MDI Status and Plans

Lau Gatignon / EN-MEF
On behalf of the MDI working group

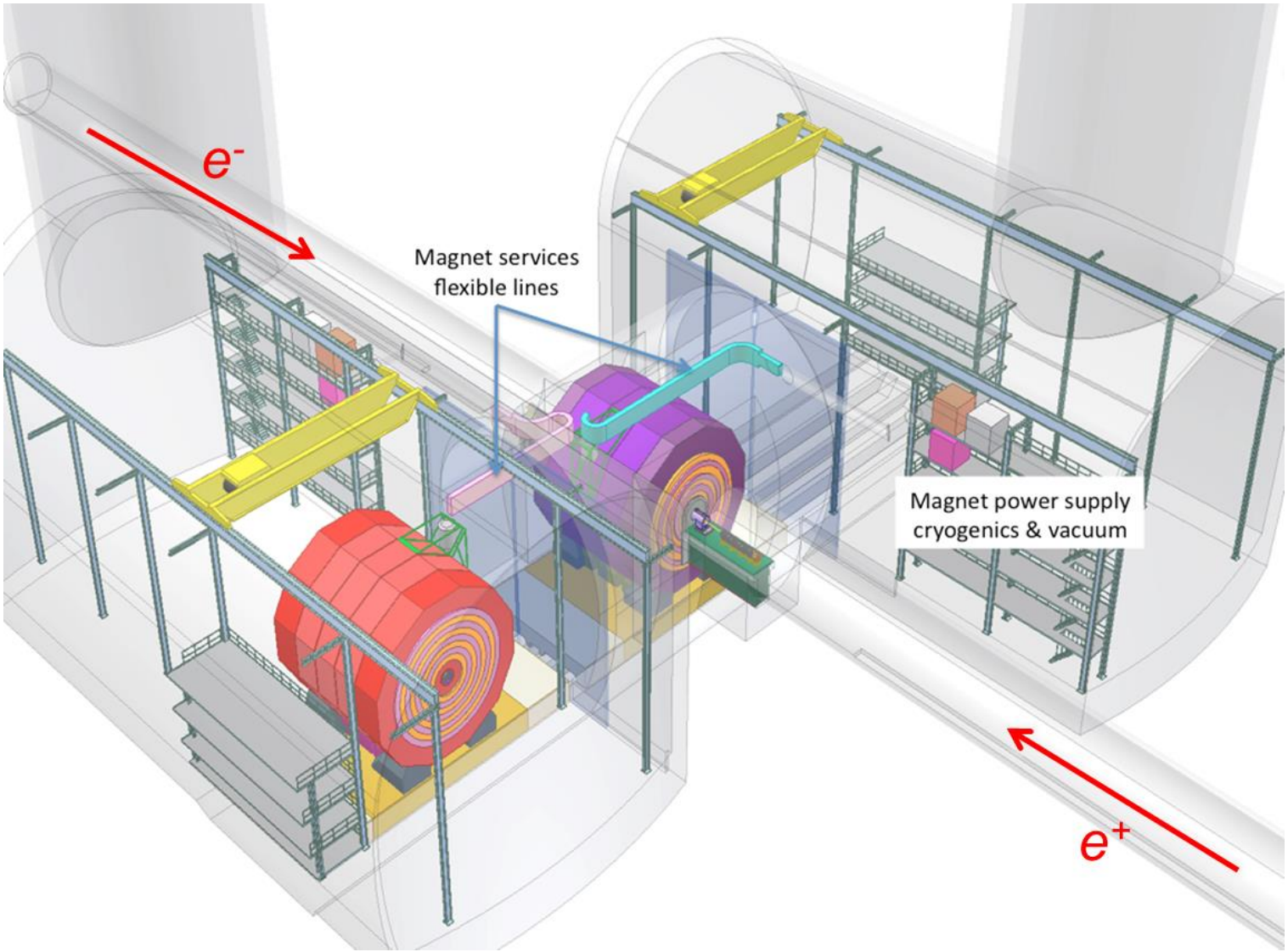
Outline

- What is MDI
- Announced changes to detector model
- Changes to MDI
- Plans

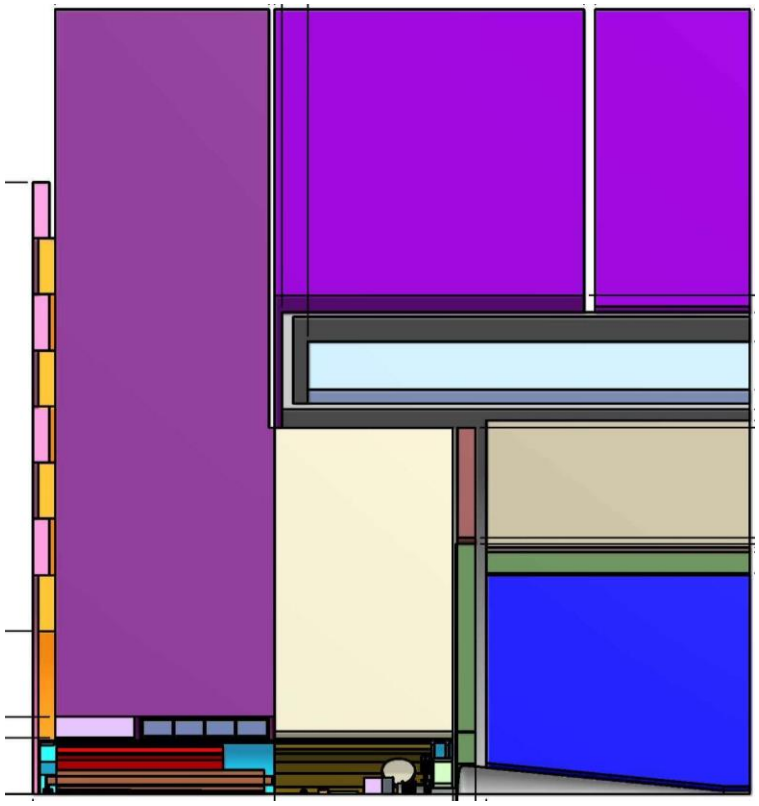
What is MDI

- The Machine Detector Interface must ensure optimum luminosity for the experiment(s) with minimal backgrounds and includes the local environment and infrastructure.It integrates the post-collision line.
- The baseline for the CDR was based on a concept with two detectors operating in push-pull mode