Test Beam Facility 5 Year Plan

In order to have detector CDR and TDR in synch with the accelerator schedule defined by GDE, the detector R&D efforts will intensify through the end of this decade and early in the next decade, FY07 – FY11 time scale. These R&D efforts will then naturally be followed by global detector design and calibration processes. For these reasons, the demand on beam test facilities will grow significantly. More specifically, the next decade or so can be categorized into three different periods:

- Phase I: Detector technology R&D phase
  - Detector technology research and development
  - Global ILC detector concept development and design (there are a total of 4 concepts being developed)
  - Choice of technologies to be used in various ILC detector concepts
  - CDR for ILC detector concepts by 2010, according to GDE schedule
- Phase II: Global ILC detector design and selection phase and the ILC detector construction and calibration phase
  - Remaining performance testing of ILC detector designs
  - Prototype testing of the selected ILC detectors
  - Calibration of the ILC detectors
  - Construction of the detectors
- Phase III: ILC Physics Era

Since an informed technology choices for most of the sub-detector systems for ILC global detector concepts must be done sufficiently before the end of this decade to meet the time scale of TDR in FY 10 to FY11, all the detector R&D groups will require beams for characterization and performance tests of the detectors. These beam tests will have to provide sufficient information to global ILC detector concept groups.

While most of these detector groups' beam requirements do not span long term, given the anticipated demands in the next few years and the fact that beam test facilities throughout the world is becoming scarce, it is vital for the success of the ILC program to prepare FNAL and SLAC facilities to accommodate the demands. It should be noted, however, that since the milestones presented in this write up has not been approved by neither FNAL nor SLAC management. Thus, the milestones must be taken with care and can probably be considered as a reasonable guess work on what has to happen to meet the program presented in each fiscal year.

The program:

FNAL: Fermilab's primary beam test facility at Meson Test beam line, MTBF, is currently undergoing a significant upgrade to accommodate the calorimeter groups' needs for low energy hadron beams, in addition to other beam line instrumentation and beam line infrastructure. Moreover, a recent development of momentum tagged neutral hadron beams at the neighboring beam line, Meson Center, provides an ideal condition for calorimeter groups to test particle flow algorithms. Given these upgrades and the anticipated activities of many sub-detector groups', the anticipated program and the milestones are presented in detail as follows:

- FY07:
  - Program: Phase I test beam, technology performance testing and selections, year 1

        - Calorimetry
            - Low level ILC Calorimeter beam test activities, including US Gas DHCAL electronics slice testing
            - CALICE SiW ECAL, Scintillator Analog HCAL and Tail Catcher (TCMT) setup and initial combined performance tests
        - Muon: U.S. muon group beam tests
        - VTX:
            - FNAL/Perdue/Cornell VTX test beam
            - LBL VTX Test beam
    - Facilities milestones:
        - Complete planned MTBF upgrades for ILC test beam
        - Commission and operate MTBF
        - Start preparation for MC tagged neutral hadron beam line
- FY08:
    - Program: Phase I test beam, technology performance testing and selections, year 2
        - Calorimetry:
            - CALICE SiW ECAL, Scintillator Analog HCAL and Tail Catcher (TCMT) combined performance test and hadronic shower runs for PFA
            - US RPC DHCAL $1m^3$ full stack performance testing w/ CALICE SiW ECAL and TCMT
            - US SiW ECAL initial performance tests
            - Asian Tungsten-Scintillator counter ECAL performance test
            - Colorado W-Scintillator offset tile ECAL tests
        - Muon:
            - Continued U.S. muon group beam tests
            - EU RPC Based muon group beam tests
        - Tracker:
            - MPI and Carlton TPC tests
            - SiD Si tracker
            - SiLC detector testing
        - VTX:
            - FNAL/Perdue/Cornell VTX test beam
            - LBL VTX Tests
            - DEPFET VTX Tests
    - Facilities milestones
        - Complete MC tagged neutral hadron beam line preparation
- FY09:
    - Program: Phase I test beam, technology performance testing and selections, year 3
        - Calorimetry:
            - CALICE SiW ECAL, Scintillator Analog HCAL and Tail Catcher (TCMT) combined performance test and hadronic shower runs for PFA
            - Completion of US RPC DHCAL $1m^3$ full stack performance test and PFA hadronic shower tests w/ CALICE SiW ECAL and TCMT and w/ US SiW ECAL

