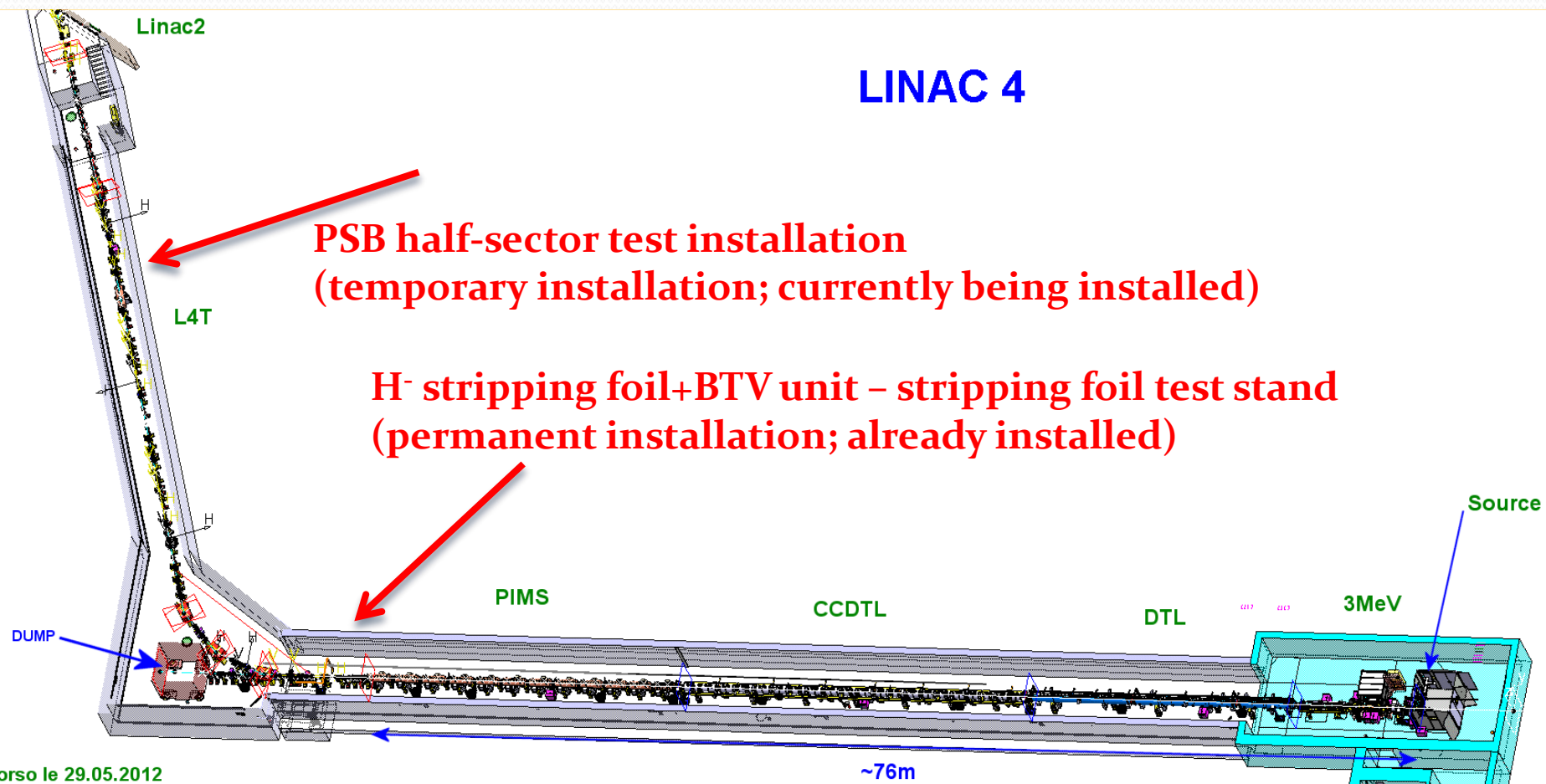


Planning and Operation of the Half-Sector Test (HST)

