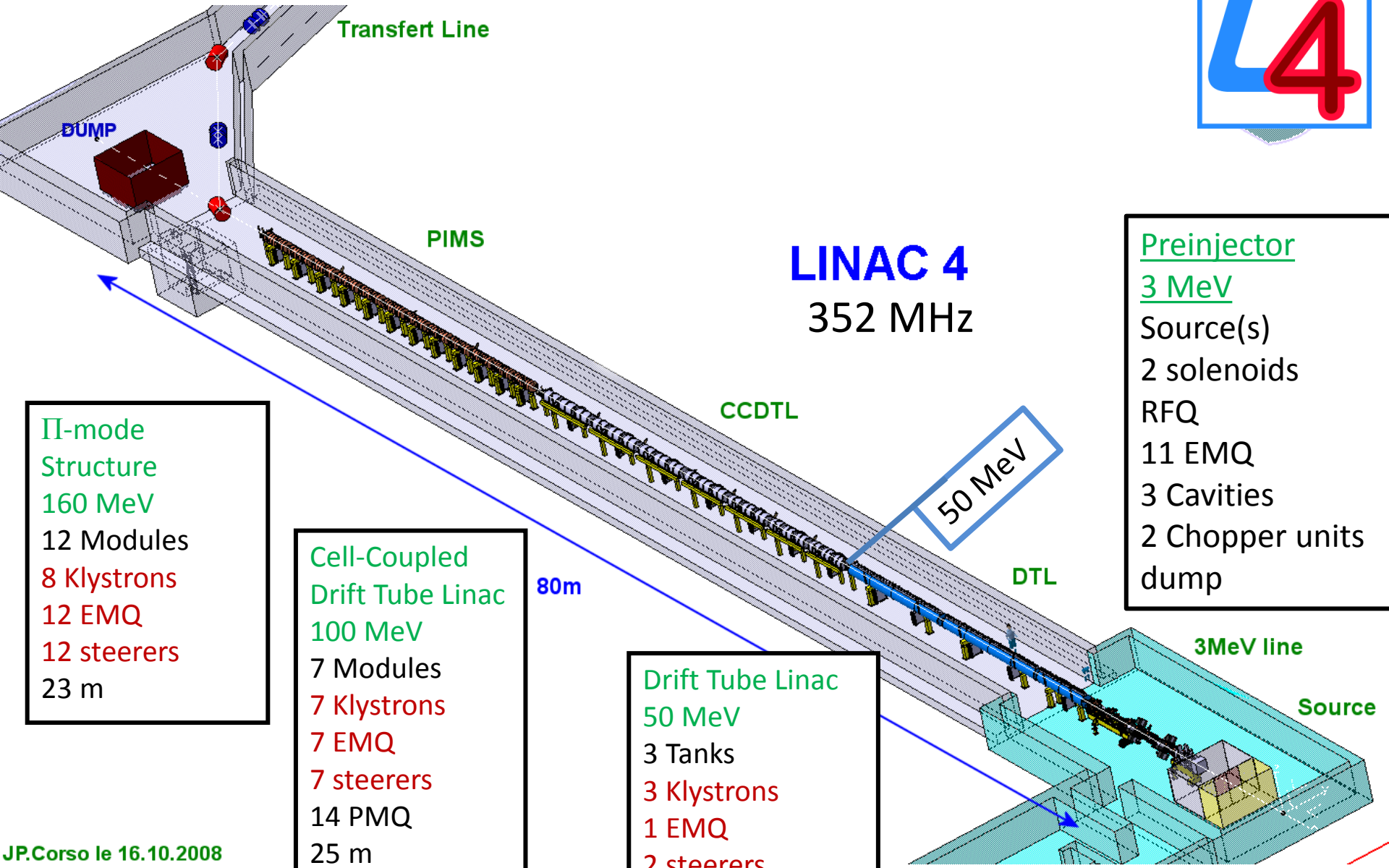
Linac4 : Commissioning, back-up for Linac2 and connection to PSB.

Alessandra Lombardi

on behalf of the LINAC4 team



Preinjector
3 MeV
Source(s)
2 solenoids
RFQ
11 EMQ
3 Cavities
2 Chopper units
dump

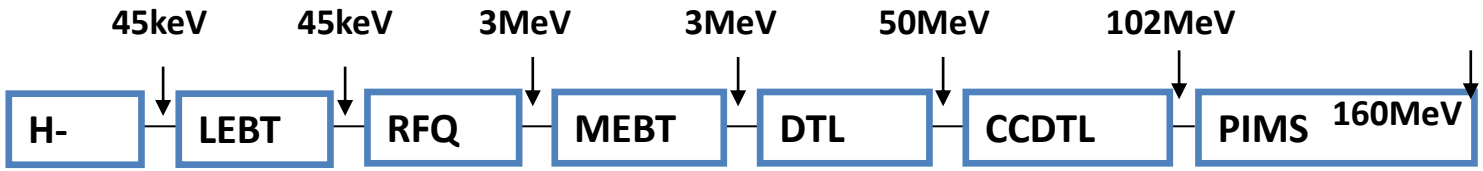
Π-mode
Structure
160 MeV
12 Modules
8 Klystrons
12 EMQ
12 steerers
23 m

