Summary of WG3 - Beam Physics/Low emittance transport

- *Main Beam & Drive Beam*
- *Beam Delivery and Machine Detector Interface*
- *Test facilities, ATF2, CTF3, CESR-TA*

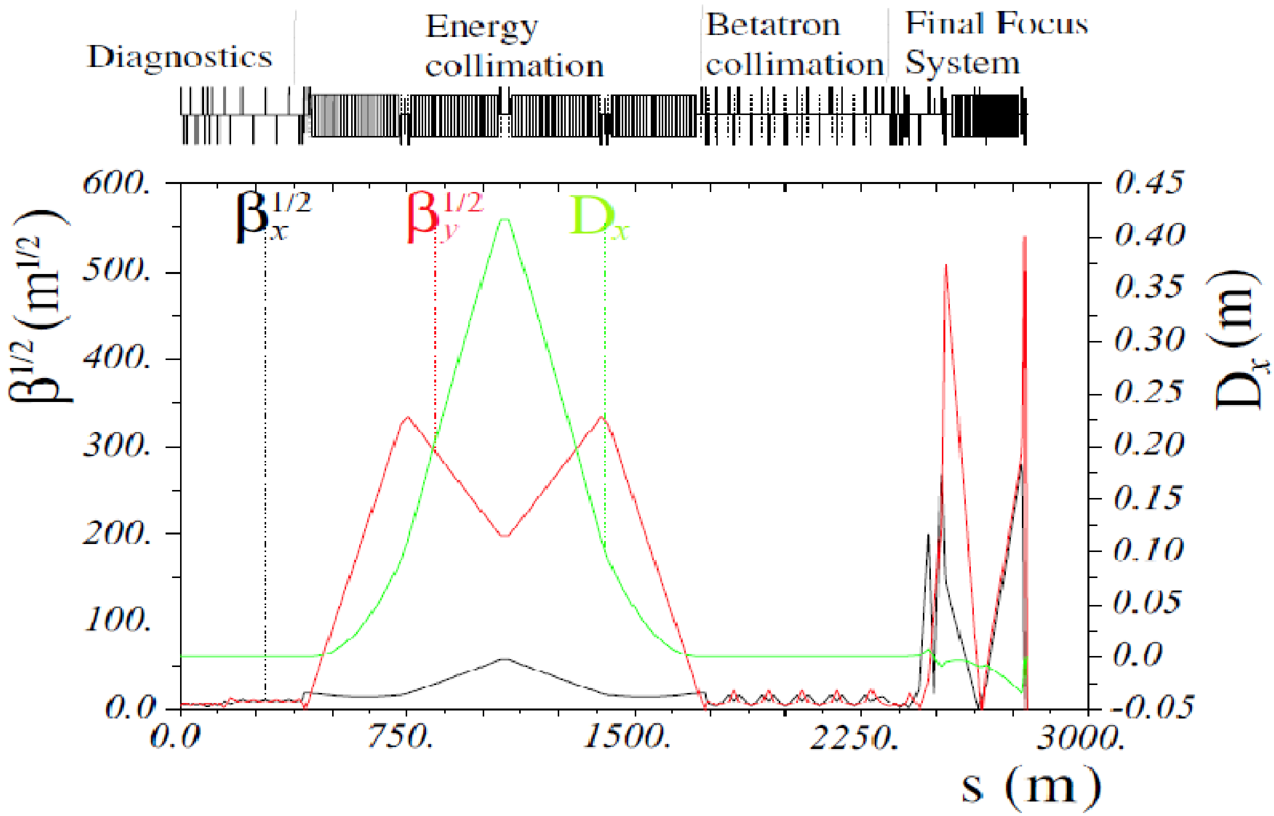
Caterina Biscari (INFN), Kiyoshi Kubo (KEK) , Bernard Jeanneret (CERN), Deepa Angal-Kalinin (Daresbury Laboratory), Rogelio Tomas (CERN), Andrei Seryi (SLAC), Roberto Corsini (CERN), Toshiyuki Okugi (KEK)

October 16, 2009, CLIC 09 Workshop

Session & topics

- Wednesday 9:00-10:30
- Collimation system review
  - Javier Resta Lopez (JAI, Oxford University)
- FFS review, options and tuning
  - Andrei Seryi (SLAC)
- Post-Collision line review
  - Edda Gschwendtner (CERN)
- From 500GeV to 3TeV
  - Deepa Angal-Kalinin (Daresbury Laboratory)

CLIC collimation system

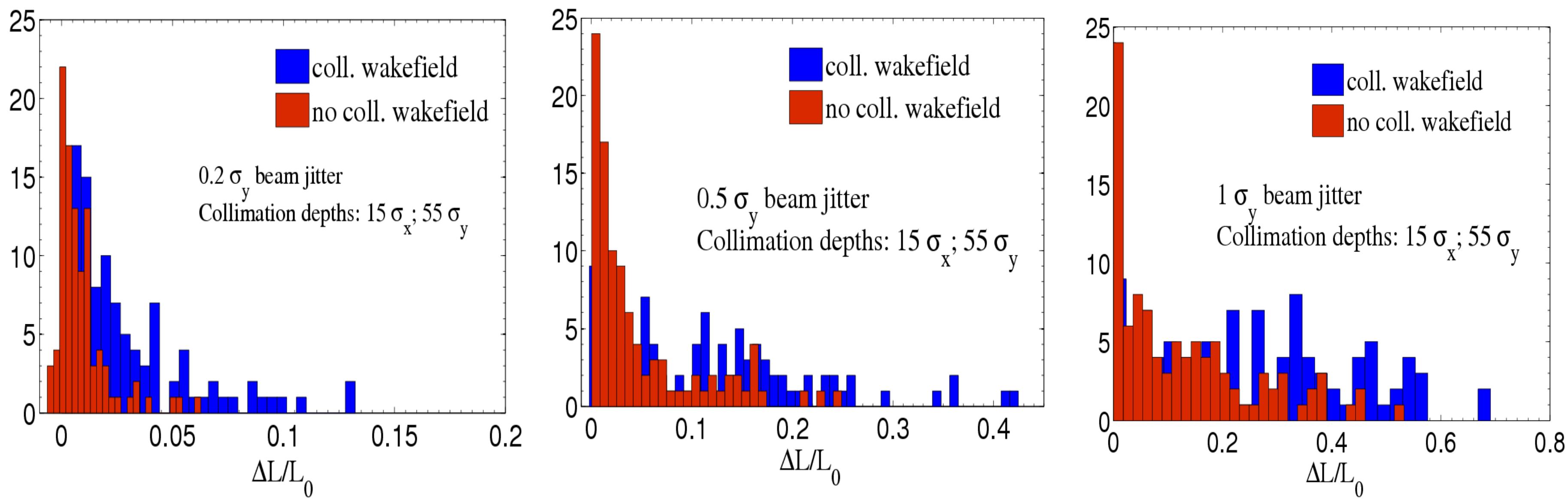


Energy collimation: Protection against mis-steered or errant beams with energy errors > 1.3%. E-spoiler half-gap: $a_x = D_x\delta = 3.51\text{mm}$

4 pairs of collimators in x,y plane to collimate at IP/FD phases

Luminosity loss

Coll. wakefields + vertical beam position jitter



Beam jitter	rms $\Delta L/L_0$ (no coll. wakefields)	rms $\Delta L/L_0$ (with coll. Wakefields)
$0.2\ \sigma_y$	1.17%	2.85%
$0.5\ \sigma_y$	5.72%	9.71%
$1.0\ \sigma_y$	12.91%	17.58%

Collimation: Summary and conclusions

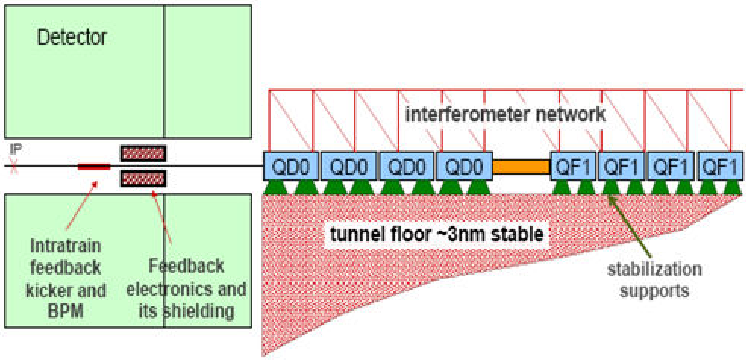
- The CLIC collimation system has recently been reviewed
- Looking for a trade-off between high collimation efficiency and low wakefield effects, recently the collimation depths have been optimised
- We have reviewed the collimator wakefield impact on the luminosity with the new collimator apertures:
  - Vertical position jitter tolerance ~ $0.2\sigma_y \rightarrow \text{rms } \Delta L/L_0 \approx 3\%$
- Remarkable progress in the development of software tools for realistic simulations (e.g. PLACET-BDSIM interface), including wakefield effects, energy deposition and secondary particle generation. ACTION: update collimation efficiency studies
- Fruitful efforts (by international collaboration) towards the consolidation of the CLIC collimation system design

Javier Resta Lopez (JAI, Oxford University)

Long L*: present issue

CLIC08 : L* = 8m proposal

A. Seryi proposed to double the L* to simplify achieving stability of FD and ease the MDI.



	L*=3.5 m	L*=8m
Luminosity	L_0	$0.72L_0$
β_y	0.07 mm	0.1 mm
QD0 jitter	0.15 nm	0.18 nm
QD0 support	detector	ground
QD0 tech	PM	PM
QD0 grad tolerances	5×10^{-6}	3×10^{-6}
Final focus length	400 m	800 m
Chromaticity	ξ	2ξ
Prealignment	10 μm	2μm

R. Tomas

'Review of FFS design, options and Tuning', A. Seryi , WG3, Wednesday.

How to improve longer L*

- Quadratic dependence of pre-alignment tolerance on L*
- It is very likely that it comes from sextupoles
- Possible improvements
  - Optics modification
    - Small rearrangements of length in aberration correction section (ACS) that will reduce chromaticity caused by QF9, QD10, … and will give some reduction of the strength of SF6, SF5, SD4 sextupoles
    - Re-optimization of ACS aiming to reduce strength of these auxiliary sextupoles
    - By doing this, it is likely to reduce their strength by ~a factor of two
  - Alignment and tuning strategy modification
    - Consider starting tuning with reduced strength of sextupoles, then gradually increase it. This should shorten the time of tuning
    - Analyze the way how orbit in ACS is controlled during tuning and optimize it
    - Consider allowing special method of pre-alignment, with tighter requirements, over the ~200m length of ACS.
- It is very likely that the measures described above will allow relaxing the pre-alignment tolerances to at least ~5um, and reduction of tuning time

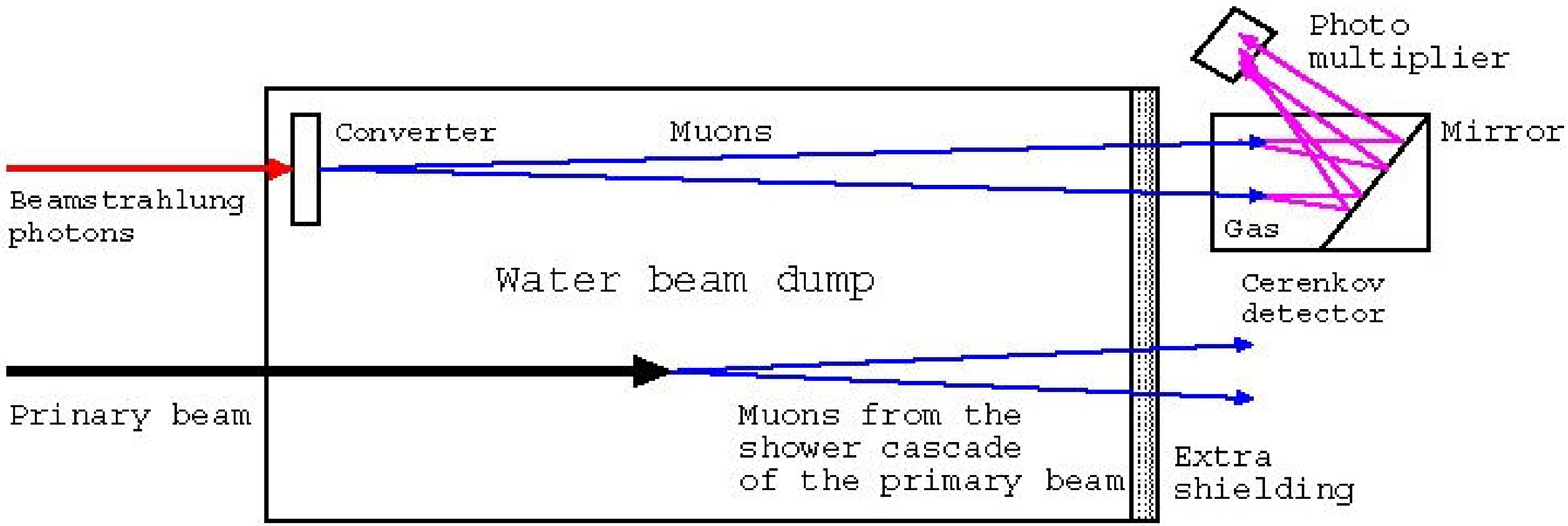
Extraction line: Luminosity Monitoring: μ+μ- pair production

Post-Collision line review

Edda Gschwendtner (CERN)

- Converter in main dump → muons
  → install detector behind dump
  - With a Cherenkov detector: 2 E5 Cherenkov photons/bunch

EUROTeV-Report-2008- 016 .

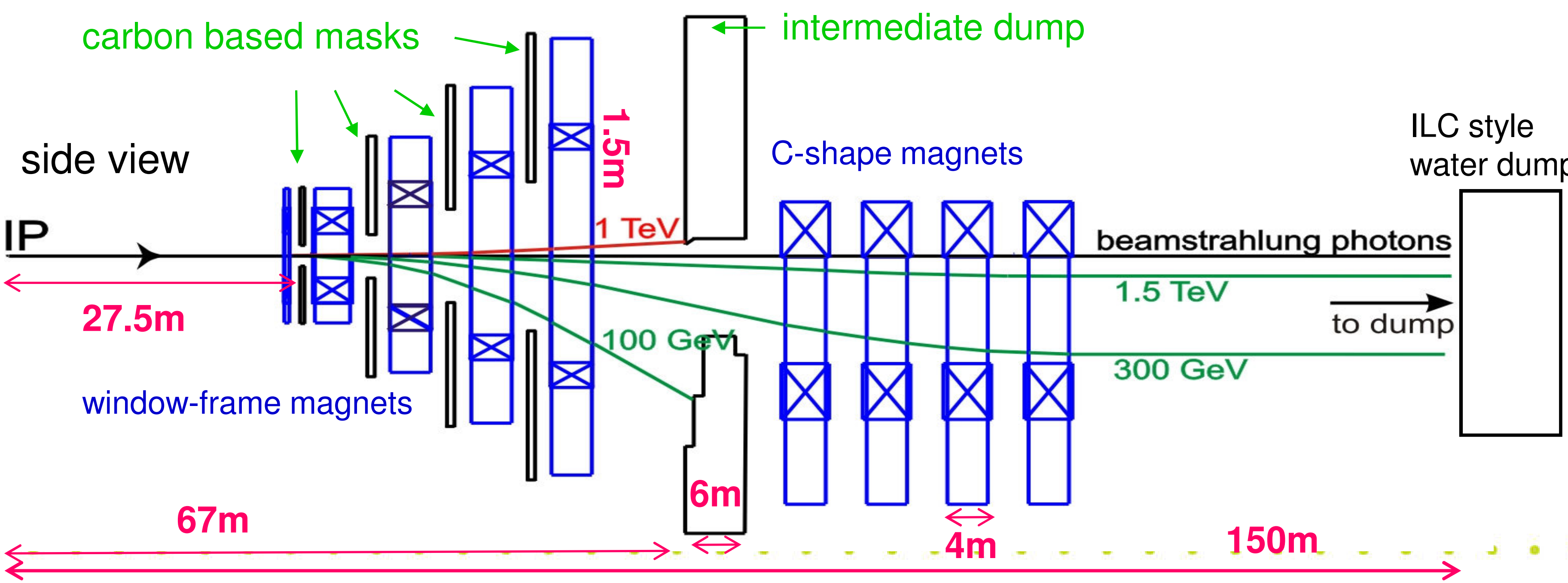


→ To be studied in more detail: background, converter, detector, etc..

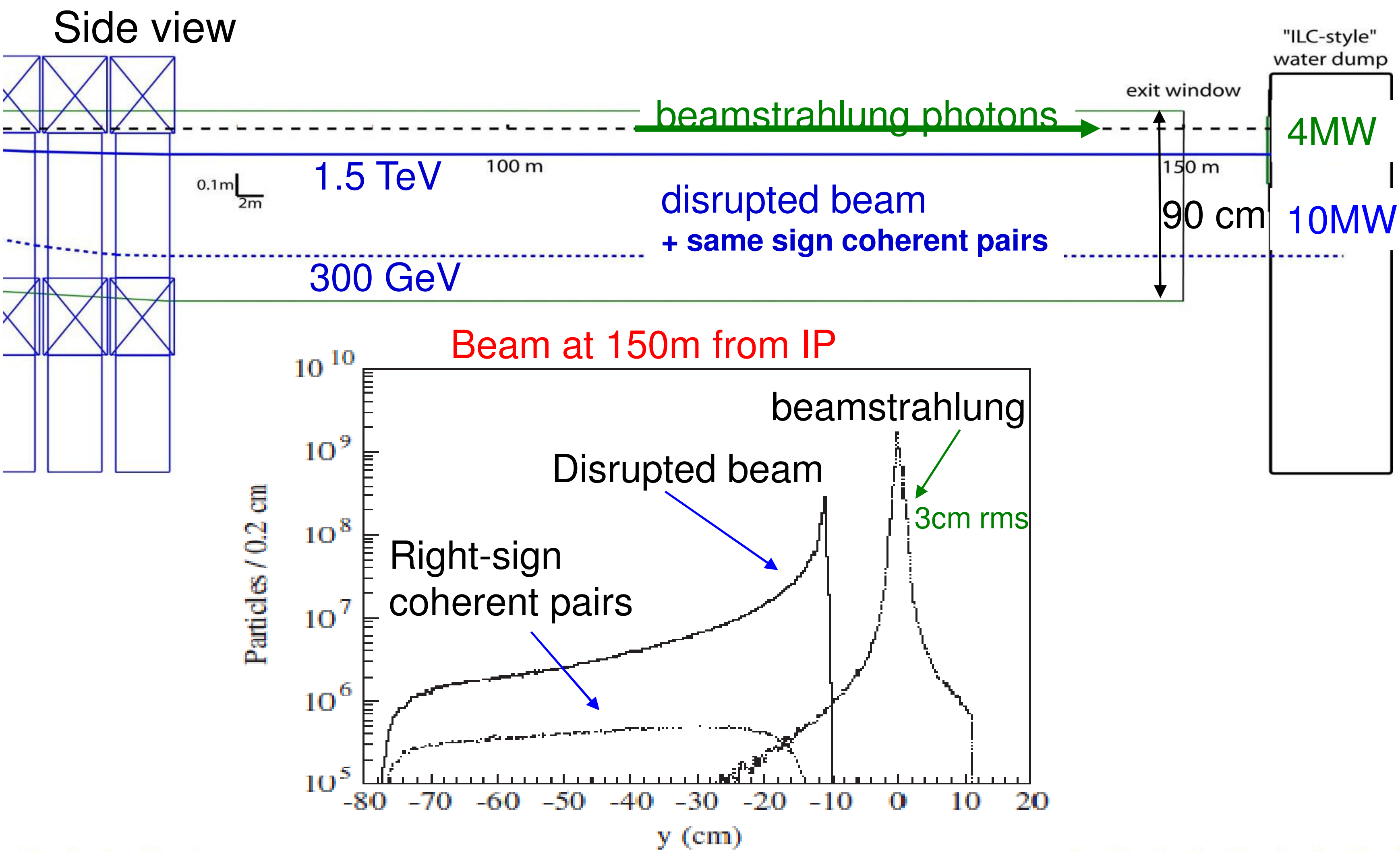
Conceptual Design

Baseline: vertical chicane with 2x4 dipoles

1. Separation by dipole magnets of the disrupted beam, beamstrahlung photons and particles with opposite sign from coherent pairs, from low energy tails
   → Short line to prevent the transverse beam size from growing too much
   → Intermediate dumps and collimator systems
2. Back-bending region with dipoles to direct the beam onto the final dump
   → Long line allowing non-colliding beam to grow to acceptable size



