Hypothetical Reuse of Belle for SuperB

Tim Gershon
University of Warwick

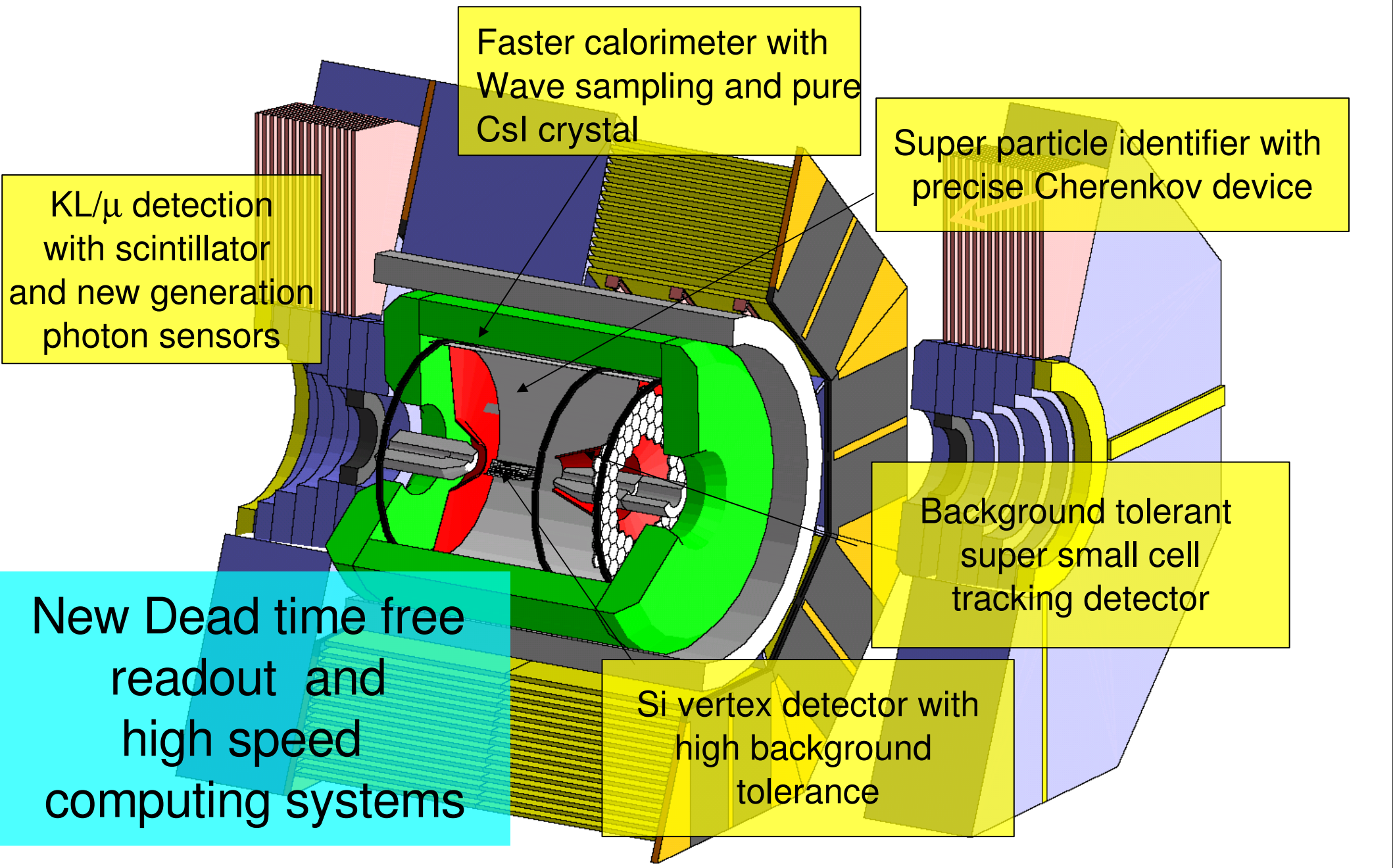
17 March, 2006

Reminder

- Activity ongoing to plan upgrade of Belle for SuperKEKB
- See talk by T. Iijima at SuperBF'05
  - http://www.lnf.infn.it/conference/superbf05/Friday/Iijima.pdf
- KEK LCPAC meeting March 24-26

