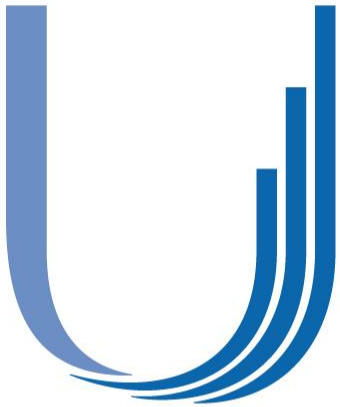


LHC Injectors Upgrade

LHC Injectors Upgrade

Status of the PSB SEM grids for injection matching

Jocelyn TAN, BE-BI

On behalf of C. Vuitton, G.J. Focker, F. Roncarolo, R. Veness, B. Riffaud

CERN

Outline

- Motivations
- Specifications
- Status
- Summary

Motivations

- **Why?** Measure the transverse matching and the emittance of the beam injected from Linac4

- **How?** see Engineering specification:
  Inject ½ PSB turn (ie ~500ns long pulse) and acquire up to 20-30 circulating profiles of the circulating beam with a SEM.

- **When?** Installation during YETS17-18 for beam commissioning in 2018.

Dedicated operation mode

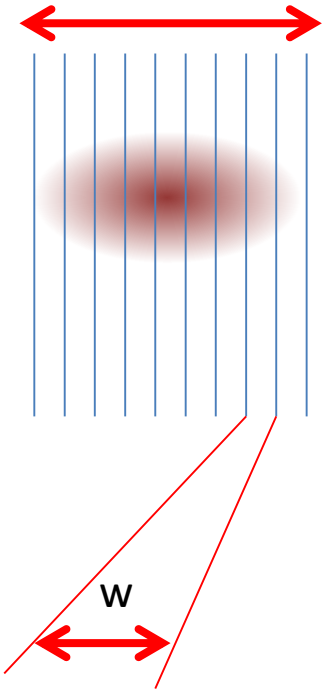
- Beam parameters

Beam kinetic energy	160 MeV
Beam intensity	$5x10^{9}$ to $2x10^{11}$ protons
Beam pulse length	50 to 500 ns
ε_{rms} of incoming beam	0.5 μm
Beam size (H/V)	1.1 to 2.4 mm (rms)
Beam size resolution	<2%

- A pair of monitors (H+V) in one ring is sufficient: ring3.
- Permament implementation for setting up new beams and MDs.
- Protection of fragile wires
  - Not PPM for reliability reasons
  - External condition interlock to prevent injection of more than 1 turn while the monitor is in.
- Beam dumped after ~100 turns: set BT line for extraction at 160MeV.

Scattering angles and energy loss with graphite

Compact monitor
Grid size : 25.2 mm
64 graphite wires



wire spacing 0.4 mm
Diametre ∅= 33 μm

Density ρ	radiation length X_0	wire spacing w	wire radius r
2.265 g/cm²	18.8 cm	0.4 mm	17 μm

- Average values for average (effective) thickness d = $r^2 \pi/w$ = 2.1 μm
- Rms scattering angle $\vartheta_{rms,\max} = \frac{13.6\ \text{MeV}}{\beta_r^2 \gamma_r E_r}\sqrt{\frac{d}{X_0}} = 0.15\ \text{mrad}$
- With logarithmic correction : $\vartheta = 0.09\ \text{mrad}$
- Energy loss $\Delta E_{av} = -2.2\ \text{keV}$ corresponding to $\frac{\Delta p}{p} = \frac{1}{\beta_r^2}\frac{\Delta E_{av}}{E_{kin}+E_r} = -0.0075\cdot 10^{-3}$
- Blow-up (phys. rms emittance) due to interaction with monitor: 0.06 μm/turn

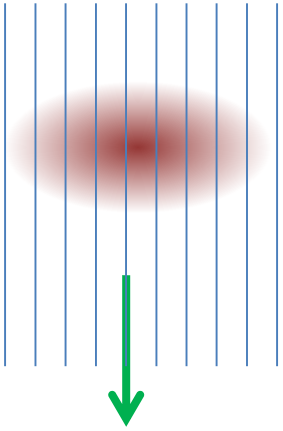
⇒ **Blow-up per turn due to monitor almost one order of magnitude lower than the expected emittance of 0.5 μm (rms)**

⇒ **Measurement can be envisaged**

Remarks:

- Expect significant tails, which may lead difficulties with profiles widths estimates (systematic errors)
- Thick frame (±15 mm) for stopping scattered protons

