SPS 200 MHz RF Upgrade

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On behalf of LIU-SPS 200 MHz Upgrade team

SPS Upgrade
LIU Project

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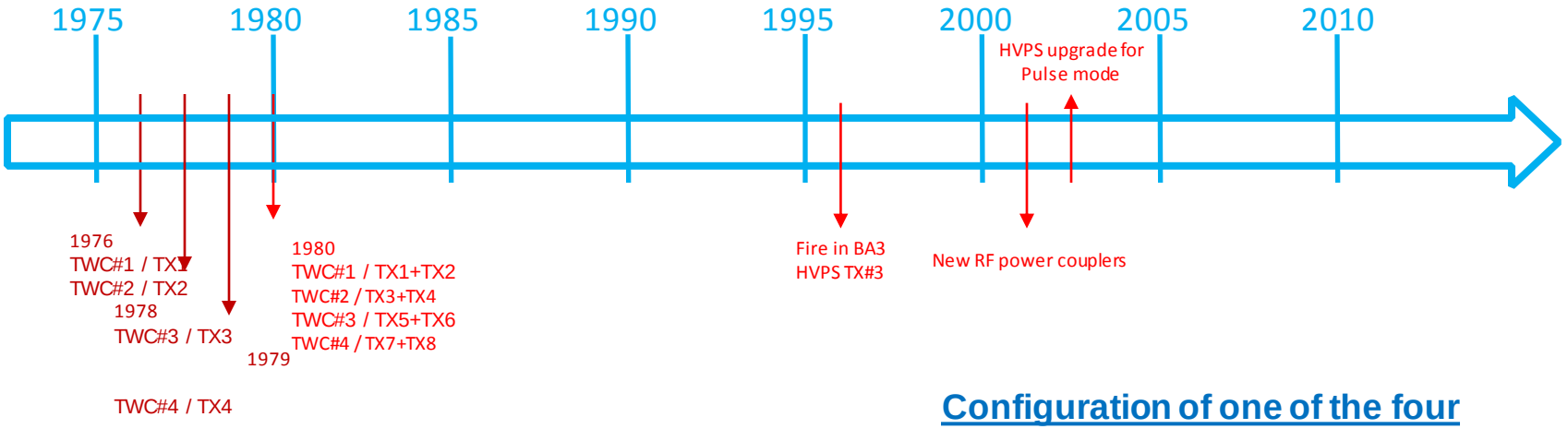
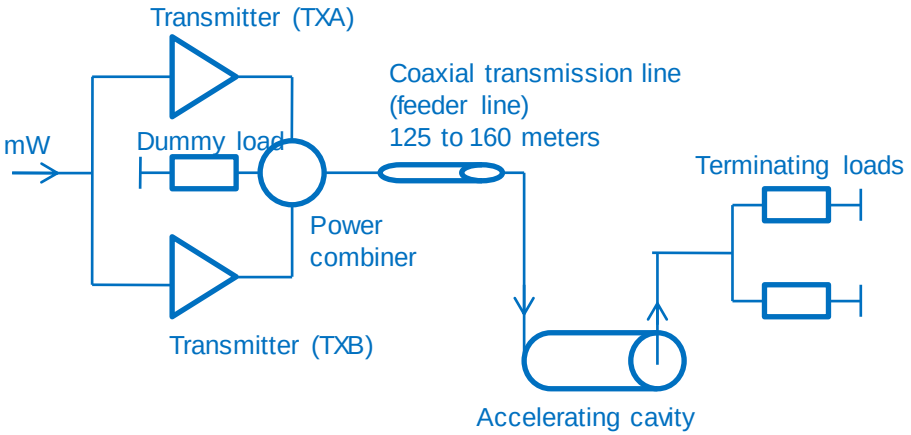
A bit of history



The SPS-RF started up in 1976 with two accelerating cavities

Since 1980, for the new role of SPS as proton-antiproton collider, there are four power plants operating @ 200 MHz

Configuration of one of the four 200 MHz power plant



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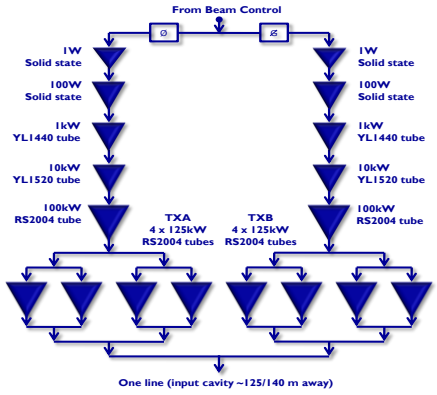
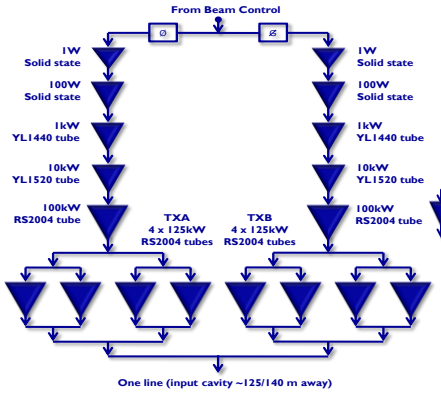
Existing amplifiers

