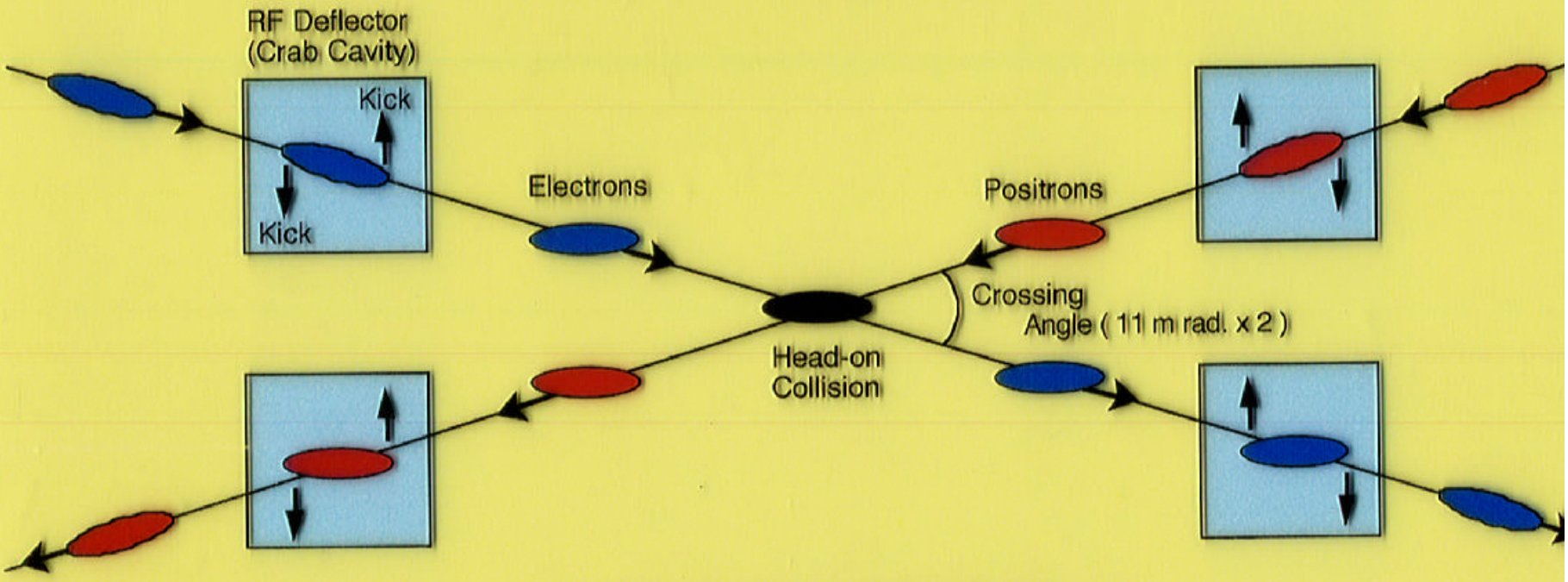
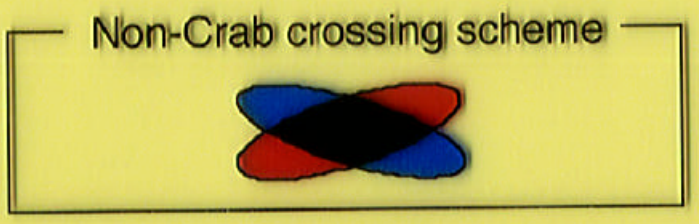
Crab Crossing Scheme