Cell-Coupled
Drift Tube Linac
100 MeV
7 Modules
7 Klystrons
7 EMQ
7 steerers
14 PMQ
25 m

Drift Tube Linac
50 MeV
3 Tanks
3 Klystrons
1 EMQ
2 steerers
114 PMQ
19 m

JP.Corso le 16.10.2008

Layout of LINAC4



	Low Energy beam transport 2 solenoid 1.8 m	Radio Frequency Quad. 352.2MHz 3 m	MEBT 11 EMQ 3 Cavities 2 Chopper units. 352.2MHz 3.9 m	Drift Tube Linac 3 Tanks 114 PMQ 1 EMQ 352.2MHz 19 m	Cell-Coupled Drift Tube Linac 7 Modules 7 EMQ 14 PMQ 352.2MHz 25 m	Π-mode Structure 12 Modules 12 EMQ 352.2MHz 22.9 m
	Temporary assembled. Final by June 2012.	**2/3 ready. Completion June 2012**	**Assembled**	**Tank1 being assembled. Completion June2013**	**1 module ready. Completion June 2013**	**1 module ready Completion Dec 2013**

- Up to 3 MeV “charge insensitive”
- In the MEBT line we have to respect the chopping dynamics
- We need to match to a permanent focusing channel in the DTL and CCDTL

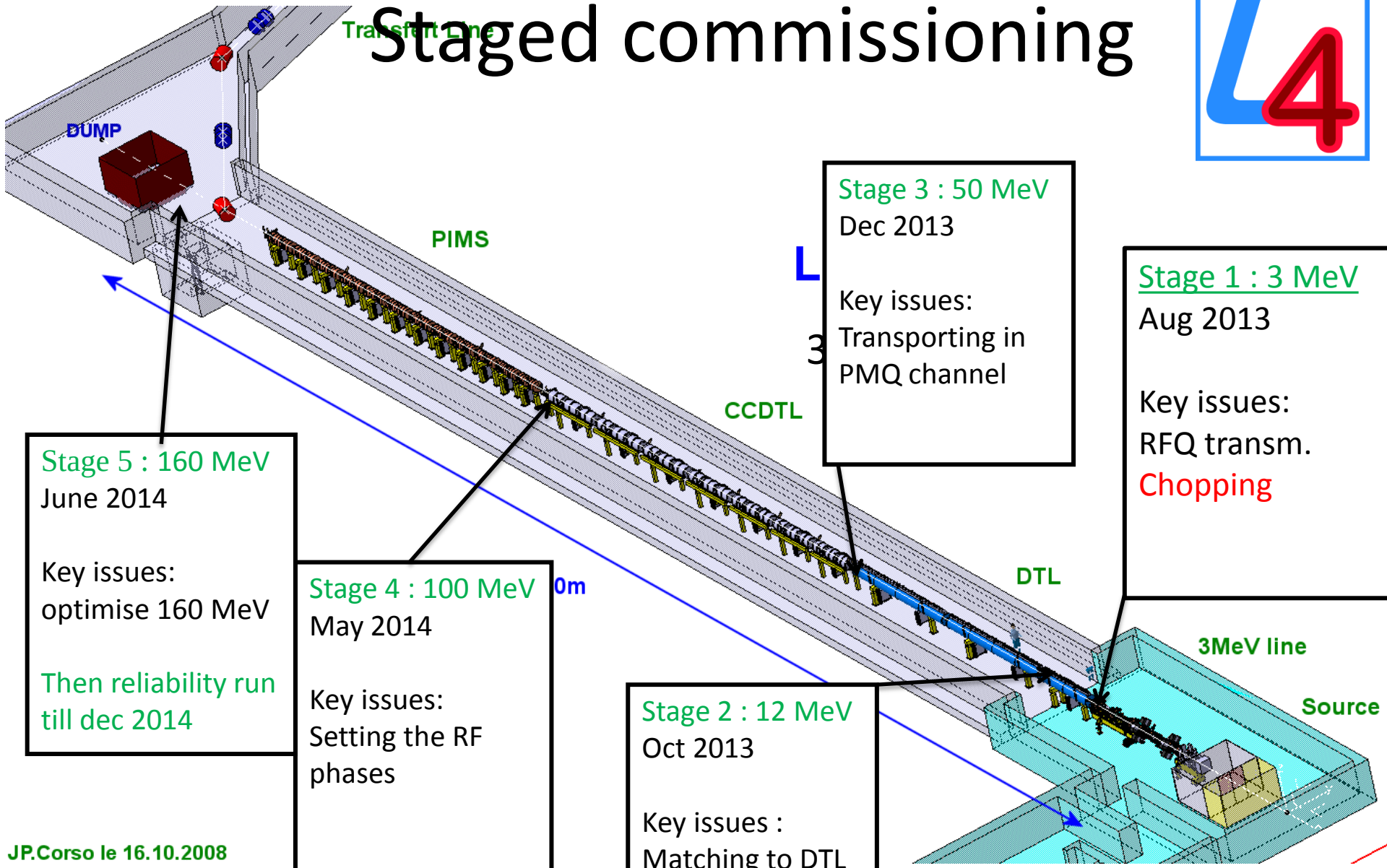
“The source(s)”