Present Conceptual Design



A. Ferrari, R. Appleby, M.D. Salt, V. Ziemann, PRST-AB **12**, 021001 (2009)

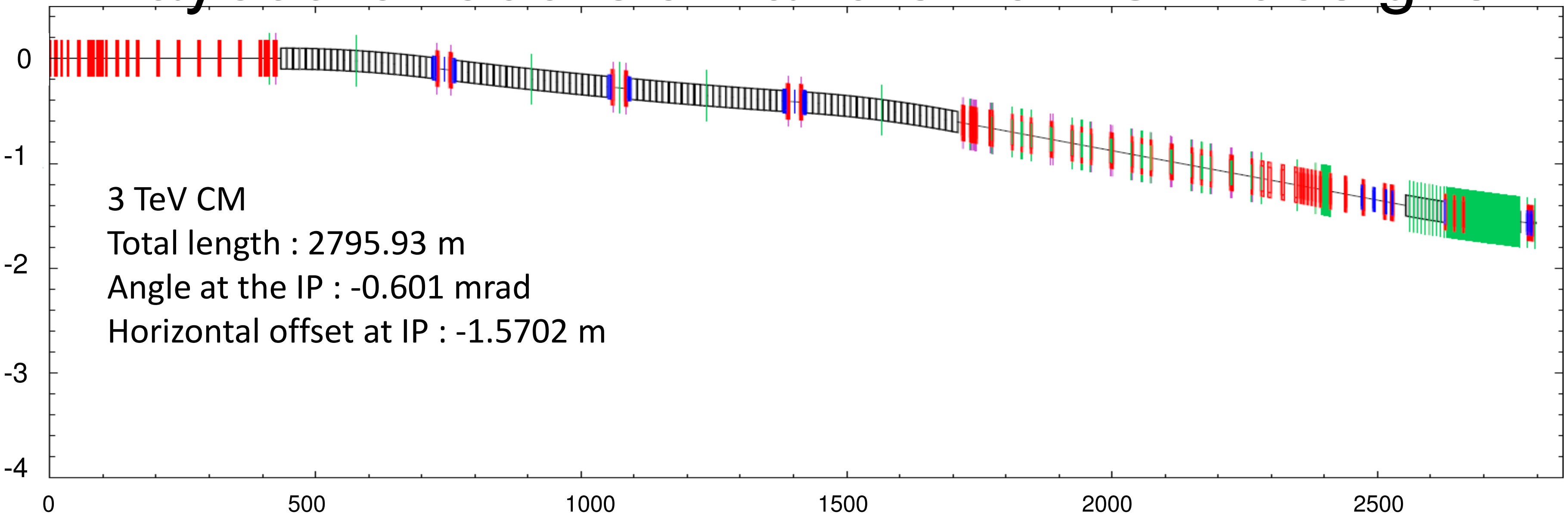
Post-collision line: Summary

Conceptual design of the post-collision line exists

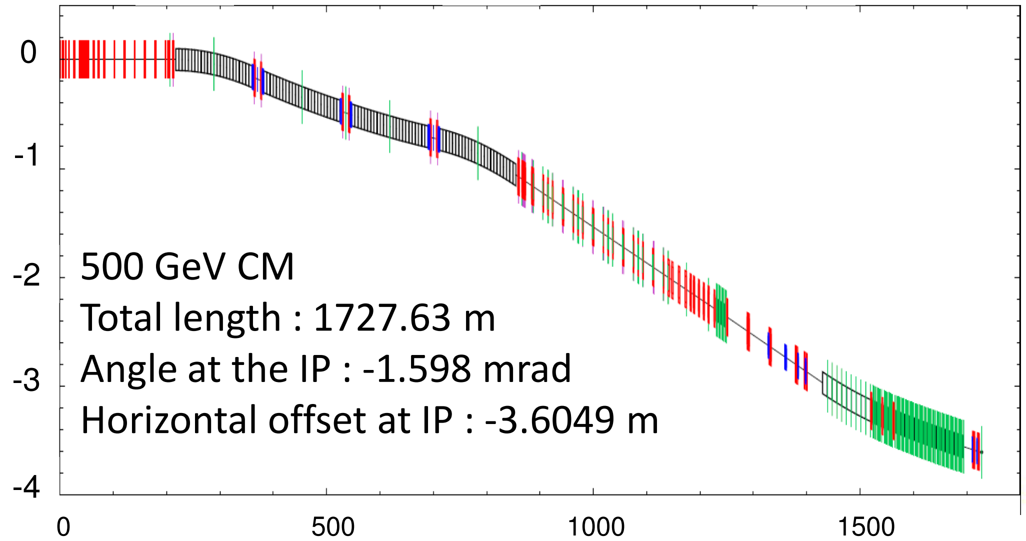
- We are in the process of forming a working group (project associate, PhD student…) concentrating on issues such as:
  - Calculations of Background to IP
    - Photons
    - neutrons
  - Beam diagnostics
    - Luminosity
    - Background to monitors
- More work needs to done on
  - Beam Dump
    - Type, entrance window
    - Background from dump
  - Large beam spot size at dump
    - Sweeping magnets or defocusing
  - Collimator and intermediate dump design
  - Magnet design
  - Radiation in post-collision line

- Post-Collision line review
  - Edda Gschwendtner (CERN)

Layout for 500 GeV and 3 TeV CM designs



Location of IP fixed.
Post collision lines and 14 MW beam dump location same.



From 500GeV to 3TeV

Deepa Angal-Kalinin

Define layout constraints

- ❑ Location of IP, post collimation lines and dump locations same
- ❑ Angle at the IP same.

- ❑ Is it absolutely essential to have a shorter BDS (the length difference is 1068m on single BDS)?

- ❑ Tunnel constraints
  - ❑ Experimental hall + Main dump shafts (stay same)
  - ❑ Muon wall tunnel vault locations should stay same
  - ❑ Locations for other shafts, caverns should be compatible for both the layouts
  - ❑ Diagnostics section : LW set up, polarimetry and spectrometry

- ❑ Collimators
- ❑ Crab system
- ❑ Collective effects
- ❑ Vacuum pipe radius

……………?

From 500GeV to 3TeV

Deepa Angal-Kalinin

Session & topics

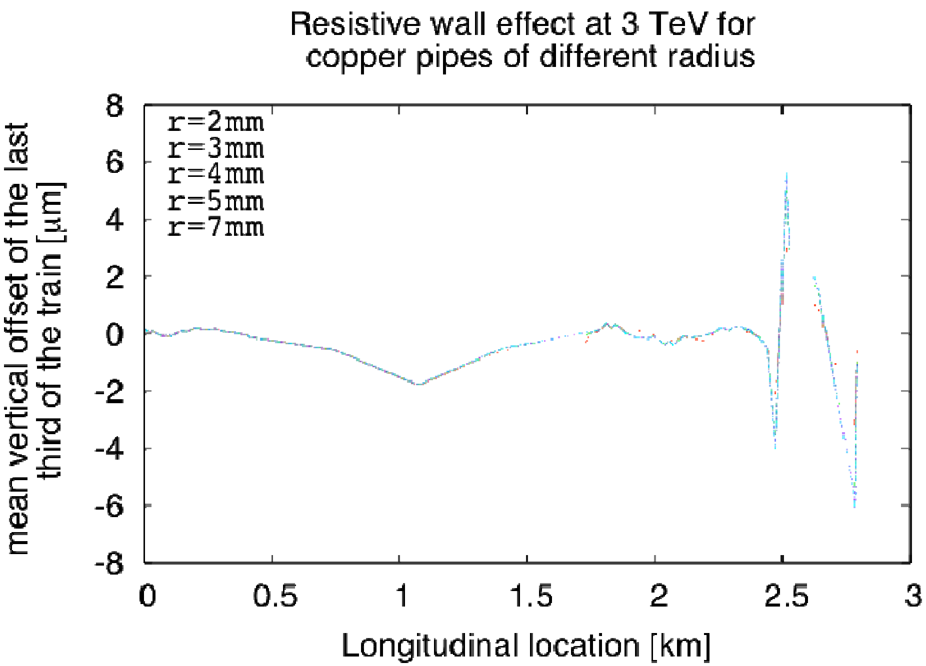
- Wednesday 11:00-12:30
- BDS collective effects review
  - Giovanni Rumolo (CERN)
- Solenoid and SR effects
  - Barbara Dalena (CERN)
- Polishing collimation optics
  - Frank Jackson (ASTeC)
- HTGEN and muons in the CLIC BDS
  - Helmut Burkhardt (CERN)
- Dielectric collimators
  - Alexei Kanareykin (Euclid Techlabs)

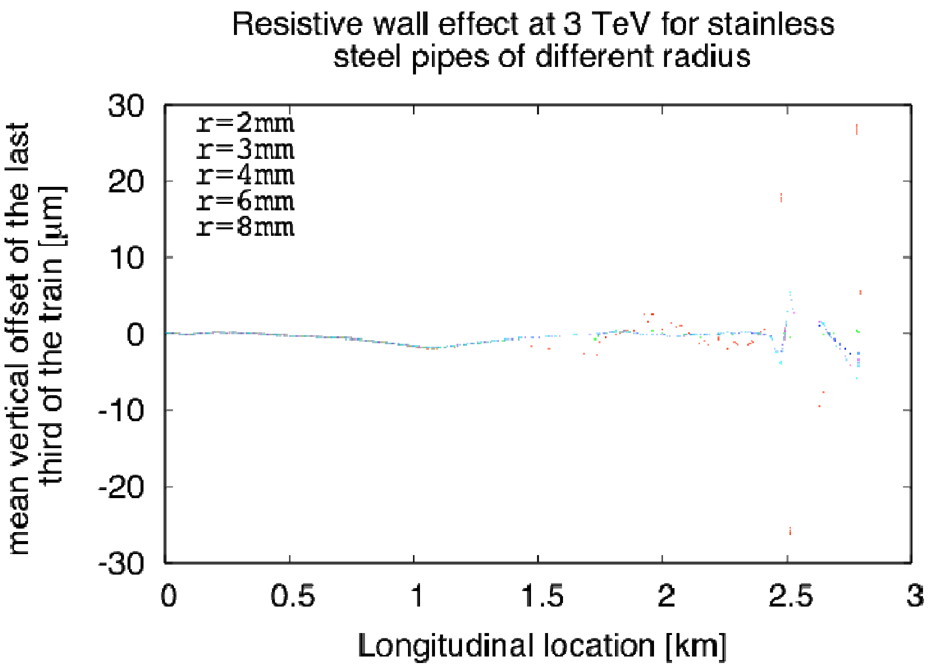
Collective effects in the CLIC-BDS

G. Rumolo, N. Mounet, R. Mutzner, R. Tomás
in **CLIC Workshop 09**, 14 October 2009

- Collective effects in the CLIC Beam Delivery System
- Resistive wall
  - Coupled bunch effects
  - Single bunch effects
  - Calculation of the wake fields
- Fast ion instability
- Outlook:
  - multi-bunch simulations
  - Single bunch study
  - Ions

Long range resistive wall effect @3TeV





Coupled bunch resistive wall effects

⟶ We assume a constant radius all along the BDS

⟶ Chamber radius has been scanned from 2 to 8 mm

⟶ For a Cu chamber, the resistive wall effect is completely suppressed for r>4mm, whereas for a StSt chamber at least r=6mm is required (safe choice r=8mm)

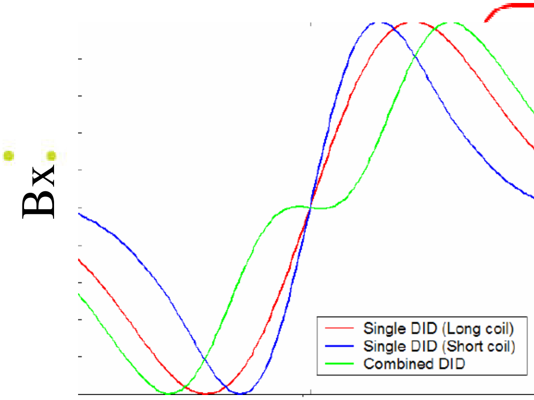
Solenoid & SR: Conclusions

- Compensation of detector solenoid effects on the beam size
  - AntiDiD increases the luminosity loss due to Synchrotron Radiation up to 25%
  - Anti-Solenoid (bucking coils covering QD0) reduces (> 90%) the optical distortions at IP
    - Interference with QD0 to be studied
    - Radiation to be evaluated
    - Main Solenoid field distortion in the tracker to be considered

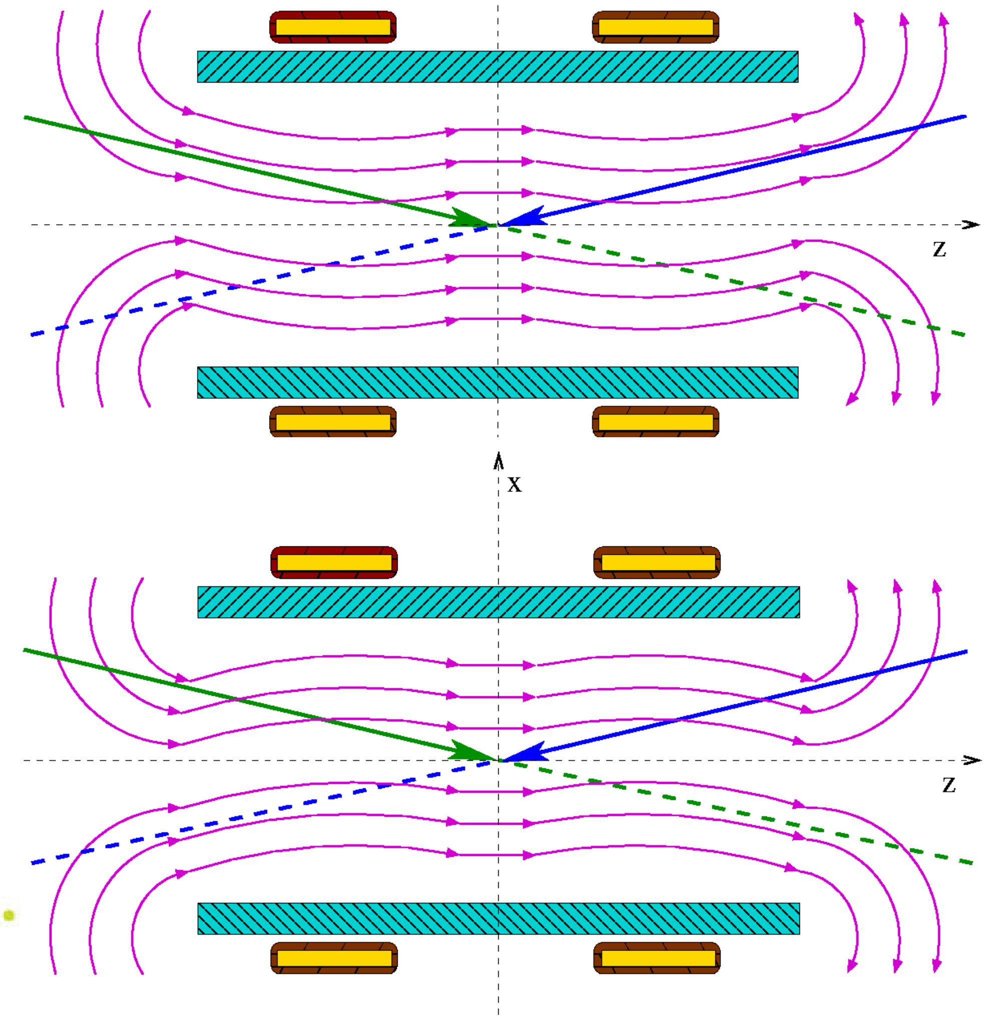
•Solenoid and SR effects

–Barbara Dalena (CERN)

DiD - AntiDiD

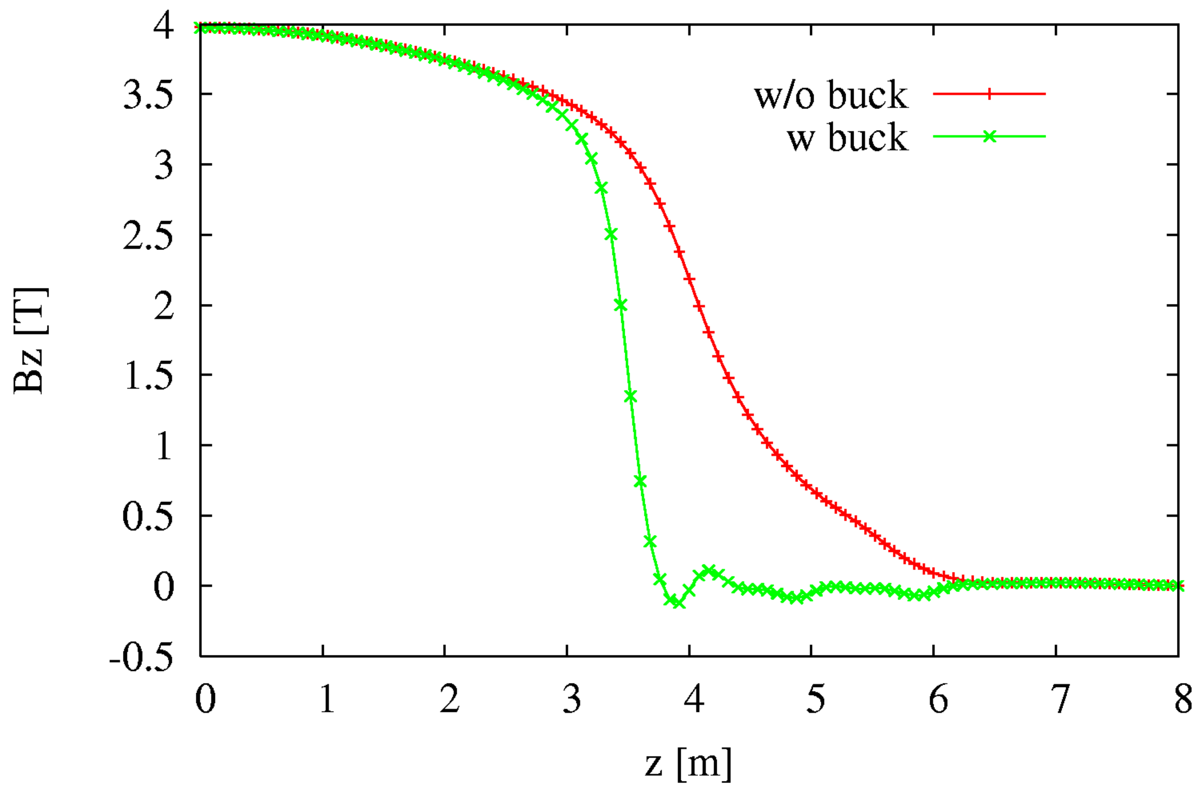


- DiD
  - Coil wound on detector solenoid giving transverse field (Bx)
  - It can zero y and y' at IP
  - But the field acting on the outgoing beam is bigger than solenoid detector alone ⇒ pairs diffuse in the detector

