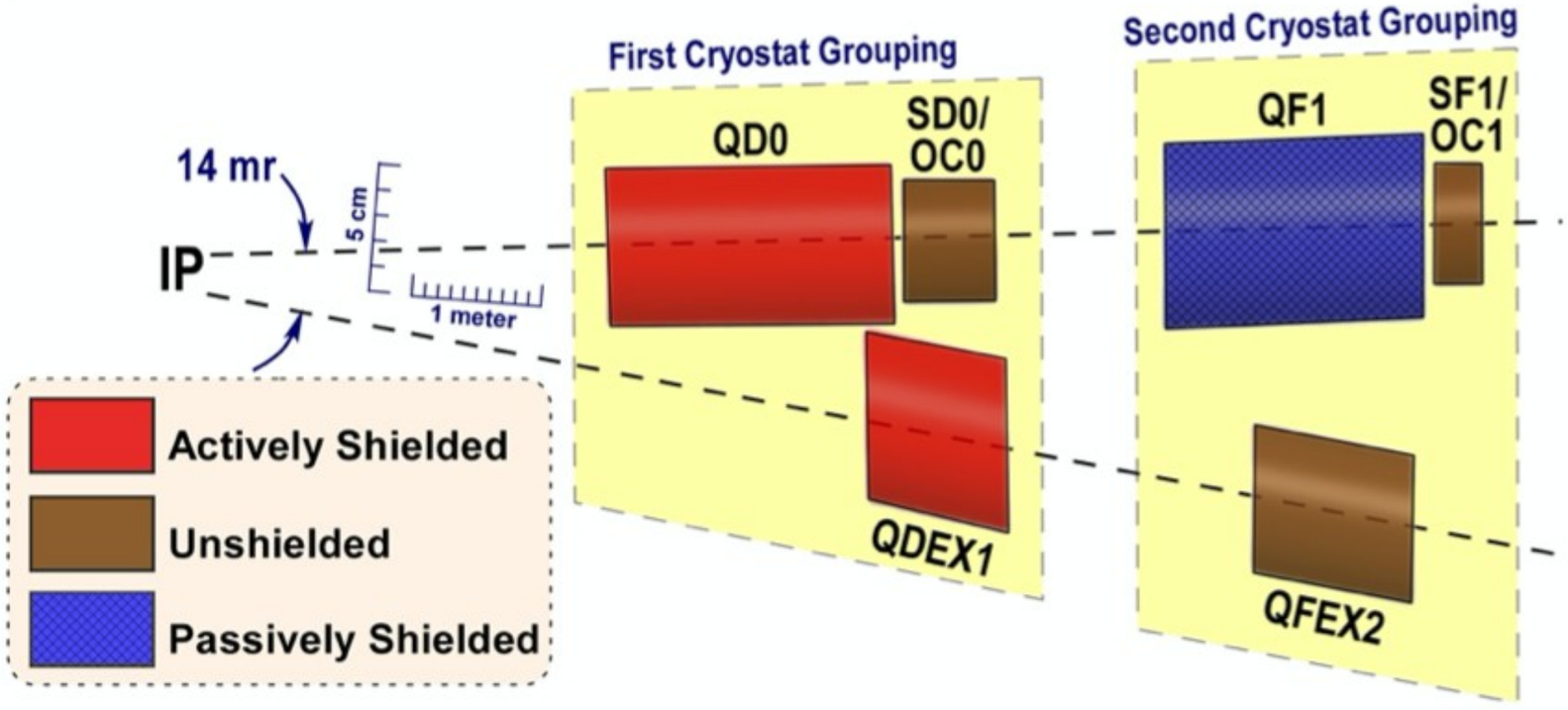
MDI-BDS/Physics – Meeting calendar and topics