B. Mikulec

HST Installations in Linac4

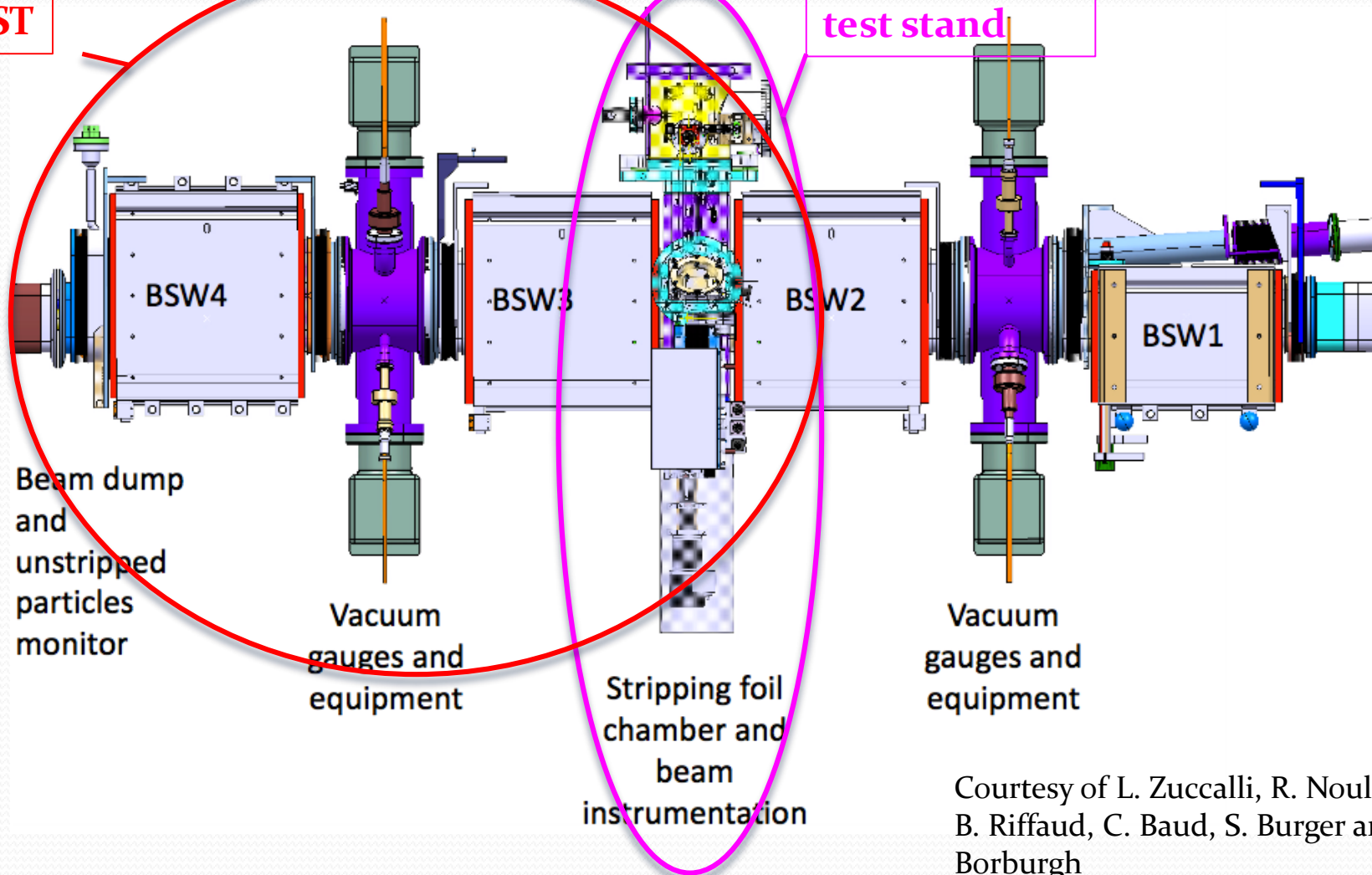
- L4T: new Linac 4 to Linac 2 transfer line



Top View of Future PSB Injection Section

HST

Stripping foil
test stand



Courtesy of L. Zuccalli, R. Noullobos, B. Riffaud, C. Baud, S. Burger and J. Borburgh