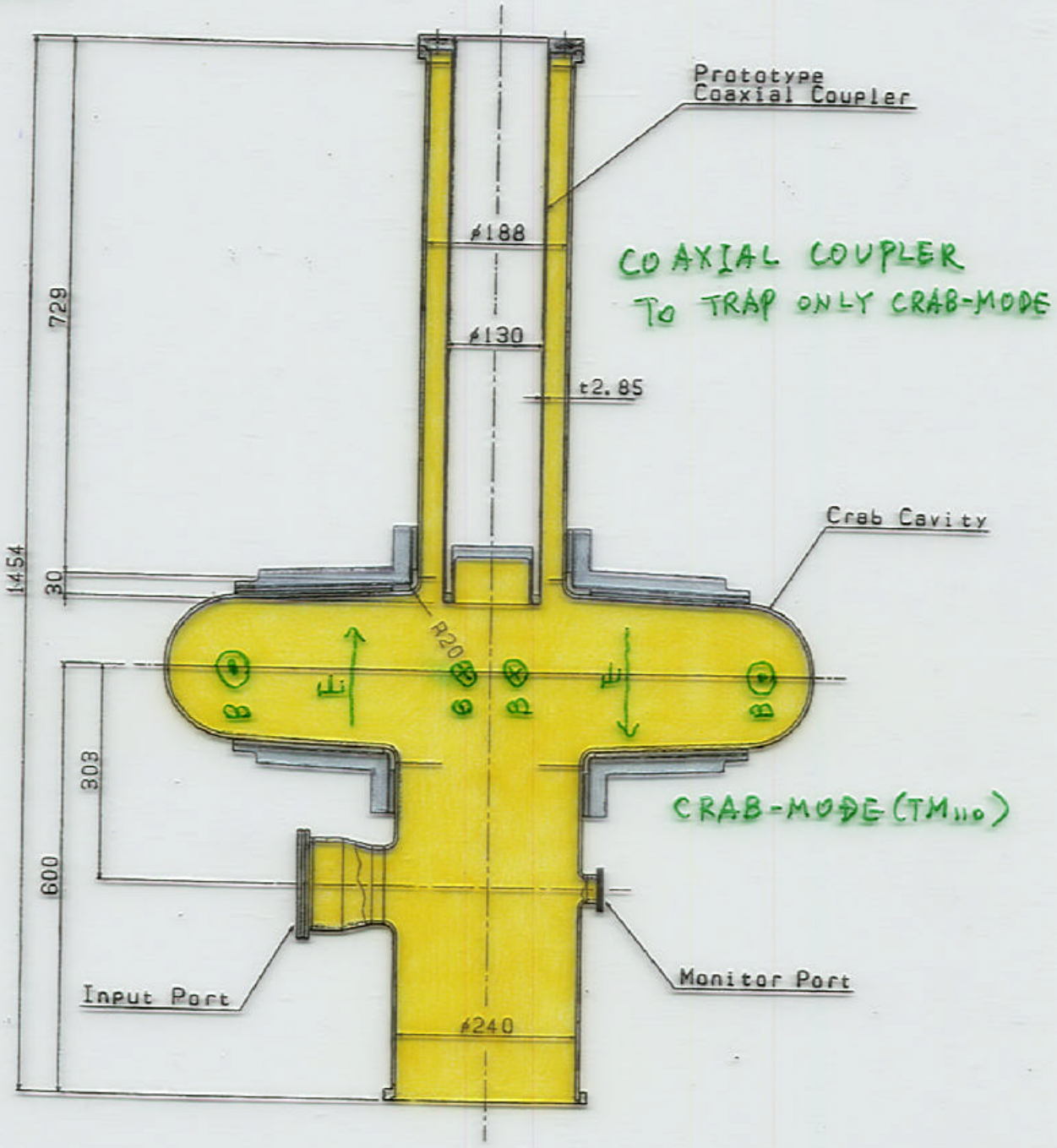




The Crab crossing scheme allows a large crossing angle collision without introducing any synchrotron-betatron coupling resonances.

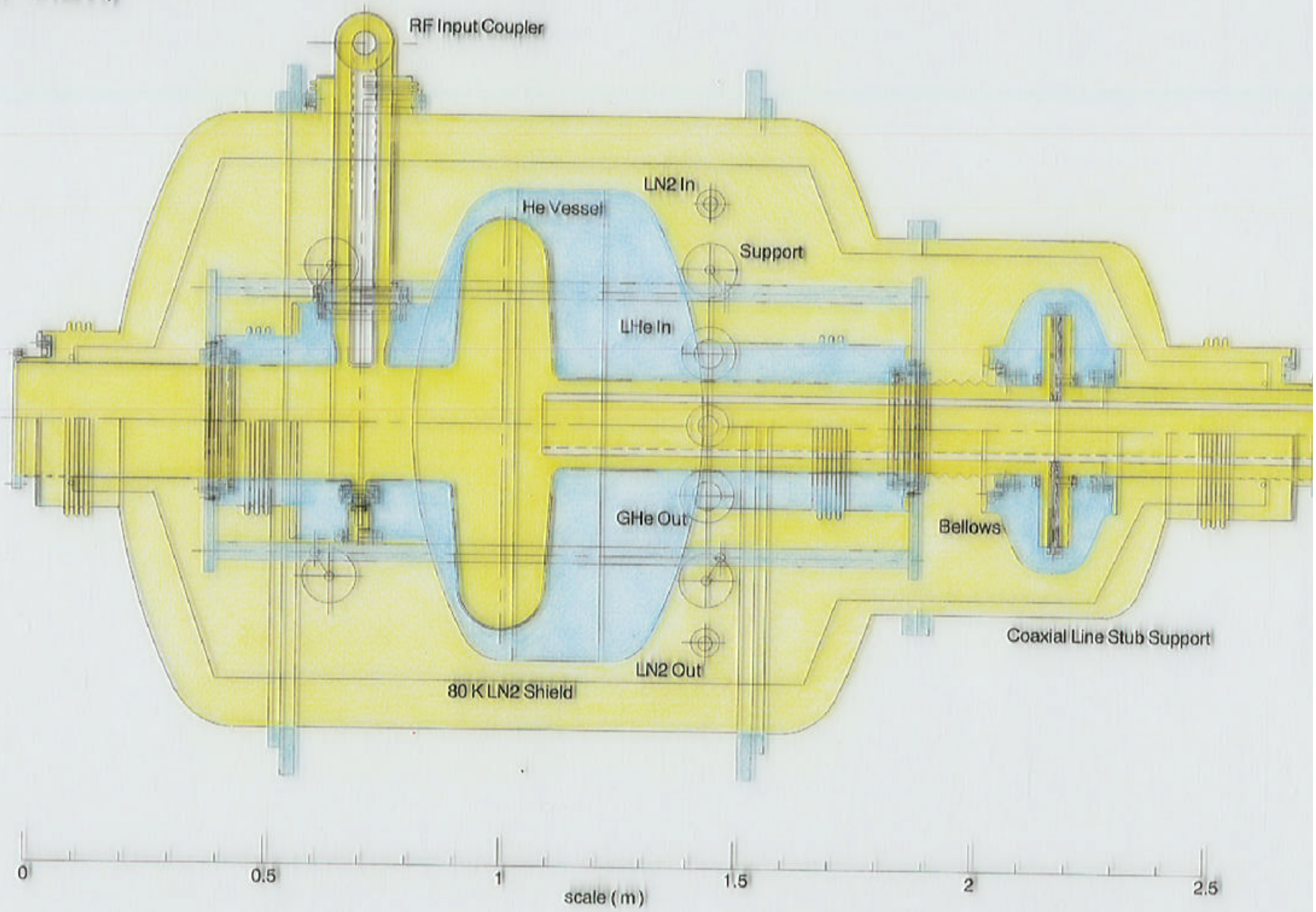
Crab Cavity Group

SQUASHED CELL CAVITY



Cross section of the Crab Cavity with the Prototype Coaxial Coupler

CRYOSTAT FOR KEKB CRAB CAVITY
(TOP VIEW)



- We are developing crab cavities in order to reach the tuneshift of 0.05. Crab cavities will be, if necessary, installed in 2003.

