LINAC4 STATUS

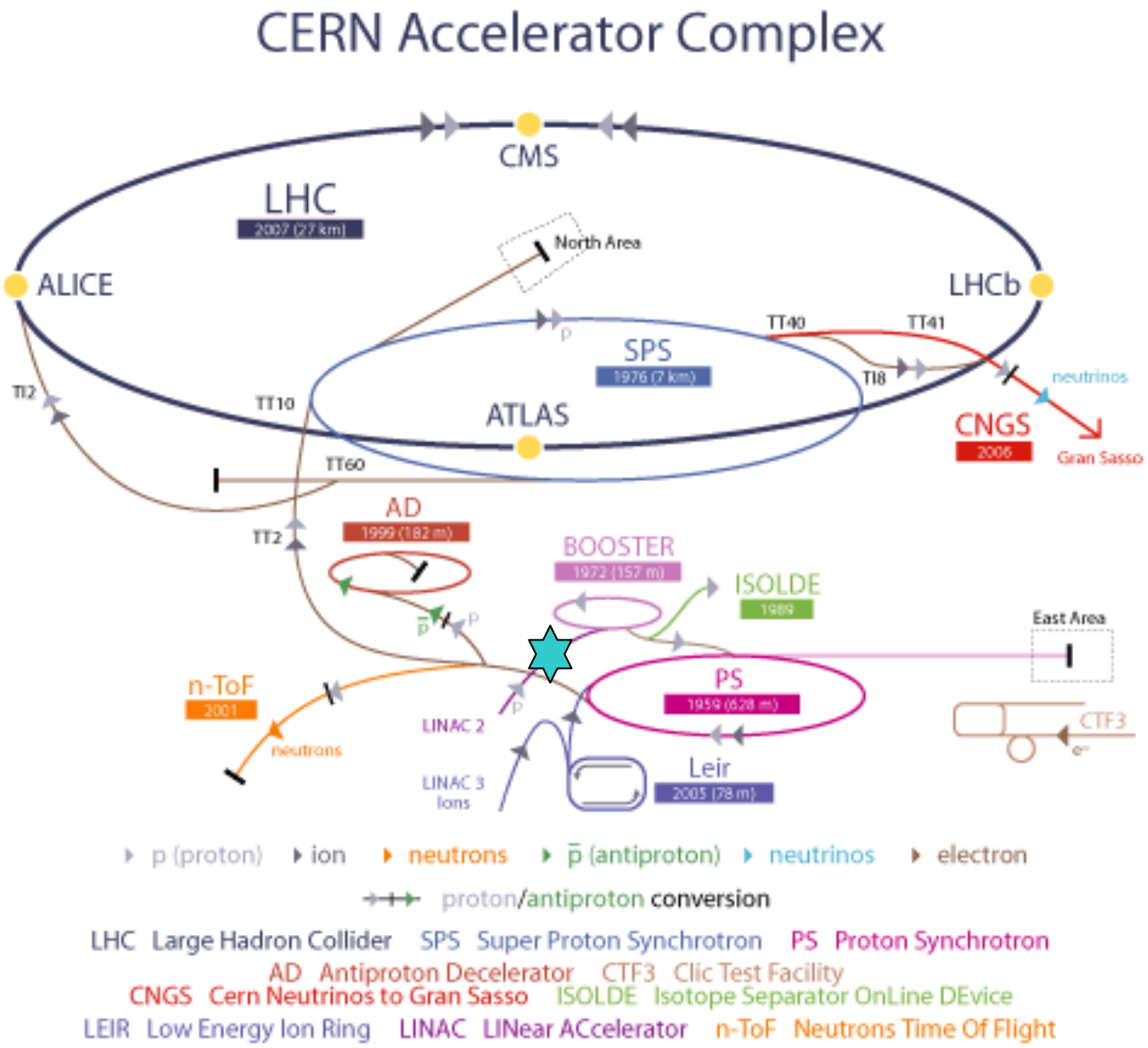
Alessandra M. Lombardi
for the LINAC4 team

In its June 2007 session the CERN Council has approved the White Paper "Scientific Activities and Budget Estimates for 2007 and Provisional Projections for the Years 2008-2010 and Perspectives for Long-Term", which includes construction of a 160 MeV H- linear accelerator called LINAC4.

1. Motivation and goals
2. Status of Linac4 2 years after official start of the project (1.1.2008)
3. Milestones and masterplan

Present

First Limitation to the intensity in the proton accelerator chain is the space charge tune shift at the PSB injection: 50 MeV protons from Linac2

