GLC Detector R&D
- Status and Plan -

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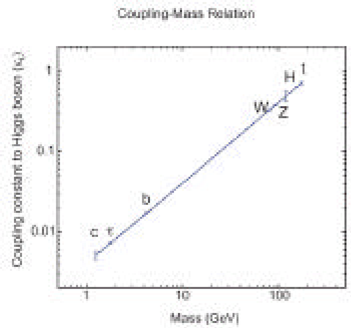
This presentation is prepared according to the request by Takasaki-san based on the LCPAC presentation in Feb. 2004.

Contents

- GLC Physics and Detector concepts
- Vertex
- Tracker
- Calorimeter
- Machine-Detector issues
- International Situation
- Summary

GLC Physics Goals

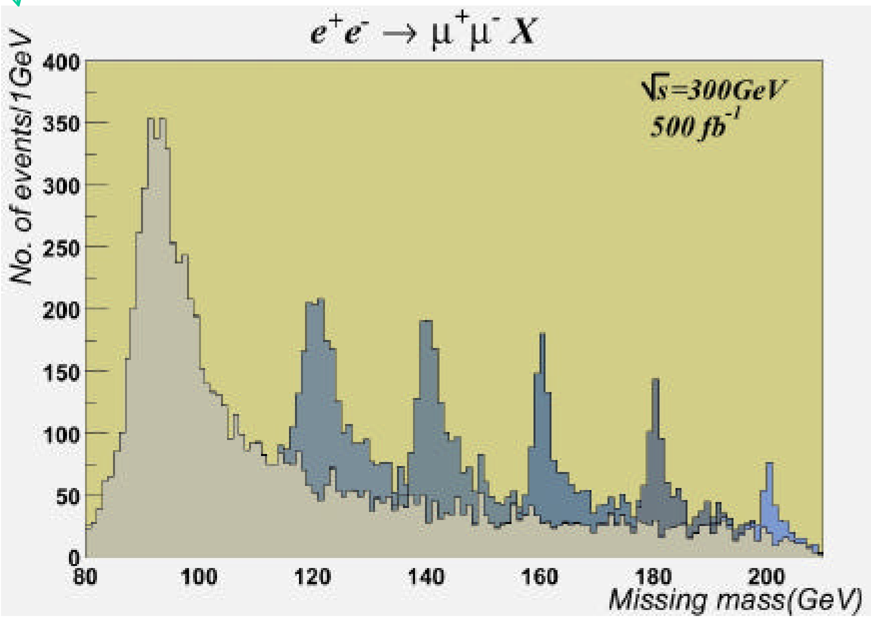
- Search/Study Higgs boson(s)
  - Spin, Mass, Branching ratios
  - Search/study model independently

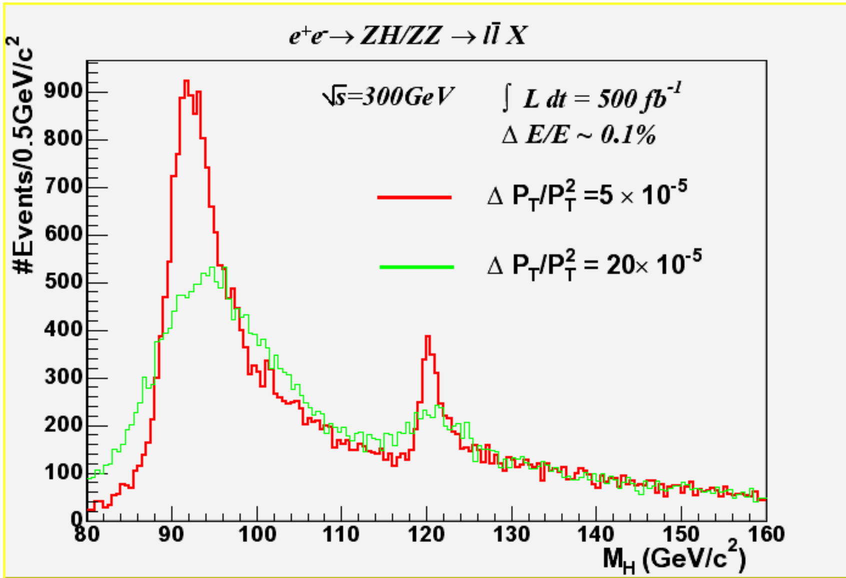


- Resolve the hierarchy problem
  - SUSY: Searches for sparticles, determine mass, spin, couplings.
    - Neutralino is a good candidate of the dark matter
  - Extra-Dimensions: $ee \rightarrow g X$ and search virtual effects in SM processes.
  - Other possibilities: Little Higgs Model,
- Precise determination of
  - Top quark mass and couplings
  - TGV and Quadric gauge boson couplings → key if Higgs is heavy
  - a_S
- Options
  - Giga-Z
  - gg collider

Higgs study in lepton mode

- Higgs mass measurement by Z recoil method
  - Model independent Higgs search
  - Δm_h~50MeV, $\Delta\sigma/\sigma$~3% possible in SM
    - Mh is very sensitive to loop effect in SUSY models: $\Delta m_h^2 \sim G_m m_t^4 \ln(\frac{m_{\tilde{t}_1} m_{\tilde{t}_2}}{m_t^2})$
  - Lesser effects of beam related background
  - Needs excellent tracker performance



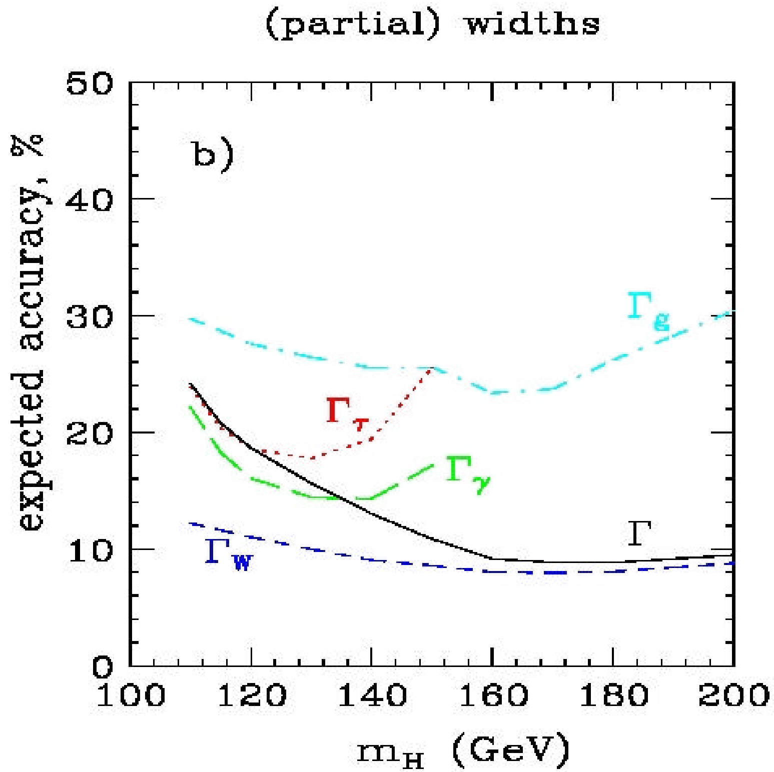


Precision Higgs Physics

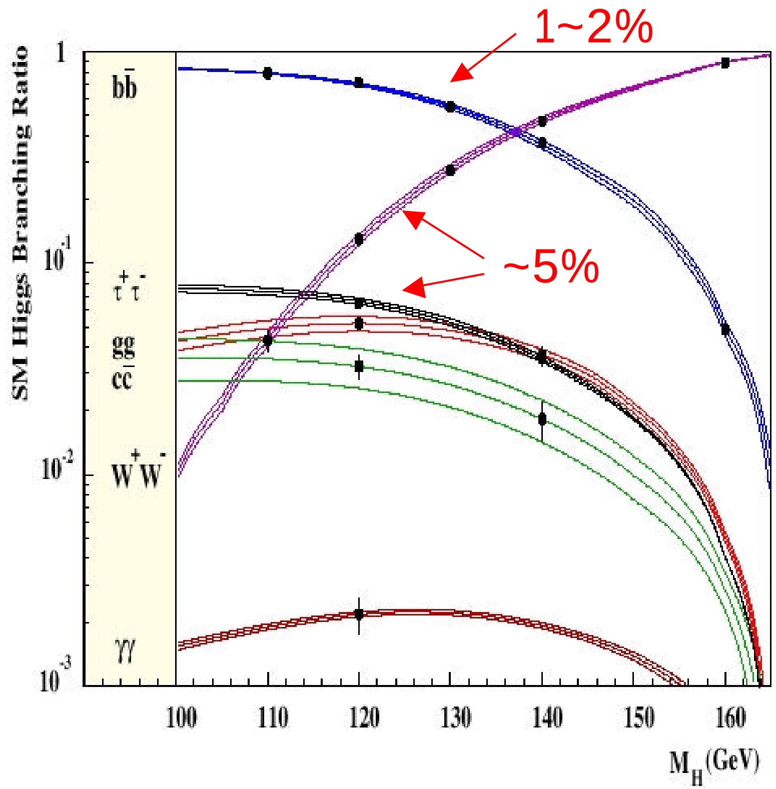
Howard E.Haber
@LCWS2004

A program of precision measurements will begin at the LHC and will reach maturity at the LC.

LHC



LC

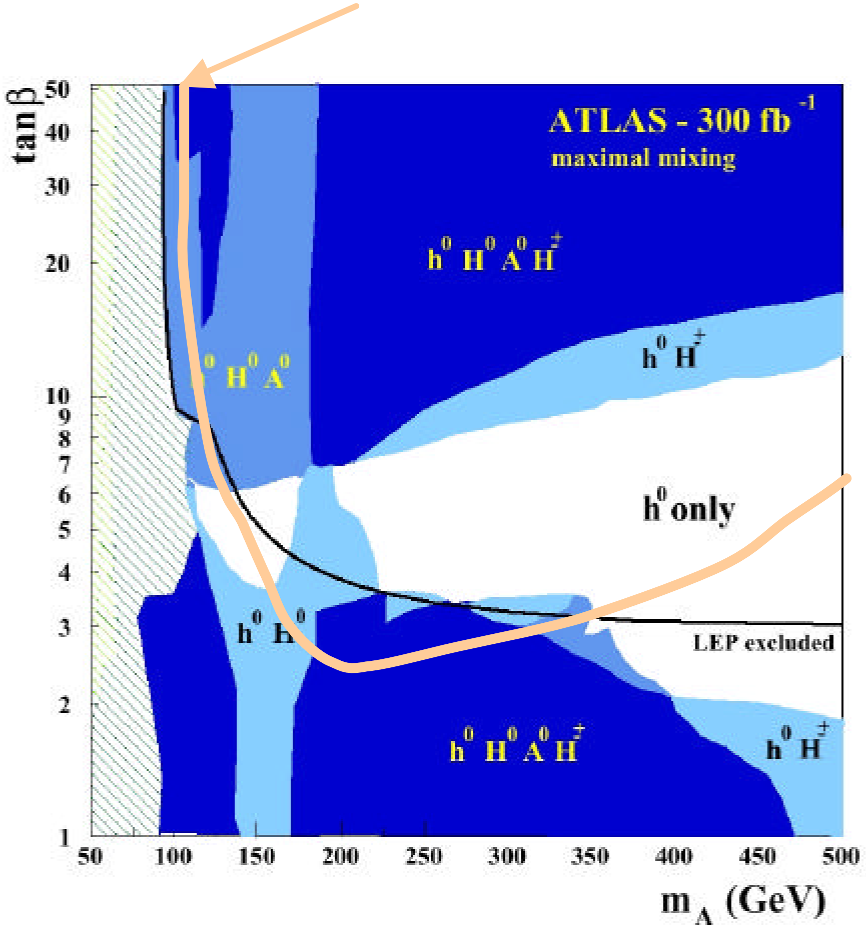


We need an excellent detector system !

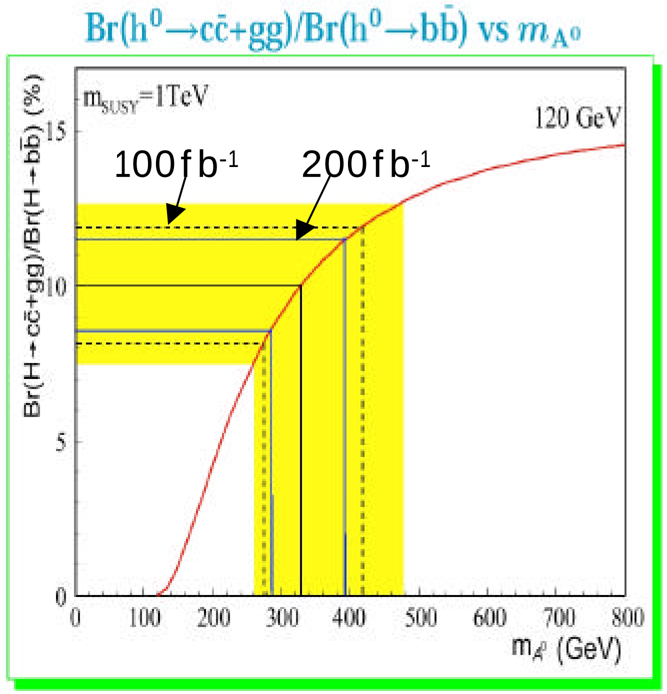
Why precise Br ?

Line corresponds to

$$\Delta(s_{Zh} \times Br(h \rightarrow b\bar{b})) = 6\%$$



Branching ratio in MSSM



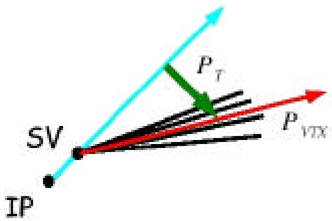
Vertex tagging

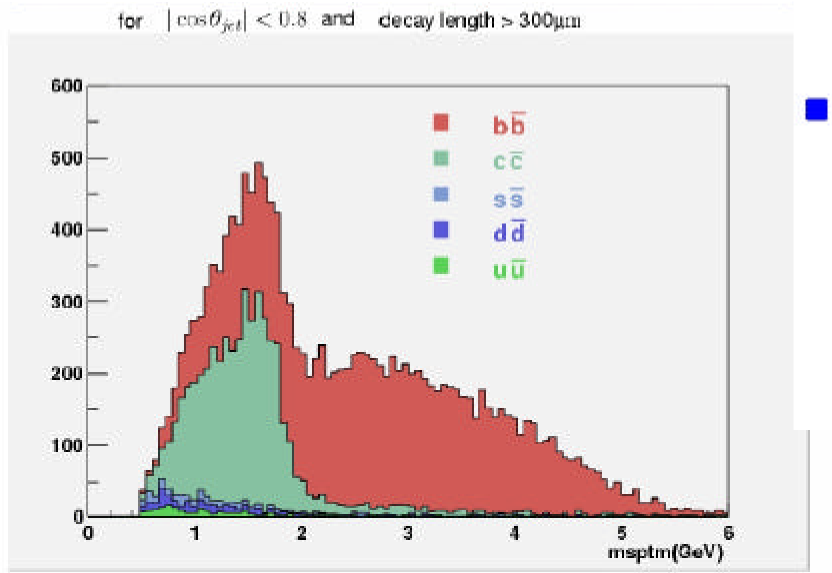
- To achieve high efficient and high purity b/c tagging, good vertex detector is crucial

Mass tagging

Use p_t corrected vertex mass

$$M_{corr} = \sqrt{M_{VTX}^2 + P_T^2} + |P_T|$$





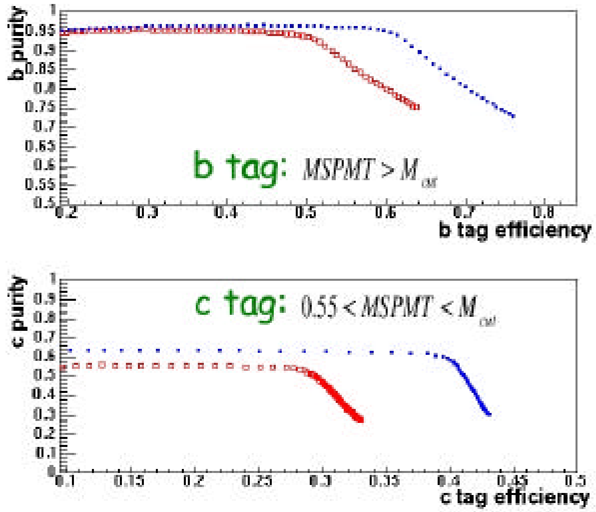
By just changing MSPTM

- 3T, 4 layer VTX (Standard)

  $|\cos\theta_{jet}| < 0.8, d_{length} > 300\,\mu m$

- Additional 5th layer at r=1.2cm
  beam pipe r=1.0cm
  VTX Thickness: 0.3%→0.12%R.L.

