SPL STUDY TEAM

SPL STUDY GROUP MEMBERS:

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COLLABORATION:

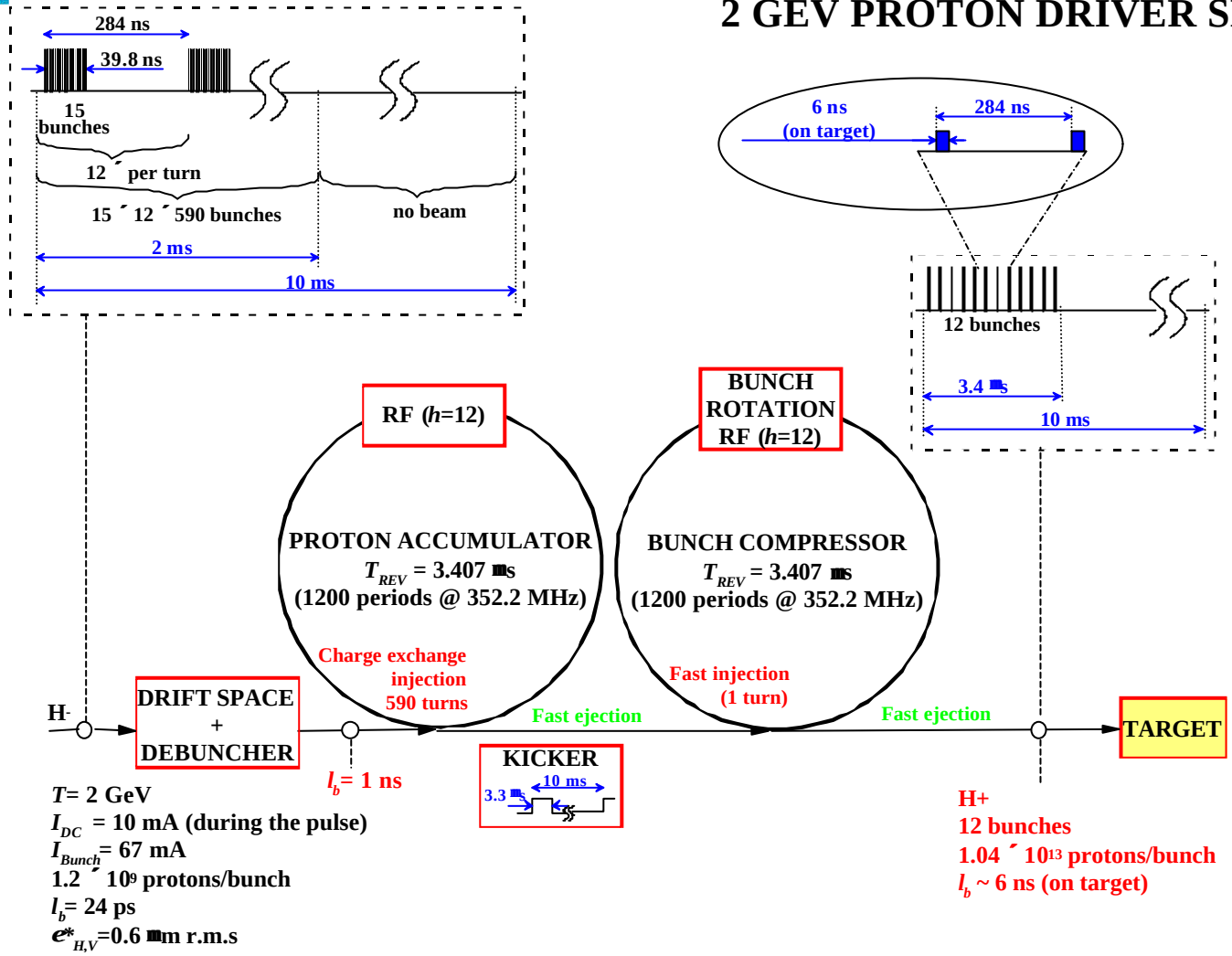
CEA (DAPNIA @ Saclay) - CNRS (IN2P3 @ Orsay & Grenoble)