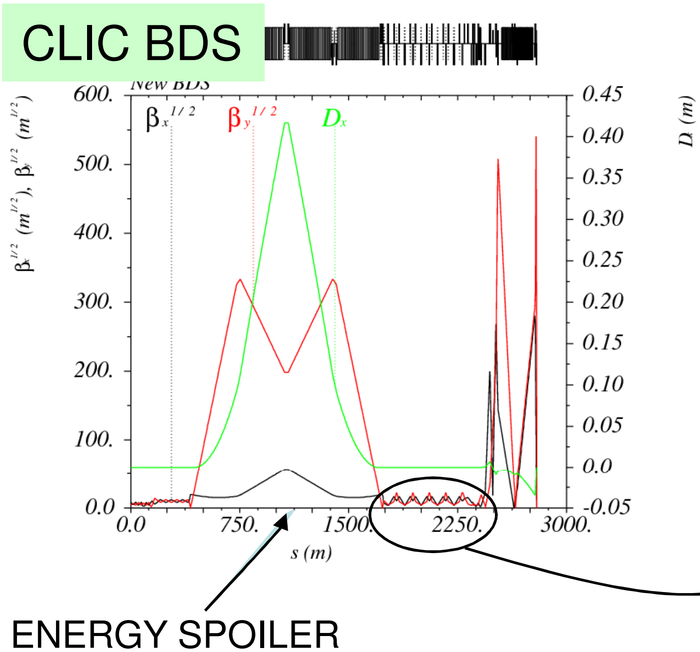


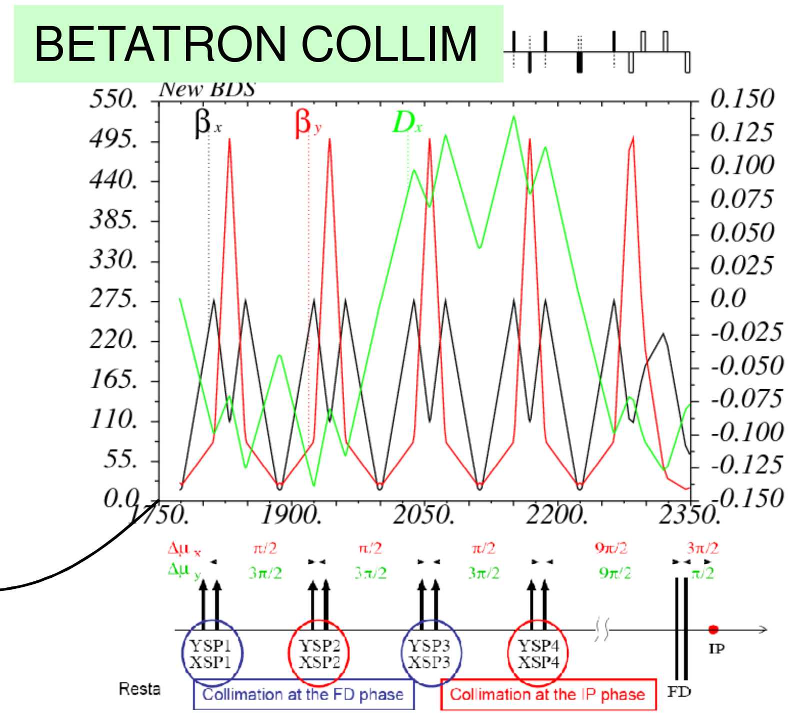
- AntiDiD
  - Reversing DiD's polarity and optimizing the strength, more than 50% of the pairs are redirected to the extraction apertures

Longitudinal Field component with antisolenoid



CLIC Collimation Scheme





- Polishing collimation optics
  - –Frank Jackson (ASTeC)

- Passively surviving energy collimation followed by consumable betatron collimation
- Betatron collimation: 4 x,y spoilers pi/2 apart, full gaps ~ 200 μm

CLIC Collimation Performance

- Collimation depth revised in 2009 (B. Dalena, CERN)
  - Used full BDS halo tracking to account for all lattice ‘imperfections’ (non-linearities, phase mismatches, etc)
  - See PAC ‘09 paper **‘Status of the CLIC Beam Delivery System’**
  - Spoilers set at $15\sigma_x$ and $55\sigma_y$ ensures no particle or photon hits final doublet
- This collimation depth calculation ensures 100% collimation performance in the design
- But can we do better? Improve transport, open spoilers further?

Polishing collimation optics: Conclusion

- Present design with 15, 55 gives good collimation performance (even though ~2% of halo particles escape)
- Phase-matching collimation→FD gives somewhat better performance
  - Not clear yet if this will permit wider collimation apertures
- More extensive search and optimisation (multipoles) might be useful
- Needs to be integrated with luminosity optimisation.

HTGEN and muons in the CLIC BDS

Helmut Burkhardt (CERN)

HTGEN : generic Halo and Tail generator.

- **Standalone + fully interfaced with PLACET for info, manual, instructions, examples see** http://hbu.home.cern.ch/hbu/HTGEN.html
- Recently upgraded by Miriam Fitterer, Erik Adli, Barbara Dalena and myself to also work with sliced beams as required for halo studies of the drive beam.
- Here : returning to the original and probably most important application :

  Halo and collimation in the BDS

  relevant for the design CLIC collimation system, vacuum specification and machine backgrounds to the CLIC Experiment(s). Important to minimize halo production. Halo collimation at high energy results in muon backgrounds (which came as a bad surprise in the SLC)

General recent summary (May 2009) - collimation paper published in PRSTAB 12.081001

***Tracking studies of the Compact Linear Collider collimation system*,**

I. Agapov, H. Burkhardt, and D. Schulte / CERN, A. Latina / FNAL, G. A. Blair, S. Malton, J. Resta-López / John Adams & Royal Holloway University

HTGEN allows to specify the residual gas individually for each element. For the estimates here, the same values were set to all elements :

LINAC section 10 nTorr CO at room temperature (300 K)

BDS section 10 nTorr CO at room temperature (300 K)

CLIC estimate. P = probability / m for scattering > 1 σ divergence

Location	E	Gas	ρ	σ_{el}	P
	GeV		m^{-3}	Barn	m^{-1}
LINAC	9	CO	3.2×10^{14}	2.7×10^{7}	8.9×10^{-7}
BDS	1500	CO	3.2×10^{14}	1.7×10^{5}	1.1×10^{-8}

Elastic : probability 80x higher beginning of LINAC at 9 GeV compared to end at 1.5 TeV and BDS. Integrated over length :

total LINAC Prob. $P = 1.16\times10^{-3}$, BDS $P = 6.0\times10^{-5}$ together 1.2×10^{-3} at 1σ

total LINAC Prob. $P = 1.29\times10^{-6}$, BDS $P = 6.7\times10^{-8}$ together 1.4×10^{-6} at 30 σ (loss)

Inelastic : scattering probability for >1% energy loss : 2.1×10^{-13}/m

summing up over both LINAC and BDS : $P = 5.0\times10^{-9}$/m

Alexei Kanareykin (Euclid Techlabs)

Why is Diamond?

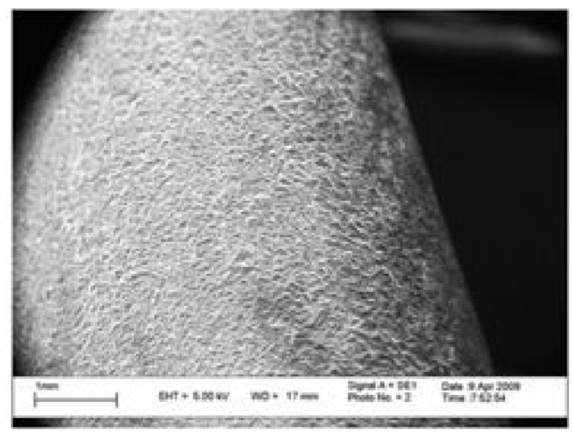
CVD DIAMOND PROPERTIES FOR DLA:

- RF BREAKDOWN THRESHOLD OF ~ 2 GV/m
- LOSS FACTOR DOWN TO $5x10^{-5}$ AT 30-140 GHz
- HIGHEST THERMAL CONDUCTIVITY
- MULTIPACTING CAN BE SUPPRESSED ,

and for Collimator use:

CVD Diamond conductivity can be controlled and adjusted during deposition process.

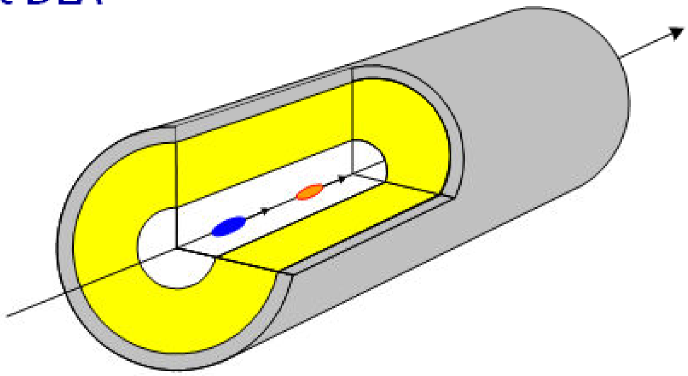
Planar is easy to fabricate, available commercially



A. Kanareykin, Euclid Techlabs LLC, CLIC'09

What can be used from the DLA studies ?

- **Drive Beam – Beam Train** - High Gradient DLA
- **Dielectric Material Beam Tests**
- Dielectric - Wakefield Power Extractor
- Tunable Dielectric Based Accelerator
- Energy Transfer: High Transformer Ratio
- **Beam Handling, Beam Breakup (BBU)**
- **Multilayer structure** – High r/Q.



Dielectric Based Accelerator issues: high gradient – drive beam, power extraction, tuning, efficiency, beam control (BBU).

Session & topics

- Wednesday 14:00-15:30 + WG1
- Beam-beam background estimates
  - Barbara Dalena (CERN)
- Very Forward Region and Beam-Beam-Background
  - Andre Philippe Sailer (Humboldt-Univ., Berlin)
- Electromagnetic background from the spent beamline
  - Michael Salt (University of Manchester)
- Energy stages overview
  - Daniel Schulte (CERN)
- Luminosity overview
  - Roberto Corsini (CERN)
- Risk registry, limitations, solutions and implications
  - Andrei Seryi (SLAC)

Beam-beam background: Summary

- Beam-Beam background study
  - Simplified simulation with GUINEA-PIG + GEANT 3 yields 3 hit in the vertex detector (r = 30 mm) due to incoherent pairs production
  - ~ 2.9 $\gamma\gamma \rightarrow$ hadronic events for CLIC nominal parameter 3 TeV CM
  - considering different beam parameter and machine conditions

  $\Rightarrow$ background increase with luminosity

- To do… realistic beam-beam background simulation
  - Static and dynamic machine imperfections + their corrections (alignment-tuning-feedback) all along the machine

Beam-beam background estimates
Barbara Dalena (CERN)

Hit distribution

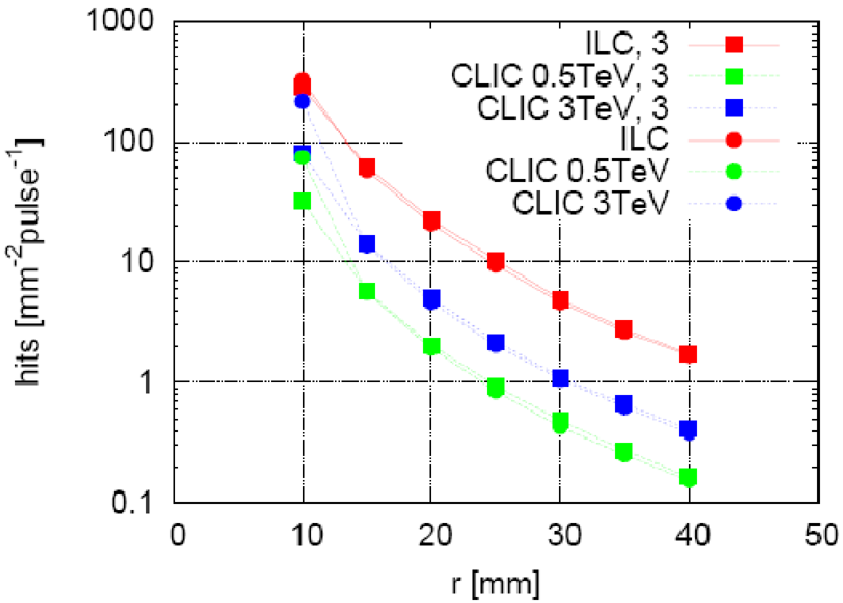
- GEANT 3 based simulation
- Angular coverage Δz/r = 3, 5 and Bz = 5 T

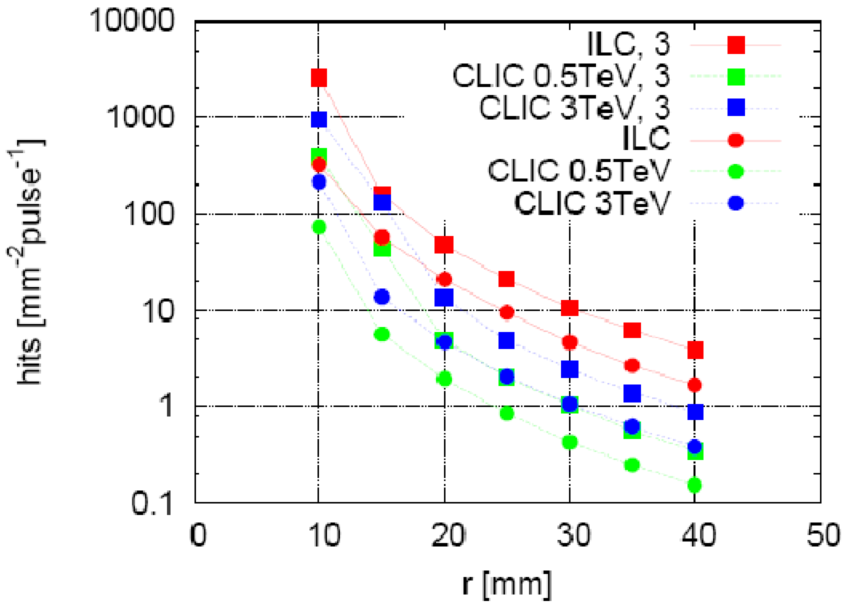
⇒ hit density does not depend on coverage angle if the radius is large enough to avoid deflected particles

- Angular coverage Δz/r = 5 and Bz = 3, 5 T

⇒ vertex radius for constant hit density scale as:

$$r \propto \sqrt{1/Bz}$$





Very Forward Region and Beam-Beam-Background

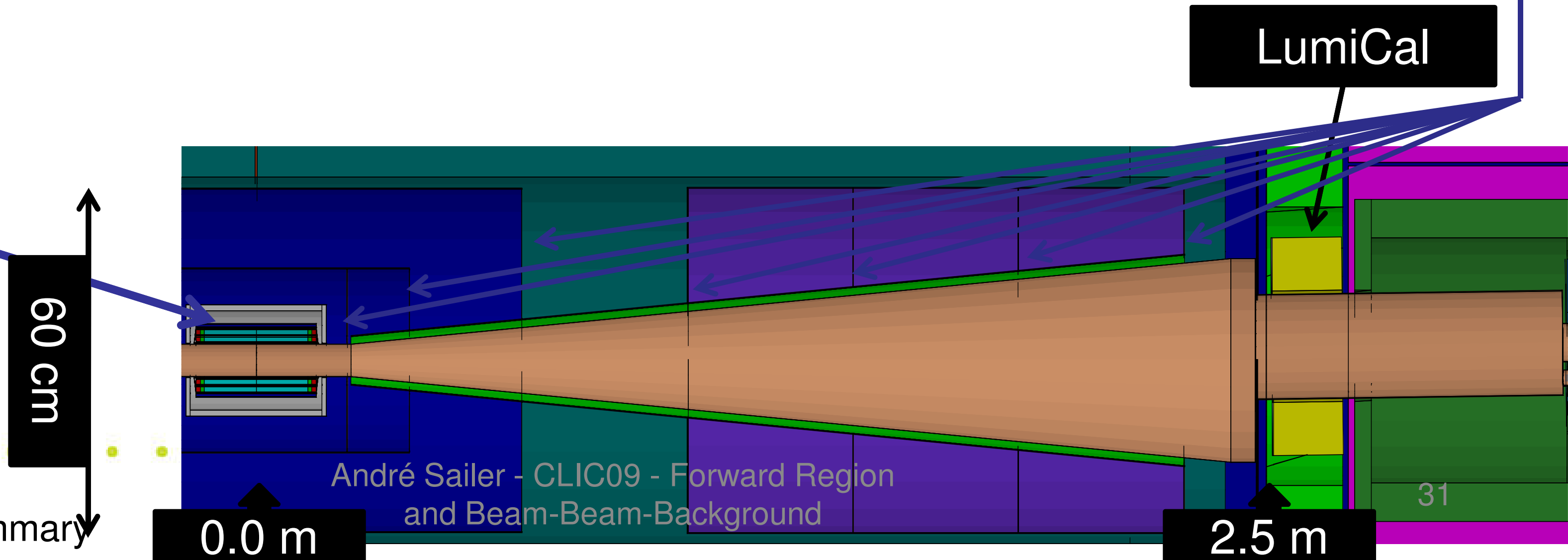
Andre Philippe Sailer (Humboldt-Univ., Berlin)

- Barbara's Talk: for Beam-Beam-Effect etc.

