BEAST Experimental Results and Estimates for Operational Background

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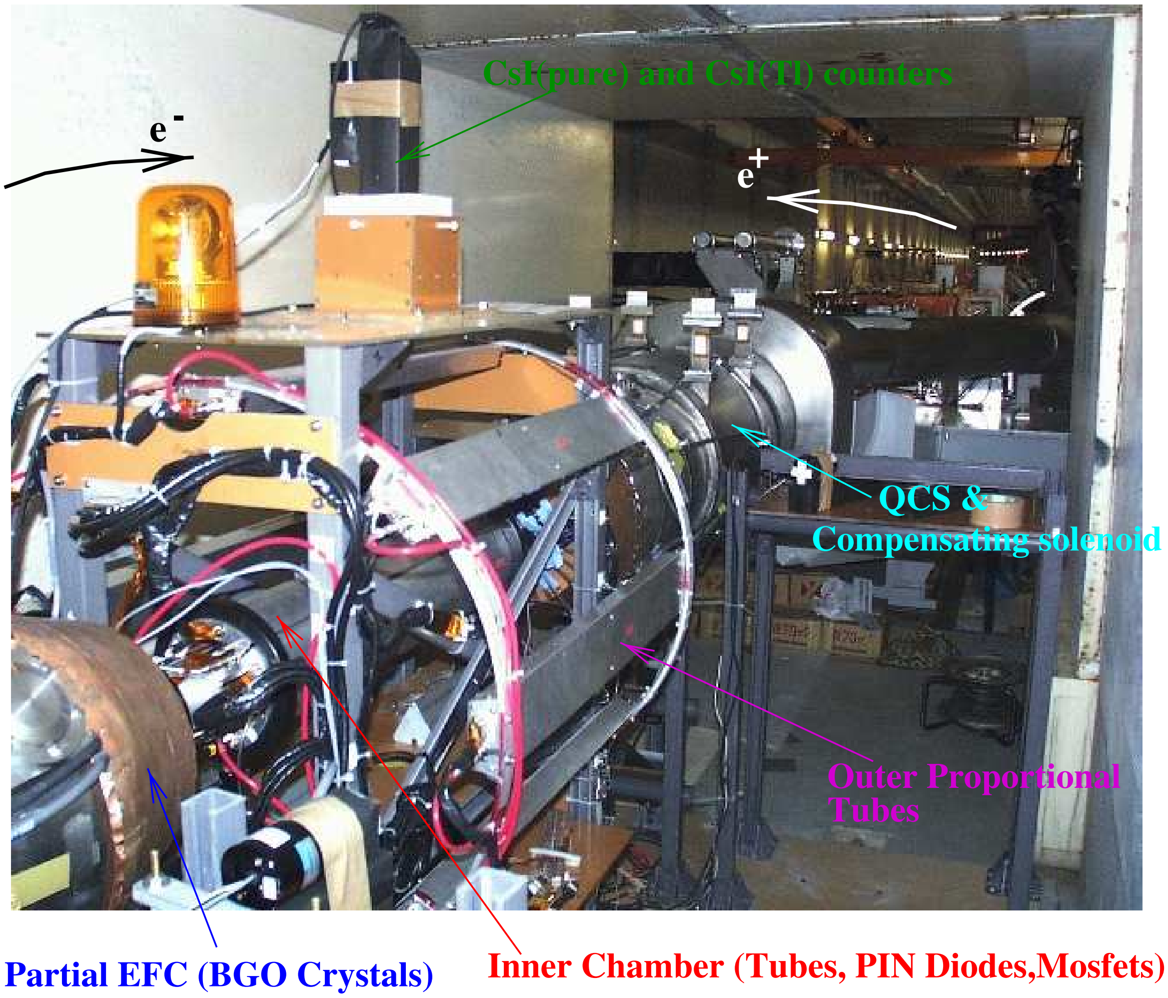
BELLE General Meeting
March 24th, 1999

- Current Radiation Dose Rates
- SVD Ladders
  - Occupancy estimates
  - Noise estimates
- Integrated Dose
- Machine/background Studies
- Projections for Roll-In Operation
  - Radiation Dose
  - Track density/trigger rates
- Future Plans