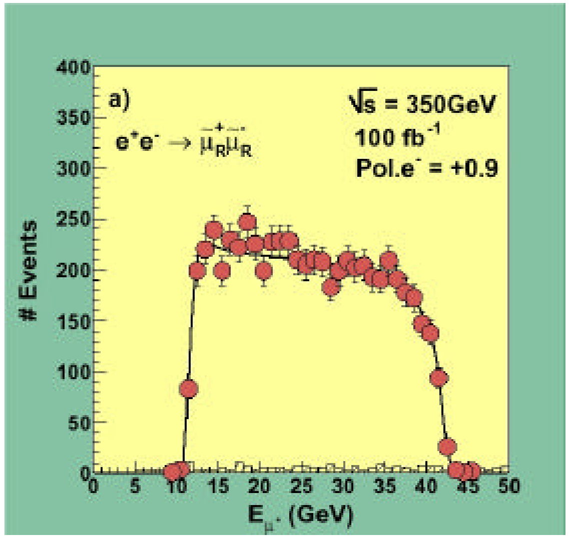
  $|\cos\theta_{jet}| < 0.8, d_{length} > 150\,\mu m$

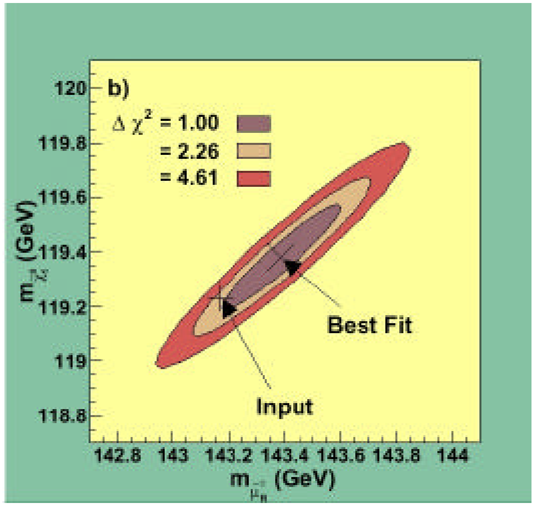


SUSY study

- Determination of sparticle mass from end points of energy distribution

$$e^+e^- \to \tilde{m}_R^+\tilde{m}_R^- \to m^+m^-\tilde{c}_1^0\tilde{c}_1^0$$





$$\frac{\Delta m_{\tilde{m}_R}}{m_{\tilde{m}_R}} \sim \frac{E_{\max} - E_{\min}}{2(E_{\max} + E_{\min})} \cdot \frac{\Delta p}{p}$$

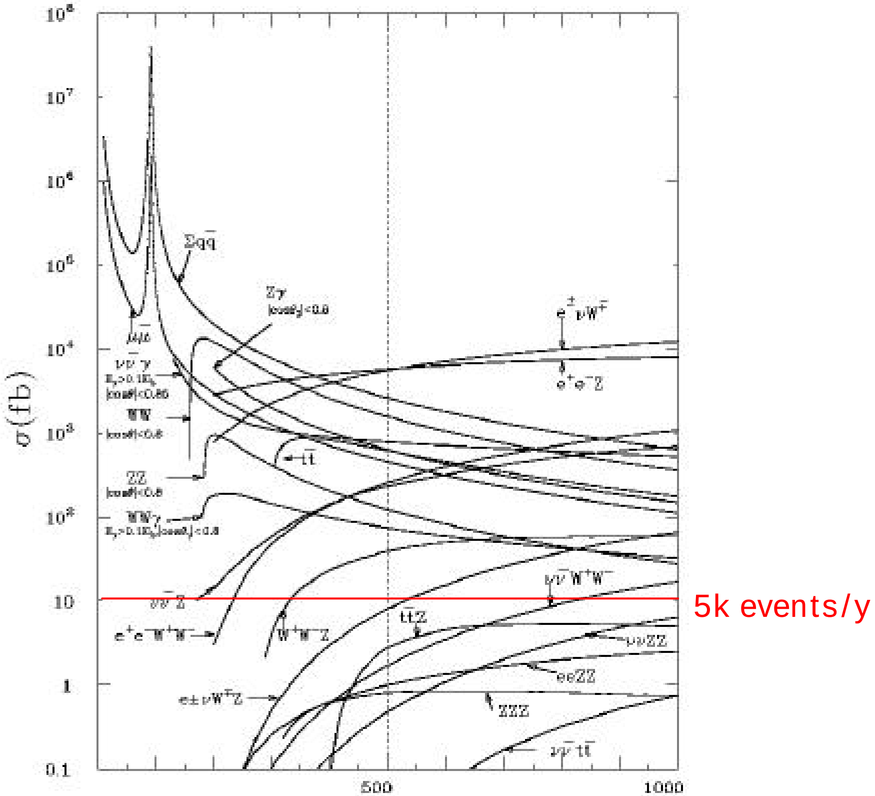
$\frac{\Delta p}{p} \leq 10^{-4}\, p(GeV)$ is required

to get $\frac{\Delta m_{\tilde{m}_R}}{m_{\tilde{m}_R}} \leq 10^{-3}$ in $100\, fb^{-1}$

Jet reconstruction

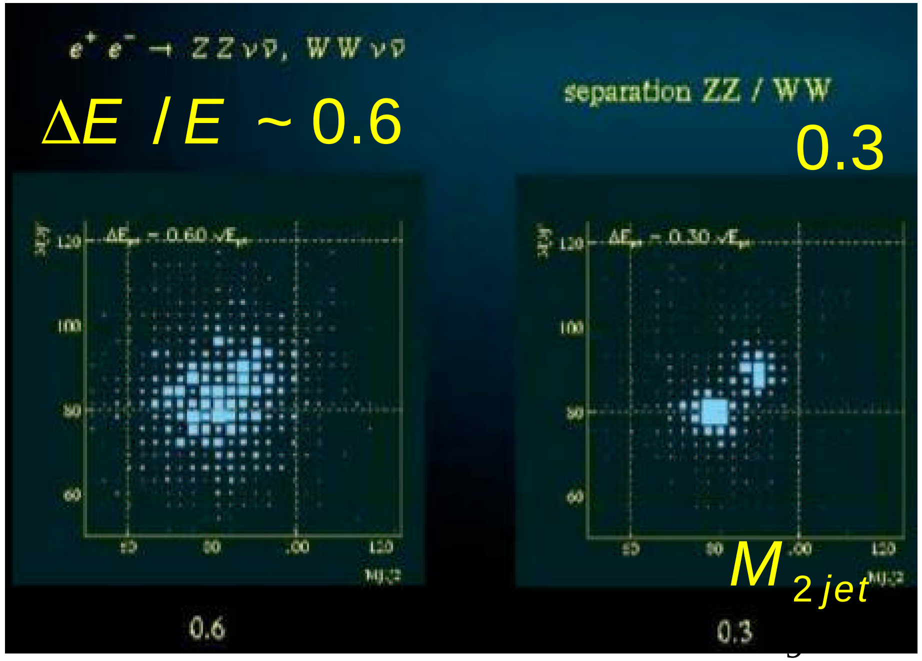
- Precise jet mass reconstruction is crucial for
  - Mass determination of Higgs and new particles
  - W/Z are copiously produced at GLC. For high efficient reconstruction, good energy resolution is crucial.

Cross sections

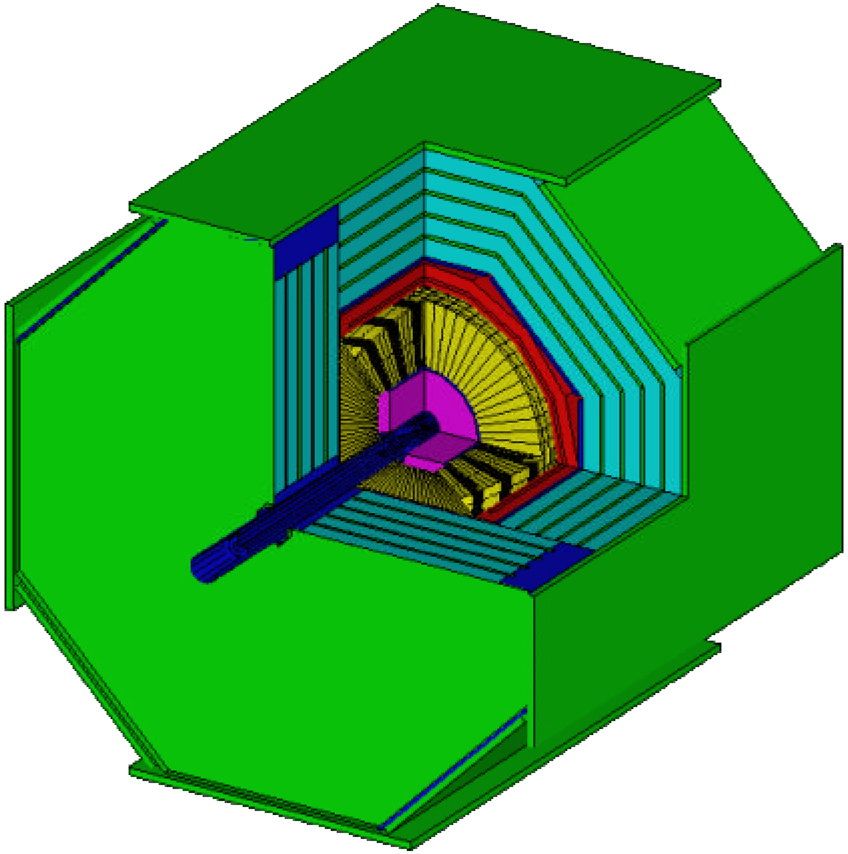


$e^+e^- \to n\bar{n}WW$ and $n\bar{n}ZZ$

Study H to VV coupling at H.E.



GLC Detector Concepts



ACFA report,
KEK Report 2001-11

- Detector requirements
  - Efficient & High purity b/c tagging
  - Momentum resolution:
    $$\Delta p_T / p_T \leq 5\times10^{-5}\, p_T$$
    For Higgs detection regardless of its decay mode.
  - Calorimeter: $\Delta E_{jet} / E_{jet} \leq 30\% / \sqrt{E_{jet}}$
    For W and Z separation in hadronic decay mode.
  - Hermeticity: $q_{veto} \leq a\ few\ 10 mrad$
    For indirect measurements of invisible particles
  - Good background masking and time stamping capability

Detector parameter

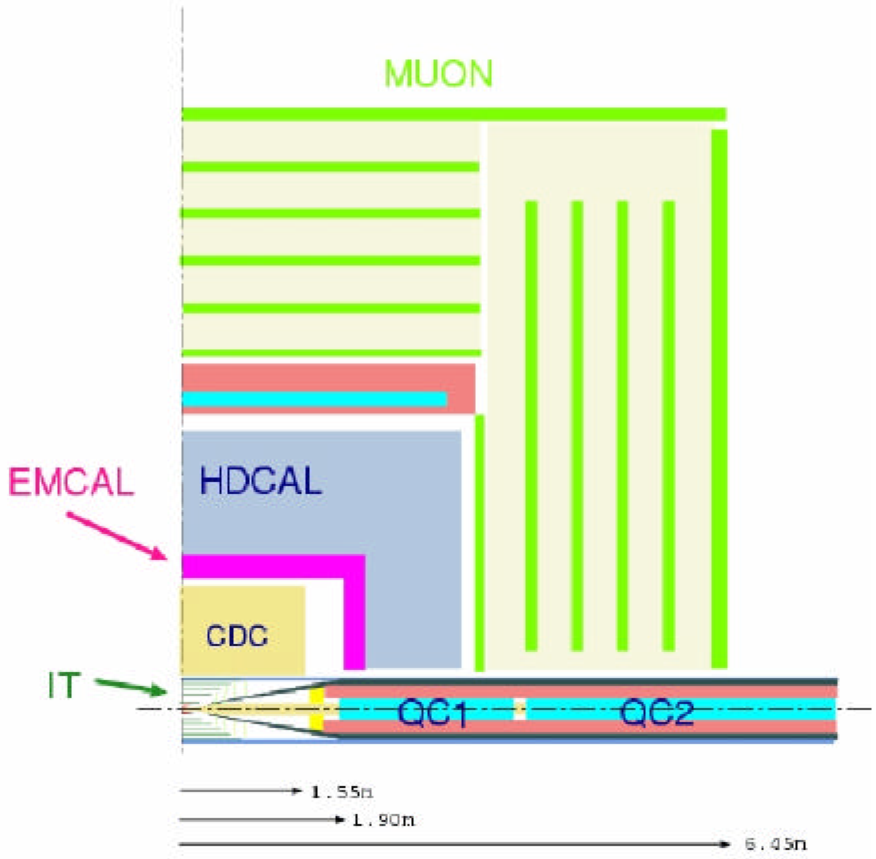
Detector size 8m(φ)x7.1m(z)
Magnet 3 tesla
Muon Number of superlayers : 6
Calorimeter Lead/Scint., compensated

EM Cal: Thickness : 27.1X_0
Segmentation : 4x4 (cm^2)
Radius(barrel) : 1.6 ~ 1.86m
$\sigma_E/E(\%) = 15\%/\sqrt{E} \oplus 1\%$

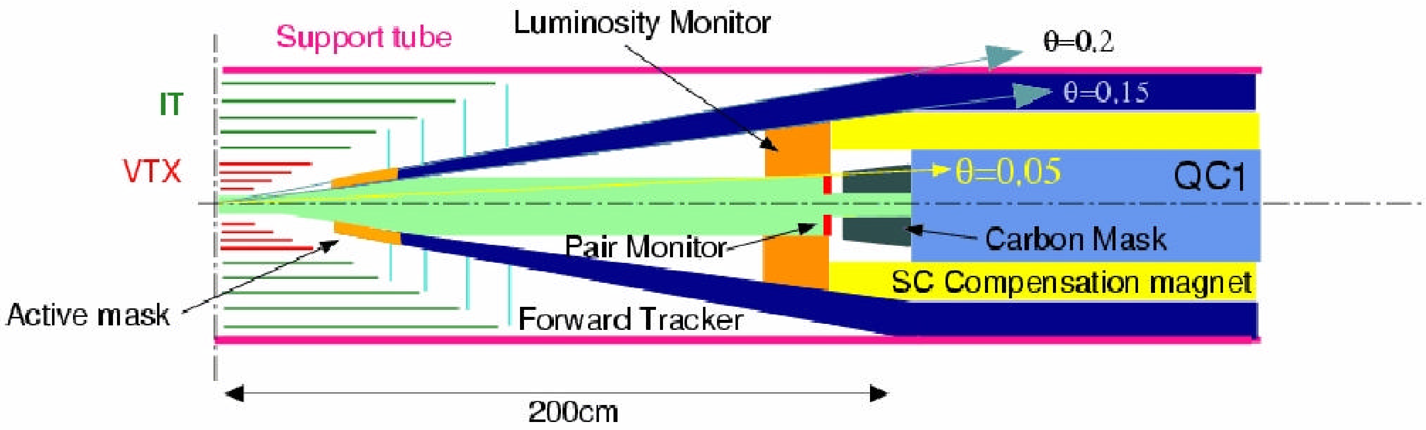
HD Cal: Thickness : 6.5λ
Segmentation : 12x12 (cm^2)
Radius(barrel) : 1.86 ~ 3.4 m
$\sigma_E/E(\%) = 40\%/\sqrt{E} \oplus 2\%$