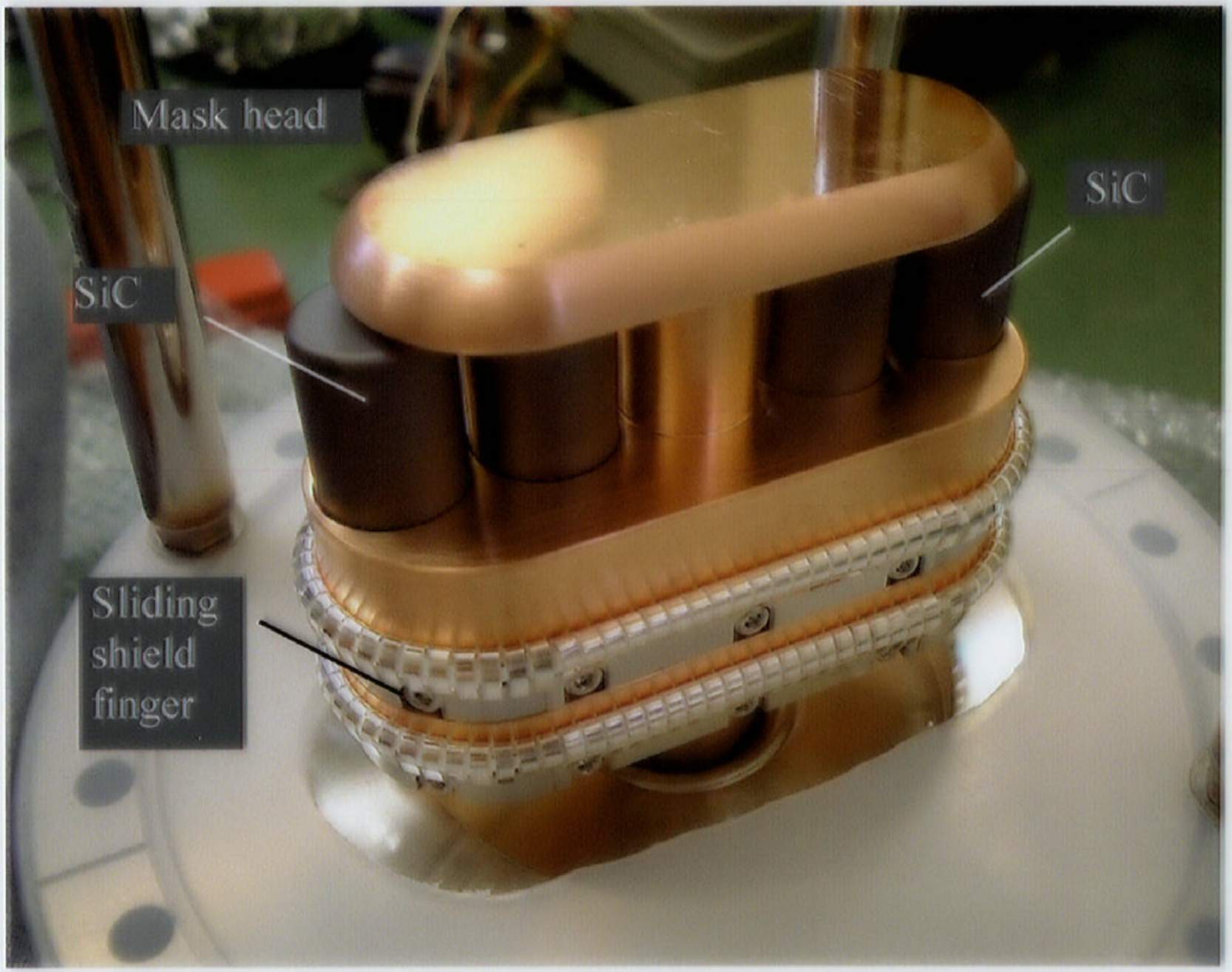
3. β_y^*

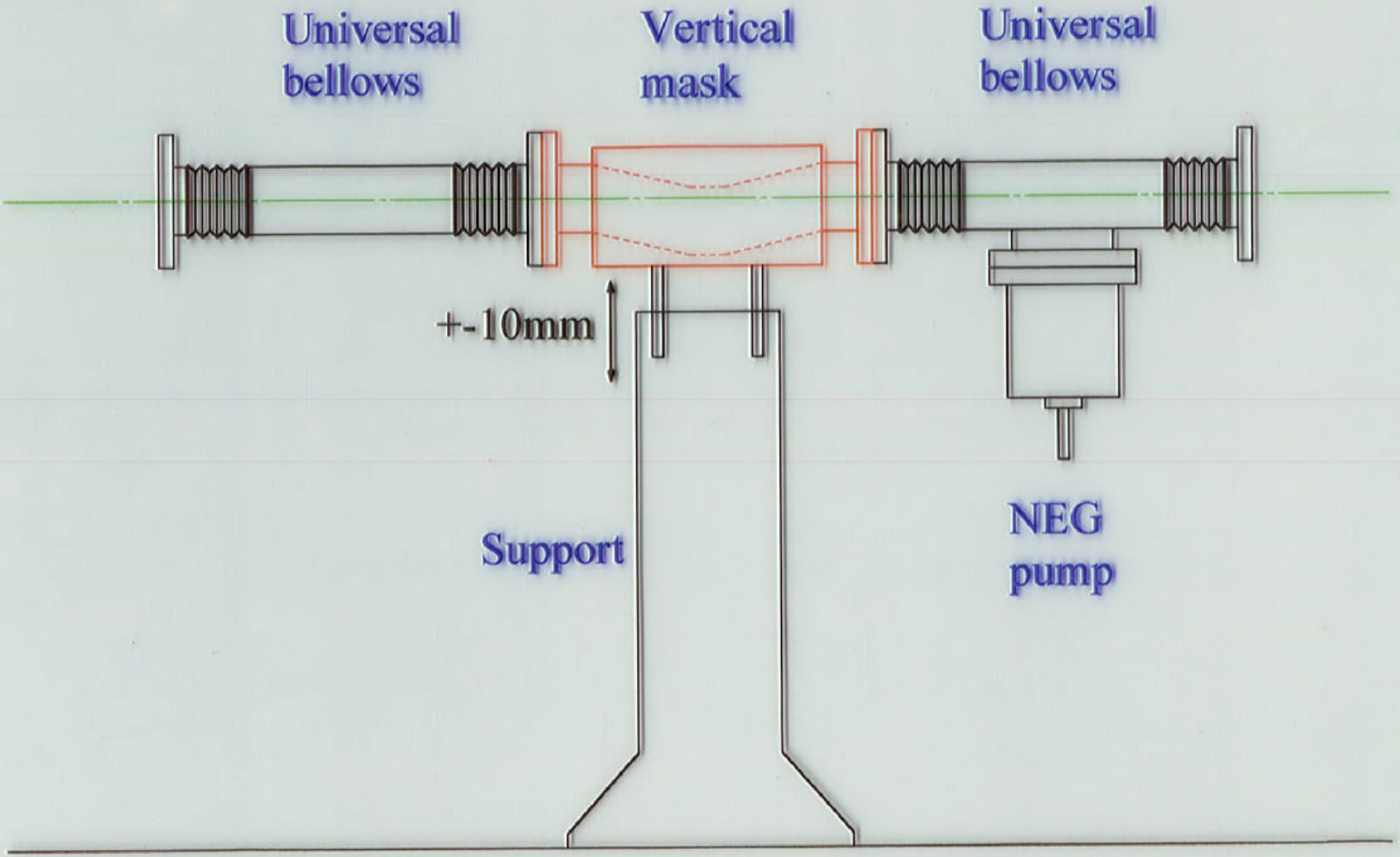
- 7 mm βy^* (design is 10 mm) has been already achieved

