Machine Detector Interface Plans

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DOE/NSF Annual ART Program Review

Fermilab

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Motivation

MDI is Essential for the ILC

ILC News Director's Corner- May 20, 2010

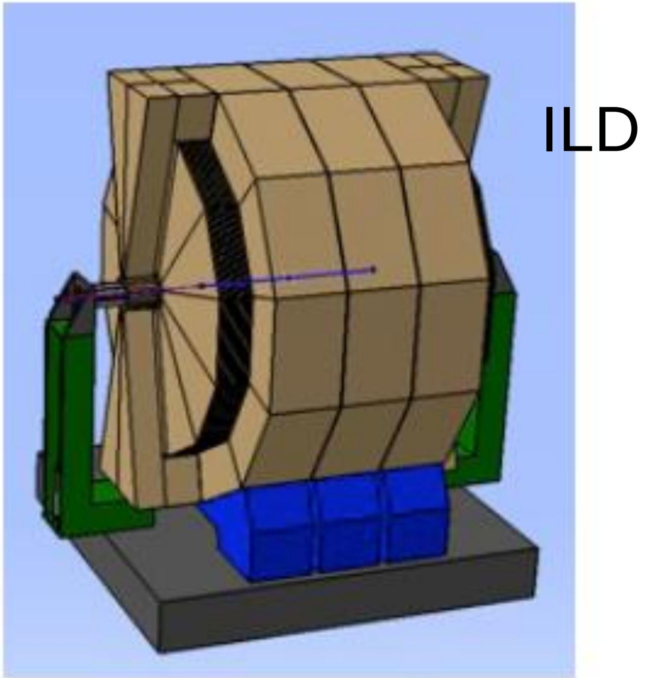
– **One important outcome of our discussions is that the laboratories will try to provide some additional engineering support for fleshing out the design of the push-pull system. This is a crucial problem to develop at this time, … for the *Reference Design Report* (RDR), we determined there were no 'show stoppers' in such a scheme. However, we did not carry out a detailed enough engineering design to understand the practicalities and challenges for implementing a push-pull interaction region.**

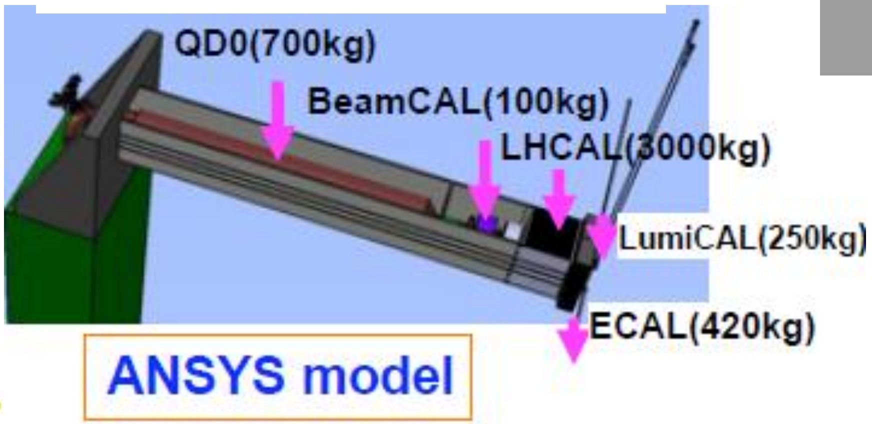
MDI is Essential for any National Collider Program