SPL beam specifications: Case 1

	Parameter	Value	Unit
MEAN PARAMETERS	Ion species	H-	
	Kinetic energy	2	GeV
	Mean current during the pulse	10	mA
	Duty cycle [mean beam power]	20 [4]	% [MW]
	Pulse frequency	100	Hz
	Pulse duration [number of H- per pulse]	2 [1.2 E 14]	ms [H^-/pulse]
FINE TIME STRUCTURE	Bunch frequency [minimum distance between bunches]	352.2 [2.84]	MHz [ns]
	Duty cycle during the beam pulse [number of successive bunches/number of buckets]	15 [15/100]	%
	Number of bunches in the accumulator	12	
	Maximum bunch current [maximum number of charges per bunch]	67 [1.2 E 9]	mA [H^-/bunch]
BUNCH CHARACTERISTICS	Bunch length (total)	~ 1	ns
	Energy spread (total) [relative momentum spread (total)]	~ 0.2 [~ 0.08 E-3]	MeV
	Normalized horizontal emittance (1σ)	0.6	π mm
	Normalized vertical emittance (1σ)	0.6	π mm
	Energy jitter during the beam pulse	Within +- 0.2	MeV
	Energy jitter between beam pulses	Within +- 2	MeV

Accumulator-Compressor scheme for a Neutrino Factory: Case 1

2 GEV PROTON DRIVER SET-UP



T= 2 GeV
I_{DC} = 10 mA (during the pulse)
I_{Bunch}= 67 mA
1.2 ´ 10^9 protons/bunch
l_b= 24 ps
$\varepsilon^*_{H,V}$=0.6 mm r.m.s

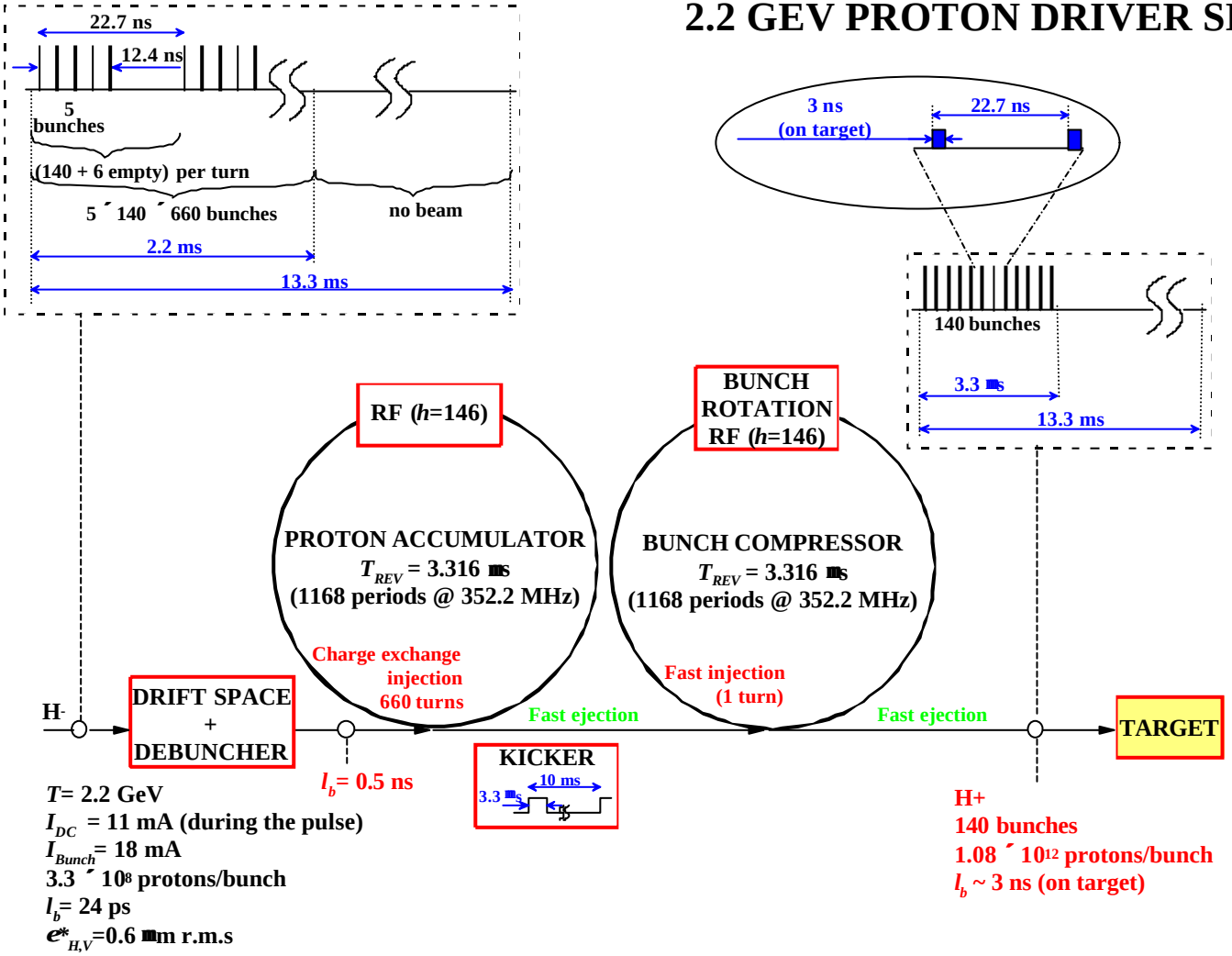
H+
12 bunches
1.04 ´ 10^{13} protons/bunch
l_b ~ 6 ns (on target)