                - US GEM DHCAL $1m^3$ full stack performance testing and PFA hadronic shower tests w/ CALICE SiW ECAL and TCMT and w/ US SiW ECAL
                - US SiW ECAL performance and PFA hadronic shower combined test
                - Completion of Asian Tungsten-Scintillator counter ECAL performance test
                - US Scintillator-based HCAL test
                - 4^{th} concept calorimeter performance tests
                - Colorado W-Scintillator offset tile ECAL tests
            - Muon:
                - Continued U.S. muon group beam tests
                - EU RPC Based muon group beam tests
            - Tracking
                - MPI and Carlton TPC tests
                - SiD Si tracker
                - SiLC detector testing
            - VTX
                - FNAL/Perdue/Cornell VTX test beam
                - LBL VTX Tests
                - DEPFET VTX Tests
        - Facilities milestones
            - Continue normal operations with maximum beam availabilities
            - Complete investigation and cost estimate for reactivation of neutrino beam lines
            - Complete plans for neutrino beam line reactivation

- FY10
    - Program: Completion of phase I test beam, technology performance testing and selections – start of Phase II preparation
        - Calorimetry:
            - Completion of US GEM DHCAL $1m^3$ full stack performance testing and PFA hadronic shower tests w/ CALICE SiW ECAL and TCMT and w/ US SiW ECAL
            - Completion of US SiW ECAL performance and PFA hadronic shower combined test
            - Completion of Asian Tungsten-Scintillator counter ECAL performance test
            - Completion of US Scintillator-based HCAL test
            - Completion of 4^{th} concept calorimeter performance tests
            - Completion of Colorado W-Scintillator offset tile ECAL tests
            - Possible CALICE ECAL and AHCAL w/ new generation of ILC electronics
        - Muon:
            - Completion of U.S. muon group beam tests
            - Completion of EU RPC Based muon group beam tests

        - Tracking
            - Completion of MPI and Carlton TPC tests
            - Completion of SiD Si tracker
            - Completion of SiLC detector testing
        - VTX
            - Completion of FNAL/Perdue/Cornell VTX test beam
            - Completion of LBL VTX Tests
            - Completion of DEPFET VTX Tests
    - Facilities milestones
        - Continue normal operations of MTBF and MC with maximum beam availabilities
        - Complete plans for neutrino beam line reactivation
        - Begin implementing neutrino beam line reactivation plan

- FY11
    - Program: Final wrap-up of Phase I beam tests and beginning of Phase II preparation
        - Calorimetry:
            - Completion of US SiW ECAL performance and PFA hadronic shower combined test
            - Completion of Asian Tungsten-Scintillator counter ECAL performance test
            - Possible CALICE ECAL and AHCAL w/ new generation of ILC electronics
            - Possible larger scale global ILC detector prototype tests
        - Muon:
            - Completion of U.S. muon group beam tests
    - Facilities milestone:
        - Continue normal operations of MTBF and MC with maximum beam availabilities
        - Complete implementation of neutrino line reactivation
        - Commission neutrino beam line
        - Operate the first assembly hall in the neutrino beam line

While all the above plans are included in the program of Fermilab, it is entirely possible that not all programs can be accommodated using Fermilab's facility without moving up the neutrino beam line reactivation ahead of time. Since the time period required for each group is uncertain at this point, FNAL facility alone might not be able to handle all of the above programs when all requests are presented.