- 17/9/21 – Layout of MDI region
- 30/9/21 – Software for and precision of/for background studies
- 14/10/21 – L*
- **26/10/21 Intermediate report at ILCX**
- 25/11/21 – Beam calorimeters
  - Plus talks on software that could not be scheduled in meeting of 30/9/21
- 09/12/21 – Beam pipe and vertex detectors
- 06/01/22 - Polarimetry and beam energy measurements
- **13/01/22 – Beam dump and detector magnets**
- **27/01/22 – Detector alignment after push pull**
- 10/2/22 – Spare slot
- 11/02/22 – 11/03/22
  - Writing of (short) summary document
  - Definition of real working groups and work program for Pre-lab
  - Including discussion of funding of activities

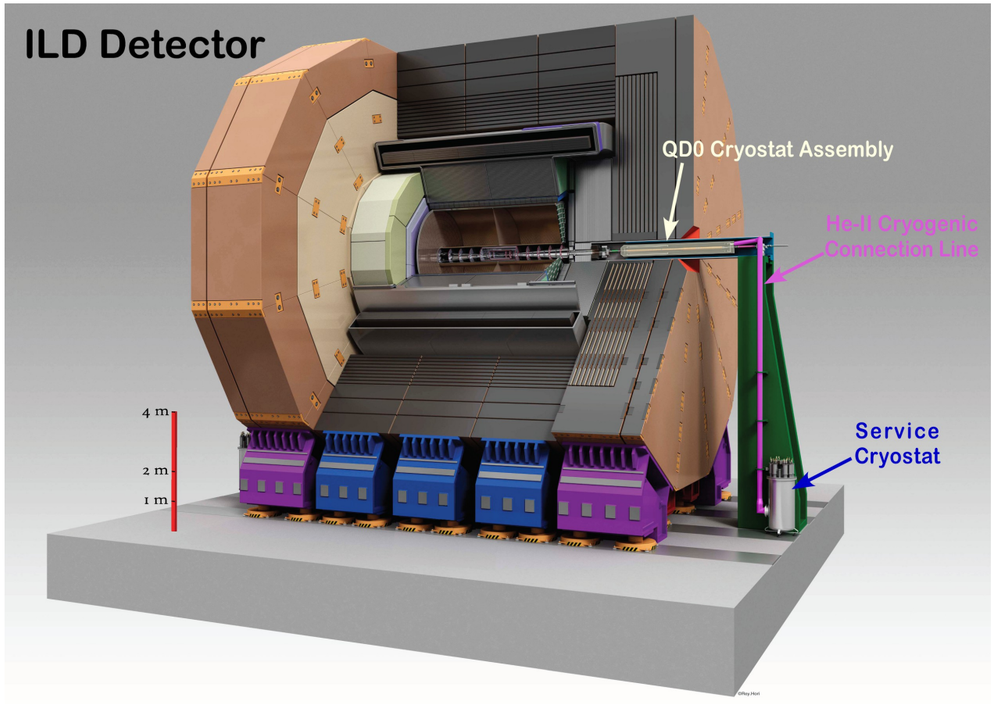
MDI-BDS/Physics – From Machine to Detector – The last step