Central Drift Chamber(CDC)
Small cell jet chamber
Number of sampling : 50
Position: r=0.45 to 1.55m, |Z|<1.55m
Position Resolution: $\sigma_{r\varphi} = 100\mu m(\text{axial})$
$\sigma_z = 1mm(\text{stereo})$
Momentum Resolution:

$$\sigma_{p_t}/p_t = 3\times 10^{-4} p_t \oplus 1\times 10^{-3}$$
$$\sigma p_t/p_t = 0.9\times 10^{-4} p_t \oplus 1\times 10^{-3}(\text{w.vtx})$$



Detector Parameter - 2



Intermediate Tracker(IT): Silicon strip/pixel

Geometry: 5 layers, r=9cm to 37cm, |cosθ|<0.9

Position resolution: σ = 40μm

Vertex Detector (VTX) : CCD

Position: 4 layers, r=2.4cm to 6cm, |cosθ|<0.9

Position resolution: σ = 4μm

Impact parameter resolution:

$$\delta = 3 \oplus 24/p^{3/2} sin^{3/2}\theta (\mu m)$$

Forward Tracker(FT) : Silicon pixel/strip

4 layers silicon

Coverage: 0.90 < |cosθ|<0.98

Pair monitor

Silicon 3D detector to monitor beam property

Luminosity monitor

W + Si pad, $42.9X_0$

Coverage: 0.05 < θ <0.15(radian)

Segmentaion: radial 32, azimuthal 16

Active mask

8 layers of W + Si pad

Coverage: 0.15<θ<0.20(radian)

Segmentaion: radial 8-10, azimuthal 32

Vertex detector R&D
Work Plan in 2004

2004/5/7

Y. Sugimoto

KEK-東北大-東北学院大-新潟大-富山商船工専 共同研究

Vertex Detectorに対する要請

- b-, c-, τ-, g-jetの同定
- Primary, secondary, tertiary vertexの分離
- Jet chargeの同定
- Decay productsの運動量 ~ 1 – 2 GeV/c にピーク
- 1~3 hits/train/mm^2 のbeam induced background

➔

- ピクセルタイプ
- なるべく薄く、なるべく衝突点に近く
- σ_b << Impact parameter of decay products of c-, τ-jets ~ 100μm

目標値： $s_{\mathbf{b}}$ **= 5** Å **<u>10</u>/(p**b**sin$^{3/2}$**q**)** m**m**

SLD: $\sigma_b = 7.8 \oplus \underline{33}/(p\beta \sin^{3/2}\theta)$ μm

Belle: $\sigma_b = 18.6 \oplus \underline{51.3}/(p\beta \sin^{3/2}\theta)$ μm

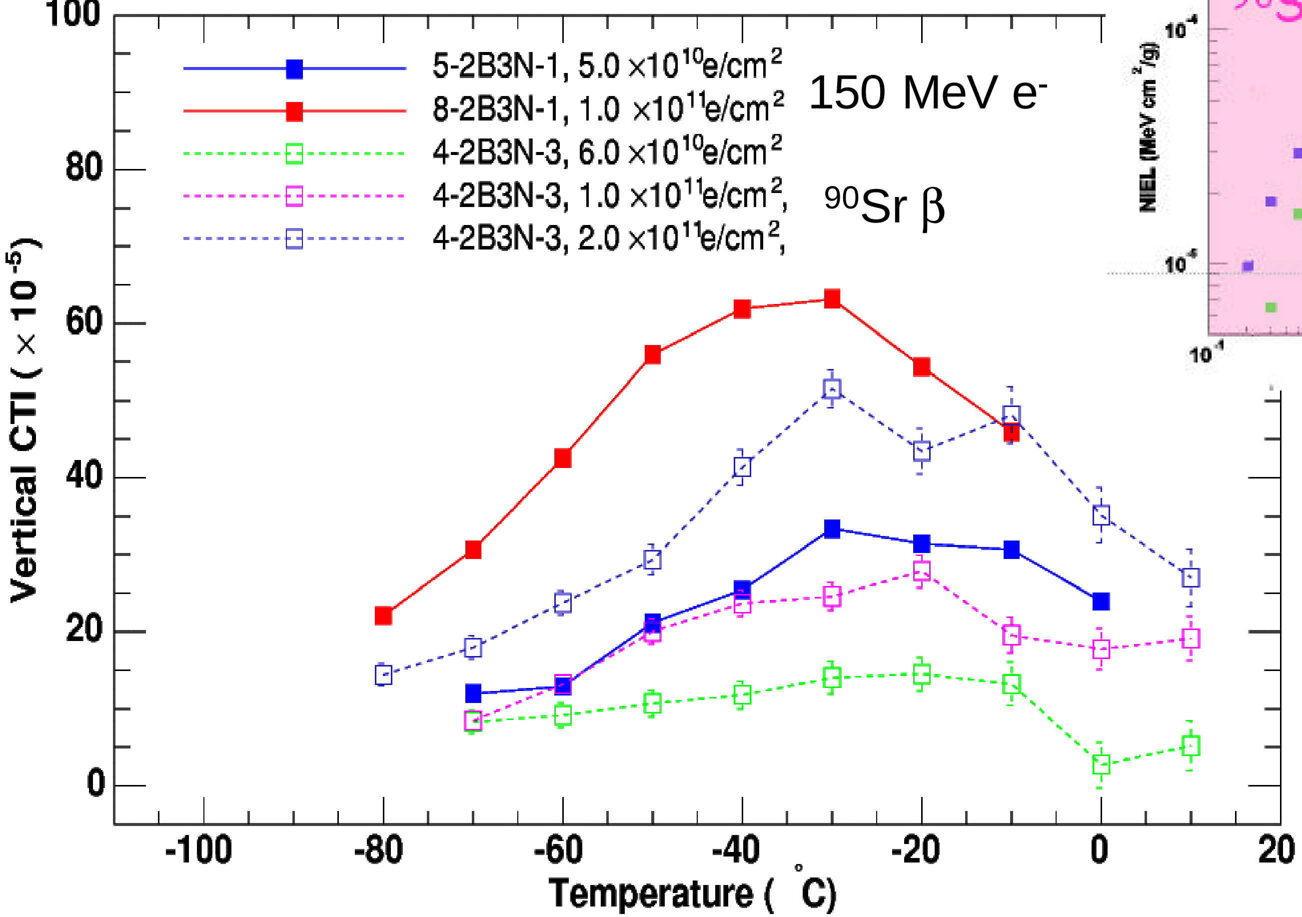
ATLAS: $\sigma_b = 11.7 \oplus \underline{106.8}/(p\beta \sin^{3/2}\theta)$ μm

- Fast readout : 1Frame/16msec(GLC), almost impossible for Tesla
  - Fast clock(~10MHz) + Multi-port readout
  - At SLD, 1Frame/200msec using 5MHz clock
- 放射線耐性：
  - > 10^{11}e/cm^2/y (~3krad/y), > 10^9n/cm^2/y

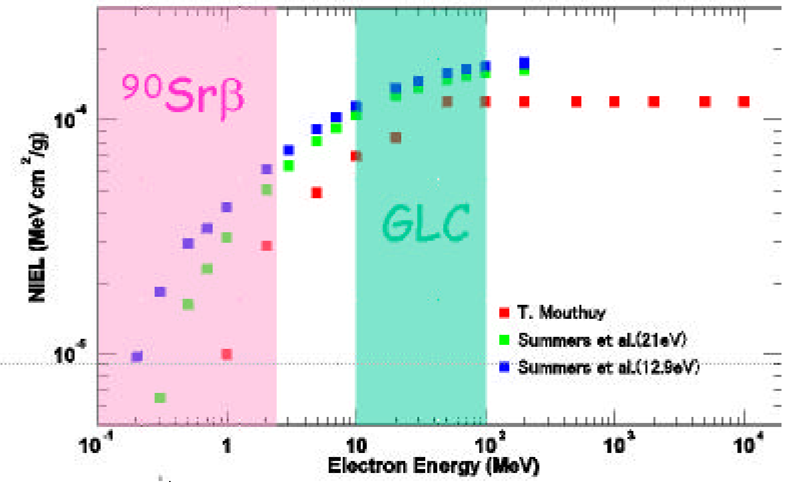
Vertex R&D achievements

- Showed that
  - S/N > 10 @ Temp. ~ 0^{o}C
  - Intrinsic spatial resolution < 3 μm
  - Radiation hardness:
    - HPK CCD can operatable up to ~10^{12}e/cm^2 and ~10^{9}n/cm^2
    - Harder structure: notch, clocking speed, etc has been studied
- Studied in 2003
  - Study of radiation hardness by 150 MeV e
  - Fat zero charge to recover Charge Transfer Inefficiency

CTI by ^{90}Sr β and 150MeV e^- Beam



NIEL models

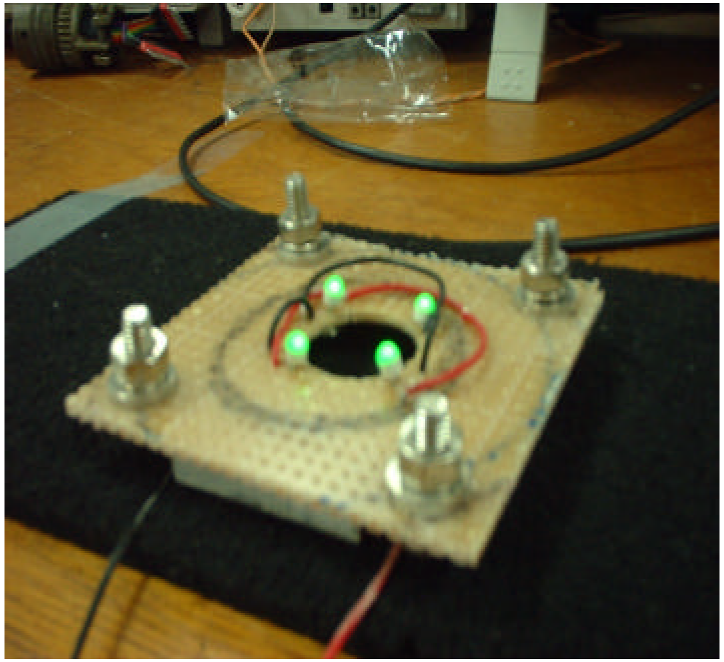


Ee(MeV)

CTI by H.E.e^-
is 2~3 times smaller
than model expectations

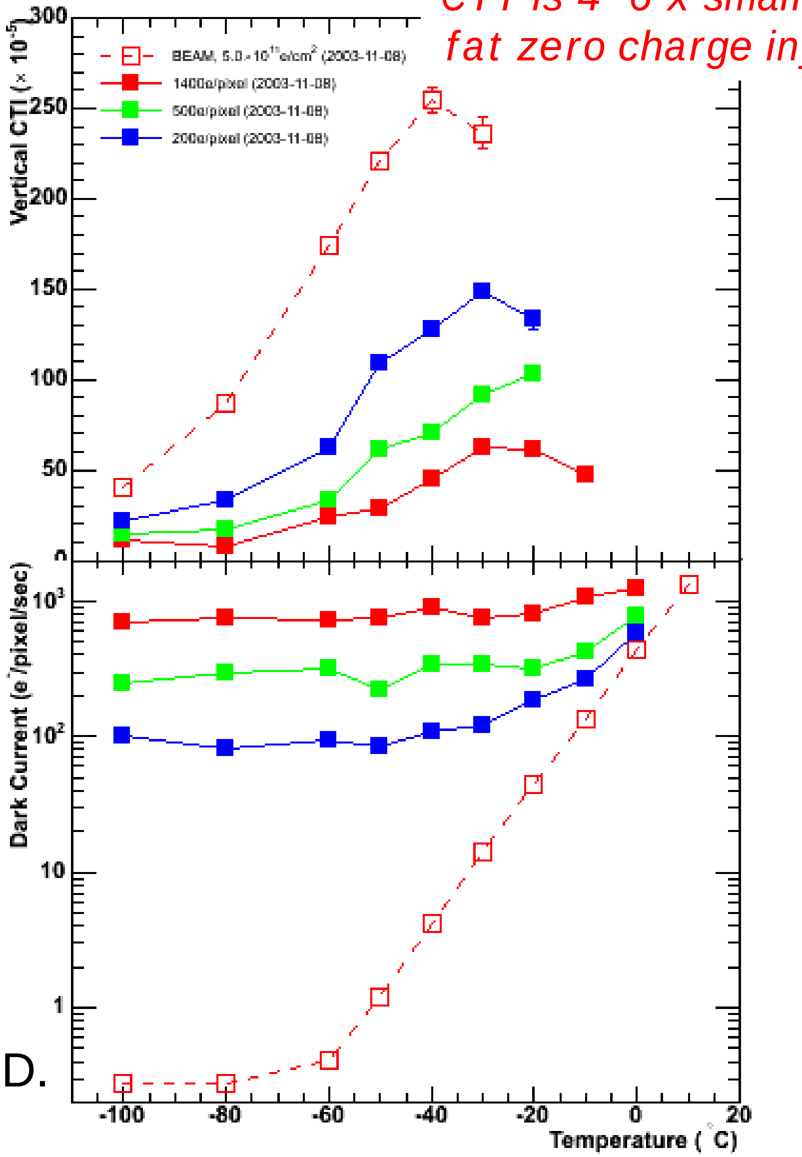
Fat-zero Charge Injection

CCDs: High energy electron irradiated sample ($5x10^{11}e/cm^2$).



LED light makes sacrificial charge in CCD.

CTI is 4~6 x smaller by fat zero charge injection

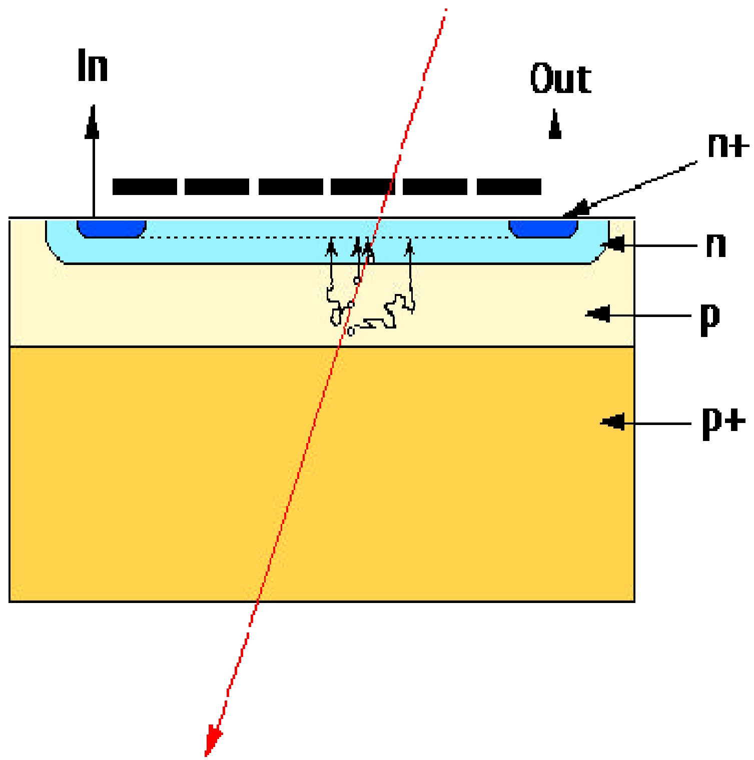


Study of charge spread in CCD

- Diffusion of electrons in epitaxial layer
  - Key of excellent spatial resolution for CCD (and CMOS)
  - Takes time to diffuse :

    How long do we have to wait for the charge collection ?