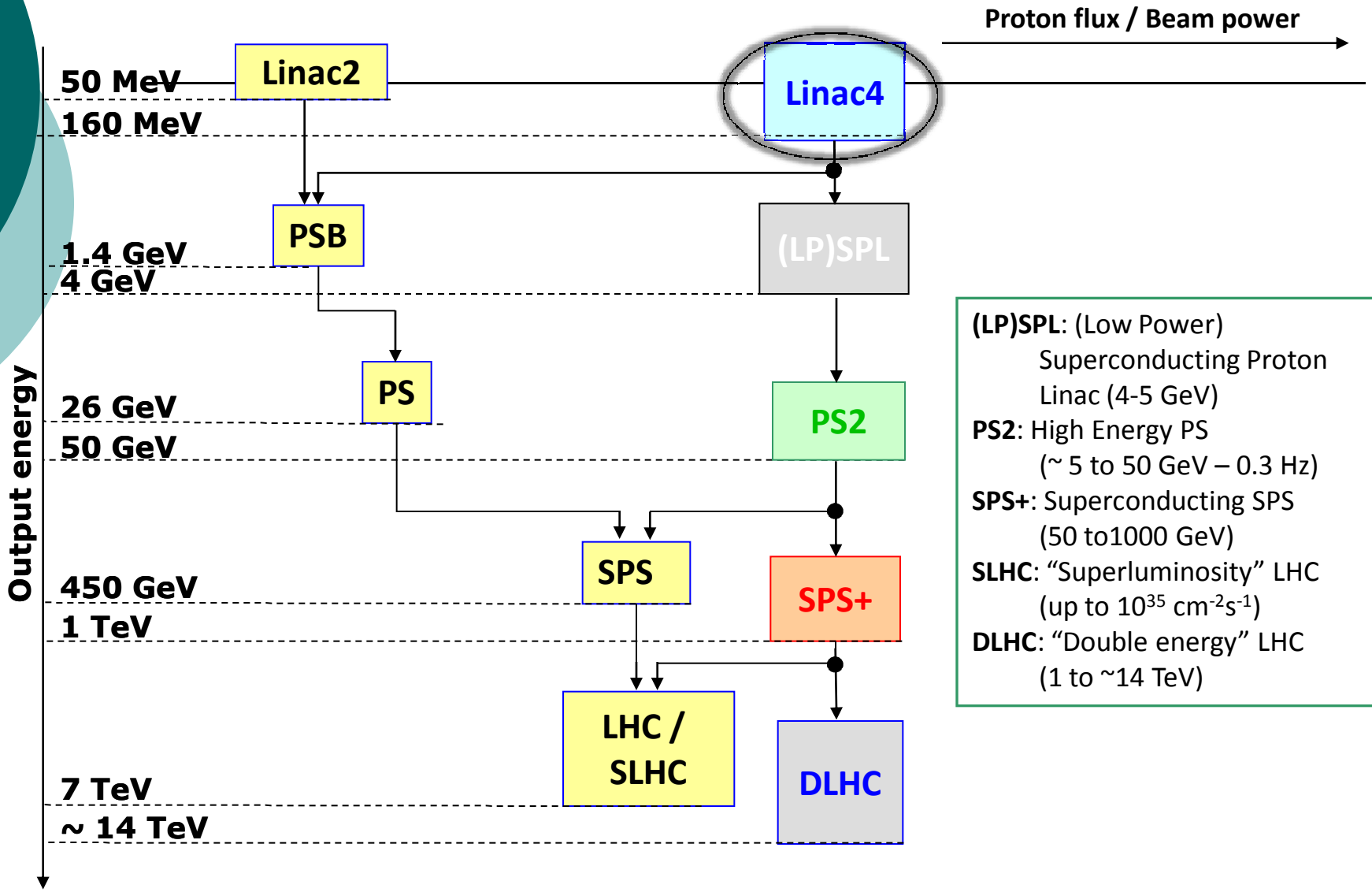


Linac4 (2008-201x)

Beam at 160 MeV in 2013; connection to PSB in 2014-15

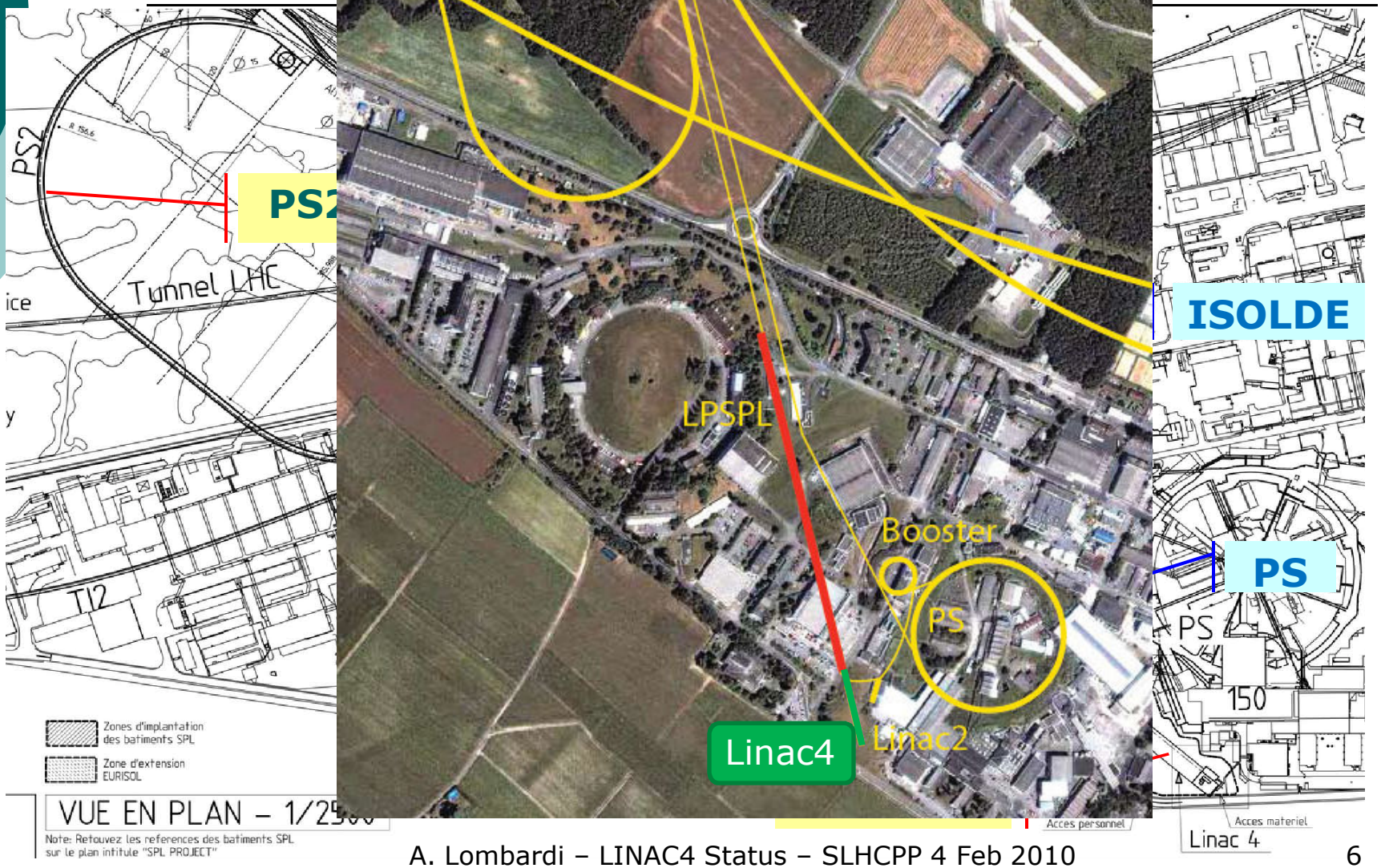
LINAC4 parameters		
Ion species	H^-	Charge exchange injection
Output kinetic energy	160 MeV	Halves the space charge detuning at PSB injection, allows single batch transfer PSB-PS
Bunch frequency	352.2 MHz	LEP klystrons
Max. repetition rate	1.1 (2) Hz	Ready for LP-SPL operation : can work as injector to a low duty (0.2%) high energy linac without any modification.
Beam pulse duration	0.4 (1.0) ms	
Chopping factor (beam on)	65%	Limit the long. losses at PBS injection . Beam is removed at 3 MeV (vs 160 MeV)
Source current	80 mA	
Linac current	64 mA	Losses at low energy
Average current during beam pulse	40 mA	After chopping
Beam power	2.8 kW	For PSB operation
Particles / pulse	$1.0\ 10^{14}$	
Transverse emittance (source)	0.25 mm mrad	
Transverse emittance (linac)	0.4 mm mrad	Half the emittance of Linac2
Maximum localised losses	1W/m at 6% beam dc	Loss control/shielding for HP-SPL operation

