BDS WG / ATF2 SUMMARY

Glen White, SLAC

Oct 10, 2014

LCWS2014, Belgrade, Serbia

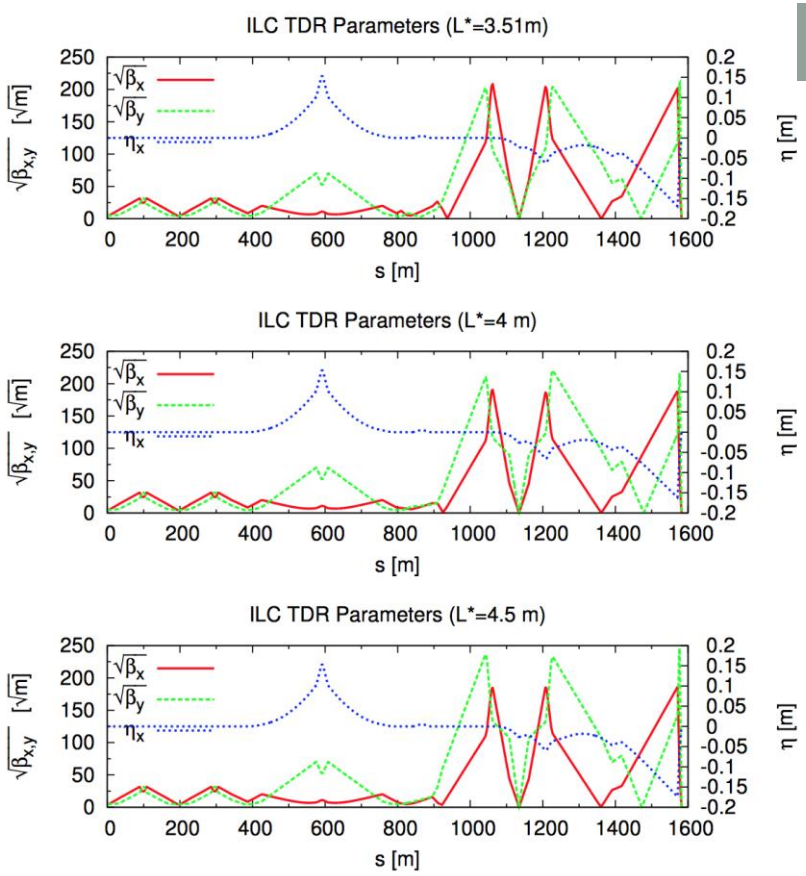
Overview of Sessions

- 8 Sessions, 28 presentations
  - 4 joint with Beam Dynamics
  - 1 joint with MDI *(content covered in MDI summary)*
- Tueday
  - ILC & CLIC
- Wednesday & Thursday
  - ATF2
    - Small spot size tuning & stabilization program
    - ILC/CLIC Instrumentation & diagnostics R&D programs
    - Biannual Technical Board review of ATF2 program

ILC BDS Progress

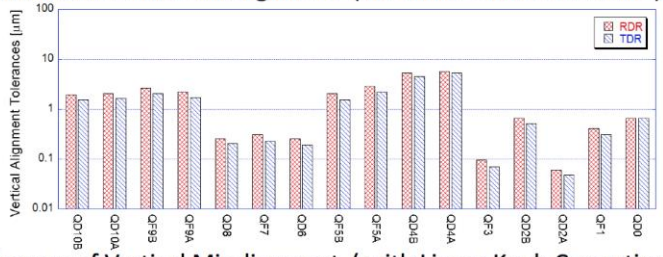
- Preparation of baseline FFS optics
  - 3.5, 4.0, 4.5m L* matched optics now exist that deliver deign IP parameters
    - 4.0m will form baseline for future studies (CR-002)
  - Misalignment, field error sensitivity studies
    - Up to order of magnitude tighter tolerances in some cases w.r.t. RDR
    - With current QF1 location, 4.0-4.5m L* preferred
  - Collimation
    - Required betatron spoiler apertures for SR hit suppression in IR studied -> OK for L*=4m
    - 250 GeV too tight in x
  - EXT design
    - Disrupted beam losses for 500 & 1,000 GeV E_{CM} (with & without beam offset)
    - High-lumi 1 TeV case losses look too large, design optimisation required
  - Optics decks for whole machine DR-Dump under preparation for release in coming months
- Beam dynamics simulations
  - Early tuning simulation results indicate poorer expected lumi performance w.r.t. RDR parameters as expected
- Parameter optimisation studies
  - QF1 & QD0 location preferences
  - IP β_x/β_y
  - Bunch length

