

MDI Issues

T. Tauchi, KEK

Huge Detector Concept Study Meeting, TV, KEK
FFIR Working Group of ACFA-LC
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What is MDI ?

MDI is Machine Detector Interface.

Machine : Beam Delivery System (BDS)

from LINAC-end to beam dump

collimation, energy/polarization, final focus,
extraction (energy/polarization) and beam dump

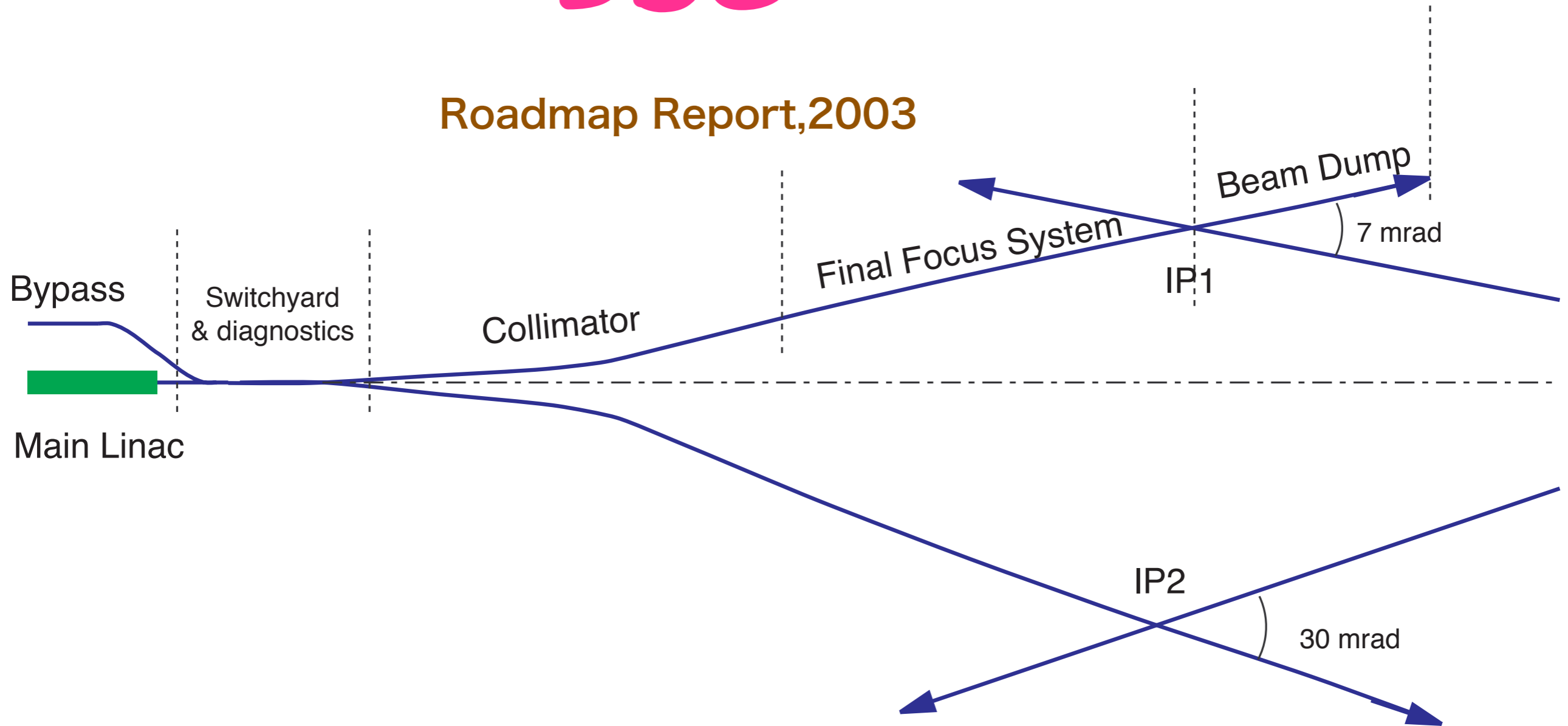
Detector : Interaction Region

experiment (physics; Higgs, Top, W/Z, SUSY, extra-D ...)