- This Talk: Full Detector Simulation (Geant4, Mokka) with Beam-Beam-Background
  - Considering only incoherent Pairs: ≈$3*10^5$ /BX
  - 10 BX for some statistics
- What is the Background in the Detector?
  - Focus on the Vertex Detector
    - But must take the rest of the Detector into account
  - How do Changes in the Forward Region affect Background levels
  - How can Background be reduced

CLIC_ILD: Vertex and Forward Trackers

- Vertex Detector: 3 double Layers of Silicon Sensors
  - At: 31, 46, 60 mm Radius, each 25 cm long (Z=±12.5cm)
- Forward Tracking: 7 Disks
  - Inner Radius: Beam pipe
  - Outer Radius: ~30 cm (For last 5 Disks)
- Beam pipe: Conical shape up to LumiCal



Forward region and background: summary

- Using a fairly realistic Simulation of Forward Region
- Simulated 10 BX of Incoherent Pairs
- Large background in Vertex Detector (6Hits/mm^2/Train)
- Further Studies regarding Layout of Forward Region
  - Add Intra-Train-Feedback System
  - Better Model of QD0 Prototype
- Simulate a full and realistic Bunch Train, including fluctuations

Very Forward Region and Beam-Beam-Background

Andre Philippe Sailer (Humboldt-Univ., Berlin)

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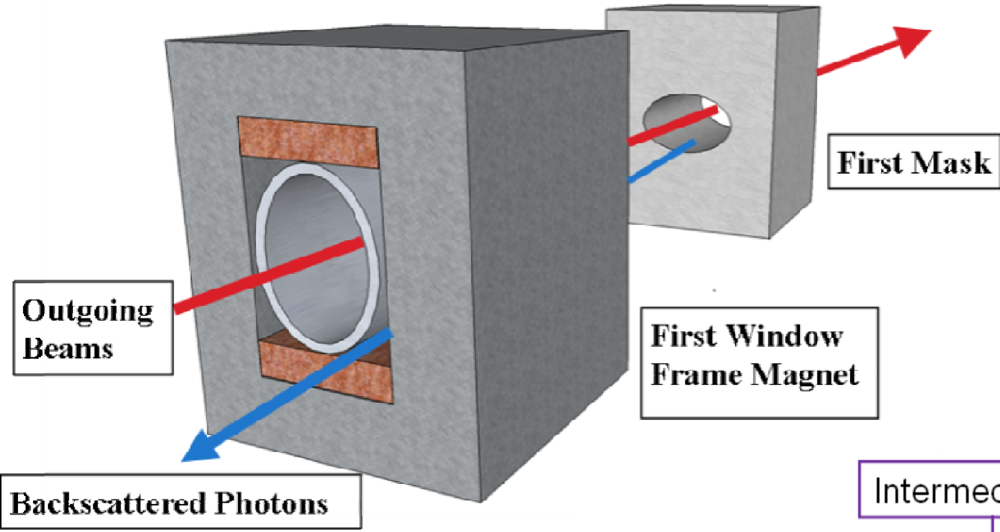
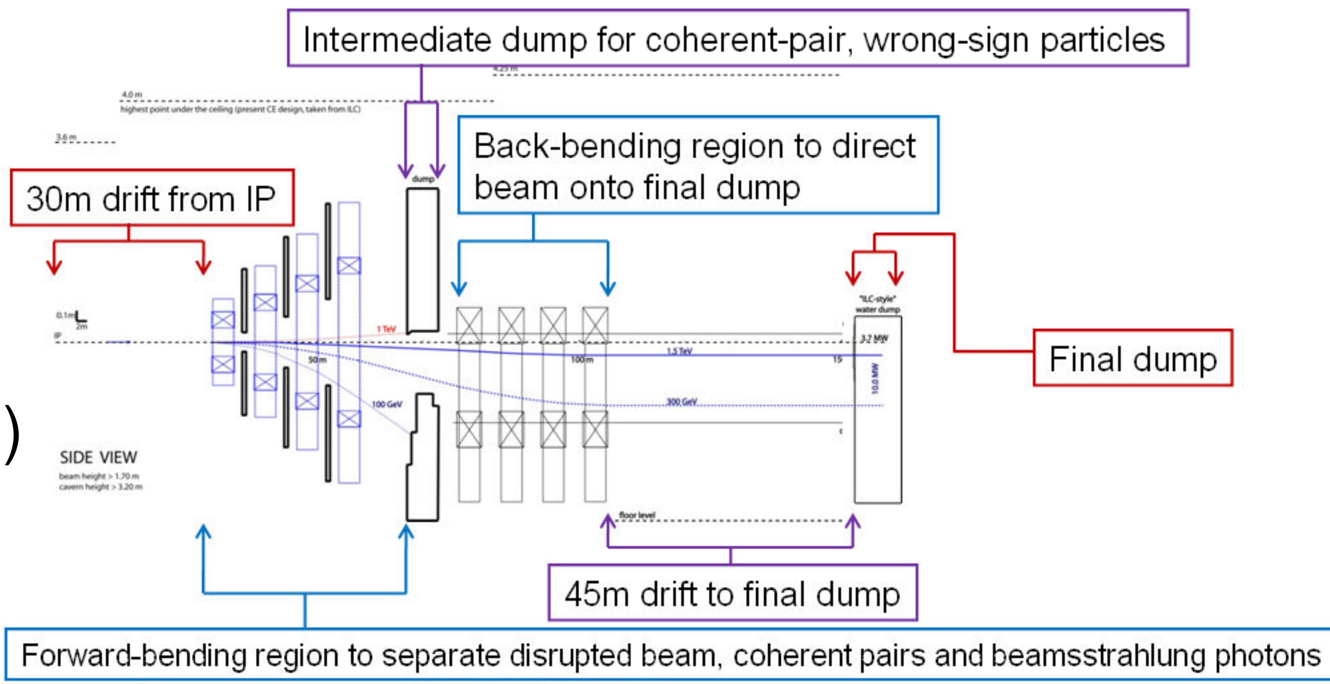
Electromagnetic background from spent beamline

Michael Salt (University of Manchester)



Michael David Salt
(Cockcroft Institute)



Energy stages overview

Daniel Schulte (CERN)

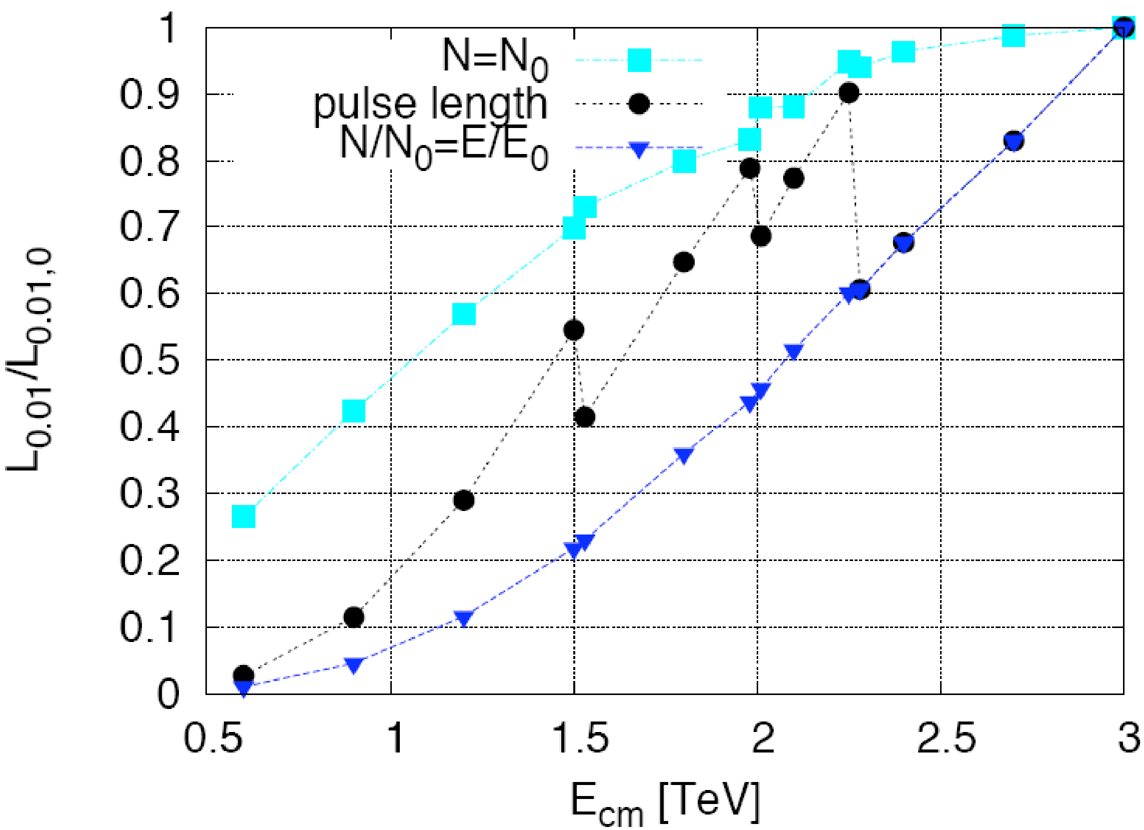
⇒ Luminosity is improved using longer pulses

⇒ This appears practical

- but need to check that we did not miss a problem

⇒ Other options need more work

- RF experts
- physics
- beam dynamics



CLIC Luminosity model

- ILC model: Luminosity → $\int L dt$ = 500 fb^{-1} in 4 years
- 1 year commissioning (not accounted for)
- 4 years of ramp up in performance (25%, 50%, 75% and 100% of the peak)
- Integrated luminosity during this period ≈ 500 fb^{-1}
- Can this model be applied to CLIC?
- LEP lessons
- SLC lessons
- Tevatron
- LHC
- CLIC upgrade scenario
- No conclusion yet => next CLIC workshop?

Luminosity overview

Roberto Corsini (CERN)

Detailed BDS risk registry, work in progress

	October 14, 2009, 15:30 CET				
Area	Concern	Present risk	Expected risk	Mitigation	Alternatives
BDS		Feasibility			
BDS		High			
BDS		Moderate			
BDS	Survivability of spoilers	High	?Moderate	?Beam test	Consum. spoilers; Nonlinear coll.; etc
BDS	Cleanness of collimation	Moderate			
BDS	Too high incoming jitter	High			
BDS	Collimation wakes underestimated	Moderate			
BDS	Crab cavity phase stability not met	Feasibility			
BDS	FD stabilization 100nm=>0.3nm	Feasibility	High	Prototype	Longer L* scheme
BDS	FD stabilization 3nm=>0.3nm	High	Moderate	Prototype	
BDS	Too high losses in extraction	High			
BDS	Survivability of large beam dump window	Feasibility			
BDS	Background from extraction line	High			
BDS	Fast meas. of beamstrah. photons in the dump	Feasibility			
BDS	Reuse of 500GeV layout cost prohibitive for 3TeV	Moderate	Low		Insert reverse bend & dogleg; or same layout
BDS	Very low field (~40Gs) bends in BDS	High			
BDS	Compatibility of PM FD & stabiliz. w. anti-solenoid	High			
BDS	Ion effects with field ionization	Moderate	Low	Simulations	
BDS	Collective effects	Moderate		Analysis	
BDS	Collim. efficiency and E-beta order	Moderate	Low	Analysis	
BDS	Plan to run at lower energy	Moderate			

to be filled

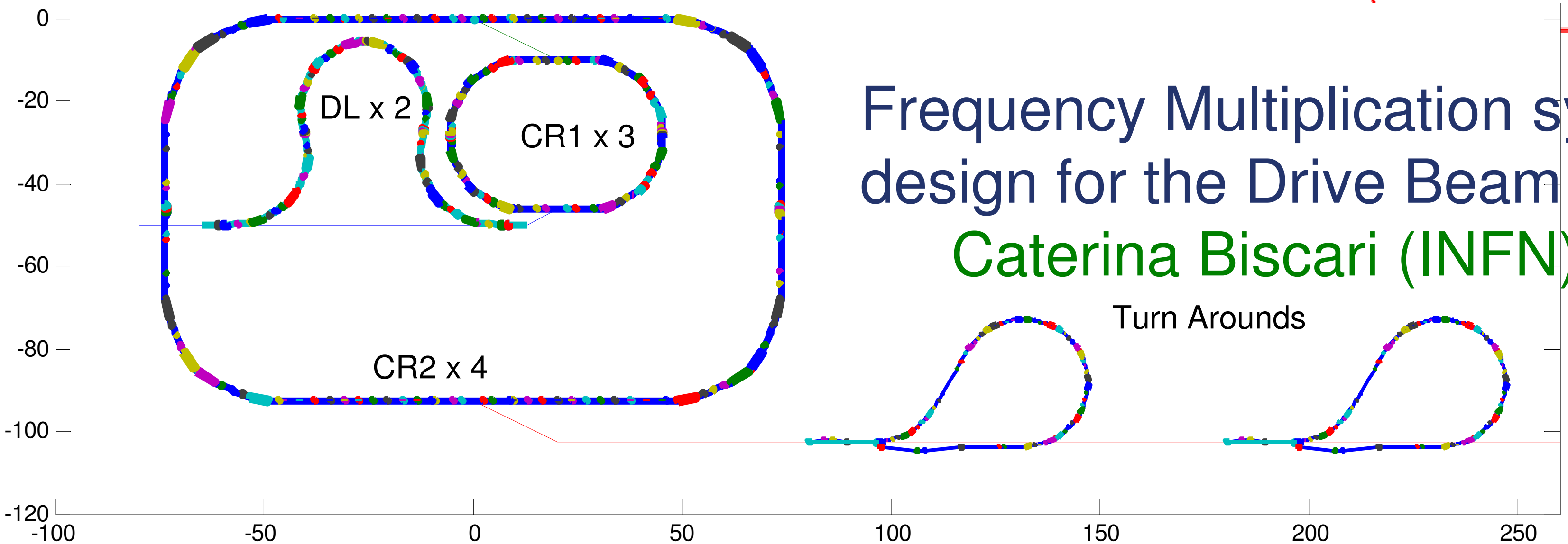
CRITICAL ISSUES / FEASIBILITY ISSUES / **BDS ISSUES**

Session & topics

- Wednesday 16:00-17:30
- Frequency Multiplication system design for the Drive Beam
  - Caterina Biscari (INFN)
- First calculations on Beam Loading in the CLIC RF deflectors
  - David Alesini (LNF-INFN)
- Ring to Main Linac beam transport
  - Frank Stulle (CERN)

Frequency Multiplication system design for the Drive Beam

Caterina Biscari (INFN)



- Layout and first order optics defined
- 2° order chromaticity compensation in CR1 and CR2 satisfactory
- Rf deflector main parameters defined
- Optimisation of injection bump in progress
- Start to end simulations in progress
- CSR computation tools
- Start to end from Linac + FMS + TA + Decelerator needed
- Misalignment & field errors, correction schemes, diagnostics to be defined

Drive Beam form Linac to Decelerator, C.Biscari et al.

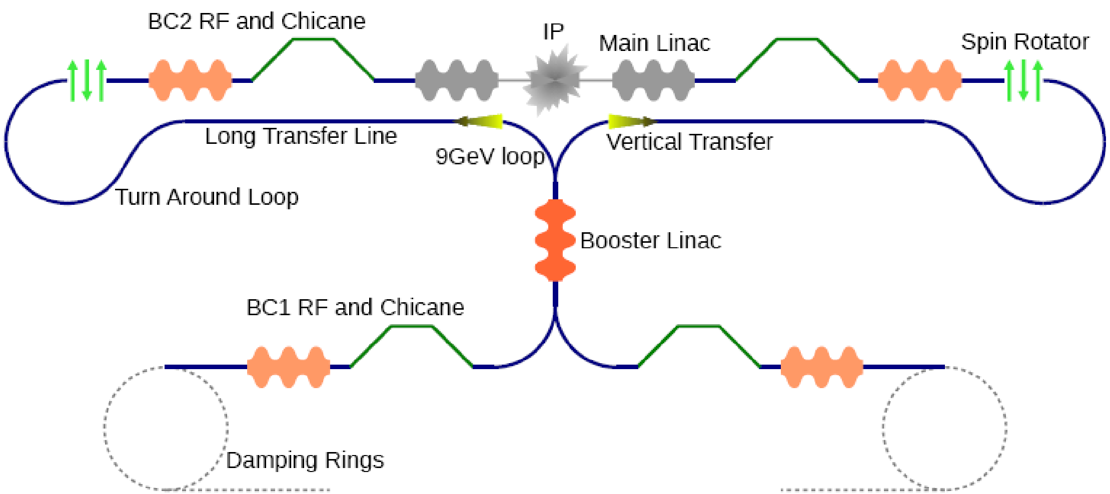
- Tracking all through DL+CR1(1..3turns)+CR2(1..4turns)+LTL+TA
  - CR2 injection bump included, but not CR1
  - grows from 100μrad --> 150μrad
  - swallows all the budget
  - Main source : unavoidable spurious dispersion by the injection bump
- Need check in DECEL

- Work to come
  - Consolidate tracking
  - Build-up new DL (circuler to longer Ω-shape) + longer TA
    - For better transverse chromatic control (CO correction, …)
  - Study changes to allow for different MB final energy
    - In particular twice longer CR1
    - Longer trains, etc

First calculations on Beam Loading in the CLIC RF deflectors

David Alesini (LNF-INFN)

- CR2 deflector is very critical
  - Low bunch spacing
  - No choice but worse case “90º phase beam loading”
  - Much more difficult than in CTF3
- Mitigation
  - Split deflector in N=6 small ones
    - Need 6x more power
    - Need to study coupling between modules
- Effect on emittance not marginal
- --> Need to evaluate combined e-growth
  - Injection bumps + deflectors + optical/misalignment errors



Main Beam RTML, F. Stulle

- The general layout is unchanged
- The spin rotator will be behind the turn around loop
- To improve CSR along RTML, the compression has been reduced in BC1 from 175μm to 300μm and the BC2 chicane has been split in two parts
- To mitigate resistive wall wakes, a large beam pipe of 10 cm diameter is being used
- Long transfer lines: to mitigate fast ion instability, vacuum better than 0.1 nTorr
- Emittace dilution and beam mis-steering due to magnetic stray fields a huge issue
- Phase stabilization is challenging

Main Beam RTML, F. Stulle

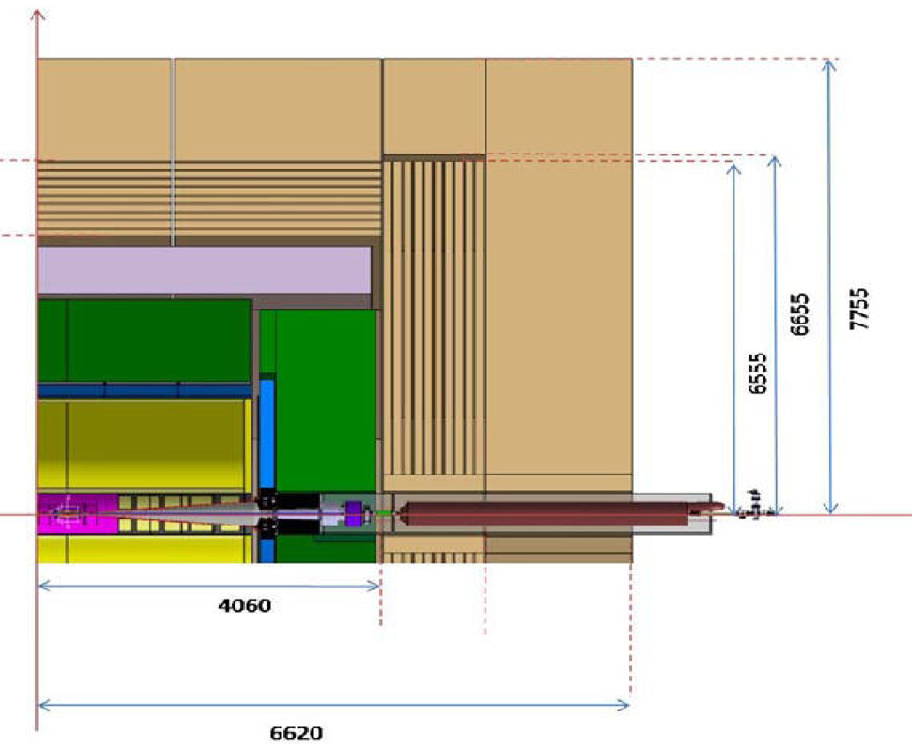
- Full layout DR --> Main Linac exist
- Tracking studies made (lattice, SR, CSR,wakes)
- Turn-around made longer , 1.1km-->1.7km
  - Still not adequate, too much emit-growth w.r.t. misalignment
- Phase stabilisation vs. compression chicanes
  - Extensive theoretical work, to allow for optimisation
  - Requires
    - Energy stable to dE/E < 2 10-4 (DR, seems granted by YP)
    - Phase control in BC2 : $d\phi < 0.05^o$ (not wlecome by RF …)
- Transfer down to tunnel
  - Vertical bendind makes trouble
  - No good solution so far
- Booster Linac
  - Multi-bunch wake-fileds might be a challenge
  - More work, pratical design needed