Foil Handling Mechanism

Radiation Hard
Camera

Mirrors and
Optical Filters

Stepping motor

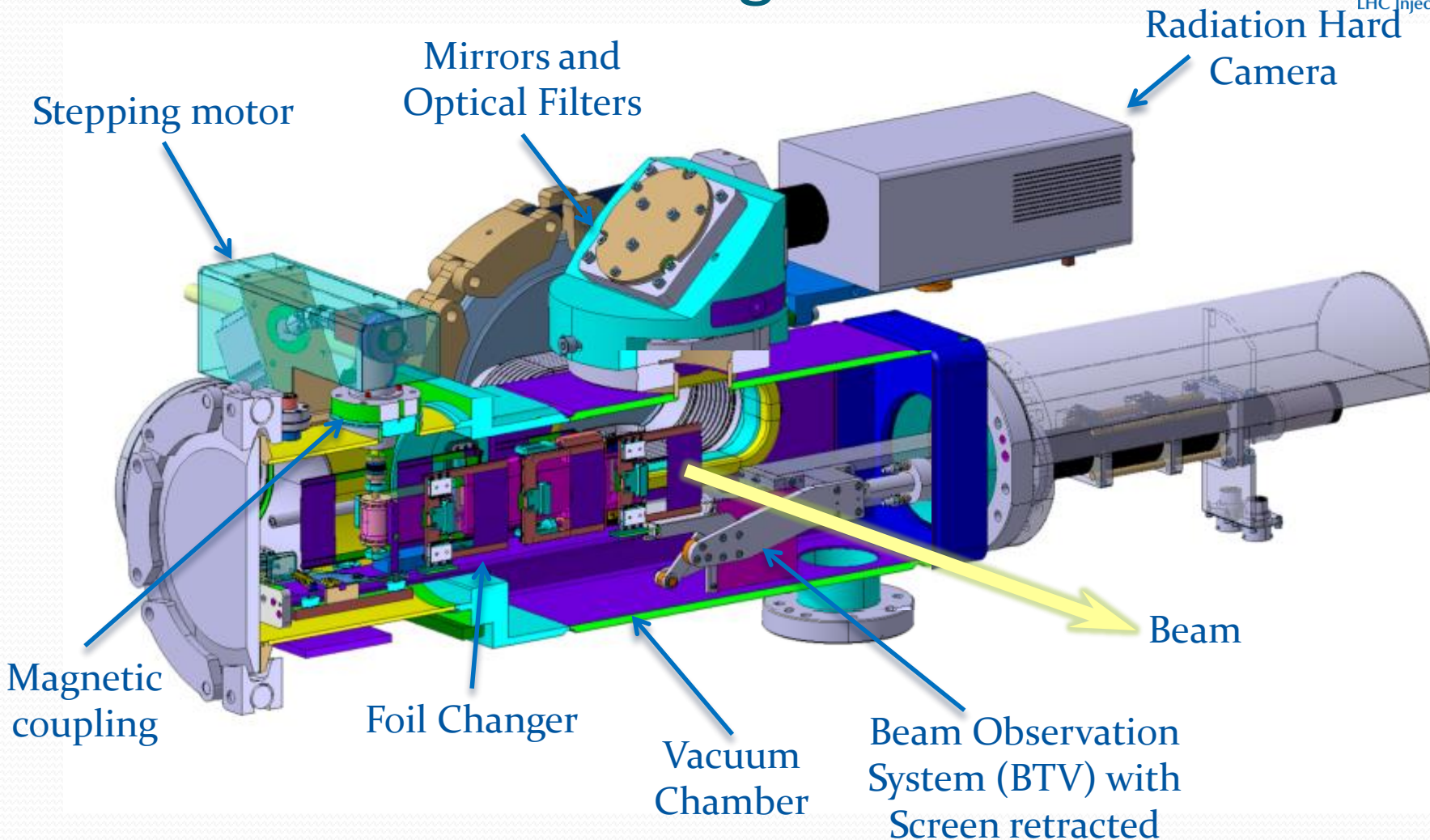
Magnetic
coupling

Foil Changer

Vacuum
Chamber

Beam Observation
System (BTV) with
Screen retracted

Beam



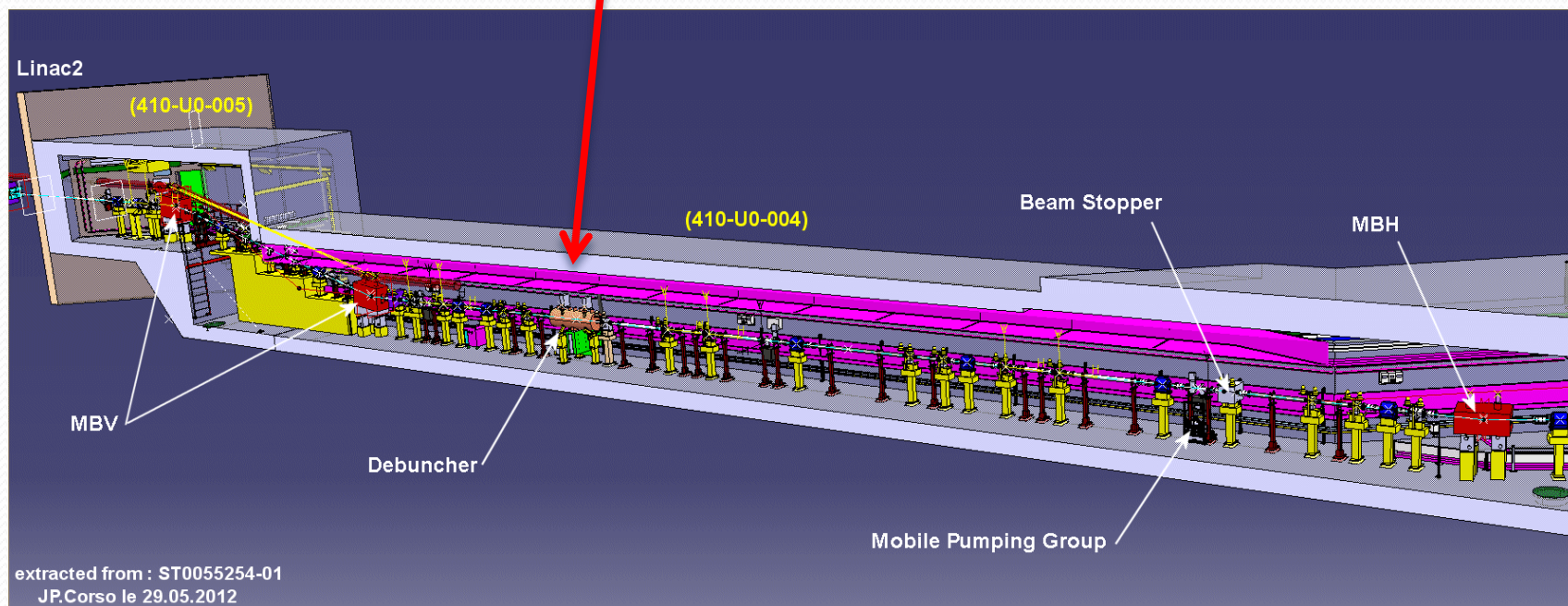
Test Program for Stripping Foil Test Stand

- **Lifetime** of different foils and foil holders
 - **Controls** of foil changer including interlock with screen insertion
 - **Commissioning and optimisation of the instrumentation** at the stripping foil (screen + mirrors + camera, *foil temperature measurement with infra-red probe* and current measurement from foil holder)
 - Rough estimate of **stripping efficiency** of different foil types and thicknesses
 - Need 2 well cross-calibrated BCTs (**L4T.BCT.0107** and **L4Z.BCT.0273**)
 - Detection of **foil breakage** (foil current); destructive tests with high-intensity beam next year
 - Hope to be able to obtain a rough estimate of **emittance growth** through the foil using the SEM grids in L4Z line
-
- Beam size on foil will be similar to situation at PSB injection
 - **Tests can be performed in parallel to Linac 4 beam tests** (except for emittance measurements of H⁻ beam at end of line)

