Feasibility of transferring 2 GeV beams from the CERN PSB to ISOLDE

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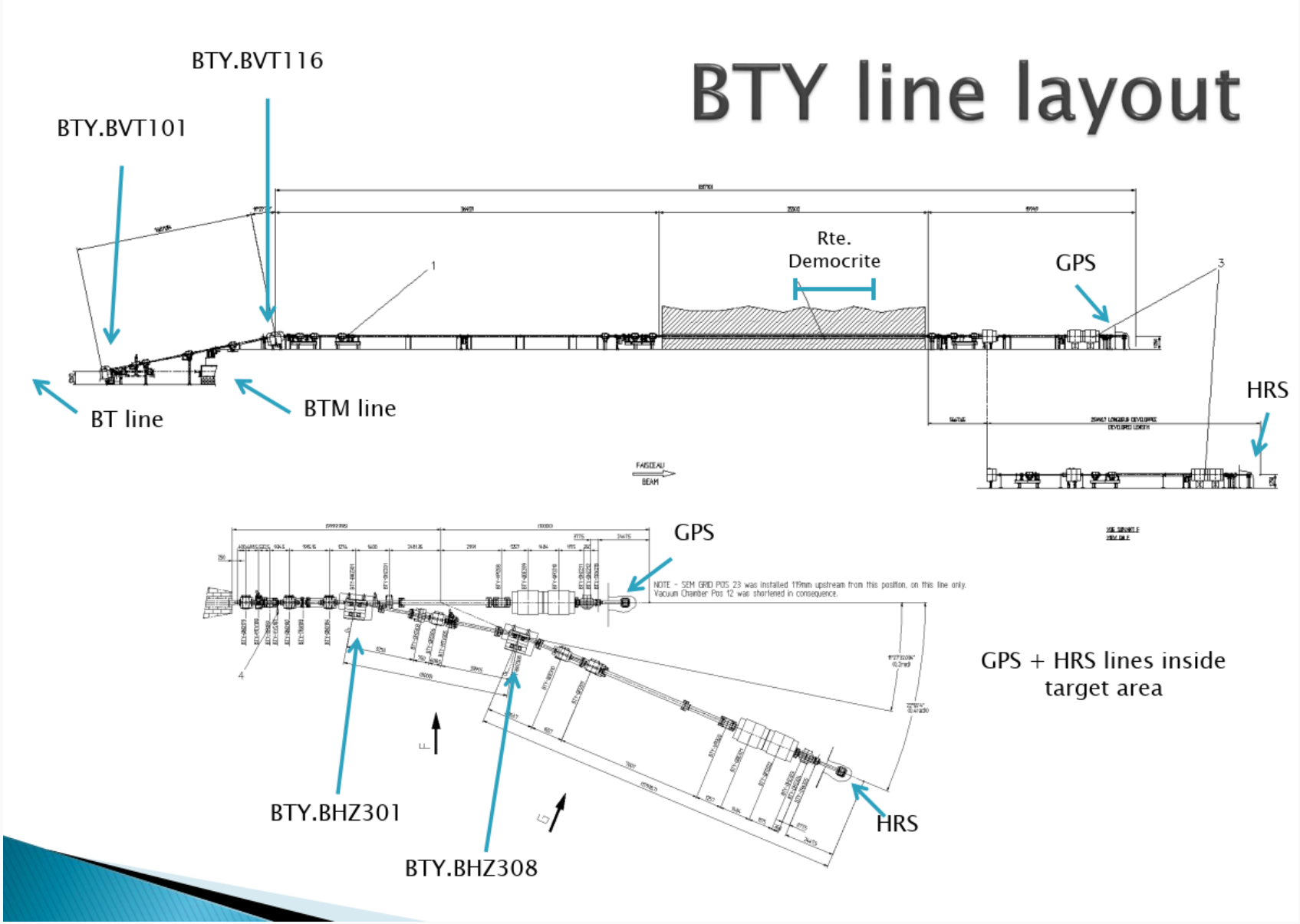
Summary

Layout


BTY line layout
BTY.BVT116
BTY.BVT101
Rte.
Democrite
GPS
HRS
BT line
BTM line
GPS
BTY.BHZ301
BTY.BHZ308
HRS
GPS + HRS lines inside
target area