Session & topics

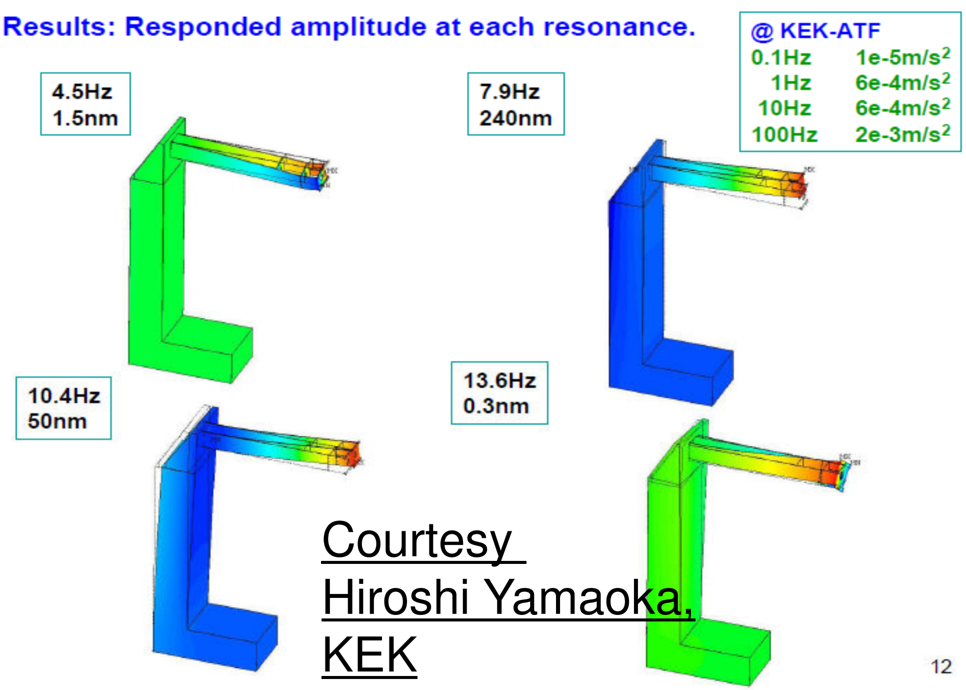
- Wednesday 16:00-17:30: WG1+WG5+part of WG3
- Novel ideas about a magnet yoke
  - Hubert Gerwig (CERN)
- Detector vibrations and QD0 support
  - Alain Herve (ETH Zurich)
- Stabilization of the FF quads + supports
  - Andrea Jeremie (LAPP)
- Progress on QD0 quadrupole
  - Michele Modena (CERN)
- Solenoid effects and compensation
  - Barbara Dalena (CERN)
- Crab cavities
  - Amos Dexter (Lancaster University)

Novel ideas about a magnet yoke

Hubert Gerwig (CERN)

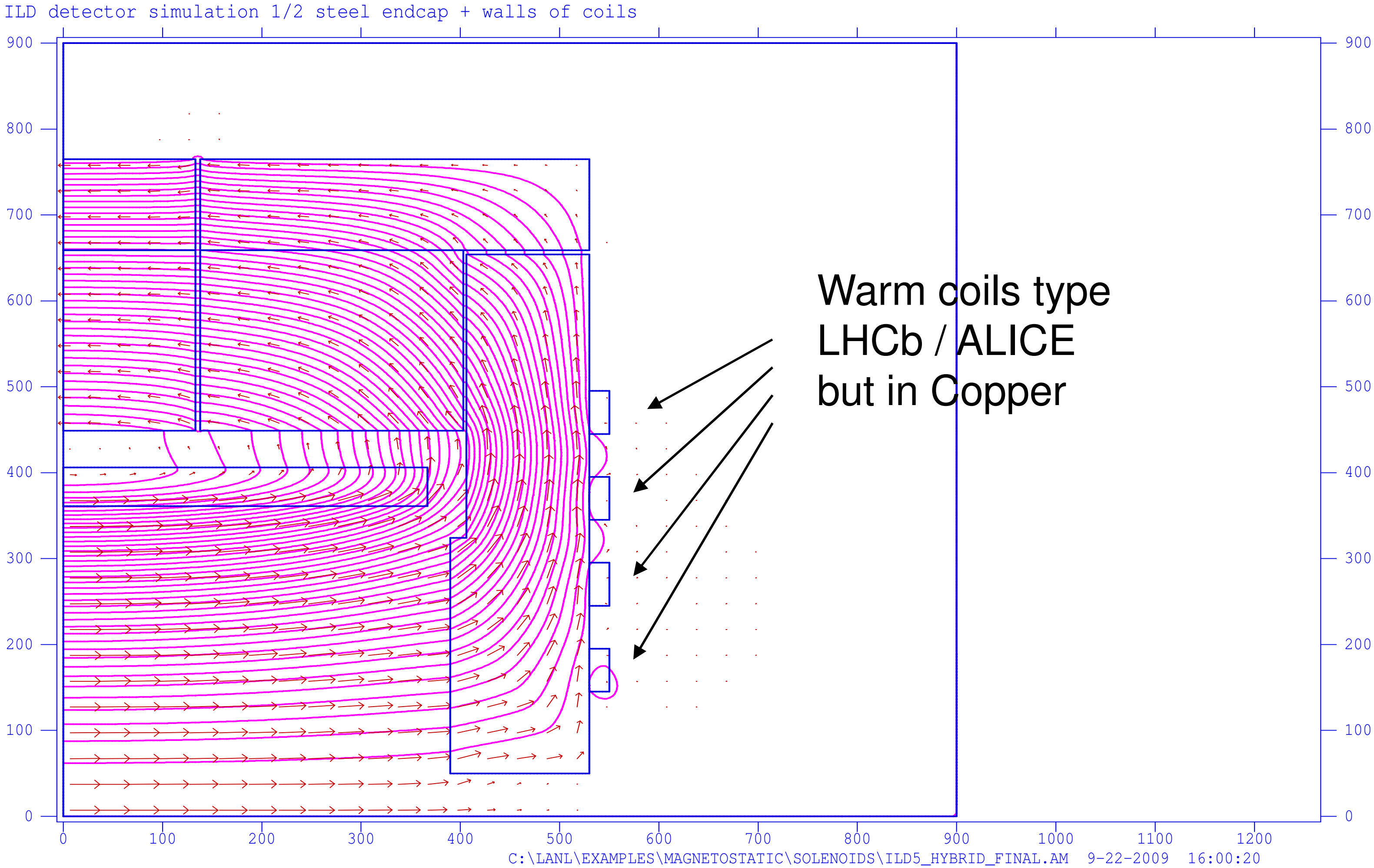


ILD Endcap thickness 2.56 meter!

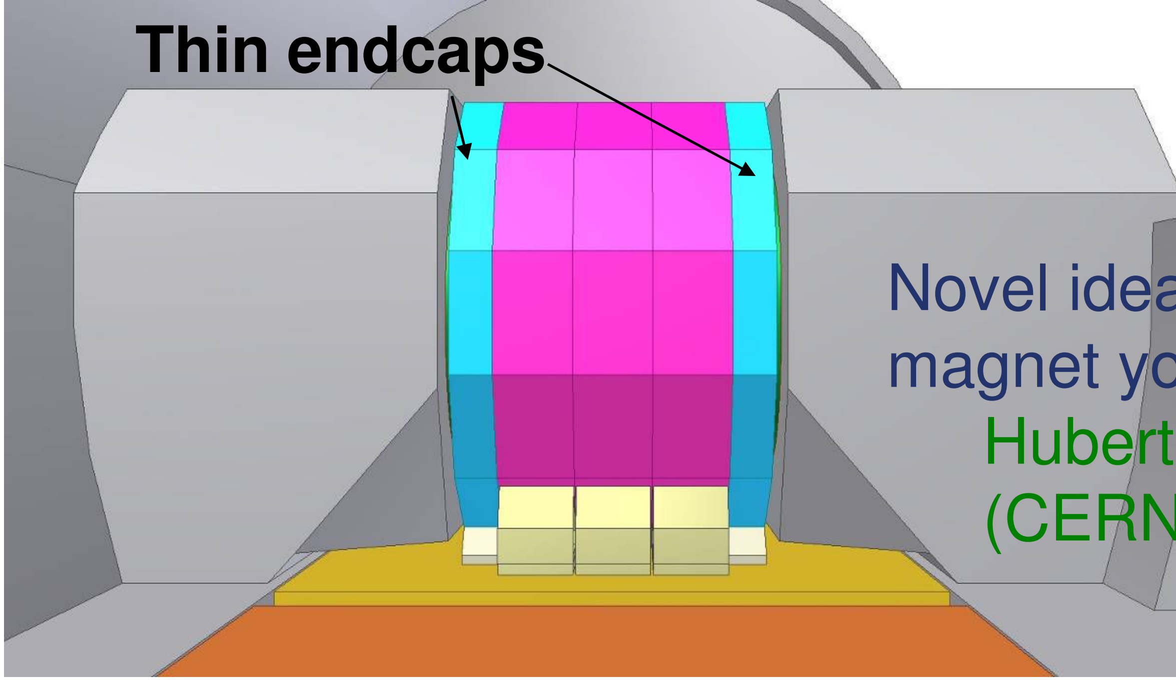


Courtesy Hiroshi Yamaoka, KEK

Why not Hybrid? Thinner endcap + coils



Warm coils type LHCb / ALICE but in Copper



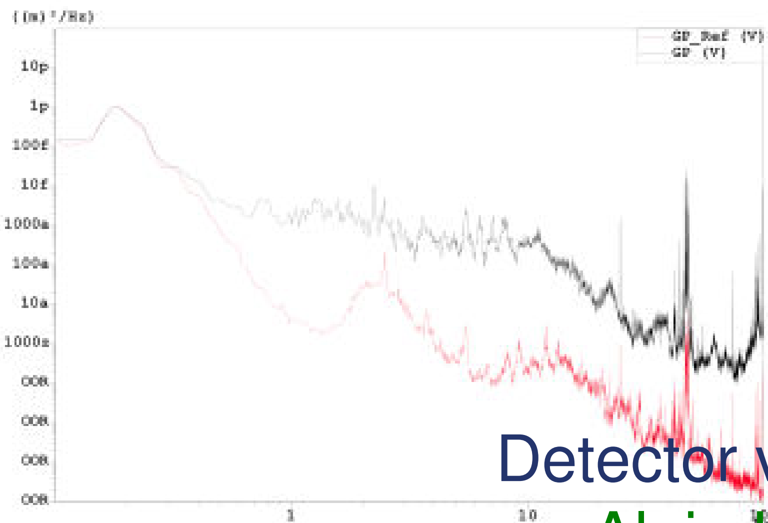
Novel ideas about a magnet yoke

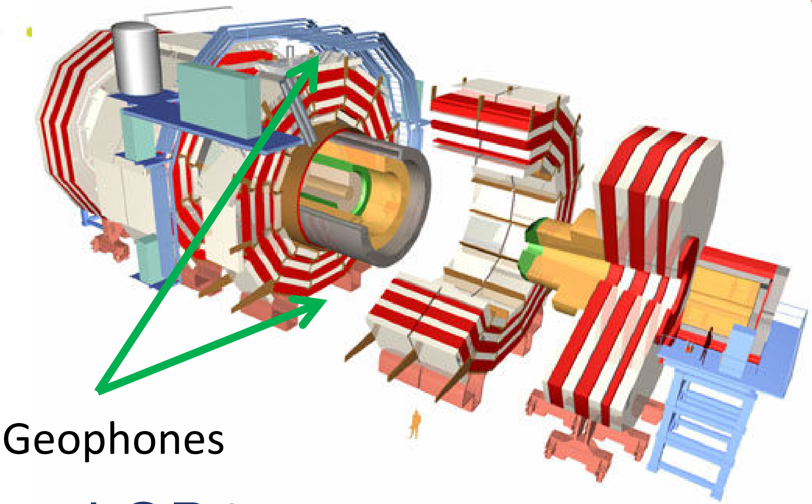
Hubert Gerwig (CERN)

- **In order to have a chance to satisfy the ambitious detector requirements of CLIC a combination of engineering and new general approaches is necessary**
- **Sharing the same cavern needs new thinking in terms of access, power, safety, stray-field etc.**
- **There is no reason to keep still an opening of the detector on IP when sitting on a movable platform**
- **Warm coils on the endcap could reduce its thickness by 50%, losing only 5% of field …**

CMS top of Yoke measurement

PSD of the signals Vertical direction



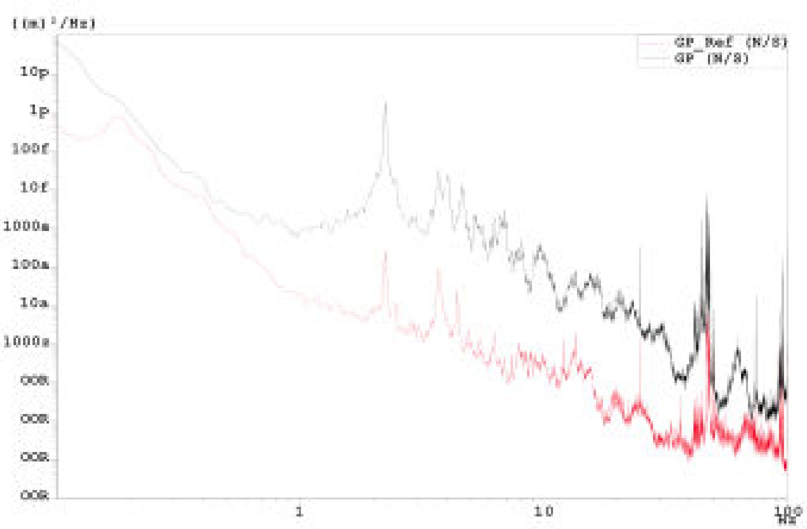


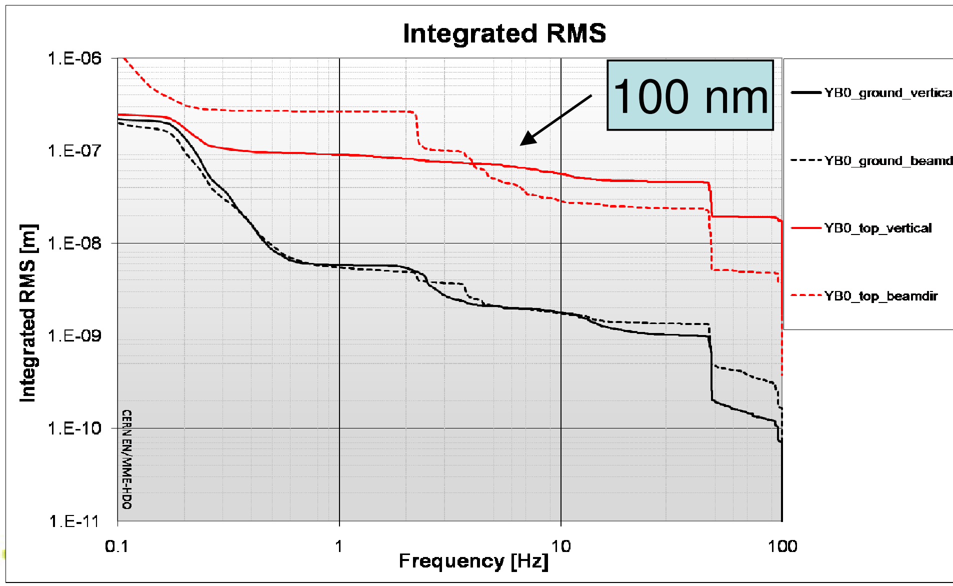
Detector vibrations and QD0 support

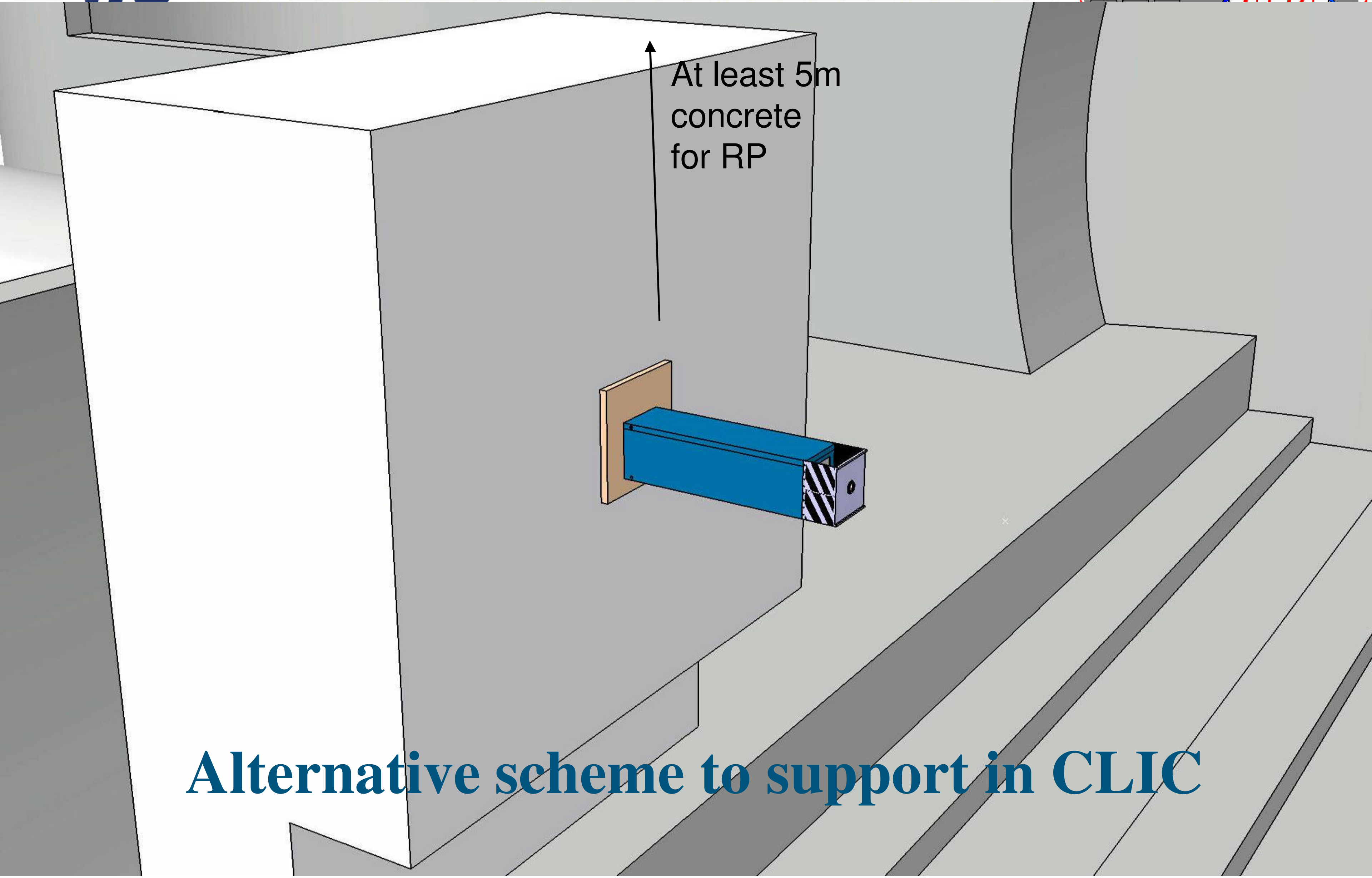
Alain Herve (ETH Zurich)