Super Belle

From M.Yamauchi seminar at LNF, October 2005



Disclaimer

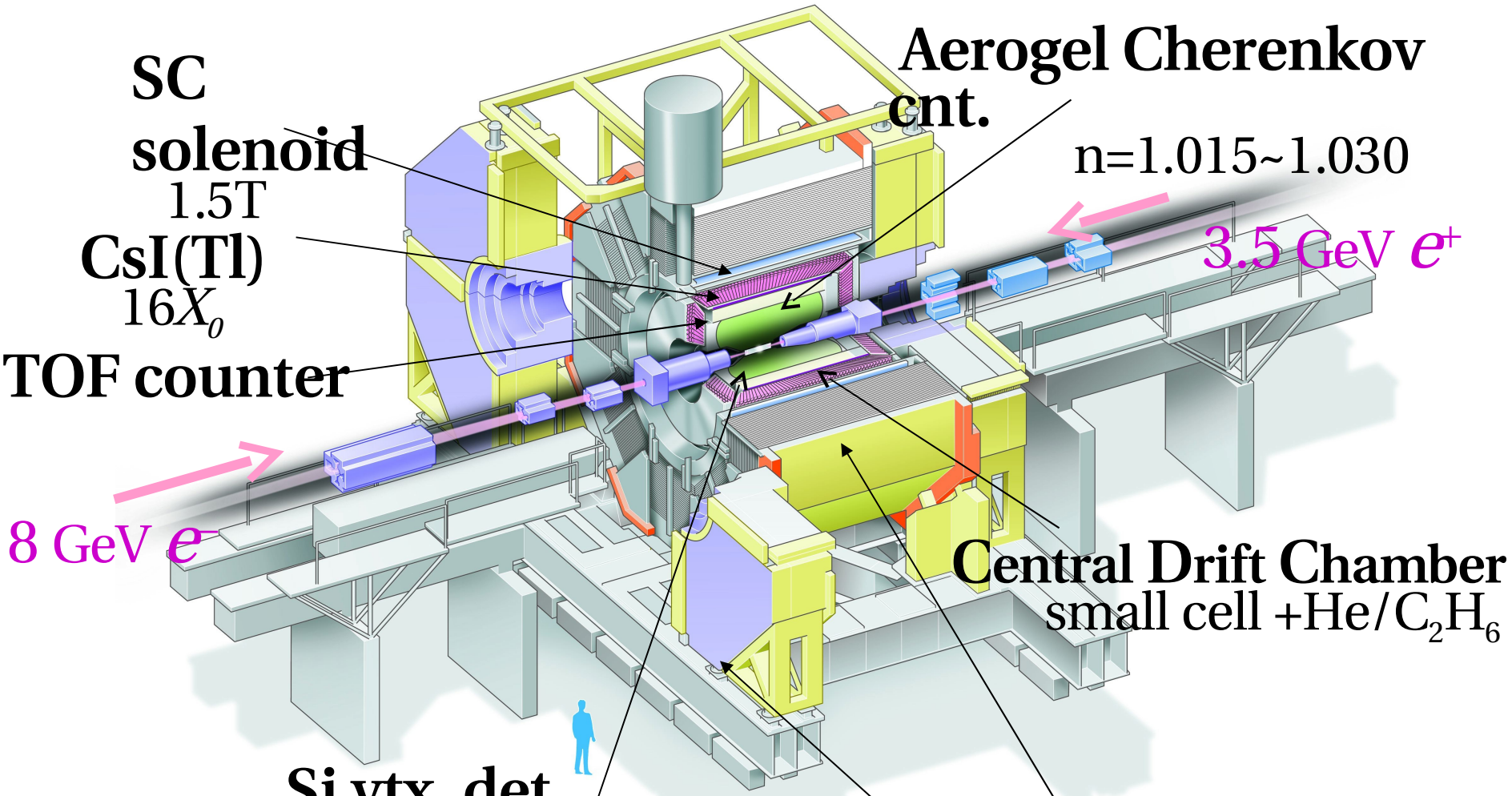
I am not a detector expert

Features of Detector at Linear SuperB

- See S.Playfer at SuperBF'05
  http://www.lnf.infn.it/conference/superbf05/Friday/Playfer_frascati.pdf
  - basic conclusion:

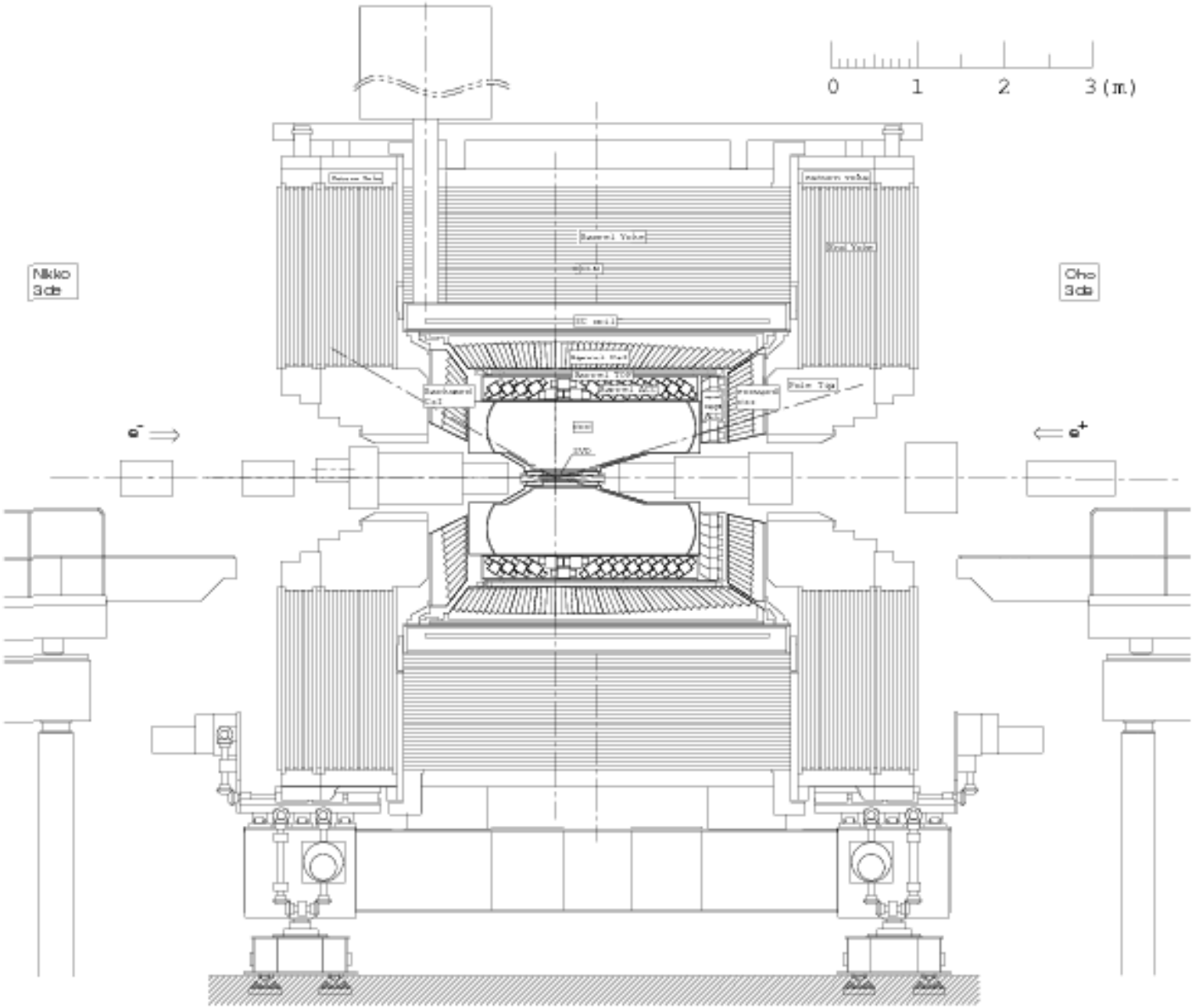
    existing B factory detector works quite well
- Features (desirables)
  - Low backgrounds
  - Small boost → good vertexing
  - High hermiticity → high efficiency
    - tracking, PID & calorimetry over a wide solid angle
  - Possible operation at energies below Y(4S)
    - symmetric beam energies
    - low energy μ-identification (if possible)