and with the final focus quadrupoles QD0 as close as possible to the interaction point (L* = 3.5 m), i.e. in the detectors.
- The MDI design included concepts for the QD0 design as well as its stabilisation and pre-alignment, but also IP feedback, BeamCal and Lumical integration, vacuum layout, cavern layout, and so forth.

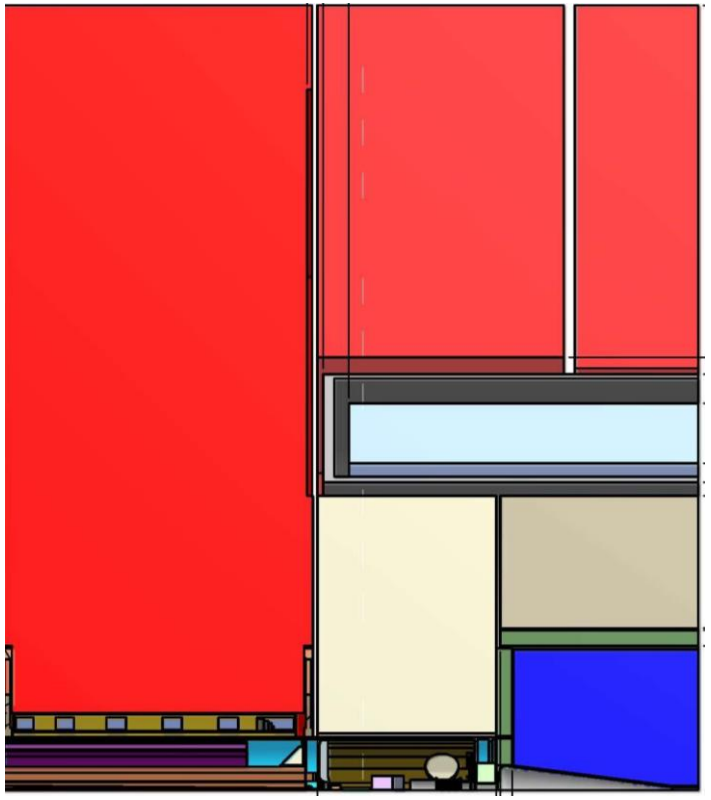
The CDR concept:



CDR Detector Concepts



L* = 4.4 m



L* = 3.5 m

Very similar but different L* (so far)

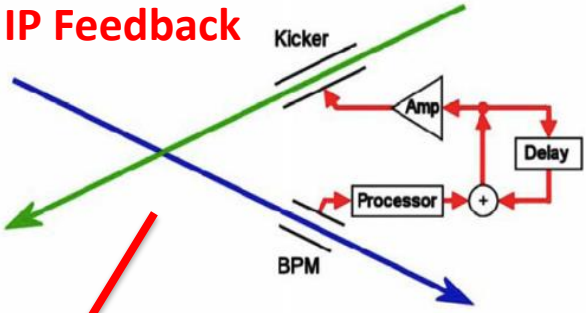
MACHINE DETECTOR INTERFACE

Plus others .....