BEAST detector installed on the beamline of KEK-B

www.phys.hawaii.edu/~beast

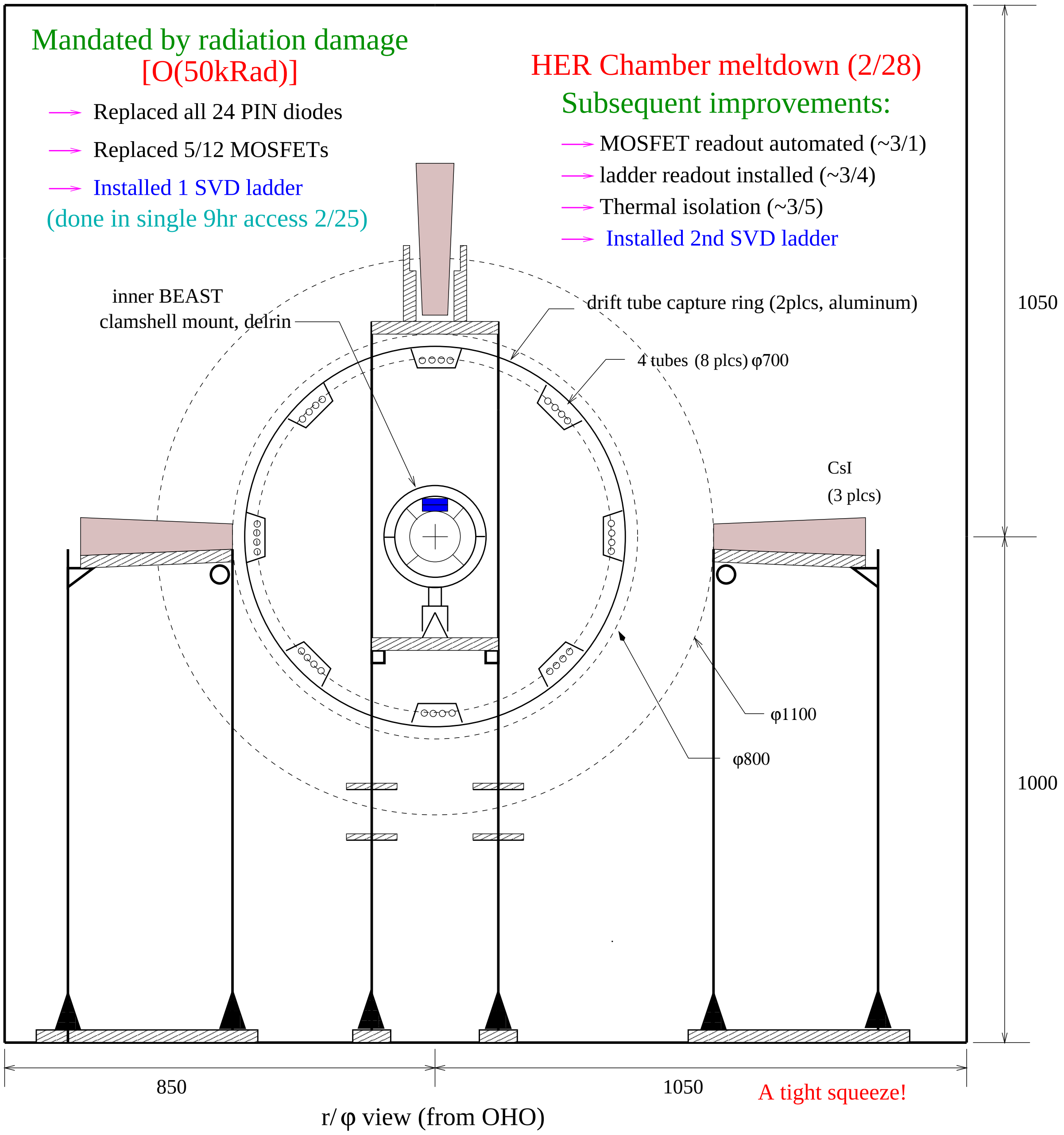
Goal : Measure the background rate
Compare with Simulation
Reduce dose rate by tuning KEK-B parameters



BELLE Commissioning Group[1]

University of Melbourne, Australia
University of Sydney, Australia
KEK, Japan
Budker Institute of Nuclear Physics, Russia
National Taiwan University, Taiwan
University of Hawaii, U.S.A.

BEAST 1.1



Mandated by radiation damage
[O(50kRad)]

- Replaced all 24 PIN diodes
- Replaced 5/12 MOSFETs
- Installed 1 SVD ladder

(done in single 9hr access 2/25)

HER Chamber meltdown (2/28)
Subsequent improvements:

- MOSFET readout automated (~3/1)
- ladder readout installed (~3/4)
- Thermal isolation (~3/5)
- Installed 2nd SVD ladder

A tight squeeze!

r/φ view (from OHO)

- Radiation dose: diodes, MOSFETs, drift tubes
- Energy spectrum/Bhabha: CsI/BGO
- Temperature: beampipe and diode RTDs