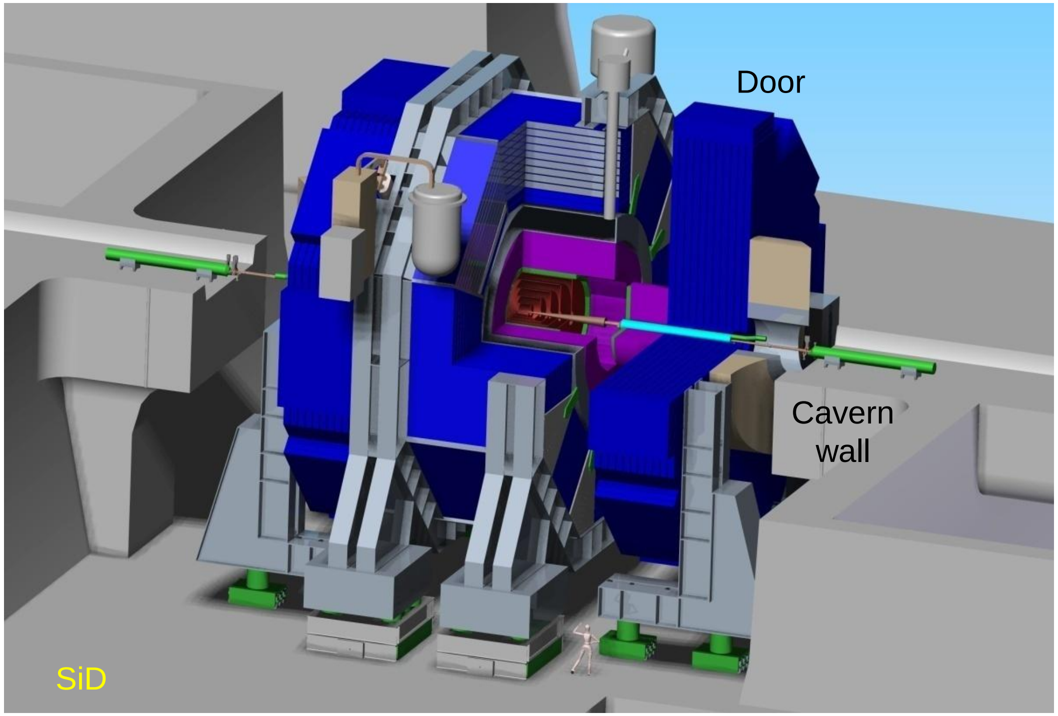
Support of the Detector and QD0 are Critical Mechanical Eng Issues

- There is ~1.5 m radial difference between SiD and ILD.
- Platform or no platform
  - **ILD prefers to sit on a platform several meters thick**
  - **SiD prefers direct ground support: less complication & cost**
  - **As a support framework to lift SiD 3-4 m with adequate stability is not cost-effective, it appears that both or neither detector use platforms.**
- QD0 support ideas
  - **SiD proposes to support QD0 by its endcap doors to minimize L***
  - **ILD proposes to cantilever QD0 from a pylon placed on the edge of the platform**
- Studies are needed to understand the vibration performance of these approaches and their cost implications.

ILD & SiD QD0 Supports







This Proposal

Reinvigorate the US ILC MDI Plan focusing on

- **Platform/No platform**
  - Platform design
- **Optimal support for QD0 and consequences of the different dimensions of the two ILC detectors**

Address remaining MDI Issues as resources allow

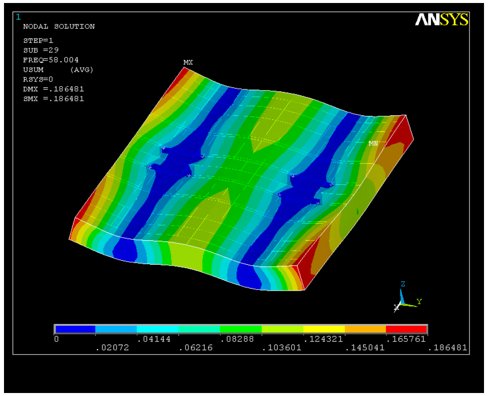
- **Rapid realignment of QD0 and precision detectors after a push/pull exchange**
- **Extension to CLIC requirements**
- **SLAC's ESA Test Beam as a facility for MDI & Detector tests**
- **Accelerator Physics questions relevant to LC IR**

WP1: Management & Strategy

- Resumption of periodic meetings
- Interface to MDI Common task Group
- Oral reports at relevant workshops
- Editing of DBR & TDR MDI sections
- Periodic review of strategy
  - **Advisors**
    - Marty Breidenbach
    - Gordon Bowden
    - Knut Skarpaas
    - Relevant team members

WP2: Platform Study

1. **Determine functional requirements of platform**
2. **Design a full scale platform that meets the functional requirements and calculate the vibration performance of the platform**
    - Begin by survey of current real or previously simulated platforms
    - Assemble descriptions appropriate for FEA vibration analysis
        - CMS platform
        - IRENG'07 platform model
        - SiD platform model



3. **Estimate total cost of 2 platform solution relative to self-supported solution**
    - Include additional IR Hall excavation costs