20 x 135 kW RS2004
'Siemens' plant (1976 to 1979)

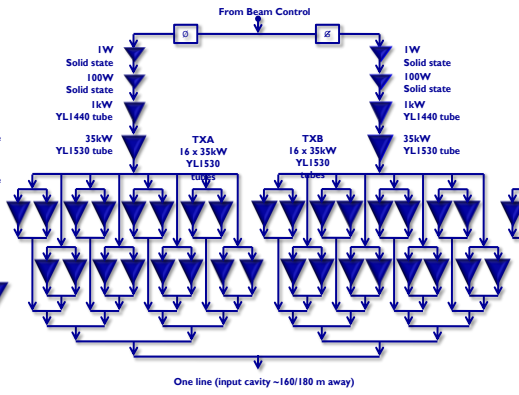
68 x 35 kW YL1530
'Philips' plant (1980)



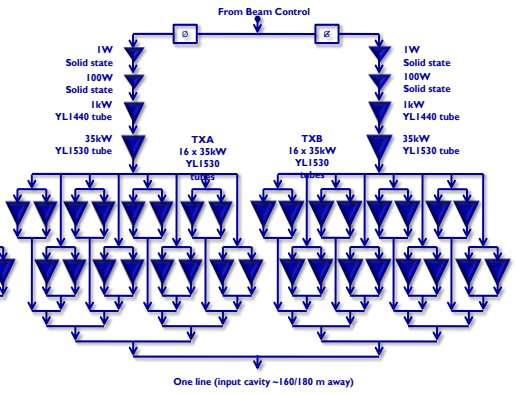
700'000 W



700'000 W



700'000 W



700'000 W

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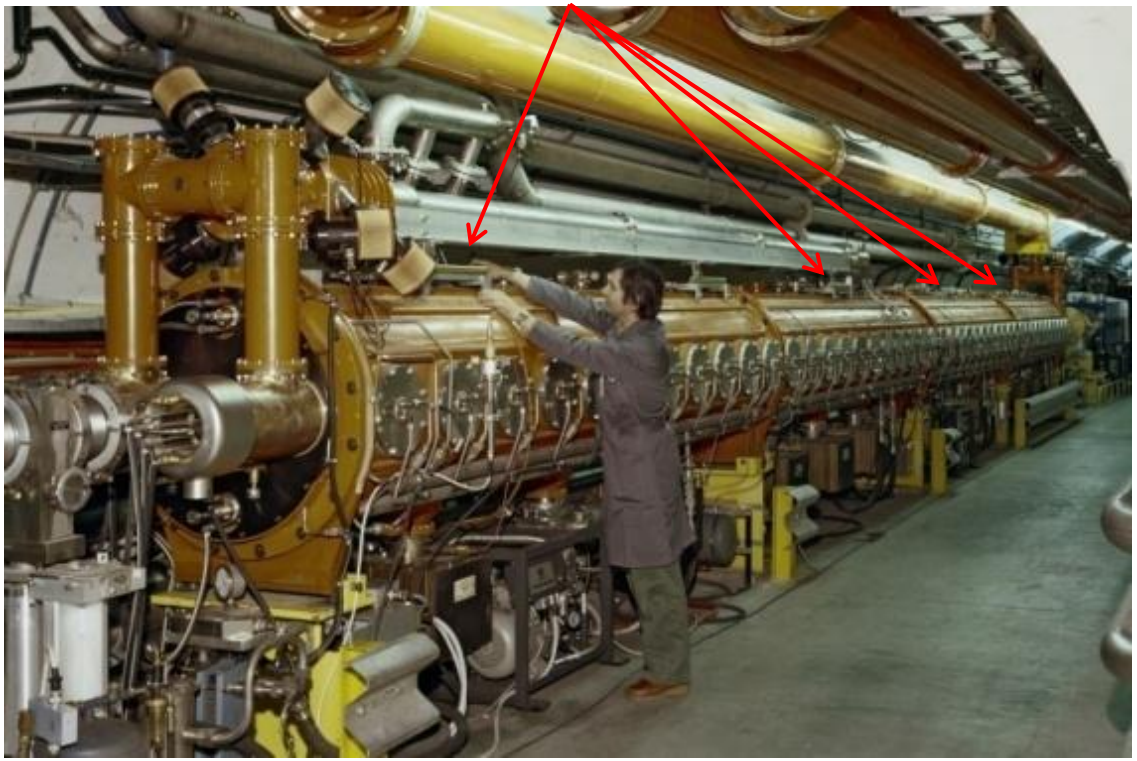
Travelling Wave Cavities: 2 x four sections & 2 x five sections

One section = 11 drift tubes

One four sections cavity
(four power couplers and two terminating power loads)