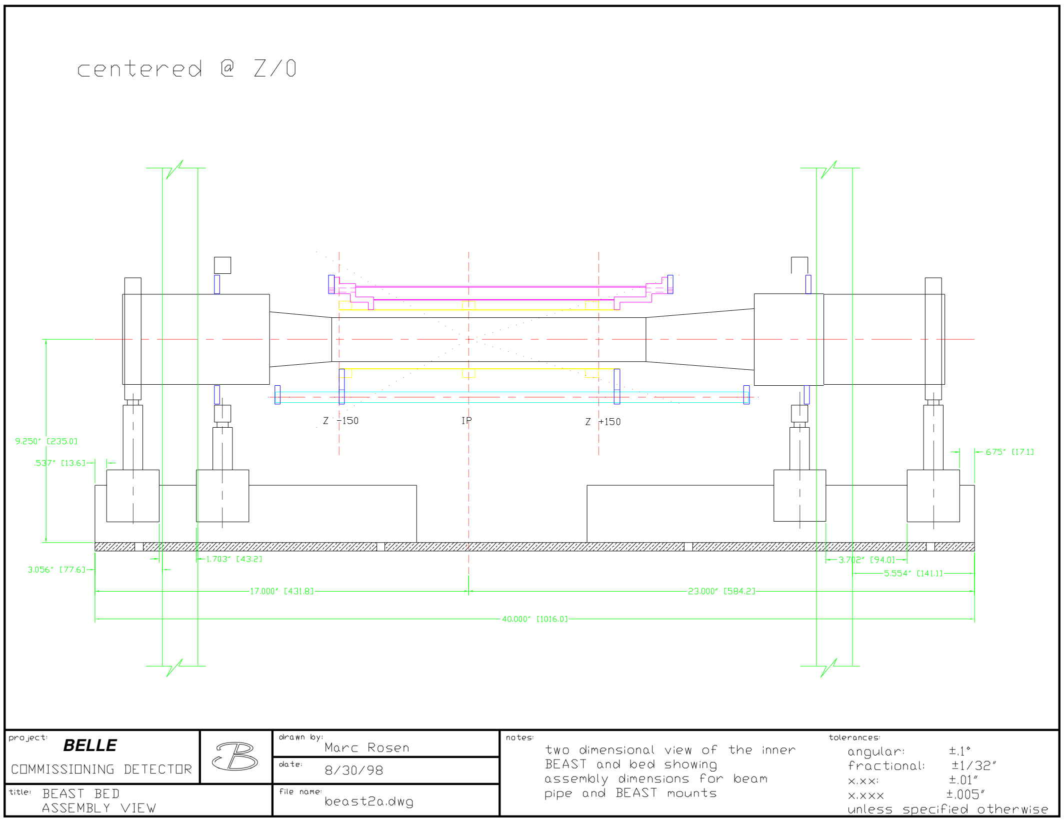
BEAST Elements

- PIN Photodiodes (24 in 12 pairs)
  - Measure I_{leak} [100mV/nA]
  - Energy deposition [25mRad/s/V]
  - **however**, I_{leak} (damage) $\sim$ 2.5nA/kRad†
- MOSFETs (12)
  - Measure V_{th} shift
  - **R**ad [2.4 Rad/mV] and **K**rad [13.2 Rad/mV]
  - Small dose measurements inaccurate
- Drift Tubes
  - Prop. mode: scaler rates and total I
  - Track density estimates - *pileup problems*
- EFC (BGO) partial array
  - Coincidence rates (Bhabhas)
  - Energy spectrum - *pileup problems*
- CsI array
  - Energy spectrum - *pileup problems*

- SVD ladders
  - Half-ladders of modest quality
  - Occupancy - *pileup problems*
  - Test sparsification algorithms