SPL beam specifications: Case 2

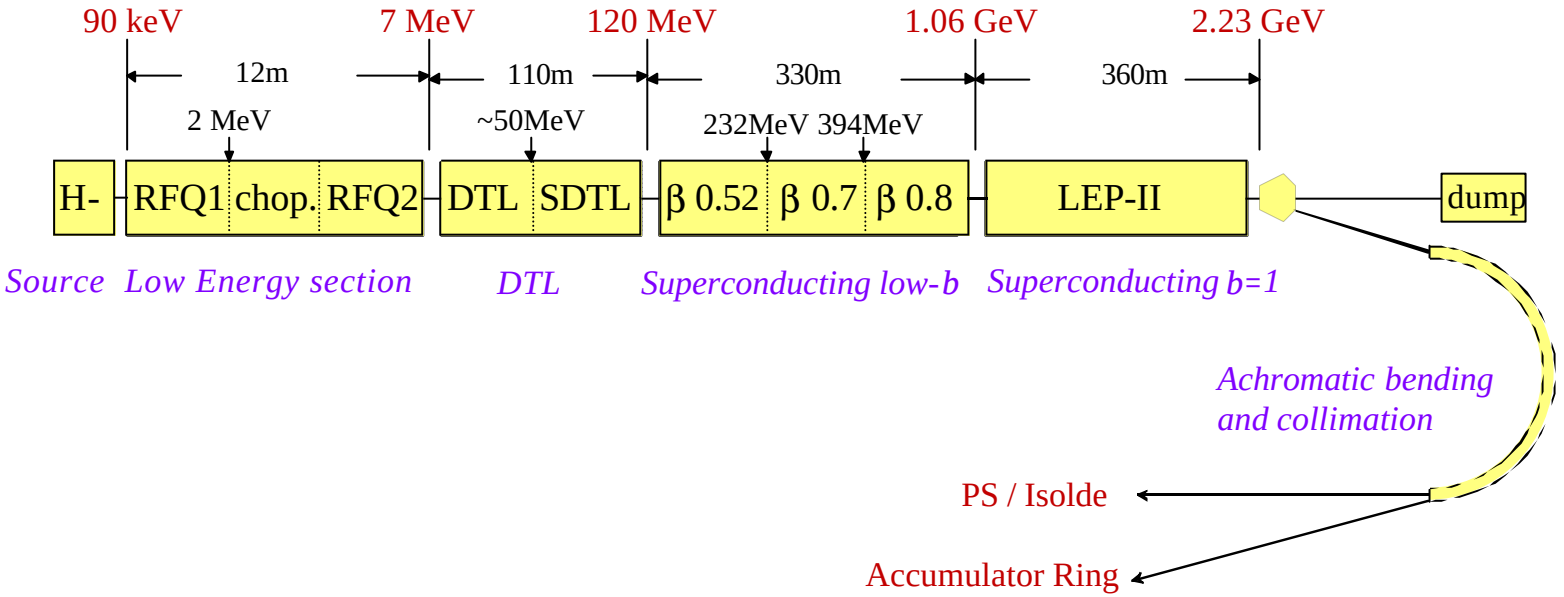
	Parameter	Value	Unit
MEAN PARAMETERS	Ion species	H-	
	Kinetic energy	2.2	GeV
	Mean current during the pulse	11	mA
	Duty cycle [mean beam power]	16.5 [4]	% [MW]
	Pulse frequency	75	Hz
	Pulse duration [number of H- per pulse]	2.2 [1.51 E 14]	ms [H^-/pulse]
FINE TIME STRUCTURE	Bunch frequency [minimum distance between bunches]	352.2 [2.84]	MHz [ns]
	Duty cycle during the beam pulse [number of successive bunches/number of buckets]	61.6 [5/8]	%
	Number of bunches in the accumulator [total number of buckets – empty buckets]	140 [146-6]	
	Maximum bunch current [maximum number of charges per bunch]	18 [3.3 E 8]	mA [H^-/bunch]
BUNCH CHARACTERISTICS	Bunch length (total)	~ 0.5	ns
	Energy spread (total) [relative momentum spread (total)]	~ 0.4 [~ 0.16 E-3]	MeV
	Normalized horizontal emittance (1σ)	0.6	π mm
	Normalized vertical emittance (1σ)	0.6	π mm
	Energy jitter during the beam pulse	Within +- 0.2	MeV
	Energy jitter between beam pulses	Within +- 2	MeV

