BDS
Summary

Andrei Seryi, SLAC
for the Beam Delivery team

TILC09

April 21, 2009

BDS activities at TILC09

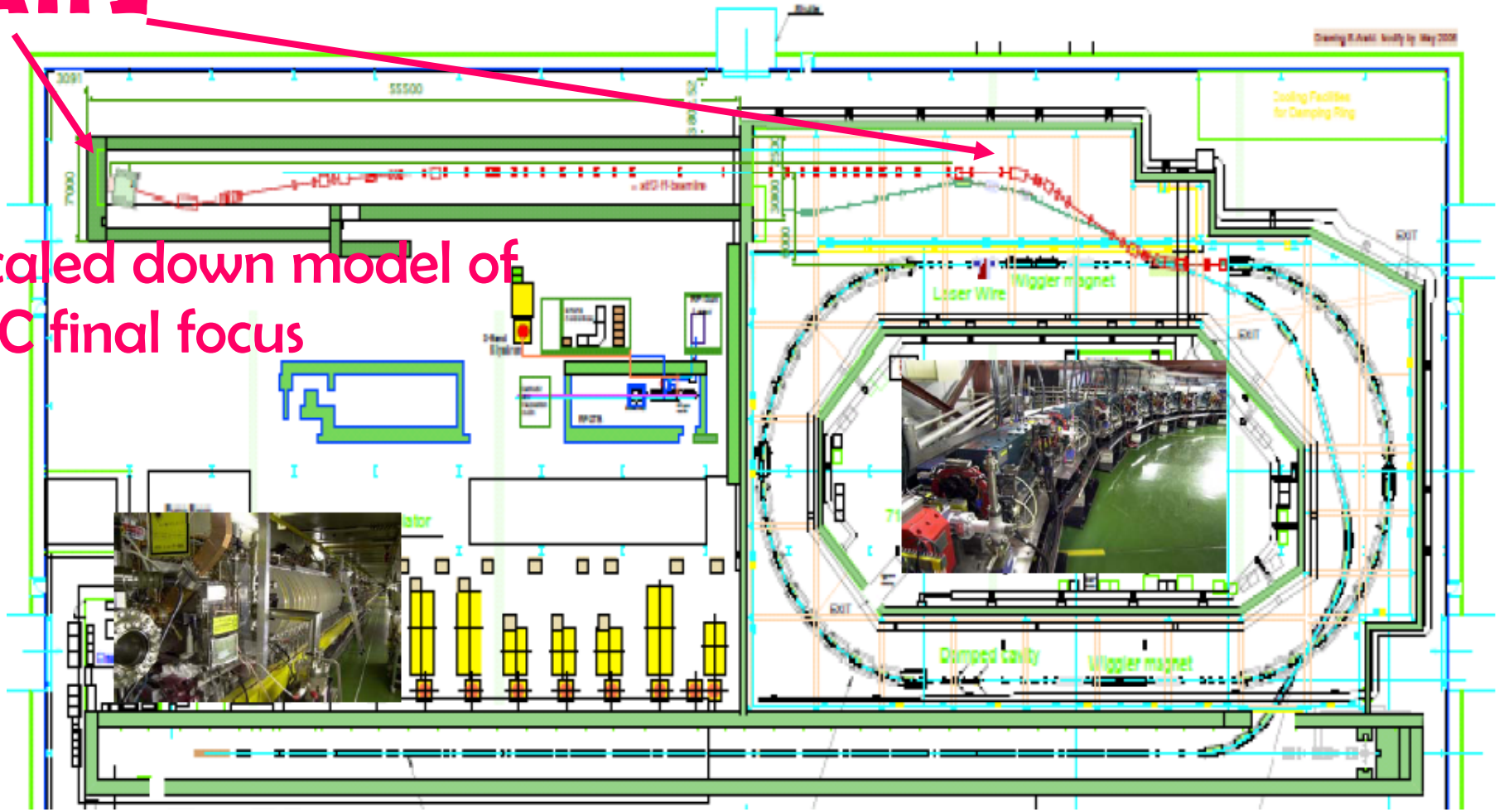
- ATF2 – review commissioning status, next steps & longer term plans
- Discussion of new optics & studies for new baseline
- Review of MDI progress with Detector colleagues and planning the next steps
- Presentations to AAP on ATF2 and BDS/MDI

ATF
Accelerator Test Facility

at KEK

ATF2

Scaled down model of ILC final focus



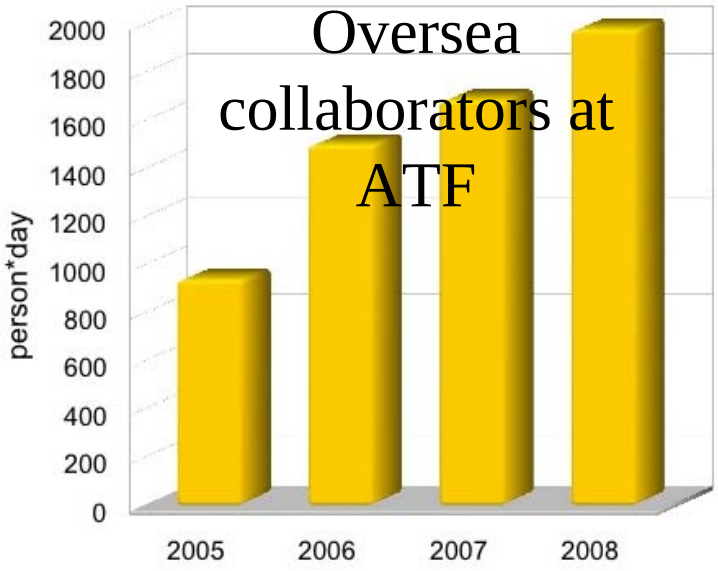
ATF International Collaboration

ATF International organization is defined by MOU
signed by 20 institutions

CERN
DESY
IN2P3
Tomsk Polytechnic Univ.
INFN, Frascati
University College London
Oxford Univ.
Royal Holloway Univ.

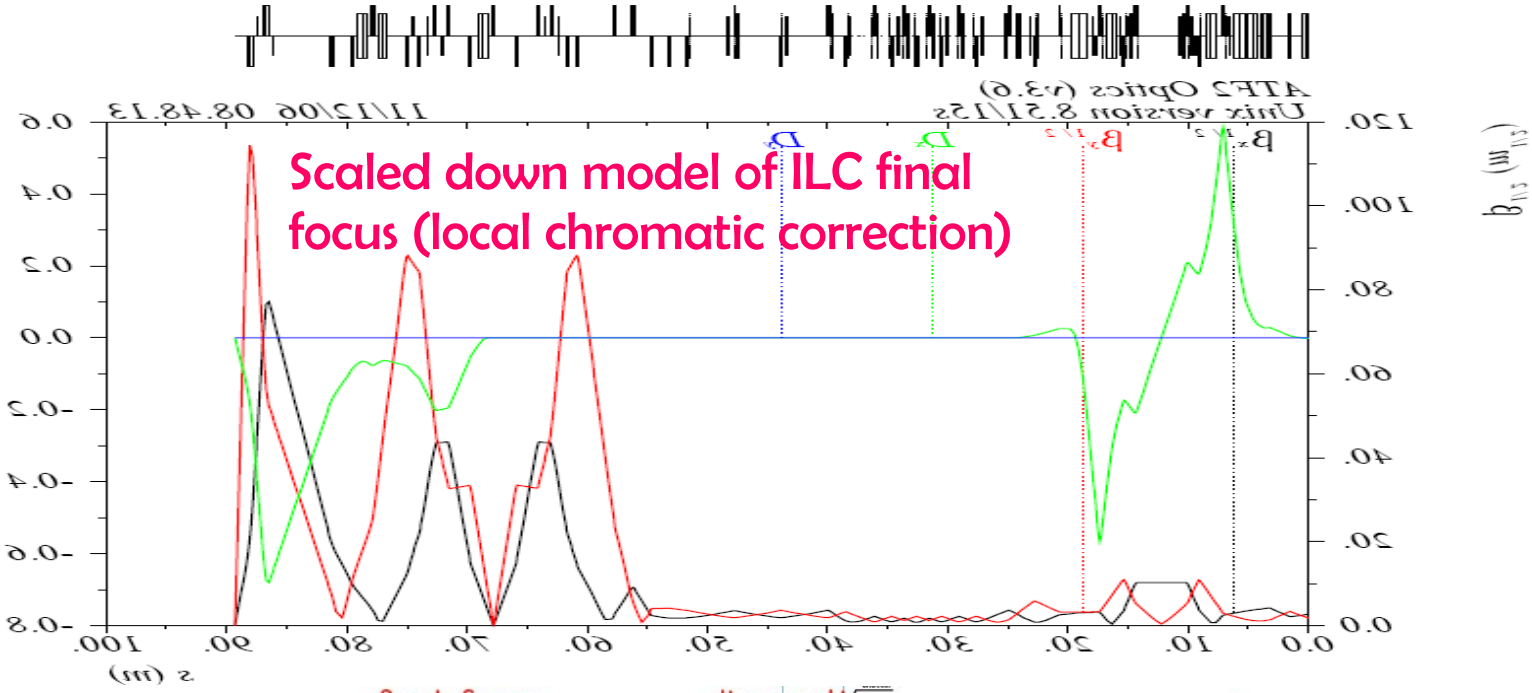
KEK
Waseda Univ.
Nagoya Univ.
Tokyo Univ.
Kyoto Univ.
Hiroshima Univ.
PAL (Korea)
IHEP (China)