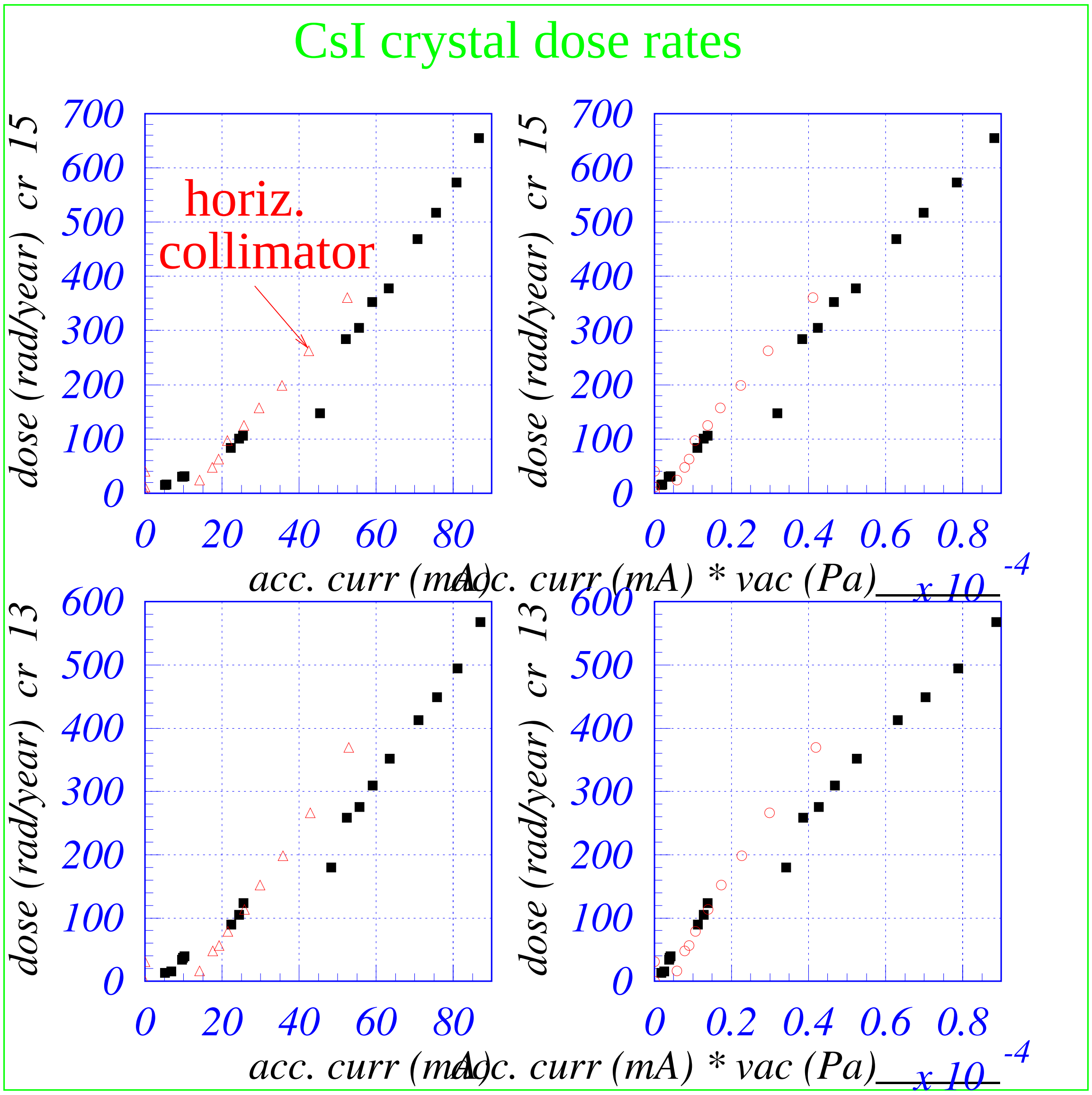
BEAST Operational Issues

- Temperature
  - Beampipe rises $2^oC/50$mA (HOM losses)
  - Diodes ($I_{\text{leak}} \propto e^{\frac{c}{kT}}$)
  - Addition of SVD ladder → diodes
  - RTD instabilities
- Dynamic range
- Bhabha rates:



project: **BELLE**
COMMISSIONING DETECTOR
title: BEAST BED
ASSEMBLY VIEW
drawn by: Marc Rosen
date: 8/30/98
file name: beast2a.dwg
notes: two dimensional view of the inner BEAST and bed showing assembly dimensions for beam pipe and BEAST mounts
tolerances:
angular: ±.1°
fractional: ±1/32"
x.xx: ±.01"
x.xxx ±.005"
unless specified otherwise

CsI Doses



- typically less than 1kRad/yr (endcap) at 100mA, current vacuum
- a tighter constraint on background from occupancy