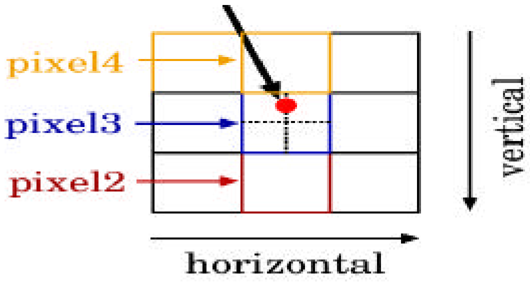
    ➔ Measurement with IR LASER pulse at Niigata Univ.



Measurement of charge diffusion

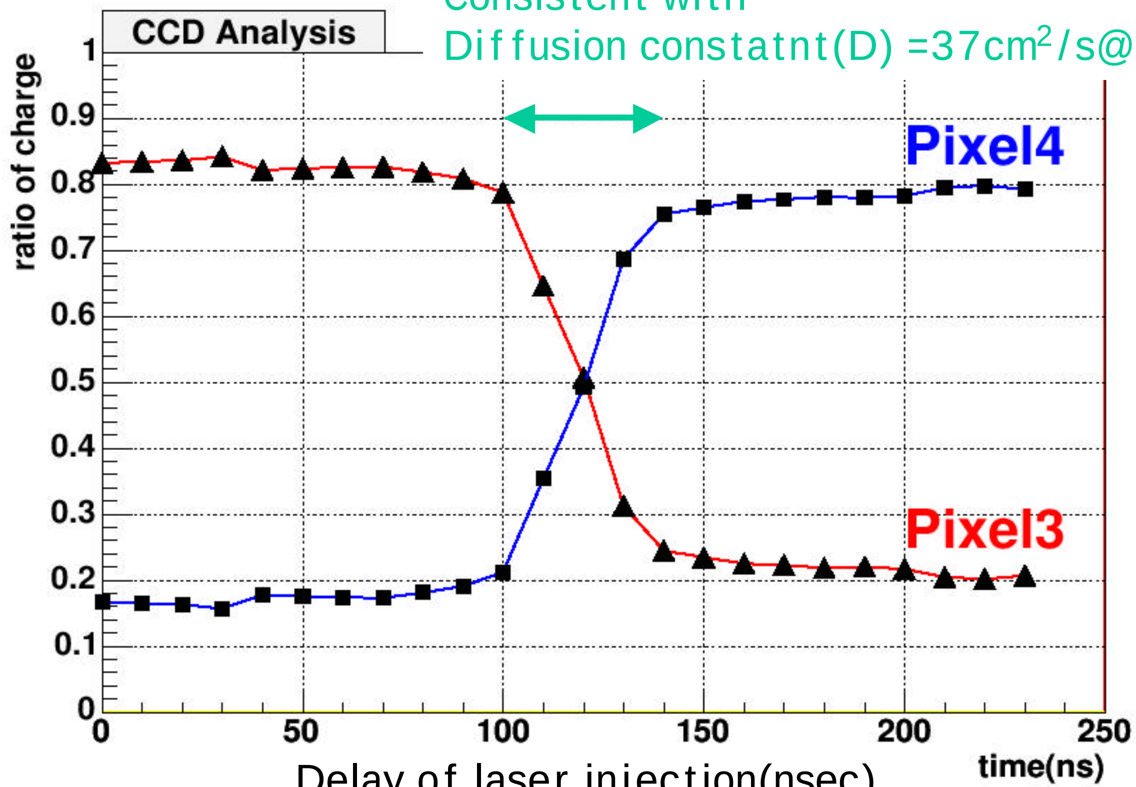
- The timing of laser injection was delayed and measured the time required to get full charge

Laser injection
(λ=1064nm)



CCD
10μm epi-layer

Consistent with
Diffusion constatnt(D) =37cm^2/s@300K



Delay of laser injection(nsec)

Implication to readout timing

- The measured data is consistent with the expectation for the diffusion length of

  $d = sqrt(Dt) \sim 20\mu m$ @ $t=100ns$

- For the sensors with 20µm epi-layer, we should wait for the diffusion at least 100ns
- Readout speed requirement for the vertex detector at cold machine is even more severe

  50 MHz (original requirement) ➔

  $50x337ns/(337ns-100ns) = 70MHz$

- Vertex detector at cold machine is very challenging

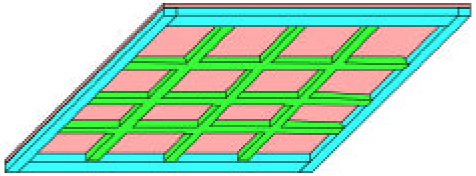
中期計画

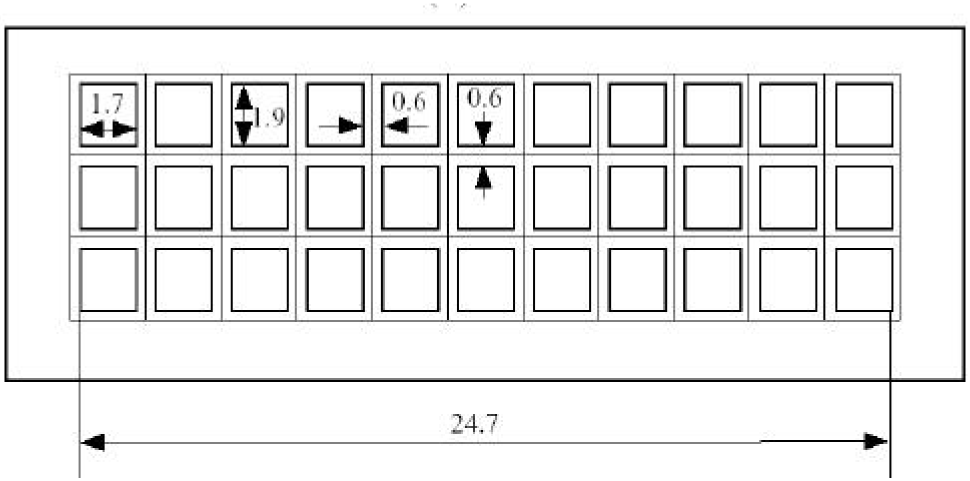
- マイルストーン:
  - Impact parameter resolution $\sigma_b=5 \oplus 10/(p\beta\sin^{3/2}\theta)\ \mu m$ が達成できるプロトタイプセンサー／ラダーの製作
  - 上記達成のため、以下のスタディが必要となる；
    - 多重散乱を最小限にするためのCCD ウェファーの薄型化。薄いウェファーの支持機構の開発も同時に必要。
    - 検出器を衝突点にできるだけ近づけるための放射線耐性。
    - LCでの実験に要求される読み出し速度に対応できる、Multi-port readout CCD の開発。これは放射線耐性の改善にも寄与する。
    - Multi-port CCDのための読み出しASICの開発
  - 3年計画
    - 2004 :基礎研究
    - 2005 :プロトタイプの詳細設計、発注
    - 2006 :プロトタイプのテスト

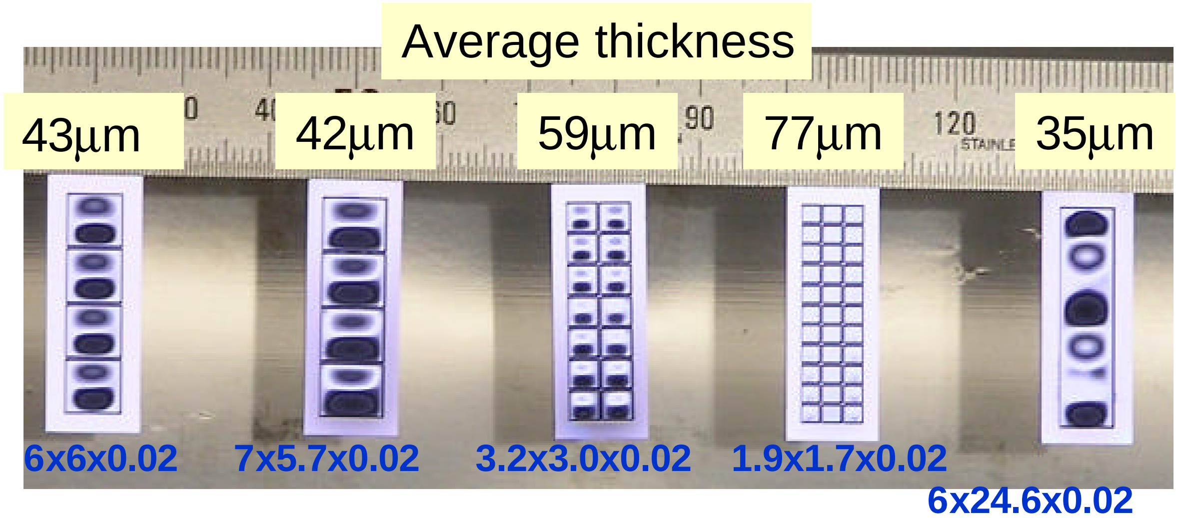
Multi-port readout

薄型CCD

Concept







2004年度R&D項目

- 薄型ウェファー(1)
  - 機械的強度
  - 電気的特性　(暗電流、速度)
  - 物理への影響 :シミュレーション (Efficiency, Purity, Jet charge, etc)
- 放射線耐性
  - CTI, DCP, Hot Pix : Clock (F, tw, Amplitude) 依存性
    - ➔新たな driver board, Timing generator (FPGA)等が必要
  - Spatial Resolution vs. Radiation Damage (LASERによる研究)
  - 薄型CCDの放射線耐性
    - ➔ Beam照射? あるいは ^{90}Sr 照射で十分か?
  - Background Simulation (特に2-photon b.g. w/o Pt cut)
  - (Readout ASIC: Conceptual design)
- (Multi-port CCD: Conceptual design)
- (TESLAの場合の代替案の検討)

(下線の部分について、予算を要求します。 (1) は納品済み)

Tracker

Tracker

- Collaboration
  - Hiroshima, KEK, Kinki, Kogakuin, Saga, TUAT, Tsukuba, MSU

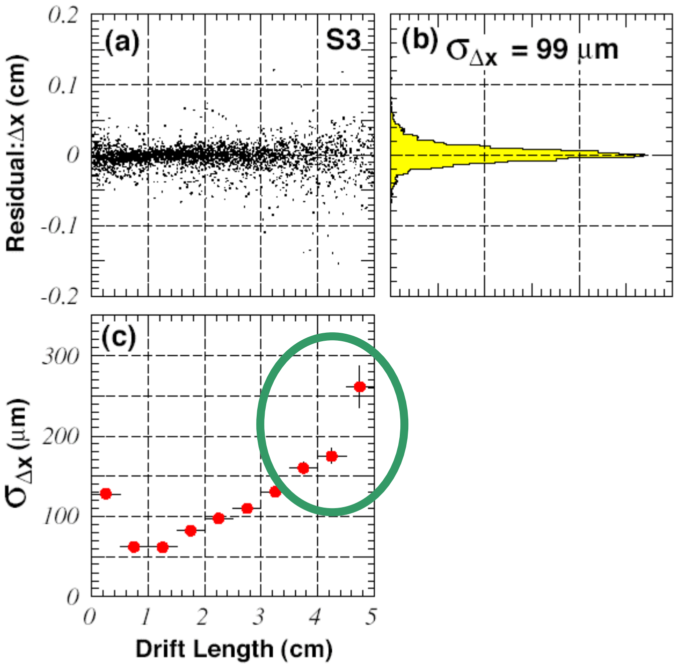
- First choice was Small Cell Drift Chamber,
  - Compare to Silicon based tracker,
    - Thinner material and redundancy due to many sampling
  - Compare to TPC with MWPC readout
    - Enough spatial resolution to achieve resolution goal

$$\Delta p_T / p_T^2 \leq 1\times10^{-4} (CDC\,only)$$

    - Standalone T0 determination

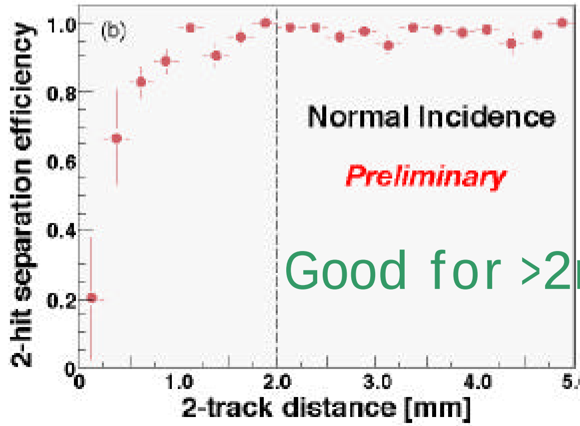
Selected results of CDC R&D

■ 4.6m-long chamber: Spatial resolution



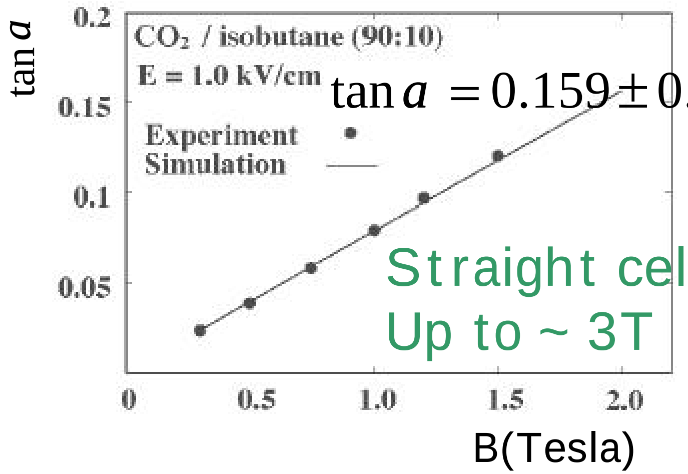
Degradation due to O_2 contamination.
Without O_2, ~90mm