Accumulator-Compressor scheme for a Neutrino Factory: Case 2

2.2 GEV PROTON DRIVER SET-UP



SPL layout


90 keV
7 MeV
120 MeV
1.06 GeV
2.23 GeV
12m
110m
330m
360m
2 MeV
~50MeV
232MeV
394MeV
H-
RFQ1
chop.
RFQ2
DTL
SDTL
β 0.52
β 0.7
β 0.8
LEP-II
dump
Source
Low Energy section
DTL
Superconducting low-b
Superconducting b=1
Achromatic bending
and collimation
PS / Isolde
Accumulator Ring

Basic Sections Parameters

Section	Out. Energy [MeV]	Frequency [MHz]	No. Cavities	RF Power [MW]	No. Klystrons	Length [m]
RFQ1	2	*352.2*	1	0.5	1	2.5
RFQ2	*7*	352.2	1	0.5	1	4
DTL	*120*	352.2	35	7.0	(6)*	110
SC β=0.52	*232*	352.2	42	1.2	(6)*	95
SC β=0.70	*394*	352.2	36	1.8	(5)*	85
SC β=0.80	1060	352.2	48	7.3	12	148
SC - LEP II	2235	352.2	116	12.9	15	357
TOTAL			279	31.2	29 (+17)	~ 802

* Under investigation: power tetrodes could be preferred to help the operation of field regulation loops and improve beam stability

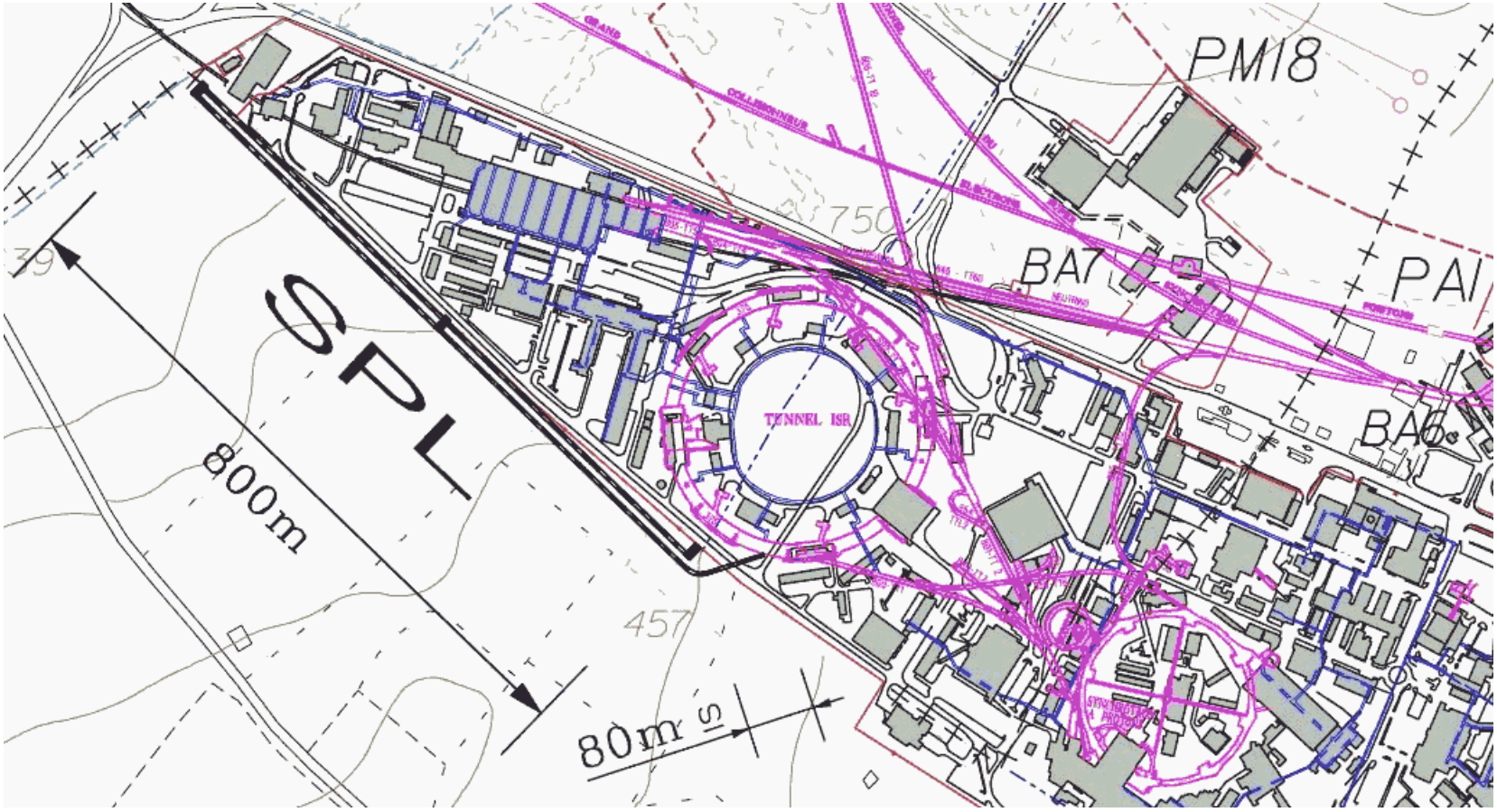
RF and Superconducting cavities Parameters