ISOLDE 2 GeV options

- 2 GeV beams for ISOLDE are technically feasible with at least the same intensity as in run 2
- **Baseline upgrade**[1]**:**
  Replace 4 large dipoles with new design and replace certain quadrupole power converters
- **Alternative:**
  Keep present dipoles and rework geometry of the lines - should work at least for the vertical step upstream the wall

[1] BTY line @ 2 GeV by D.Voulot et al., 2013,
`https://edms.cern.ch/document/1357395/1`

Upgrade baseline

Limitations for 2 GeV

- Increase of beam rigidity by 30%
- 2 dipoles to make the vertical step and 2 dipoles to separate horizontally GPS and HRS targets
- 8 quadrupoles exceed power converter limits

Dipoles

- Present dipoles can't be powered with higher current - limitations in saturation, cooling, field homogeneity
- Each dipole and each power converter $\approx$ 500 kCHF + space
- Replace dipoles with new design matching existing power converters
- New magnets will likely have larger envelope $\rightarrow$ have to make space in beam line

Quadrupoles

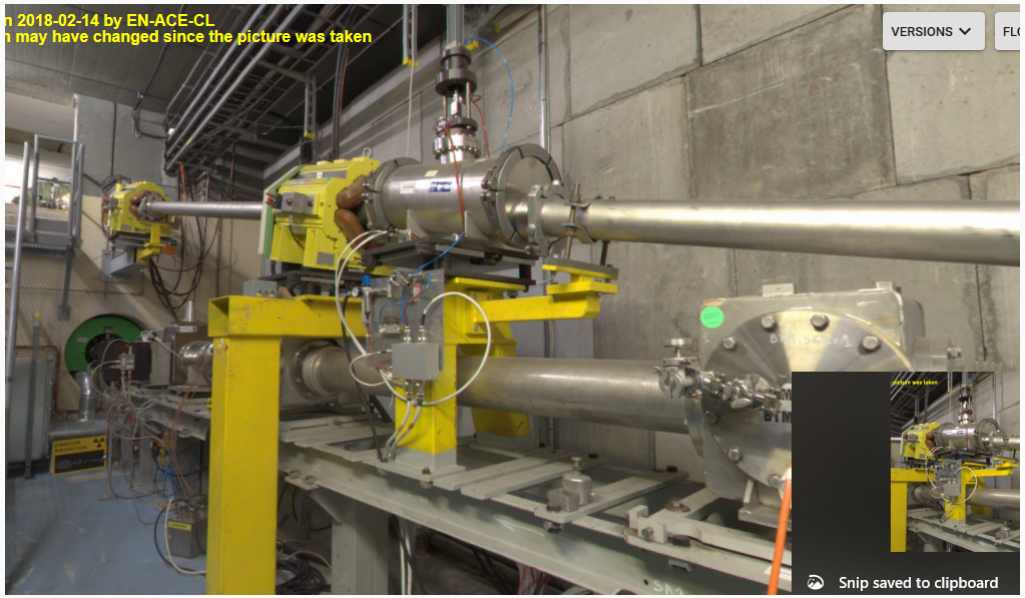
Quadrupole	type	GPS 1.4GeV I(A)	GPS 2.0GeV I(A)	HRS 1.4GeV I(A)	HRS 2.0GeV I(A)	Magnet peak current I(A)	Power Converter specification I(A)
BTY.QDE104	Q130	182.20	243.97	182.20	243.97	220.0	220
BTY.QFO108	Q130	134.95	178.22	134.95	178.22	220.0	220
BTY.QDE113	Q130	182.26	244.06	182.26	244.06	220.0	220
BTY.QFO119	Q130	136.51	180.32	136.51	180.32	220.0	220
BTY.QDE120	Q130	198.53	268.07	198.53	268.07	220.0	220
BTY.QFO122	Q130	77.33	102.58	77.33	102.58	220.0	220
BTY.QFO148	Q130	47.31	63.49	47.31	63.49	220.0	220
BTY.QDE151	Q130	113.90	150.26	113.90	150.26	220.0	220
BTY.QFO153	Q130	77.06	102.23	77.06	102.23	220.0	220
BTY.QFO179	Q130	0.00	0.00	107.86	142.32	220.0	150
BTY.QDE182	Q130	43.07	57.92	164.67	218.97	220.0	220
BTY.QFO184	Q130	67.12	89.32	105.15	138.78	220.0	220
BTY.QDE209	**Q100**	132.42	177.54			700.0	300
BTY.QFO210	**Q100**	140.07	187.99			700.0	350
BTY.QFO304	Q130			196.62	265.21	220.0	220
BTY.QDE310	Q130			182.53	244.45	220.0	220
BTY.QFO311	Q130			153.53	203.49	220.0	220
BTY.QDE321	**Q100**			186.10	248.97	700.0	300
BTY.QFO322	**Q100**			182.55	244.37	700.0	350