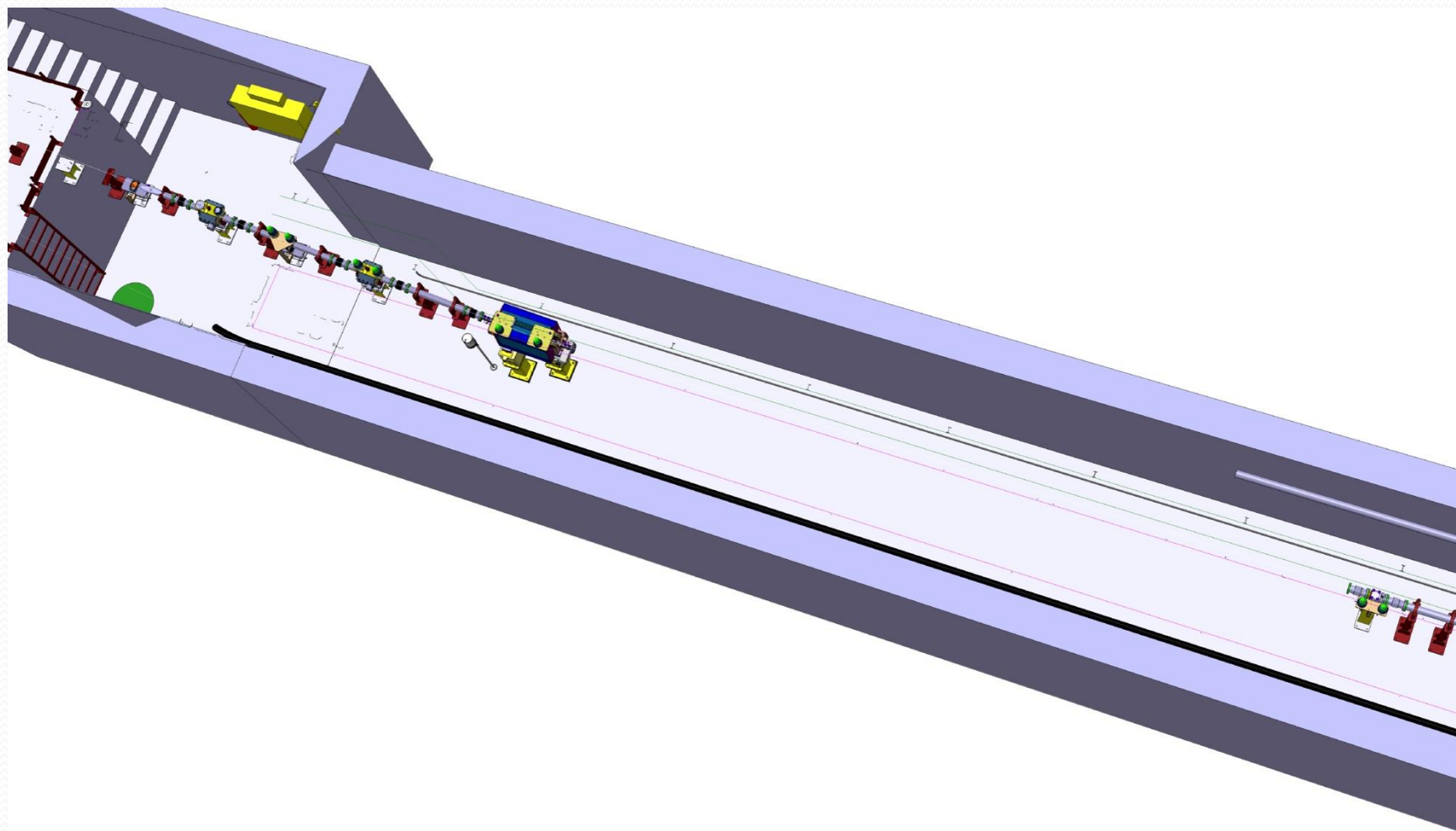
HST Location

Temporary installation of half of the future PSB H⁻ injection chicane + external dump

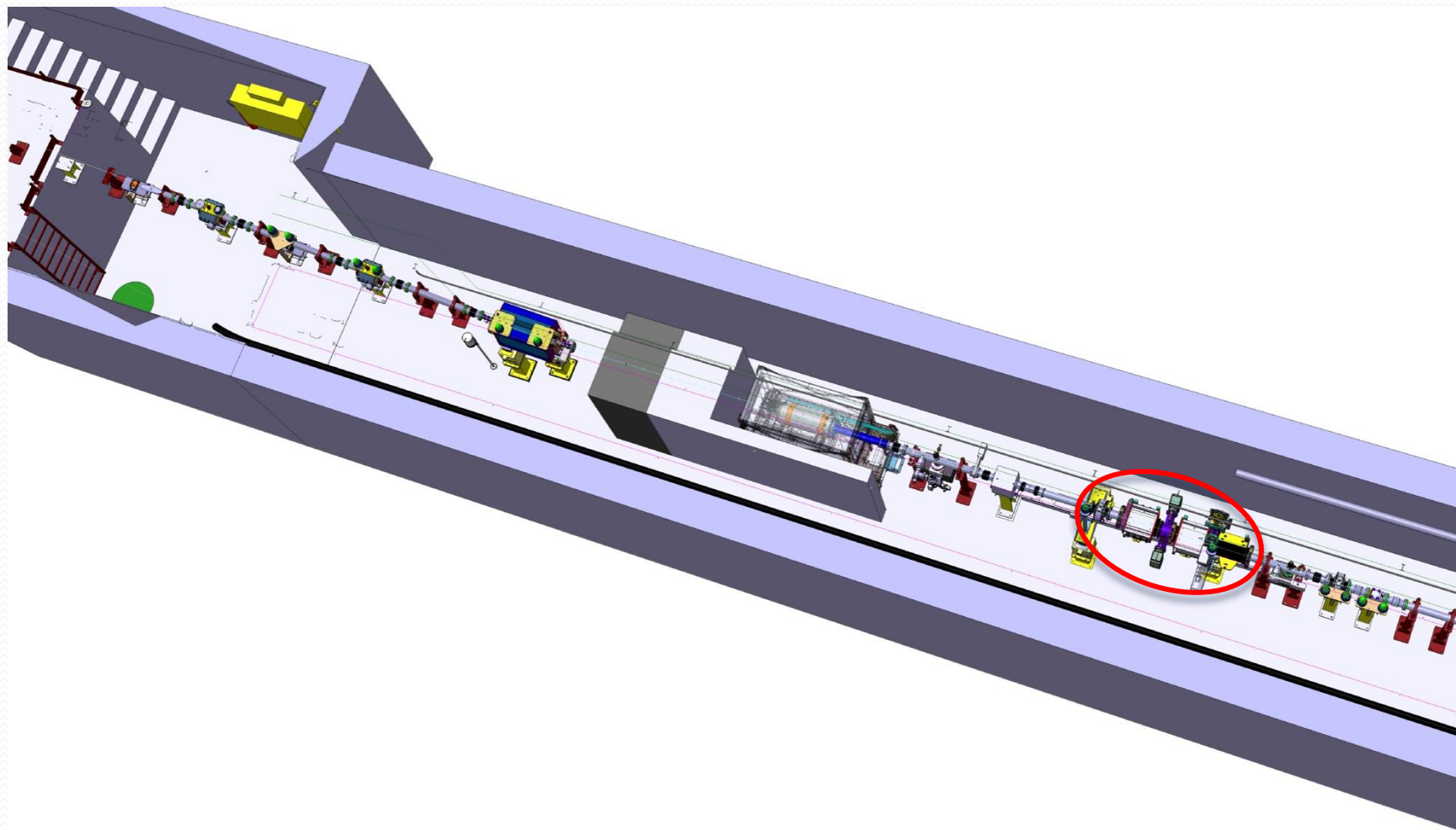
- Around location of debuncher (L4T sector 4.5)
- Install L4T only up to this point (plus line between 2 vertical bends)
- Positive 'side effect': Commission already L4T line until debuncher