Upgrade with a look to the future

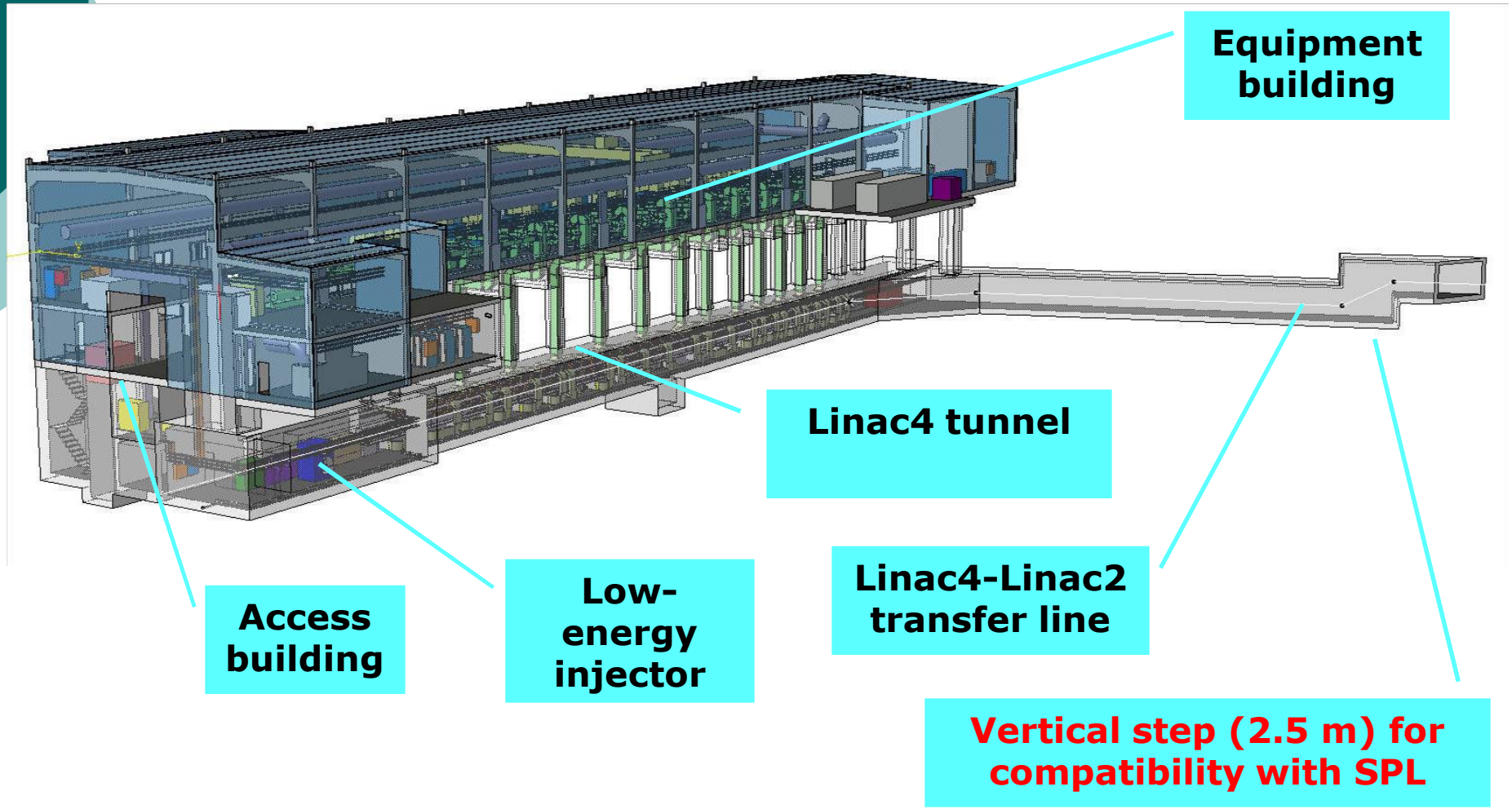


(LP)SPL: (Low Power) Superconducting Proton Linac (4-5 GeV)
PS2: High Energy PS (~ 5 to 50 GeV – 0.3 Hz)
SPS+: Superconducting SPS (50 to1000 GeV)
SLHC: "Superluminosity" LHC (up to 10^{35} $cm^{-2}s^{-1}$)
DLHC: "Double energy" LHC (1 to ~14 TeV)