FFS Optics, Tolerances

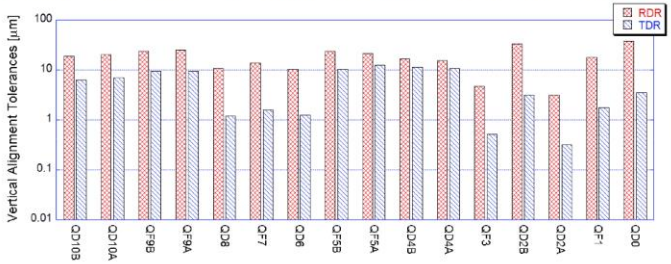


Marin, SLAC

Tolerance of Vertical Misalignment (no Linear Knob Correction)



Tolerance of Vertical Misalignment (with Linear Knob Correction)



RDR parameter
βx* = 0.021 m
βy* = 0.00040 m

TDR parameter
βx* = 0.011 m
βy* = 0.00048 m

	RDR	TDR
QF3	4.8μm	0.5μm
QD2B	33.3μm	3.2μm
QD2A	3.2μm	0.3μm

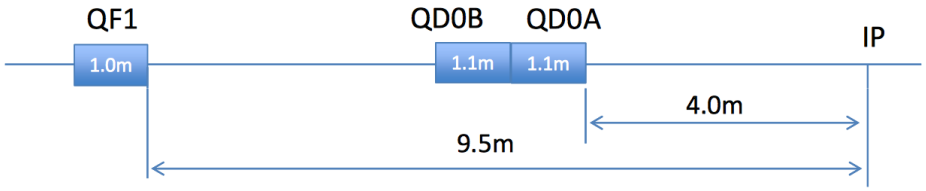
Tolerance after linear knob tuning were much different.

Okugi, KEK

Optics now exists for all L* options to deliver TDR IP parameters @ E_{CM} = 500 GeV. Tolerances significantly worse than RDR.

E_{CM} = 250 GeV

Okugi, KEK



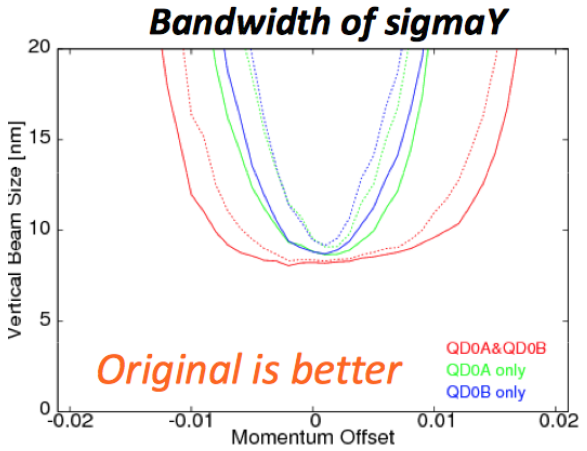
Simulation of the collimation depth for various QD0 arrangement