■ Two-track efficiency



Good for >2mm

■ B dependence of Lorentz angle



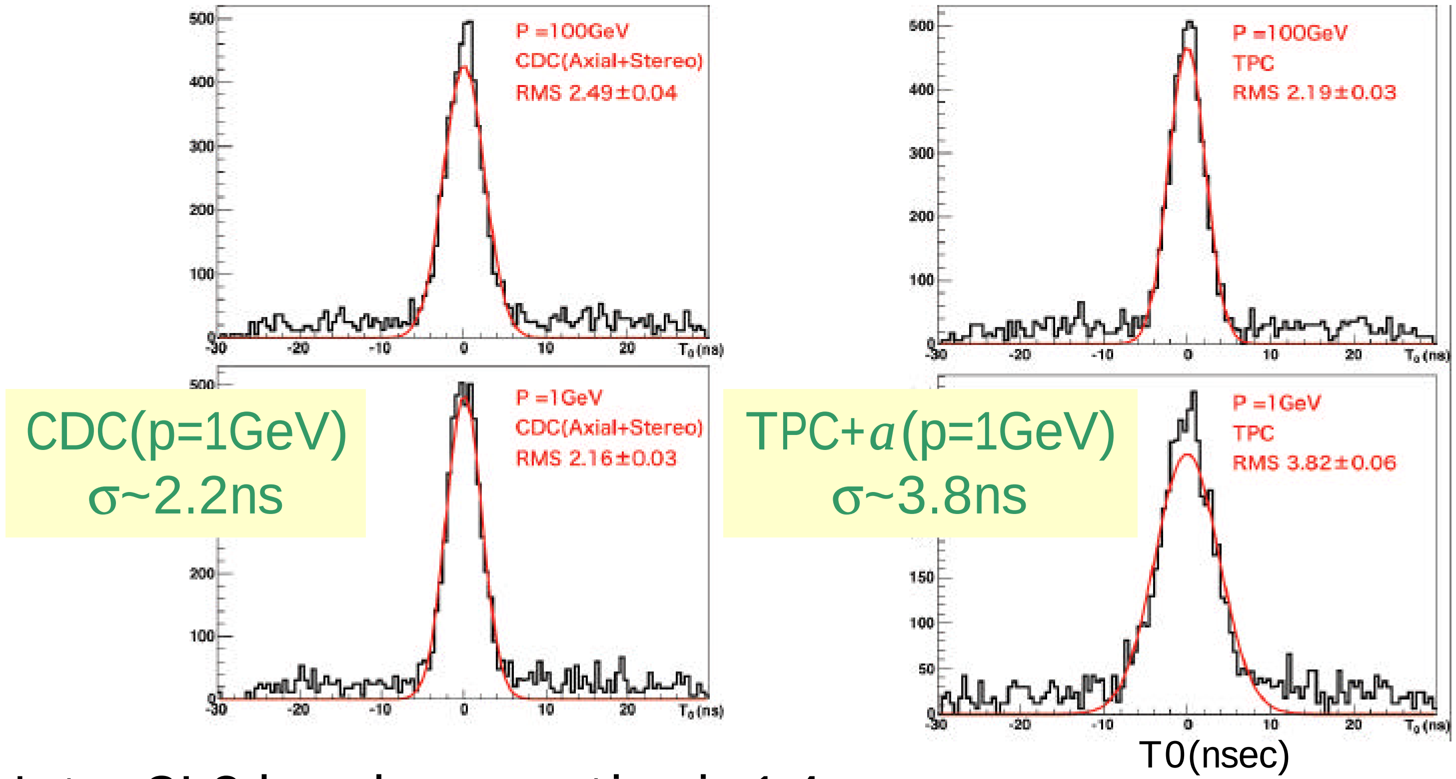
$\tan a = 0.159 \pm 0.002$

Straight cell is OK
Up to ~ 3T

Time stamping capability

- CDC: self t0 reconstruction by staggered cell
- TPC: by Z coordinate matching with an external device

  - Simulation of T0 reconstruction:
    Signal on random background



Note: GLC bunch separation is 1.4nsec

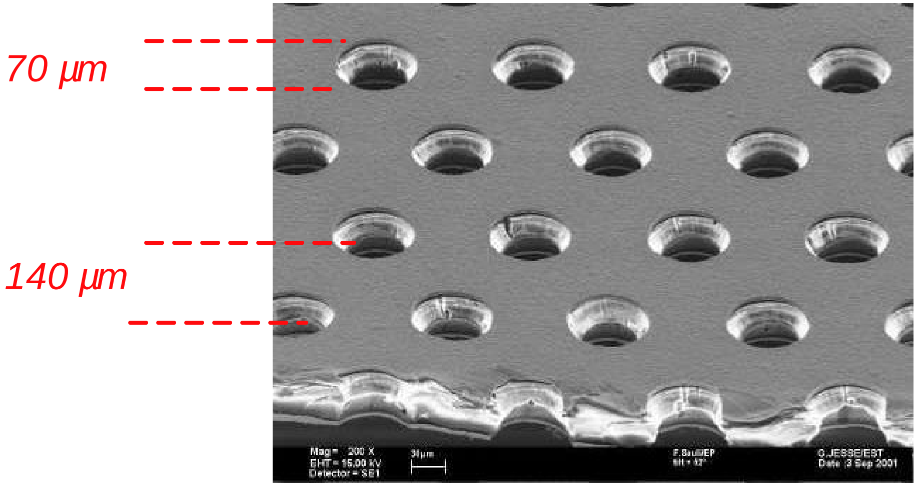
New direction of Tracker R&D

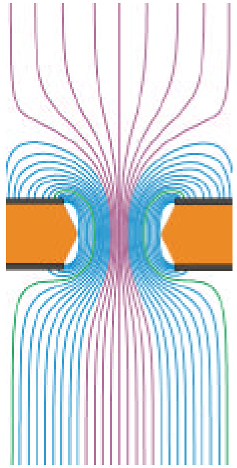
- Tracker group considers initial R&D goals has been achieved.

- Instead of go in to the next step of engineering studies, tracker group thinks it important to seek for other possibilities:
  TPC with Micro Pattern Gas Detector readout

Micro Pattern Gas Detector

- Example: GEM





Electrons are amplified by a strong field at holes

- Why MPGD TPC ?
  - Spatial resolution and 2-hit separation similar to CDC
  - Less sector boundary than MWPC-TPC
  - Less end-plate material
  - Can operate with B>3T
  - TPC can be used in “cold machine”

Plan of TPC R&D

- R&D goals — start in 2004
  - Develop large area a Micro Pattern device
  - Operate in B-field and confirm performance
  - Develop high density, low mass readout

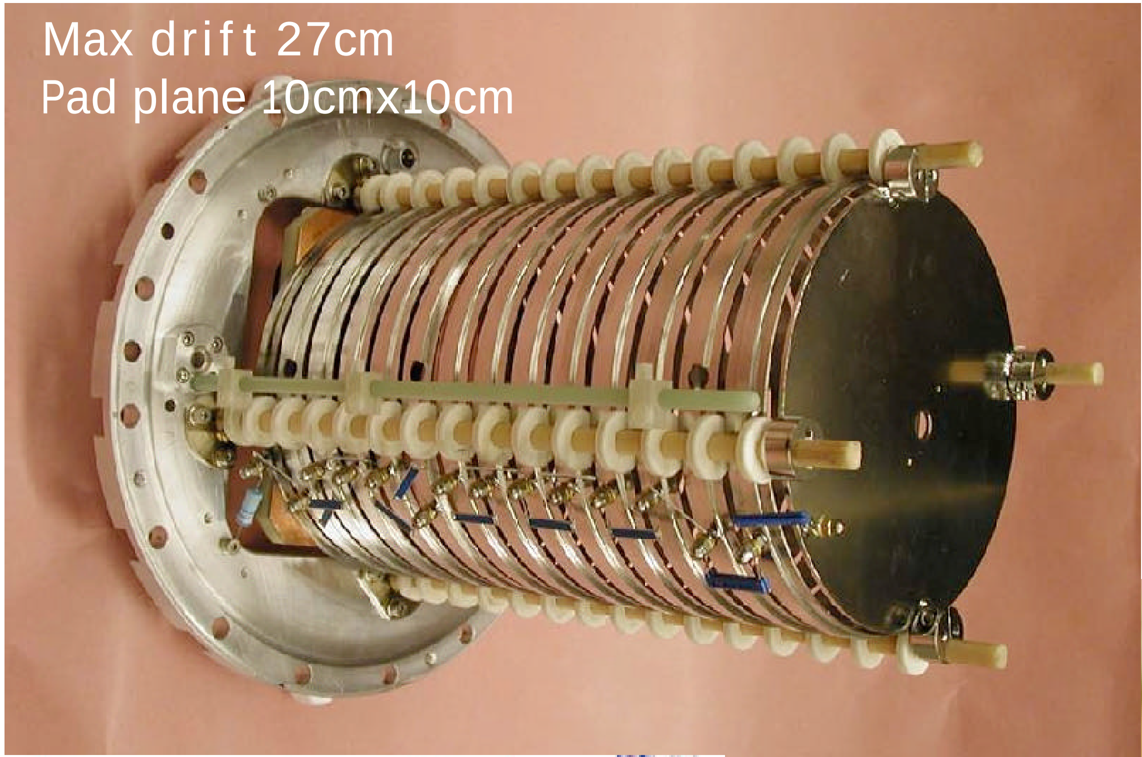
- Collaboration for TPC R&D
  - CDC collaboration + Tokyo + ...
  - Internationally, work together with Munich, Orsey, LBL, ...

TPC R&D plan in 2004

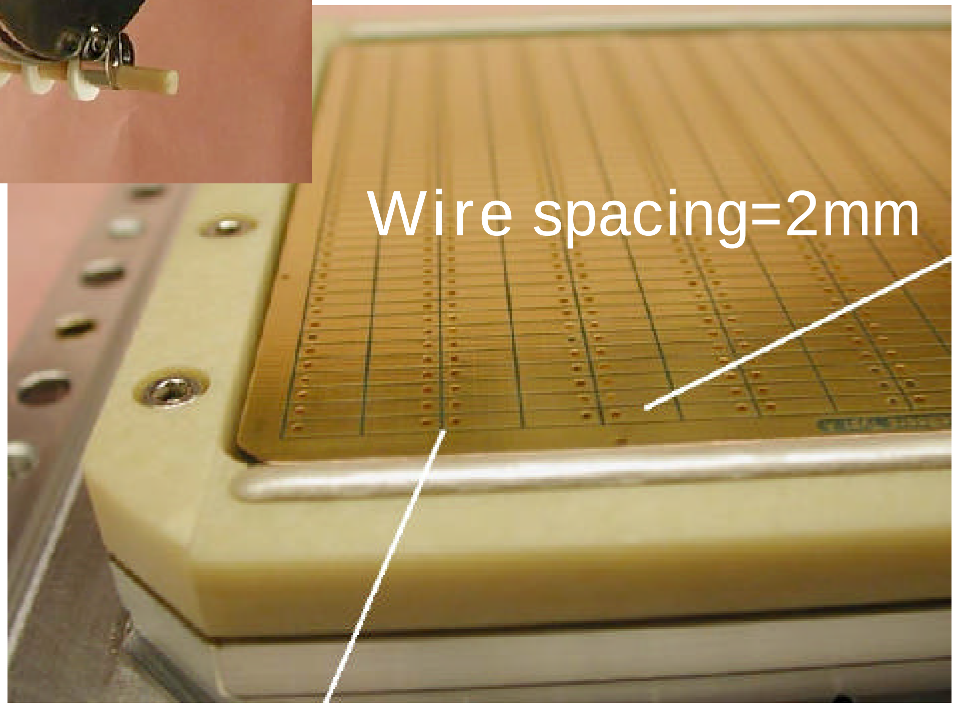
- Beam test(June): First test of MPGD-TPC in magnetic field
  - Purpose - Compare basic chamber performance, such as spatial resolution, ion feedback, etc, for MWPC and GEM readout
  - Collaboration: GLC CDC+X, MPI/DESY, IPN Orsay
  - Budget: by IPNS budget

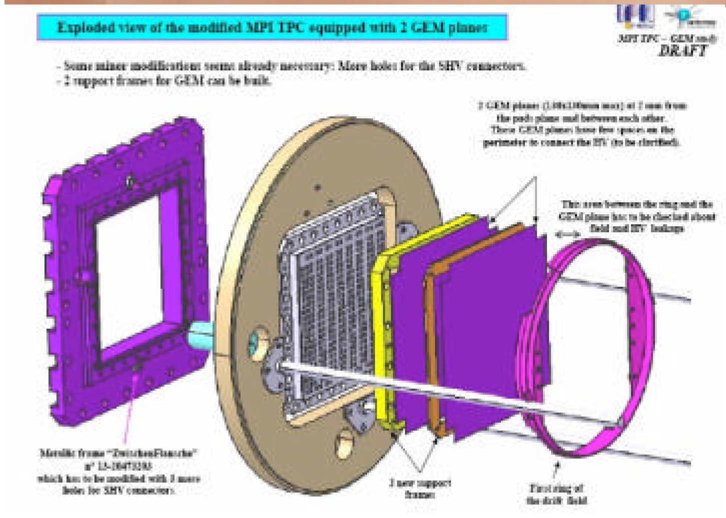
- Build MPGD test chamber and optimize GEM structure
  - 機構追加配分に要求
  - 要求の内容は主に
    - GEM フォイルなどの試作
    - テスト用チェンバーシステムの作成

MPI TPC field cage



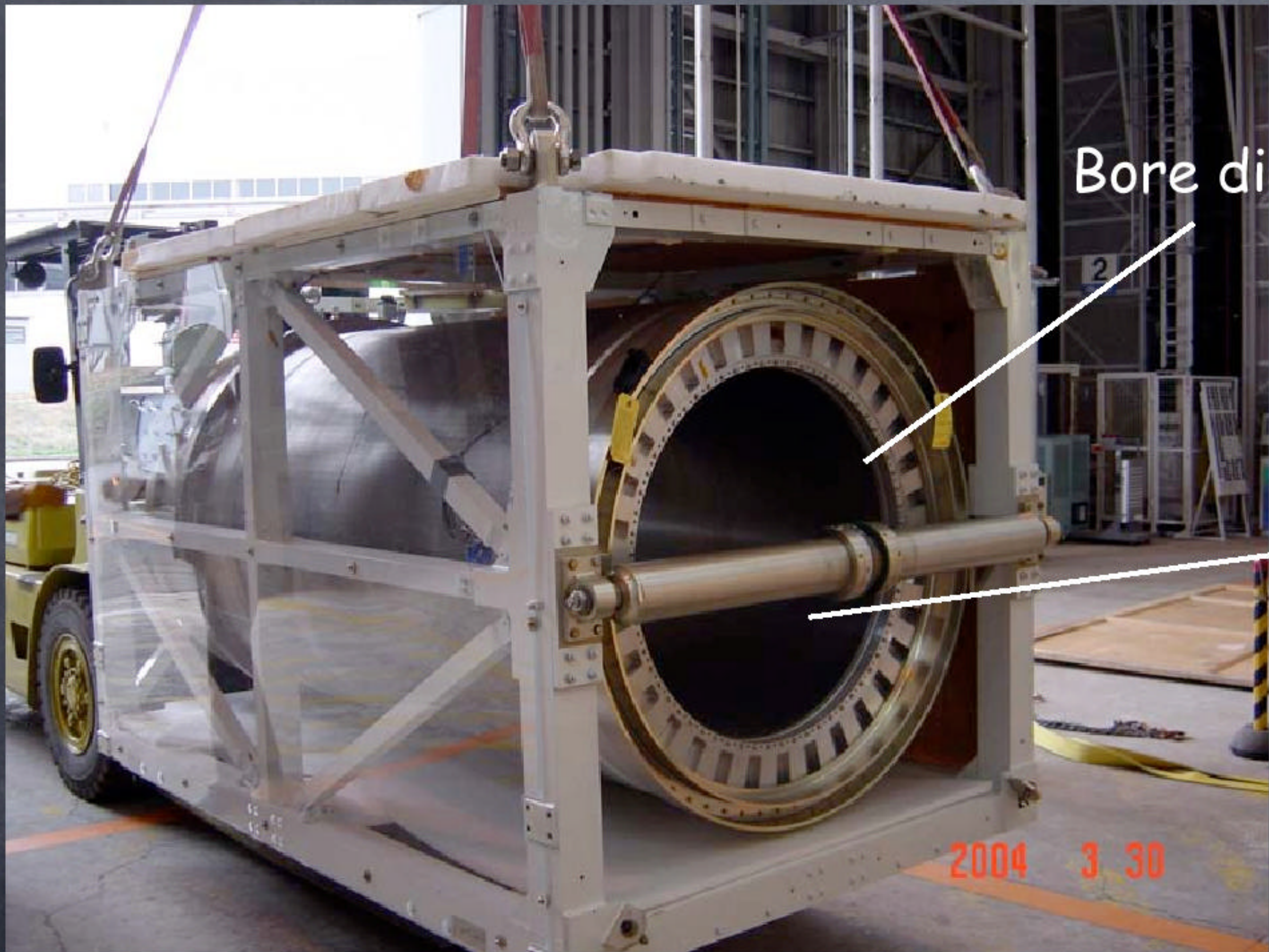
12 rows of 64 2mmx6mm pads





For GEM test

Magnet (JACEE)



Bore diameter: about 80cm
Length: about 1m

B up to 1.2 T

Field Uniformity
< 1.3% in R
< 0.4% in Z
in the TPC region

Now being checked out for cooling and excitation with great helps from the KEK cryogenic group !