luminosity, background and minimum veto-angle

BDS

Roadmap Report, 2003



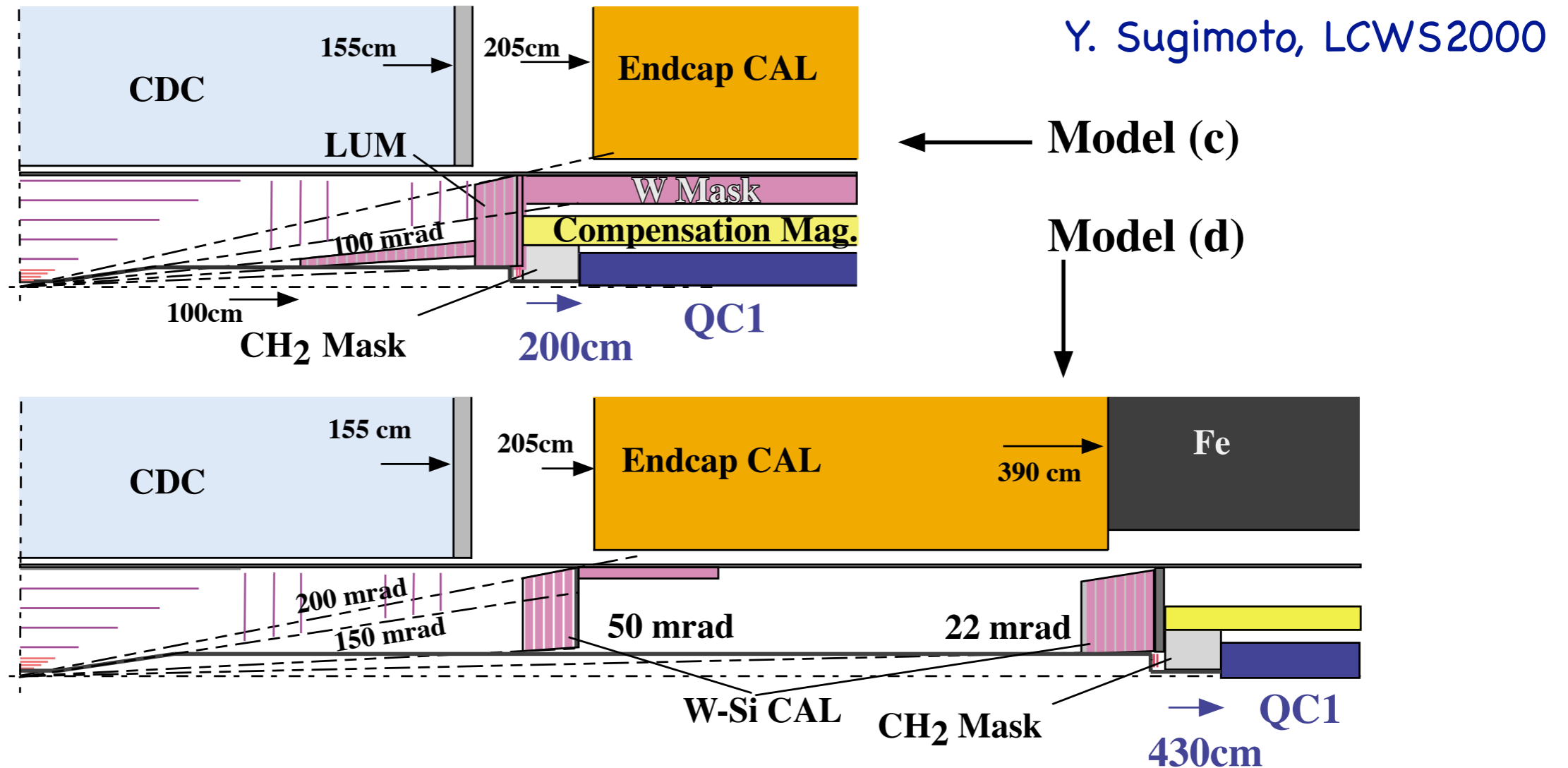
Crossing angle

2 IP's for 2 "identical experiments"

Precise energy and polarization measurements

Backgrounds (muons and synchrotron radiations)