Location upgrade future



Linac4 Building



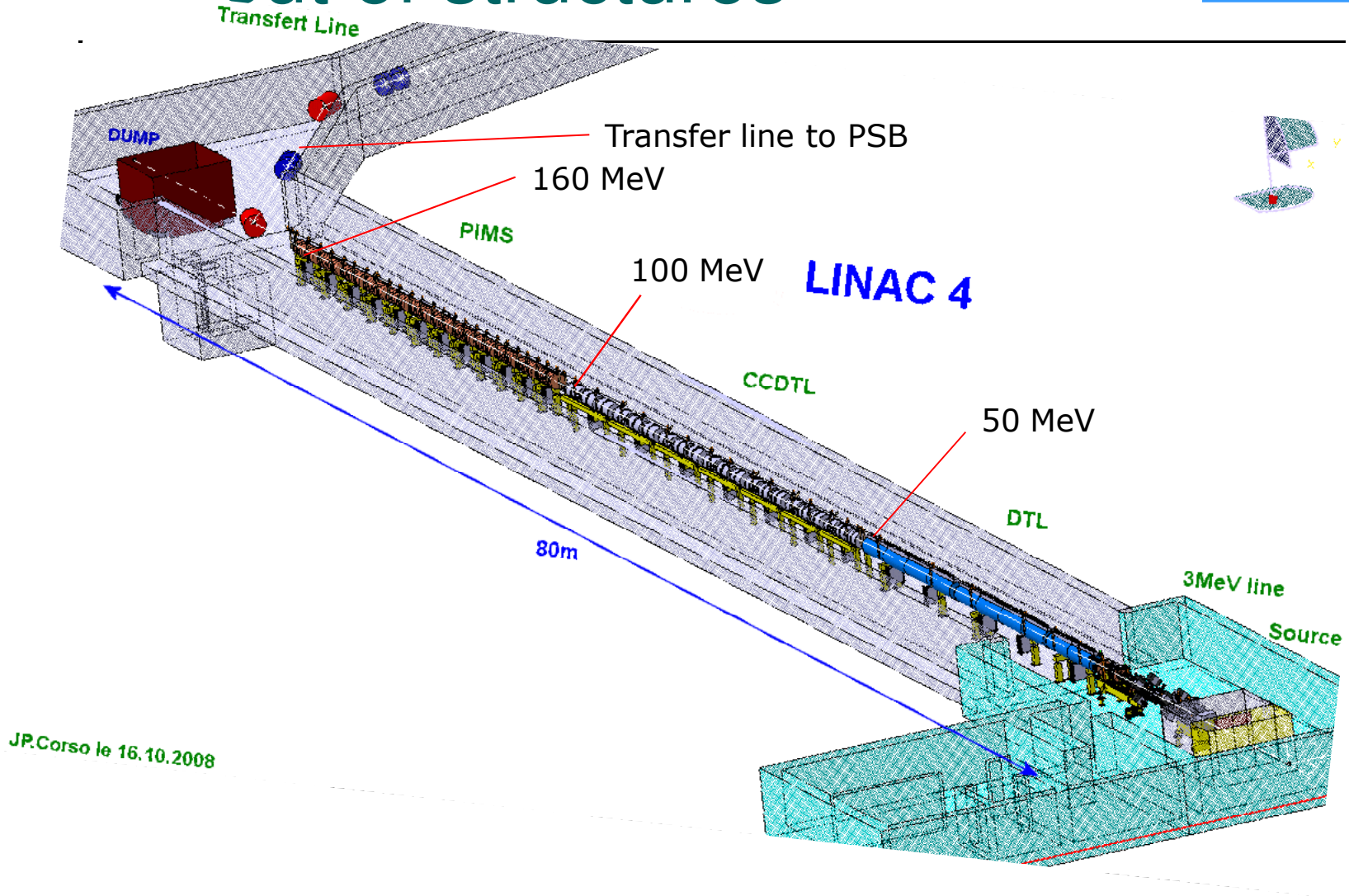
Civil engineering

- Building delivery end 2010
- Infrastructure delivery end 2011

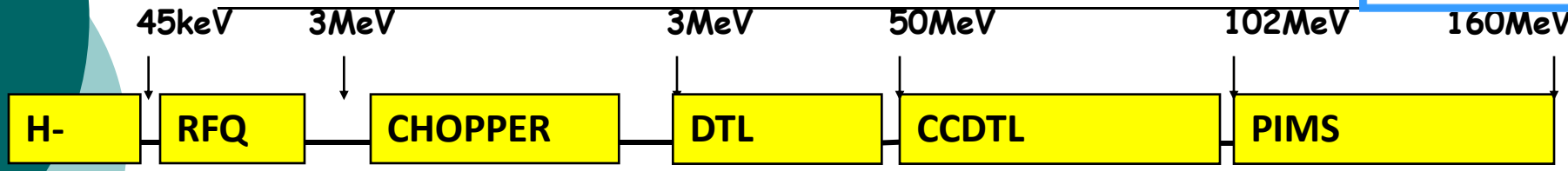
December 2009

Klystrons building slab concreted

Layout of structures



Linac4 Layout



H-	RFQ	CHOPPER	DTL	CCDTL	PIMS
RF volume source (DESY) 45 kV 1.9m LEBT	Radio Frequency Quadrupole 352 MHz 3 m 1 Klystron 0.6 MW	Chopper 352 MHz 3.6 m 11 EMquad 3 cavities	Drift Tube Linac 352 MHz 18.7 m 3 tanks 3 klystrons 4 MW 111 PMQuad	Cell-Coupled Drift Tube Linac 352 MHz 25 m 21 tanks 7 klystrons 6.5 MW 21 EMQuads	Pi-Mode Structure 352 MHz 22 m 12 tanks 8 klystrons ~12 MW 12 EMQuads

Total Linac4:
80 m,
19 klystrons

Beam Duty cycle:
0.1% phase 1 (Linac4)
3-4% phase 2 (SPL)
(design for losses : 6%)

4 different structures,
(RFQ, DTL, CCDTL, PIMS)

Ion current: 40 mA (avg. in pulse), 65 mA (bunch)

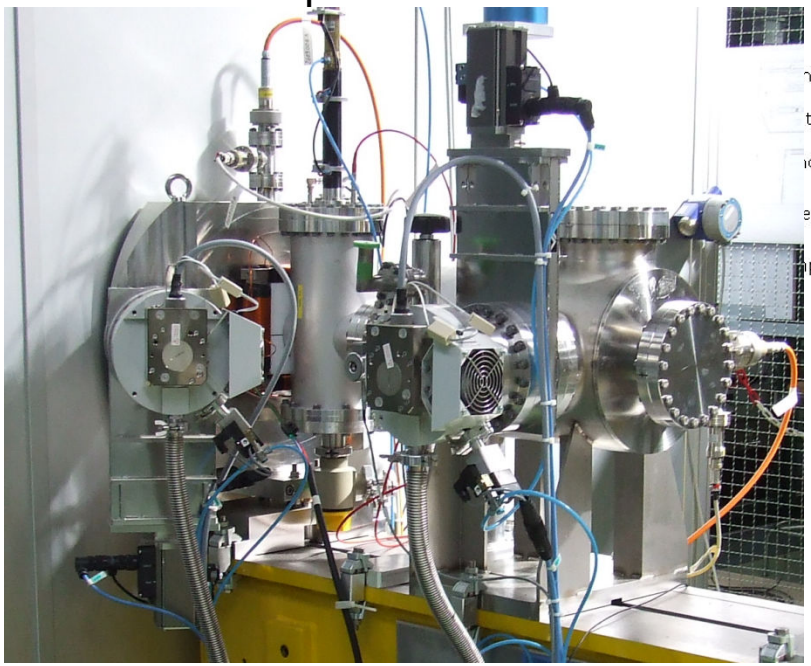
1st negative ion beam – July 2, 2009

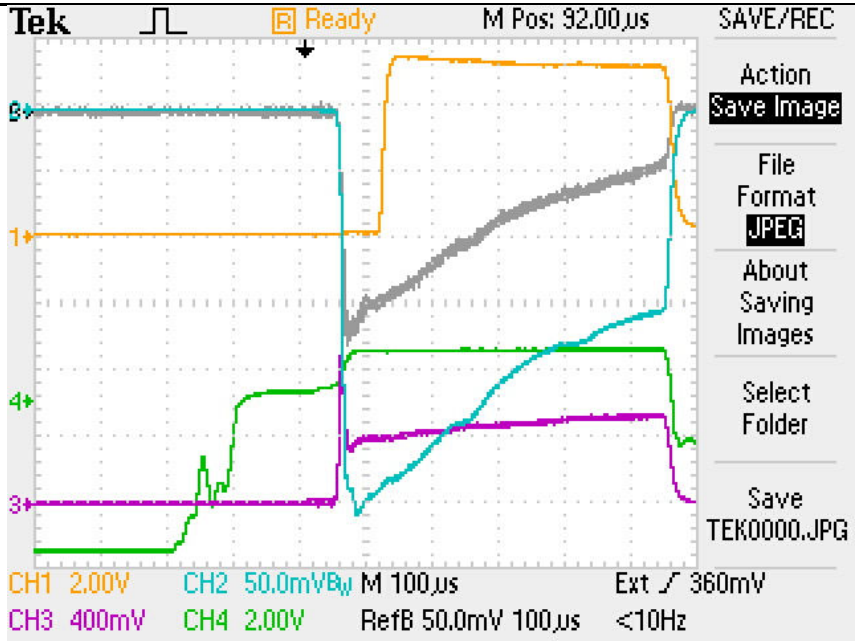
LINAC4 RF ION SOURCE

6 mA of negative ions measured at the Faraday cup

15 kV (nominal 45 kV)
Low RF power

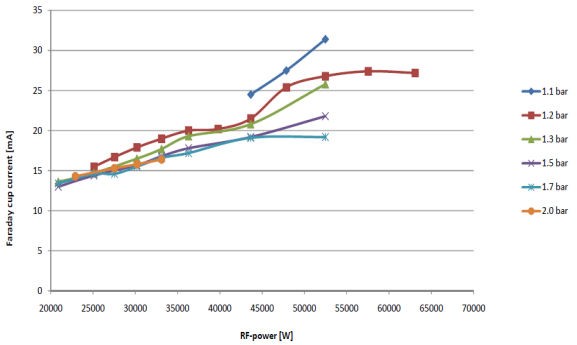
20mA end August



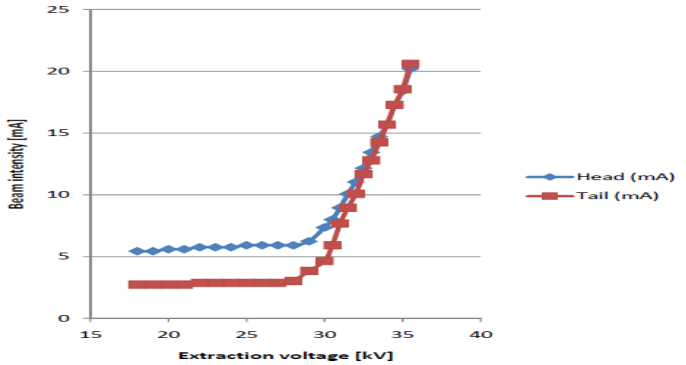


1. Orange=light from RF plasma
2. Blue= Faraday Cup Signal (into 50 Ohms).
   (1mA per division)
   Grey= Faraday Cup Signal without suppression.
3. Purple= Current exiting source (1A/V).
4. Green=RF reflected power.