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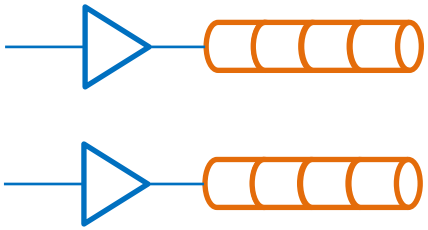
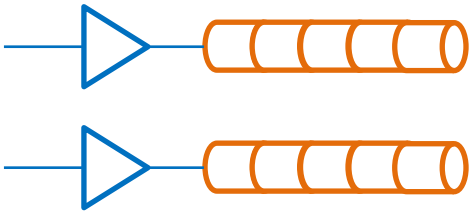
Cavities redistribution

2011 : 4 cavities (18 sections)

2 x 4 sections



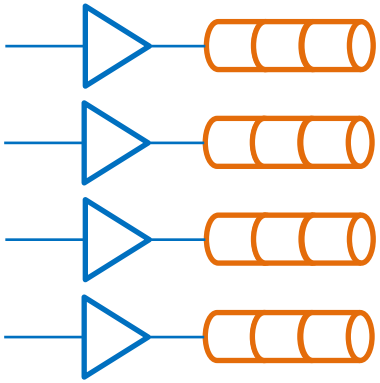
2 x 5 sections



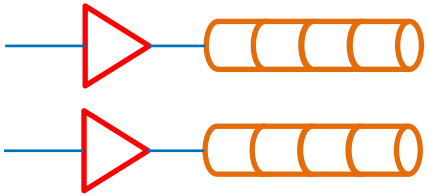
+ 3 spare sections

2018 : 6 cavities (20 sections)

4 x 3 sections



2 x 4 sections



+ 1 spare section

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Motivations

With present 4 cavities configuration we will have difficulties at high intensity LHC beam in the SPS : IPAC11, Upgrade of the 200 MHz RF system in the CERN SPS

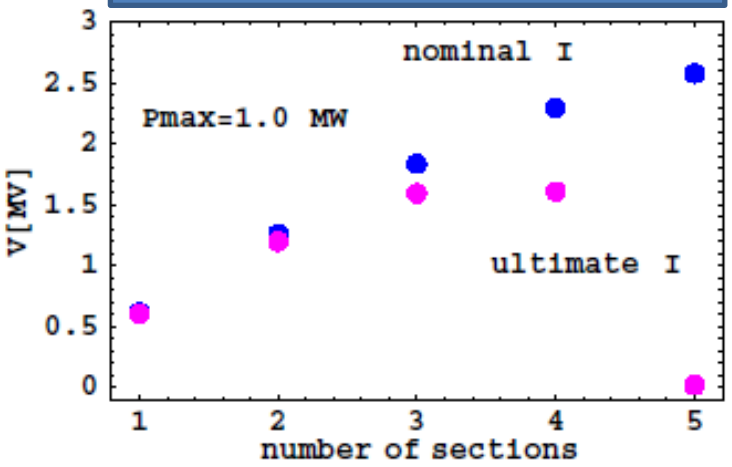
Increasing number of shorter cavities with 2 extra power plants should significantly improve the RF performance for higher LHC intensities

The best new compromise is 6 cavities:

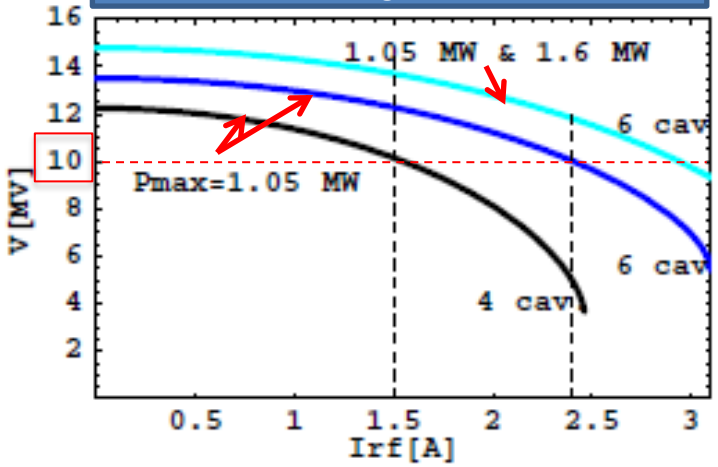
- 4 x 3 sections cavities with 1.0 MW
- 2 x 4 sections cavities with 1.4 MW

Courtesy of Elena Shaposhnikova

Available RF voltage as a function of # section with 1.0 MW RF and with 1.5 A and 2.5 A Irf