SLAC: SLAC test beam facilities provide capability with both primary and secondary beams. Primary beams have energy up to 28.5 GeV with similar bunch charge, bunch length and bunch energy spread as for ILC. Secondary beams of electrons or pions in energy range from 2-20 GeV are possible.

i) Primary beams: tests of prototype systems for Beam Delivery and Interaction Region, including MDI beam instrumentation. Test beam programs include Collimator wakefields, energy spectrometers, bunch length diagnostics, IR background studies.

Ii) Secondary beams: tests for prototype Detector subsystems, especially vertexing and tracking (assume most calorimetry tests are performed at FNAL)

Facility milestones:

1. FY07: program: Energy spectrometers and collimator wakefields
    i. Operate primary and secondary beam experiments. Currently have scheduled 5 weeks of running in FY07 for primary beams. Plan to request additional short test beam requests to study secondary beam capabilities for post-FY08 era in both ESA and SABER facilities.
    ii. Install 5 magnets for energy spectrometer beam tests.
2. FY08:
    i. Operate primary and secondary beam experiments, totaling 4-5 weeks.
    ii. Begin ESA infrastructure upgrades for i) Personnel Protection System (PPS), ii) pulsed magnets in Beam Switchyard (BSY) to facilitate interleaved running of ESA with LCLS, and iii) connection of A-line with the SABER bypass line. These infrastructure upgrades are not yet approved.
3. FY09:
    i. complete upgrades for PPS, BSY pulsed magnets, bypass line connection with SABER (all tentative)
4. FY10 - 11:
    i. Operate primary and secondary beam experiments.

Budget profile:

FNAL

	FY07	FY08	FY09	FY10	FY11	Total
M&S	$150k	$350k	$150k	$400k	$400k	$1.45M
PD						
PP	2	2	2	1.5	2	9.5
BP	1.5	1.5	0.5	1	1.5	6.5
EE	0.5	0.5	0.5	1	1	3.5
ME	0.5	0.5	0.5	0.5	1	3
TT	1	2	1.5	1.5	2	8
CP	0.5	0.5	0.5	1	1	3.5
GRA						
Other						

Acronyms PD – PostDoc, PP – Physicist, BP – Beam Physicist, CP – Computer professional, GRA – Graduate student, TT – Technician :

SLAC:

	FY07	FY08	FY09	FY10	FY11	Total
M&S	$100k	$600k	$600k	$100k	$100k	$1.5M
PD						
PP	1.5	1.5	1.5	1.5	1.5	7.5
BP						0
EE						0
ME						0
TT	1	1	1	1	1	5

CP						
GRA						
Other						

Acronyms PD – PostDoc, PP – Physicist, BP – Beam Physicist, CP – Computer professional, GRA – Graduate student, TT – Technician :

Notes for SLAC budget profile

i. Current FY07 budget supported by SLAC ILC Accelerator budget is $100K M&S and 2.5 FTEs. In addition, 0.5FTE postdoc is supported for one of the accelerator beam tests.
ii. Budget would be funded from some combination of SLAC infrastructure, ILC accelerator and ILC detector.
iii. Assume baseline FY07 budget continues through FY11.
iv. Assume infrastructure upgrades to allow continued ESA operation past FY08 ($500K M&S for infrastructure upgrades in each of FY08 and FY09 assumed).
v. Program includes primary beam tests for ILC accelerator and detector MDI studies, and secondary beam tests for ILC detector studies.
vi. After FY08, some beam tests may happen in the new SABER test beam facility at SLAC.
vii. After FY08, assume that the first 2/3 of the SLAC Linac will be used for the SABER test beam facility. Some ILC tests can be accommodated there. There is also a possibility to have an upgrade that would connect the SABER bypass line to ESA. Also assume that last 1/3 of the SLAC Linac will be used for the LCLS project. ESA infrastructure upgrades are needed to allow continued ESA operation, compatible with LCLS operation; several operation modes are possible for primary and secondary beams, using LCLS beam or the high energy beam, and these are under study.