Calorimeter

Goals of Calorimeter R&D

- Design criteria to achieve 2-jet mass resolution sufficient to separate W and Z.
  - Good energy resolution for single particles
  - Fine transverse and longitudinal granularity for PFA
  - Operational in strong magnetic field – Photon detector
  - Hermeticity
- Baseline design
  - Lead/plastic scintillator sampling calorimeter for ECAL/HCAL
    - $4cm^{W}x4cm^{H}x1mm^{T}$-sci. + $4mm^{T}$-Pb
  - Hardware compensation for excellent hadron energy resolution and linearity
- Optional design
  - Strip-array ECAL, $1cm^{H}x20cm^{W}x2mm^{T}$-Sci

Calorimeter R&D

- Collaboration:
  - KEK, Kobe, Konan, Niigata, Shinshu, Tsukuba

- International Collaboration:
  - JINR/DLNP, Russia:
    - KEK/IPNS and JINR have concluded on MoU on linear collider detector R&Ds in July 2003.
    - Based on this MoU, test modules were fabricated and tested at KEK in March 2004.
  - DESY, Germany:
    - Co-works with DESY-HCAL group are in progress on photon detector R&D and on beam test programs.
    - Our shower position detectors were tested at DESY in collaboration with DESY-HCAL group in Sep. 2003.
    - They participated in our beam test at KEK in March 2004, with their photo-detectors (SiPM)

International Collaboration

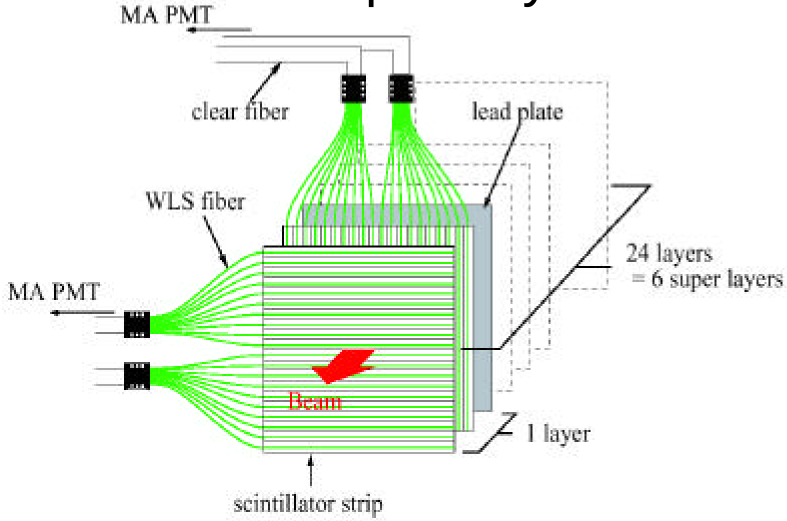
at KEK beam test, March 2004

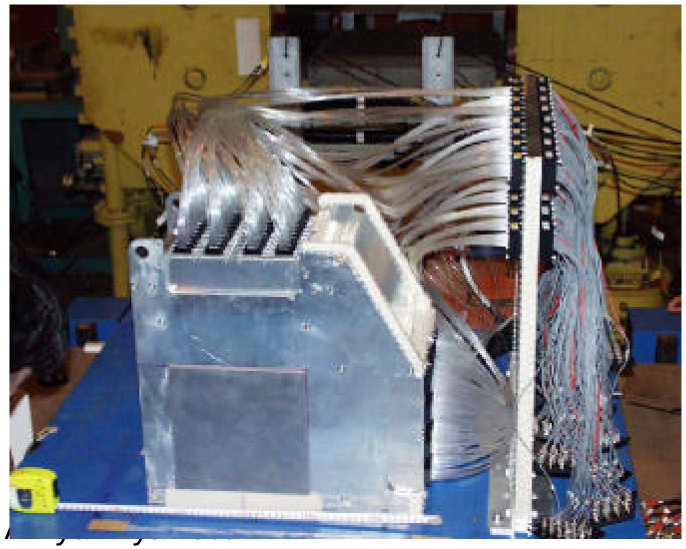
ECAL Beam tests

- Objectives
  - Study uniformity for the simulator inputs
  - Resolutions of energy, position, and shower direction
  - Examine 2-cluster separation and ghost-rejection
- Three tests in series since Fall of 2002
  - 2002: T517 at KEK (e/μ/π, 1-4 GeV)
    - tile/fiber ECAL, strip-array ECAL, sinti-strip Shmax
  - 2003: Test at DESY (e, 1-6 GeV)
    - Scinti-strip SHmax with WLS-fiber and APD readout.
  - 2004: T545 at KEK (e/μ/π, 1-4 GeV)
    - Compare several readout, HAPD, APD, SiPM, EBCCD,..
    - Check performance of tile/fiber made by JINR.
    - Tile/fiber with staggered WLS readout were also tested.

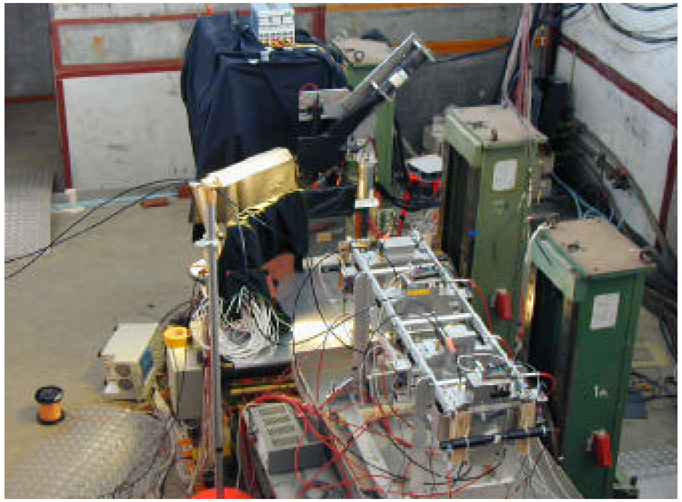
ECAL beam test setup

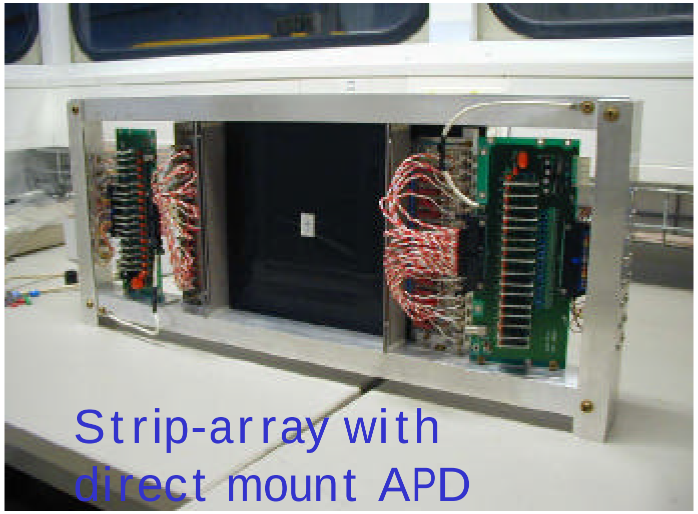
Strip-array ECAL



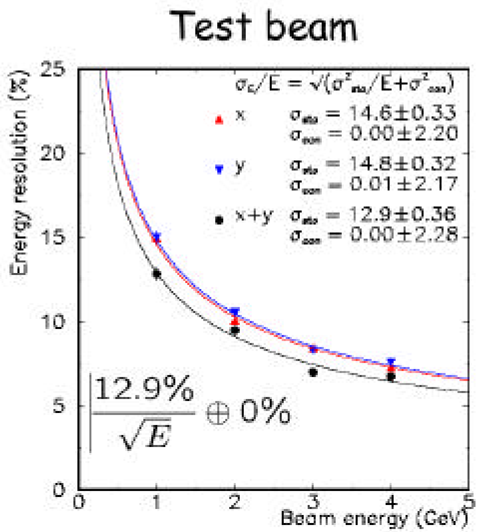


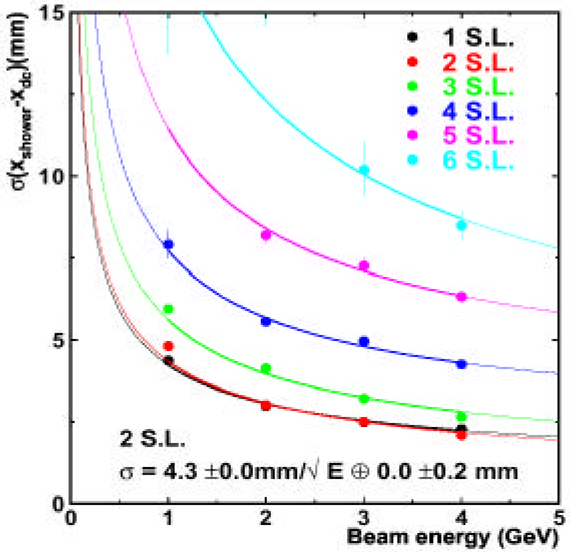
DESY ST21





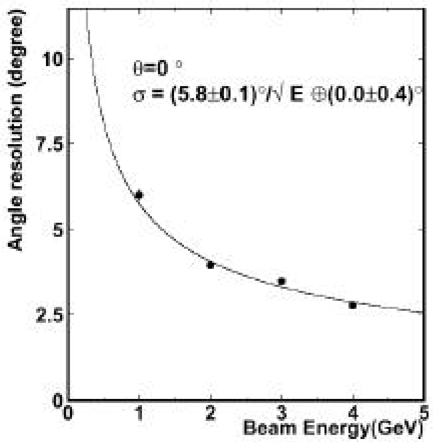
Beam test results





■Position resolution:
Best at shower maximum
~ 2mm for 4GeV electron

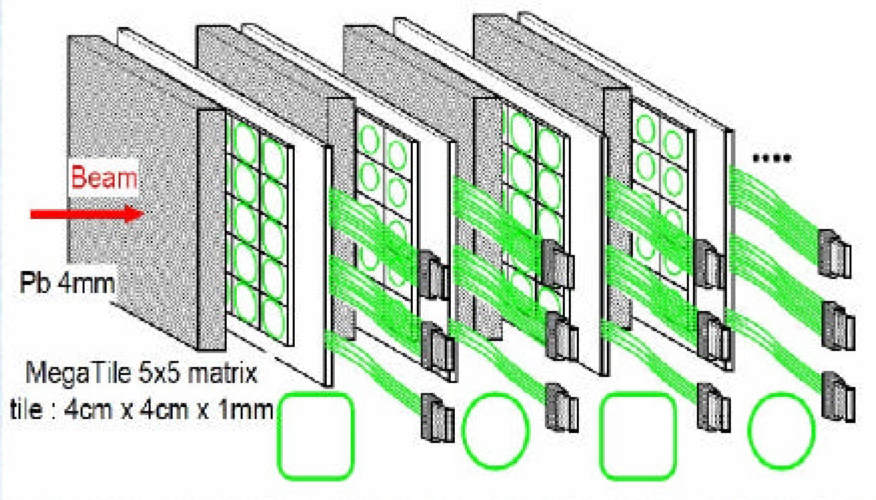
■Energy resolution:
Consistent with MC if photon statistics are taken into account.
Design criteria satisfied



■Angular resolution:
Angle of shower axis is determined by a linear fit of first 5SL.
θ~50mrad for 4GeV electron

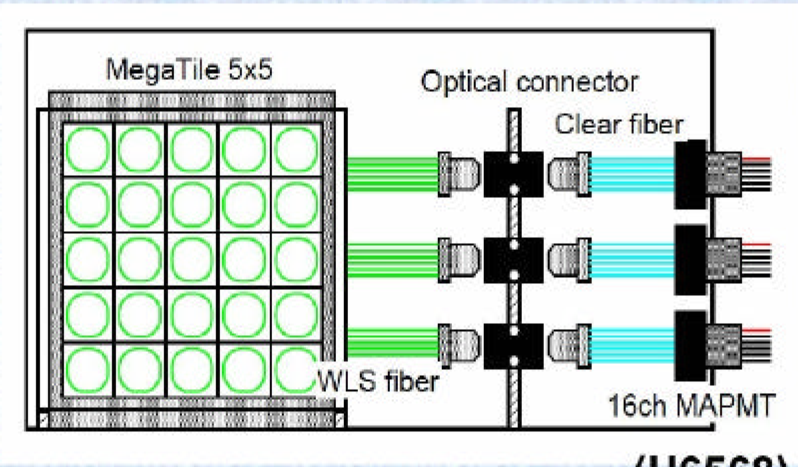
Test of tile/fiber ECAL

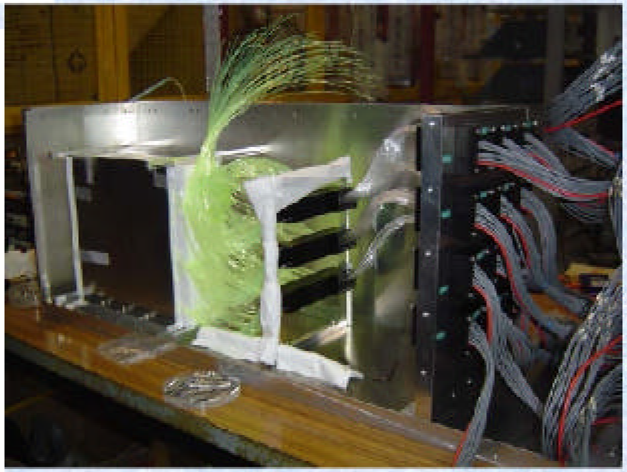
Mega tile → cost reduction
Staggered WLS → Better uniformity



4 Layers = 1 Super Layer
6SL = 17 X_0

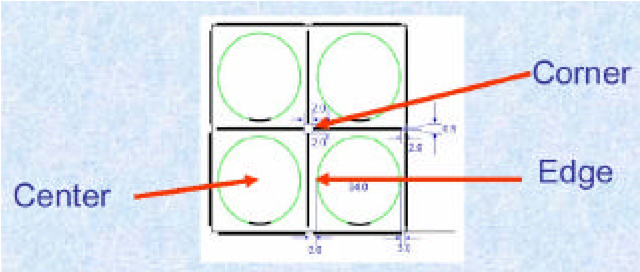
Total No. of R/O Ch:
5x5x6= 150

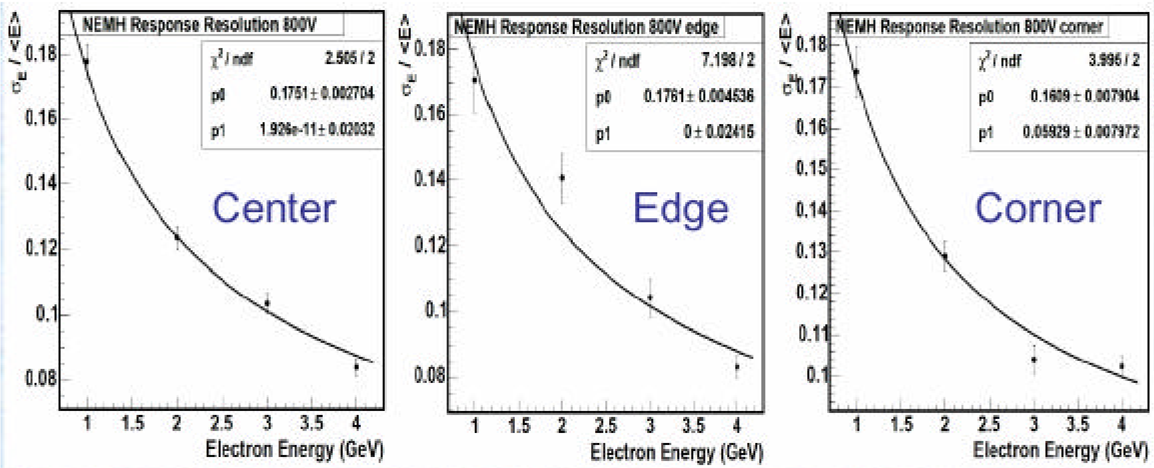




(H6568)