Available RF voltage as a function of Irf



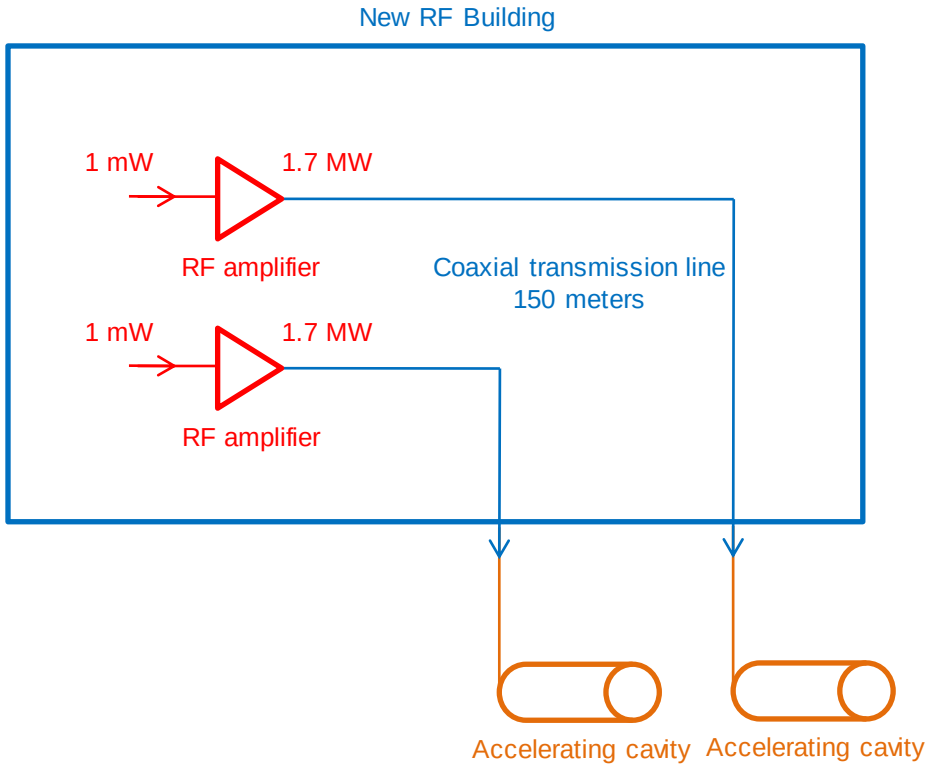
SPS 200 MHz RF system upgrade

Existing Amplifiers upgrade

New RF Amplifiers

New RF Building

LSS3 Tunnel integration



Existing amplifiers upgrade

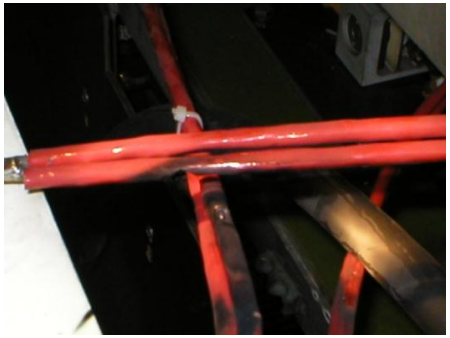
Ratings	Present	Future
Pulsed 10 us/43 kHz	700 kW	1100 kW

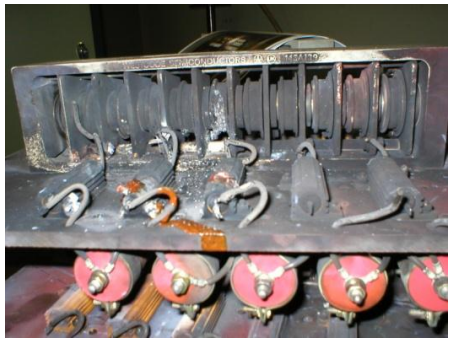
Philips air cooling plant has to be modified to allow higher power

Siemens HVPS need a full re-cabling and an air cooling improvement

Be ready to pay for new tubes

Philips burnt tube because of lack of air cooling





Siemens HVPS damaged HV cabling and diode bridge during high power tests

New 1.7 MW amplifier, i.e 1.4 MW cavity

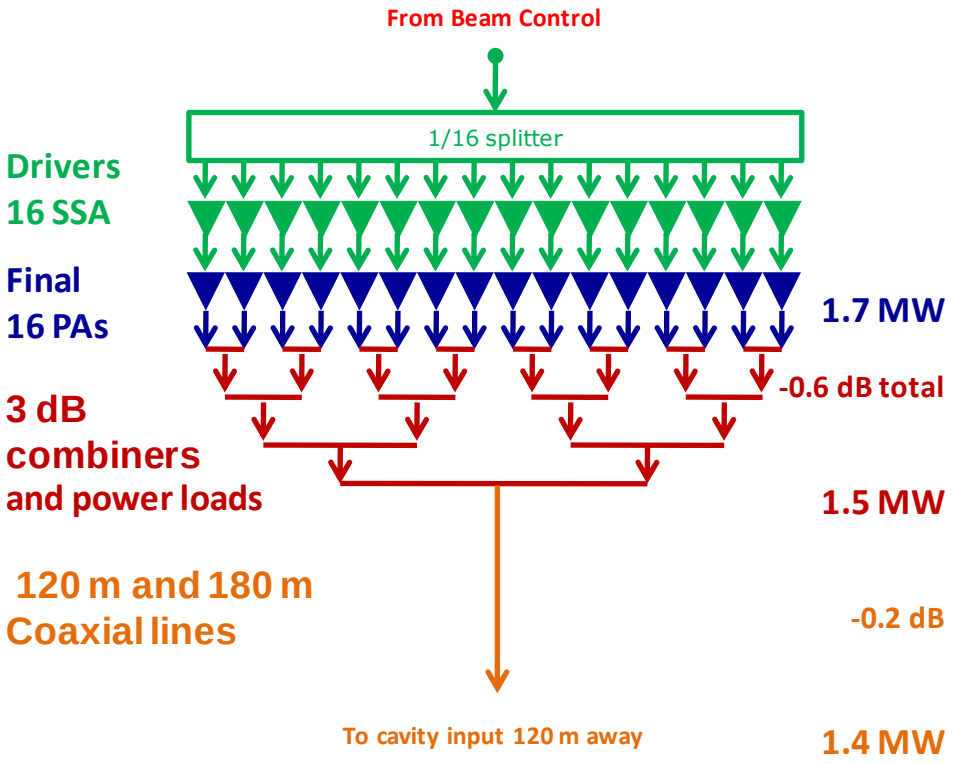
Pulse mode: 1.7 MW max (10 µs / 43 kHz)
Average: 850 kW (thermal limitations)