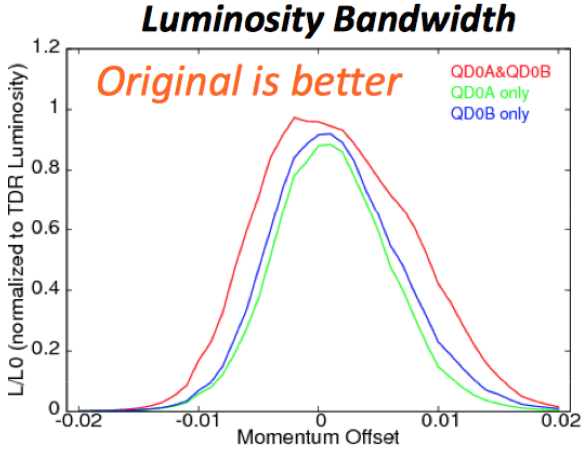
(QD0 L) = 4.0m*

(Half aperture of SPEX) = 1.60 mm (Δp/p = 1%)

	QD0 Length	QD0 L*	QD0 Center	BetaX at QF1	BetaY at QD0	Collimator Half Aperture (SP2/SP4) X collimator	Y collimator
QD0A	1.1m	4.0m	4.55m	29,660m	39,387m	0.65mm (3.2 σ)	0.67mm (58 σ)
QD0A & B	2.2m	4.0m	5.10m	30,630m	46,376m	0.66mm (3.3 σ)	0.57mm (48 σ)
QD0B	1.1m	5.1m	5.65m	26,713m	59,536m	0.68mm (3.4 σ)[*]	0.48 mm (40 σ)

Too tight!