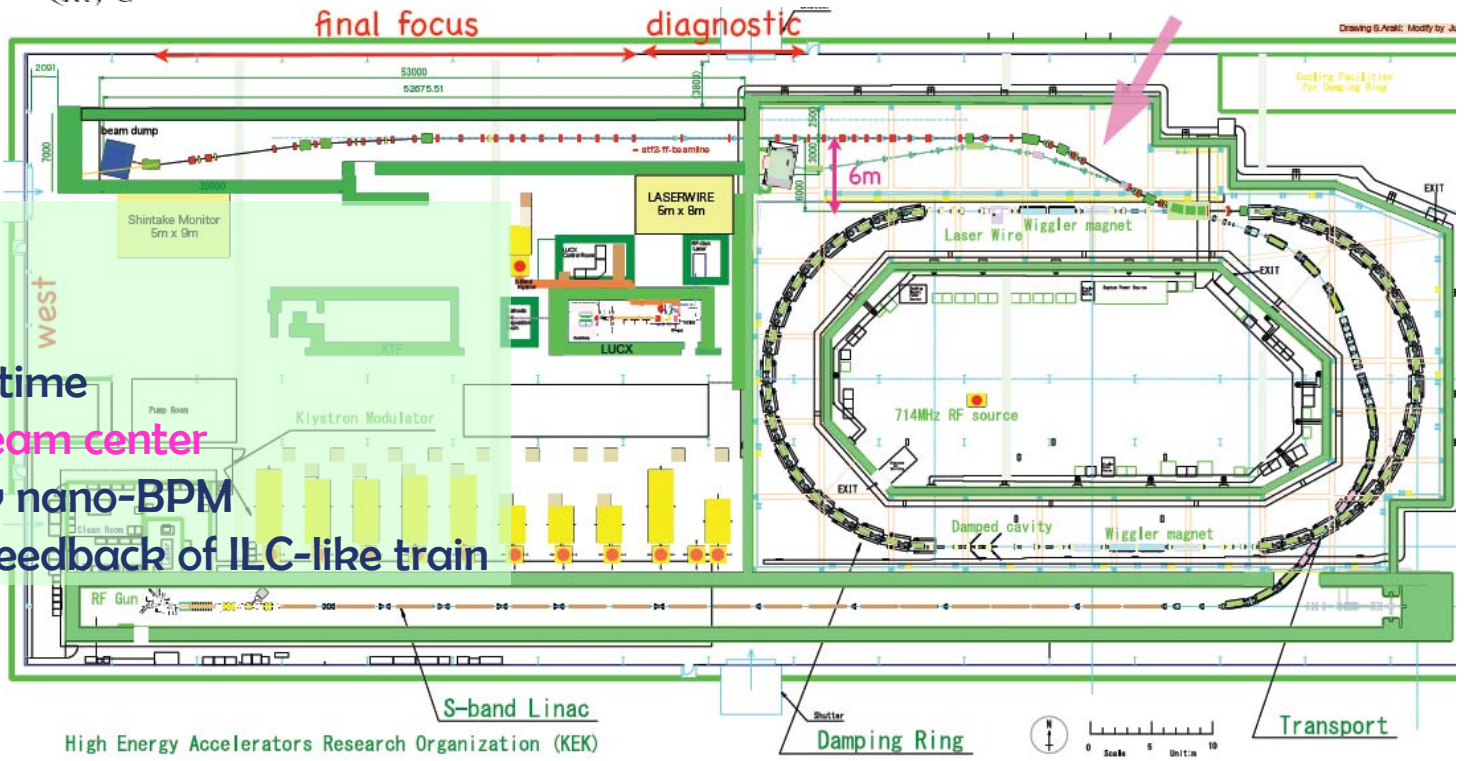
SLAC
LBNL
FNAL
Cornell Univ.




ATF2 project meeting, 15-18 December 2008, KEK

ATF2 – model of ILC BDS

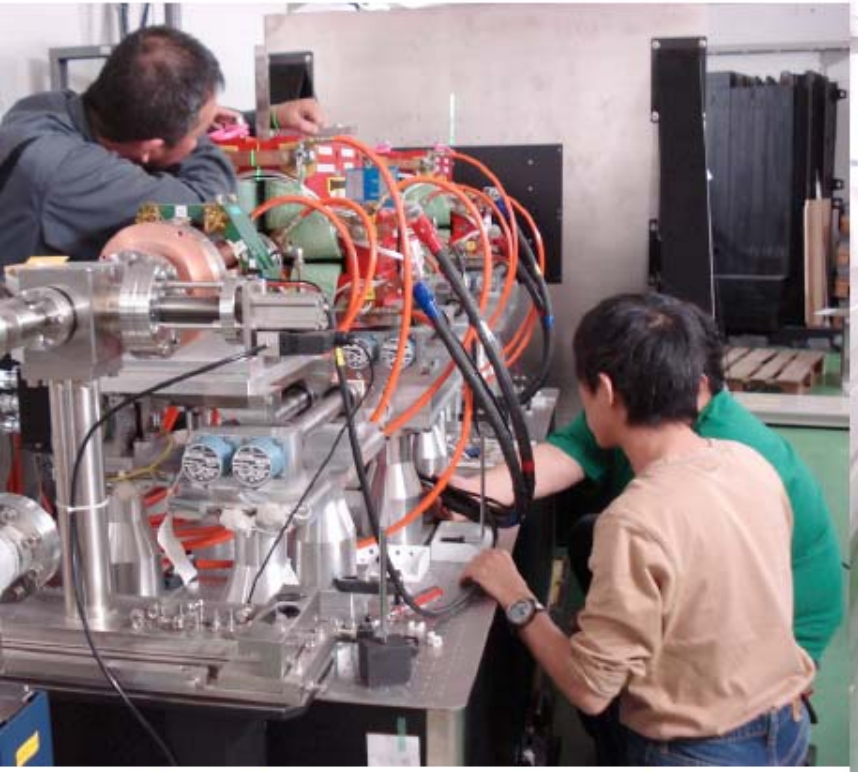




ATF2 goals

(A) Small beam size
Obtain σ_y ~ 35nm
Maintain for long time

(B) Stabilization of beam center
Down to < 2nm by nano-BPM
Bunch-to-bunch feedback of ILC-like train



FD alignment after the
Radiation Inspection ,
11 December, 2008

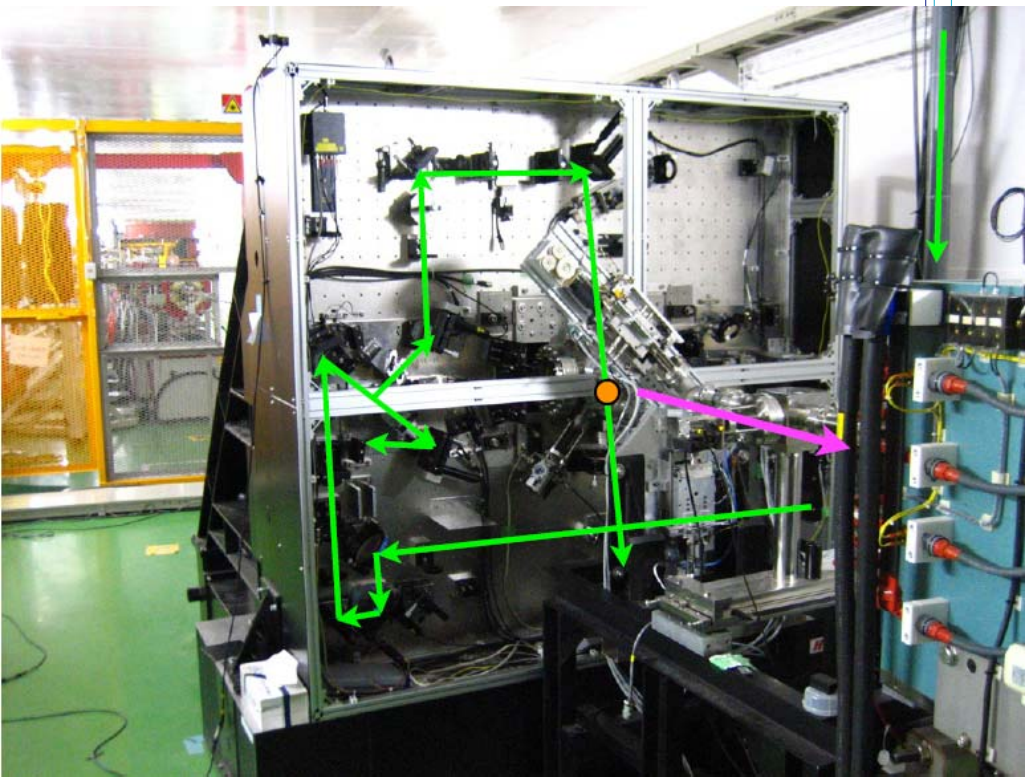
Highlights of recent runs

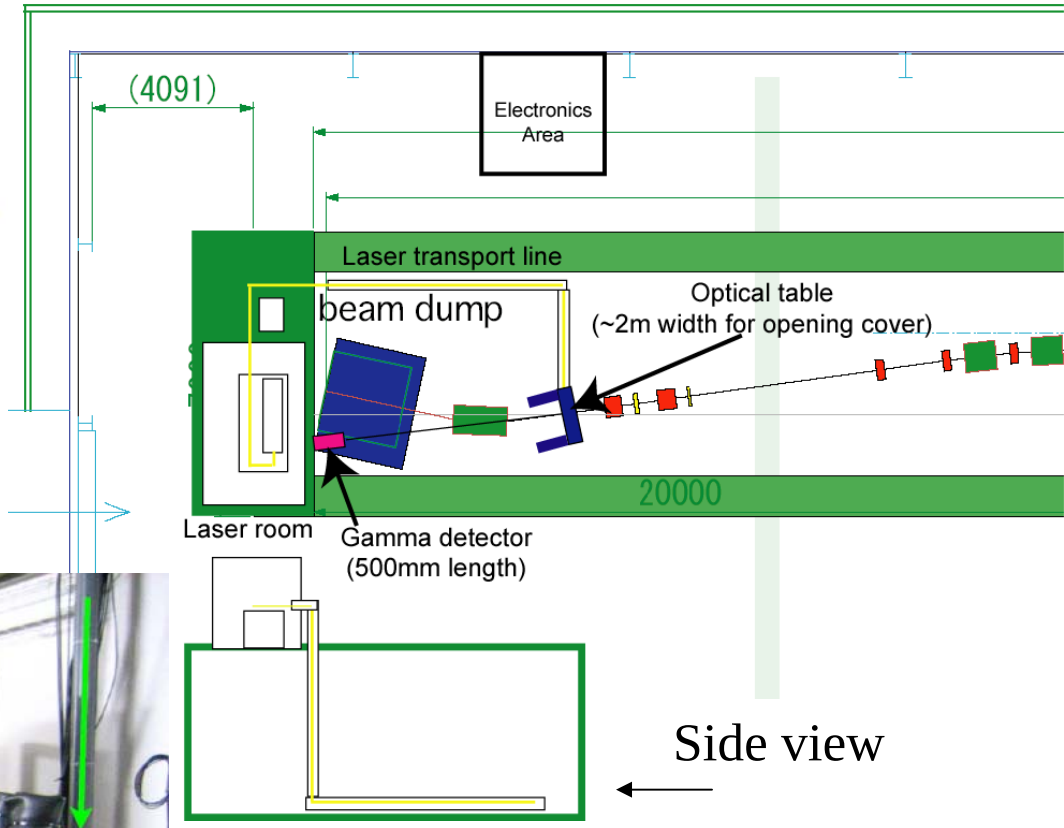
- December 2008 (pilot run)
  - large IP beta optics, semi-ballistic trajectory
  - Establish beam to beam dump, minimize losses, Radiation inspection
  - First tests of hardware and tuning software (FS)
  - BSM commissioning & background characterization
- Jan 2009
  - Continue hardware commissioning & fast kicker study
  - Replace QM7 to one with larger aperture (possible source of EXT ε growth)
- Feb-Mar 2009
  - Large (8cm beta*), all magnets ON
  - Continue hardware commissioning
  - Commission laser wire mode of BSM
  - Tuning tools (EXT disp./coupling corr., IP scans, β/η & ε determ, BBA)
- Current April 2009 run
  - Optics verification for ~1um beam (large, 1cm β*) / IP wire scanners
  - Commission interferometer mode of BSM

Beam Size Monitor

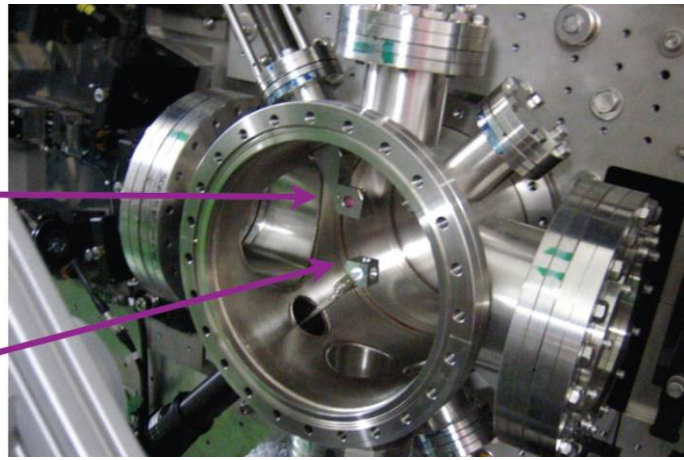
Tokyo Univ.