Anti-solenoid

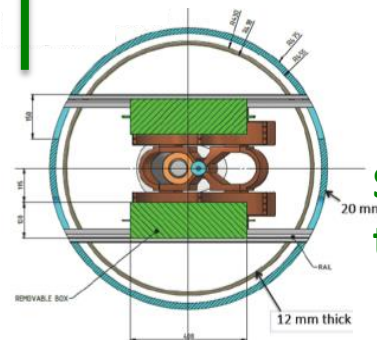
Beamcal+
Lumical

IP Feedback

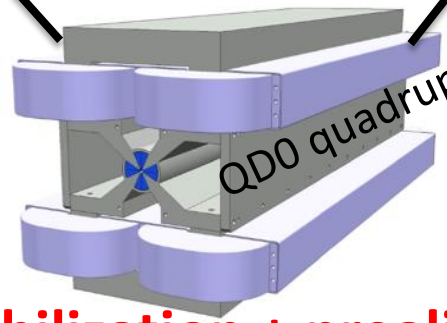


Post collision line

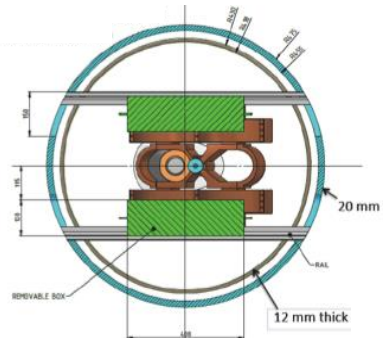
Vacuum



Support tubes



+Stabilization + prealignment



Some justifications for the CDR choice

The choice of short L* was justified by the fact that

- this option would provide the maximum (peak) luminosity
- this layout is the most challenging
  (If you have a plausible solution for short L*, the longer L* should be easier for the stabilisation, radiation, B-field, etc)
- at the time the pre-alignment tolerance was considered unrealistic (2 μm for L*=8 m, 10 μm for L* = 3.5.m).
  Since then significant progress has been made in the BDS optics.

Announced changes to the detector model

- The detector team has decided to concentrate for the time being on a **single** detector with all-silicon tracking.

No more push-pull

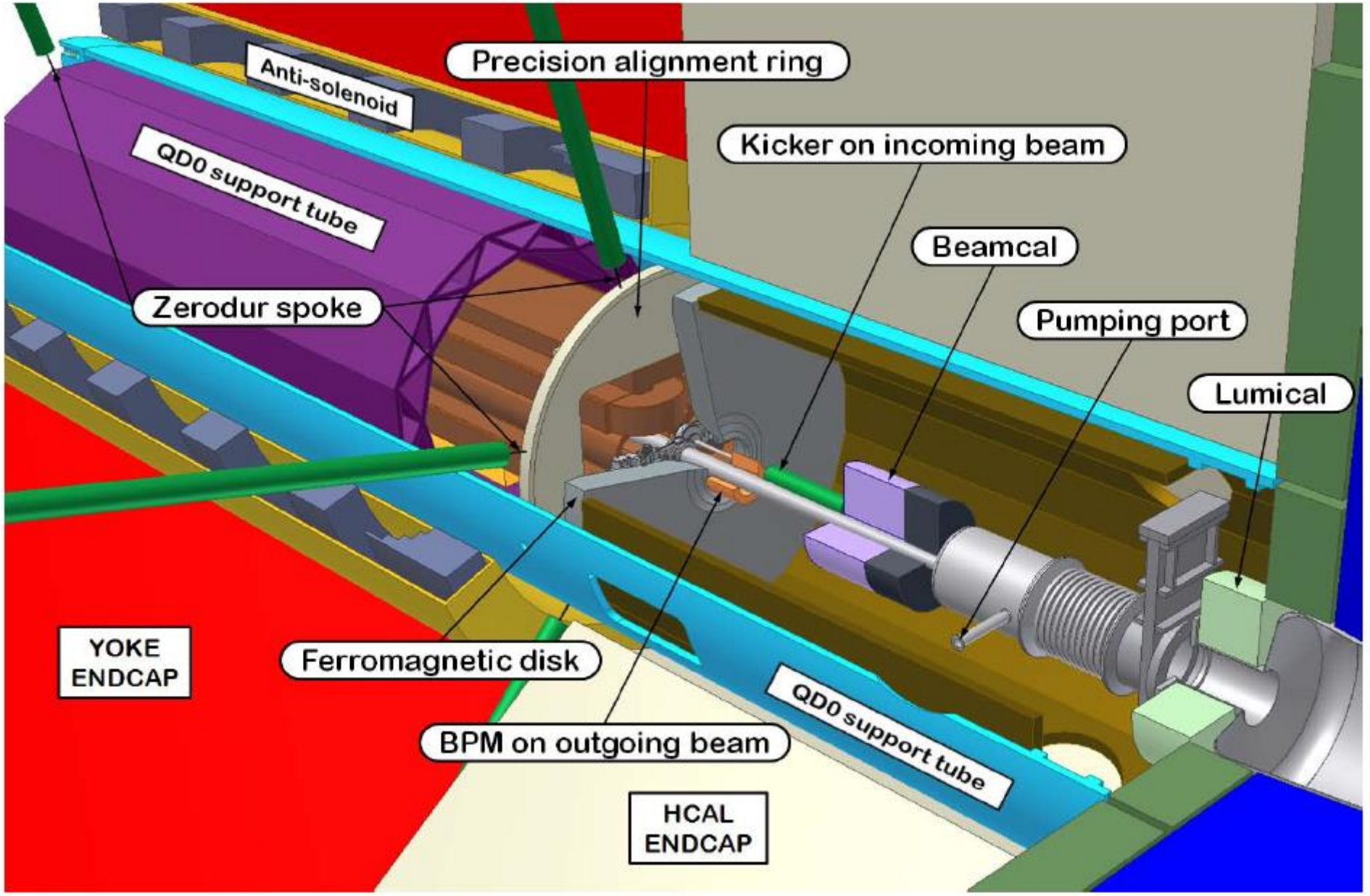
- A number of **parameters have been** frozen to allow consistent studies on detector optimisation and performance.
- For the forward region design they concentrate now on the long L* solution with **QD0 in the tunnel**, i.e. outside the detector.
  The exact value of L* remains to be defined precisely.