IR



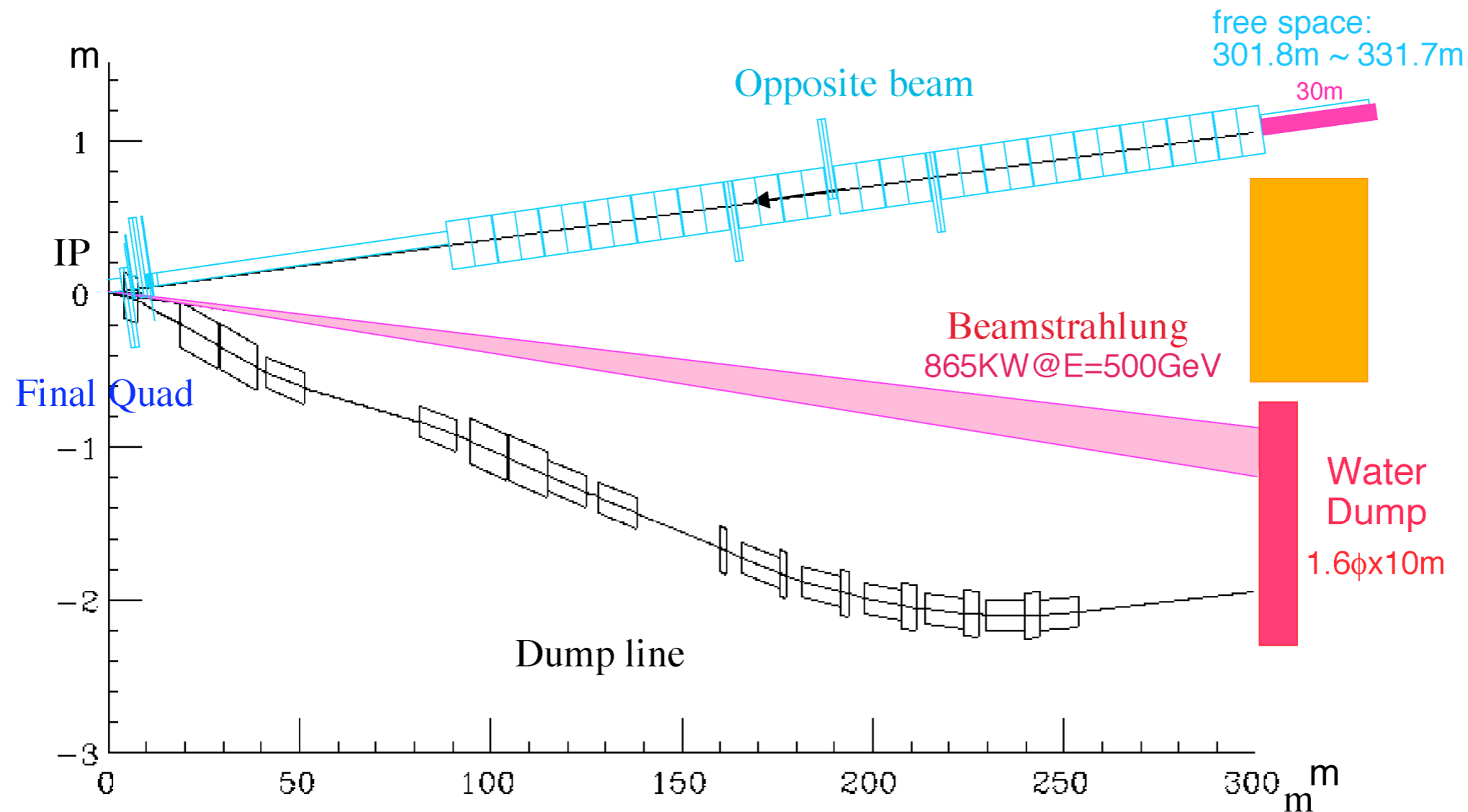
L* : Distance of QC1 from IP

Minimum veto-angle (very forward calorimeter)

Backgrounds (pairs, mini-jets, backscattered γ and n)

Instrumentations (pair monitor, feedback, Shintake monitor ...)

BDS: Extraction Line



Crossing angle

Choice of final quadrupoles (L^*)

Precise energy and polarization measurements

Backgrounds (disrupted beam, back-scattered n and γ .)