Shintake monitor Interferometer table on the ATF2 beam line



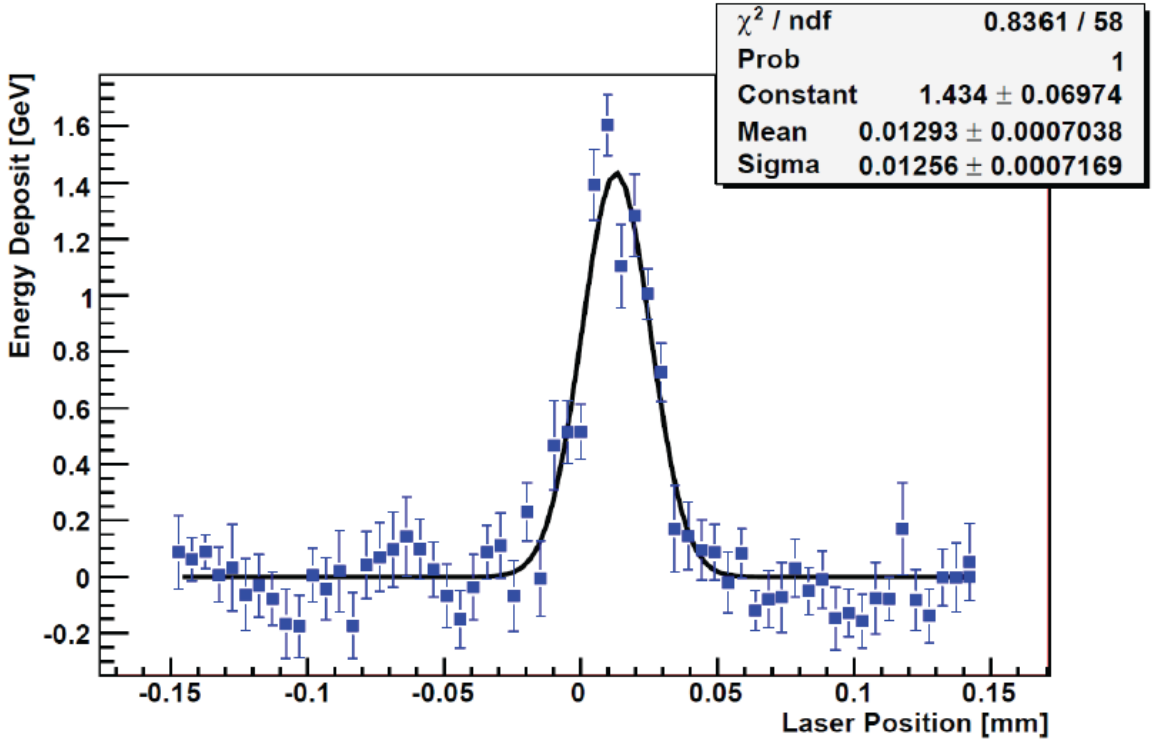


Side view



Feb-Mar run highlights

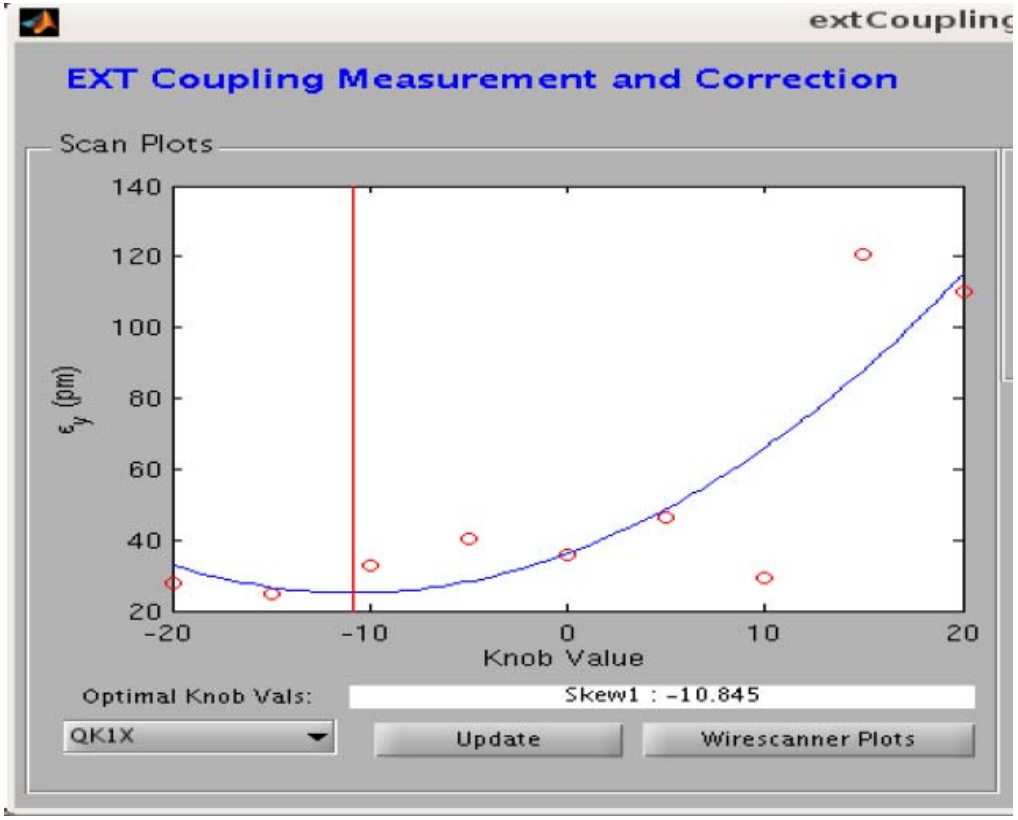
BSM Compton signal in LW mode



Convoluted size of 13microns was measured

Feb-Mar run highlights

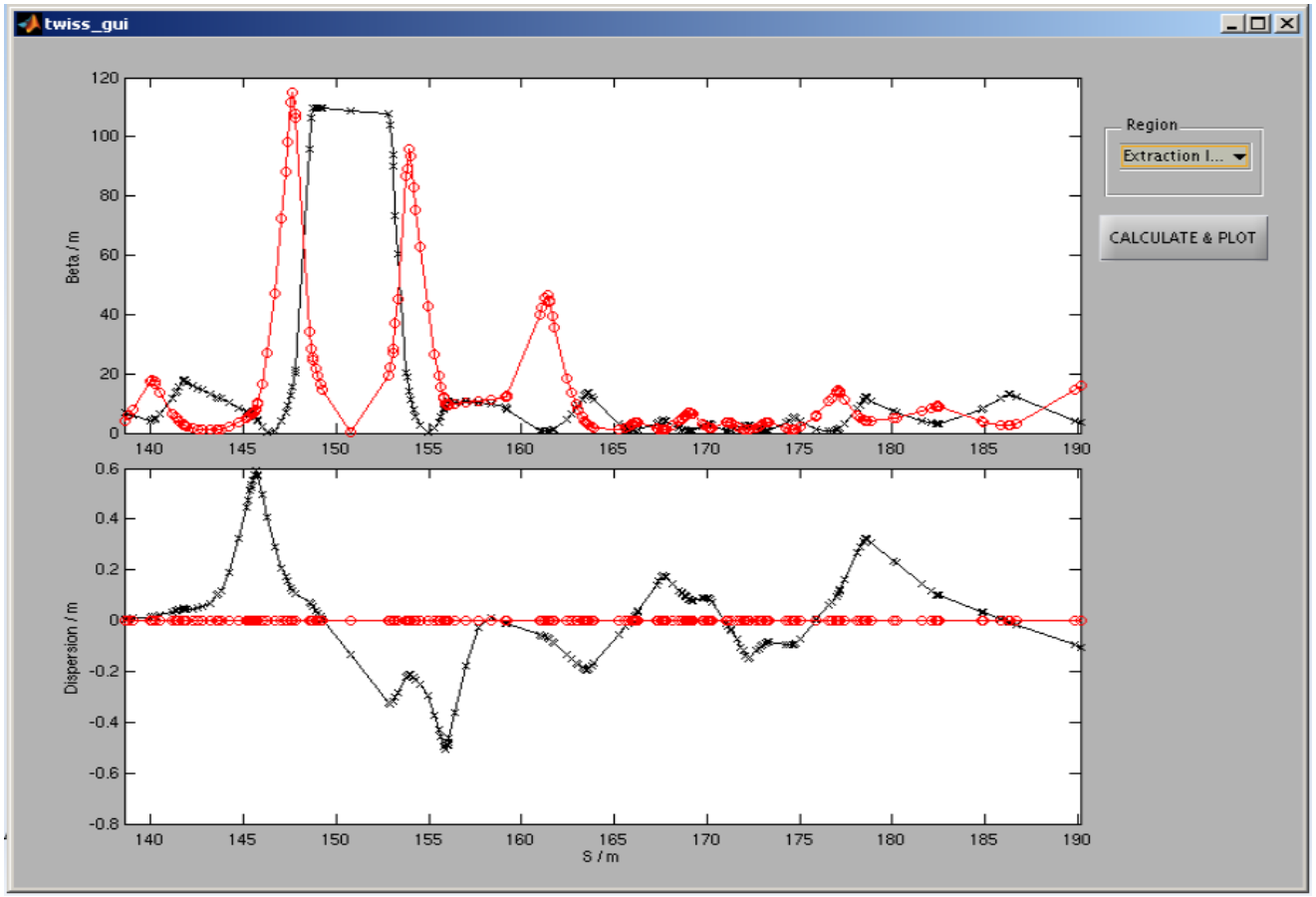
EXT coupling correction



- Vertical emittance scans using 2 available skew quads
- Emittance measurement using 5 vertical wire scanners