This has major implications for MDI

Some of the frozen parameter values

Parameter	Value
Magnetic field of detector solenoid	4 T
Inner bore radius	3.2 m
Inner layer radius of vertex detector	31 mm
Half length of tracking detector	2.3 m
Tracking detector radius	1.5 m
Si-W electromagnetic calorimeter	25 layers
Scintillator-steel hadronic calorimeter	7.5 λ_I

The detector length and L* depend on shortening of end yokes, end coils, …

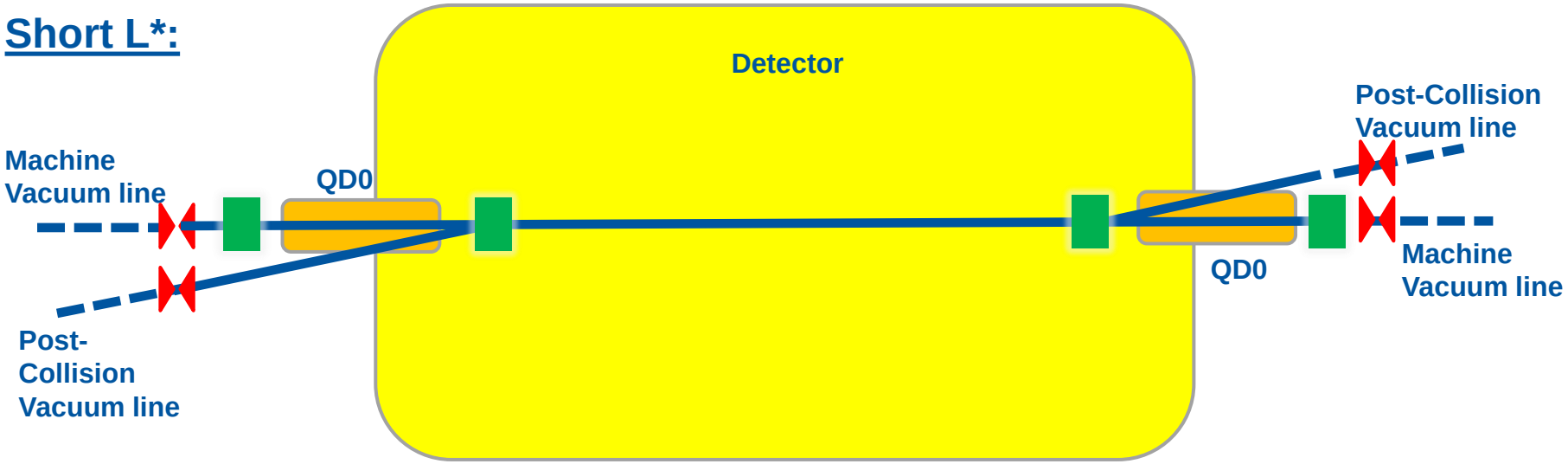

Anti-solenoid
Precision alignment ring
QD0 support tube
Kicker on incoming beam
Beamcal
Zerodur spoke
Pumping port
Lumical
YOKE ENDCAP
Ferromagnetic disk
QD0 support tube
BPM on outgoing beam
HCAL ENDCAP

What if no push-pull

- A number of constraints for access to QD0 and/or vacuum connections could be dropped.
  Also the need to isolate the QD0 vacuum tube may no longer be so imperative.
- Cedric Garion from TE/VSC has e.g. had a first look at the vacuum layout implications: see next slide.
- Opening of the detector and access to equipment may become simpler.

Beam Line Sectorisation Scheme

Short L*, no push-pull



*Pumping port number and position could change depending on pressure requirements or space constraints…

QD0 in the tunnel or not

- QD0 in the detector takes away a significant fraction of the **acceptance in the forward region**. **Although with recent HTS magnet technology it may be possible to reduce the loss.**
- Due to the presence of a **strong magnetic fiel**d, **higher radiation** and **lack of space and access** inside the detector some critical components may require more or longer interventions, leading to loss of integrated luminosity.
- For the **chosen L* value** the **BDS optics must be re-optimised** (impact on QD0 parameters, required pre-alignment precision, etc).
- In case QD0 moves to the tunnel, the question is legitimate whether the **anti-solenoid** and/or **IP feedback** are still required inside the detector and how their implementation must be revised.