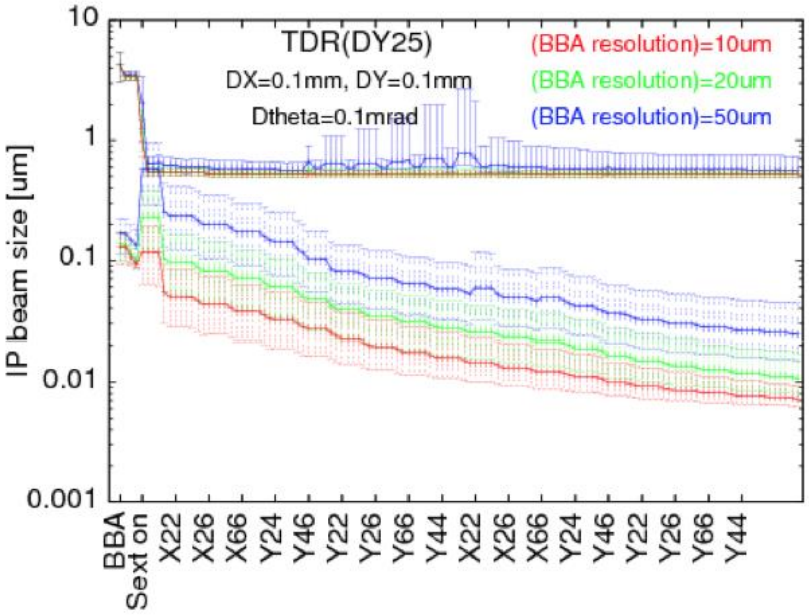


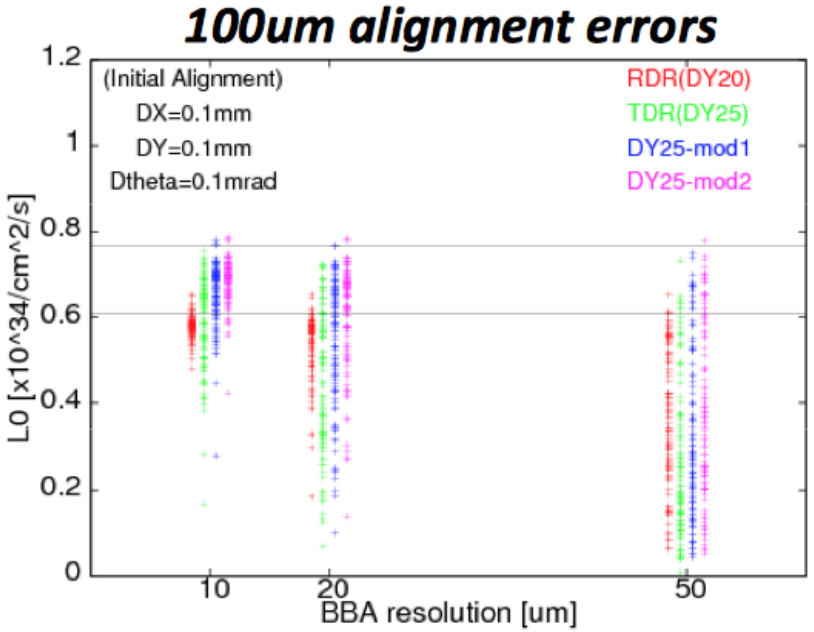


No solution currently for 250 GeV: Hard to optimise optics with shorter QD0, collimation requirement far too tight.

Tuning Simulations

Okugi, KEK





Poor tuning performance w.r.t. RDR. Slow & sensitive to errors. Performance can be improved by increasing β_x^* (reducing β_y^* some to compensate for lumi loss). Will continue to work to optimize and fully characterise performance.

Parameter Optimisations

List of

RDR, TDR and 2 more new IP

	R			
Beam Energy	250			
Nb	1			
frep	5			
betaX*	21			
betaY*	0.4			
sigmaZ	0.3			
emitx (normalized)	10			
emity (normalized)	0.0			
sigmaX*	65			
sigmaY*	5.3			
Geometric Luminosity L0 [1/cm^2/s]	0.6			
Dy	1			
Ay = sigmaZ/betaY*	0.750	0.625	0.787	0.938
Luminosity (no waist) [1/cm^2/s] [*]	1.05e34	1.55e34	1.36e34	1.23e34
Luminosity (waist) [1/cm^2/s] [*]	1.17e34	1.71e34	1.54e34	1.39e34
L / LTDR	0.68	1	0.90	0.81

[*] calculated by K.Yokoya with CAIN

Idea

Wang, Gao, IHEP

— Reduced bunch length enables:

1) less beamstrahlung with the same luminosity,
2) or higher luminosity with equal amount beamstrahlung.

— The approach is to use flatter beams

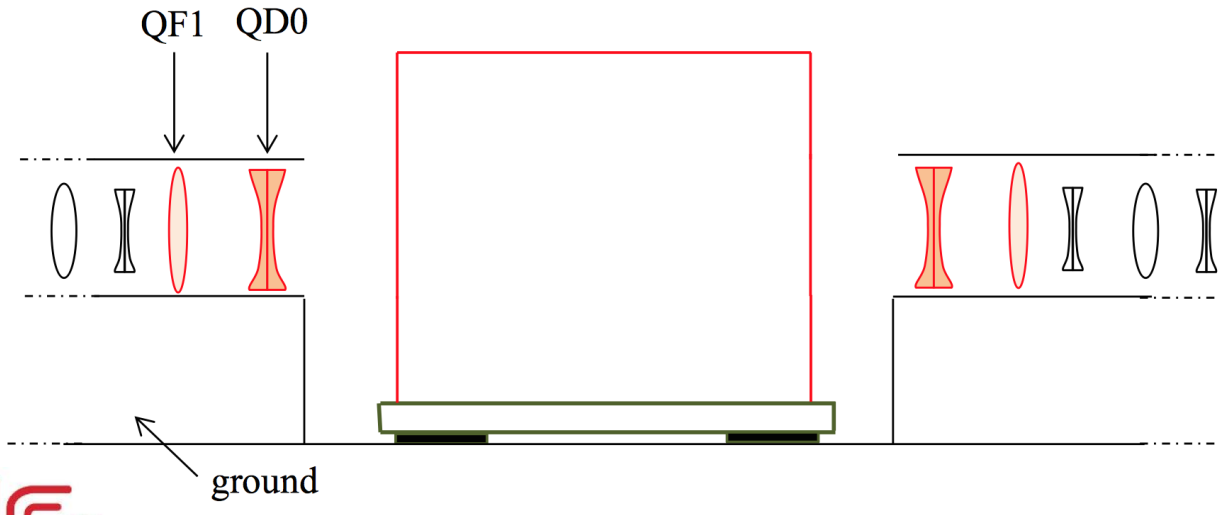
— using exactly the same magnets as ILC nominal design, only refitting them, but requiring a short bunch length (150 or 200 microns), which is the price to pay...