Current Belle Detector



Current Belle Detector

Lab frame coverage ~ 17° - 150°



Belle / BaBar Differences – IP

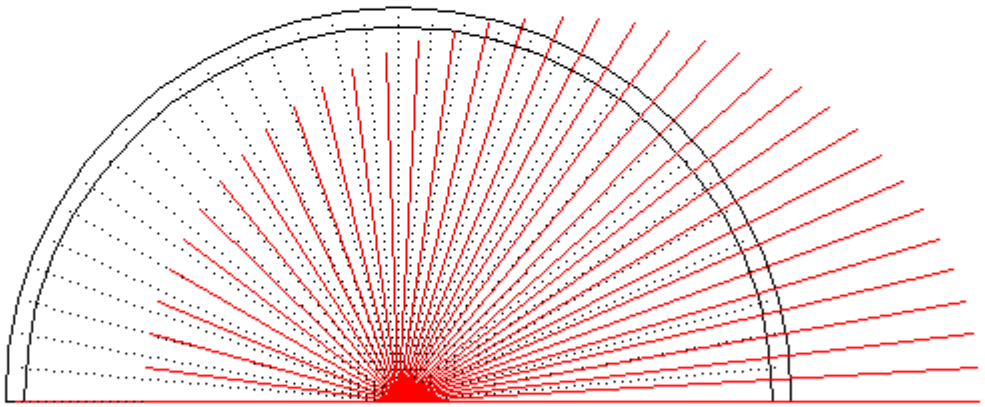
- Beam asymmetry
  - Belle: 8.0 GeV e^- on 3.5 GeV e^+ $\Rightarrow$ $\beta\gamma = 0.425$ (22 mrad)
  - BaBar: 9.0 GeV e^- on 3.1 GeV e^+ $\Rightarrow$ $\beta\gamma = 0.56$ (head on)
  - SuperB: 7.0 GeV e^- on 4.0 GeV e^+ $\Rightarrow$ $\beta\gamma = 0.28$ (head on?)

  small (few %) differences in acceptance could be significant for hermiticity of events with ~10 particles

- x-angle $\Rightarrow$ reduced backgrounds
- Crab cavities now being installed/tested at KEK-B

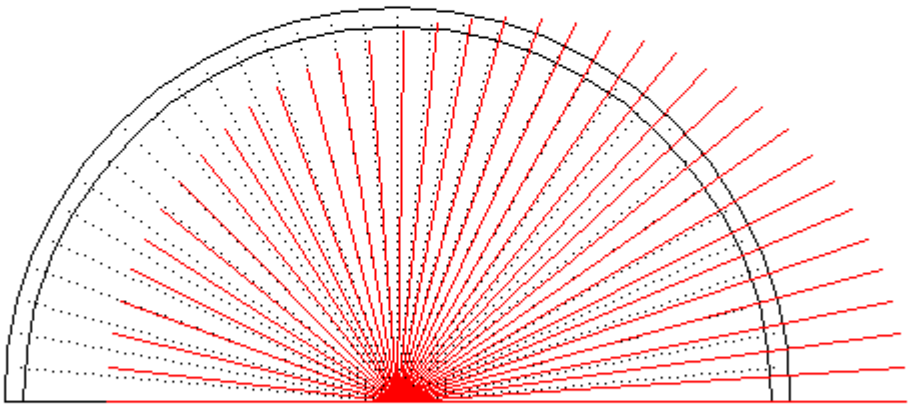
Borrowed from D.Hitlin: Detector Protractor