Power converters

- 5 quads exceed the limit and 3 with less than 10% margin
- New converters for 7 quadrupoles needed, 1 can be reassigned, spares available
- Pulsing the quadrupoles at 2 GeV would keep the power consumption at the same level as DC at 1.4 GeV
  Additional space required

Beam stopper and instrumentation

- Beam stopper BTY.STP103 will be replaced during a YETS before LS3 (CONS)
- Lines are reasonably well instrumented with beam position and loss monitors, current transformers and profile monitors
- Upgrades unlikely needed for 2 GeV, consolidation need might come up



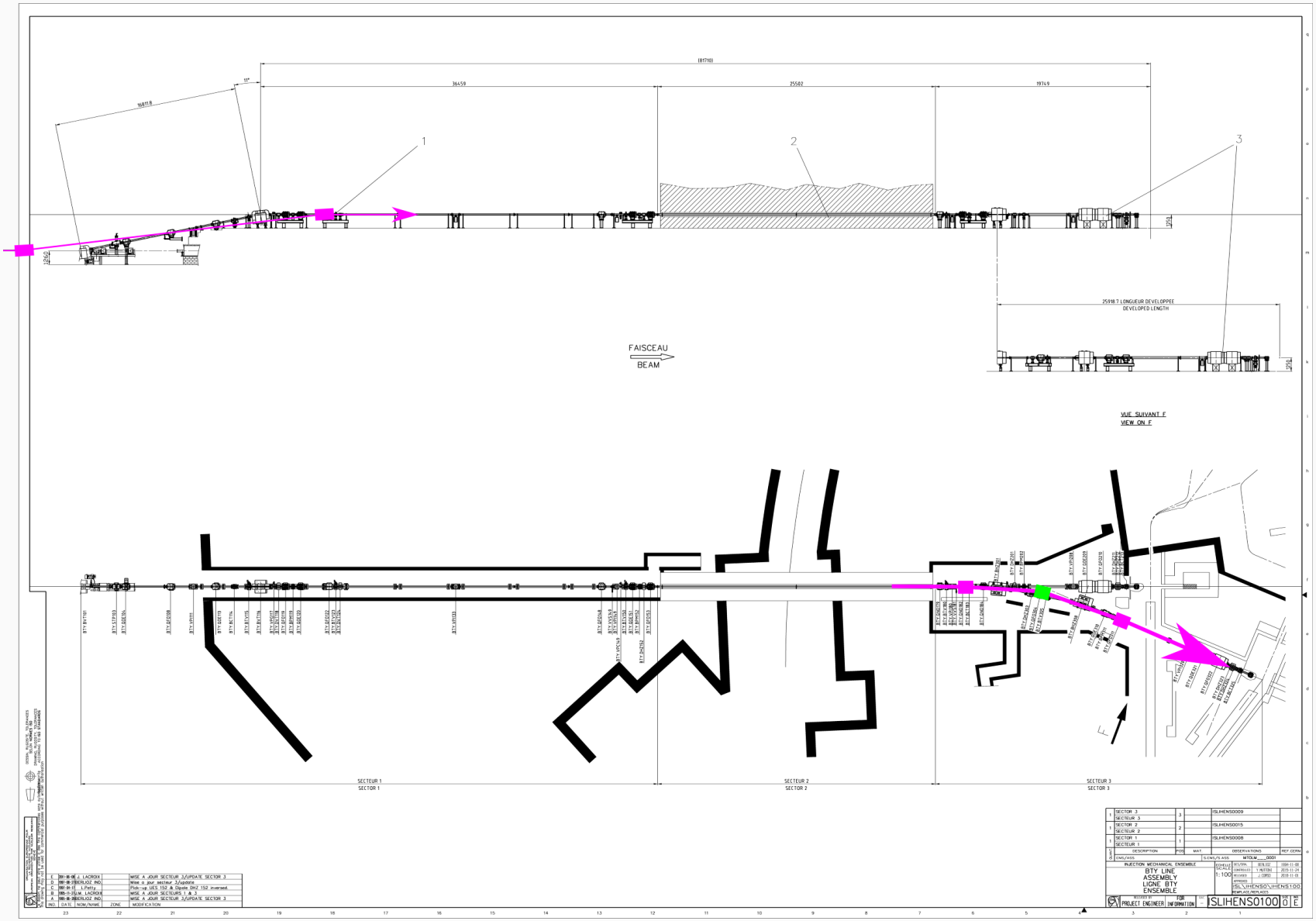
Cost estimate

- Drivers are magnets and power converters with total of 3 MCHF
- Supports, transport, civil engineering and integration studies remain to be estimated

	#	Cost in MCHF
dipoles + chambers	4	1.86
converters	7	1.12

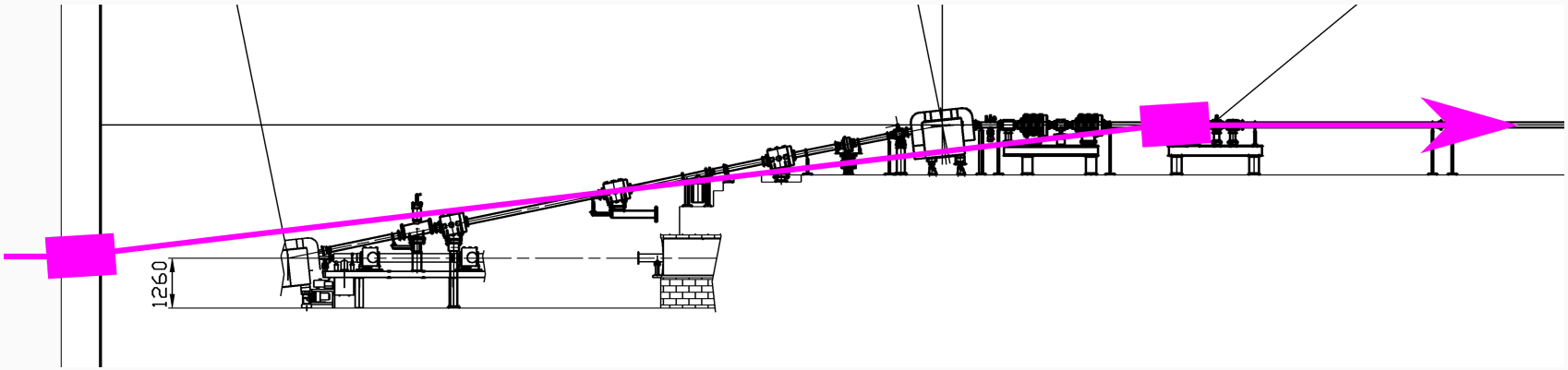
Upgrade alternative

Line geometry



BTY line upstream

- With present dipoles line angle has to reduce from 11 to 8.5 deg
- If symmetrically placed, both dipoles need to be shifted by 2.4 m