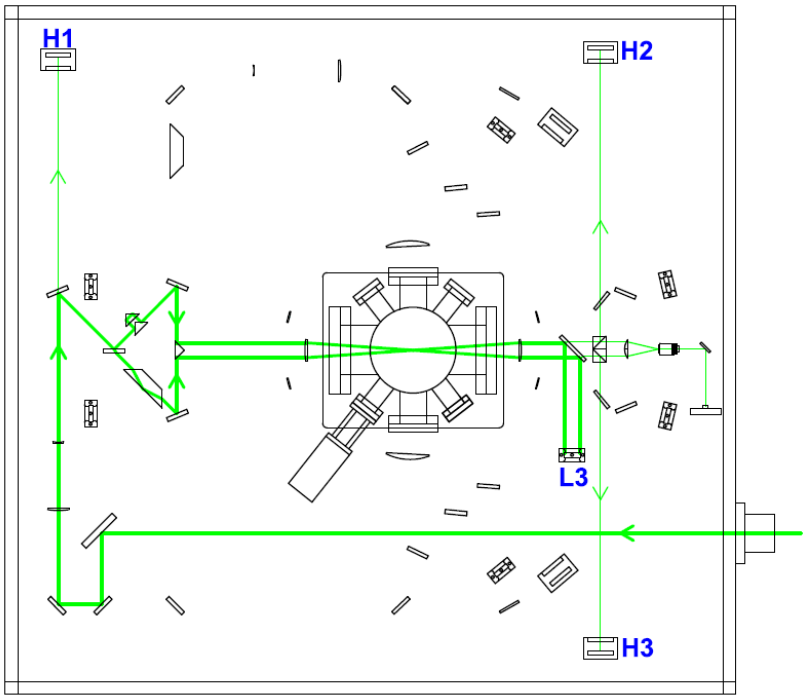
Highlights of April run

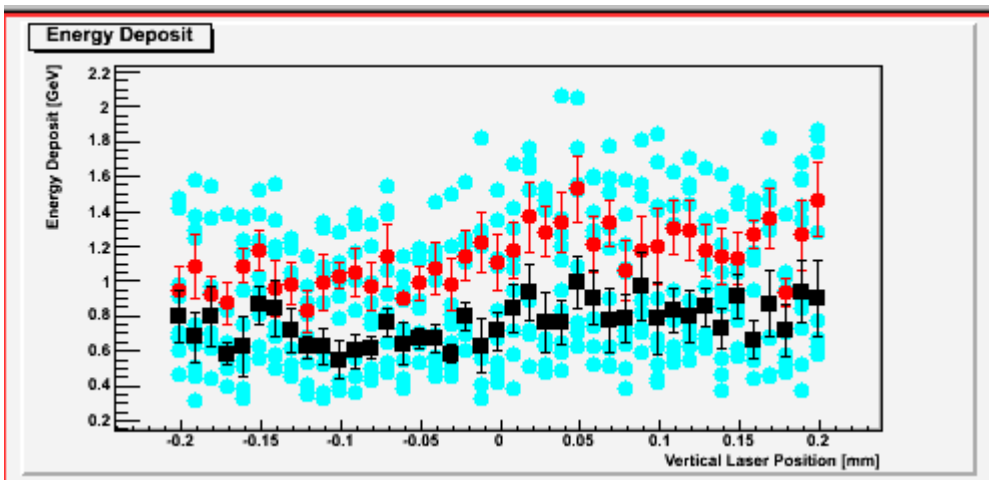
Optics verification tools



- Can verify and correct optics
- DR to EXT well matched, BMAGy~1.04

Highlights of April run

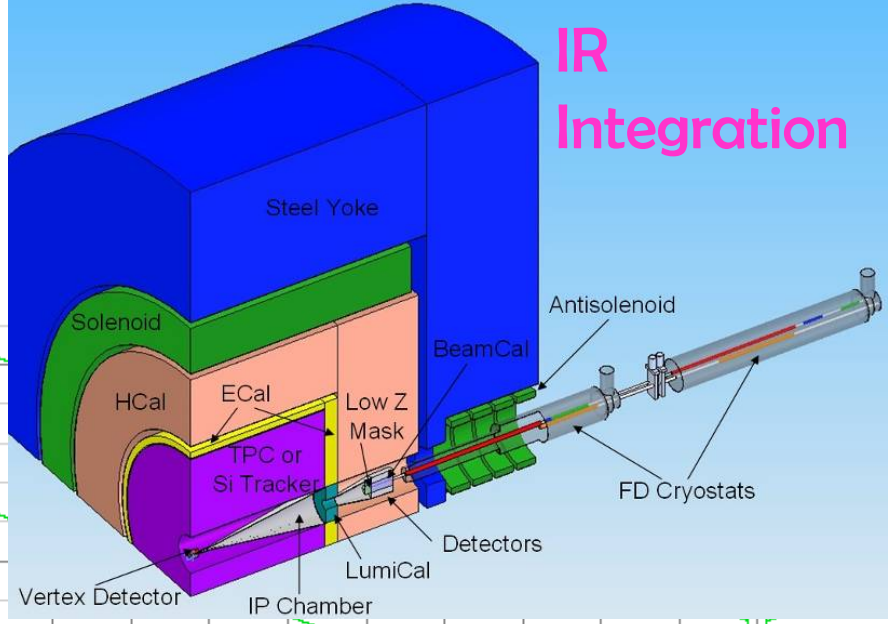




- BSM: 8 deg mode
- Can observe the signal from the start
- Continue working on laser and optics, to achieve beam size and see it by BSM

BDS RDR design

1TeV CM, single IR, two detectors, push-pull



grid: 100m*1m

Diagnostics

Beam
Switch
Yard

β-collimator

Sacrificial
collimators

E-collimator

Final Focus

Tune-up &
emergency
Extraction

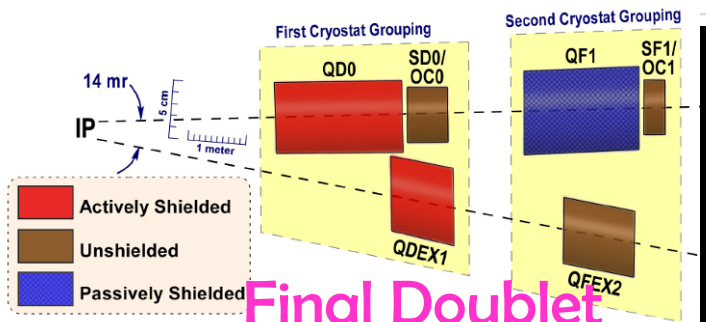
Tune-up
dump

14mr IR

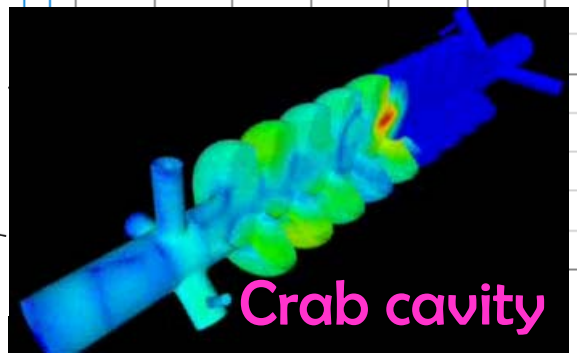
Muon wall

Main dump

Extraction



Final Doublet



Crab cavity

Table 3.4: TD Phase Beam Test Facilities Deliverables and Schedule.

Test Facility	Deliverable	Date
Optics and stabilisation demonstrations:		
ATF	Generation of 1 pm-rad low emittance beam	2009
ATF-2	Demonstration of compact Final Focus optics (design demagnification, resulting in a nominal 35 nm beam size at focal point).	2010
	Demonstration of prototype SC and PM final doublet magnets	2012
	Stabilisation of 35 nm beam over various time scales.	2012

3.3.5 Beam Delivery System

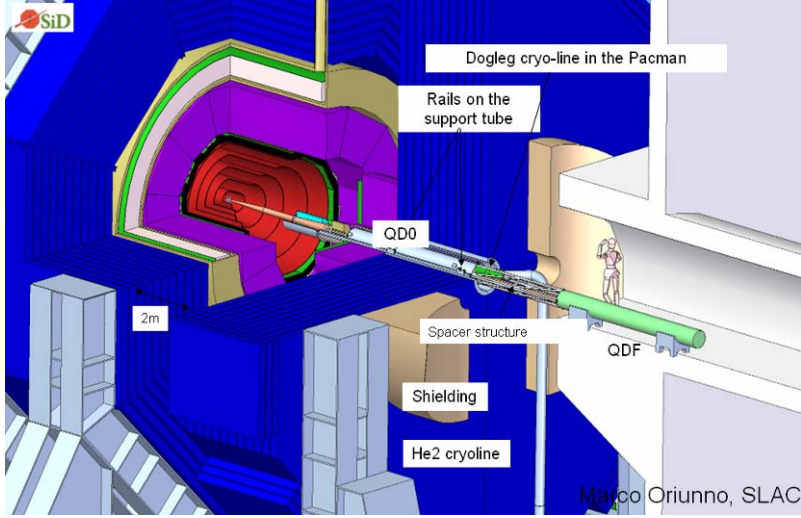
The main R&D focus for the BDS is the ATF-2 programme at KEK which will allow demonstrations of many of the key BDS components and design concepts, the Machine-Detector activity for optimization of the Interaction Region, and design for those BDS subsystems which are critical for system performance or which may expand the physics capabilities of the collider. Examples of R&D are:

- Development of instrumentation (e.g. laser-wires), algorithmic control software, beam-based feedback systems and emittance-preservation techniques to achieve the small beam-size goals (2010)
- Developing of IR Interface Document defining MDI specifications and responsibilities (2010) and design or optimised IR (2012)
- Development of the prototype of the Interaction Region SC Final Doublet (2012)
- Development of Interferometer system for FD stability monitoring (2012)
- Design of the beam dump system (2012)
- Tests of SC and PM Final doublet at second stage of ATF2 (2012)
- Design studies for the photon collider option (2012)
- Collimation and dump window damage tests at ATF2 (2010)
- Development and demonstration of the SCRF crab-cavity system (2010)

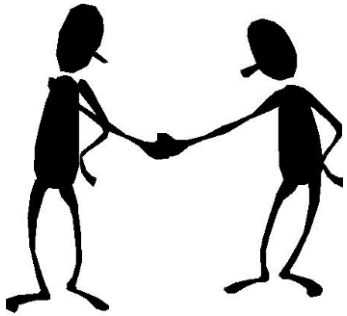
BDS in GDE Technical Design Phase plan

IR integration

PLAN AS SHOWN IN EARLY 2008 (Sendai):



- Machine – Detector work on Interface issues and integration design is a critical area and a focus of efforts
- IR integration timescale
  - EPAC08 & Warsaw-08
    - Interface document, draft
  - LCWS 2008
    - Interface doc., updated draft
  - LOI, April 2009
    - Interface document, completed
  - Apr.2009 to ~2012
    - design according to Interface doc.