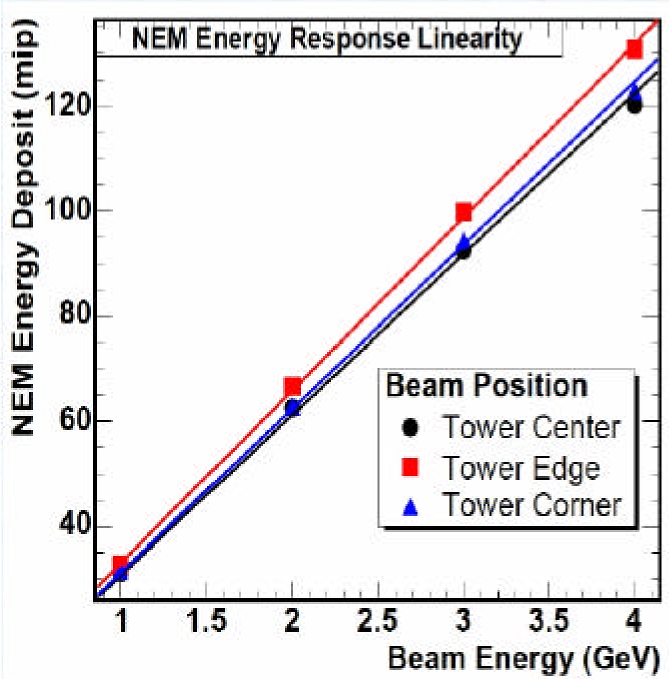
Preliminary results





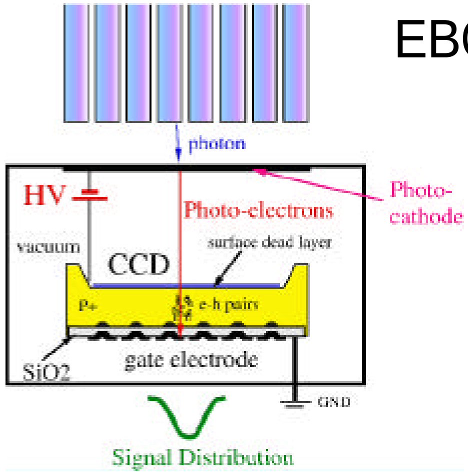
σstat = 17.5%　　σstat = 17.6%　　σstat = 16.1%

$$\frac{\sigma}{E} = \frac{\sigma_{stat}}{\sqrt{E}} \oplus \sigma_{const} \quad (A \oplus B = \sqrt{A^2 + B^2})$$



Photon detector R&D

- Photon-detectors are now the most essential component of any plastic scintillator-based calorimeters
- Following devies are tested in JFY2003.
  - APD
  - Multi-channel HPD
  - Multi-channel HAPD
  - EBCCD
  - SiPM



EBCCD

- APD(Hamamatsu S8864-55) were already used for the strip-array detector, satisfactory
- Others were tested in March 2004 beamtest

Plan of CAL study in 2004 and beyond

- Carry out full simulation study (based on Geant4) to get optimum parameters for ultimate calorimeter performance
  - Granularity, Particle Flow Algorithm, ...

- Fully understand and establish design and performance of tile/fiber calorimeter based on the test module construction experience and test beam data so far

- Develop digital hadron calorimeter suited for Particle Flow Algorithm. by Shinshu group.

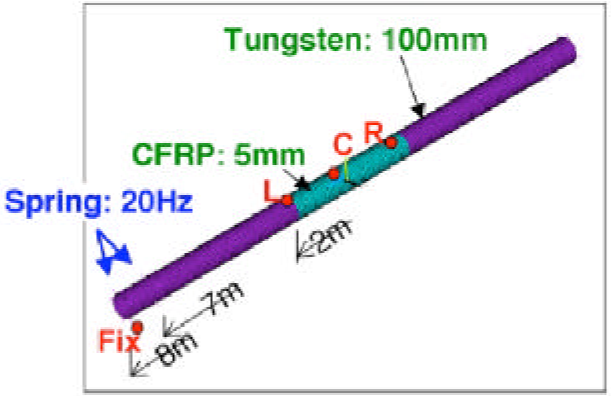
- Continue photon detector R&D's and find best device:
  - High gain, Operate in B field, timing information, Low cost, availability, ...

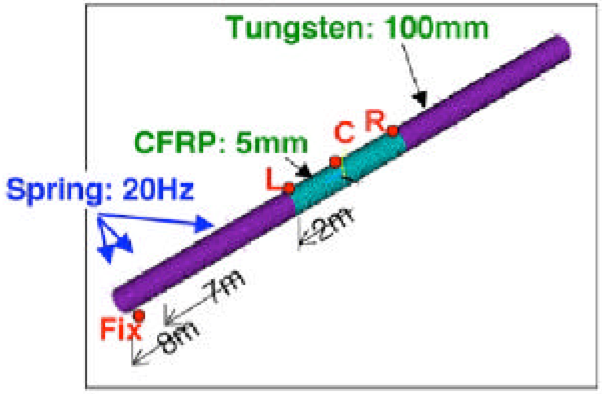
Interaction Region
and
Beam Delivery System

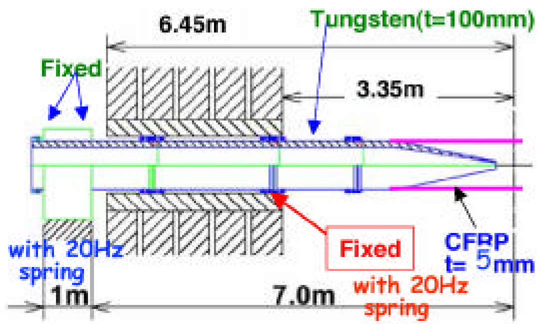
Goals and activities

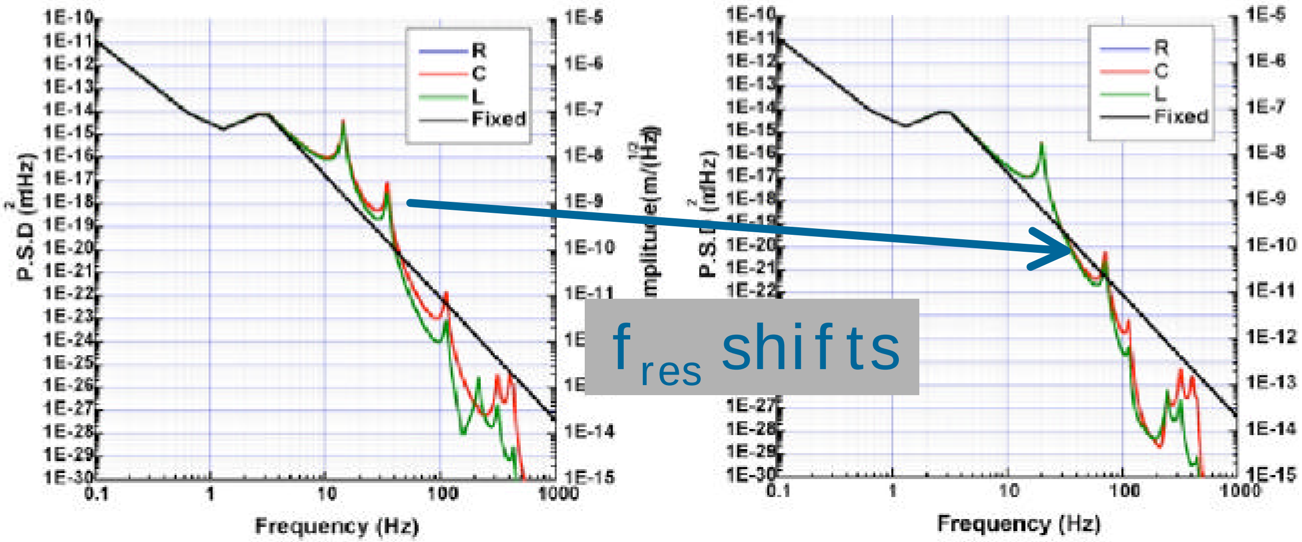
- Goals of the IR and BDS study
  - Design a mask and support system near IR
  - Optimize systems such as collimation, final focus, extraction and beam dump lines, and crossing angle in collaboration with accelerator group.
  - Develop beam diagnostic system, such as energy/polarization measurements and beam position measurements
  - ......
- Activities
  - Designed BDS, IR, and dump line and estimated backgrounds such as muons, synchrotron lights, e^+/e^- pairs, neutrons, etc.
  - Studying stability of the support tube by a 1/10 model and model calculations
  - Studying fast feedback system for sub-nano meter beam control, in collaboration with UK group.
  - ......

FEM analysis of Support tube







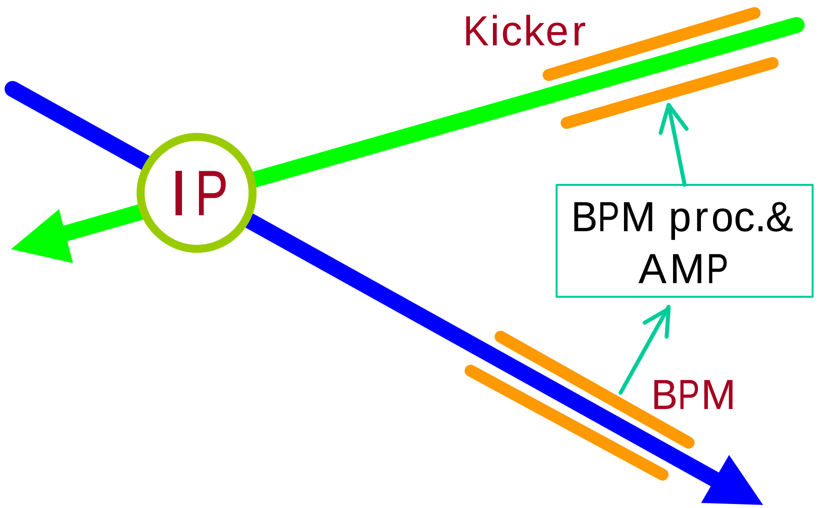


- Support near IP is crucial
- FEM calculation consisten with a test by 1/10 model
- Next step is to test a real size model.