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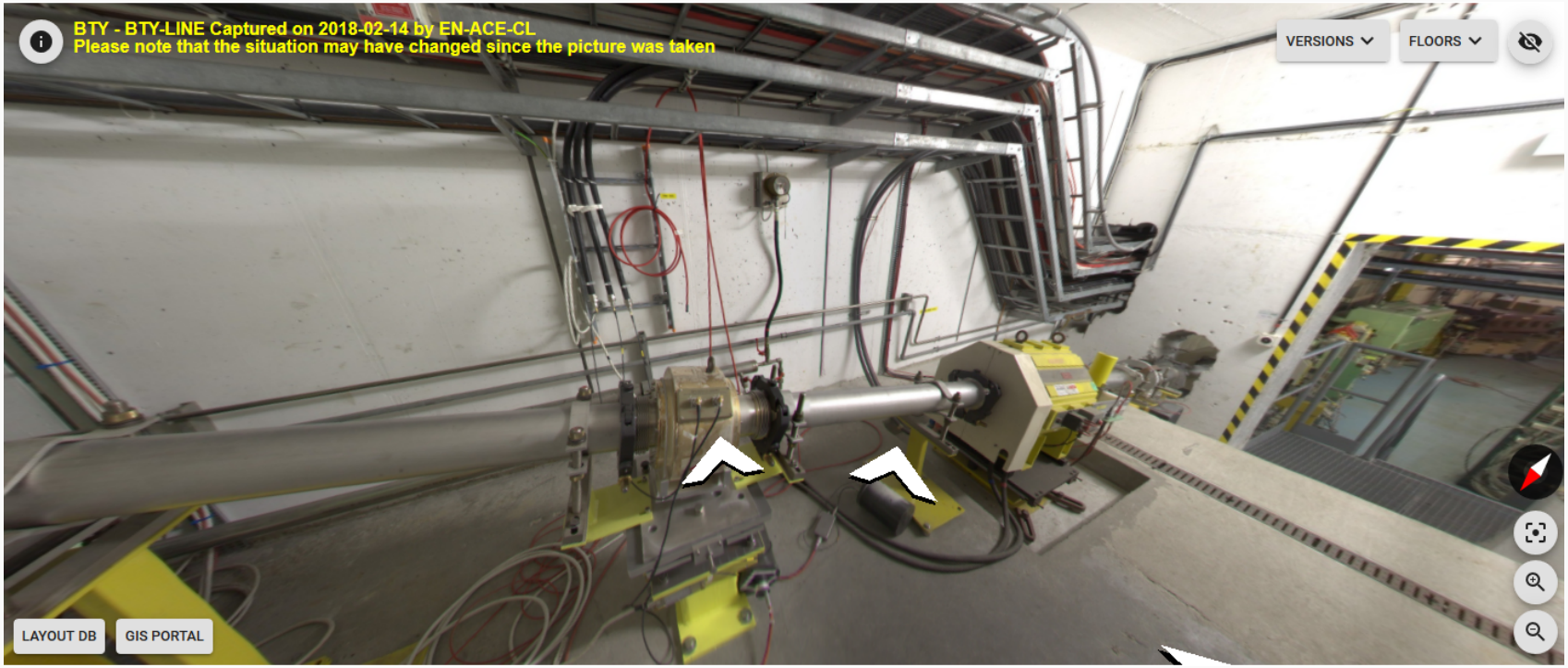