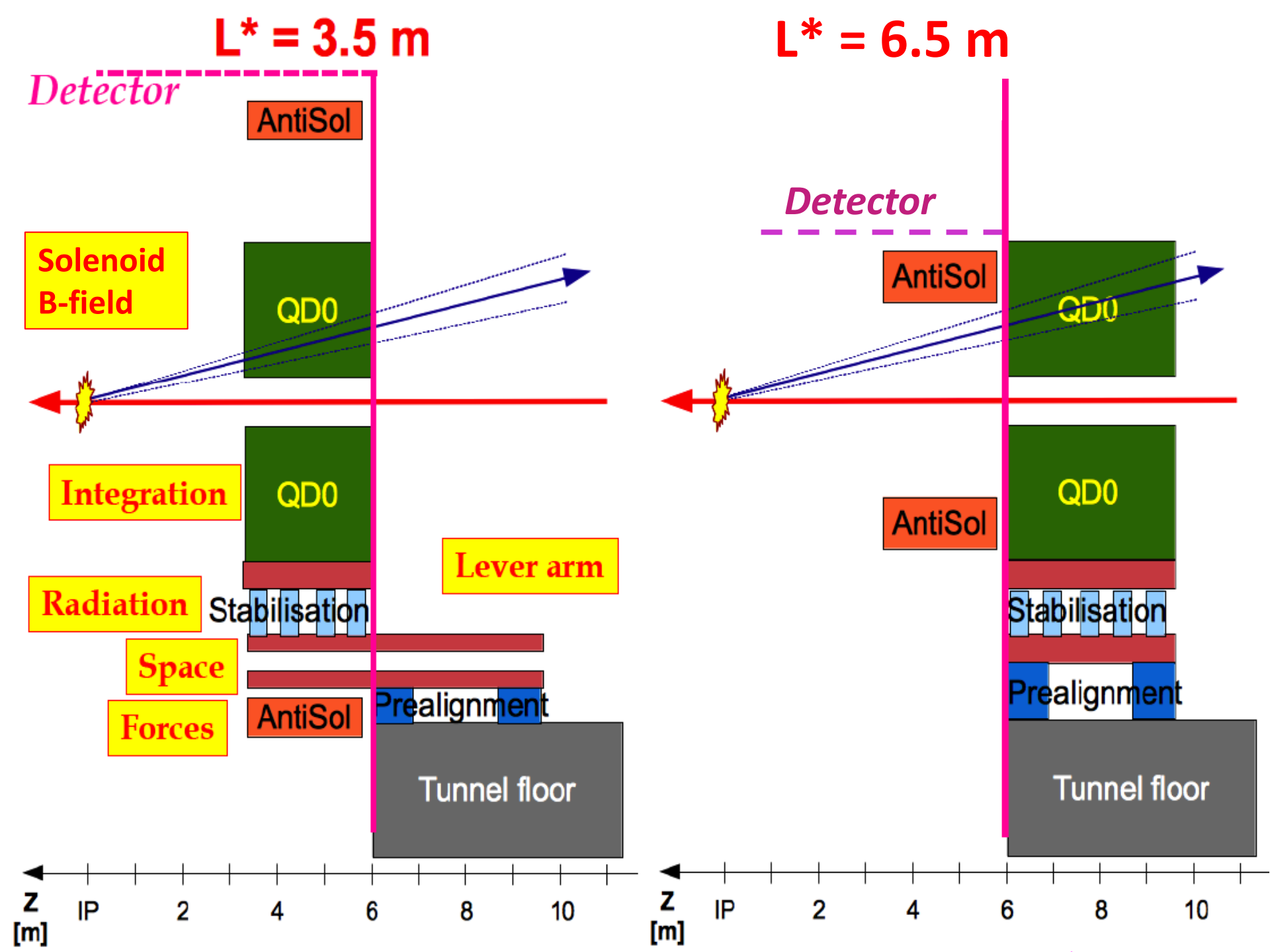
In the end a fair comparison between short and long L* in terms of physics performance can be made.

Some work has started

- Michele Modena has started studies for a more compact QD0 magnet design using **HTS technology**. This could reduce significantly the acceptance loss for a short L* implementation but also **reduce the weight to be stabilised** for a long L* implementation. See Michele's presentation. **Thursday afternoon**
- Cedric Garion has prepared first preliminary ideas for a vacuum layout
- Phil Burrows has discussed the implications for the IP feedback system

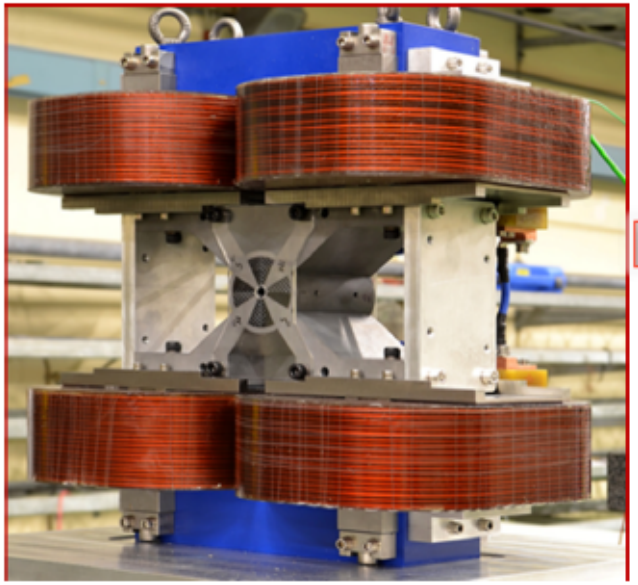
Many other systems have to be re-evaluated, such as the QD0 pre-alignment scheme, stabilisation, pre-isolator, ….