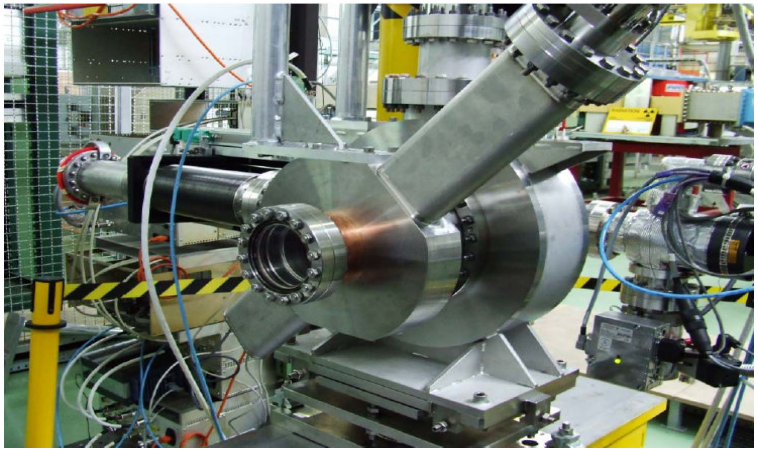
Source-progress



Intensity vs. RF power



Intensity vs. extraction voltage



Emittance measurements have started

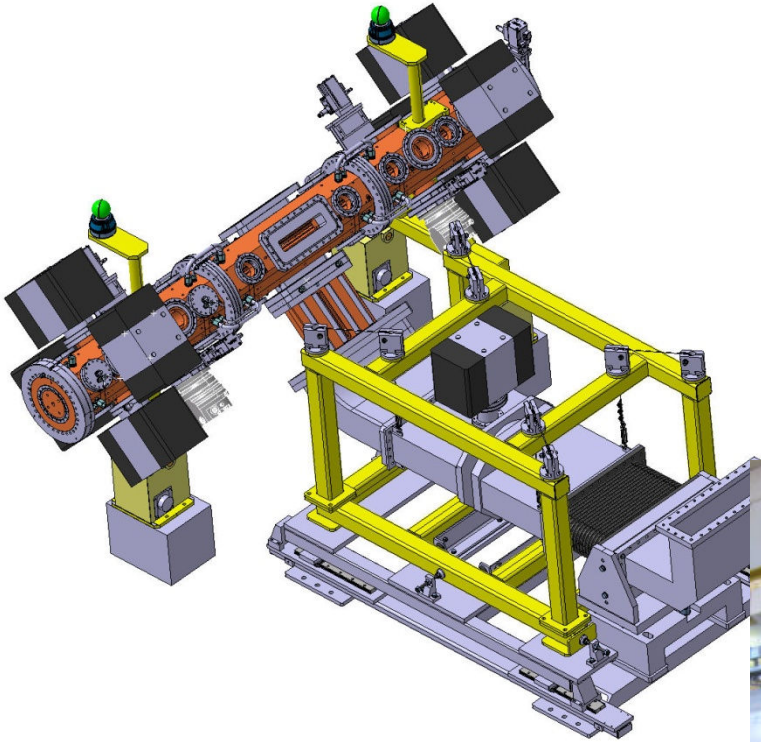
Today

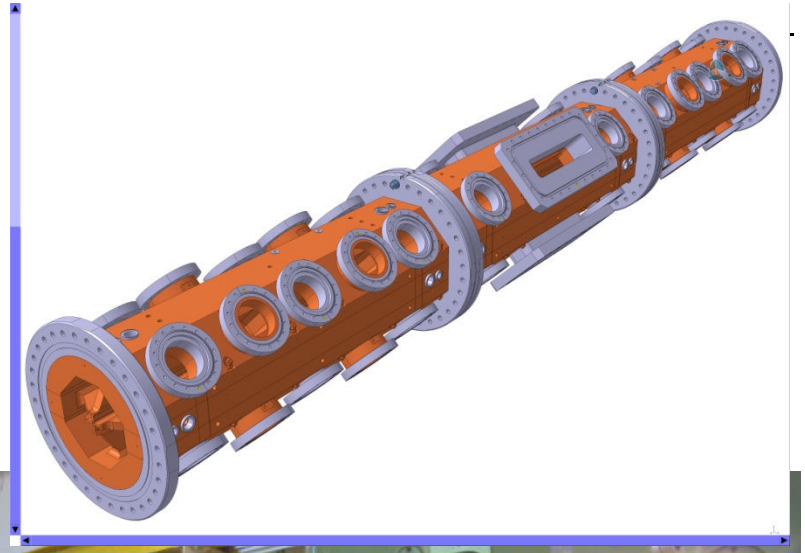
-35 kV beam
-30 mA (peak)
-20 mA stable and reproducible.