TARGET: 40 (min)-80 mA; 400 µsec ; emitt=0.25 π µm rms norm at RFQ input; 45keV (±2kev)

WPIS H^- Ion source: staged approach, 2 units each *+ spare*

	#1 Volume source	#2 Surface source	#3 Magnetron
Operational experience H^- current	DESY 30 mA	SNS 50 mA	BNL 80 mA
Plasma Heating process	2 MHz RF Ext. antenna	2 MHz RF Int. & Ext. antenna	Arc discharge
Cesiation		Cs-chromate Single deposition:	Cs metal Constant flow
Cs-Oven test stand		Nov. 2011	Nov. 2011
Electron / H^- ratio	10-100	10	0.5 - 1
45 keV beam available	**aug 2012**	**mid 2013**	**after 2015**

Staged commissioning



Stage 5 : 160 MeV
June 2014

Key issues:
optimise 160 MeV

Then reliability run till dec 2014

Stage 4 : 100 MeV
May 2014

Key issues:
Setting the RF phases

Stage 2 : 12 MeV
Oct 2013

Key issues :
Matching to DTL

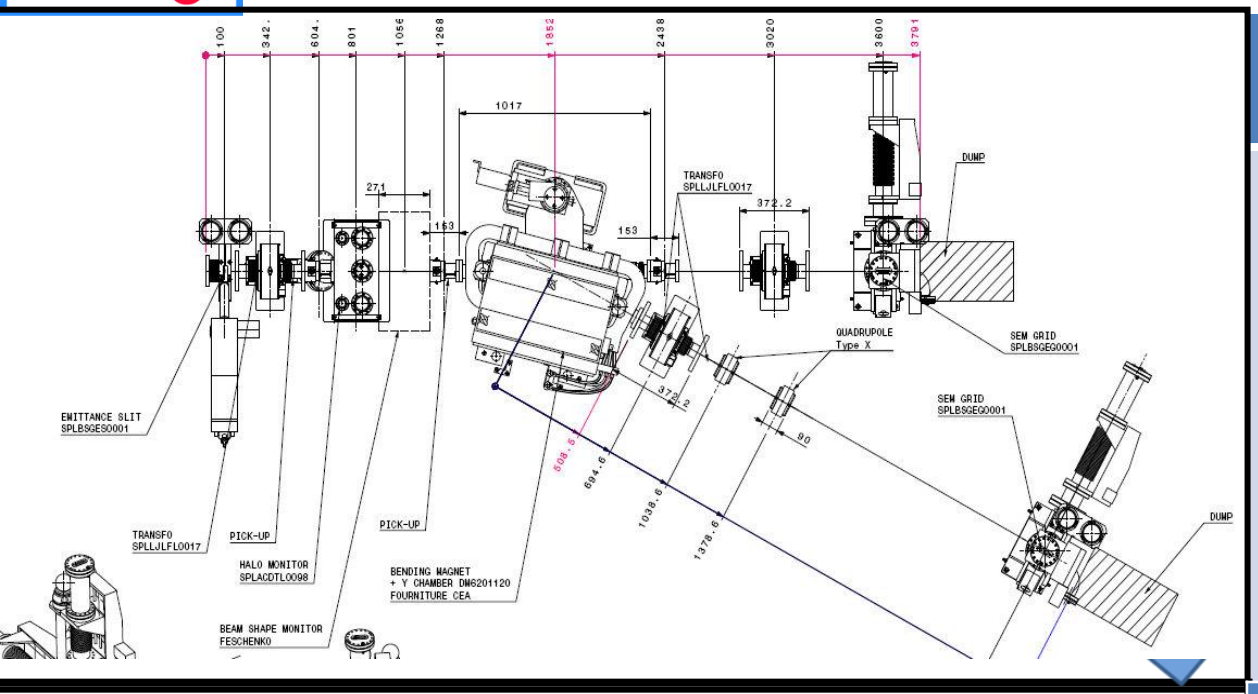
Stage 3 : 50 MeV
Dec 2013

Key issues:
Transporting in PMQ channel

Stage 1 : 3 MeV
Aug 2013

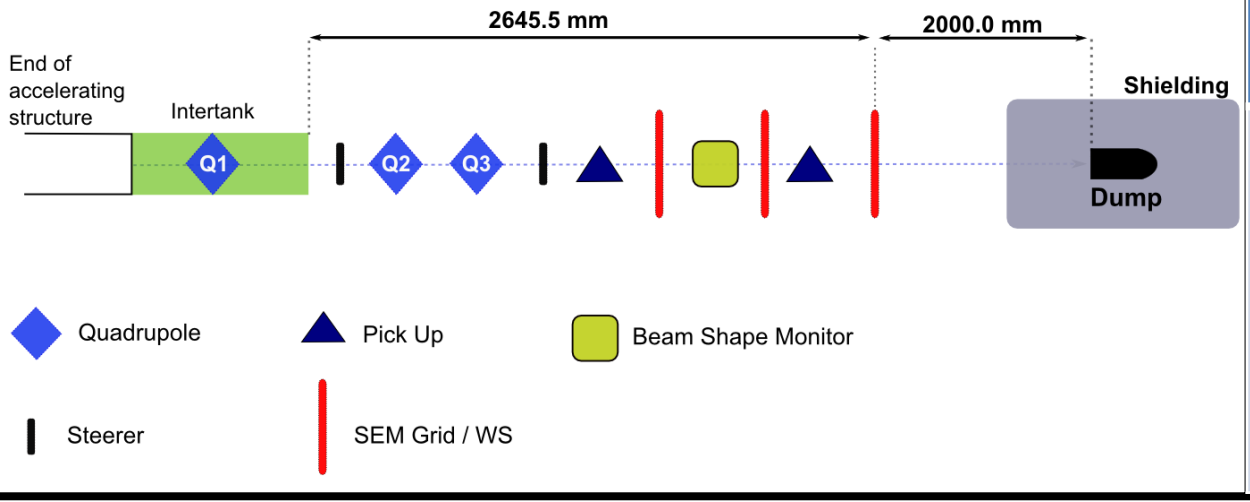
Key issues:
RFQ transm.
Chopping

Movable Temporary Benches



Low energy bench (stage 1-2) – Sept 2012

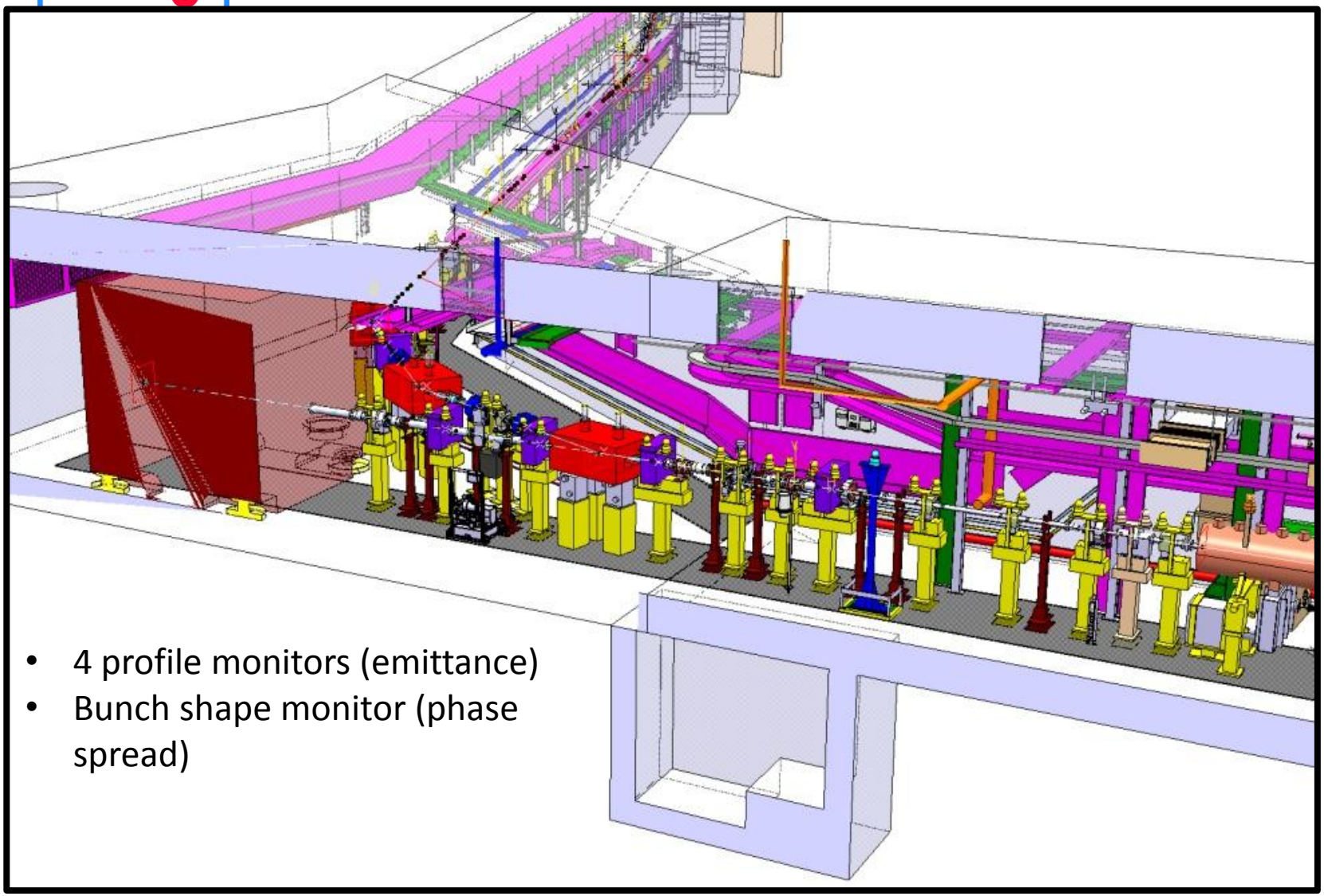
Spectrometer (0.2 %)
Slit and Grid Emittance
ToF (calibration)
Bunch Shape Monitor
Halo Monitor (chopping eff.)