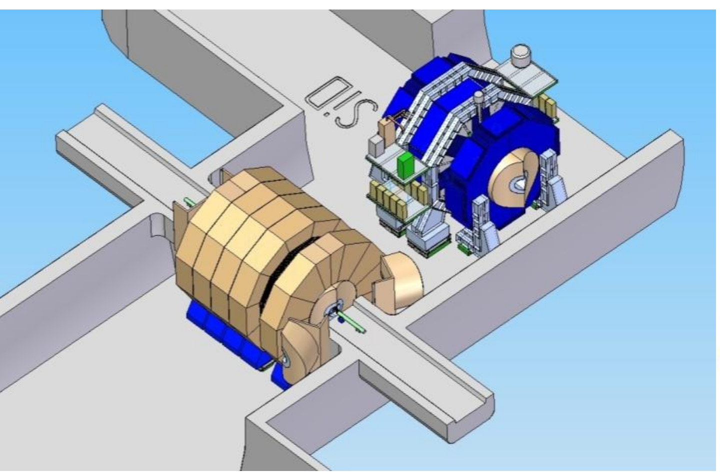
WP2: Platform Study

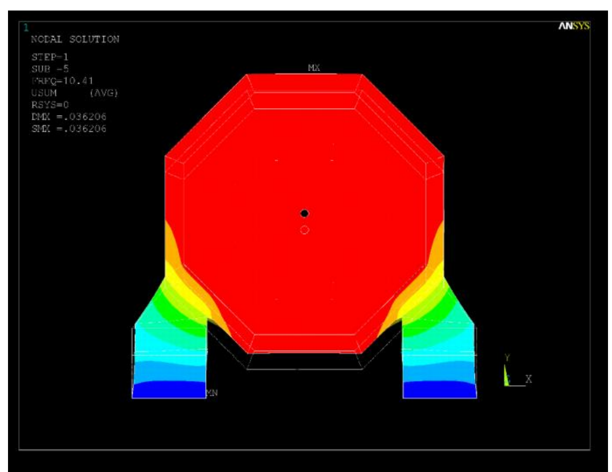
4. Possible extension of program
    1. **Design a scaled prototype platform that accurately reflects the relevant physical parameters of a full scale platform and that, when loaded appropriately with mass, satisfies the functional requirements**
        - Steel I beam(s) with shielding blocks
        - Proposed rollers or supports
    2. **Fabricate and measure the performance of an appropriately loaded prototype platform**
        - Geophone based measurements
        - Laser (or other) based measurements

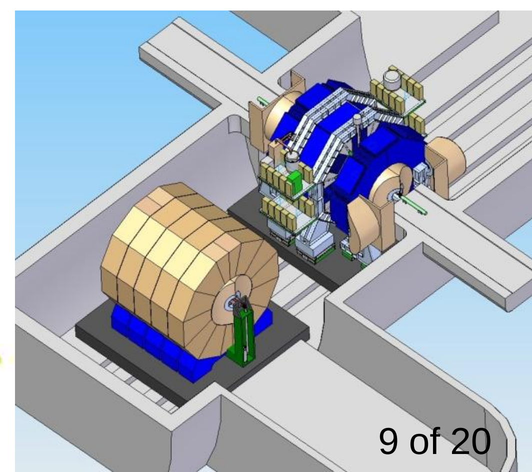
WP3: Specific MDI Design

1. Investigate consequences of SiD / ILD height difference to beamline

- Find vibration as a function of height for a given support design
- Find increased cost & mass of design that keeps vibration constant as function of increased height
- Estimate vibration/cost penalty paid by SiD to make up for ILC's larger height in a bare floor model
- Define maximum platform thickness for which SiD pays no vibration penalty
  - A platform of this thickness then becomes an option if desired





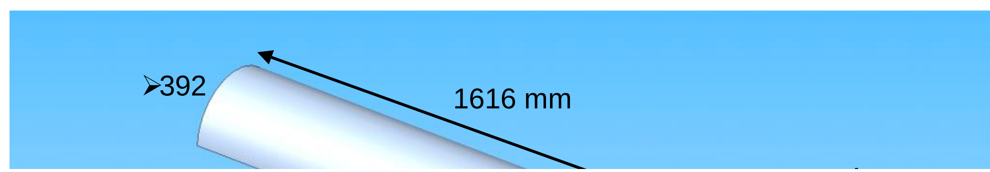


WP3: Specific MDI Design

2. Continued development of SiD R20 design

(“R20” region = all detectors within ~20cm of beamline):

- FCAL=LumiCal+Beamcal
- Beampipe
- Masking
- Feedback BPM
- Feedback Kicker,
- Vacuum pumps(?)