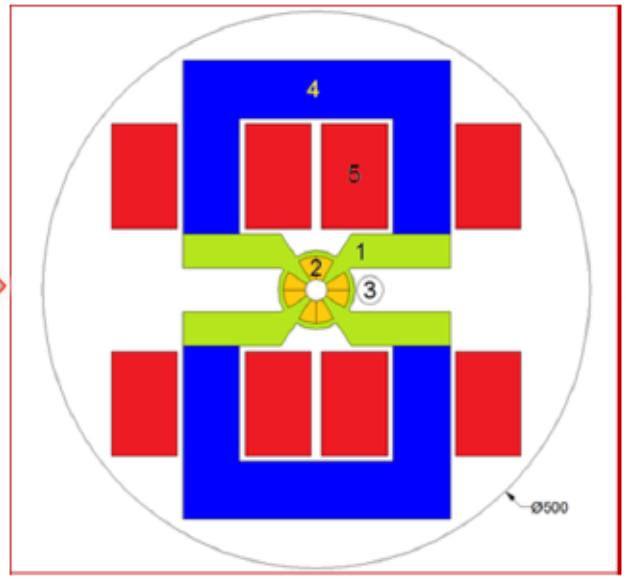
Thursday afternoon


L* = 3.5 m
Detector
AntiSol
Solenoid
B-field
QD0
Integration
QD0
Lever arm
Radiation
Stabilisation
Space
Forces
AntiSol
Prealignment
Tunnel floor
Z
[m]
IP
2
4
6
8
10
L* = 6.5 m
Detector
AntiSol
QD0
AntiSol
QD0
Stabilisation
Prealignment
Tunnel floor
Z
[m]
IP
2
4
6
8
10

Possible QD0 design evolution, a super-ferric version:

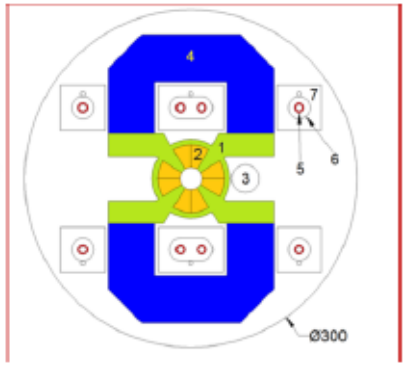
The super-ferric variant (i.e. same hybrid core design but with small superconducting coils at the place of the low current density resistive coils) will minimize the weight (and the cross section) preserving the "visibility" and accessibility of the iron part, making easier and more precise the alignment and the stabilization the QD0.





ILC parameters:

Gradient	127 T/m
Aperture radius	10 mm
Ampere-turns	5 kA

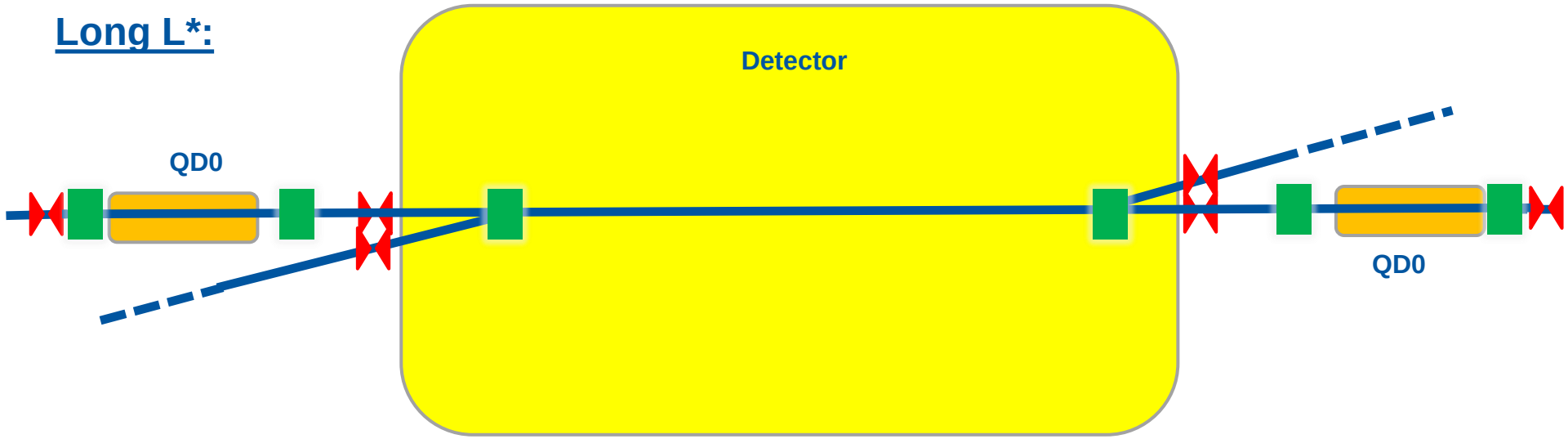


1. *Quadrupolar core in Permendur*
2. *SmCo PM inserts*
3. *Post-collision line vacuum chamber*
4. *Return iron yokes*
5. *Coil packs: 9 NbTi SC wire turns wound around the 4.5 K LHe cooling circuit pipe.*
6. *Cryostat @75K shield*
7. *Cryostat assembly*

M-Modena

Beam Line Sectorisation Scheme

Long L* option

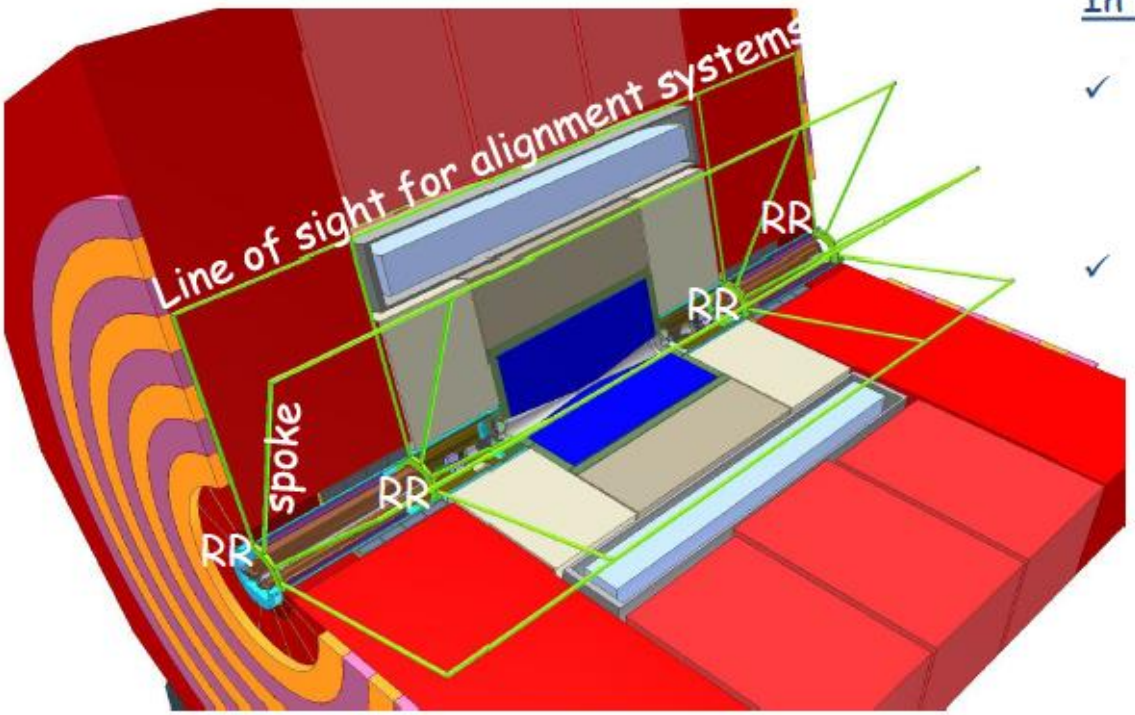


*Pumping port number and position could change depending on pressure requirements or space constraints…

MDI: monitoring of left QD0 w.r.t right QD0

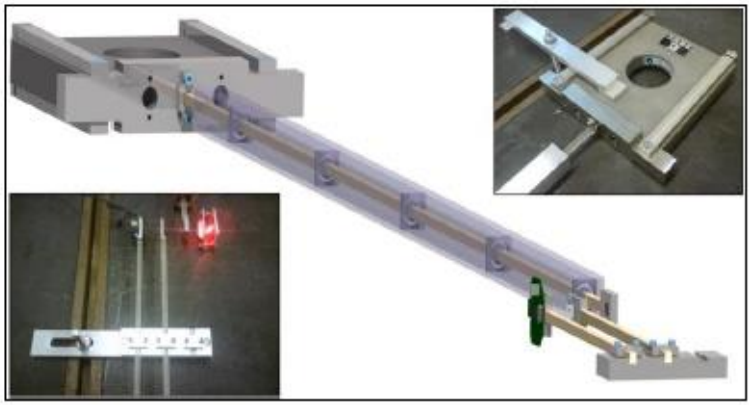
Concept

- ✓ 4 Reference Rings (RR) located at each extremity of QD0, supported from outer tube
- ✓ 6 radial spokes per RR



In two steps:

- ✓ A monitoring of the position of QD0 w.r.t RR thanks to proximity sensors. (initial calibration of their position performed on a CMM)
- ✓ A transfer of the position of RR thanks to 6 spokes to alignment systems. By combination of redundant information, the position of the center of 4 RR is computed.