Medium energy bench (stage 3-4) – Oct 2013

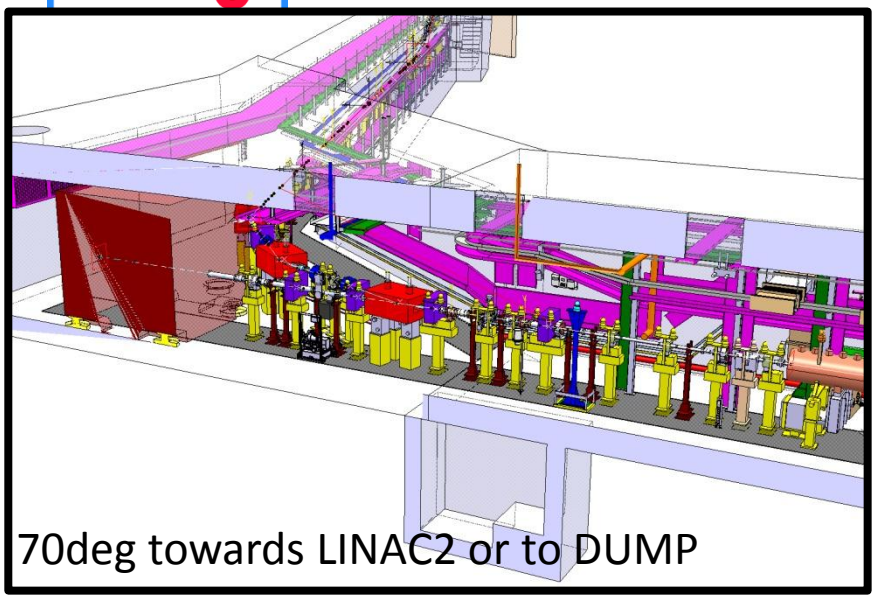
ToF (0.1 %)
Emittance via Profiles
Bunch Shape Monitor

