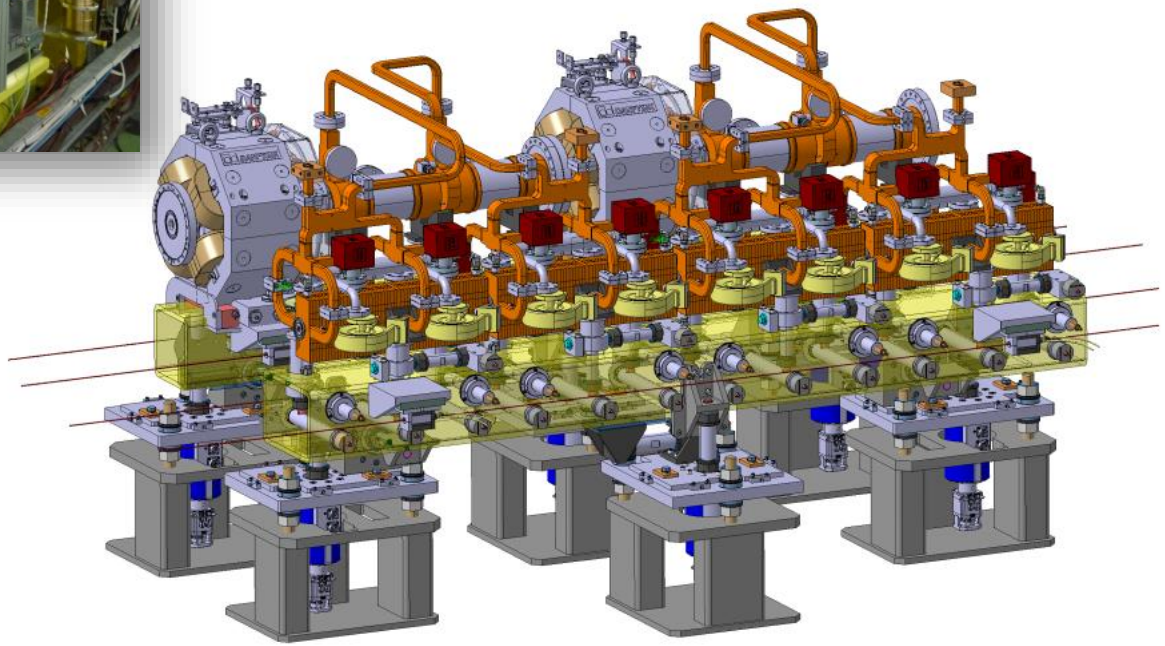


Figure 2: A CLIC Two Beam Module (TBM)

CLIC klystron base module

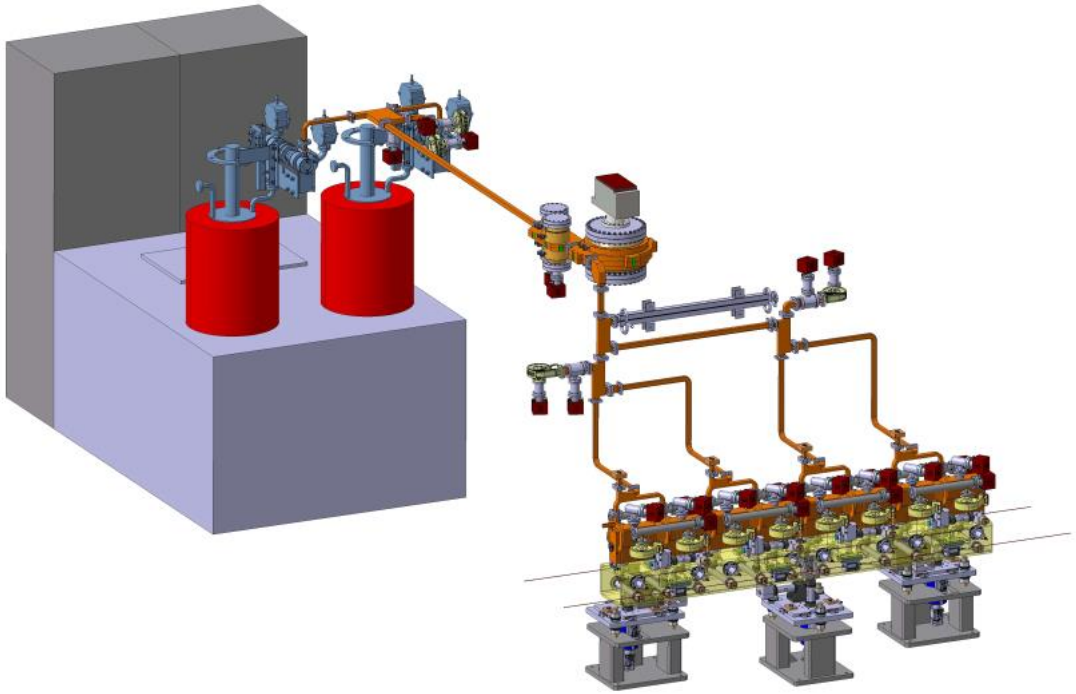


Figure 3: A CLIC Klystron Module

Discussion

- We would like to break down the machine in several sectors with a length and a cross-section, will generate table (see preliminary example below)
- Will provide data of main building blocks either per meter or per unit and number of units.
- Attention some updates needed with respect to shown data

Drawing 1.17999.0002	Type	Length (m) (all to finalised)	Dimension (to be checked)	CE	Shafts and caverns	Surface buildings	Materials	Comments
	ML	7000	5.6	Done	Included in studies made	At shafts and coll. point?	Specify (include turn around)	All CE covered in earlier studies, check surface buildings
	BDS	4000	5.6	Done	Included in studies made		Specify	All CE covered in earlier studies
	Detector(s)	NA		Cavern done	Included in studies made	Surface buiLding?	Specify	Attempt to provide overall material breakdown
DRIVE BEAM INJECTOR COMPLEX AND TRANSFER TO ML TUNNEL	DB	2300	Cut out, give dim	Cut out and building	NA	30x9	Specify	On surface
	DL and CR	1100	Cut out?, 4x3 ?	Cut out? Buildings?	NA	Surface building?	Specify	Understand surface or cut out
	DB transfers until ML tunnel	4500	4x3 and then down	Cut out? Transfer tunnel	NA	Surface building?	Specify	Surfce/cut out and then transfer tunnel
MAIN BEAM INJECTOR COMPLEX	Injectors "active"	900	Surface buildings	Buildings	NA	Surface building	Specify	Buildings (no cut out?)
	Transfer to ML tunnel	3000	4x3 and then down	Same transfer tunnels as DB	NA	Surface building?	Specify	Surfce/cut out and then transfer tunnel
	DR	1200	Cut out?, 4x3	Cut out and/or building	NA	Surface building?	Specify	Building or cut out