ILC-Note-2009-050
March 2009
Version 4, 2009-03-19

Functional Requirements on the Design of the Detectors and the Interaction Region of an e^+e^- Linear Collider with a Push-Pull Arrangement of Detectors

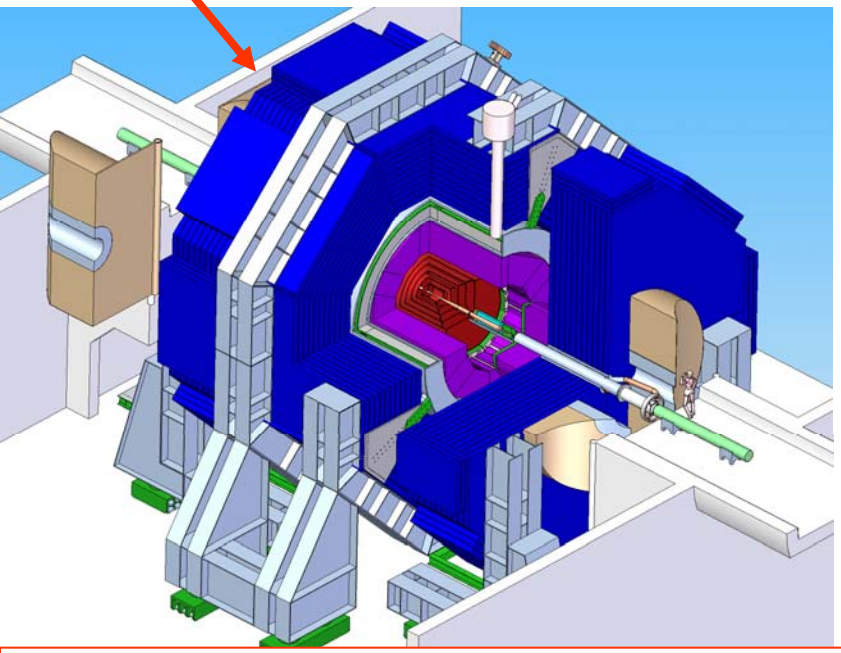
B.Parker (BNL), A.Mikhailichenko (Cornell Univ.), K.Buesser (DESY), J.Hauptman (Iowa State Univ.), T.Tauchi (KEK), P.Burrows (Oxford Univ.), T.Markiewicz, M.Oriunno, A.Seryi (SLAC)

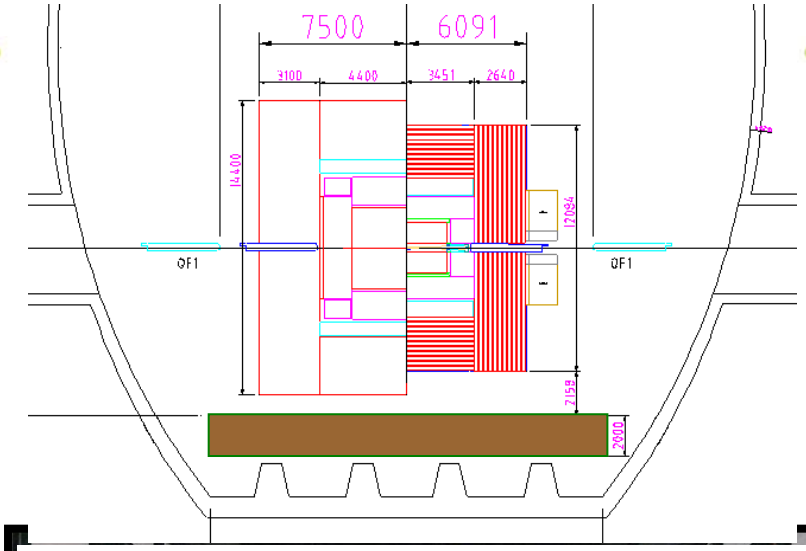
Abstract
The Interaction Region of the International Linear Collider [1] is based on two experimental detectors working in a push-pull mode. A time efficient implementation of this model sets specific requirements and challenges for many detector and machine systems, in particular the IR magnets, the cryogenics and the alignment system, the beamline shielding, the detector design and the overall integration. This paper

http://ilcdoc.linearcollider.org/record/21354?ln=en

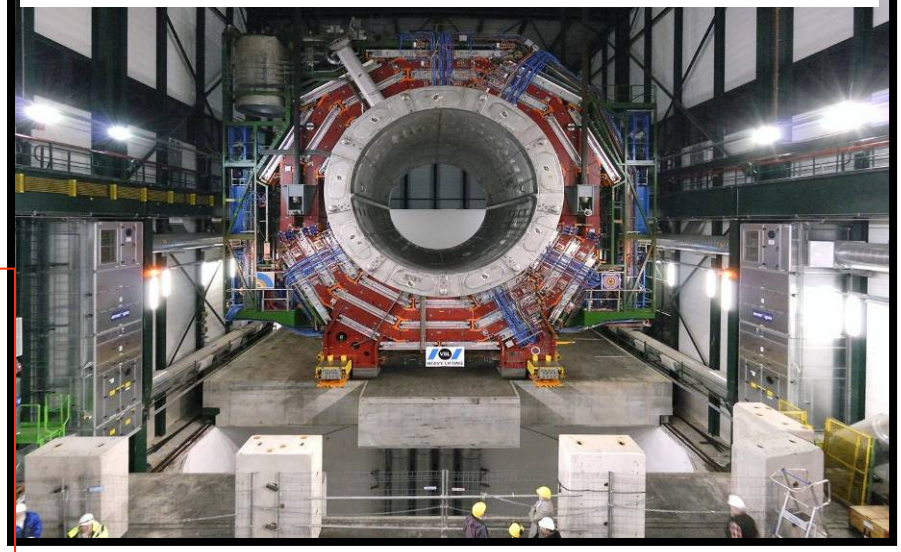
MDI issues to keep working on

Detector motion system with
or without an intermediate platform





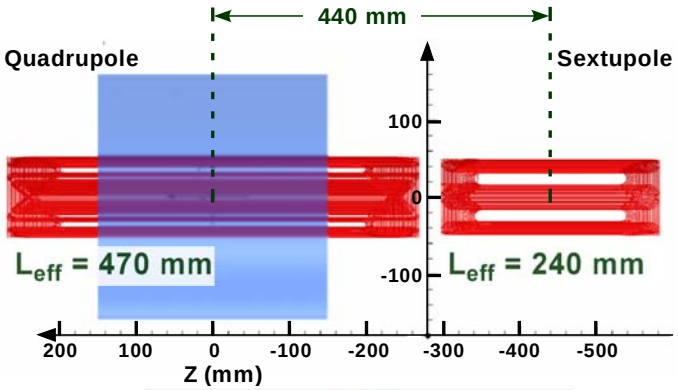
CMS platform – proof of principle for ILC



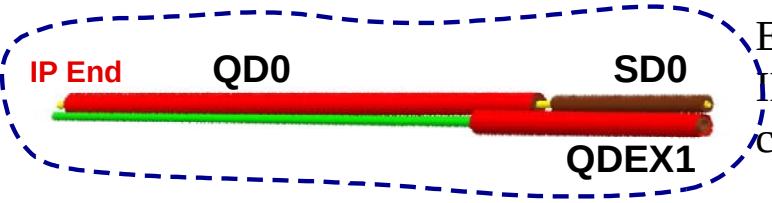
Planning for further design work aiming to bring different push-pull solutions to a compatible and cost effective design

SC FD modified plans and ATF2 tests

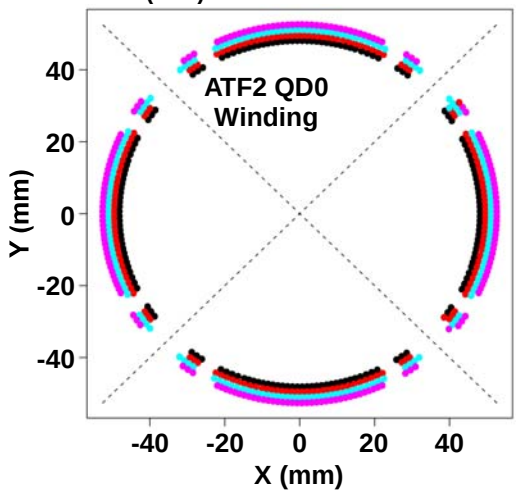
QD0 Cryostat Design for L* = 4.5 m.



Brett Parket, at al, BNL



Earlier plan was to prototype ILC-like QD0 magnet with cryostat & study its stability