A major improvement to existing systems will be to have ***individual SSA drivers*** per Final

Combiners and lines will be the same as with existing systems

Four contracts :

- Drivers (SSA)
- Finals (SSA or Tetrodes)
- Combiners (3 dB above 100 kW)
- Transmission lines (coaxial, 345 mm outer)



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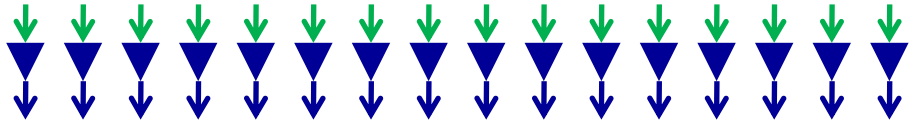
Two new power amplifiers

Qualified solution must have demonstrated to be reliable under scientific operation (not only broadcast operation)

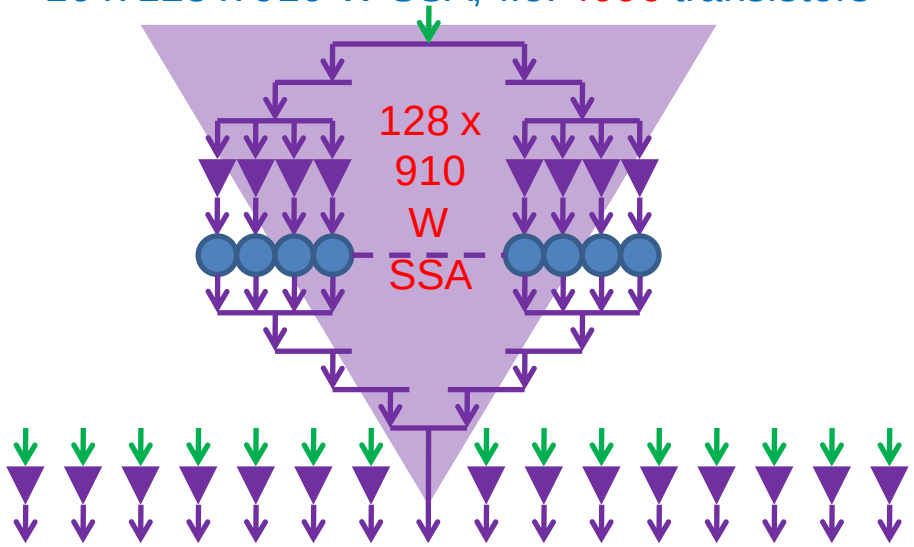
2 x 1.7 MW Klystron	2 x 8 x 225 kW tetrodes Equivalent to 'Siemens'
2 x 8 x 225 kW IOTs	2 x 16 x 106 kW tetrodes Equivalent to 'Philips'
2 x 4 x 450 kW Diacrodes	2 x 2048 x 830 W SSA Equivalent to 'SOLEIL'