Dust "burst" characteristics

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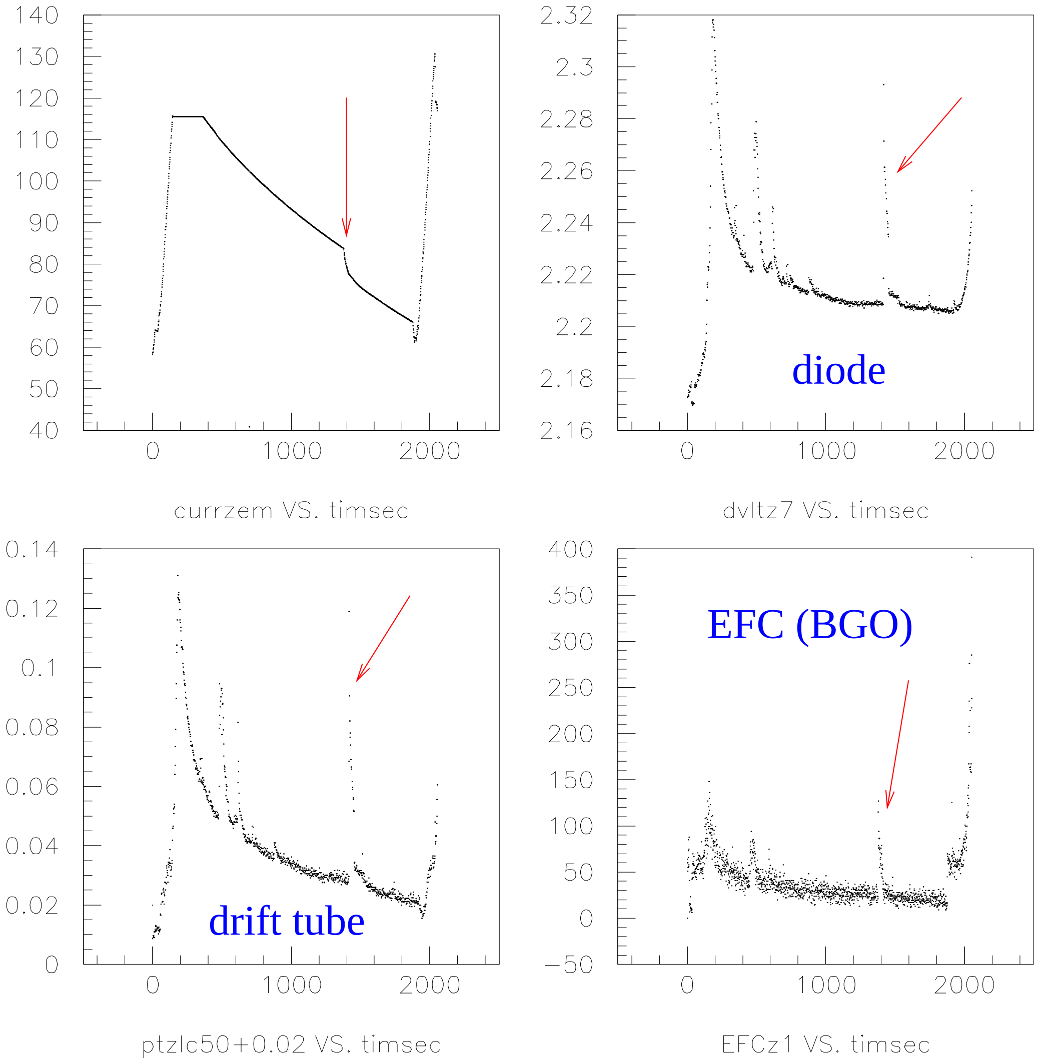
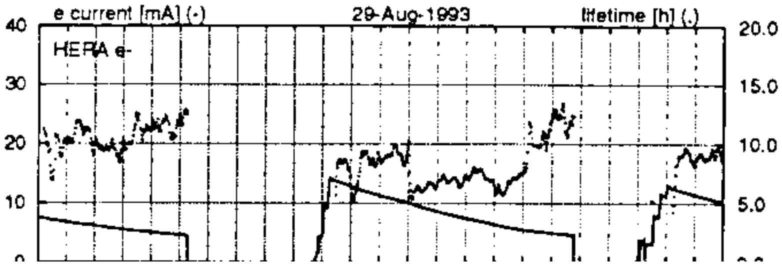
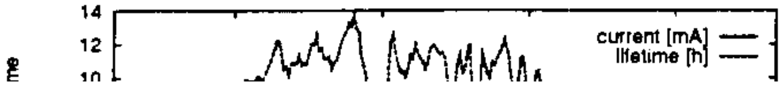


- *not* see in LER
- some sort of positive ion trapping?
- something similar seen before

HERA: A "dust" Problem





- traced to ion pump problems

Dust Busting

- if hard particulates, should be able to “cook” with high current beams
- frequency should drop over time