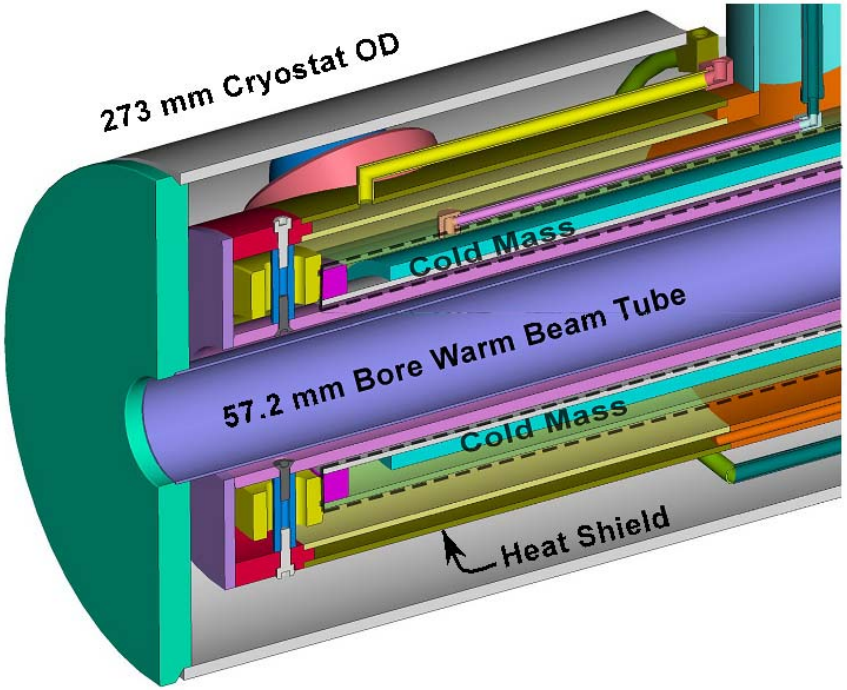


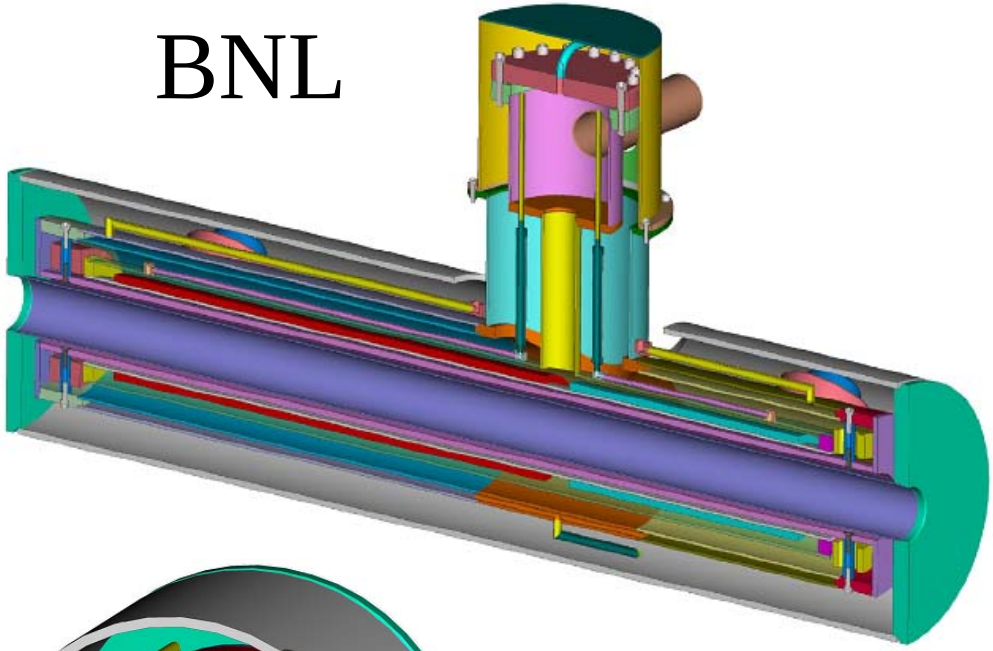
- In TDP, plans for SC FD prototype at BNL were adjusted
  - delay efforts on ILC-like FD prototype; for near-term only make long cold mass and perform its field tests (cryostat later)
  - enhance efforts on ILC-technology-like SC Final Doublet for ATF2 upgrade

- Only produce one quadrupole/sextupole magnet combination (in common cryostat).
- No self-shielding or anti-solenoid (simple).
- KEK Cryogenic system (major challenge).
- 50 mm aperture but with a warm bore (i.e. optimize to limit cold mass heat leak).
- Minimum degrees of freedom (correctors).
- Found it easy to match corrector coils and main coil magnetic lengths.

SC FD for ATF2

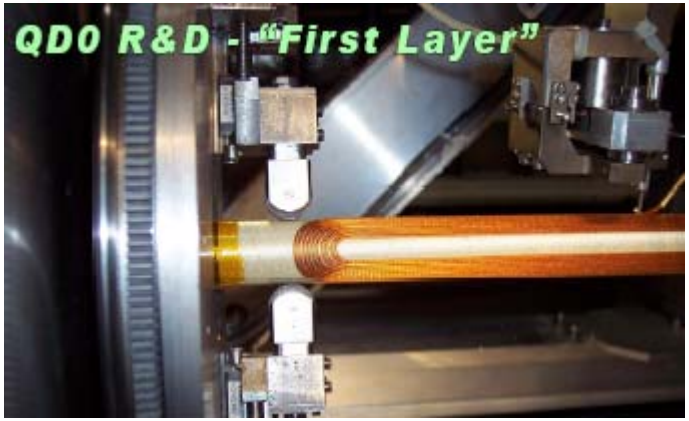
BNL



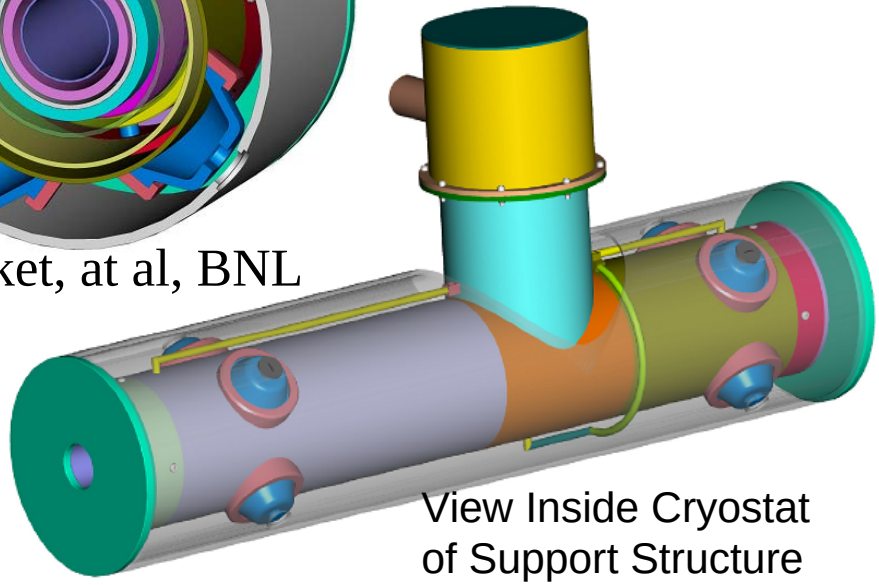


Cross Section View at Support Location

Brett Parket, at al, BNL



Long coil winding

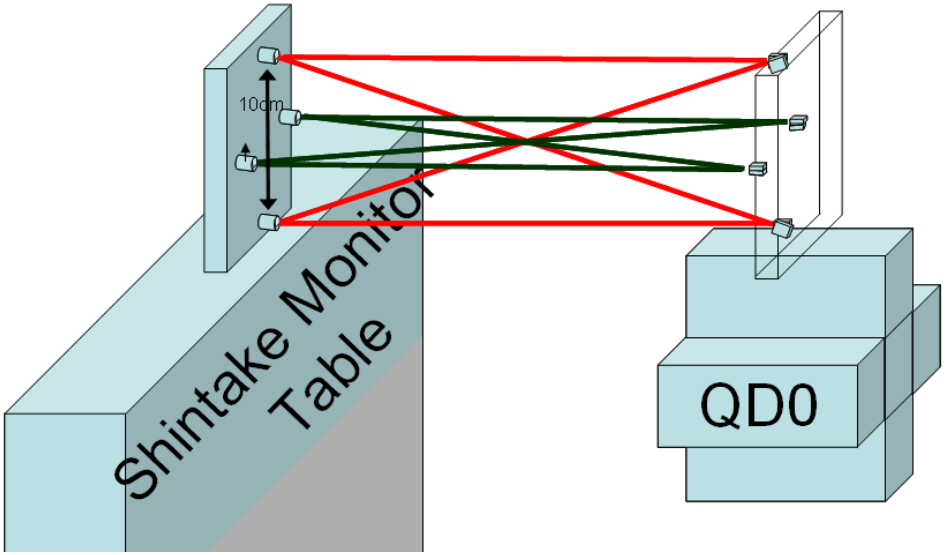


View Inside Cryostat of Support Structure

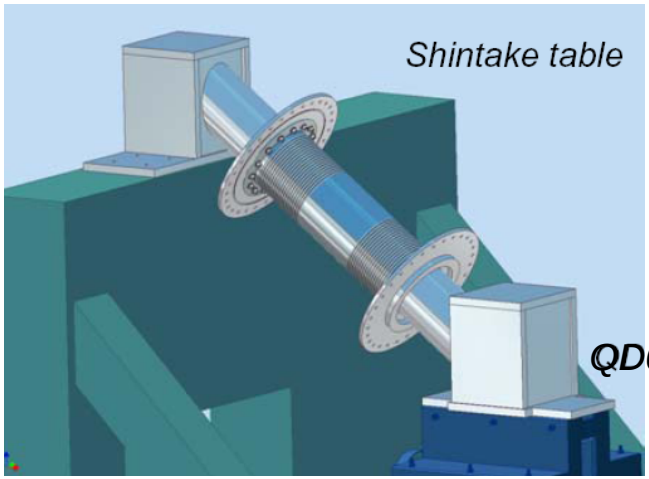
IP Interferometer

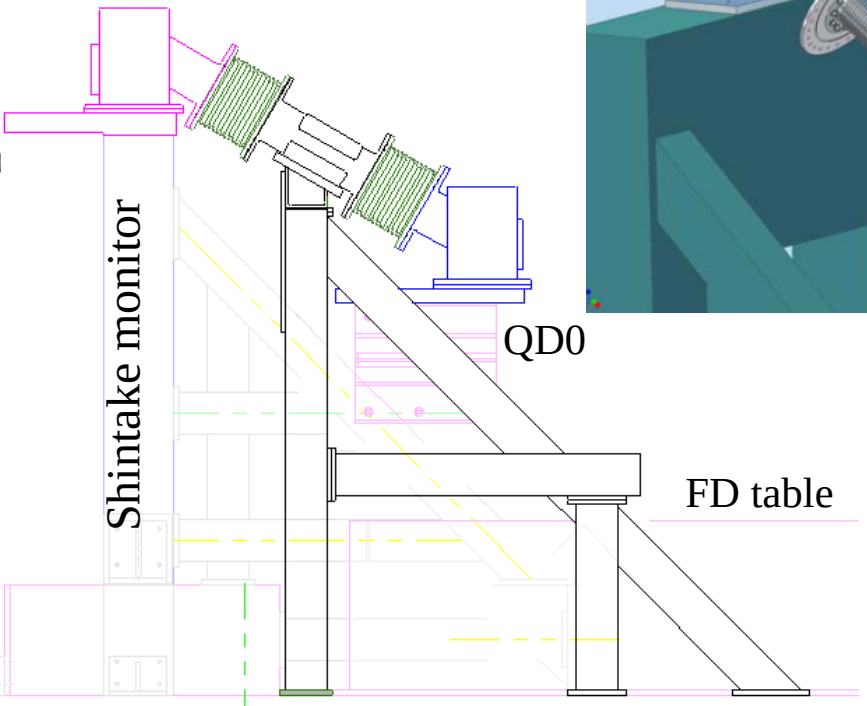
Monitoring Alignment & Stabilisation with high Accuracy

MONALISA Oxford



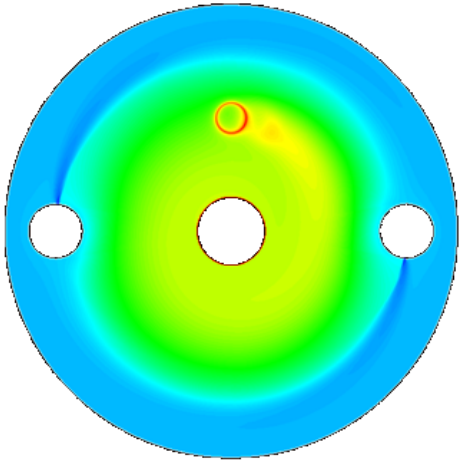
- MONALISA: measures 6D position of two objects separated by several meters with a precision of nanometres using interferometers
- Expect resolution: σ_y:10nm
- Use FFI and FSI (Fixed Frequency and Frequency Scanning Interferometry)
- Measure position of FD with respect to Shintake monitor