L,E,P Measurement Goals

Luminosity, Luminosity Spectrum

- Total cross sections: absolute $\delta L/L$ to $\sim 0.1\%$
- Z-pole calibration scan for Giga-Z: relative $\delta L/L$ to $\sim 0.02\%$
- threshold scans (ex. top mass): relative $\delta L/L$ to 1%
- +L(E) spectrum: core width to $< 0.1\%$ and tail population to $< 1\%$

Energy

- Top mass: 200 ppm (35 MeV)
- Higgs mass: 200 ppm (25 MeV for 120 GeV Higgs)
- W mass: 50 ppm (4 MeV) ??
- ‘Giga’-Z A_{LR} : 200 ppm (20 MeV) (comparable to $\sim 0.25\%$ polarimetry)
- 50 ppm (5 MeV) (for sub- 0.1% polarimetry with e^+ pol) ??

Polarization

- Standard Model asymmetries: $< 0.5\%$
- ‘Giga’-Z A_{LR} : $< 0.25\%$ ($< 0.1\%$ with e^+ pol)

Present and Future Effort in ACFA-FFIR group

Contents: [Interaction Region](#), [Support Tube](#), [Collimation](#), [BDS Simulation](#), [Final Focus System](#), [Dump Line](#), [SLEPT Project](#), [Ground Motion](#), [FEATHER](#), [Nanometer BPM](#), [Laserwire](#), [Polarimetry](#), [Luminosity](#) | [IR ISSUES](#) | [Talks](#) | [Minutes](#) | [Advanced R&D](#)

Comments and suggestions are very welcome. (toshiaki.tauchi@kek.jp)

Interaction Region

- Optimization of IR-layout (L^* , innermost layer of VTX, crossing angle, extraction line, FEATHER, pair monitor ([Tohoku univ.](#), [minutes](#)) and background)
 - Physics and detector
 - Acclerator
- [First optimization](#) was completed in 2000; B=2 and 3 Tesla, $L^*=2\text{m}$, 4.3m.
- Recent background estimation; [talk\(pdf, 2.9MB\)](#) presented at LCWS04, 19 April,2004, and [talk \(pdf, 90KB\)](#) presented at the 6th ACFA-LC video conference, December 12, 2003, by T. Aso (Toyama National College of Maritime Technology).

Support Tube R&D

- short history
 - 2000, ANSYS calculations of the support tube in the JLC detector, fabrication of support tube prototype was started.
 - 2001, sensor,software improvement and measurements of vibration properties.
 - 2002, fabrication of the 1/10 model (cantilever with 4 segmentions, flat and taper flanges)
 - 2003, [plan](#) (test of the 1/10 model, optimization of the CFRP central tube thickness, etc.)
 - 2004, [plan](#)
- measurement of oscillating amplitude with different phases at both ends,
- manufacturing of 1/10 model with realistic structures
 - photo:[1/10 model](#) (80mm outer diameter, 10mm thick, Al tube), [Taper Flange](#)
- stiffness test of the model and study of a vibration isolation system.
- active feedback system at sub-nanometer level.

- Optimization of thickness of central connection tube, which shall be thinnest keeping stability of oscillation properties of the tube.
- Recent progress report can be found here : tube with [taper flanges](#), [flat flanges](#), and [loads](#).
- [Frequency response analysis](#)

Collimation System

- calculation of synchrotron radiations by SAD (new implementation in SAD) : [1](#), [2](#)
- JLC scheme with muon attenuators (presented at APPI03 by Ohgaki) : [1](#)
- estimation of muon background by MUCARLO in cooperation with Namito-san, short muon attenuator?
- understanding of TFO (Tail Folding Octupoles) -role quantitatively and optimization of the collimation system
[First estimation](#)
- collimator design
collimation depth -- innermost layer of a vertex detector
calculation of wake field at the spoilers and absorbers; [Yokoya's calculations](#) and [a short review](#),
- beam halo
gas scattering ; [brief review](#), [NLC](#), [1](#), [2](#), [3](#) and Yamamura's master thesis, Tokyo univ., 2004.3 [Japanese](#), pdf,8,4MB
dark current ; [1](#), [2](#), [3](#), [4](#), [5](#), [6](#), [7](#)
[longitudinal tail](#), to be collimated at pre-LINAC collimation.
- Possibility of shorter collimation: [1](#)