Cooling system OFF

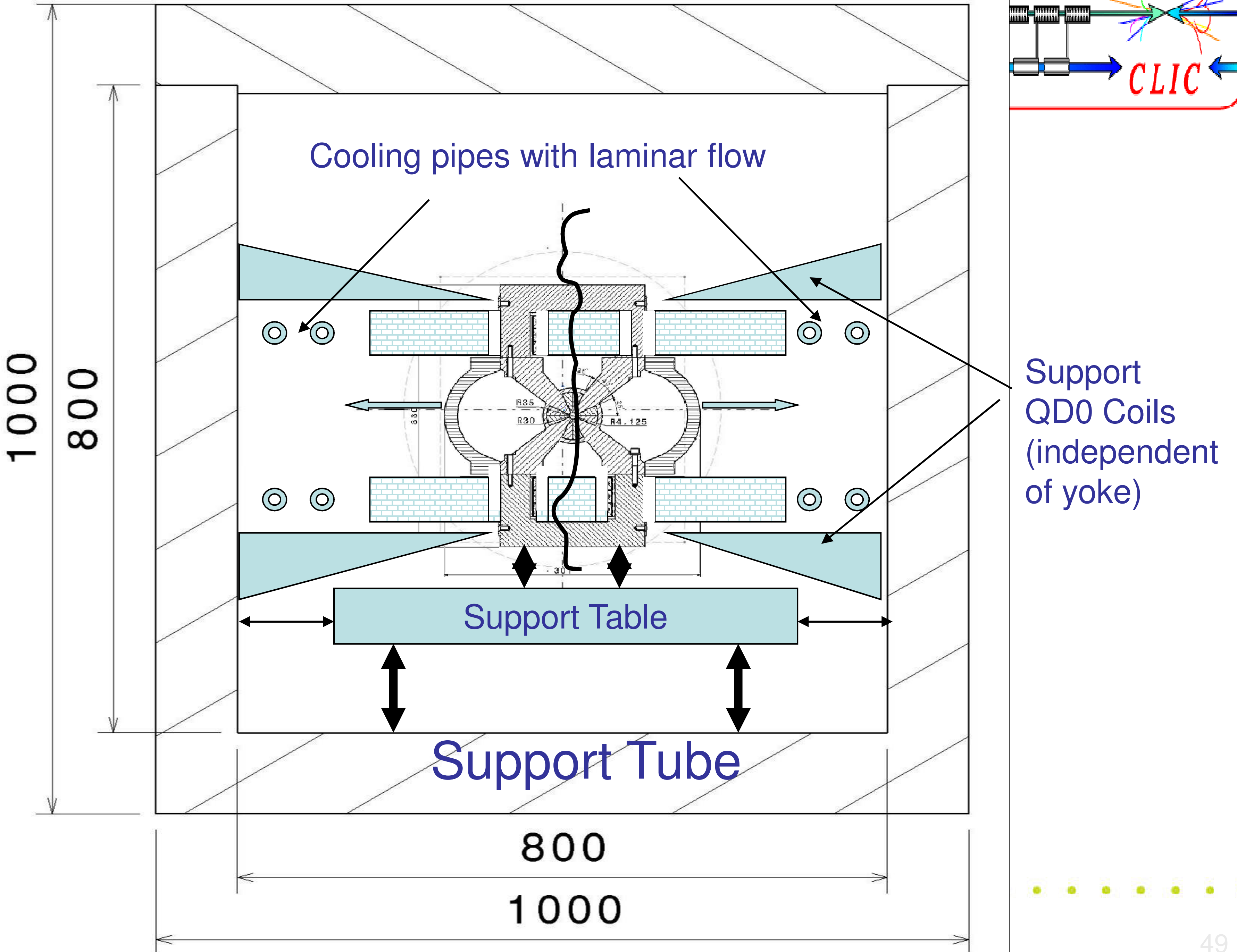
PSD of the signals Beam direction



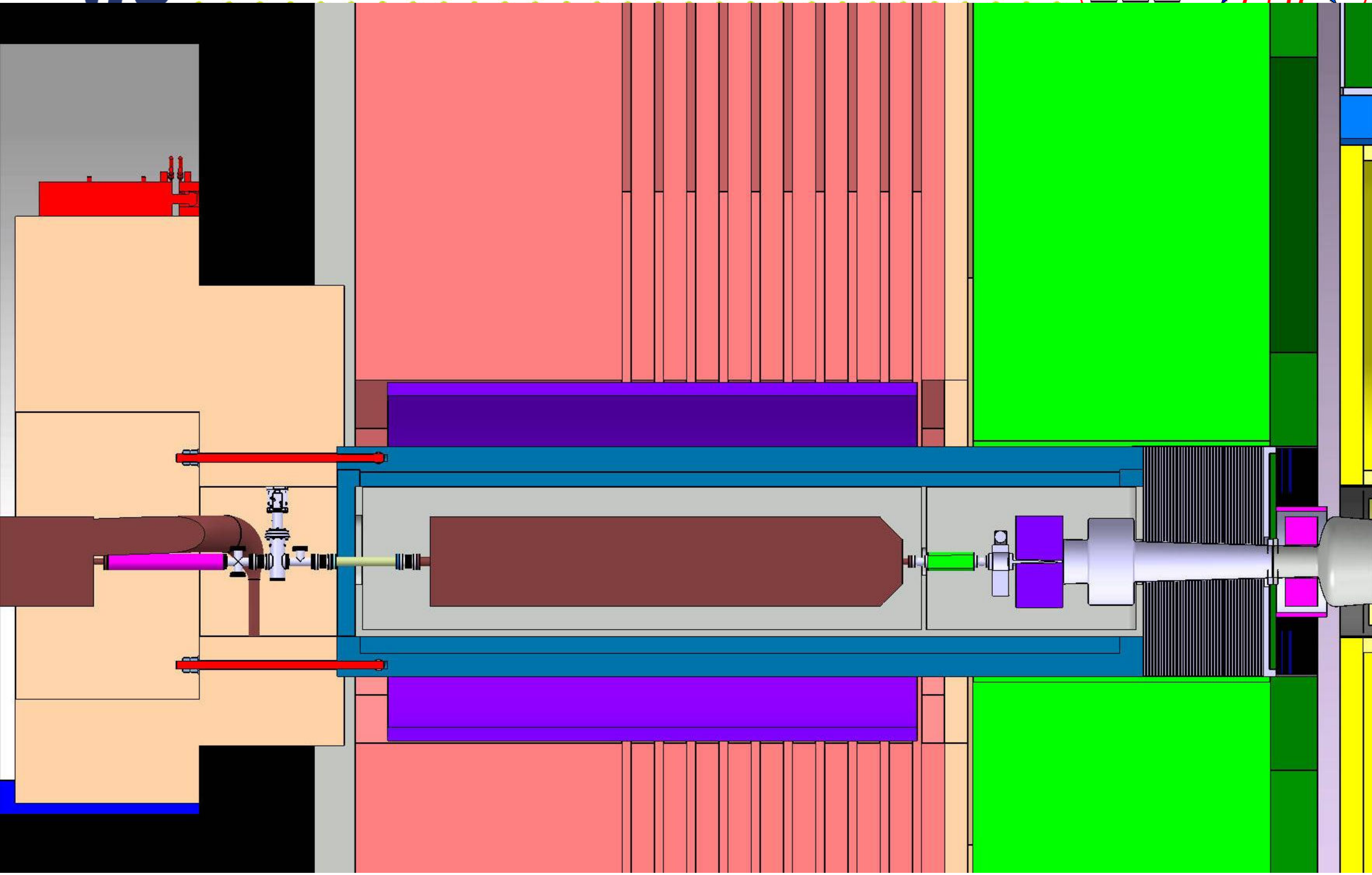




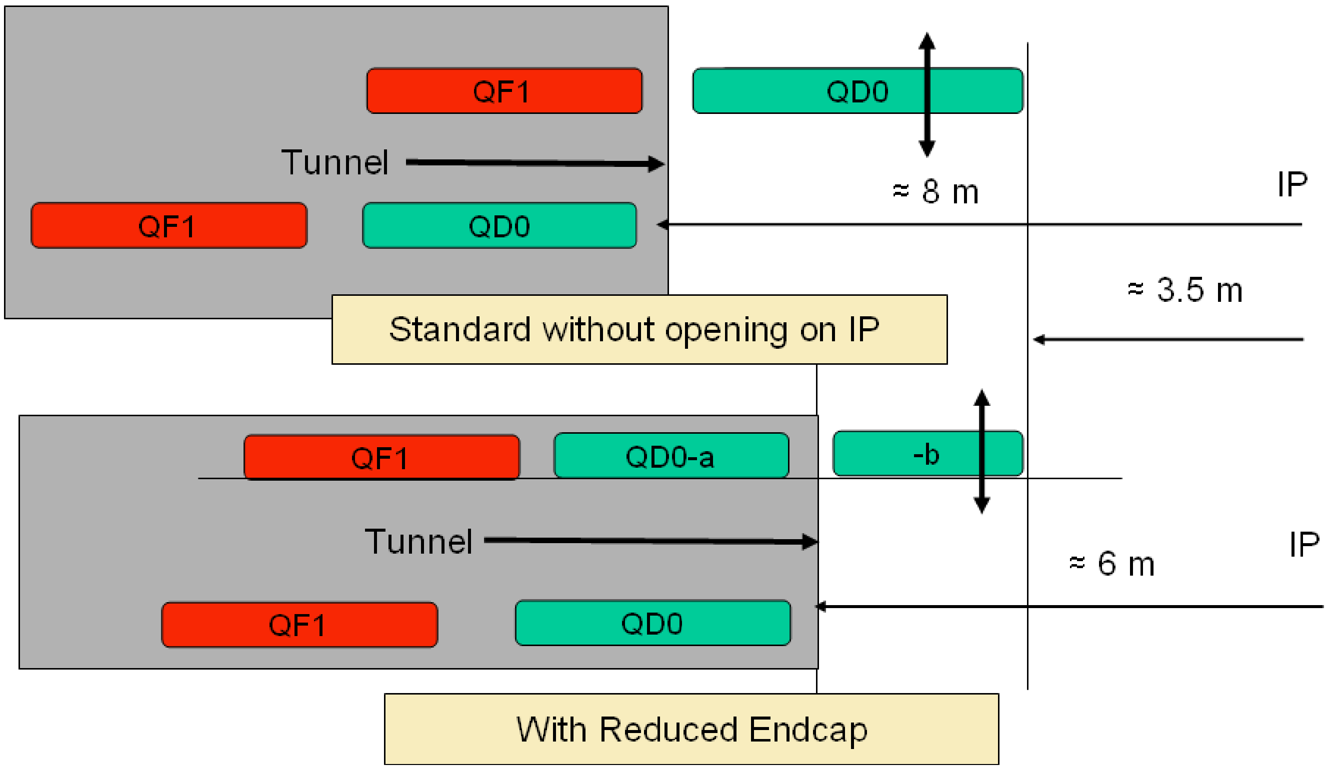
Alternative scheme to support in CLIC


Cooling pipes with laminar flow
Support
QD0 Coils
(independent
of yoke)
Support Table
Support Tube
1000
800
800
1000
R35
R30
R4.125

On IP



Summary: possible configurations of last FF



Detector vibrations and QD0 support

Alain Herve (ETH Zurich)

•Computations made for ILD and SiD suggest that a short and rigid support may work for CLIC if the environment is "quiet"

• Obtaining "quiet" environment requests that *special effort* must be made in design of machine and experimental area *from the beginning*

What can active stabilisation do?

Since the isolation systems don't isolate 100%, but only reduce the vibrations by a given factor (x10 for common systems, x100 VERY difficult, x1000 "impossible")

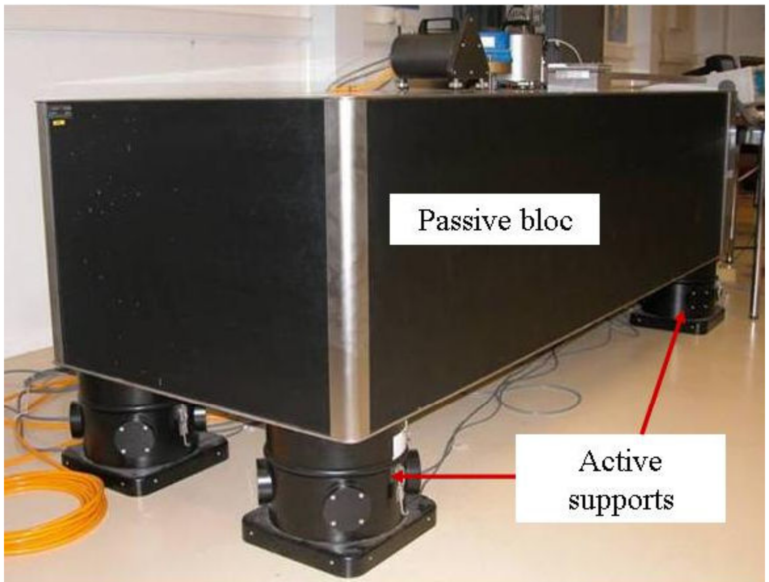
- The initial vibration background has to be as low as possible => if we want
  - MB stab of 1nm, the ground should already be 10nm
  - 0.15nm for the FF, the support should not be subjected to more than 2nm.
- Vibration measurements have shown:
  - Ground measurements at 1Hz vary from 2nm (LEP) to 150nm (ATF2).
  - Common detectors move already by 30nm to more than 100nm!

Stabilization of the FF quads + supports

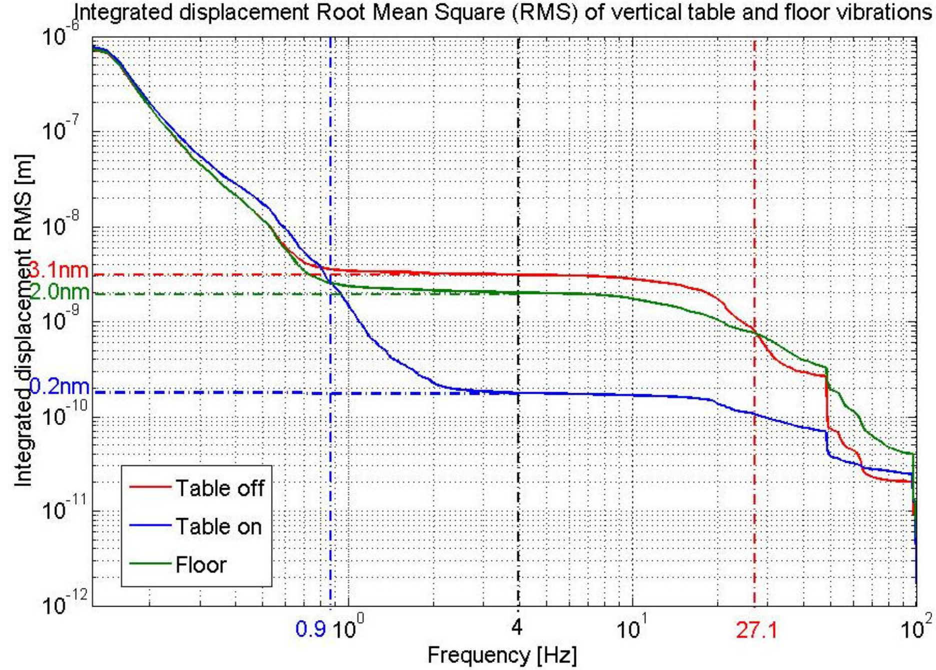
Andrea Jeremie (LAPP)

The industrial solution

✓ **An industrial solution : the TMC table of CERN.**



Active control

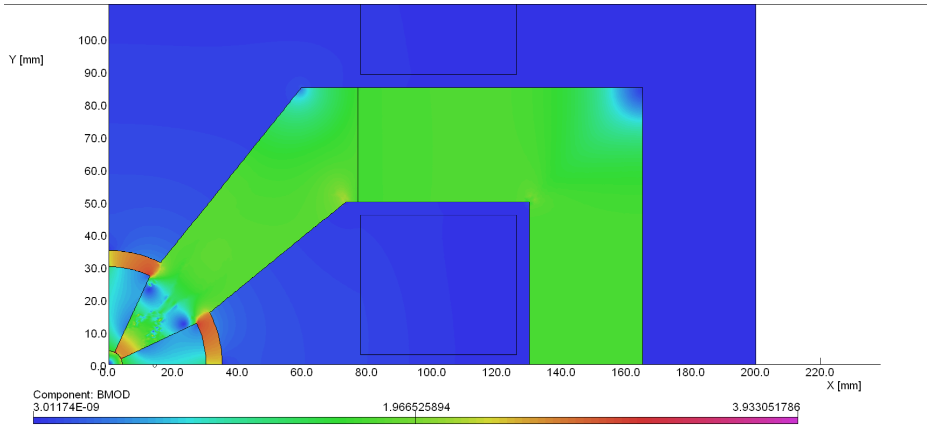


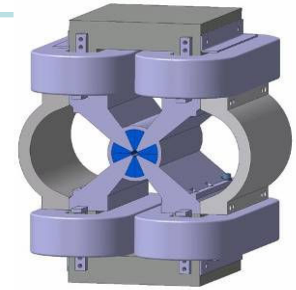
✓ **Composed of a passive bloc, placed on 4 active feet (STACIS).**

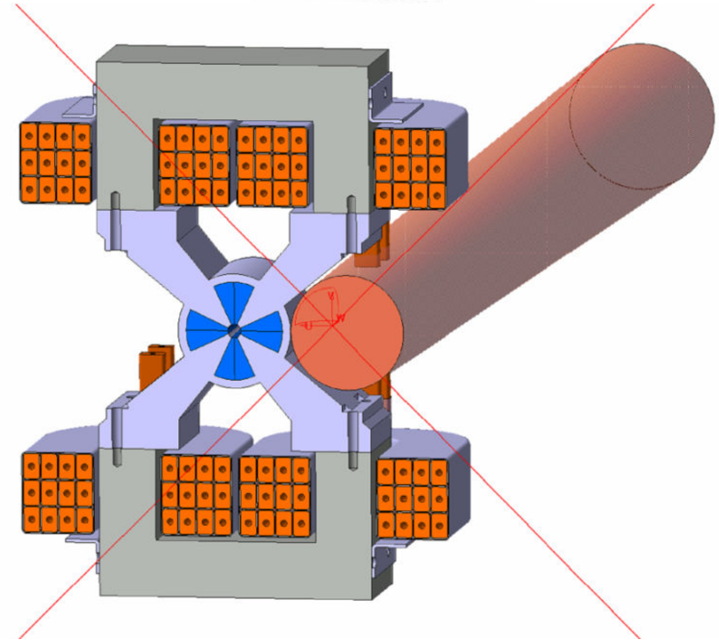
- <u>Passive isolation :</u> attenuates all the high frequency disturbances but amplifies the low frequency disturbances (like a resonant filter).
- <u>Active isolation :</u> attenuates the disturbance amplified by the passive isolation (low frequencies disturbances).