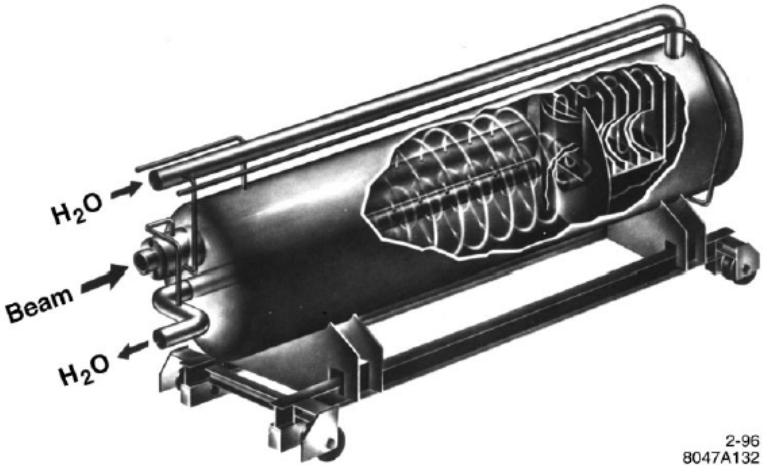
18MW Beam dump

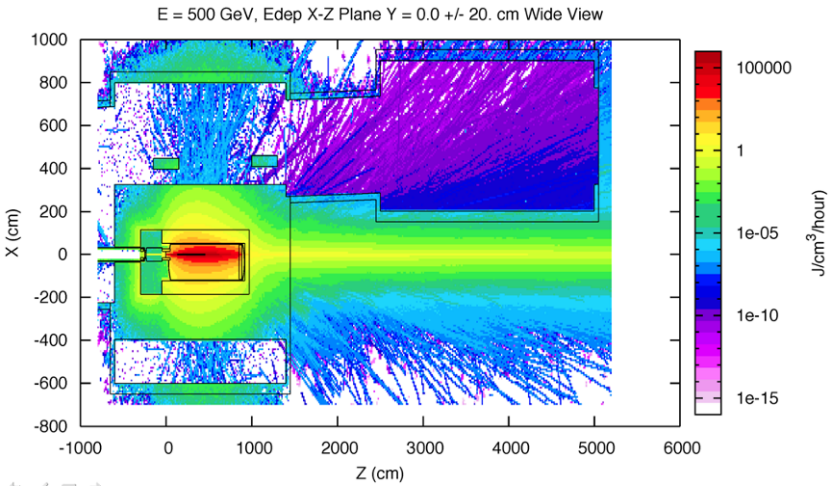
BARC, India, & SLAC, collaboration

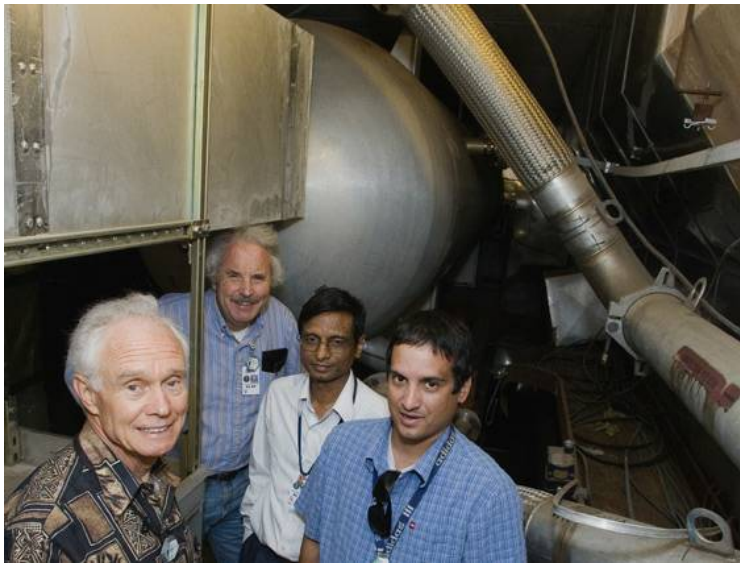


Beam dump with double header (Satyamurthy Polepalle et al, BARC-SLAC)

Maximum Temperature – 147^{0}C
Maximum delta T – 28^{0}C

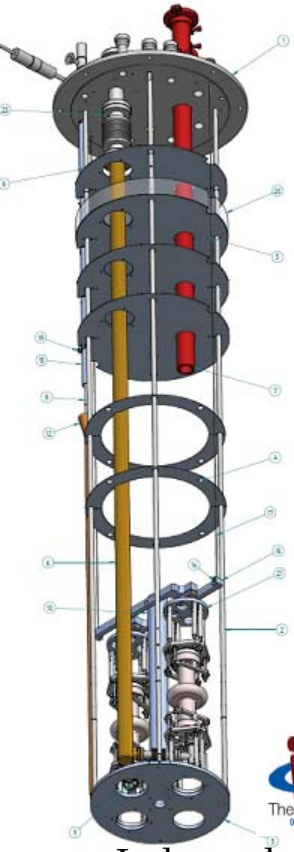


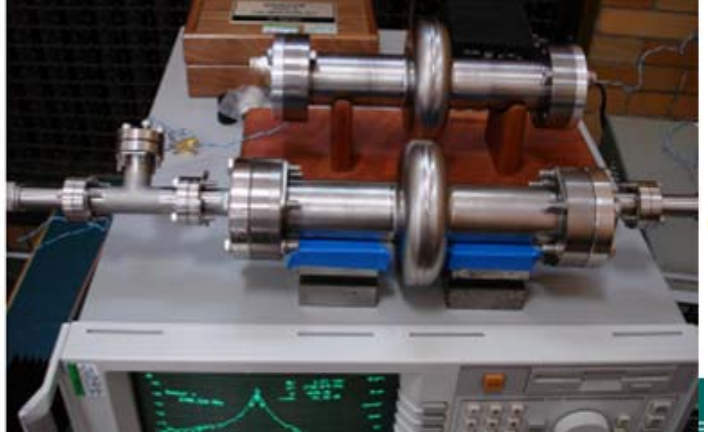


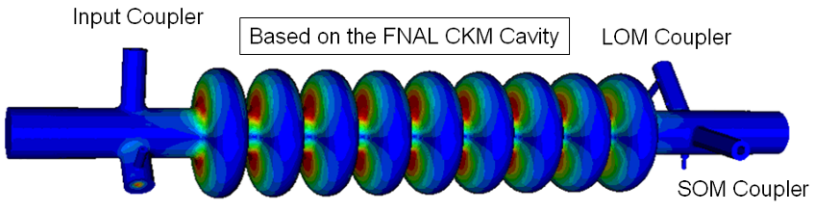


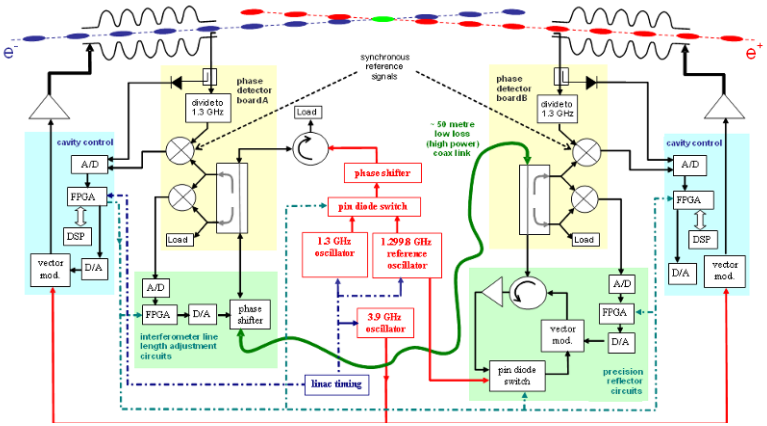
Dieter Walz, Ray Arnold, Satyamurthy Polepalle (BARC, India), John Amann, at SLAC beam dump area (February 2008)

Planning for the next working meeting of the task force at SLAC in ~May 2009, to continue the work on beam dump design

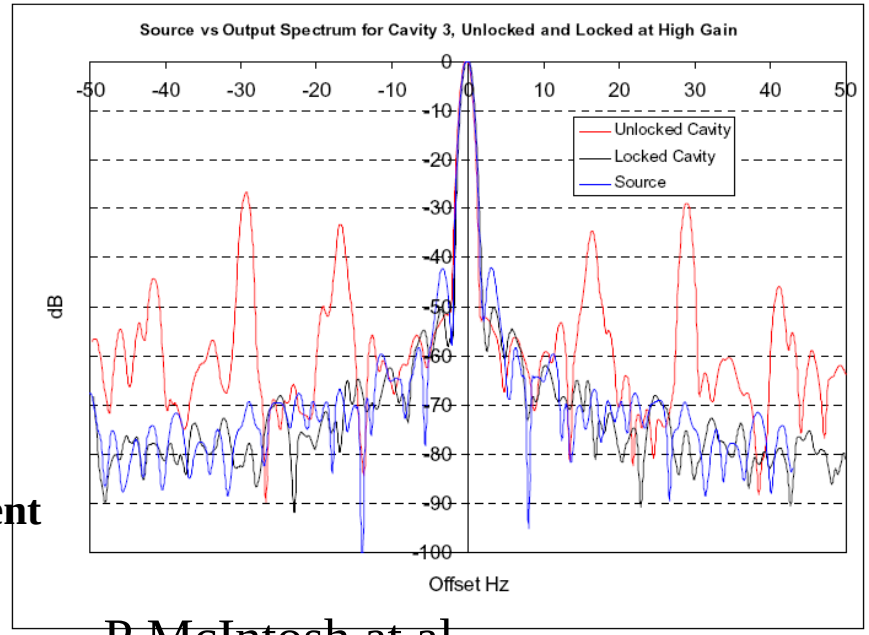








Cavities limited in gradient to 1 MV/m (~40kV/cell) – shielding implications.