8.0 on 3.49801 GeV ($\beta\gamma = 0.425519$)



36 steps of ϑ

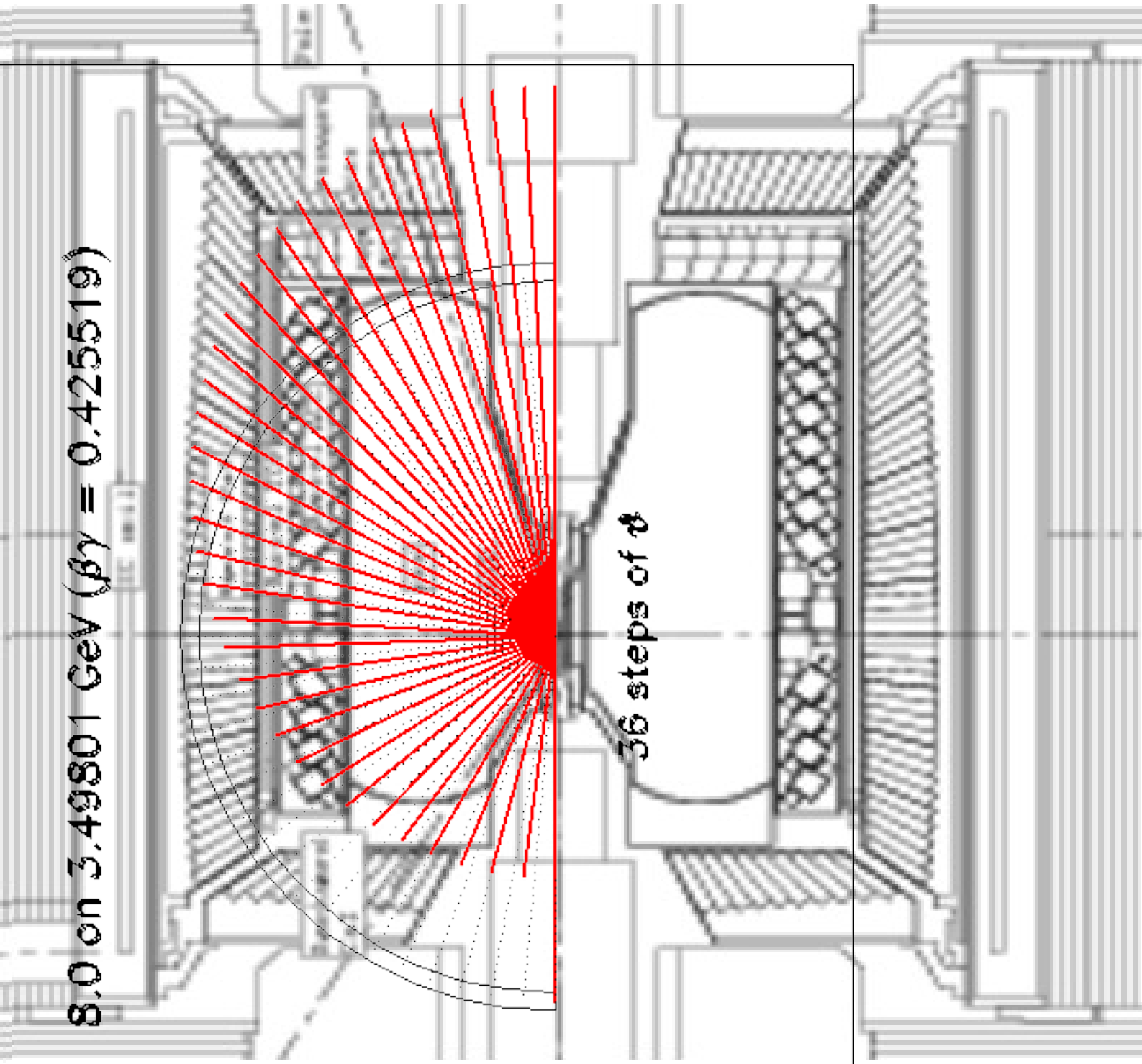
7.0 on 3.99773 GeV ($\beta\gamma = 0.283768$)