HST Implementation

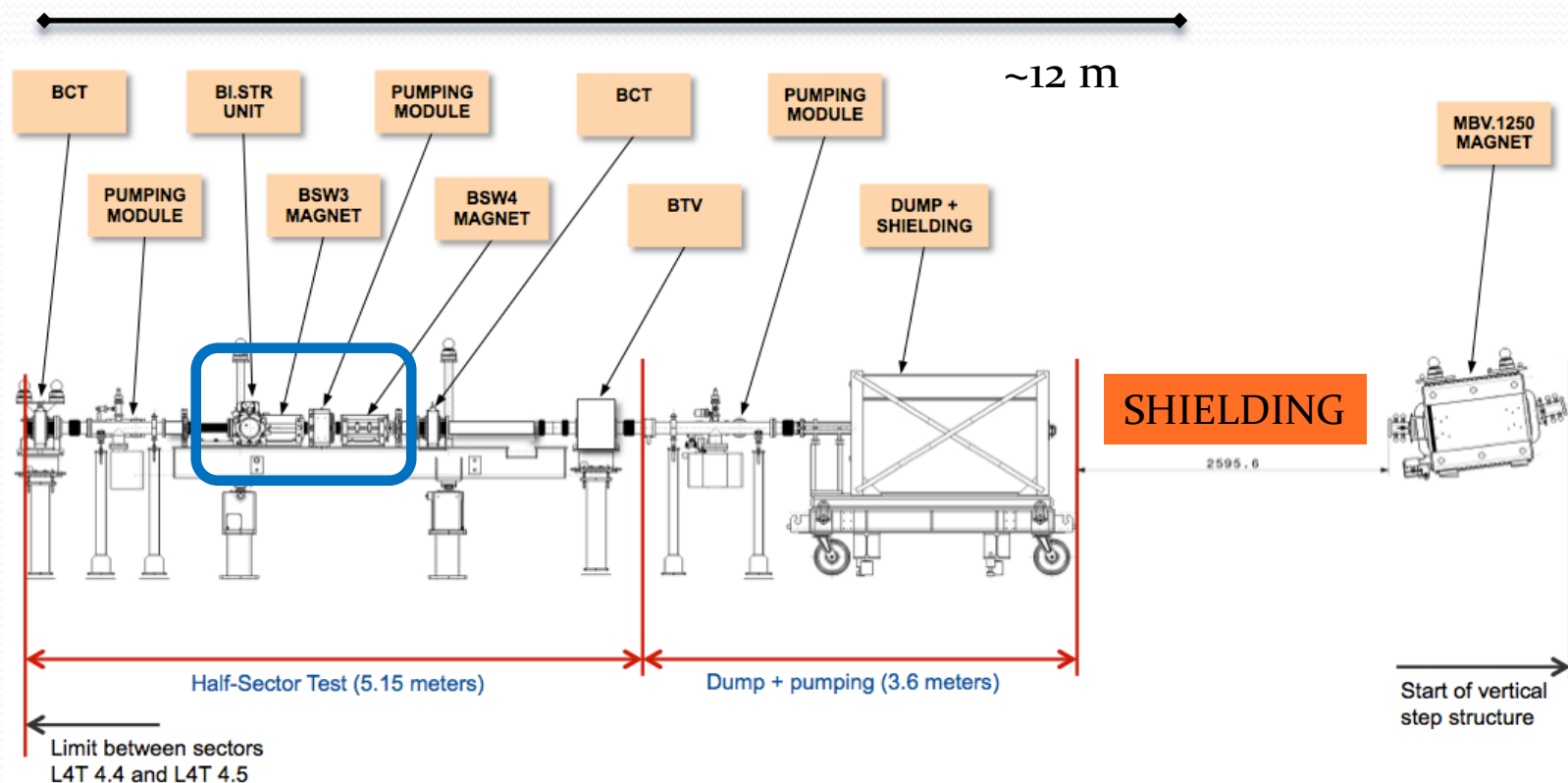


HST Implementation



Courtesy B. Riffaud and J-P. Corso

Schematic Layout of HST



- Install another stripping foil+BTV unit, half of the injection chicane (BSW₃ + BSW₄) including the H⁰/H⁻ dump and the H⁰/H⁻ current monitor
- In addition: 1 standard + 1 diamond BLM, 2 BCTs (stripping efficiency cross-check), 1 BTV + external beam dump+shielding (including vacuum valve)
- 2 sector valves enclosing the installation, pumping groups

Current Installation Status HST

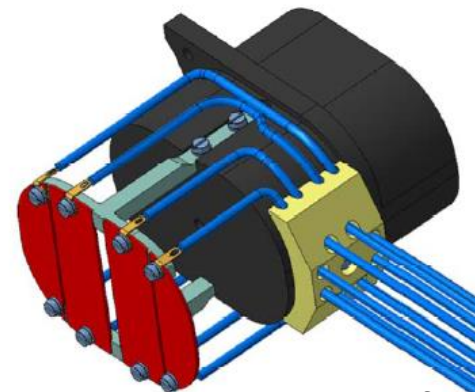
Girder
Lower
27/07/16



27/07/2016 – HST Girder with external dump

Test Program for HST

- **Stripping foil**
 - More precise stripping efficiency measurement of H^0 and H^-
- **BSW₃₊₄**
 - Powering and control of half of the chicane magnets
 - Refine chicane parameters
 - Current stability, precision and *interlocking*
- **H^0/H^- dump**
 - Aperture check
 - Temperature cross-check with simulated values → refine cooling needs
 - *Interlocking* (temperature and pressure drop – define operational thresholds)
- **Diamond BLM**
 - Diamond BLM to measure secondaries close to H^0/H^- dump; evaluate operational conditions for foil degradation measurement and fast losses
- **H^0/H^- current monitor**: New development!
 - Sensitivity check for H^- plates (use low-intensity beam w/o foil); comparison to theory
 - Aperture check
 - Influence on measurement if beam passes besides the monitor (use thicker foil; simulate circulating beam)?
 - *Interlocking* – essential for dump protection
- ***Interlock system test*** for part of PSB injection (BIS + SIS) → see presentation Andrea
- Prepare and test new **applications + controls**



Drawing of H^0/H^- monitor provided by F. Zocca

Proposed Operational Phases

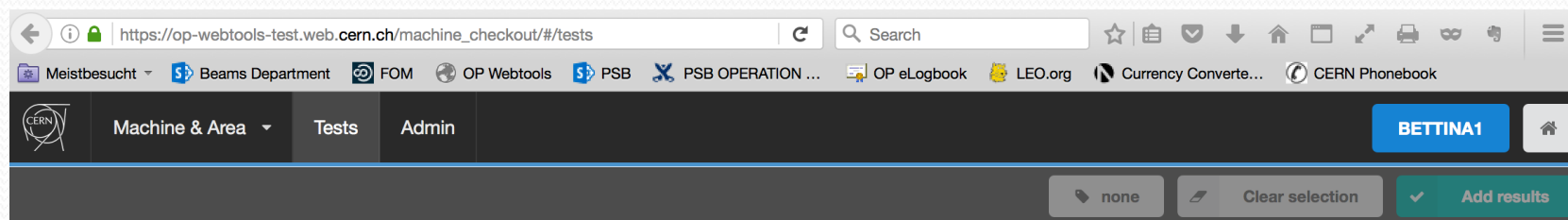
- RP simulations: **max. allowed beam power for 98% stripping efficiency is 445 W**, corresponding to **$\sim 2E_{13}$ H⁻**, but only single shots planned at convenient times
 - With these results will be able to increase slightly the intensity of test part 2, in particular also because the repetition rate will be much lower
 - Probably not more than 30 mA current from Linac4 → **could even send full 100 μ s pulse**
 - Need chopper to remove head/tail and reduce pulse length**