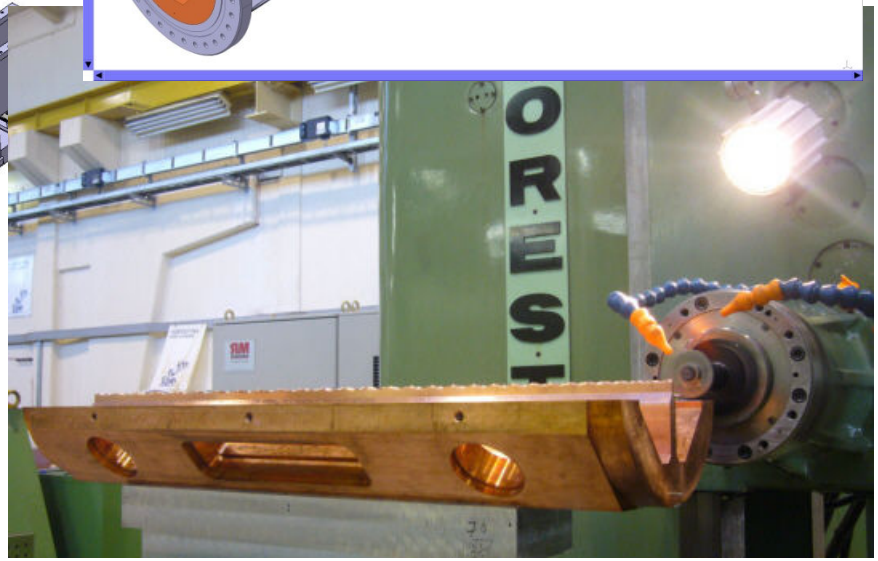
Goal

45 kV
80 mA
0.25 mm mrad

RFQ



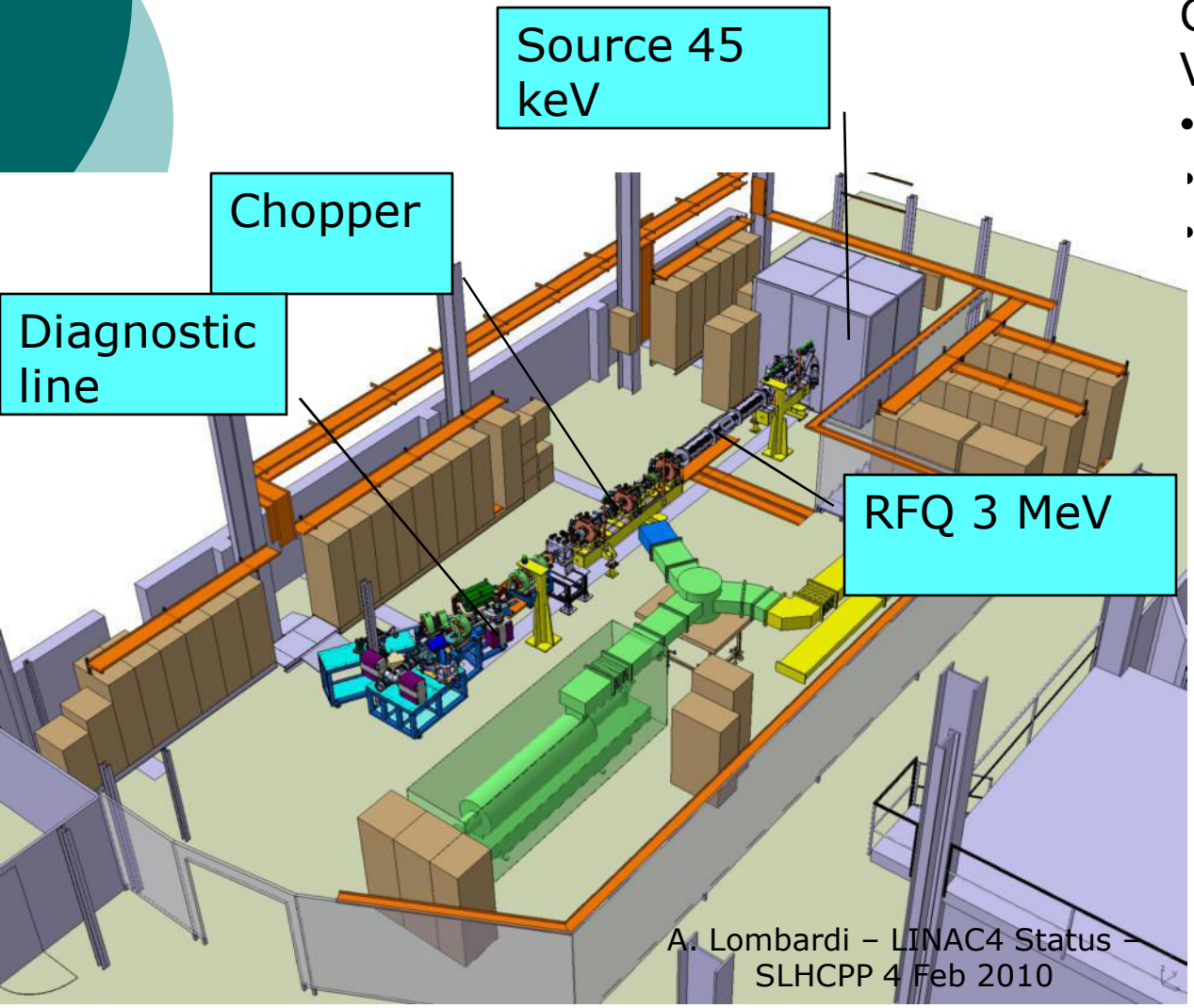




- Two mayor poles of the first session have been machined at "semi-finishing stage"

- Brazing is expected for february.

Testing the low energy part (0-3 MeV)

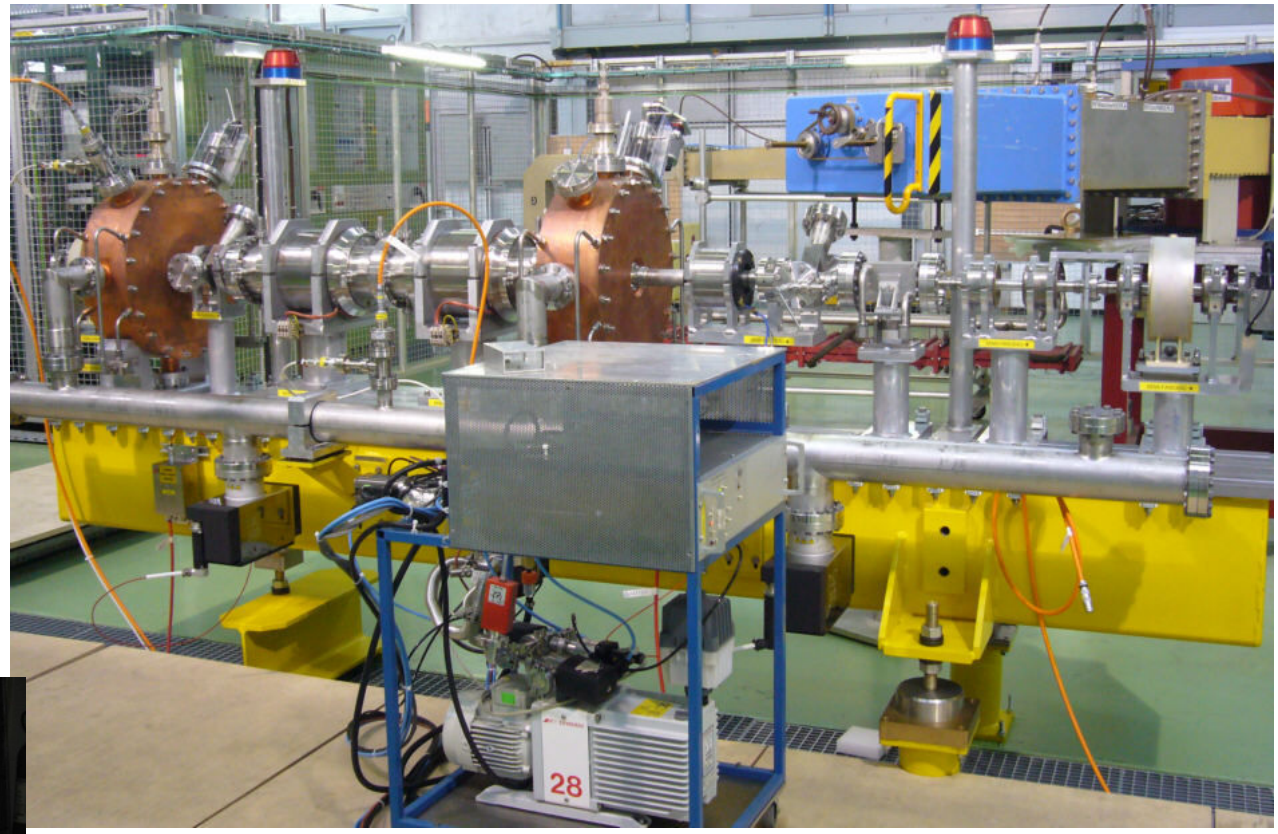


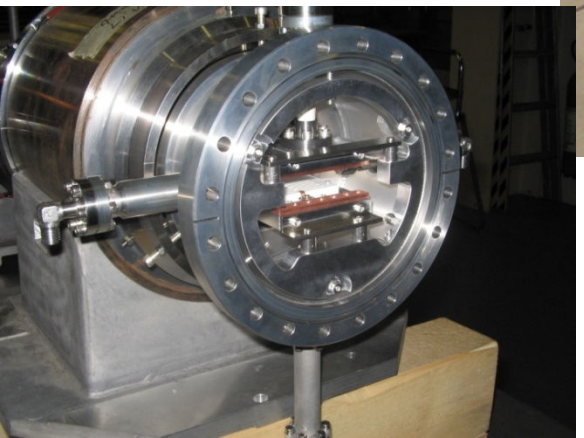
Goals :
Validate by 2011
- Source and LEBT design
- RFQ design
- Chopping and matching