3. Beam currents

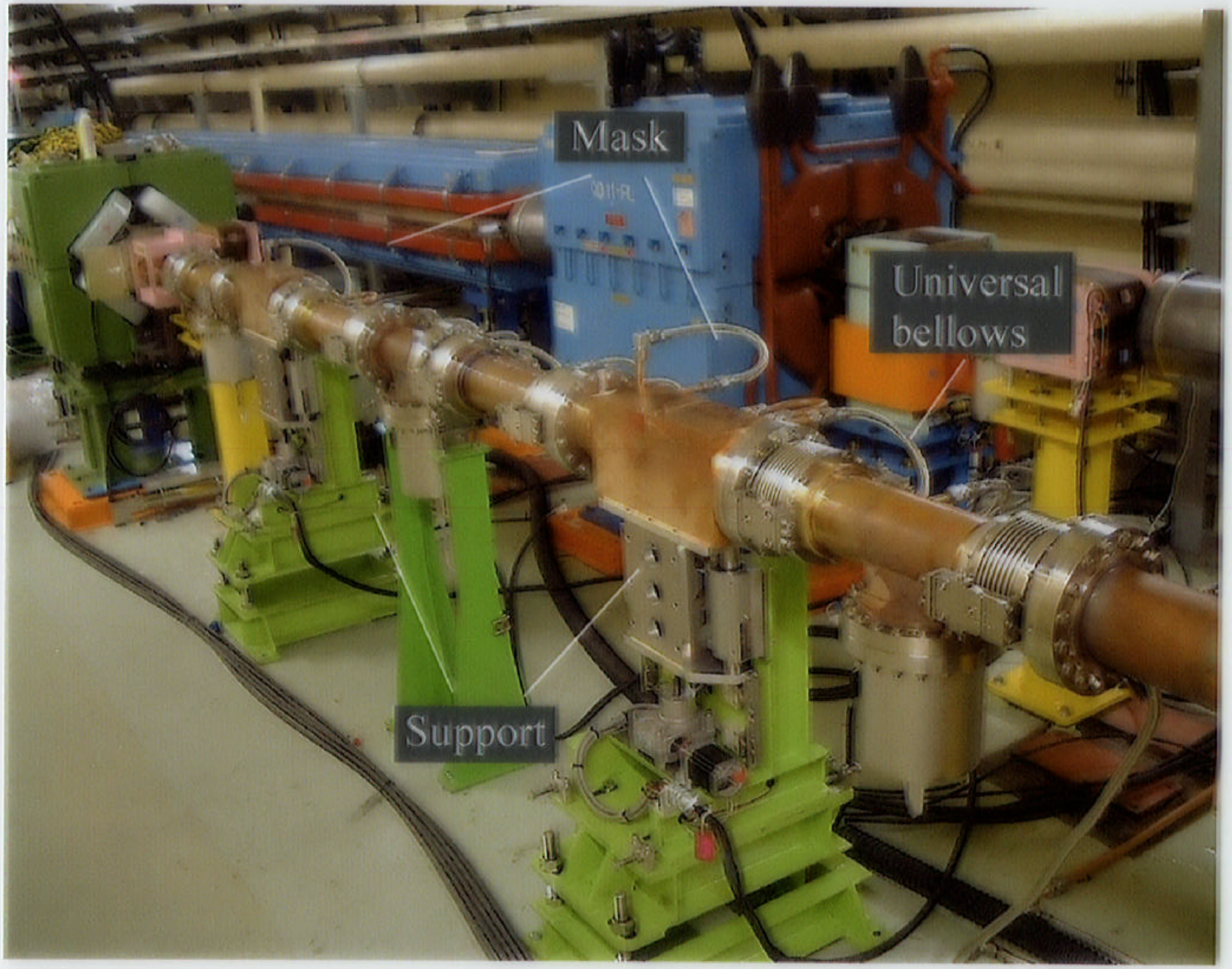
- Weak vacuum components (movable masks and IP bellows) limited the stored currents.