Progress on QD0 quadrupole

Michele Modena (CERN)







	Iw=5000 [A]
Grad [T/m] Sm_2Co_{17}	531
Grad [T/m] $Nd_2Fe_{14}B$	599

- The presence of the “ring” decrease slightly the Gradient (by 15-20 T/m) but will assure a more precise and stiff assembly

- EM Coils design will permit wide operation conditions (with or without water cooling) that can be critical for performances (ex. stabilization)

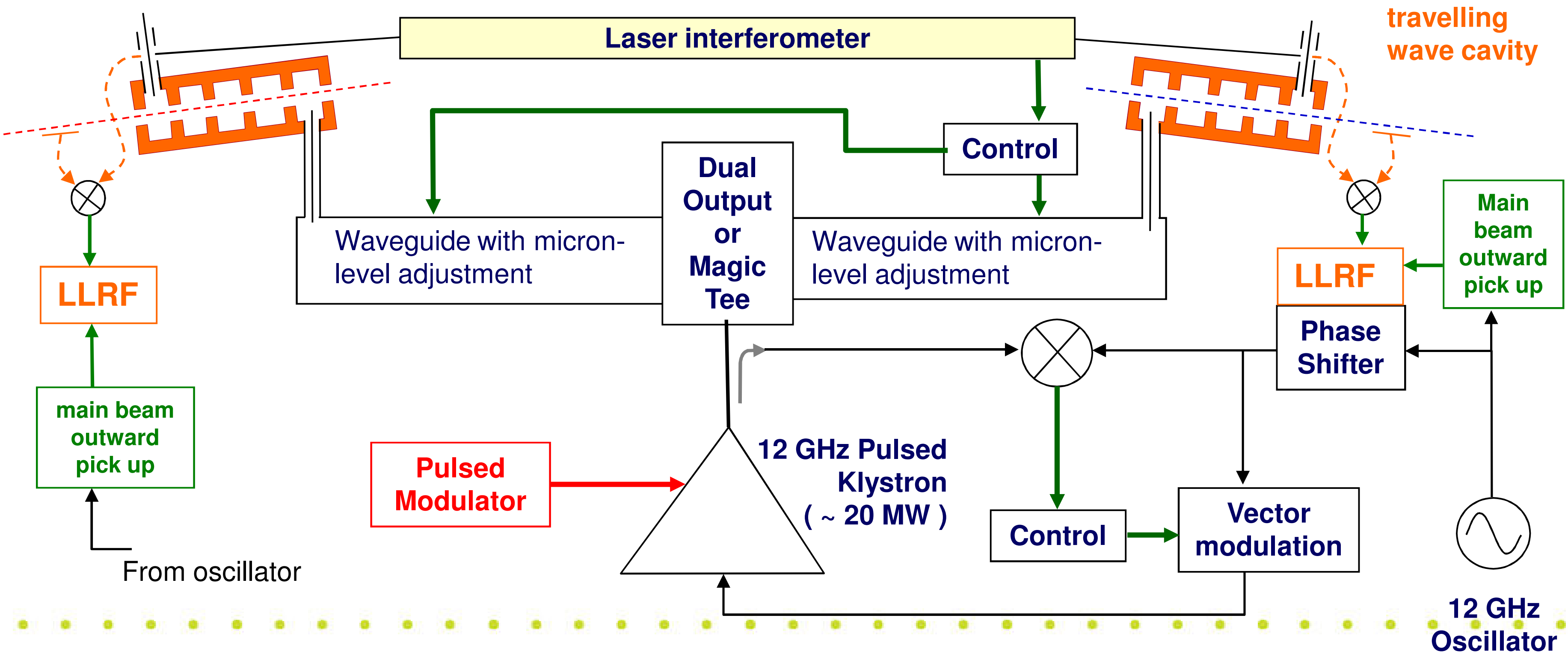
“CLIC09 Workshop” 12-16 October 2009, M. Modena

Amos Dexter (Lancaster University)

- Beamloading constrains us to high power pulsed operation
- Intra bunch phase control looks impossible for a 140 ns bunch

SOLUTION

- One Klystron (~ 20 MW pulsed) with output phase and amplitude control
- Intra bunch delay line adjustment for phase control (i.e. between bunch trains)
- Very stable cavities



Session & topics

- Thursday 9:00-10:30
- How to establish a Straight Line on the Dynamic Curved Surface of the Earth
  - Sebastien Guillaume (CERN)
- Magnetic Background Issues above 1Hz for CLIC beams
  - Cesary Jach (CERN)
- Drive Beam Linac Stability Issues
  - Avni Aksoy (University of Ankara)

- Height between HLS sensors moves by 5→50 µm (several frequencies day/month)
- This is predictable and can be reduced
- At short distance (< 1 km), the required ~ 1µm accuracy seems to be reachable with more work
  - Internal accuracy : 1µm done
  - Stability with time present 5µm/month, objective 1µm/month
  - Absolute calibrationpresent 10µm , objective 1µm
  - Modelisation of tidal variations must be improved

Magnetic background Issues, C. Jach

- Specification
  - Main Linac B < 0.2 nT above 1 Hz
  - LTL B < 0.01 nT above 1 Hz
  - Near IP B < 80 nT above 1 Hz?
- SOURCES
  - FNAL, measured away from powered beam areas B = 100nT
  - HT Power Lines B ~ 20 nT
  - Trains passing near Meyrin , current/field measured in LEP

    B = 6000 nT

    While topology railways/linac much worse for CLIC along Jura
- Not considered power network in the tunnel, vac.pumps, etc …
- MAJOR ISSUE, need solid investigation/solutions

Drive Beam Linac Stability Issues , A. Aksoy

- A design of the DB Linac finally exists
- Work based on RF- structure designed by R. Wegner and E. Jensen
- Implemented four kind of lattices (2 FODO, doublet,triplet)
- Large current & long pulses :
  - Multibunch transverse wakes are strong
  - This is calcualeted and simulated for the 4 lattices
  - FODO lattice seems to be more robust
  - Emittance growth : 20% for 200μm rms misalignment of quadrupoles
- A large instability occurs at the junction of even- and odd-trains
  - Similar effect is observed at CTF3
  - Delicate issue. Requires further thoughts
- Remains to look at
  - Longitudinal stability
  - Phase and energy errors

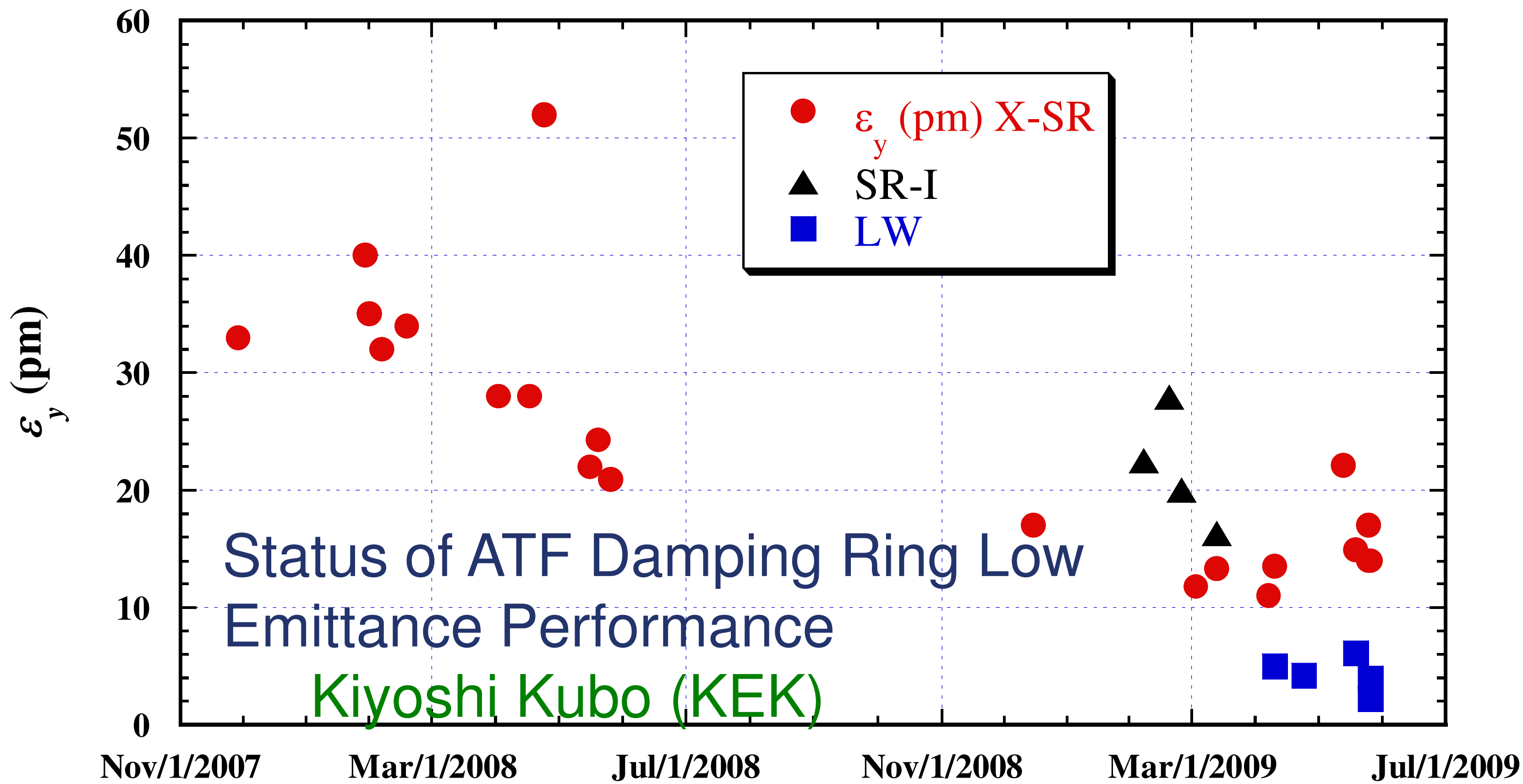
Session & topics

- Thursday 11:00-12:30
- Long distance Optical Fibers with fs resolution
  - F. O"mer Ilday (Bilkent University)
- Overview of the Phase Measurement System at SLS/PSI
  - Vladimir Arsov (Institut fuer Kernphysik)
- Femtosecond optical synchronization system for FLASH
  - Matthias Felber (DESY)
- Will be covered in Summary of WG5

Session & topics

- Thursday 14:00-15:30
- Status of ATF Damping Ring Low Emittance Performance
  - Kiyoshi Kubo (KEK)
- Status of ATF2
  - Toshiyuki Okugi (KEK)
- Status of ultra-low beta proposal at ATF2
  - Eduardo Marin Lacoma (Universitat Politècnica de Catalunya, UPC)

Recent history of emittance in ATF DR



Status of ATF Damping Ring Low Emittance Performance

Kiyoshi Kubo (KEK)

Vertical emittance < 10 pm (from Laser Wire measurement)

Smaller than limits of other monitors?

S. Kuroda and N. Terunuma

ATF DR: Summary and Future Plans

- Low emittance tuning and efforts for improving DR emittance
  - Re-alignment
  - BBA (BPM - Magnet offset measurement)
  - Optics matching (Beta-beat correction)
  - ORM (Orbit Response Matrix) analysis

- The emittance performance has been recovered.
  - **$\varepsilon_y < 10$ pm in April and May 2009. Good enough for FF test.**
  - Effectiveness of each item for this recovery is not clear yet.

- Plans for smaller emittance (2 pm is ILC DR design.),
  - More simulation studies on the tuning procedure
  - Analysis of beam measurement, e.g. ORM.
  - Upgrade of all BPM electronics (20 out of 96 BPMs were already upgraded)
  - Re-alignment of magnets.

ATF2 Operation Status

Status of ATF2

Toshiyuki Okugi (KEK)

2009 February – March

- Operation of ATF2 beam line was started.
- IP-BSM was commissioned for the horizontal laser wire mode.
- Since IP-BSM group required the horizontal beam size of 10-20 μm, beam optics was the high beta optics (βx=0.08m, βy=0.04m).
- Beam size tuning was concentrate only for the horizontal direction.
- Most of the beam time was spent to hardware and software commissioning.

2009 April – May

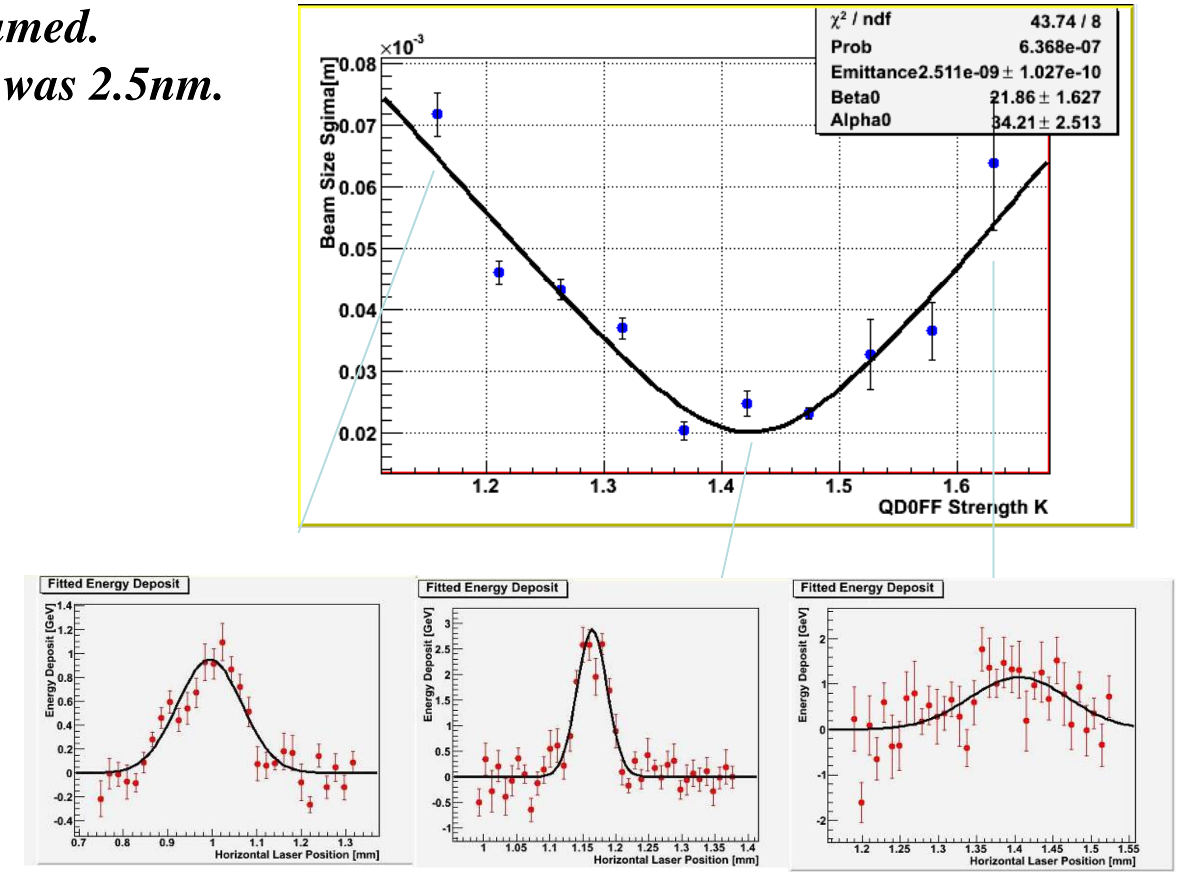
- IP-BSM was commissioned for the vertical interference mode as well as the horizontal laser wire mode
- Since IP-BSM group also required the vertical beam size of 1 μm, beam optics was changed to new high beta optics (βx=0.08m, βy=0.01m).
- Both horizontal and vertical beam size tunings were applied.

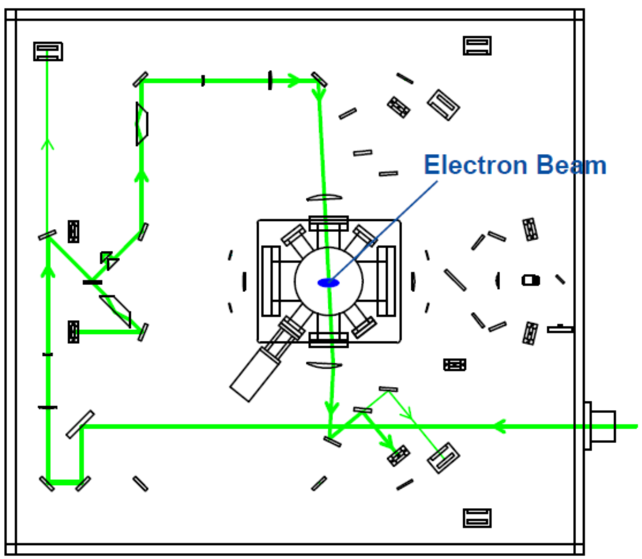
Horizontal Measurement (Laser Wire Mode)

-First Compton signal was observed at February.

-Beam size and emittance measurement was done at May.

- horizontal beam size at MW1IP was 20μm.
- laser beam size 10μm assumed.
-fitted horizontal emittance was 2.5nm.





laserwire mode optics (horizontal measurement)

Rough Schedules of ATF2 operation

We will start ATF&ATF2 Operation from end of this week.

2009 October

Fast kicker study in DR

Startup of the beamline and concentrate the hardware works for ATF2.

2009 November, December

Main Target of the ATF2 operation
is the measurement of the sub-micron beam size by Laser Interferometer

After the 2009 operation

- Decision of the beam optics for 2010 operation.

- improvement of the IP-BSM DAQ to be used for beam operation

- Installation of the multi-OTR chambers.