Section	design beta	Gradient [MeV/m]	N. of cells/cavity	Cryostat length [m]	Input Energy [MeV]	Output Energy [MeV]	N.of cavities	N.of cryostats	N.of klystrons	RF Power [MW]	Length [m]
1	0.52	3.5	4	5.76	120	232	42	14	(6)	1.2	95
2	0.70	5	4	8.46	232	394	36	9	(5)	1.8	85
3	0.80	9	5	11.29	394	1060	48	12	12	7.3	148
4	1	7.5	4	11.29	1060	2235	116	29	15	12.9	357
TOTAL							272	68	27 (+11)	23.2	615.6

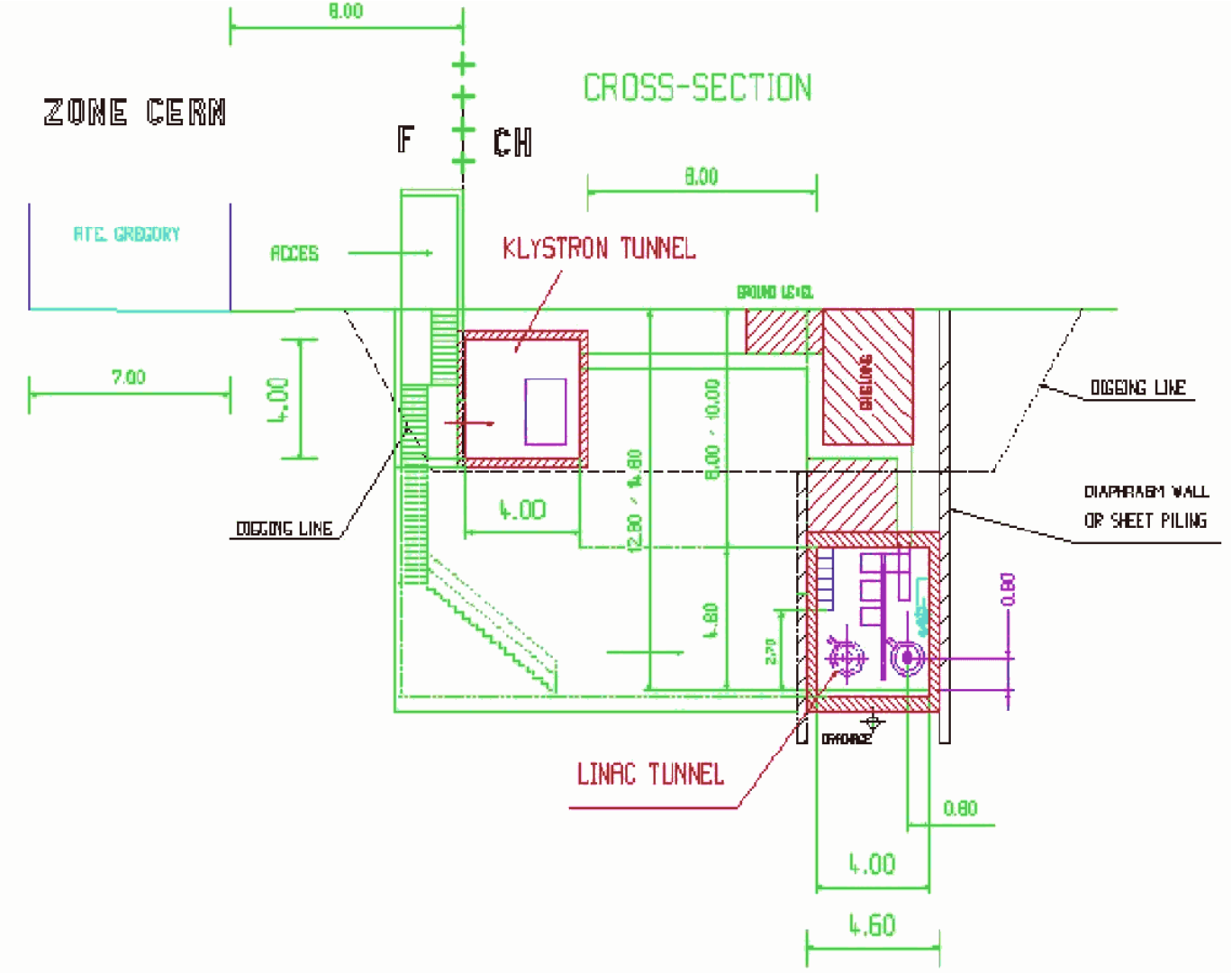
NOTES:

- distance between cryostats (for focusing doublets) is 1 m all along the linac
- sections 1 and 2: power tetrodes could be preferred to help the operation of field regulation loops and improve beam stability
- section 3: 4 cavities/klystron
- section 4: 8 cavities/klystron
- gradient in section 4 adjusted for a maximum klystron power of 860 kW

Sketch of a possible layout (top view)



Sketch of a possible layout (cross section)



Themes under study

ITEM	MAIN THEME	CONTRIBUTORS
H- source (30 mA pulsed)	20 % duty cycle & low emittances	C. Hill, D. Kuchler
Chopper	Rise time ~ 1 ns	F. Caspers, F. Gerigk, M. Paoluzzi
RFQ(s)	20 % duty cycle & emittances preservation	A. Lombardi, M. Vretenar
DTL	20 % duty cycle & emittances preservation	M. Vretenar, F. Gerigk
SC – reduced b	- High power test beta=0.8 - Multi-cell beta=0.7 - Mono-cell beta=0.52	R. Losito, E. Chiaveri
Klystrons Power Converters	Minimise peak and reactive power for mains	A. Krusche
SC – LEP 2	Maximum gradient	R. Losito, E. Chiaveri
Servo-systems for pulsed operation of SC cavities	Field stabilisation in the presence of microphonics	J. Tuckmantel
Debunching	Increase bunch length to 0.5 ns	F. Gerigk, K. Bongardt
Beam dynamics	Optics design, particle tracking Halo and distributed losses	K. Bongardt, A. Lombardi, F. Gerigk, M. Vretenar
Cryogenics	Infrastructure definition	R. Losito
Services (electricity, cooling water etc.)	Infrastructure definition	M. Poehler (coordinator)
Radio-protection	Safety	M. Silari
Lay-out & civil engineering	Siting	M. Poehler (coordinator)
Coordination with users – Refinement of specs.	- PS complex improvement - ISOLDE improvement - Neutrino Factory and Proton Driver	R. Cappi, R. Garoby M. Lindroos, H. Ravn B. Autin, R. Cappi, R. Garoby, H. Haseroth, A. Lombardi, H. Schonauer, R. Scrivens

Planning

AIM	DEADLINE	OUTPUT
Refinement of the design of a 4 MW SPL matching the specs. of the 2 GeV Accumulator/compressor set-up (« PDAC ») including the lay-out on the CERN site	May 2000	- Contribution to « nFact'2000 » - Data for paper on NFWG work at « EPAC2000 » - Data for paper on PDAC design at « EPAC2000 »
Conceptual design of a 2 GeV SPL on the CERN site	July 2000	- CERN yellow report - Contribution to « LINAC2000 »
SPL cost estimate (352 MHz option)	October 2000	Special note
Analysis of a 704 MHz option for the SPL	November 2000	Report
SPL cost estimate (704 MHz option)	December 2000	Special note