36 steps of ϑ

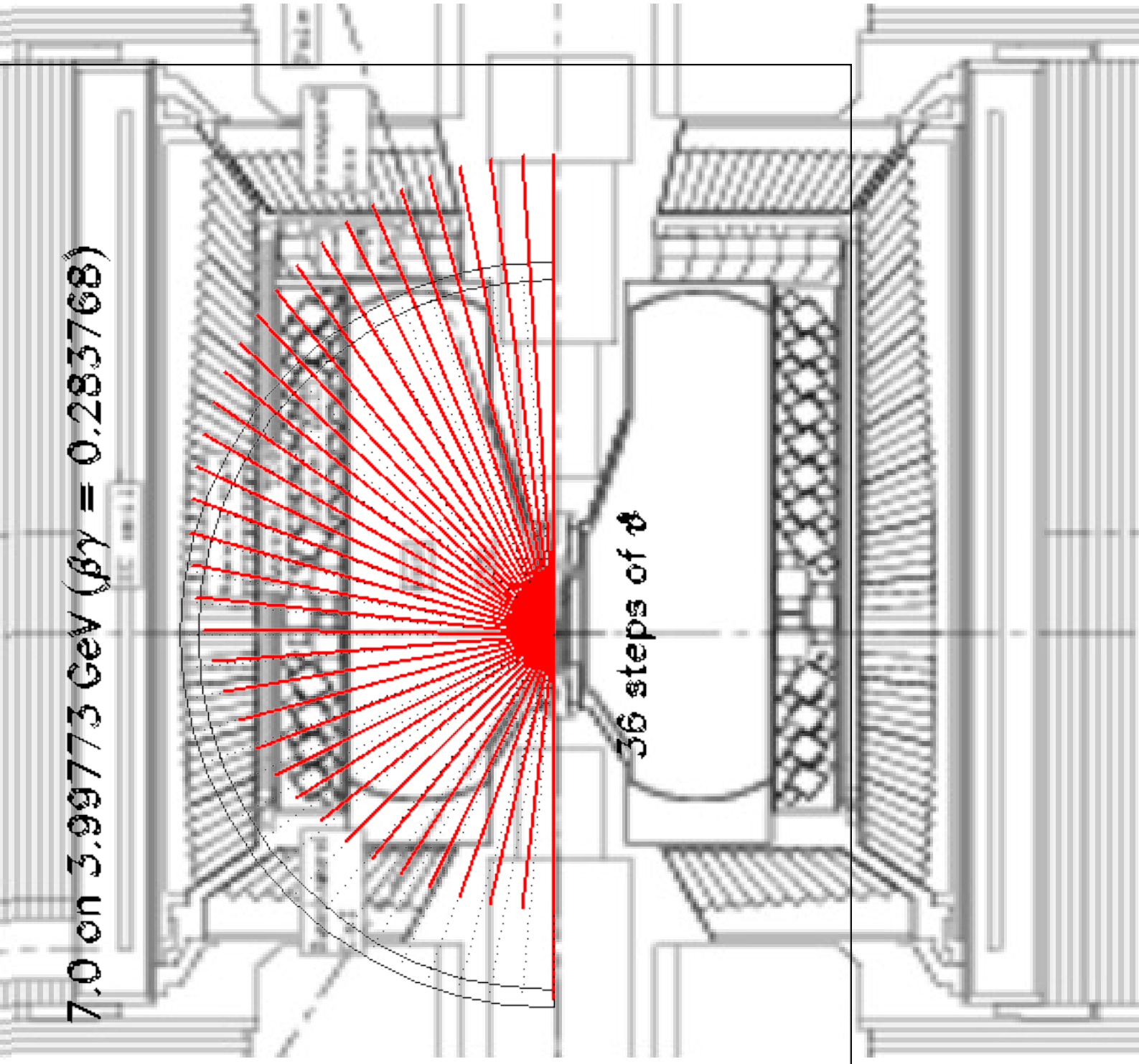
Assume massless particles, head on collisions along z-axis