Okugi, KEK

Look for ways to improve tolerances and get better tuning performance. Obviously parameter changes have to be carefully considered together with other systems.

Alternative FFS Design Options

Plassard, CERN



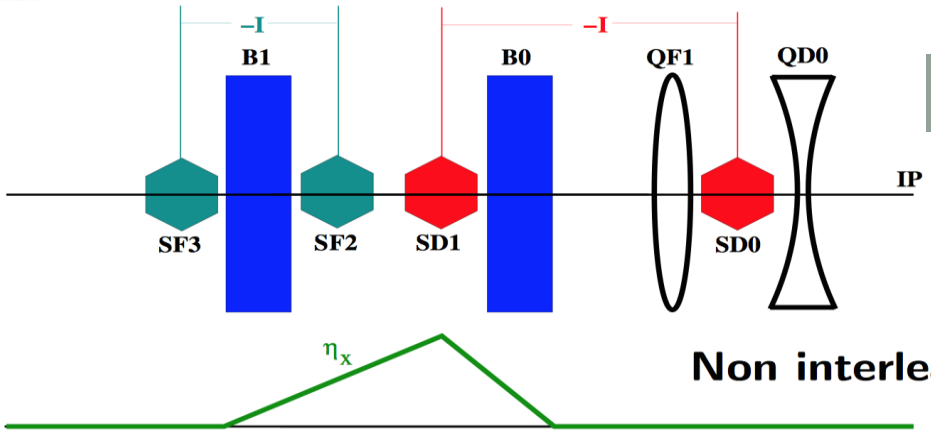
Long L^* option

- Magnets outside of the detector on a stable ground ⇨ **small magnet vibration**
- Same magnet for all detectors

Problem :

Luminosity and tuning of the FFS for the long L^* option

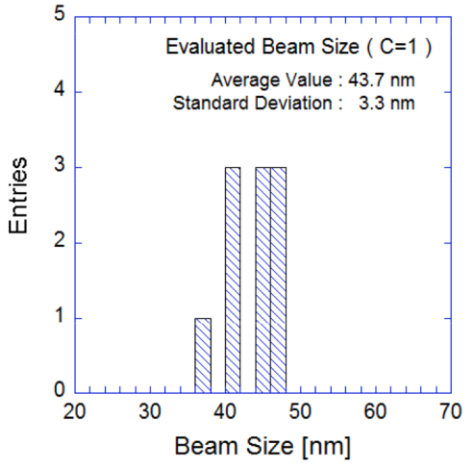
Blanco, CERN



Innovative FFS R&D continuing for CLIC, keep a keen eye on progress for possible future implementation if design improvements relevant to ILC shown.

ATF2 Status – Goal 1

Achieve 37nm vertical beam waist



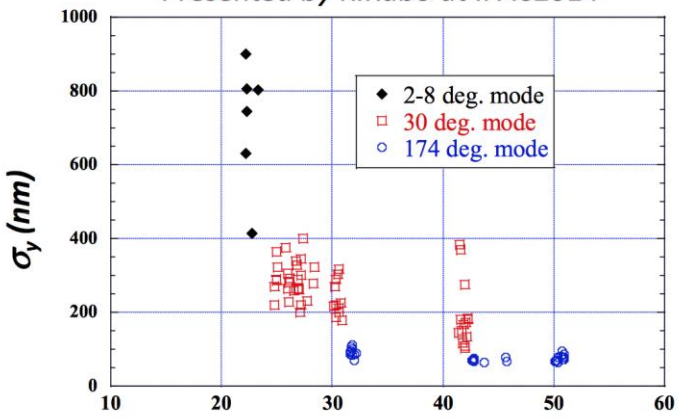
Minimum beam size at ATF2 is 44nm or less.