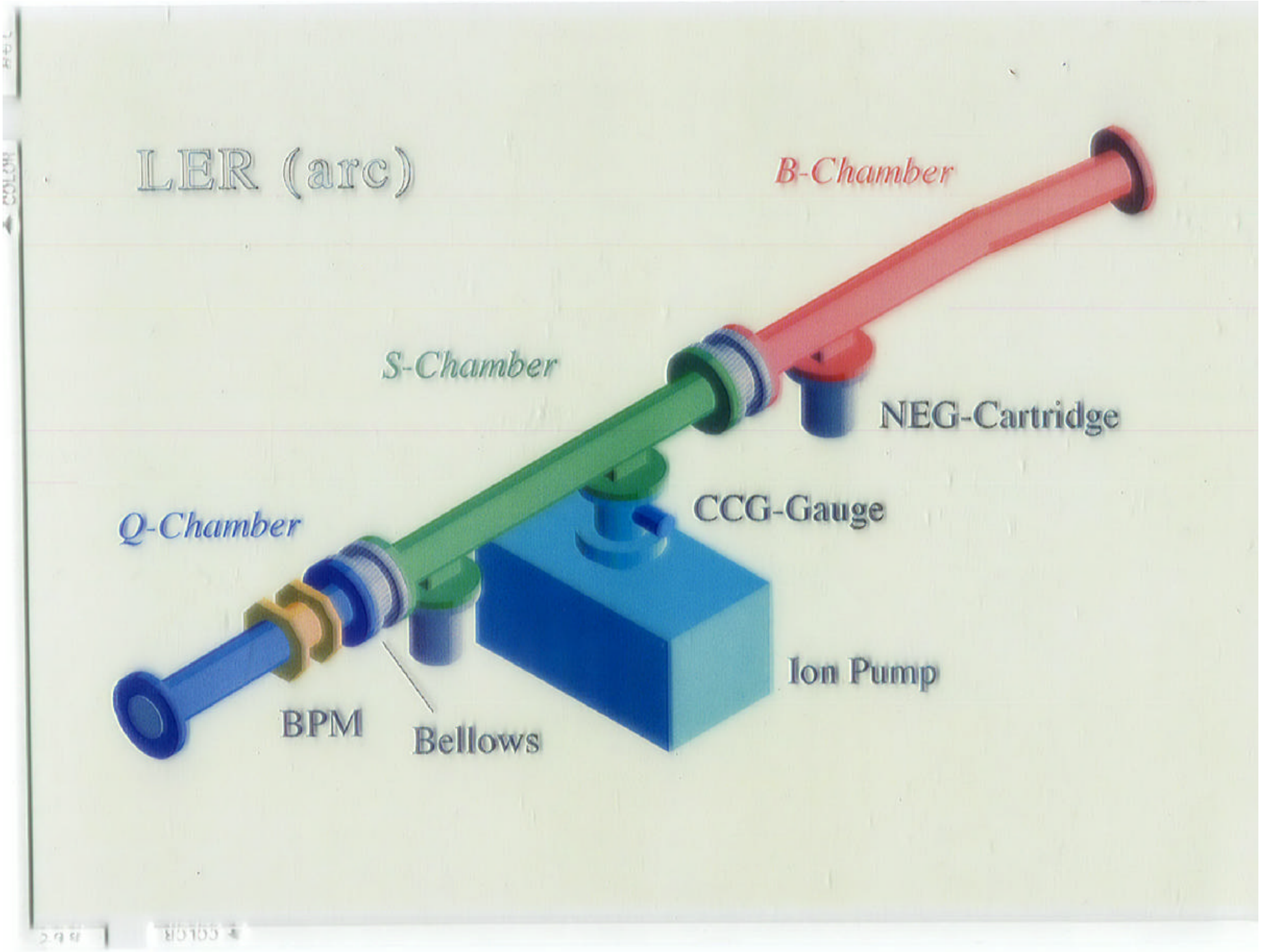
- During 2000 summer shutdown these components have been replaced.


Mask head
SiC
SiC
Sliding
shield
finger



Configuration of Type-1 movable mask.


Mask
Universal bellows
Support


LER (arc)
B-Chamber
S-Chamber
NEG-Cartridge
CCG-Gauge
Q-Chamber
Ion Pump
BPM
Bellows

- HER current is still limited by movable masks. We will be ready to replace them anytime after April.

4. Beam blowup in LER

- Photoelectrons excite head-tail instabilities in LER and beams blow up.

- This beam blow-up limits the luminosity.

- Effect of C-yoke magnets to cure the problem was not so evident.

- Solenoid coils were wound over LER vacuum chamber during 2000 summer shutdown and 2000-2001 winter shutdown.