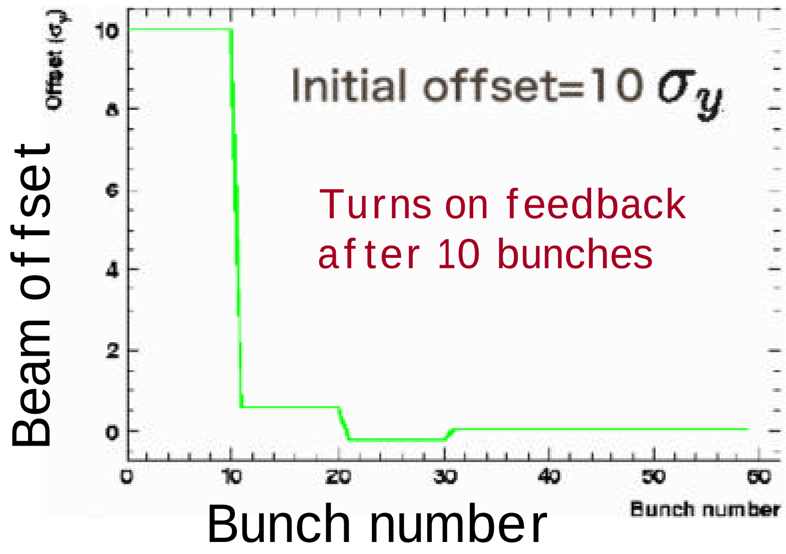
FEATHER

Feedback AT High Energy Requirements

N.Delerue

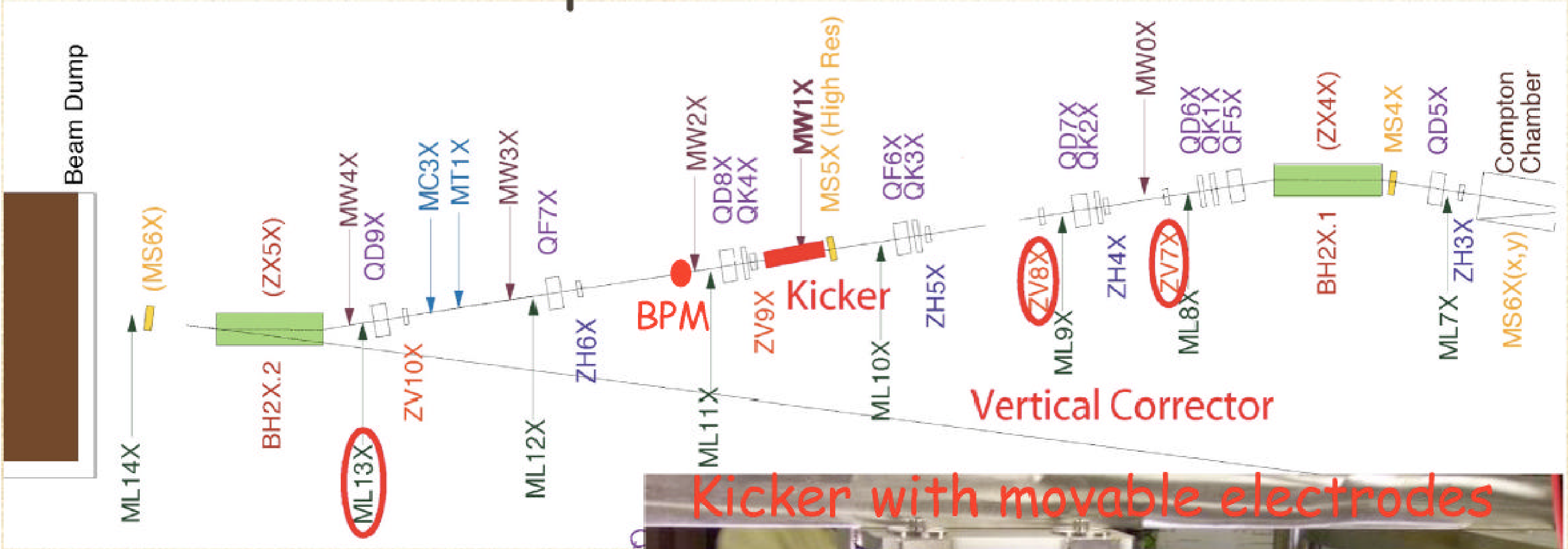


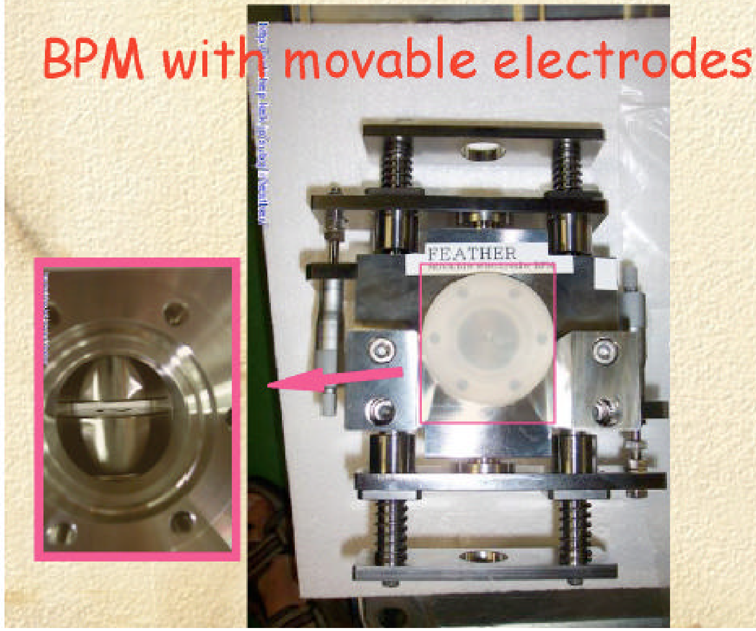
Simulation results

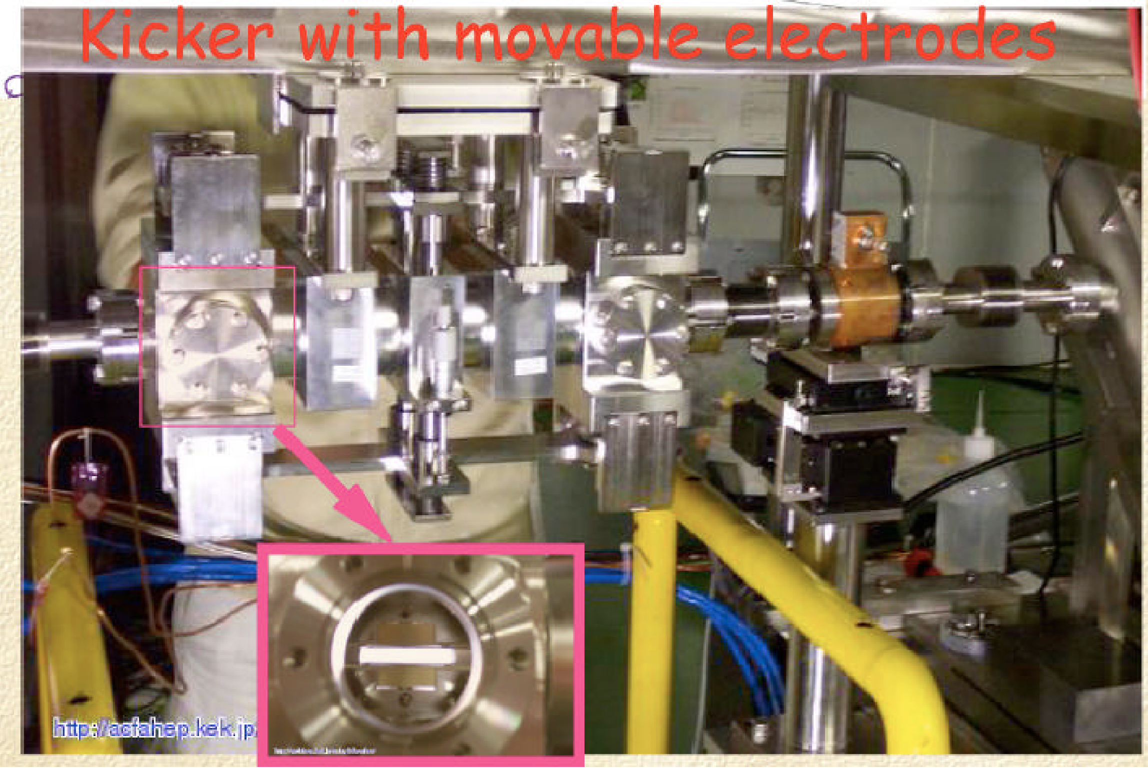


- Test of the system has started at the ATF extraction line.

FEATHER setup at the ATF extraction line

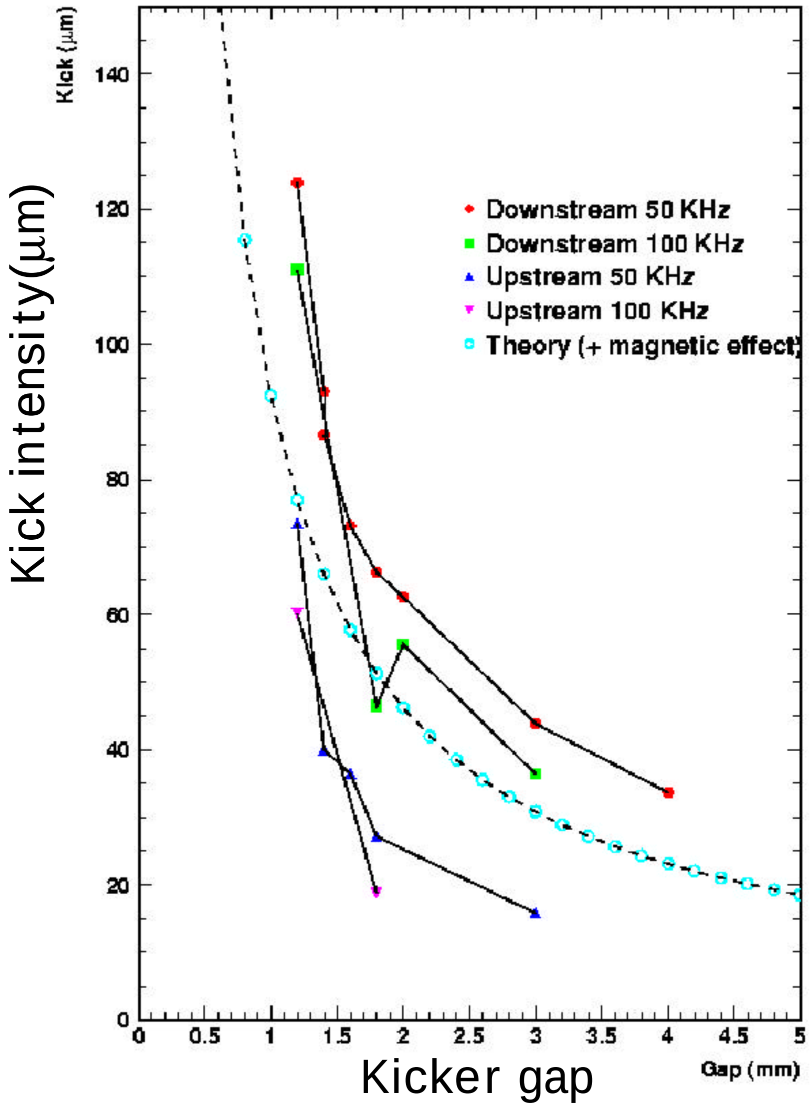






Test of Kicker performances (at low frequency)

- Kicker pulses were fed from upstream and down stream of the kicker and kick intensity is compared
- Larger kick intensity is seen when the pulse is fed downstream.
  - This is qualitatively consistent with theoretical expectation.
  - Quantitative disagreement would be due to miss alignments of beam and kicker strip.
- Study continues to stabilize the beam at ATF by this Autumn.



IR R&D plan in 2004

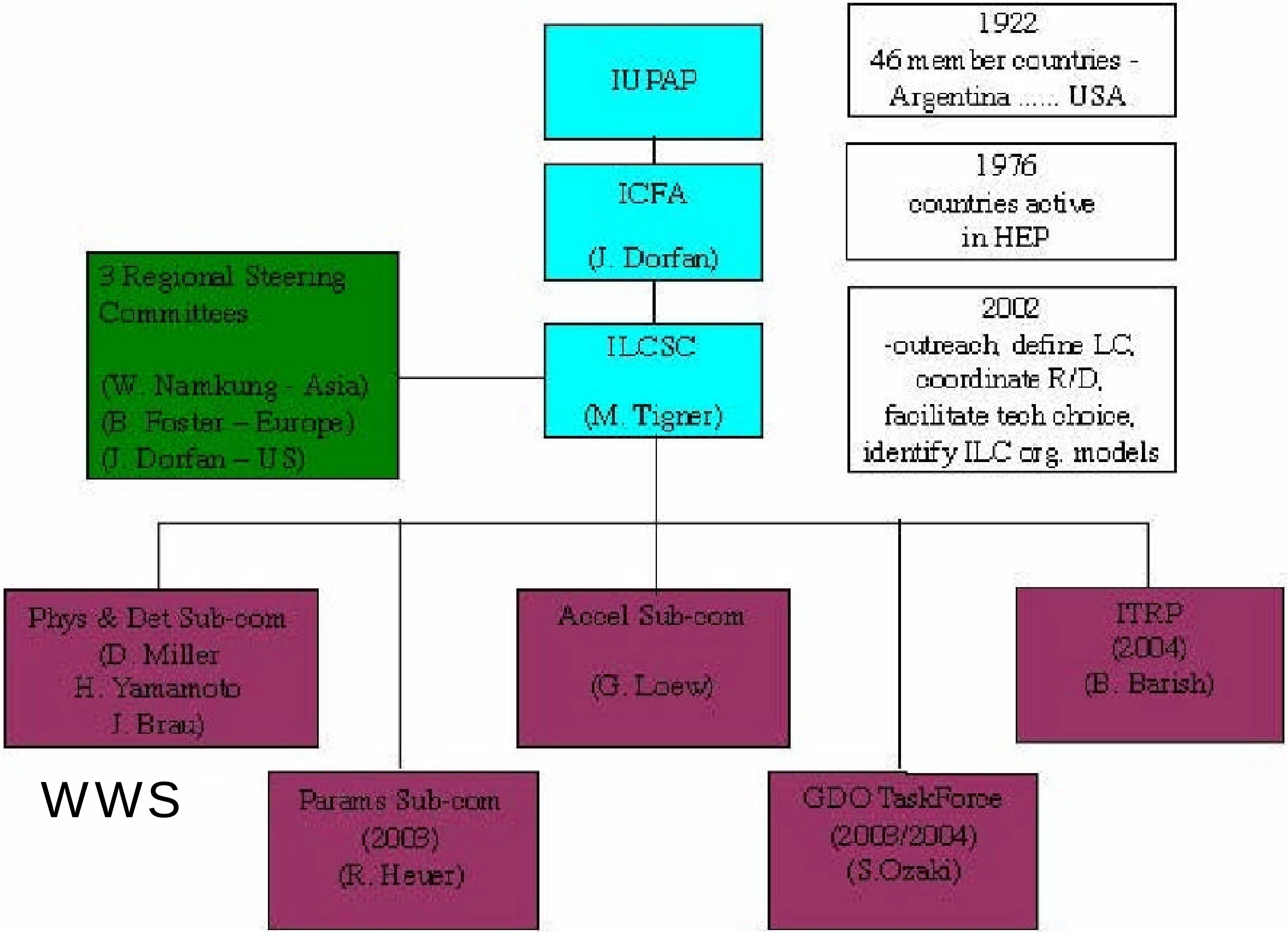
- Support Tube R&D
  - Construct an active mover of the final focus quadrupole magnet (Q_{FF}) in the support tube
    - Roadmap report spec.: 80cm$^{\phi}$, 1m length to put a load of Q_{FF}
- Continues FEATHER studies at ATF
- Nano BPM R&D
  - Develop a cavity type Beam Position Monitor with a resolution less than 2nm.
  - In collaboration with Accelerator group and SLAC.
  - IPNS would like to contribute a support system and a vibration monitor system.

International Situation

What's happened

- JLC → Global LC (Feb. 2003)
  German Government "Internationalize Tesla" (Feb. 2003)
- DOE Office of Science Future Facilities Plan: (2003 fall)
  LC is first priority mid-term new facility for all US Office of Science
- International Technology Recommendation Panel was formed (Jan. 2004)
- OECD Ministerial Statement (January 2004)
  "…noted the world wide consensus of the scientific community, which has chosen an electron-positron linear collider as the next accelerator based facility to complement and expand on the…LHC…"
- ICFA (i.e. CERN,DESY,FNAL,KEK,SLAC etc) February 2004
  reaffirms its conviction that the highest priority for a new machine for particle physics is a linear electron-positron collider with an initial energy of 500 GeV, extendible up to about 1 TeV, with a significant period of concurrent running with the LHC
- Funding Agency for Linear Collider met at London (April 2004)
- Press release of "consensus document" signed by 2600 physicists (April 2004)
  A summary of the scientific case for the $e^+ e^-$ Linear Collider, representing a broad consensus of the particle physics community

International Organization



Time scale of Acc.

ILCSC (see presentation by M.Tigner) :

2004 technology recommendation (confirmed by ITRP)

Establish Global Design Organization (GDO)

2005 CDR for Collider (incl. first cost estimate)

2007 TDR for Collider

2008 site selection

2009 construction could start

......

~2015 First collision @500GeV

ILCSC charge to WWS

At their February meetings, ILCSC and ICFA asked us to propose,
in parallel with the Global Design Initiative for the LC machine,
an *organisation* which will do three separate jobs:

1. Ensure that at least two different detector concepts are developed;
   by worldwide teams which will:
   - prepare CDR(s) on concepts, by ~2006;
   - *be ready to form the cores of the collaborations** when funding is in place and bids are called for.

2. Encourage and coordinate inter-regional R&D on essential detector technologies, and give peer-reviewed recognition to nationally funded R&D programmes as part of the worldwide project.

3. Make sure that vital questions of machine-detector interface and beamline instrumentation are as fully supported as accelerator and detector R&D. This will involve close links with the GDI.

*slightly edited from Monday's ungrammatical version.

David J. Miller; towards a WWS response to ILCSC/ICFA

WWS reply

The WWS organising committee will reply to the ILCSC meeting at ICHEP Beijing in August.
Proposal to be finalised at ALCPG Victoria workshop, end July.

Points so far:

Detector and MDI R&D is underfunded; so many essential tests can not be done yet.

But we must give cost and performance input at each stage of the GDI accelerator roadmap to show that the experiments can do the physics.

The community will grow and R&D accelerate when more funding appears. We must encourage new ideas and new entrants.

>1 overall detector concept is needed.

David J. Miller; towards a WWS response to ILCSC/ICFA

Time scale of detector

We propose to tie detector milestones to the Global LC Design Initiative.

GDI Milestones

2004	Technology choice. Global Design Effort MOUs
2005	Accelerator CDR
2007	Accelerator TDR
2008	Site selection

Proposed Detector Milestones

A. Costing of >1 whole-detector concepts (single joint document with performance estimates for each concept, + reference to R&D done and still needed)

B. Receive Letters of Intent (or "CDRs"?) for experiments (maybe different set of concepts from A, above, as new ideas come with new people)

C. Global Lab immediately invites ~2 TDRs on basis of Letters of Intent. TDRs to be presented within 1 year.

~2009 Construction begins

David J. Miller; towards a WWS response to ILCSC/ICFA

Inter-regional Sub-detector R&D

- First report of "Linear Collider Detector R&D"
  - Inter-regional efforts to summarize detector requirements and current activities.
  - Available at http://blueox.uoregon.edu/~lc/randd.pdf
- Inter-regional phone conferences on detector studies
  - Since LCWS2002 @Jedu. Held on a day before regional workshops, 1/03(Vtx), 7/03(Tracker),11/03(Cal), 12/03(Vtx), 1/04(Tracker)
  - The conferences provide opportunities of more frequent exchange of information
- Several inter-regional collaborations on sub-detector R&D have been formed independently with detector concepts which has been developed regionally.
  - LC-TPC, CALICE, SiLC, LC Simulation, ...
  - Japanese/Asian activities are partially involved in these activities.

Asian activities

- ACFA is our base for international presence.
- "ACFA report" was prepared by ACFA LC P&D group
- Asian detector activities other than Japan
  - Korea : Strong LC group at CHEP, Tegu. and Korea Univ.
    Hardware R&D is on silicon.
  - Philippine: Mindanao State University
    - Work together with Japanese tracker group
  - India : shifting from LHC to LC
  - China : BES is busy for 2~3 more years.
    Requesting a found for theory+simulation studies on LC
  - Taiwan : Next ACFA workshop will be held in Nov~Dec 2004
  - Many other nations
  - Many Asians working at US&Erope

Summary

We should put more efforts on
LC detector studies.