The minimum beam size was measured at 6/12/2014.

Remaining Issues to reach design 37nm:

- Identify and fix wakefield sources
- IP beam-fringe jitter
  - Orbit jitter
  - IPBSM laser jitter
  - Magnet jitter

Presented by K.Kubo at IPAC2014



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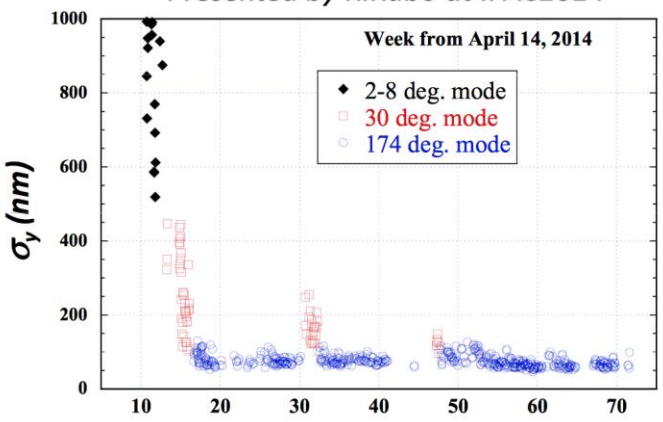
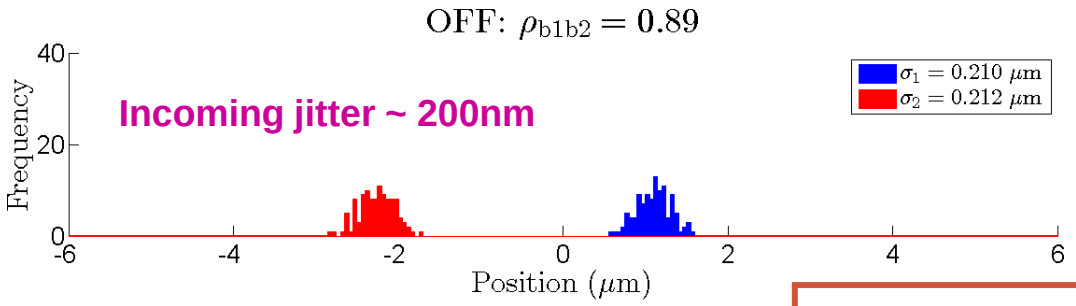
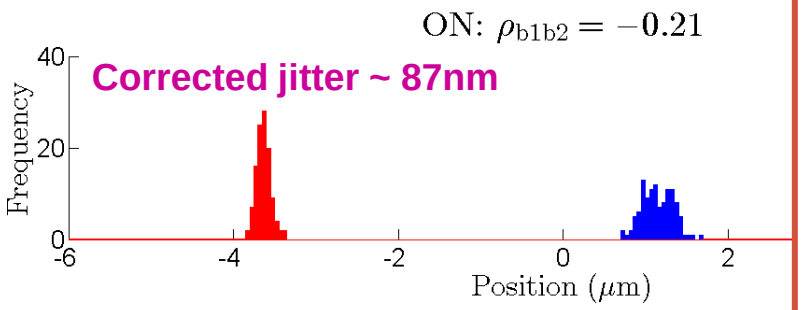


~32 hrs recovery from 3 wk shutdown. ~16 hrs revovery from weekend beam-off.