BDS Simulation

- estimation of beam halo and dark current at LINAC; beam gas scattering, wake field etc; [project](#), [1](#)
- estimation of backgrounds at detectors; results of [1](#) , [2](#).
synchrotron radiations from final doublet and others
muons (collimators)
neutrons (dump line) : [1](#), [2](#), [3](#)
pairs (IP), primary in VD and secondary in CDC
- energy loss along the beam line -- radiation loss

Final Focus System

- **New Final Focus with large L***

New optics interest : [1](#), [2](#), [3](#), [4](#), [5](#)

Optimization of L^* ; $L^*=3.5\text{m}$ (roadmap) or 4, 5m? ([3.5/4.3m](#), [4.3m](#), chromaticity;[1](#), [2](#), [3:ATF2](#)) from physics/detector

Assessment of effects due to errors in strength ([Q](#) , [SEXT](#)), positions ([Q](#) , [SEXT](#)) and rotations/longitudinal position ([Q](#) , [SEXT](#)) of each magnet at the FF system

Beam stabilization ; study on feedback method with orbit corrections

Estimation of momentum acceptance in terms of luminosity and background

- [Q/A of errors and \$L^*\$ at the old design \(by Oide\)](#)

- **Crab Crossing**

7mrad or 20 mrad? | [discussion](#)

[Crossing Angle of GLC\(pdf\)](#), presented at the JLC-KEK weekly meeting by K.Yokoya, 18 July,2003.

[Review of NLC crab cavity by H. Hayano,23 April, 2003](#)

[Crab cavity at KEKB by K.Akai](#)

- **Superconducting final doublet (large aperture with 7 mrad crossing)**

design: [1](#), [2](#), [3](#), [4](#), [5](#), [6](#), [7](#), [8](#)

- $L^*=4.3\text{m}$

Estimation of background at the dump line, specially [synchrotron radiations](#) generated by extractede beam in the final Q, by the BDS simulation

- **Permanent final doublet**

[R&D issues](#)

[method](#) of varying the strength (for Ebeam=45GeV ~ 250GeV) -- rotation of segmentations?

tolerances of various errors for the design: [strength](#)

recent progress report can be found [here \(pdf\)](#), which was presented at the [ISG11](#), December 16-19, 2003, by T. Mihara (Kyoto university).

- **Conventional final doublet**

Design for the optics of $L^*=3.5\text{m}$ or 4.3m

Extraction Line and beam dump

- Design of extraction line : [1](#), [2](#), [3](#), [4](#), [5](#), [6](#), [7](#), [8](#), SQ: [9](#), [10](#), [11](#), [12](#), [13](#)
- Dump design: water dump ([1](#) , [2](#)) , [beamstrahlung photons](#)
- Optimization of optics (the second IP through the beam dump); [two dumps](#) and [single dump](#)
- Design of magnets considering neutron background
- Estimation of neutron background from a single or two dumps for beamstrahlung photons and electron(positron) beam

SLEPT Project

- Interface to SAD and CAIN for a unified program routine : [SLEPT](#)
- [Effect of missing quad-movers and BPMs](#)
- [Various BNS damping and low \$\beta\$ optics](#)
- Assessment of Ground motion effect on main linac and BDS ; studies of [1](#), [2](#), [3](#) .
- References
 - [Manual\(PDF,732KB\)](#), K.Kubo, K.L.F.Bane, T.O.Raubenheimer and K.A.Thompson, Phase space simulation program for main linacs of future linear colliders, NLC-Note 14, May 1995.
 - Correction Strategy ([PDF, 46KB](#), [html\(Japanese\)](#)) , K.Yokoya, written in Japanese, 5 March 2003.
 - [Requirements for movers at LINAC](#)

Ground Motion

(JLC site study group : [home page \(access control\)](#))

- Poster presented at [the ITRP meeting \(KEK\)](#) ; [gif, 951KB](#)
- Preliminary results of KEK GM measurements, [talk \(pdf,52.9MB\)](#) presented at the [ISG10](#), June 17-20 2003, by T.Tauchi.
- Measurements; KEK, Konoike-Tsukuba, F-net etc.
 - [Preliminary Results \(PDF, 2.3MB\)](#) presented at [the ISG video meeting](#), 8 May, 2003, by T.Tauchi, K.Fujii, T.Matsuda, H.Yamaoka and N.Uchida.
 - Uchida's master thesis, Tsukuba univ., 2003.2, [Japanese, pdf](#)
- [Measurements at TRISTAN ring, KEK](#)
- GM models
 - [Brief review of GMmodel and talk\(PDF, 2.5MB\)](#)

Fast feedback system: **FEATHER**

The fast feedback again becomes relevant at CLIC.