Current Belle Detector, 8/3.5 GeV



CM frame coverage ~ 28° - 158°

Current Belle Detector, 7/4 GeV



CM frame coverage ~ 25° - 155°

Belle / BaBar Differences - Vertexing

- Silicon vertex detector / tracker
  - Belle: 3 layers; 30 mm → 60 mm from IP (until summer 2003)
  - Belle: 4 layers; 20 mm → 88 mm from IP (from summer 2003)
  - BaBar: 5 layers; 32 mm → 144 mm from IP
- SuperB requires
  - 1st layer close to IP (precise vertexing) 10 - 15 mm ?
    - Use striplets/pixels? Maybe not *necessary*, but helpful. R&D active for Super Belle & others
  - last layer far from IP (efficient K_S vertexing) 150 mm ?
  - wide angular coverage (hermiticity)

Tracking

- Expectation that gaseous tracker continues to work OK in SuperB environment
  - fast gas / readout
- Anyway replace innermost layers, where rates highest
- Reuse of existing Belle CDC seems OK
- How to improve angular coverage?
  - Additional forward/backward trackers?
    - Silicon?
    - Does space allow it?
    - Planar geometry → recover low-p_t tracking efficiency

Belle / BaBar Differences – Particle ID

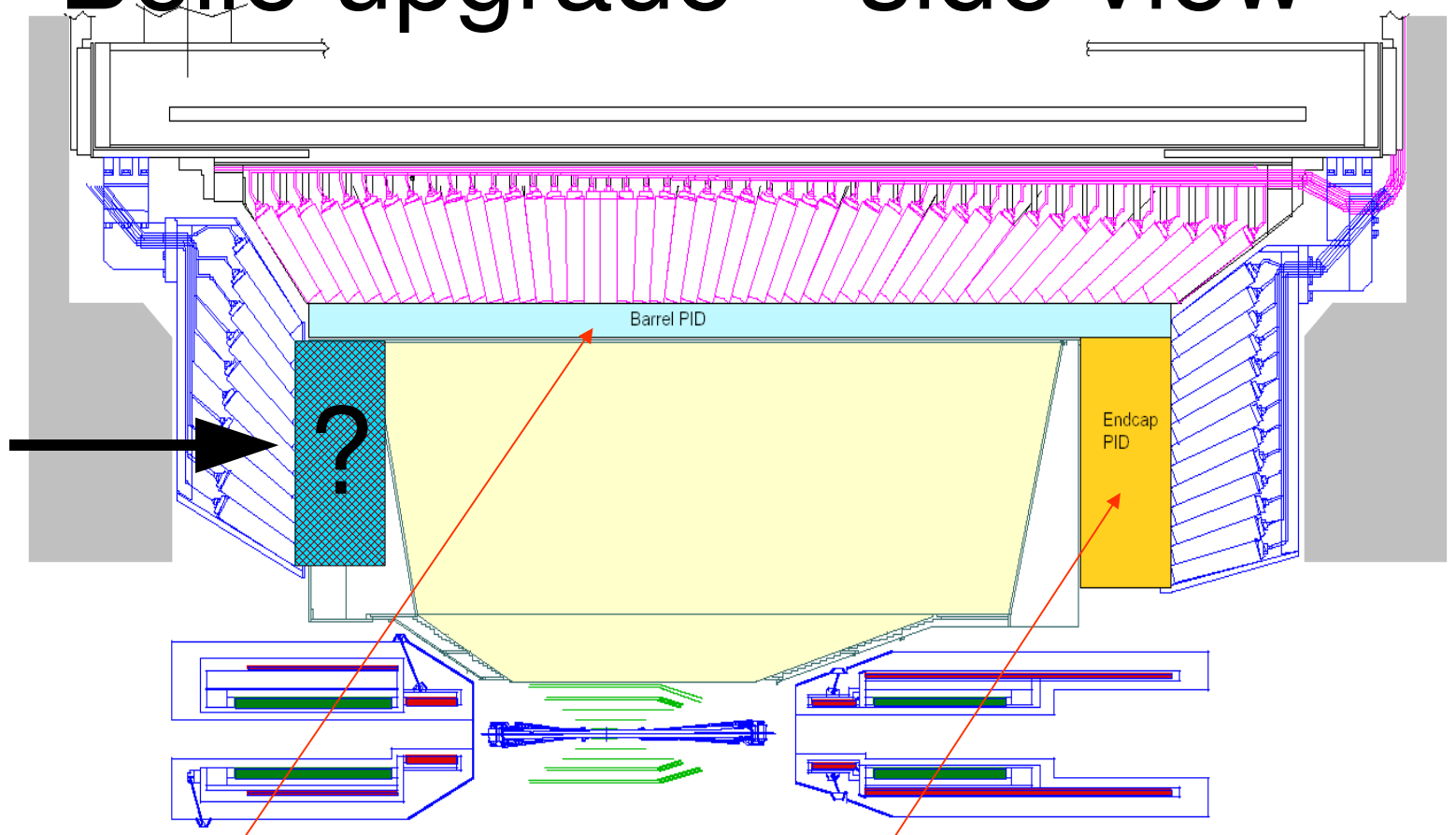
- Belle:
  - time-of-flight counters (TOF)
  - aerogel Cherenkov counters (ACC)
- BaBar:
  - Cherenkov light internally reflected in quartz bars (DIRC)
- Both also use dE/dx measurements
- BaBar performance better
  - improvements in physics performance