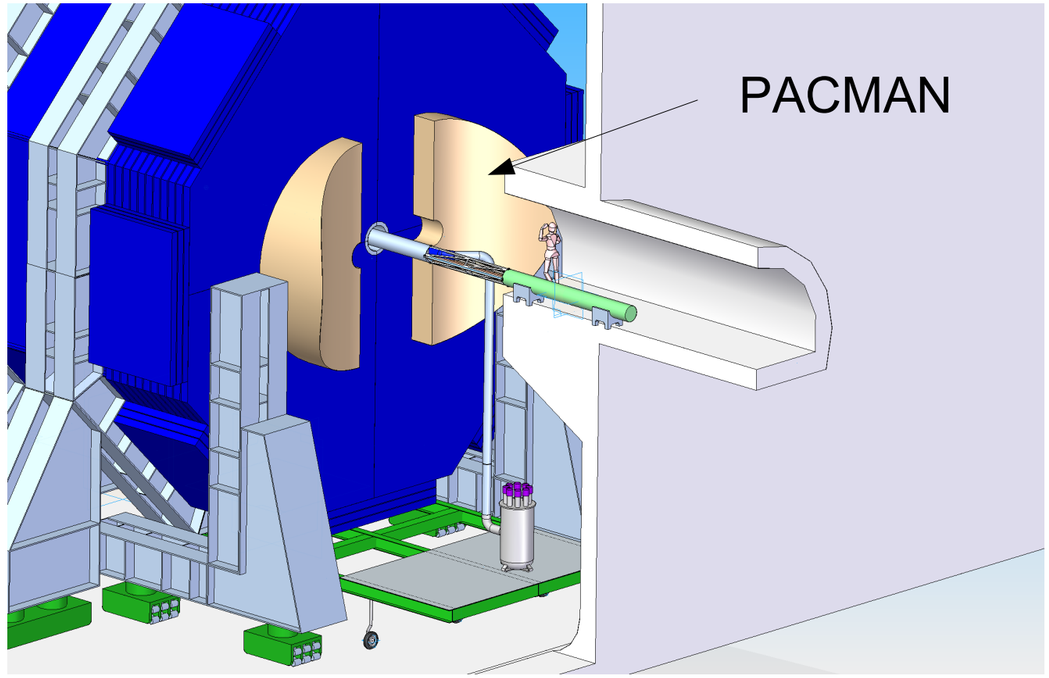


- Beams collide under 14mrad crossing angle
  - Is this casted in stone?
- Focusing into the interaction region with final doublet QD0 and QF1
  - (Current baseline) QD0 is part of detector (ILD) and QF1 is part of the machine

MDI-BDS/Physics – QD0 Support by detectors

M.C. Fouz. T. Markiewicz, M. Oriuonno



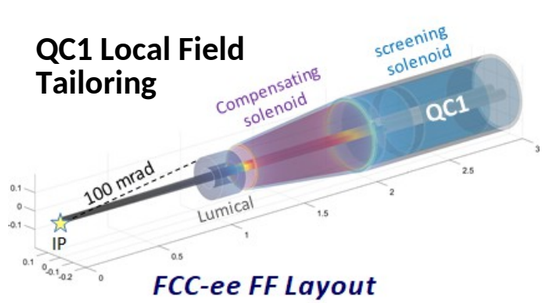


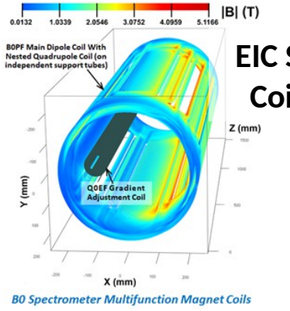
- Different solutions to support QD0
- ILD features a support pillar (also to protect against vibrations)
- In SiD the QD0 is supported from the endcaps (so far no drawbacks observed)

MDI-BDS/Physics – QD0 next steps

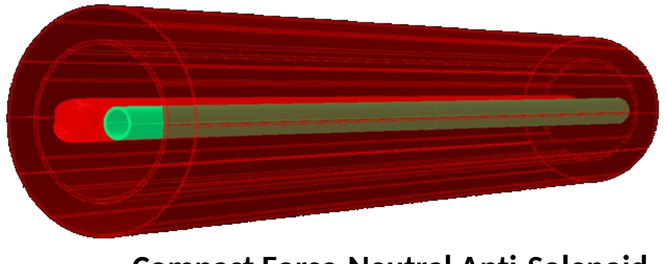
Brett Parker

- The ILC TDR IR baseline was optimized for 500 GeV CM energy; however, if we initially run several years at 250 GeV, we can look to reoptimize the IR magnet coil parameters (cost of new IR magnets for a 500 GeV IR upgrade is expected to be small compared to the cost of missing luminosity during initial ILC running).
- In the past 7 years BNL Direct Wind technology and IR design experience has advanced tremendously (examples: Double Helical coil winding for EIC and FCC-ee IRs and the Sweet Spot coil concept for EIC).
- We should also formulate detector specific anti-solenoid configurations and confirm that these designs satisfy ILC FF optics and MDI requirements.
- We see some possibility to reduce the transverse size of the QD0 cryostat in the detectors (MDI desirable).
- We should coordinate with the experiments re. their plans to implement (or not) any anti-DID coils for background reduction (again needs MDI coordination).