Current conceptual solution is to support massive Lumical+mask+Beamcal cantilevered from nose of QD0

- Effect on QD0 vibration stability
- Precise and reproducible positioning of Lumical

WP4: Design and prototype a full 5 axis QD0 alignment system with minimal radial dead space

1. Refine functional requirements

- Range, sensitivity, integrated vibration performance
- Magnetic field insensitive drives
- Capable of holding actual BNL compact SC or a PM quad
- Capable of holding a dummy cylinder which may in turn hold a device to simulate the beam (laser?)

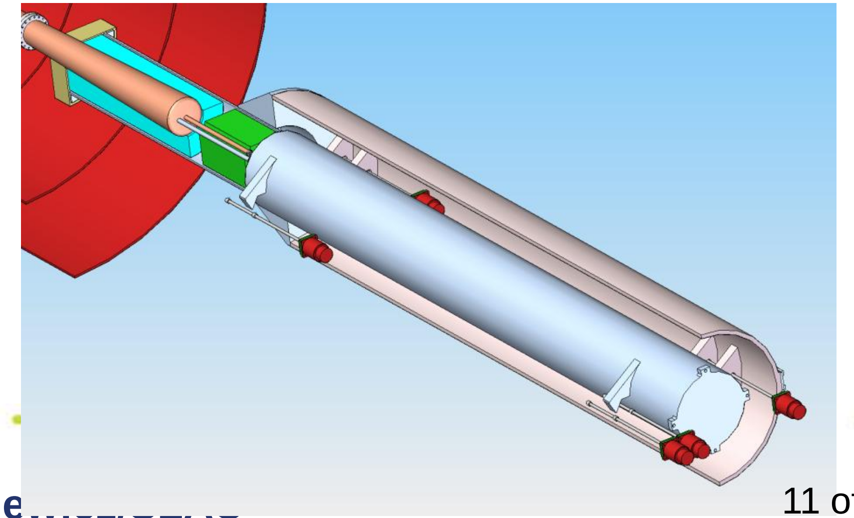
2. Survey solution space

- Range, sensitivity, response time, useful life and frequency response capabilities of cam (FFTB, LCLS), wedge (SLD), piezo and other mover systems

3. Design

4. Fabricate

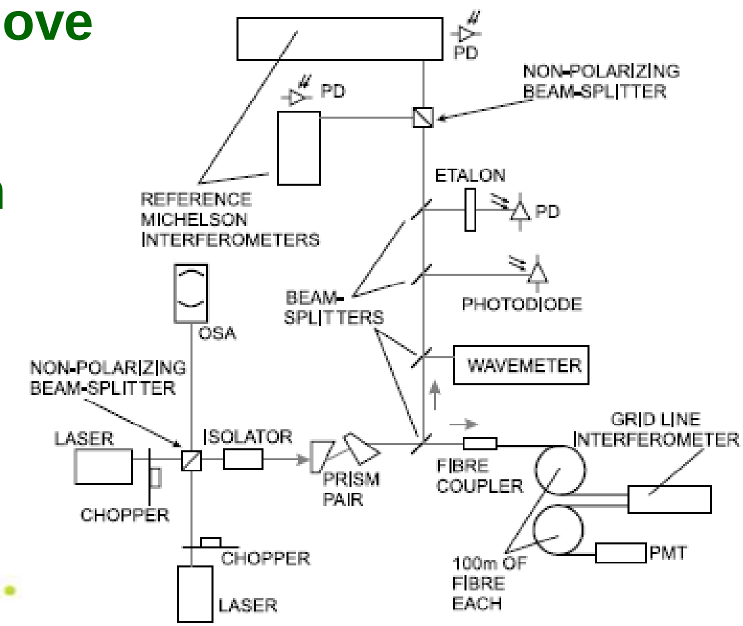
5. Test



1. Traditional geophone based measurement
   – **Required for assessing any mechanical support system**
     - Reassemble SLAC owned Struckheisen STS-2 and other geophones, as well as ADCs and LabView DAQ, and analysis codes
     - Geophone map of all of SLD and interpretation
     - Prototype platform or candidate platform measurements

2. Develop and implement a FSI (Frequency Scanning Interferometer) based optical measurement system for verifying QD0 position