Other considerations



Electronics: still under development

- Beam interaction : ~ **10 μA max** in the graphite wire
- Tungsten would yield ~3x larger signal but proton scattering is also larger

➢Amplifier Type	Linear, Integrator in he ADC module
➢Input impedance	93 Ω
➢Bandwidth	>5MHz
➢Sampling rate	1 MHz
➢Cable length	the shorter the better (max ~25 m)

- 2018: Commissioning with a prototype

Concerns on ageing

- Sensibility of central wires seeing more beam reduced w.r.t. outer wires

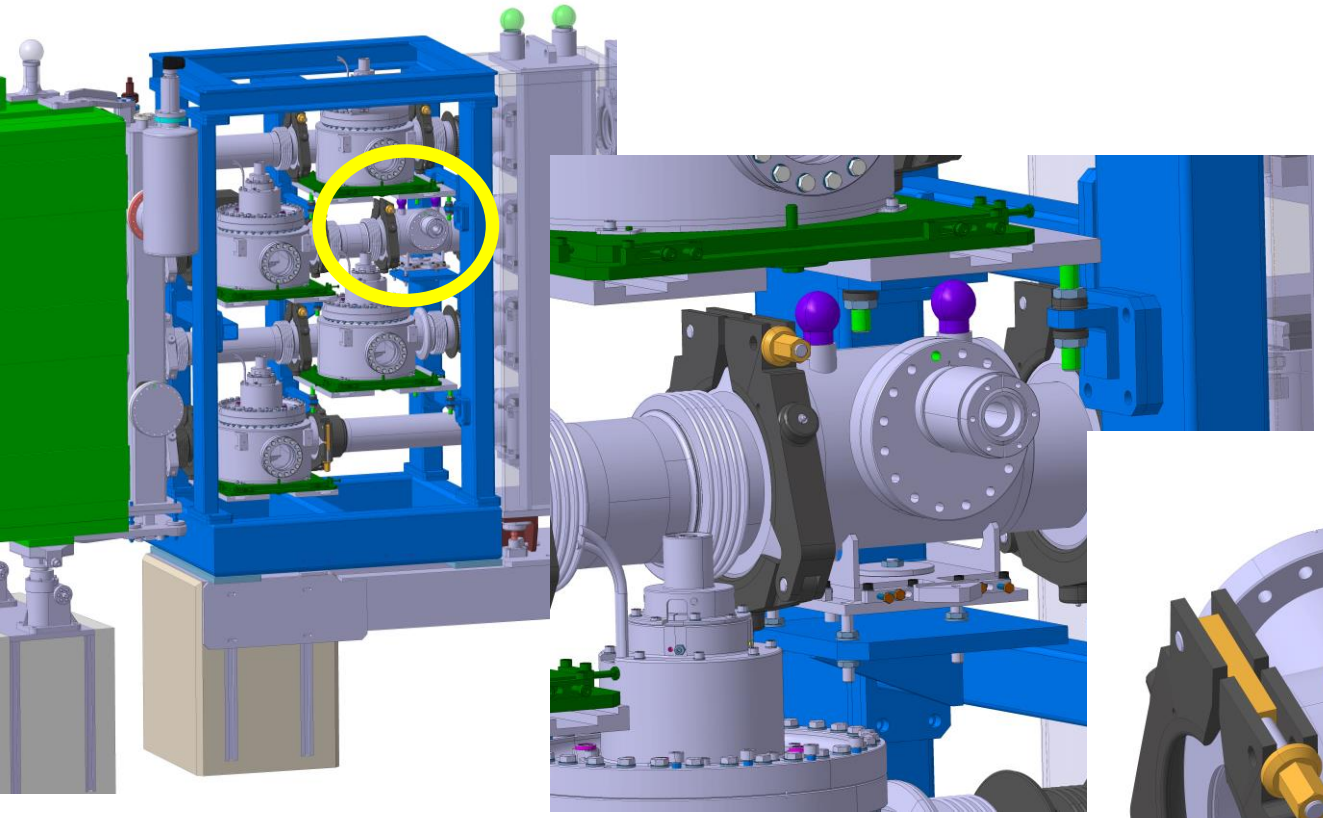
Cabling: plan #10071

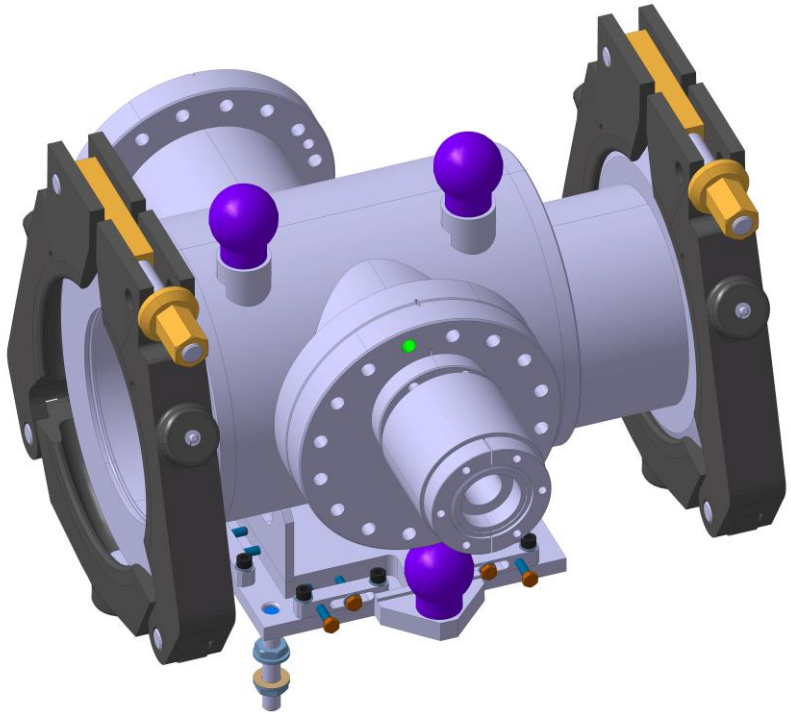
- Budget charged by EN/EL in 2016

ECR

- It will be done when the integration work is complete.