Ultimate goal is to demonstrate
70 mA H-
400 μs
1 Hz
3 MeV
0.4 mm mrad
0.15 deg KeV
Chopped and matched to the DTL

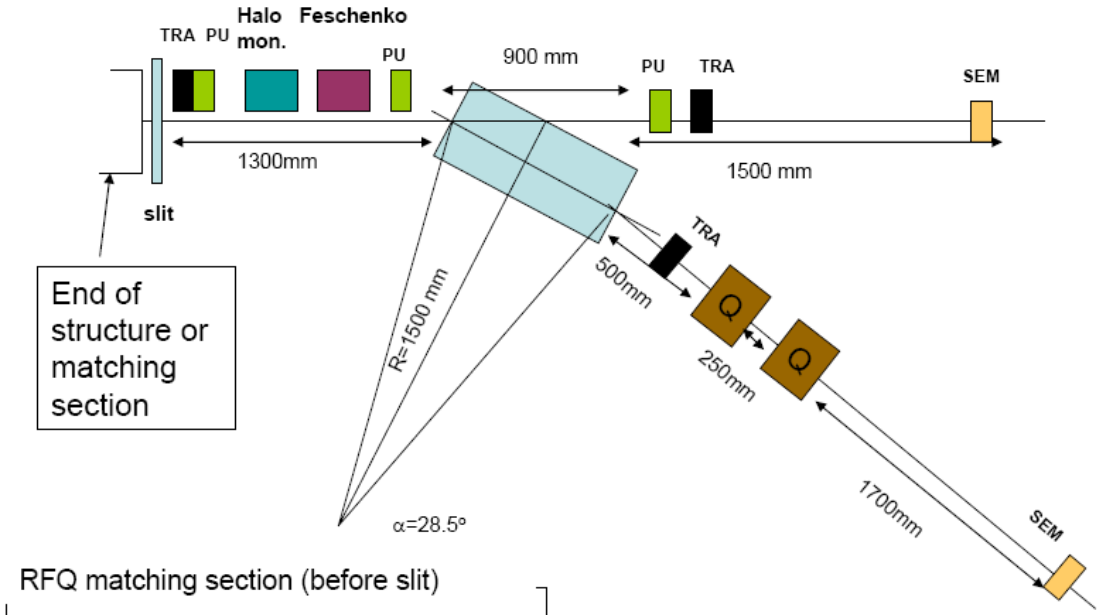
3MeV test stand-chopper line

- Assembled
- Vacuum tested
- Ready for beam since 2008

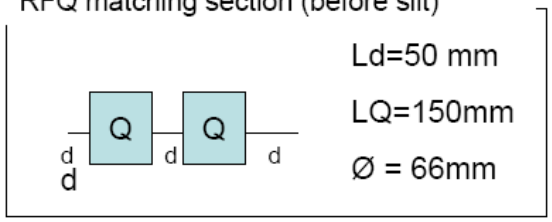


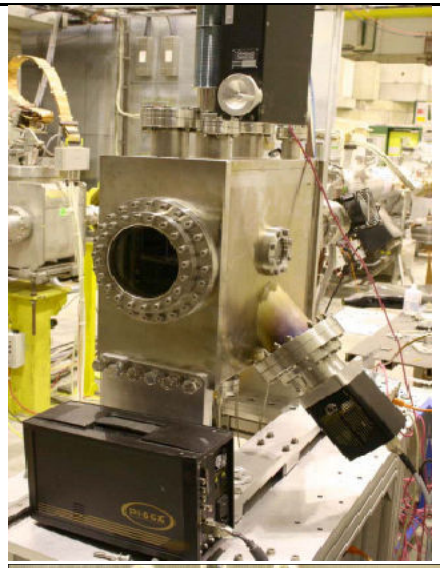


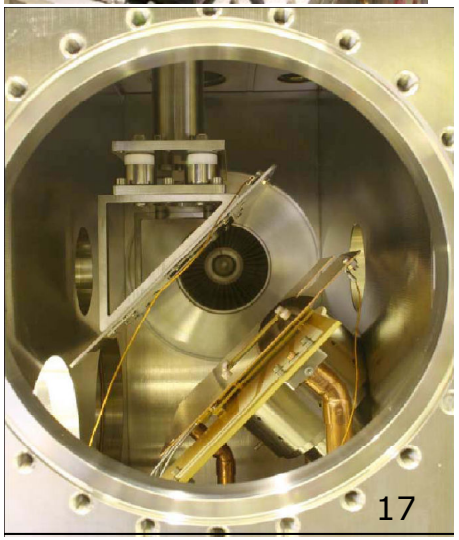
3MeV test stand-diagnostics line



RFQ matching section (before slit)



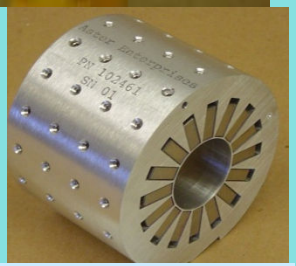




- Integration is finished
- Hardware is being built or procured
- Halo monitor ready and tested

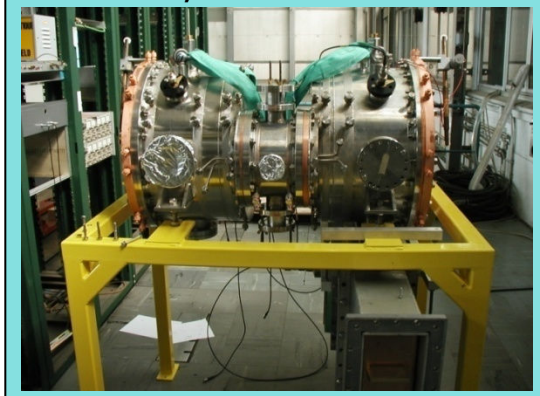
Acceleration 3-160 MeV

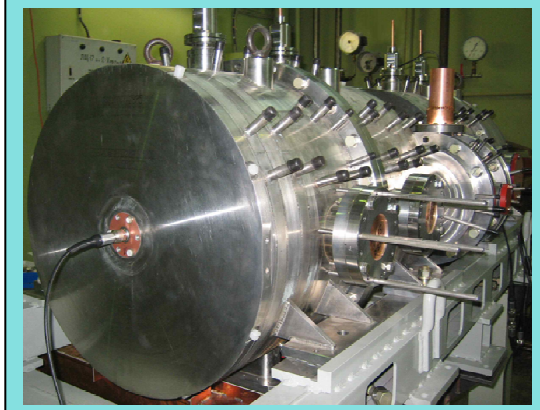
DTL, 3 – 50 MeV



Prototype tested at 7.5% dc, almost full power. Costruction starts in 2010

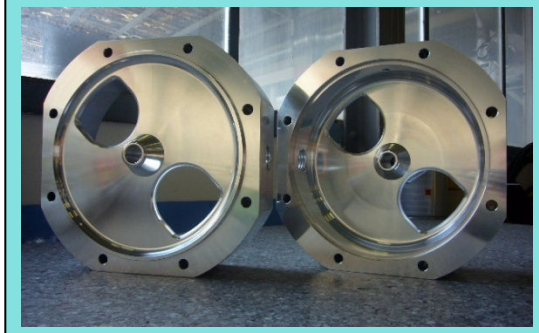
CCDTL, 50 – 100 MeV





Two prototypes built and tested Construction started in 2009.