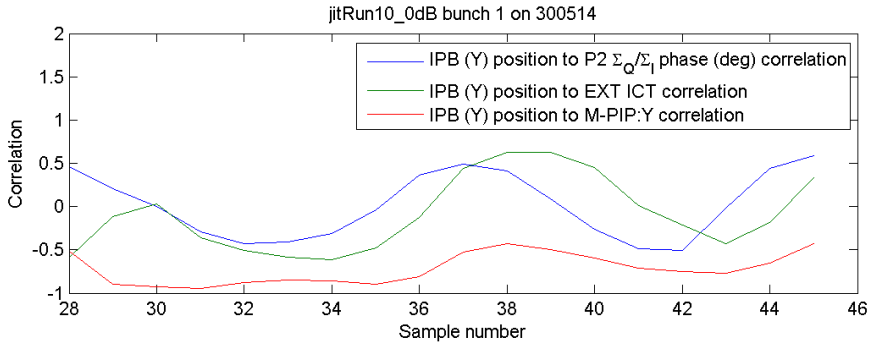
ATF2 Status – Goal 2

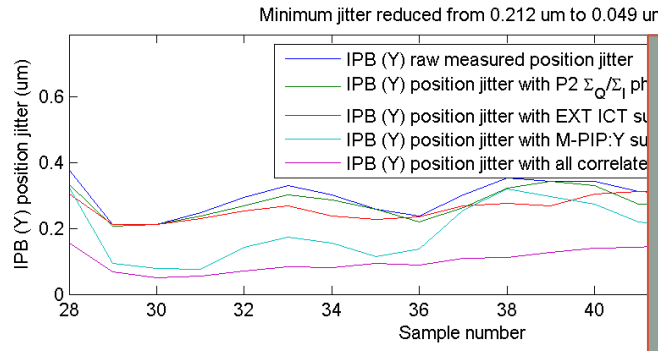
IP vertical nm-level beam stabilisation





- IP beam stabilisation by ~10 MHz feedback system
- Currently limited by IP BPM performance
  - Ongoing R&D to achieve O(2nm) resolution





212 nm
→
49 nm
(correlations)
→
41nm
(averaging)

ATF2 R&D

ATF2 IP Beam Size measurements systematics	*Ms. Jacqueline YAN*
Kopaonik (30), Hyatt Regency	09:00 - 09:20
ATF2 IP BPM System	*Mr. Siwon JANG*
Kopaonik (30), Hyatt Regency	09:20 - 09:40
Development of a High Resolution Cavity BPM for the CLIC Main Beam	*Jack Raymond TOWLER*
Kopaonik (30), Hyatt Regency	09:40 - 10:00
Mitigation of ground motion in ATF2	*Marcin PATECKI*
Beograd (Joint with Beam Dynamics), Hyatt Regency	11:20 - 11:40
Halo Collimation	*Mrs. Nuria FUSTER*
Beograd (Joint with Beam Dynamics), Hyatt Regency	11:40 - 12:00
Updates on mechanically adjustable PM Final Doublet	*Dr. yoshihisa IWASHITA*
Beograd (Joint with Beam Dynamics), Hyatt Regency	12:00 - 12:20
Octupoles / magnet design	*Michele MODENA*
Kopaonik (30), Hyatt Regency	15:00 - 15:20
Diamond sensor installation plans	*Ms. Shan LIU*
Danube (40), Crowne Plaza	14:00 - 14:20
Plans for wakefield-free steering in ATF2	*Dr. Andrea LATINA*
Danube (40), Crowne Plaza	14:20 - 14:40
OTR/ODR	*Stefano MAZZONI*
Danube (40), Crowne Plaza	14:40 - 15:00

A very rich ongoing research program into state-of-the-art diagnostics and beam dynamics control systems relevant to ILC & CLIC.

Thanks…

- To all speakers, co-conveners T. Okugu, R. Tomas, N. Terunuma
- Workshop organisers for fantastic venue and support.