Reliability and overall efficiency will be part of the adjudication

16 x 138 kW Tetrodes, i.e 32 tetrodes



16 x 128 x 910 W SSA, i.e. 4096 transistors



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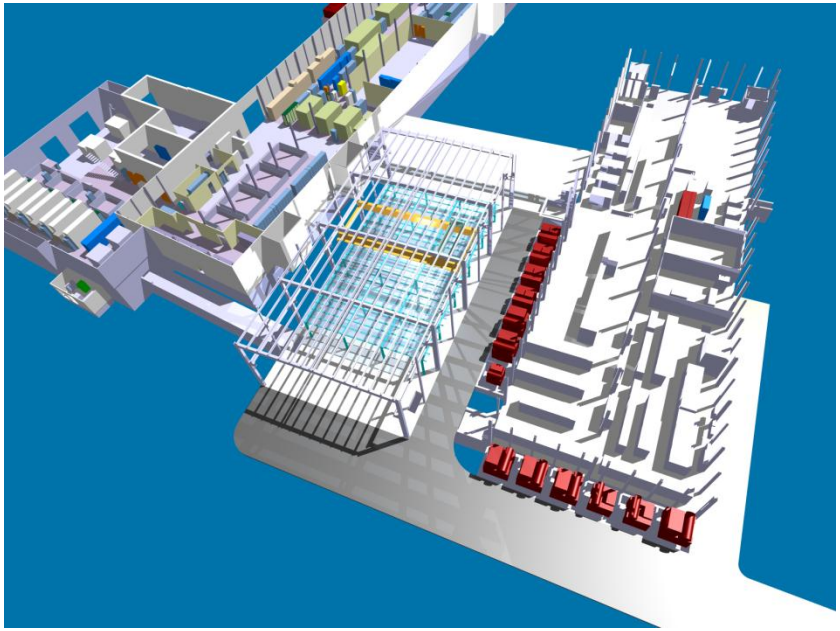
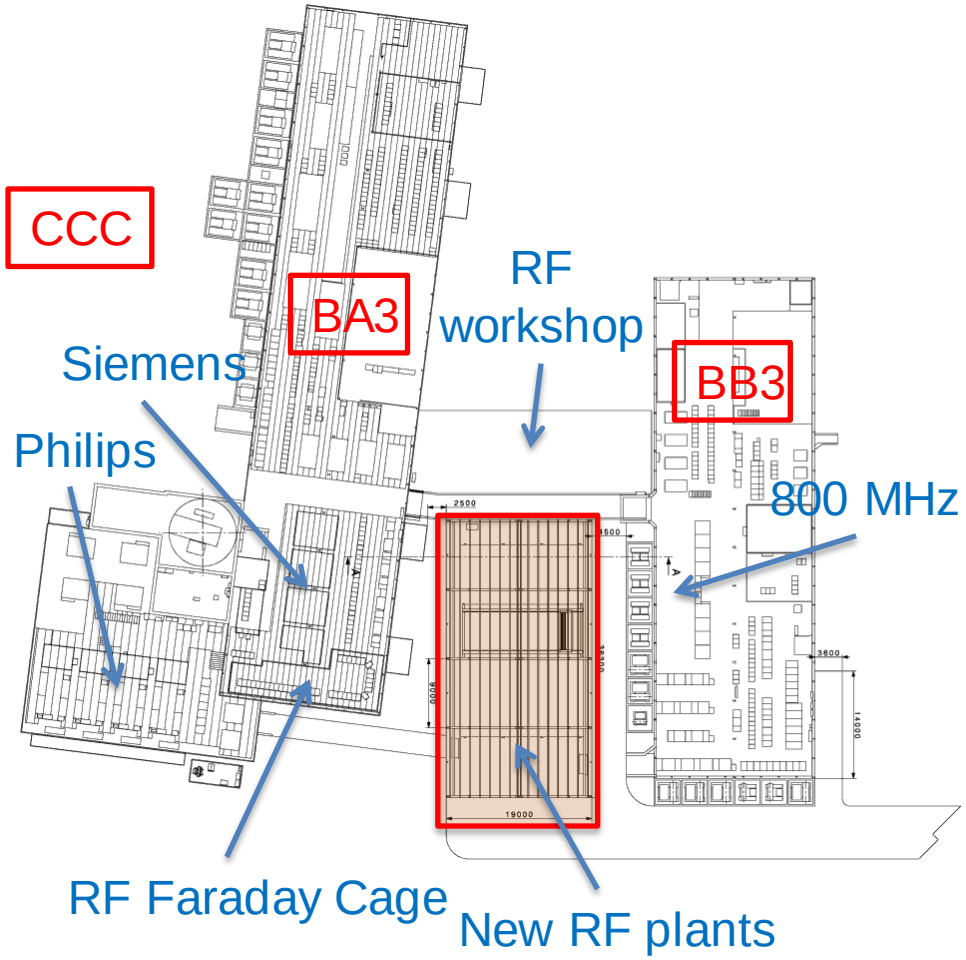
New RF building

Whatever the solution, SSA or Tetrodes, the same building

Best possible location is between BA3 and BB3

Maximum 'RF' foot print will be 2 x 450 m^2





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Cavities rearrangement

We already disassembled all cavities (2001-2004 realignment campaign)