Operating Scenario	HST Part 1 (2 months)	HST Part 2 (2 months)
Max. pulse current	40 mA	40 mA
Max.+avg. pulse length	0.5-1 μs	10 μs
Max. repetition rate	0.833 Hz	0.833 Hz
Pulse period	1.2 s	1.2 s
Max. number of particles/pulse	$2.5E_{11}$	$2.5E_{12}$
Particle energy [MeV]	160 MeV	160 MeV
Particle energy [J]	$2.563E-11$ J	$2.563E-11$ J
Max. energy/pulse	6.4 J	64 J
Mean power/pulse	5.33 W	53.3 W
Beam designation	Pencil beam	Low-intensity beam
1 σ beam size	$\sim 1.9 \times 2.4$ mm ²	$\sim 2.2 \times 3.3$ mm ²

Original rough plan

HST Operation Planning Update

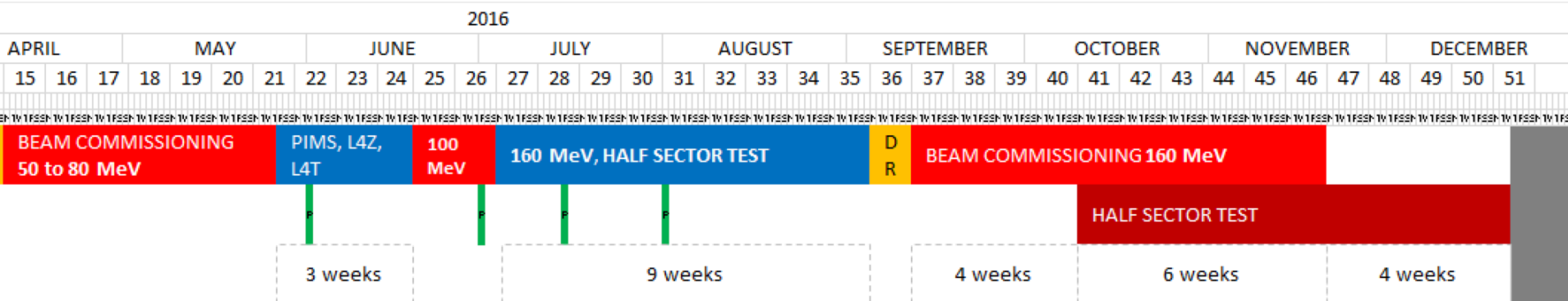
- Detailed checklist prepared and being integrated on web (G. Guidoboni, B. Mikulec, C. Bracco; web interface E. Matli and P. Hardyn for IRWG)



LINAC4 HST

1) PRE-REQ: No Beam	0%	▼
2) PRE-REQ: 160 MeV To L4 Dump	0%	▼
3) Steer LOW Intensity To HST	0%	▼
4) LOW Int. Beam Meas. @ HST	0%	▼
5) HIGH Int. Beam Meas. @ HST	0%	▼

Linac4 Planning Update



J. Coupard, <https://espace.cern.ch/coordination-installation-linac4/default.aspx>

- **HST installation: July 2016**
- **HST equipment commissioning: August 2016**
- **HST cold checkout and parallel beam preparations with 160 MeV commissioning beam (separate cycle): September 2016**
- **HST beam tests** from October 2016 in parallel with 160 MeV beam commissioning
 - Low-intensity beam steering to HST (screen IN), BI checks etc.; **October 2016 for ~2 weeks**
 - **HST low-intensity beam measurements: min. 3 weeks in November 2016**
 - **From December 2016 (running into 2017) higher intensity beam measurements**

Summary

- HST installation well advanced
- Many issues already identified during fabrication and installation → avoids delays for PSB installation
 - Soldering of undulated vacuum chambers and production non-conformities, contamination issues of stripping foil vacuum chamber, connections of stripping foil controls, mechanical tolerances of H^0/H^- dump mounting etc.
- Push for all equipment groups and OP to advance with equipment and controls/applications
 - For baseline LS2 installation in PSB expect useful input from beam measurements; should allow potential modifications
- Very good test for BIS and SIS in view of future operation

Documentation

- ✓ Layout drawing: [SPLLJLHS0001](#)
- ✓ Rack area in b.400 modified for temporary EPC rack+transformer installation: rack layout [SPLEY____7001](#)
- ✓ Stripping foil test stand ECR: [EDMS 1376356](#)
- ✓ HST Engineering Specifications: [EDMS 1571173](#)
- ✓ HST Twiki website:
<https://twiki.cern.ch/twiki/bin/view/PSBHalfSectorTest/WebHome>
- ✓ Indico: <http://indico.cern.ch/category/5296/>