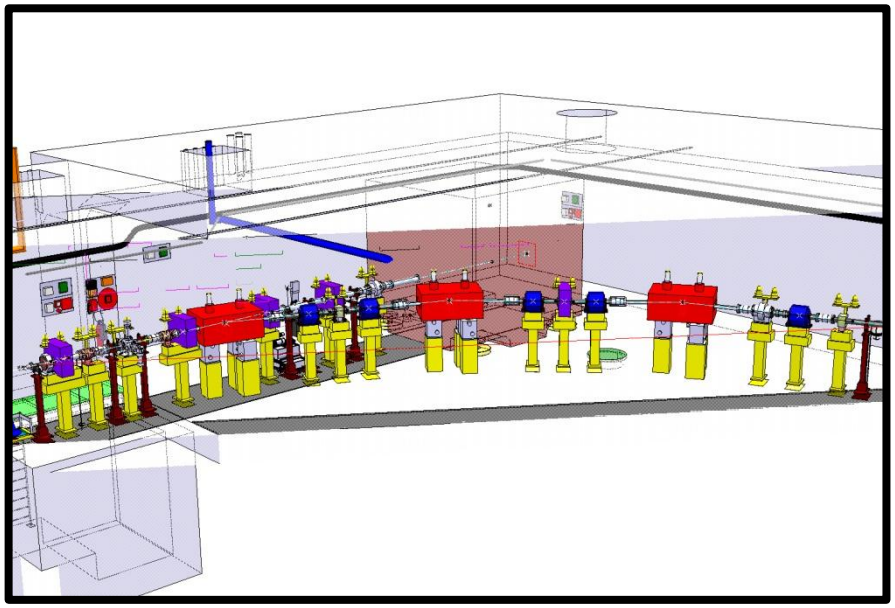
Permanent Measurement Line

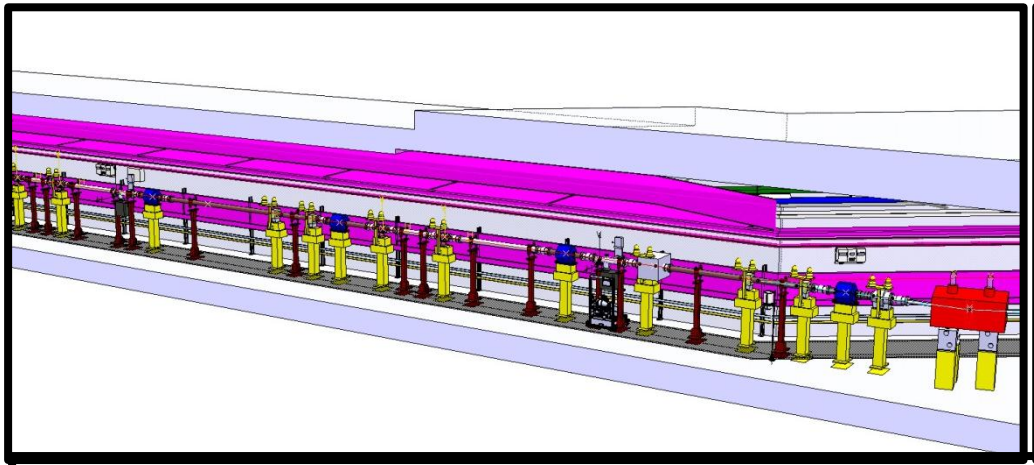


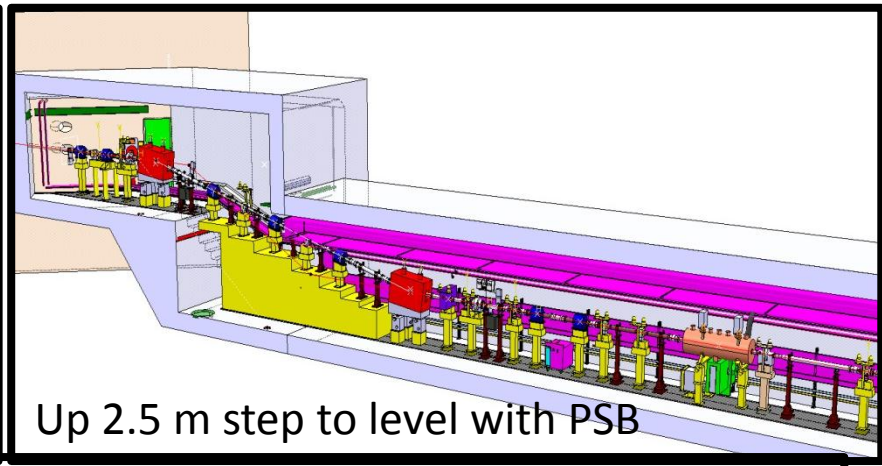
- 4 profile monitors (emittance)
- Bunch shape monitor (phase spread)

Transfer Line









About 30 quads; 1 Rf cavity, 5 bendings, 10 steerers – elements ready in house by 2014.

What needs to be set

		EFFECT ON
Focusing	LEBT solenoids (2)	Intensity and Transverse Emittance
	MEBT quadrupoles (11)	Chopping efficiency
	DTL CCDTL PIMS quads (22)	Intensity
	Transfer Line quadrupoles (15+18)	Intensity , Matching and Dispersion
Steering	Steerers hor and vert (36)	Intensity
RF	Phase and Amplitudes (22)	Energy, energy spread