EIC Sweet Spot Coil Example



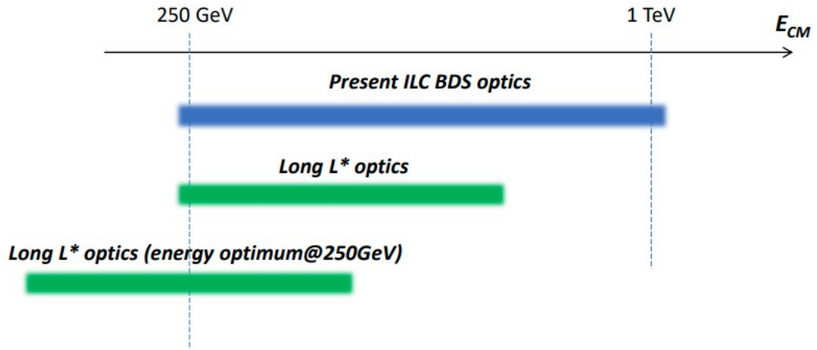
Compact Force-Neutral Anti-Solenoid

Concrete work on QD0 is IDT-WG2 business but tight communication with experiments is needed
Result of optimisation may impact
Concrete detector layout
Beam characteristics -> Physics performance

Alternative L* - Elements of discussion

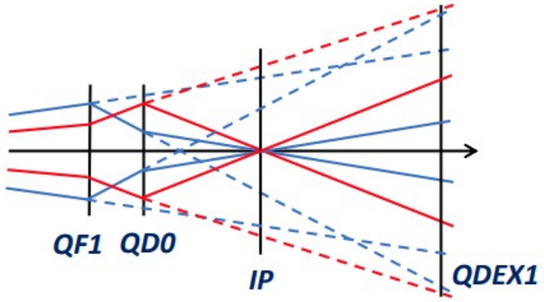
- Putting the QD0 into the tunnel may ease push-pull operation and allow for more stable operation
  - Less prone to vibrations
  - Faster restart after push-pull
- QD0 in tunnel = Longer L*
- A priori no drawback on luminosity by longer L* (dixit Okugi-san) but ...

- Energy reach of ILC may be compromised



Following argumentation by Okugi-san

- Inner detector aperture will have to be larger

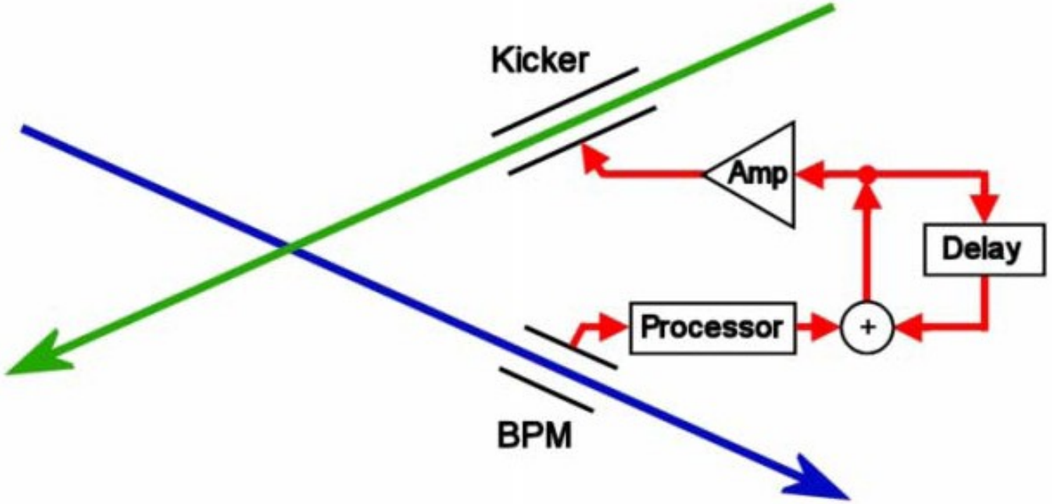


- Inner radius of beam pipe is no problem with current L* setting
- If L* would be increased, the effect of SR from the Final Doublet in the SC magnet in the extraction line becomes larger, the collimation depth is reduced and the inner detector aperture should be increased