HER vacuum still poor after breach

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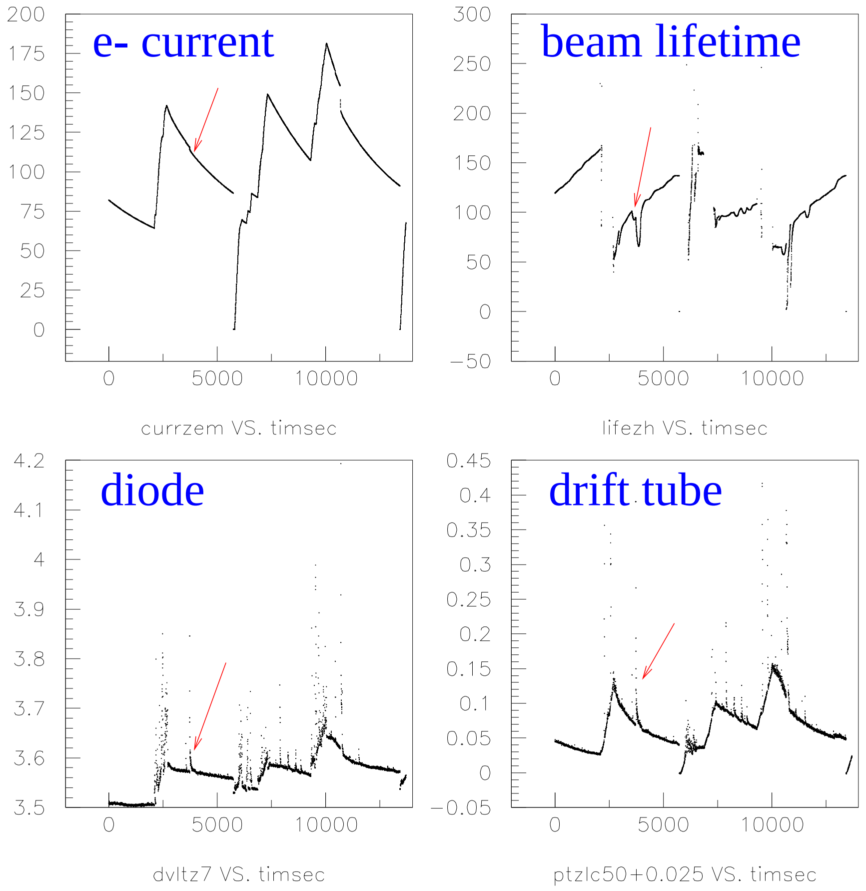
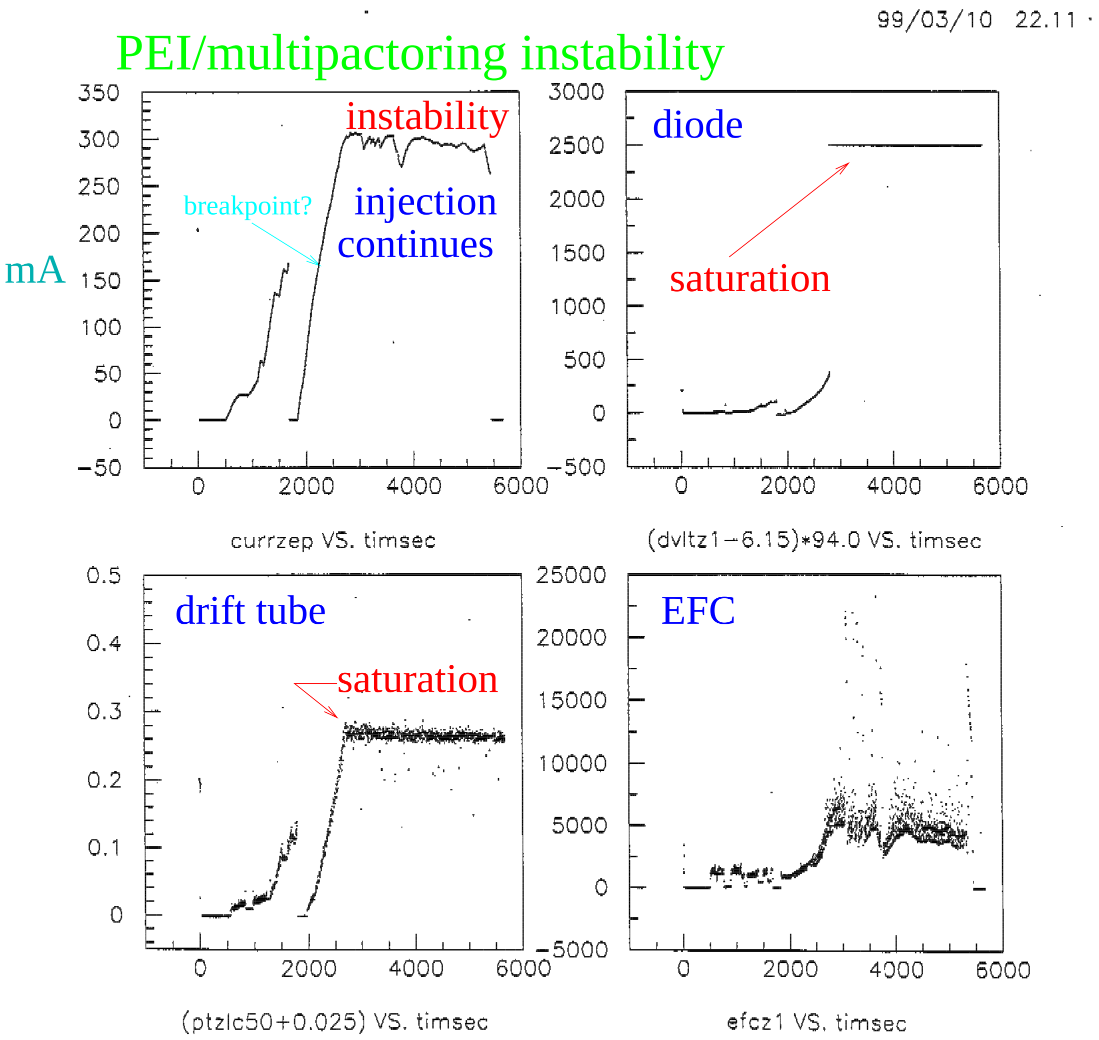