TOTAL of some 120 parameters

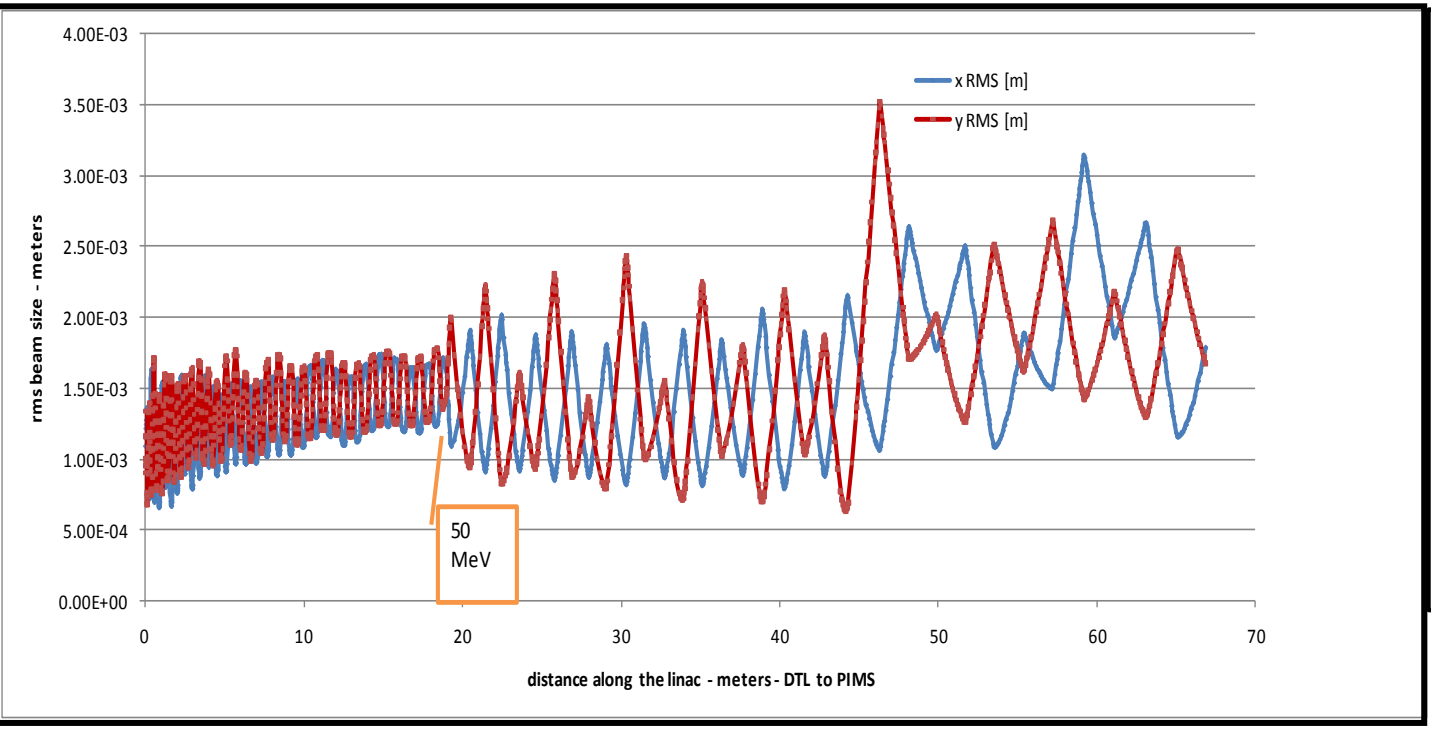
Nominal Beam at PSB

Intensity	40 mA (after chopping)
Transverse	E= 0.3-0.4 pi mm mrad norm rms Alpha= 0 Beta x = 5,2.5,10 m Beta y = 4,2,8 m Dispersion = 0 or 1.2 m
Longitudinal	±100 keV rms energy spread (100-800 KeV possible) 160 MeV ± 1.2 MeV (dynamically over 20 µsec)
Chopped	1 µsec for the distributor rise time 1 MHz frequency of the PSB (cut 100/352) as low as just letting few µbunches (50 nsec)

What if…we need 50MeV p

- Need DTL + CCDTL module 4 + all the quadrupoles – not before end 2014
- Switch the source to P mode and complete installation new transfer line
- Reposition BHZ20

1-2 months



E = 0.28 pi rms norm

DW=100 keV (1rms)

40 mA

50MeV

400 µsec

Linac4 vs. Linac2

on 50 MeV protons

	energy	current	Pulse length (4rings)	Emittance (rms mm mrad)	Energy spread (rms –keV)
LINAC4	50MeV	40 mA	400μs	0.3	250 100 (CCDTL mod4)
LINAC2	50 MeV	160mA	100μs	1	160 (measured 3/2011)
		Current in linac4 is limited by the klystron (beam loading)	Present distributor is limited to 15 turns (100μs)	We could profit from smaller emittance	

From PSB studies (VR,BM,CC) : Brilliance in the PBS 65% of nominal

Take the LINAC4 beam as last resort!