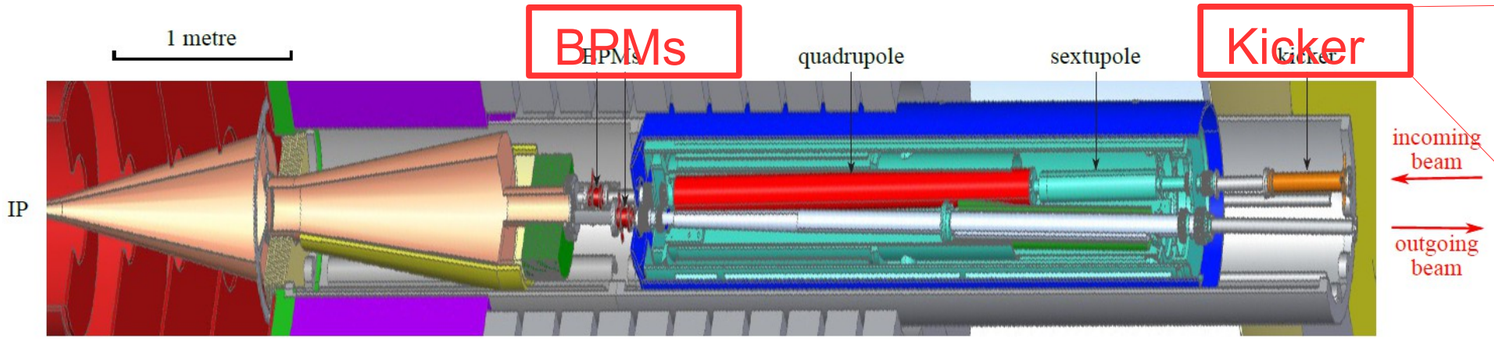
IP Beam Collision Feedback

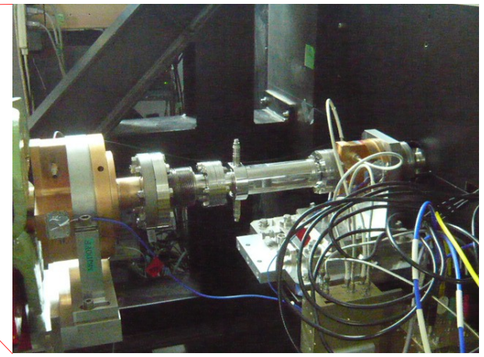
Phil Burrows

- **Last line of defence against relative beam misalignment**
- **Measure vertical position of outgoing beam and hence beam-beam kick angle**
- **Use fast amplifier and kicker to correct vertical position beam incoming to IR**



SiD QD0 region





Example: ATF2 IP Kicker

Personal remark:
Feedback system has potential for lots of concrete studies in test facilities such as ATF3
e.g. RF noise in vertex detectors