Mechanics: integration in 4L1



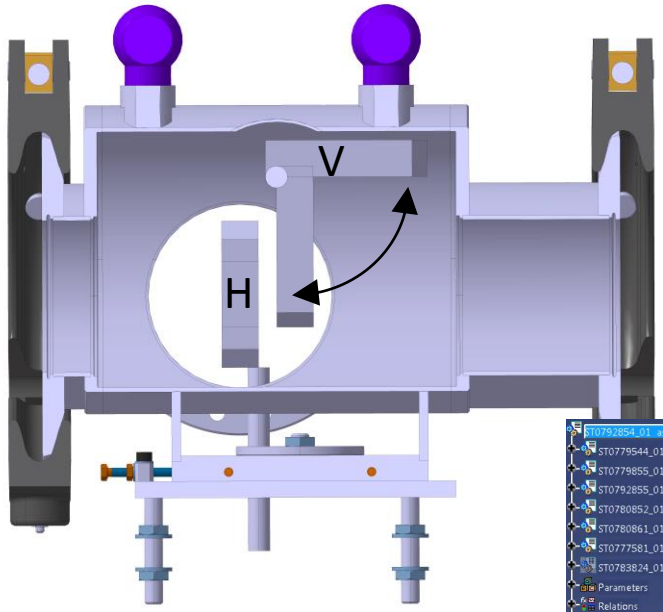


YETS17-18 : installation on a temporary support structure

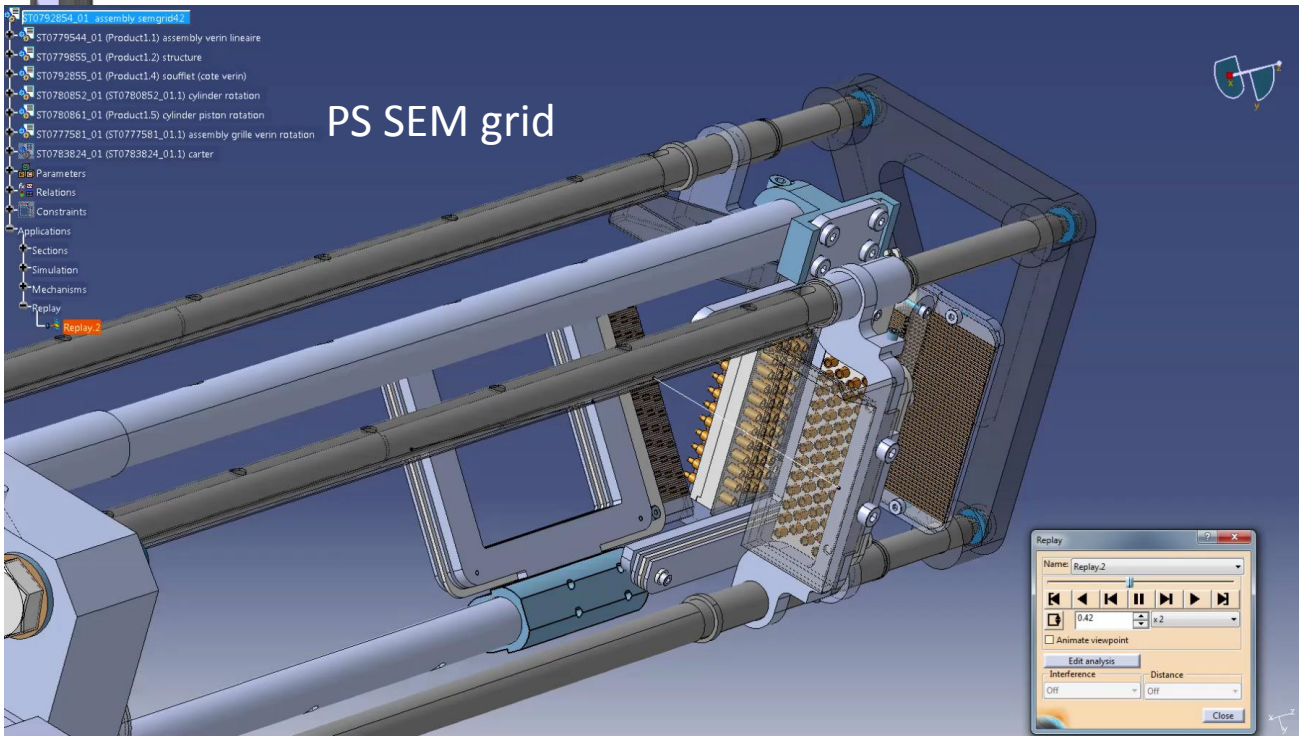
LS2: The final support system (in blue) will be installed with the series of wire scanners

Courtesy: B. Riffaud

Mechanics: grids actuation

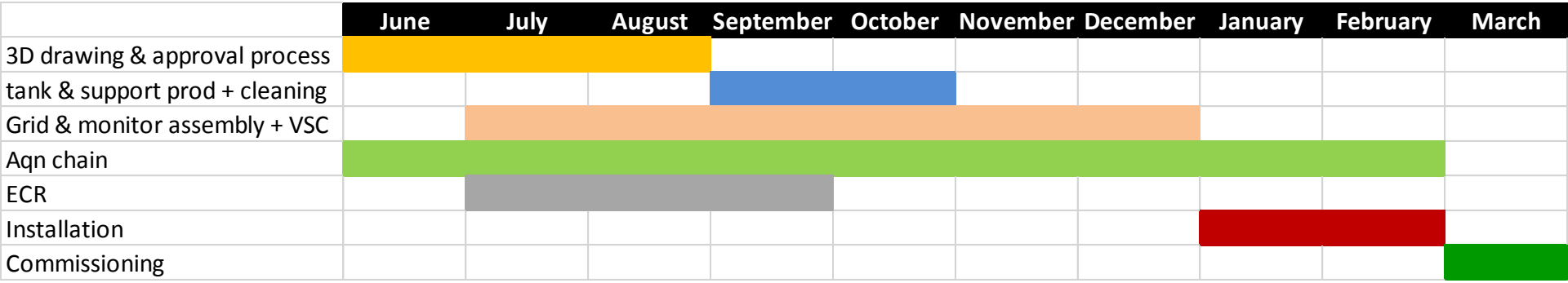


- No bellow
- Actuation by magnetic motors:
  - translation for H plane
  - rotation for V plane
- Animation example below: PS SEM grid
- Wiring in vacuum: use of extruded kapton
- First tests of grid assembly: end of June



Courtesy: C. Vuitton

Planning and budget



- Tight mechanic production schedule
- It should be supported as a priority in MME by the LIU project

2016

- Cabling+electronics 57 kCHF

2017: **65% commited**

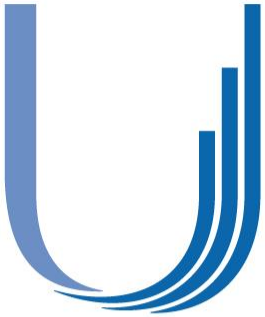
- Design office 15 kCHF
- Acq chain+actuations 45 kCHF
- Monitor production 20 kCHF

2018

- Installation 4 kCHF

Summary

- Mechanical design nearly completed
- No below for enhanced reliability
- Monitor should be installed in YETS 17-18, but…
- We need LIU support to set Tank production as high priority for EN-MME in Q3-2017
- Beam commissioning will likely take place with a prototype board.



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THANK YOU FOR YOUR ATTENTION!