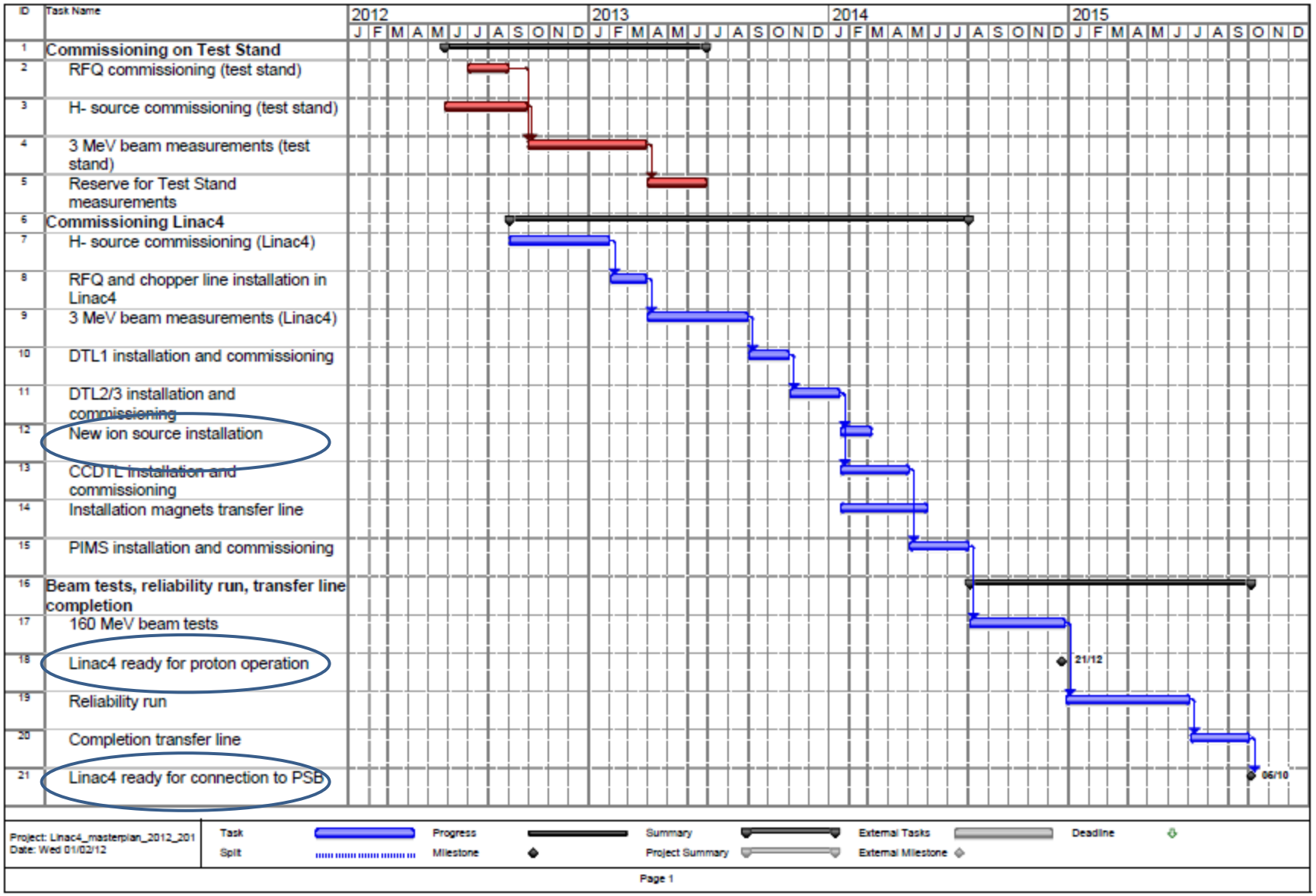
Comparison Linac4-Linac2

on what they are designed to deliver to PSB

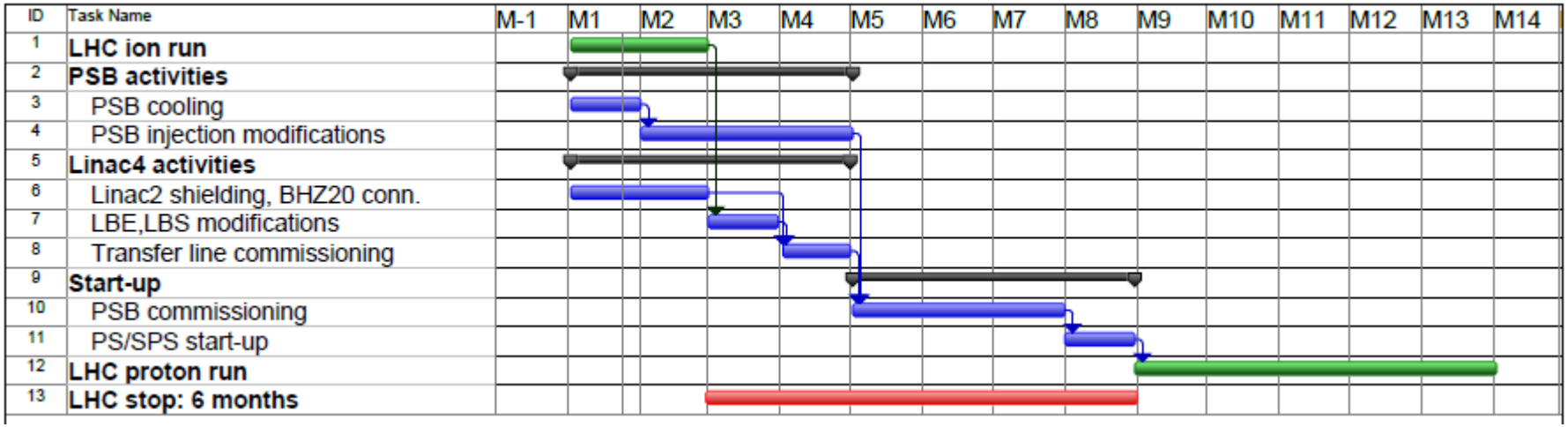
	energy	current	Pulse length (4rings)	Emittance (rms mm mrad)	
LINAC4	160MeV	40 mA	400μs	0.3	Chopped , H
LINAC2	50 MeV	160mA	100μs	1	

1. Lower emittance from the LINAC4, charge exchange injection allow for tailoring the emittance in the PSB
2. H- and chopping : lossless injection
3. Longer pulse , higher energy and lower current

take the beam as soon as it is available (stable and reliable) !


ID
Task Name
2012
2013
2014
2015
J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D
1 Commissioning on Test Stand
2 RFQ commissioning (test stand)
3 H- source commissioning (test stand)
4 3 MeV beam measurements (test stand)
5 Reserve for Test Stand measurements
6 Commissioning Linac4
7 H- source commissioning (Linac4)
8 RFQ and chopper line installation in Linac4
9 3 MeV beam measurements (Linac4)
10 DTL1 installation and commissioning
11 DTL2/3 installation and commissioning
12 New ion source installation
13 CCDTL installation and commissioning
14 Installation magnets transfer line
15 PIMS installation and commissioning
16 Beam tests, reliability run, transfer line completion
17 160 MeV beam tests
18 Linac4 ready for proton operation
19 Reliability run
20 Completion transfer line
21 Linac4 ready for connection to PSB
21/12
06/10
Project: Linac4_masterplan_2012_201
Date: Wed 01/02/12
Task
Split
Progress
Milestone
Summary
Project Summary
External Tasks
External Milestone
Deadline
Page 1

Connection to PSB



Need 8 months / LHC stop of 6 months
Ready from 2015 (Linac4 must be already commissioned)

Summary

- Plan for commissioning LINAC4 in 5 stages with two temporary measurement benches.
- The present schedule foresees end of commissioning by 2014, followed by a 9 months reliability run
- From October 2015 LINAC4 can be connected to the PBS
- Need a shutdown of 8 months for the connection