IP Beam Collision Feedback – Comments/Issues

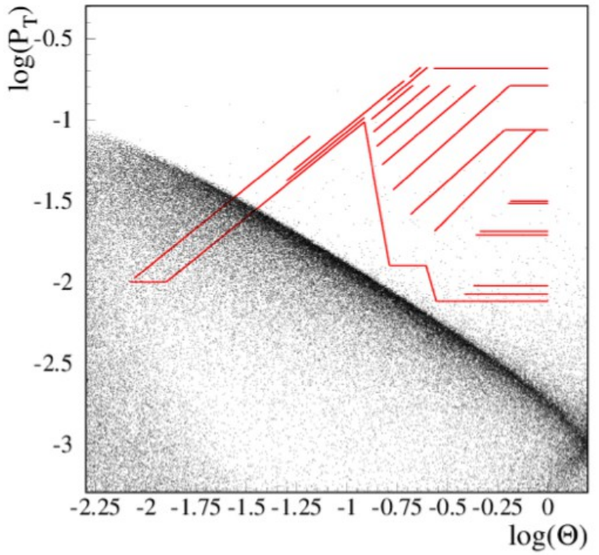
Phil Burrows

- Update engineering drawings to reflect L* change to ~4m
  - more major revision needed if QD0 → tunnel
- Re-visit ‘functional requirements’ of IR systems to reflect ILC 250 vs. 500 GeV, L* etc:
  - beam rigidity x2 lower
  - vertical beam size 30% larger (IP FB spec. was ‘50 sigma’)
- Final designs of BPM + kicker + electronics can be tuned for global optimisation of MDI systems
- Location of cabling + electronics needs serious thought:
  - radiation considerations
  - ferrites don’t like magnetic fields
  - RF interference
- Dither luminosity FB using BEAMCAL input needs detailed design
  - C. Grah did excellent job on conceptual design
  - Further look in meeting on 25/11/21

Software for MDI Studies

- Two (main) types of background:

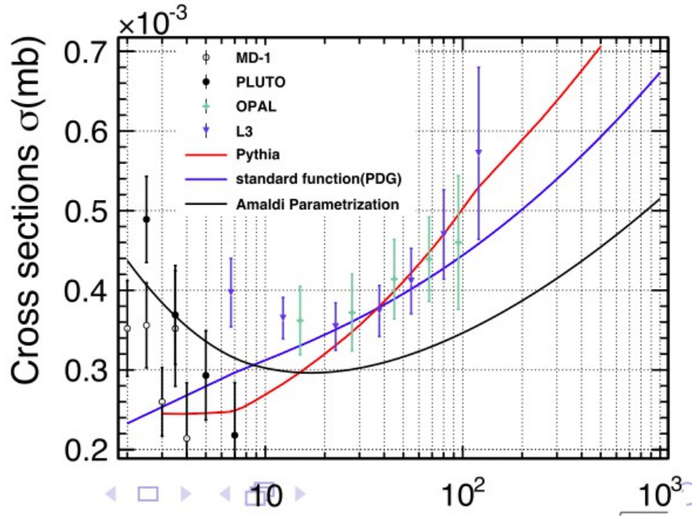
- Pair background:
  - Pair creation of photons in the beam by the strong fields
  - Production chain and software packages:
    GuineaPig -> CIRCE 2 (as part of WHIZARD)
    -> fast (SGV) simulation as input to full simulation
  - Requires careful setup of beam files
  - CAIN as alternative to GuineaPig?
    - CAIN provides e.g. polarised beam



- $O(10^5)$ pairs per physics event
- Have to pick the few that reach the detector

- Low pT hadrons from γ(*)γ(*)
  - Generation with PYTHIA for Mγγ > 2 GeV
  - Generation with custom made generator by LCGG for Mγγ < 2 GeV

γ(*)γ(*) events
O(1)/BX



- Proper simulation of beam backgrounds requires careful expert work
  - This slide is even not the tip of the iceberg
- How to validate the input to e.g. GuineaPig (see Meeting on 25/11/21)?

Software for MDI Studies - Comments

- A well oiled software chain is essential for efficient communication between machine experts and experiments
  - Current turn around after change of beam parameters ~few months
  - Personally I am lacking a feeling whether this is quick enough for dynamic development during pre-lab
    - Assessment needed