Reuse of Belle PID

- TOF is anticipated to fail in SuperKEKB environment
  - replaced with TOP (time-of-propagation) & aerogel RICH
    - proximity focusing RICH may allow low p_t μ-ID (?)
  - TO{F/P} OK for Linear SuperB,
    - assume precise T0 information exists
- ACC should be OK (but maybe replaced)
- PID upgrade would anyway be beneficial for SuperB
- Low momentum PID (e/π/K/p) provided by dE/dx

Belle upgrade – side view

Possibility for backward PID?
- Need to make space



Two new particle ID devices, both RICHes:

Barrel: TOP or focusing DIRC

Endcap: proximity focusing RICH

See talk by Peter Krizan

Calorimeter

- Belle / BaBar have similar calorimeters (ECL / EMC)
  - CsI(Tl) crystals
  - BaBar has forward endcap only, Belle also has backward
  - Belle also has extreme forward/backward calorimeter (EFC)
    - BGO crystal arrays
    - luminosity measurement
- Strategy to cope with SuperKEKB rates
  - fast readout
  - Pure CsI in endcaps
- May not be necessary for linear SuperB (?)
- Better calorimeter = better hermiticity

K_L/μ Detection

- Planned upgrade for SuperKEKB:
  - shield radiation from {up/down}stream bending magnets
  - replace RPC with scintillator strips/tiles
- Can K_L detection be improved?

Solenoid

- Assumed to be the same (1.5 T)
- Lower magnetic field may be possible if TOF/ACC replaced by TOP/RICH
  - larger radius drift chamber helps momentum resolution
  - should help low p_t PID

Trigger / DAQ / Computing

- Existing triggers should work
- More data, more DAQ
  - existing solutions scaleable?
  - use of GRID

Summary

- Existing Belle detector looks well suited as basis for SuperB
- Some upgrades desirable for physics
- Take advantage of R&D for SuperKEKB

Super B Factory ⇒ Super Flavour Factory