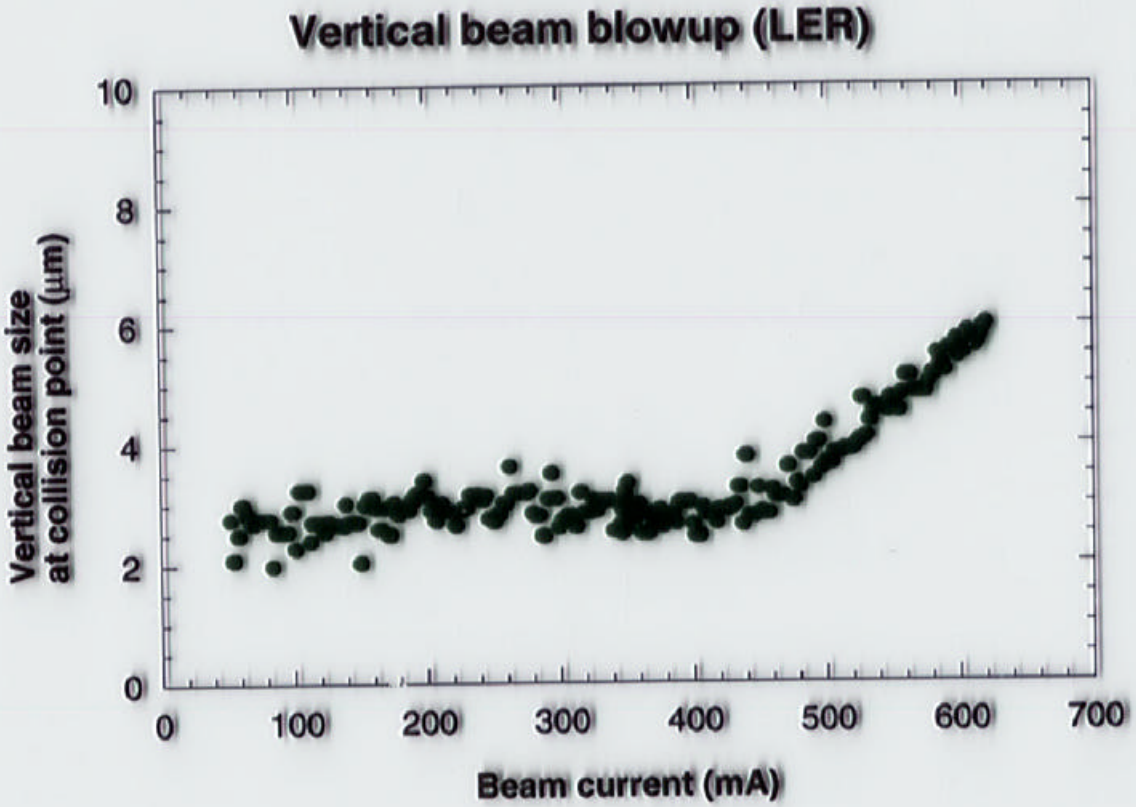
3.Beam break-up(BBU)/Head-tail instability by the photoelectron cloud

To explain the blow-up, the beam break up/head-tail instability in a bunch caused by the electron cloud is proposed.

A. Model (F. Zimmermann, K. Ohmi)

- Electrons which is generated by the synchrotron radiation form a cloud by the attractive force of multi-bunch positron beam.

- Beam breakup/head-tail oscillation in a bunch occurs by the mediation of the cloud.


Vertical beam blowup (LER)
Vertical beam size at collision point (μm)
10
8
6
4
2
0
0
100
200
300
400
500
600
700
Beam current (mA)