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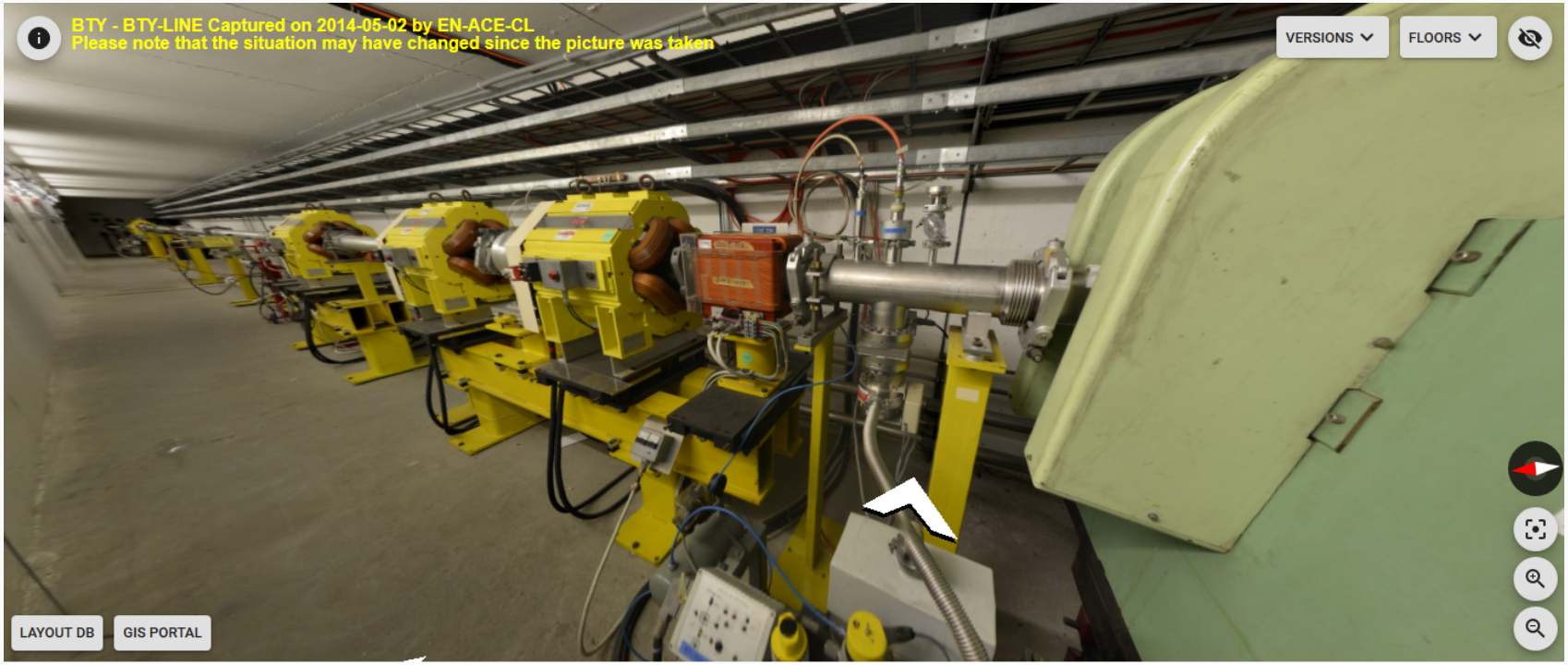