Target by the end of 2010 spring run

Beam size measurement of <100nm beam

Session & topics

- Thursday 16:00-17:30
- Beam Phase Monitor for CLIC and CTF3: pick-up design
  - Fabio Marcellini (INFN-LNF)
- Drive beam generation in CTF3
  - Simona Bettoni (CERN)
- Linear Collider activities at Cesr-TA
  - Mark Palmer (Cornell University, CLASSE)
- Discussion on test facilities future program
  - Roberto Corsini (CERN)

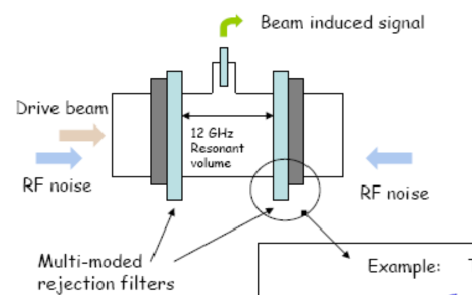
F. Marcellini - Beam Phase Monitor for CLIC and CTF3: pick-up design

- The Beam Phase Monitor is an essential component of the proposed CLIC phase feed-back/feed forward system.
- Fabio presented the first RF design of a monitor based on a proposal of Igor Syratchev of a 12 GHz "choke-filter resonant cavity". A prototype will be built and tested in CTF3 - in the frame of EuCARD activities -

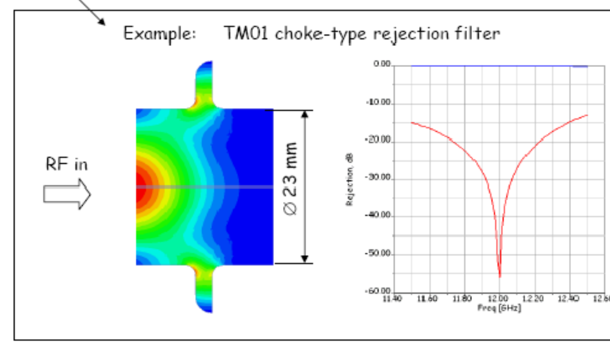
Phase monitor main requirements

- Resolution of the order of 20 fs.
- Very low coupling impedance due to the high beam current.
- Rejection, by means of proper designed filters, of RF noise and weak fields in the beam pipe that otherwise could affect the measurements.
- Detection is done at 12 GHz.
- $\tau_{f\ monitor} \approx 10ns = 2Q/\omega \rightarrow Q \approx 380$, BW ≈30MHz.

Schematic view of the 12 GHz pick-up concept



Considerations:
1. We have to keep big aperture of the pick up (I used 23 mm – similar to one in the PETS).
2. Low impedance!
3. The sensitivity of the device will depends on the RF nose rejection level
4. We need a resonant volume anyway (Q loaded to be defined)



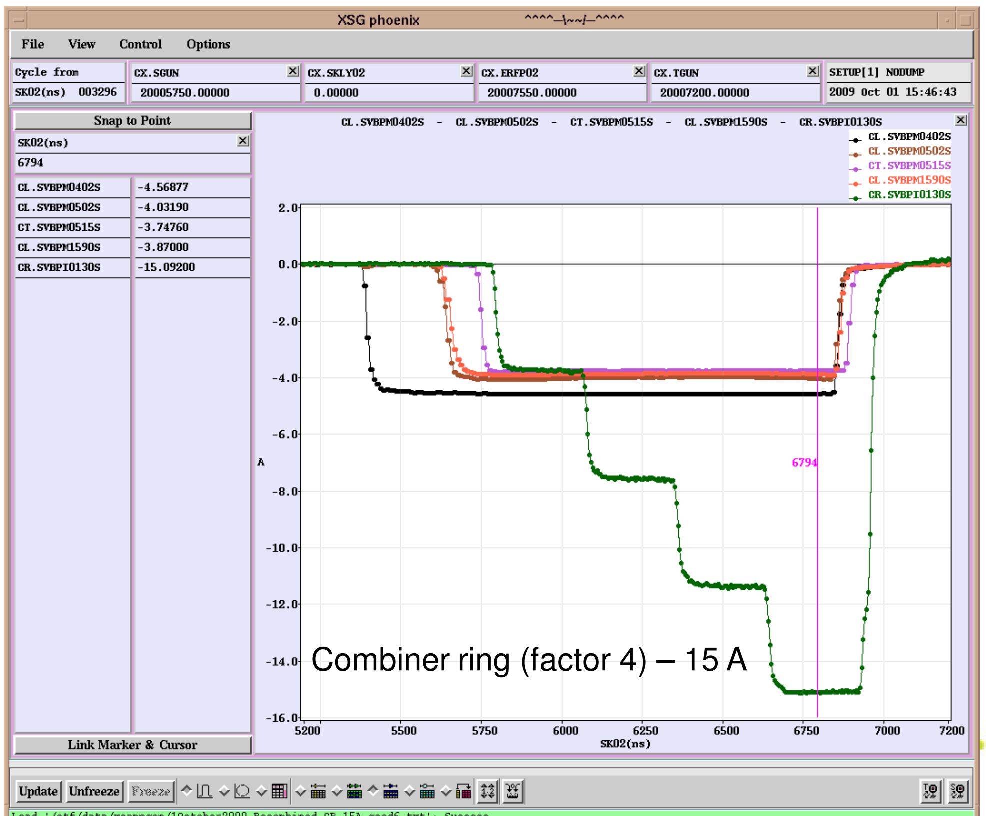
Prototype pick-up design

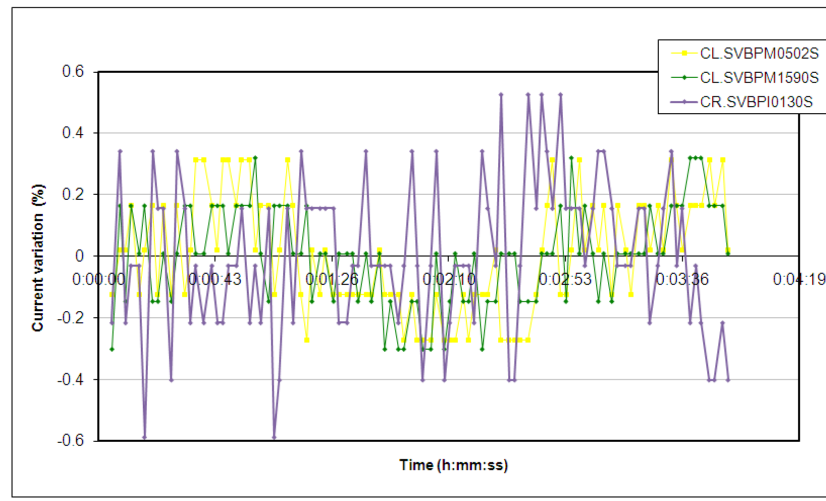
- The design of a possible pick-up has started.
- It could be tested in the CTF3 and installed in the chicane region, before the Delay Loop, where the vacuum pipe diameter is 40mm.
- Design followed the concepts already developed by **Igor Syratchev**.

- Pick-up design in progress.
- Main criteria fixed.
- According to the obtained results the adopted solution seems feasible.
- A lot still to do to get a detailed design ready for construction.

Simona presented the recent progress on drive beam generation studies in CTF3:

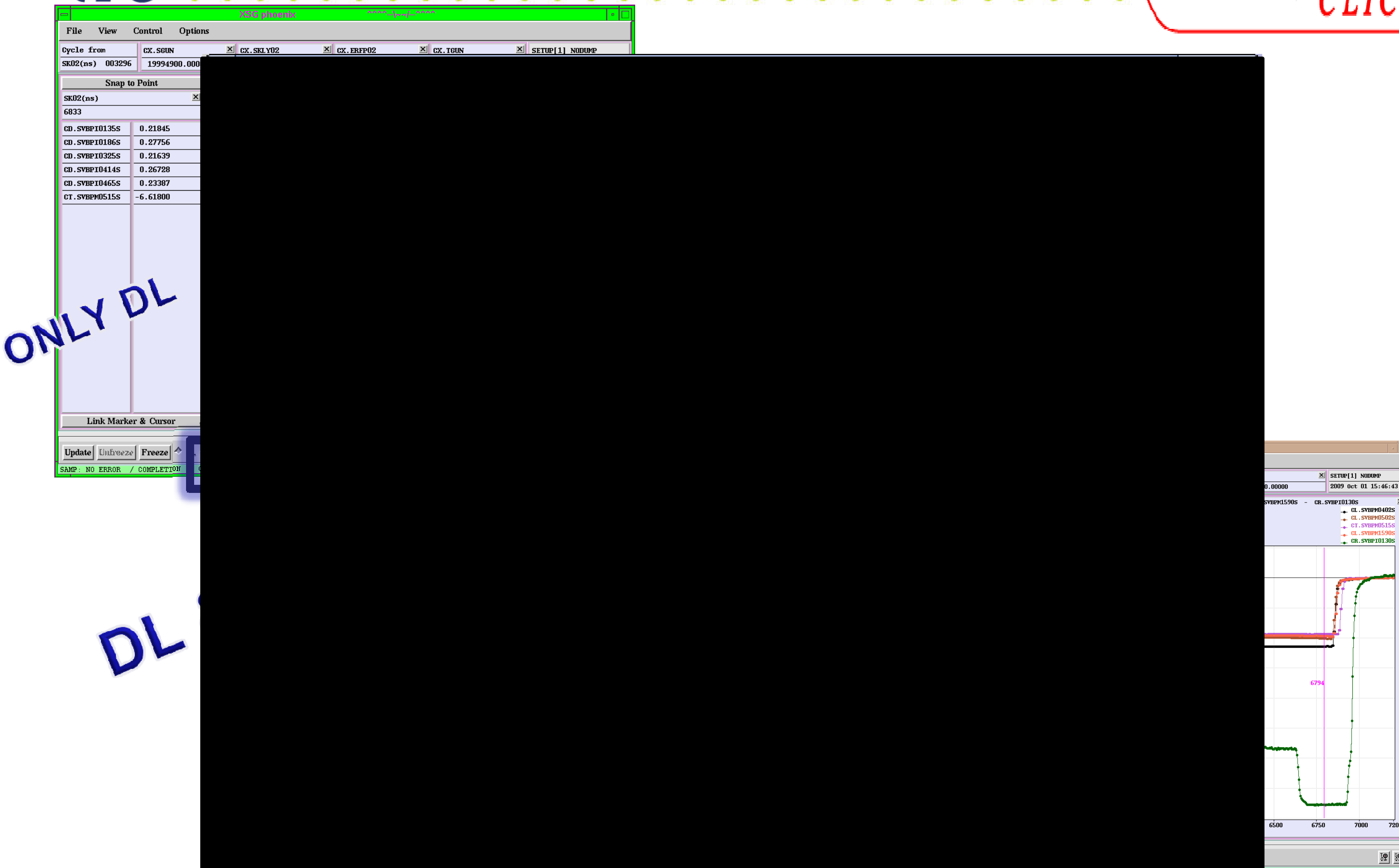
- The Delay Loop was put back in operation with a combination factor 2 (6.5A)
- The combination factor 4 in the CR is now routine, with 15 A peak reached (no losses)
- The recombined beam short term stability in both cases is excellent (a few 10^{-3})
- Optics studies made as well a lot of improvements, still work to be done for TL2 and CLEX beam lines
- And, last but not least, you'll be able to see the re-combination 2 x 4 results (next slide)





	CL.SVBPM0502S	CL.SVBPM1590S	CR.SVBPI0130S
Min. (A)	-4.038	-3.888	-15.176
Max. (A)	-4.014	-3.864	-15.008
Mean (A)	-4.025	-3.876	-15.097
Std (A)	0.007	0.006	0.038
Variation (%)	0.18	0.16	0.25

Delay loop & combiner ring: THE recombination



Mark Palmer - Linear Collider activities at Cesr-TA

Mark gave an overview of CesrTA status and planned activities:

- CesrTA flexibility, the presence of damping wigglers and the possibility of positron operation (on top of its availability as a test facility) makes it an unvaluable tool for a variety of studies relevant for linear colliders.
- The present goal for vertical emittance is below 20 pm, close to ATF values. First measurements indicate a value about a factor two above – at the first try!
- Hardware upgrades are essentially complete, and will enable to improve performances (e.g., new BPM system)
- The experimental program is largely dedicated to e-cloud studies, but low emittance tuning and related diagnostics development play an increasingly large role as well.
- Of particular interest for CLIC are also the stability tests and the potential access to conditions adapted to IBS studies. Other opportunities in the next years are to be explored.

Lattice Parameters

Ultra low emittance baseline lattice

Energy [GeV]	2.085	5.0	5.0
No. Wigglers	12	0	6
Wiggler Field [T]	1.9	—	1.9
Q_x	14.57		
Q_y	9.62		
Q_z	0.075	0.043	0.043
V_{RF} [MV]	8.1	8	8
ε_x [nm-rad]	2.5	60	40
$\tau_{x,y}$ [ms]	57	30	20
α_p	6.76×10^{-3}	6.23×10^{-3}	6.23×10^{-3}
σ_l [mm]	9	9.4	15.6
σ_E/E [%]	0.81	0.58	0.93
t_b [ns]	≥4, steps of 2		

Range of optics implemented

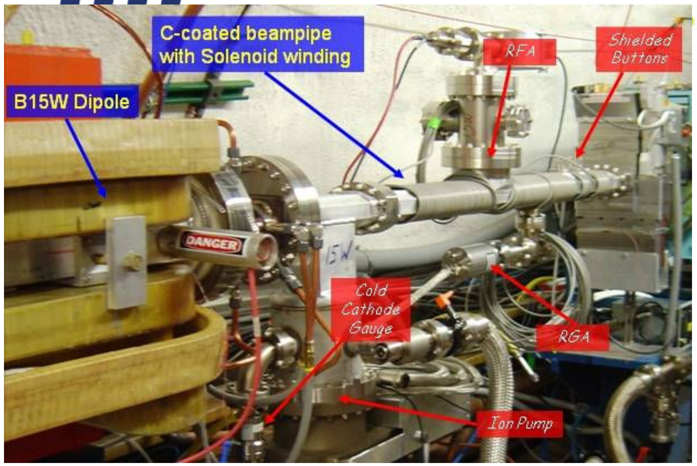
Beam dynamics studies

Control photon flux in EC experimental regions

E[GeV]	Wigglers (1.9T/PM)	ε_x[nm]
1.8*	12/0	2.3
2.085	12/0	2.5
2.3	12/0	3.3
3.0	6/0	10
4.0	6 /0	23
4.0	0 /0	42
5.0	6/0	40
5.0	0/0	60
5.0	0/2	90

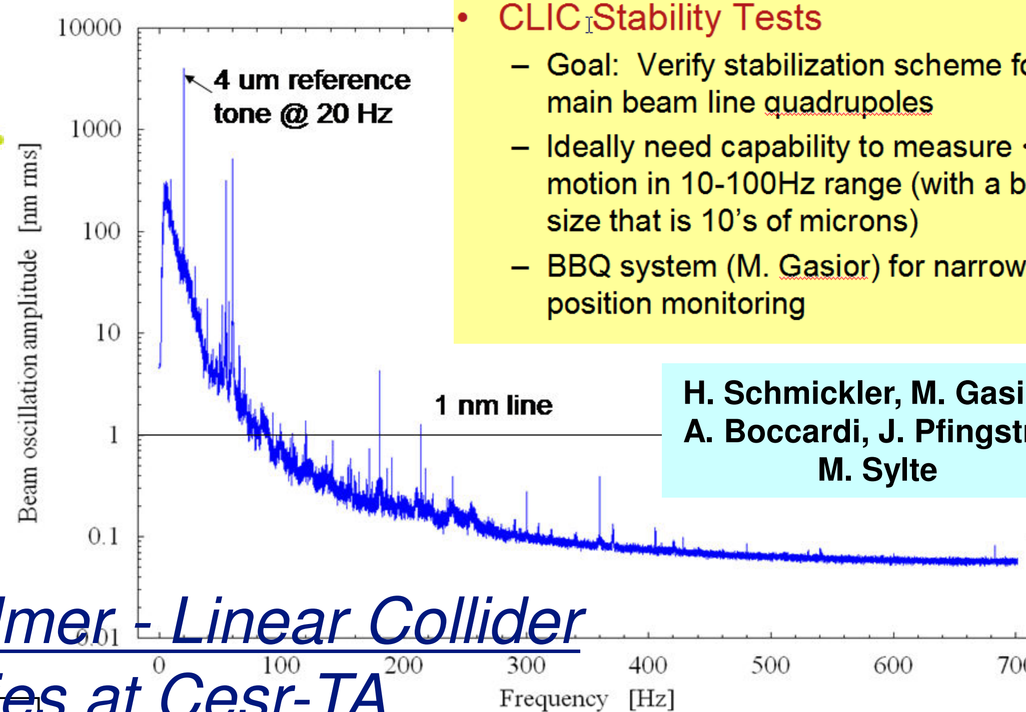
IBS Studies (first three rows)

* Orbit/phase/coupling correction and injection but no ramp and recovery. In all other optics there has been at least one ramp and iteration on injection tuning and



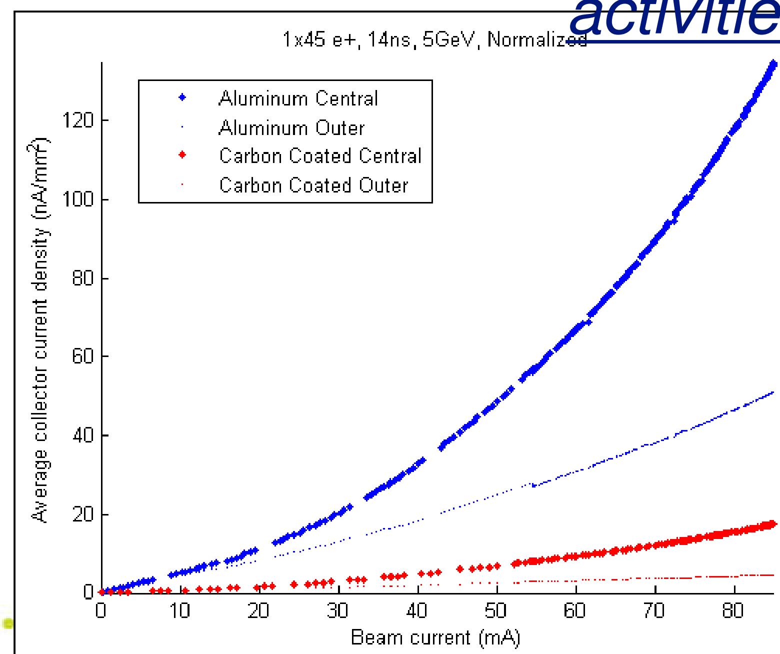
E-cloud mitigation studies

Mark Palmer - Linear Collider activities at Cesr-TA



- CLIC Stability Tests
  - Goal: Verify stabilization scheme for main beam line quadrupoles
  - Ideally need capability to measure <1nm motion in 10-100Hz range (with a beam size that is 10's of microns)
  - BBQ system (M. Gasior) for narrowband position monitoring

H. Schmickler, M. Gasior, A. Boccardi, J. Pfingstner M. Sylte



Cornell University
Laboratory for Elementary-Particle Physics

Future Plans

- 3 additional runs are scheduled as part of the current CesrTA program
  - Run 5: Nov 17 – Dec 23, 2009 with major focus on:
    - Low emittance tuning
    - EC induced instabilities and emittance dilution at low emittance
    - Completing a range of EC characterizations with a scrubbed machine
  - Run 6 tentatively scheduled to begin April 2010
  - Run 7 tentatively scheduled to begin September 2010
  - CTA09 Workshop ⇨ List of critical studies to address in the next year: https://wiki.lepp.cornell.edu/ilc/bin/view/Public/DampingRings/CTA09/WebHome
  - Time exists in the schedule to support outside experimental requests
- *ALSO* ⇨ We have submitted a proposal to the NSF for operating funds to continue the program for another 3 years (thru March 31, 2013)
  - Reduced running schedule ≤ 40 days/year which will allow:
    - Long-term tests of mitigation performance
    - Targeting vertical emittance reduction to 5-10pm range
    - IBS and other beam dynamics studies
    - Characterization of instabilities in a regime closer to that of the ILC DR
    - Additional collaborator experiments
  - NSF site visit/review during next run: December 2-3 at Cornell
  - We would welcome your participation!

Overall summary

- A lot of progress
- Many things to do for CDR
- Keep (and increase) momentum!