- 1999 Autumn - 2000 Summer

  Permanent magnet quads
  (C-Yoke) were used

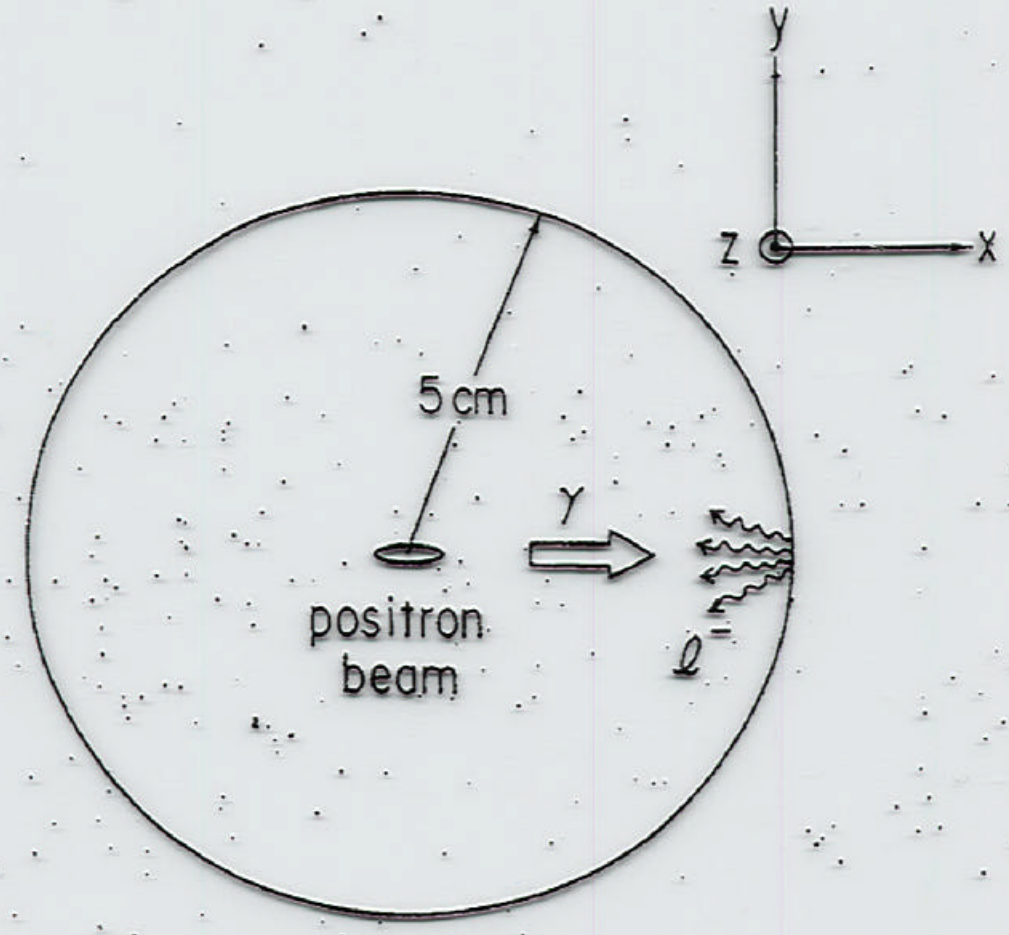
- 2000 Summer Shutdown

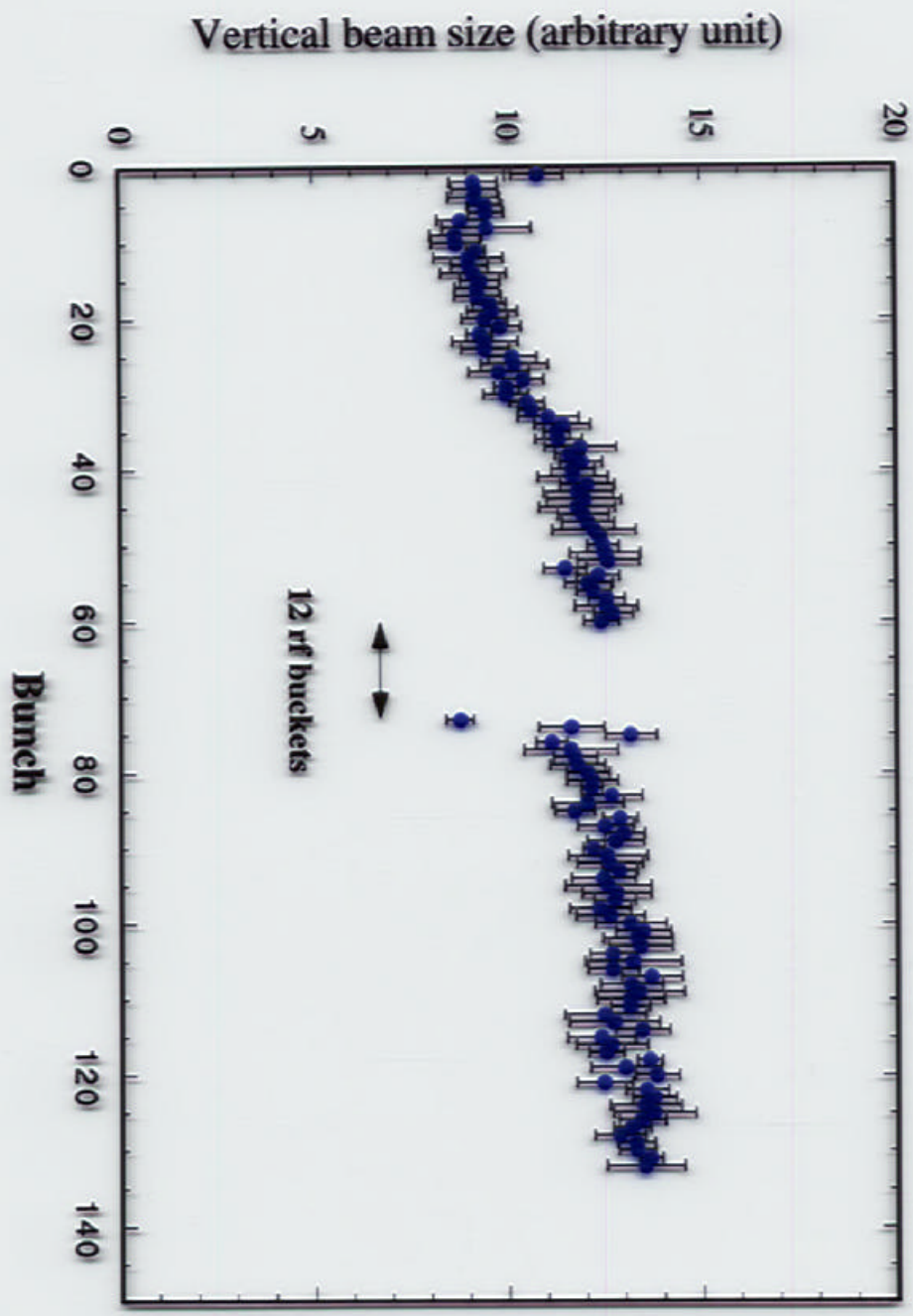
  Solenoids were wound over
  800 m

- 2000 - 2001 New Year Shutdown

  Solenoids were wound over
  additional 400 m

Photo-Electron Instability