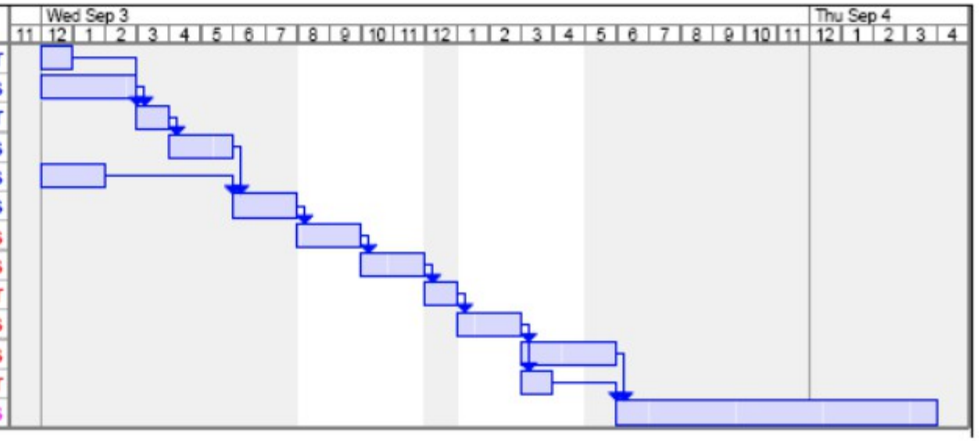
- Software or better said manipulating the generators can quickly become a single point failure!!!
  - Only very few experts
    - Essentially one for GuineaPig and one for CAIN (and CAIN would need complete revision)
    - ... and we haven't yet talked about neutron background (FLUKA <-> GEANT4)
  - Also downstream of the generators dedicated work is needed and there are not many capable of doing that

Push pull ...

Marty Breidenbach – Meeting 14/10/21

Time Estimate

ID	Task Name	Duration
1	Secure ILC Beams	1 hr
2	De-energize magnets	3 hrs
3	Open Beamline Shielding	1 hr
4	Disconnect Beamlines	2 hrs
5	Checkout Detetctor Transport s	2 hrs
6	Transport Detector 20 m	2 hrs
7	Transport other detector on bea	2 hrs
8	Connect beamline	2 hrs
9	Close Beamline shielding	1 hr
10	Check gross detector alignment	2 hrs
11	Energize magnets	3 hrs
12	Safety Checks before beams	1 hr
13	Begin Beam Based alignment	10 hrs



The time intervals in this estimate appear conservative.

With careful engineering and an experienced, well rehearsed crew, it seems plausible to make the push-pull cycle, not including the beam based alignment and re-tuning of the machine, in less than a day.

The converse is also true!

2009! → 19 April 2009 M. Breidenbach TILC09 18

Revision of time spent on push-pull needs to be revised

- Which tools in 2035-2040?
  - Hardware and software?
- Beam based alignmnent with few tracks and AI?

Summary

- Consolidated MDI Activites since Spring 2021
- Regular meetings on CFS and series of topical meetings on selected BDS/Physics topics
  - Good attendance and lively discussions witness interest in topic(s)
  - Topical meetings still rather in forum mode
- Already interesting insights and hookons for work program for Pre-lab
  - A lot of topics need revision of existing results (that are up to more than a decade old)
  - Many activities are at risk due to shortage in manpower
- Topical meetings will continue until ~January/February 2022
- Workplan based on meeting series until Spring 2022 (I wish we would be late)
  - This should come along with a plan on how to raise resources (person power and money)
- Summary document
  - https://www.overleaf.com/1791765841bkdgkpjdxndv
  - Meanwhile I am wondering whether this should be a summary or not already a definition of a workpackage structure --> Conclusion at meeting on 18/11/21: Should be mixture of summary and workpackage definition

Workpackage structure – A first attempt

- WP1: Layout of MDI regions
  - Defines envelopes, checks for conflicts
  - May include beam pipe and vertex detectors
  - Detector magnets
- WP2: IP Collision feedback system
  - Studies functionalities of feedback systems
  - Interaction feedback system <-> sub-detectors (e.g. RF noise in vertex detectors)
  - hardware and software tools
  - Vibration control (QD0)
- WP3 Software and precision of background studies
  - Revision of tools + training
  - Background sources
  - Theoretical input to e.g. beam background studies
  - Interface to full detector simulation
- WP4: Beam polarisation, polarimetry and energy measurements
  - Polarisation, effects on beam energy uncertainty, transport to interaction region
  - Polarimeters (downstream)
  - Energy measurements, shikane and in-situ
- WP5: Push-pull
  - Technologies (overlap with CFS)
  - Alignment

Backup