- will impact bake-out
- dust theory in its infancy

LER: PEI Instability

- Onset at certain current density



- A couple of theories
- Sets a limit on LER current storage
- dust theory in its infancy

BEAST Proposal for Commissioning (I)

1. Observe improvement of HER, LER backgrounds with vacuum chamber baking/improvements in machine optics
    - 1 dedicated BEAST run/week with sequential LER, HER fills
    - use RF voltage to cover large range in I_{beam}
    - **3 shifts** `after 3/26`
2. Systematically test effects of collimators on beam background
    - according to simulation, a factor of 5 reduction is possible
    - Tsukuba straight sections: **1 shift** `3/29-4/6`
    - Arc collimators: **1 shift** `3/29-4/6`
3. Understand background from injection and test background dependence on injection parameters
    - Define relevant parameters? **1 shift** `3/29-4/6`

    Onset of instabilities associated with background bursts in high current fills.
    - Other causes??
    - injection timing?

BEAST Proposal for Commissioning (II)

1. Understand effect of steering/magnet parameters on beam background
    - **1 shift** `3/29-4/6`
2. Find localized sources of background
    - Heat `neg` pumps to make pressure bumps
    - **1 shift** `4/4-4/10`
3. Study backgrounds with colliding beams
    - Is $\mathrm{BKGND}^{\mathrm{total}} = \mathrm{BKGND}^{\mathrm{HER}} + \mathrm{BKGND}^{\mathrm{LER}}$?
    - **3 shifts** `4/11-4/17`
4. Measure SVD occupancies and radiation damage
    - $f(I_{\mathrm{beam}}, \mathrm{bkgnd})$
    - Understand $CsI(Tl)$ and drift tube performance under high backgrounds