- With push-pull, establishing alignment technology is crucial
  - **For verifying QD0 position**
  - **For assuring that tracking systems do not need to be recalibrated with beam after each move**
- Partner with U. Michigan
  - **Establish FSI system at U. Michigan**
  - **Duplicate system at SLAC**

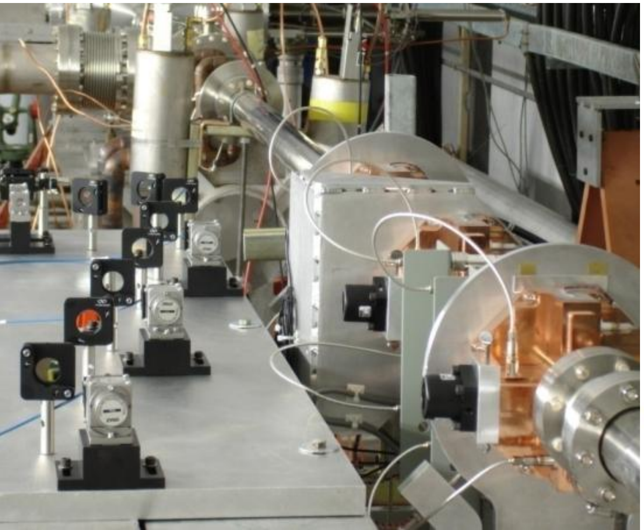


3. Develop and incorporate a non-magnetic vibration sensor & piezo actuator for active stabilization (CLIC) and incorporate in the 5 axis QD0 support
   - **Refine functional requirements of the sensor**
   - **Survey solution space**
     - LIGO
   - **Possible solutions**
     - Optical Anchor (CLIC)
     - SLAC/Frisch style RF driven sensor
       - Commercialized →

SEISMIC SENSOR IMMUNE TO MAGNETIC FIELDS FOR PARTICLE BEAM FOCUSING IN SUPERCOLLIDERS
LC501

WP6: ESA Experimental Program

- ESA has been used to establish critical Luminosity, Energy & Polarization measurement systems
- DOE Detector R&D program has funded SLAC to restart ESA
- Beam expected summer 2011
- Users Workshop to be organized before end of 2010
  - Incremental investment will establish test beams for critical Accelerator Physics or LC MDI instrumentation



Wakefield Study →

BPM Study ←

WP7: Accelerator Physics & Backgrounds

A number of critical issues need to be revisited, in concert with ongoing detailed detector design,

- **Luminosity dependence on L* with reasonable assumptions on beam and consequences to hardware**
- **Collimation study for travelling focus**
- **Synchrotron Radiation study with backscattering & second order effects**
- **Impedance effects in IR area with rapidly changing beam pipe apertures**
- **Transfer function relating beam optics to a magnet support scheme and effect on luminosity**

Capability is important to maintain for future US projects

Future

- Plan is by no means worked out in detail and work has not been started
  - **Your input required**
- Would like to restart collaborative R&D with BNL on the vibration characteristics of the compact SC QD0 quad prototype and integrate with WP4 (support system) and WP5 (measurements)
- Will continue to consult with ILC Common Task Group on MDI

Deliverables

- **FY10**
  - **Progress report on activities**
- **FY11**
  - **Downselect on platform/no-platform**
- **FY12**
  - **Conceptually engineered push-pull solution**

Human Resources

- Recruiting personnel is key to success

Management: WBS 1
Tom Markiewicz-PHYS
ANSYS Engineering-WBS 2,3
John Amann-ENG
Marco Oriunno-ENG
Prototype Engineering: WBS 4
Steve Lundgren-ENG
Gene Anzalone-MD
Reggie Rogers-PPA Tech

Measurement & Feedback Systems: WBS 5
Kirk Bertsche-PHYS
Achim Wiedemann-PHYS
ESA: WBS 6
Zen Zelata-Software
Alison Chaiken-Software
Scientific program coordination-TBD
Accelerator Physics & Backgrounds: WBS 7
Mike Sullivan-PHYS
Alexander Novokhatski-PHYS
Takashi Maruyama-PHYS
Glen White-PHYS

Budget Features

- Approximately Four FTEs labor/year
  - **1.00-1.75 ME identified**
  - **Remainder Physicists**
- M&S and technical support for prototyping not yet budgeted
- M&S items under discussion
  - **FSI Hardware**
  - **ESA Hardware**
  - **Rent-a-Engineer**
  - **Other**