PIMS, 100 – 160 MeV

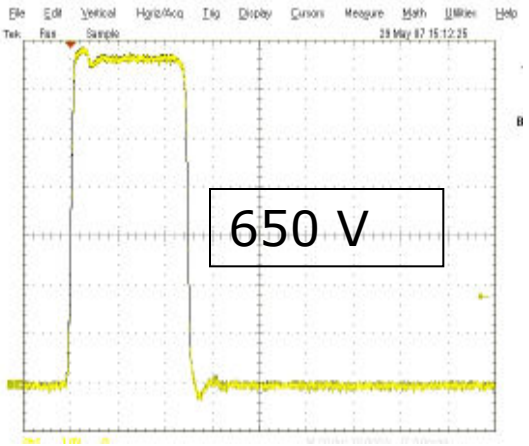


7-cell cavities in p-mode (12 cavities)

Prototype in construction

…forget me not…..

352 MHz Klystron pulsed mode test set-up : 1.3 MW achieved.



Chopper driver pulse, fulfills the specs for amplitude, rise and fall time.

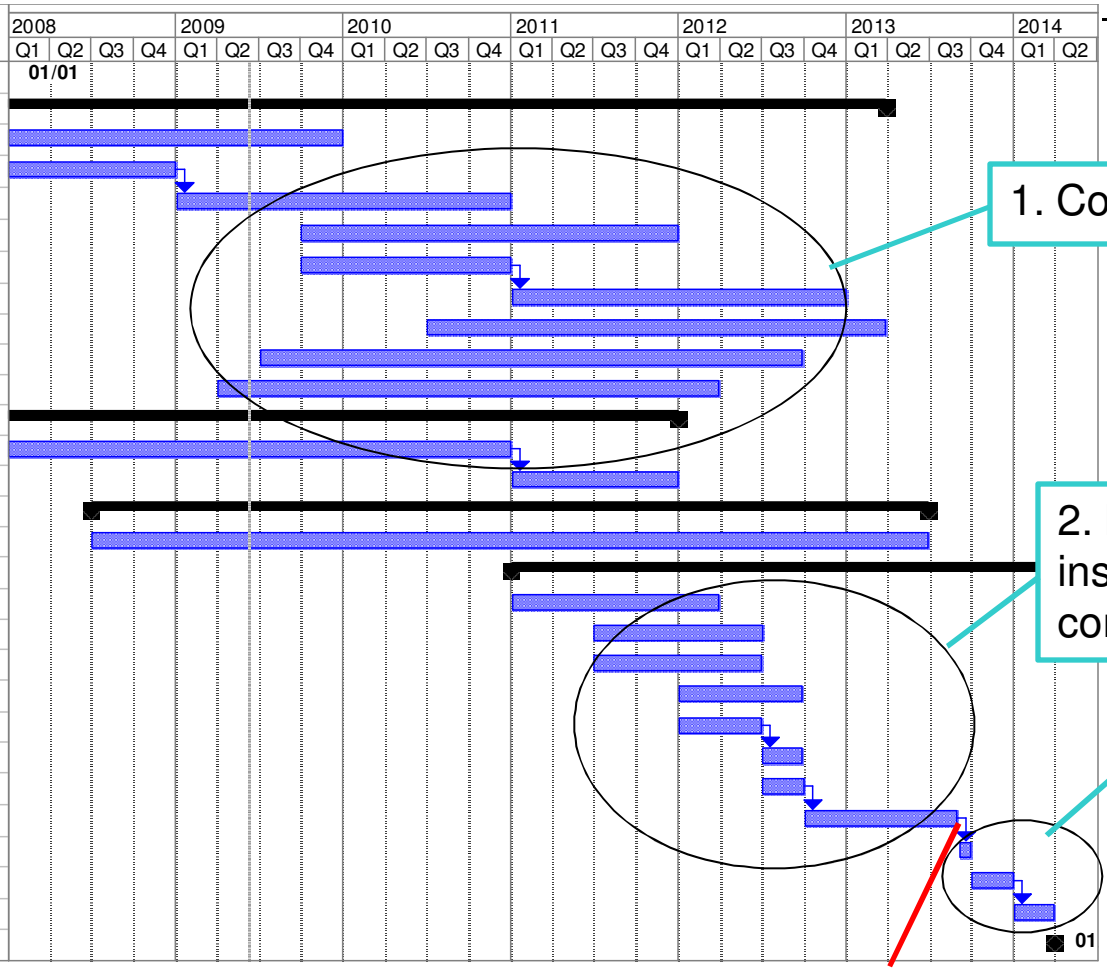
Milestones

2011 : results from 3 MeV test stand
2012 : installation in the tunnel
2013 : beam at 160 MeV on the straight dump
2014 : continue commissioning / reliability tests
2014 Shutdown : connection to PBS, modification of PBS injection
2015 : CERN accelerator operates with Linac4

Present Master Plan, approved in April 2009

Linac4 schedule

ID	Task Name
1	**Linac4 project start**
2	**Linac systems**
3	Source and LEBT construction, test
4	Drawings, material procurement
5	RFQ construction and commissioning
6	Accelerating structures construction
7	Klystron prototypying
8	Klystrons production
9	Transfer line construction and installation
10	Magnets construction
11	Power converters construction
12	**Building and infrastructure**
13	Building design and construction
14	Infrastructure installation
15	**PS Booster systems**
16	PSB injection elements construction
17	**Installation and commissioning**
18	Test stand operation (3 + 10 MeV)
19	Cavities testing, conditioning
20	Cabling, waveguides installation
21	Accelerator installation
22	Klystrons, modulators installation
23	Hardware tests
24	Front-end commissioning
25	Linac accelerator commissioning
26	Transfer line commissioning
27	PSB modifications
28	PSB commissioning with Linac4
29	**PSB beam ready for PS**



1. Construction

2. Linac installation, commissioning

3. Connection and PSB commissio ning

MILESTONE: Linac4 ready for connection to PSB, *end 2013*

Summary

- Linac4 first two years –highlights
  - Civil engineering started
  - Source is being commissioned
  - RFQ is being machined
  - Prototyping started on all accelerating structures/critical components.
  - Big contracts are (about to) be placed
- Linac4 next 3 years
  - At the moment it seems feasible to respect the masterplan approved in April 2009 and produce a 160 MeV beam on the dump by winter 2013