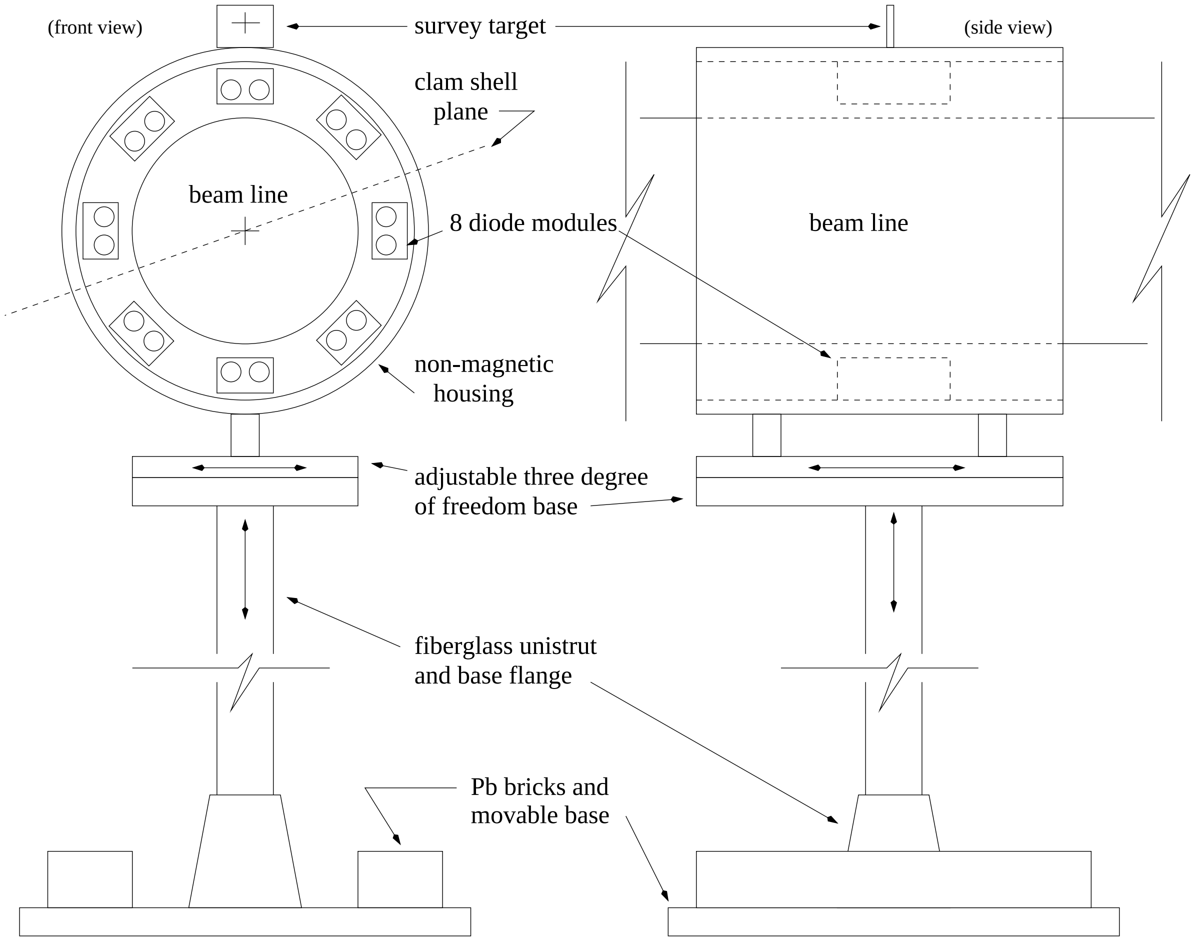
Leading to a **key decision**

- Decide on a criterion for BELLE roll-in *OR*
- limits on KEK-B luminosity from BELLE (f(bkgnd))

The BEAST *will* not die

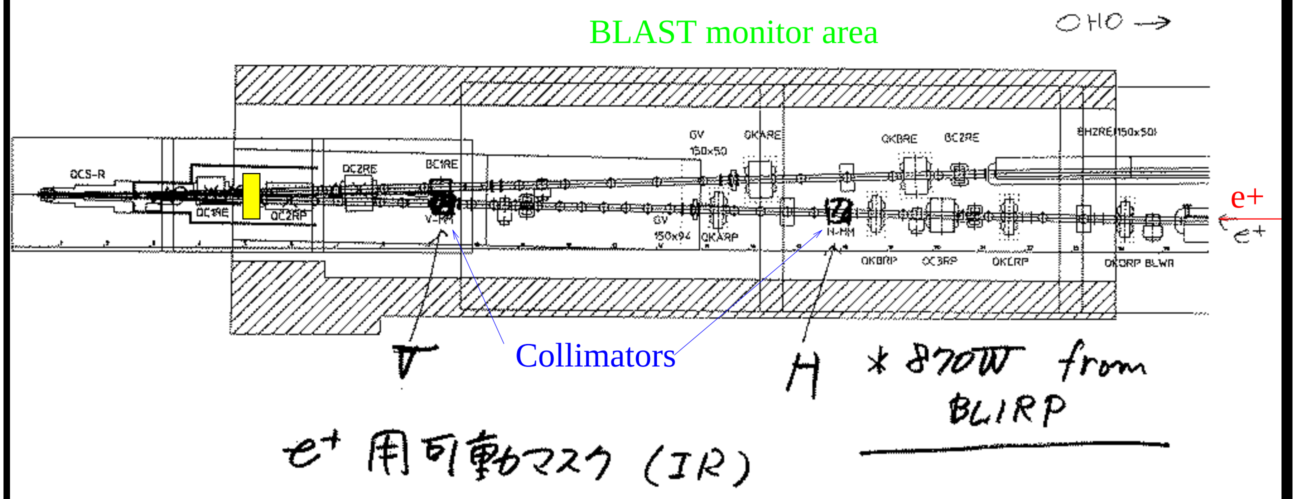
- BEAST removed from IP `4/19`
- Like all good beasts, will mutate

BLAST: Beam Loss Array for Straight Transport sections



Commissioning is not over

- BLAST elements to provide detailed beam loss diagnosis on the straight sections
  - background remediation
  - collimator effects on beam
  - increase Luminosity - detailed understanding of final focus
- BLAST (initially) largely composed of cannibalized BEAST components
- make mobile - troubleshoot *hotspots*



An Informal Summary

- The **Optimist** says:
  - *the glass is half full*
    - have obtained high LER and HER currents
    - can probably get $L \sim 2 \times 10^{33}$
    - vacuum improving
- The **Pessimist** says:
  - *the glass is half empty*
    - emittances large
    - vacuum near IP
    - LER: `PEI` and HER: `‘‘dust’’`
    - orbit drift
    - even if survive dose, track densities
- The **BEAST** says:
  - *halfway to* **glass 1.1**
- `An analogy`: BELLE is like a high-performance sports car

- What is know as of today:
  - radiation damage *injection* dominated
  - track densities
  - trigger rate
- Machine studies ongoing
  - moveable mask studies (*simulation* next talk)
  - COD drift
  - **will** continue after roll-in
  - new machine optics after roll-in
- Name changes, mission continues
  - BEAST → BLAST
    - ∗ Background remediation
    - ∗ Luminosity boost
    - ∗ Vertexing improvement (see later presentations)