We know all needed specific tooling

It will be a huge challenge …

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Cavities rearrangement

… even if this will be (very) stressing …

…we are confident we can do it, however…

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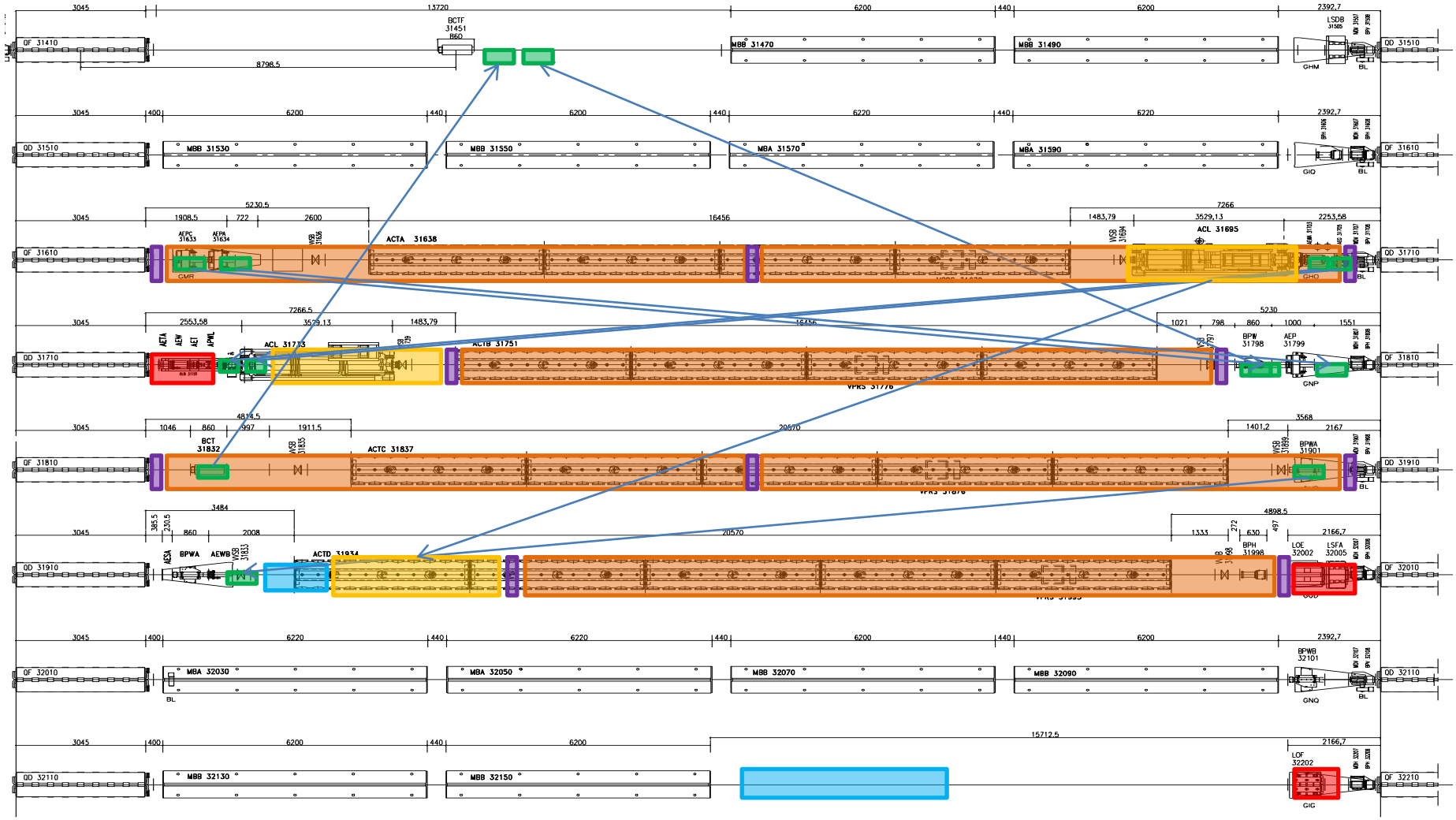
LSS3 rearrangement



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Key RF devices

Three spare sections : ~ 3.5 years

- Refurbishment (missing items)
- Power tests

New power couplers : ~ 5 years

- More power and shorter -> new design
- Prototyping and tests
- Series and pre-conditioning (x 30)

New amplifiers : ~ 5 years

- New building
- Construction of amplifiers
- Long duration tests

New LLRF : ~ 4 years

- Design
- Train onto a spare cavity in the new RF building
- Test onto an existing system prior to deployment