Independent phase lock achieved for both cavities:

– **Unlocked => 10º r.m.s.**

– **Locked => 0.135º r.m.s.**

• Performance limited by:

– **Source noise (dominant); ADC noise; Measurement noise; – Cavity frequency drift; Microphonics**

• Improvements being made; new tests being prepared

P.McIntosh at al

New Low P parameter set

	Nom. RDR	Low P RDR	new Low P
Case ID	**1**	**2**	**3**
E CM (GeV)	500	500	500
N	2.0E+10	2.0E+10	2.0E+10
n_b	2625	1320	1320
F (Hz)	5	5	5
P_b (MW)	**10.5**	**5.3**	**5.3**
$\gamma\varepsilon_x$ (m)	1.0E-05	1.0E-05	1.0E-05
$\gamma\varepsilon_y$ (m)	4.0E-08	3.6E-08	3.6E-08
βx (m)	2.0E-02	1.1E-02	1.1E-02
βy (m)	4.0E-04	2.0E-04	2.0E-04
Travelling focus	No	No	**Yes**
Z-distribution *	Gauss	Gauss	Gauss
σ_x (m)	6.39E-07	4.74E-07	4.74E-07
σ_y (m)	5.7E-09	3.8E-09	3.8E-09
σ_z (m)	3.0E-04	2.0E-04	**3.0E-04**
Guinea-Pig δE/E	**0.023**	**0.045**	**0.036**
Guinea-Pig L ($cm^{-2}s^{-1}$)	**2.02E+34**	**1.86E+34**	**1.92E+34**
Guinea-Pig Lumi in 1%	1.50E+34	1.09E+34	1.18E+34

*for flat z distribution the full bunch length is $\sigma_z * 2 * 3^{1/2}$

Travelling focus allows to lengthen the bunch

Thus, beamstrahlung energy spread is reduced

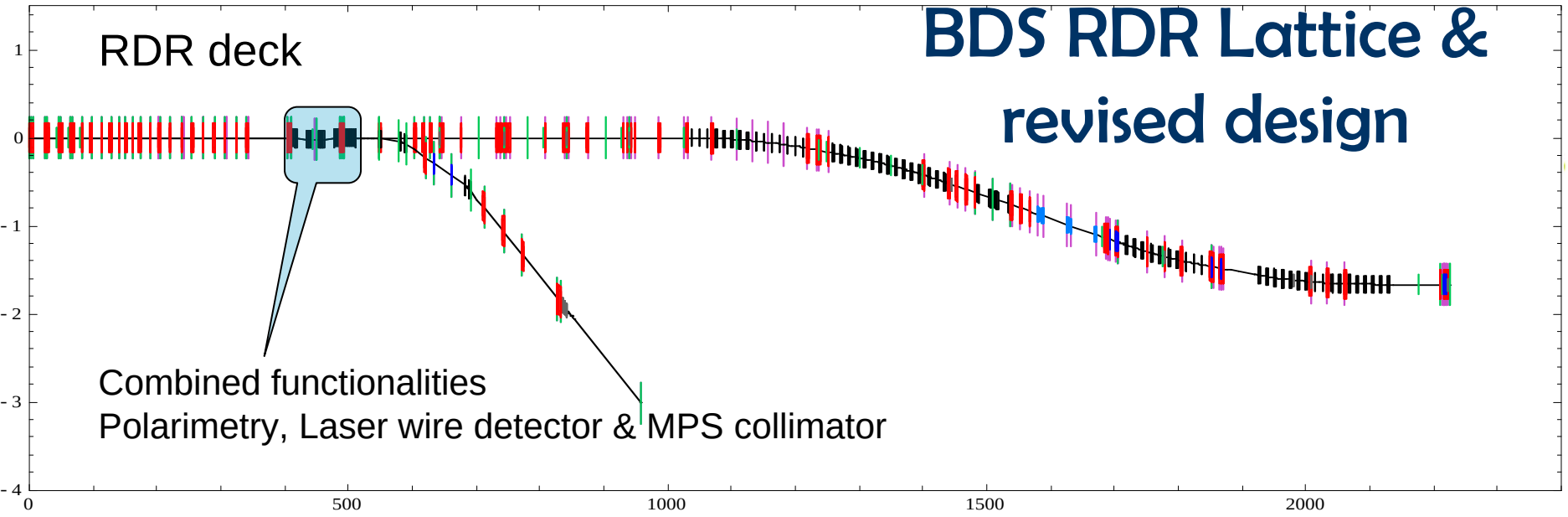
Focusing during collision is aided by focusing of the opposite bunch

Focal point during collision moves to coincide with the head of the opposite bunch

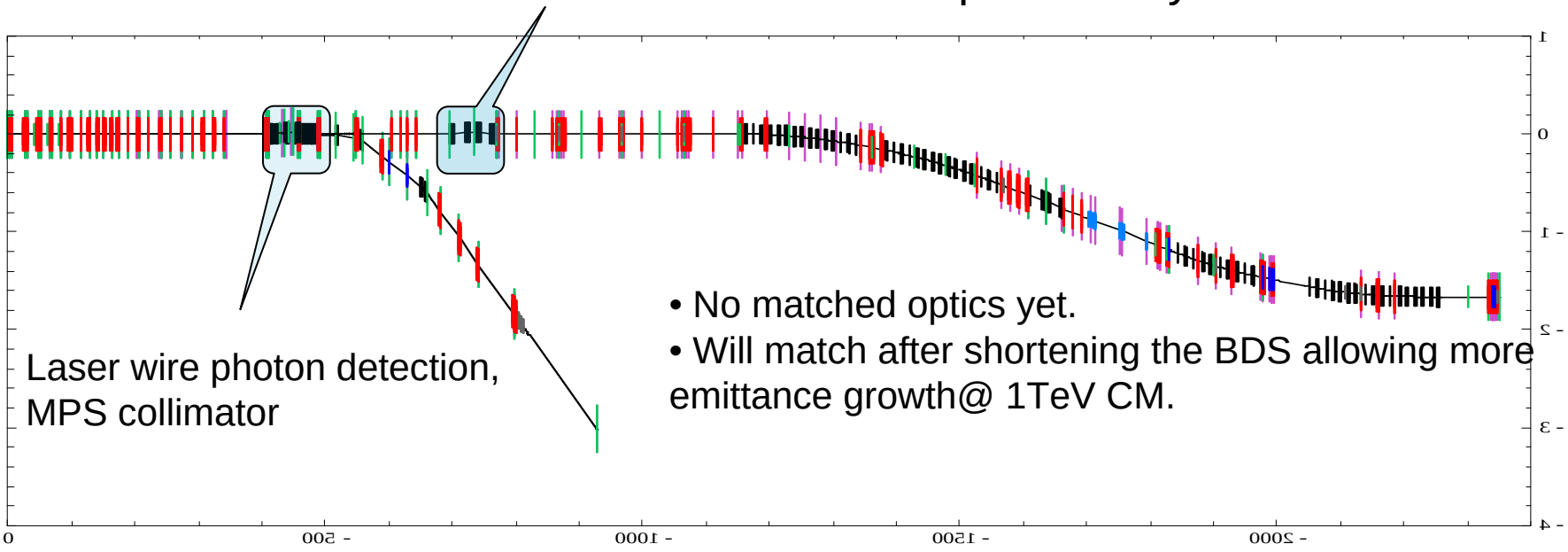
BDS Lattice design plans

- BDS Lattice improvements & modifications:
  - next steps of modifying the RDR deck to separate combined functionalities of upstream polarisation measurements + laser wire detection + MPS
  - Reduction in BDS length to allow more emittance growth @1TeV CM.
- Studies for BDS with central region integration
- Plan to have revised lattices ready by October'09.

BDS RDR Lattice & revised design



Include additional chicane for polarimetry:



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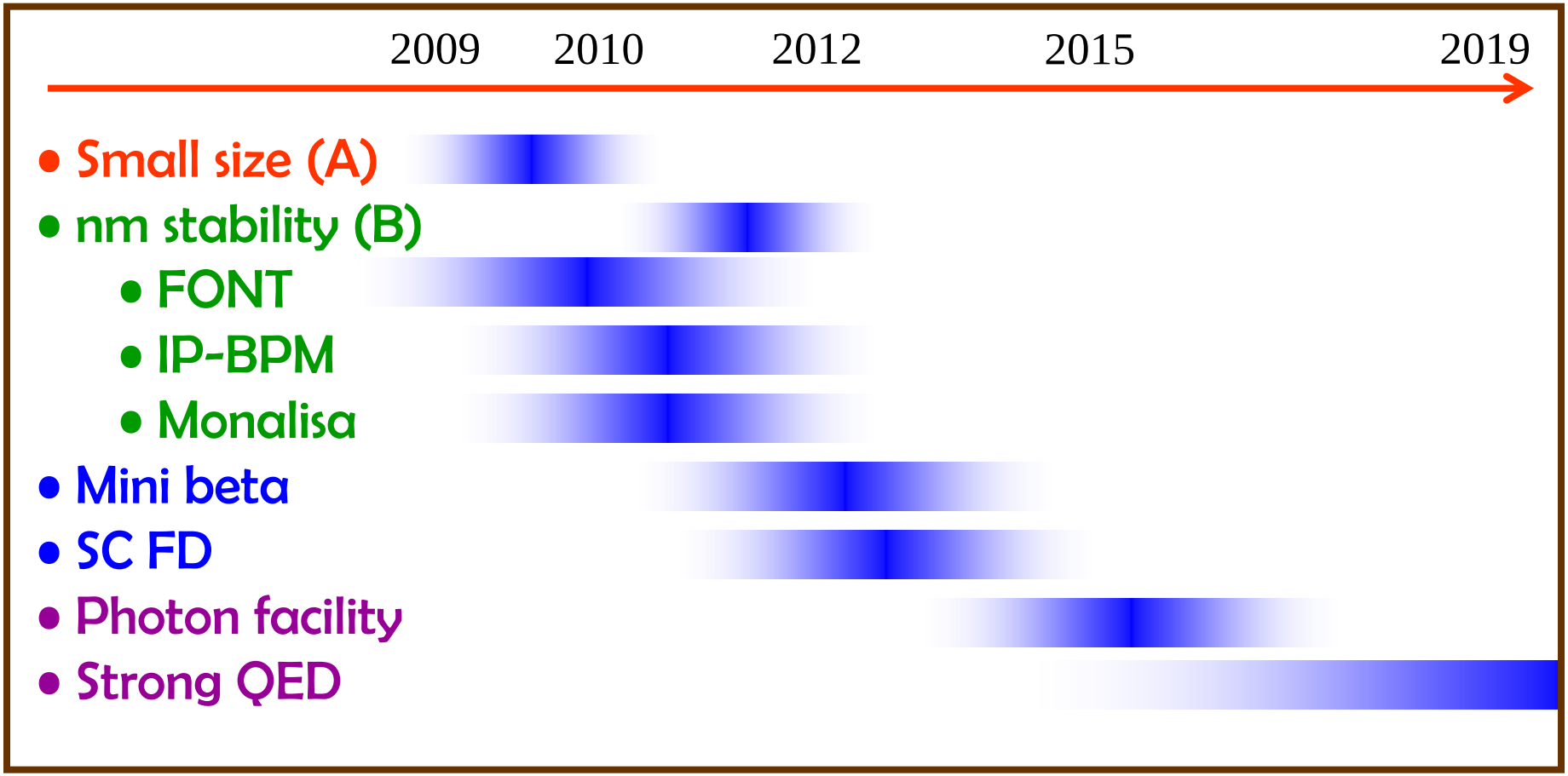
ATF2 Outlook



Summary on ATF2

- ATF collaboration has completed construction of ATF2 facility and has started its commissioning
- ATF collaboration & BDS team has streamlined the organization of commissioning to match the challenge and the timescale
- Hardware for the second goal of ATF2 is being developed
- Looking into the future, planning upgrade of ATF2
- Tentative long term plans being developed

Conclusion

- The BDS group, in TDP phase, is focused on
  - ATF2 test facility
  - Machine Detector Interface
  - and several key systems
- that may make significant contribution to reduction of cost, risk and increase of machine performance