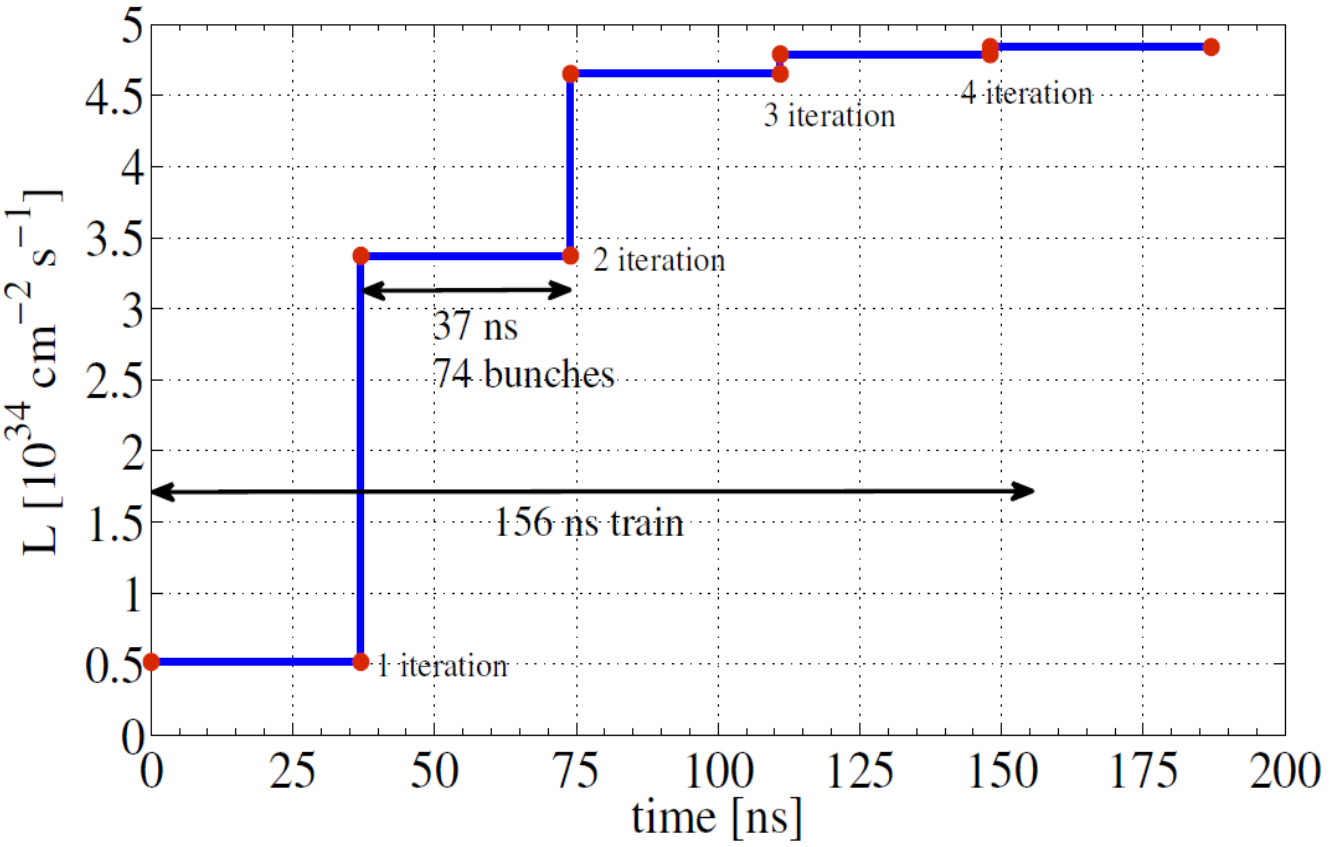
Status:

- ✓ 1m long spoke built and validated
- ✓ Sensors under validation on the Two Beam Module

H.Mainaud Durand

CLIC IP FB Performance (CDR)

Single random seed of GM C, CDR implementation



Ph. Burrows, Resta Lopez

IP FB with long L*

- Current CDR geometry:
  time of flight IP → BPM → kicker → IP ~ 24 ns
- Demonstrated FONT3 electronics latency = 13ns
- Estimated IPFB latency = 37ns
- In principle, change of L* need not affect IPFB position and latency, but needs to be engineered carefully, considering other beam line components

Plans

- First priority is to **fix the new (long) L* value**.
  Hence regular MDI and more frequent smaller
  'MDI layout meetings' to look at the detailed layout
- This will allow the BDS team to design a new optics and hence to **define the new parameters for QD0,** as well as (e.g.) the **luminosity achievable**.

See F.Plassard last Monday

- Look in detail at the many implications on all MDI systems, including QD0, anti-solenoid, stabilisation, pre-isolator, pre-alignment, IP feedback, Beamcal and Lumical integration, vacuum, ….)
- Only at a later stage revise the more 'external' parameters (cavern layout, RP aspects, …)

The MDI working group

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