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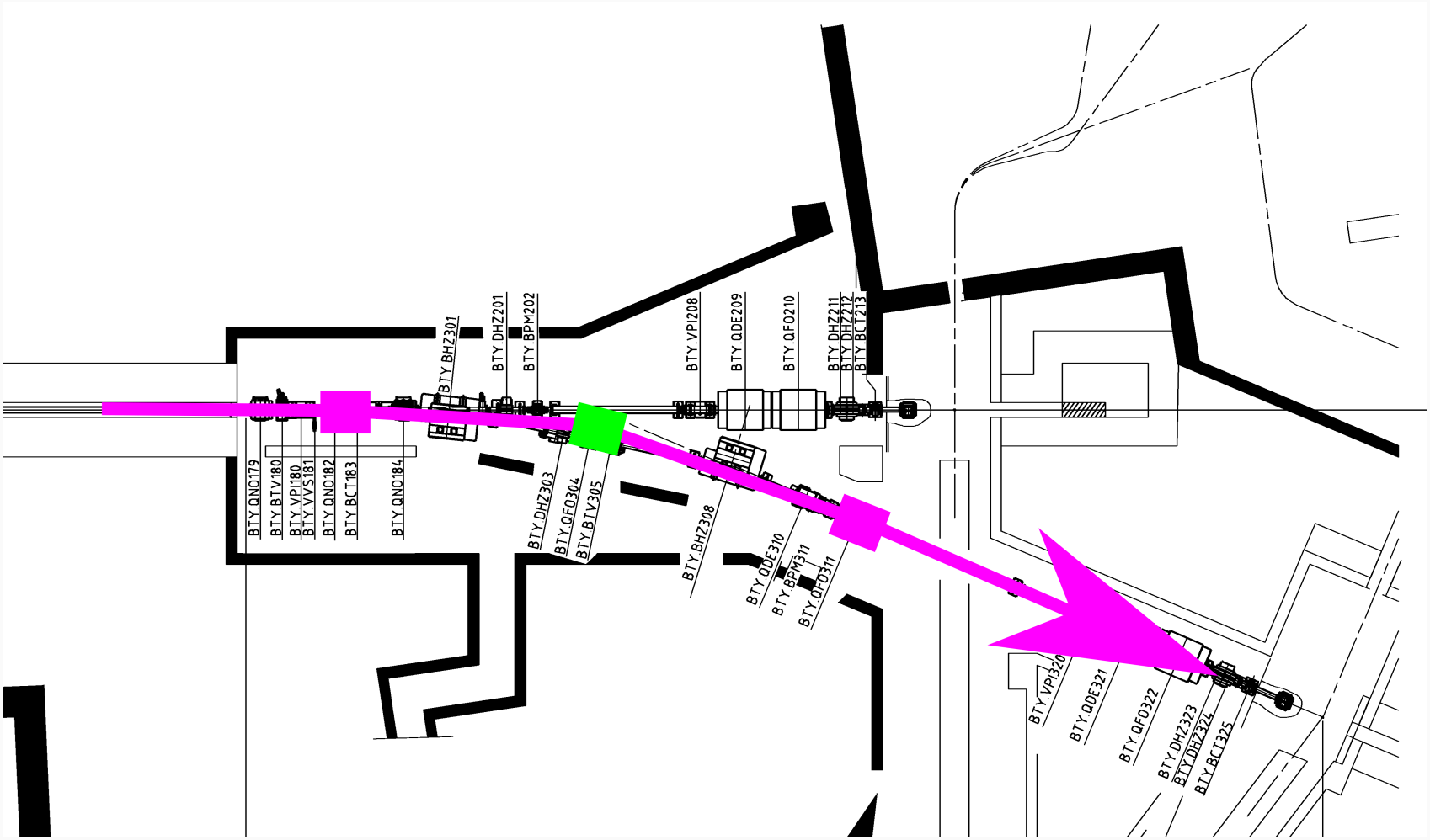
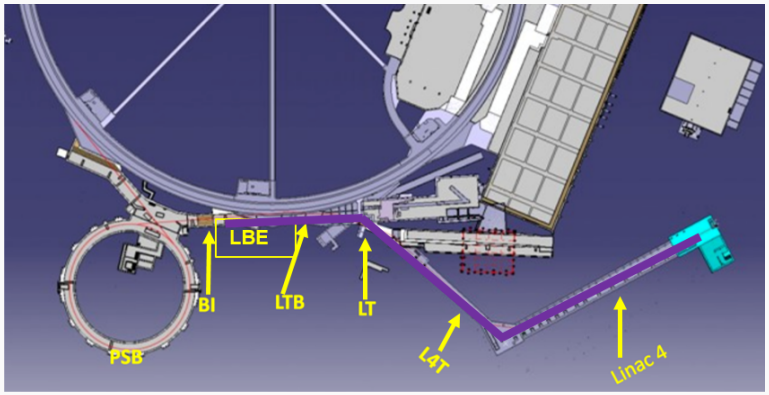
BTY line target area



Expected beam parameters from Linac4

Linac4 LBE run, B. Mikulec



- Beam current [mA] measured in the LBE line just before PSB entrance (Nov. 2019)
- Can expect $\approx$ 23 mA (unchopped beam current) at PSB entrance with current source for the post-LS2 restart
  $\rightarrow$ should be able to provide max. 4.8E13 p per pulse[2] to ISOLDE post-LS2 - more than pre-LS2

[2] 4 rings including 10% overall loss margin

Linac4 current in the next years 1/2, A. Lombardi

Goal is 45 mA in 2023

Determine maximum current that we can deliver to the RFQ with the present design – including stability and availability	06/2019
Study the geometry of J-parc and SNS where current in excess of 60mA are routinely obtained (their RFQ has comparable acceptance) and make some experiment in this direction at the test stand	12/2019
Test a different geometry à la J-parc (and review results)	12/2020

Linac4 current in the next years 2/2, A. Lombardi

Implement/optimise new geometry (extraction + LEBT)	06/2021
Measurement and optimization of the new geometry at the test stand	06/2022
Beam formation studies to gain informations and better simulate the transition plasma to beam	06/2022
Long term test at the test stand and decision to install in LINAC4	10/2022

Conclusions

- Transferring 2 GeV beams from PSB to ISOLDE facility is feasible - beam intensities expected to increase wrt run 2
- Baseline option with replacing dipoles and certain quadrupole converters at cost of about 3 MCHF (not including integration, supports, transport)
- Alternative of (partially) keeping dipoles and re-working the line geometry - severe integration studies needed
- Need statement from ATS sector management if and when studies should commence - being discussed in IEFC with input of groups involved