- Simulation by using CAIN -- evaluation of feedback performance
- Performance with beam blow up for 7 mrad crossing and $L^*=3.5\text{m}$
- Design of the fast feedback system (simple, delayed, improved models, etc.)
- Construction of prototype system (Kicker, BPM etc.) at the ATF extraction line for beam test
- [Schedule, 2004-2007](#)
- Link to [FONT](#)

Nanometer BPM ; collaboration with SLAC, LLNL and UK groups

- Demonstration of nanometer beam position resolution by cavity-type BPM
- [Schedule, 2004-2007](#)
- [Future Plan, December, 2003](#)

also, to be used in energy spectrometer (UK).

Laserwire ; collaboration with UK, DESY and SLAC groups

- Laser Based Beam Diagnostics at the ATF
- Beam profile measurement
- Beam energy distribution measurement at the 2nd IP of the GLC extraction line.

Polarimetry

- Upstream Compton polarimetry; before collisions at sources, DR, LINAC etc.
- Downstream Compton polarimetry after collisions at the dump/extraction line.

[Development of polarized positron beams for JLC](#), T. Hirose (Tokyo Metropolitan), presented at LCWS95

- Physics events; WW scattering
- Depolarization during collisions

ref 1) Depolarization due to beam-beam interaction in electron-positron Linear Colliders, Kaoru Yokoya, Pisin Chen. [SLAC-PUB-4692](#), Sep 1988

ref 2) Spin depolarization due to beam-beam interaction in NLC, Kathleen A. Thompson. [SLAC-PUB-8716](#), Jan 2001.

Luminosity

- Luminosity measurement as a function of the center-of-mass energy
 - Energy spread before collisions and beamstrahlung effects as well as initial state radiation
 - Bhabha scattering; acollinear angle
- Luminosity monitor (forward calorimeter) and active mask: [first study results](#)
- Beamstrahlung monitor: studies of [1](#), [2](#), [3](#)

Plan of MDI mini-workshop

- We would like to discuss on future direction of MDI R&D after the "COLD" decision.
- Under discussion, January 2005, place?
- First (world-wide), we meet at the 1st ILC workshop, 13-15 November 2004, KEK
- Asian discussion at the 7th ACFA-LC workshop, 9-12, November, Taipei.

**Crossing angle, L^* , minimum veto angle
Luminosity, Energy, Polarization measurements
Background evaluation
and
Design of IR & Beam Delivery System**

From Mike Woods, 15 September 2004; Dear MDI advocates,
To further concrete the October phone meeting, let me suggest

1. prior to phone meeting,
 - merge and organize MDI task lists from 3 regions into one common list
 - identify current efforts and people for tasks where known
 - exchange ideas on MDI workshop format and agenda; have a strawman proposal
 - are we agreeing to not have an MDI detector sub-system review at Taiwan ACFA meeting?

We should clarify and communicate this with Bob Hsiung

2. we have a 2-hour phone conference with following start times:

SLAC time (10 pm Wed. Oct. 6)

UK time (6am Thurs. Oct. 7)

Europe time (7am Thurs. Oct. 7)

KEK time (2pm Thurs. Oct. 7)

(is this too soon given proposed agenda below and prior work to be done above? Other conflicts?)

3. Meeting agenda:

- review/comments on task list
- review/comments on resources (people, facilities, budget) to carry out tasks
- prioritization and timeline for R&D (with emphasis on what's needed for CDR)

(above 3 items will be useful input for ILC meeting at KEK in November)

- MDI workshop format and agenda

- discuss/agree on

i) communication to ICFA/ILCSC regarding MDI workshop

ii) date and/or location for MDI workshop

(possibilities include standalone January meeting, connection to LCWS at SLAC in March)

iii) next phone conference