Impossible to re-arrange cavities within LS1

Only 5 pickups / 17 devices to be reinstalled

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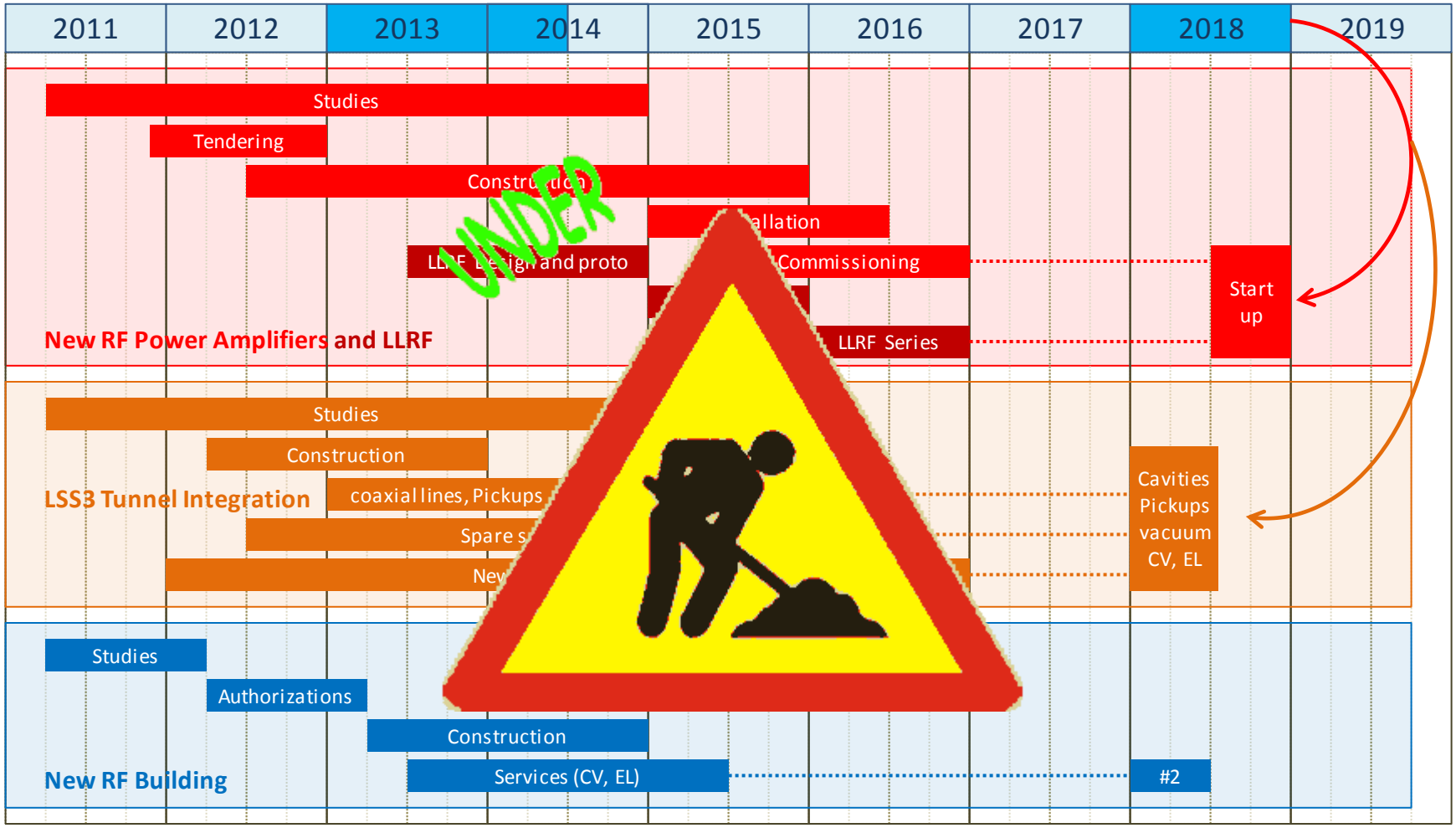
Schedule

6 months cavities re-arrangement
2 months RF Power conditioning
4 months LLRF commissioning



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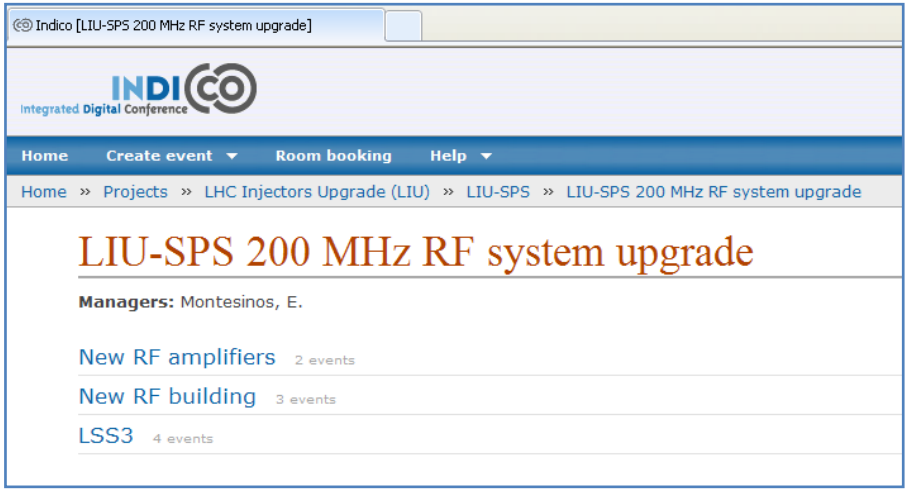
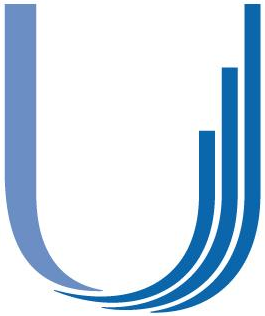
Persons involved

Dep-Group	Persons
BE-RF	Eric Montesinos, Thomas Bohl, Wolfgang Höfle, Urs Wehrle, Elena Shaposhnikova, Philippe Baudrenghien, SPS power team
BE-ABP	Patrick Bestmann, Yannis Papaphilippou
BE-ASR	Paula Carvalho Correia, Emmanuel Paulat
BE-BI	Christian Boccard, Patrick Odier
DGS-SEE	Guillaume Fontana, Cécile Pinto
EN-CV	Michel Obrecht, Mauro Nonis
EN-EL	Guillaume Gros, Joël Lahaye, Christophe Crombez
EN-HE	Caterina Bertone, Pascal Brunero, Serge Pelletier, Yann Seraphin
EN-MEF	Frédéric Galleazzi, Yvon Muttoni, David McFarlane
GS-SE	Luz-Anastasia Lopez-Hernandez, Evelyne Crocci-Torti, Antoine Kosmicki
TE-VSC	Paolo Chiggiato, Antonio Mongelluzzo
TE-MSC	Jérémie Bauche





LHC Injectors Upgrade

THANK YOU FOR YOUR ATTENTION!