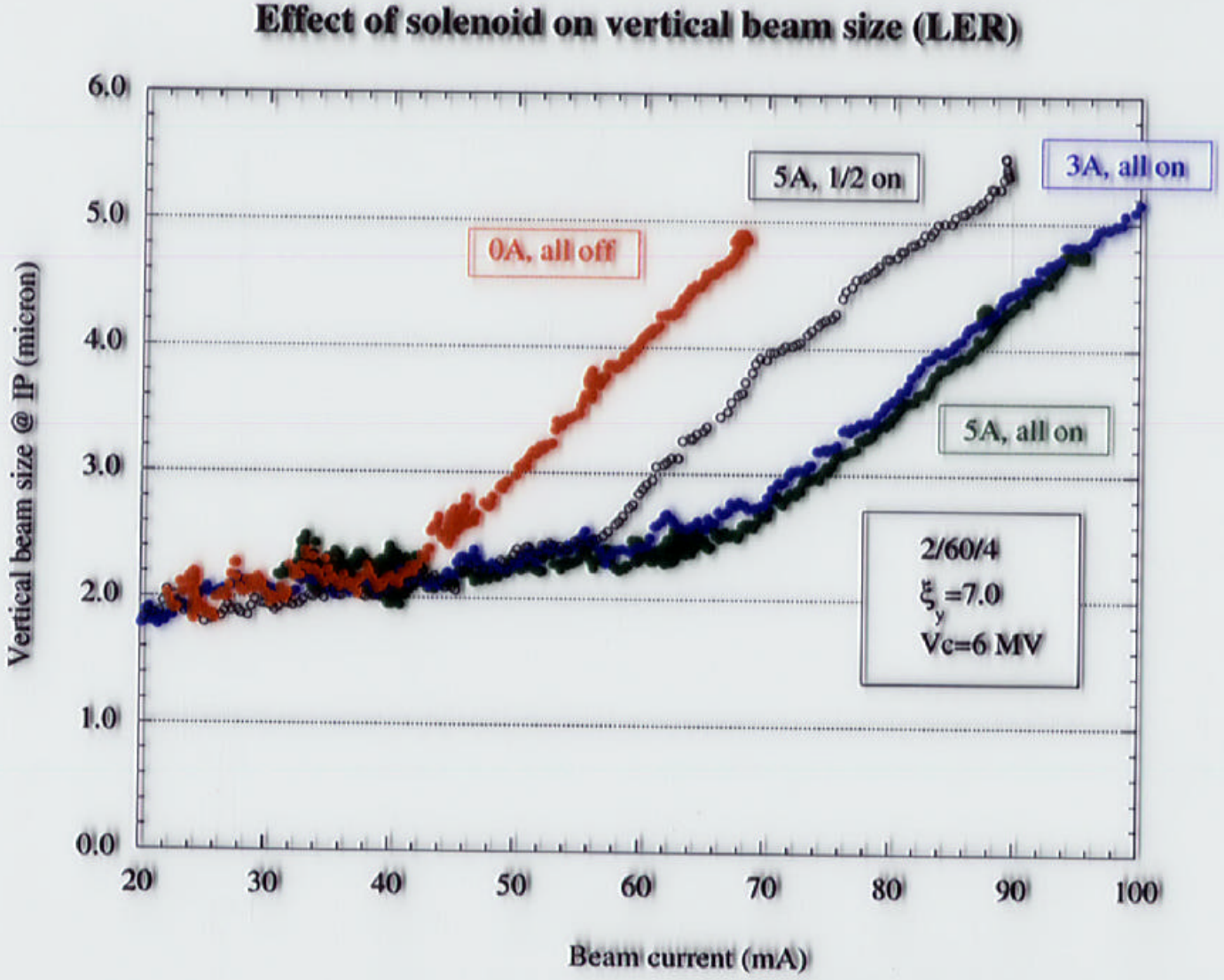

Vertical beam size (arbitrary unit)
0
5
10
15
20
0
20
40
60
80
100
120
140
Bunch
12 rf buckets

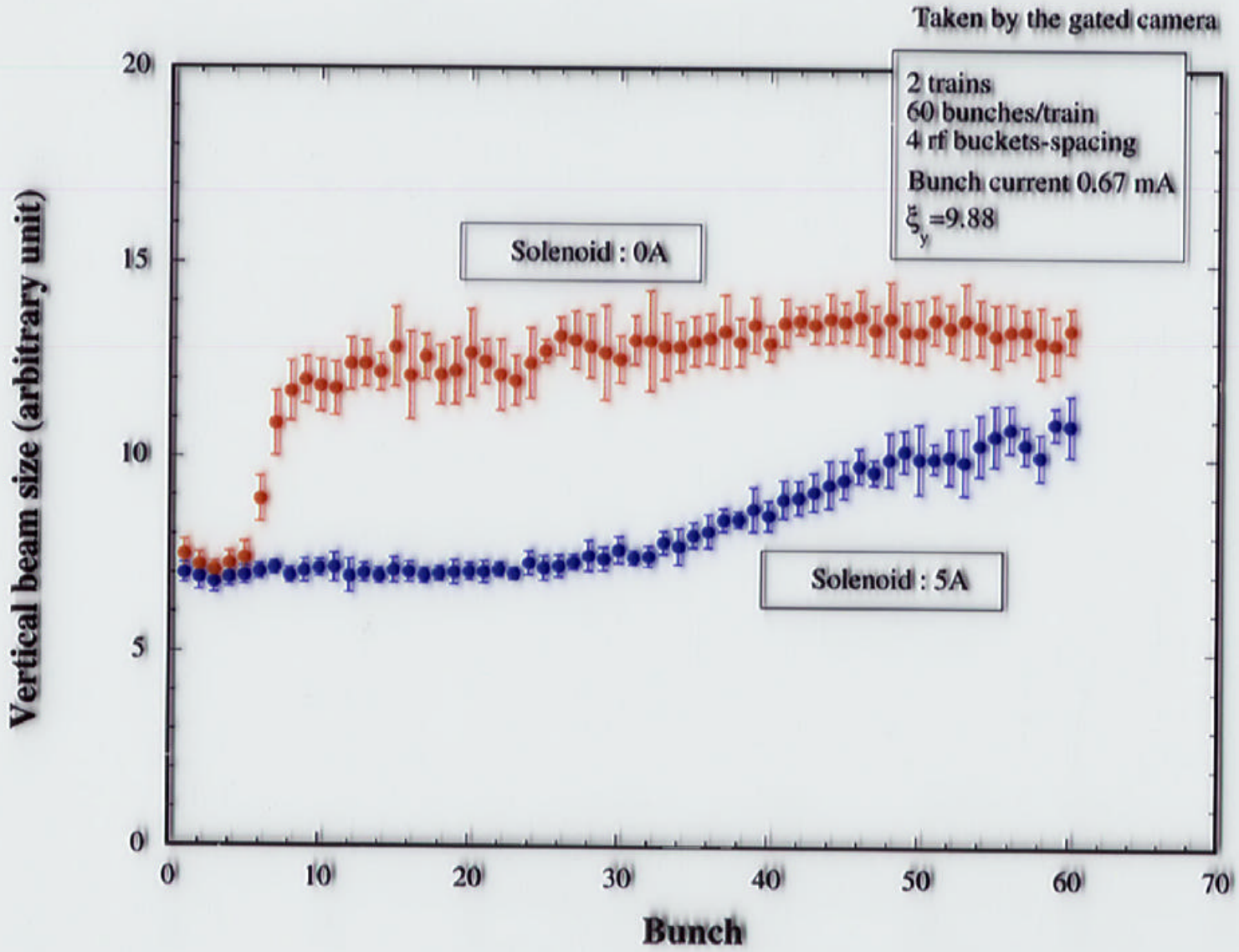
- Solenoid coils partly cured the beam blow-up. We are not sure whether solenoids will cure the problem completely, after every field-free region is covered by them.

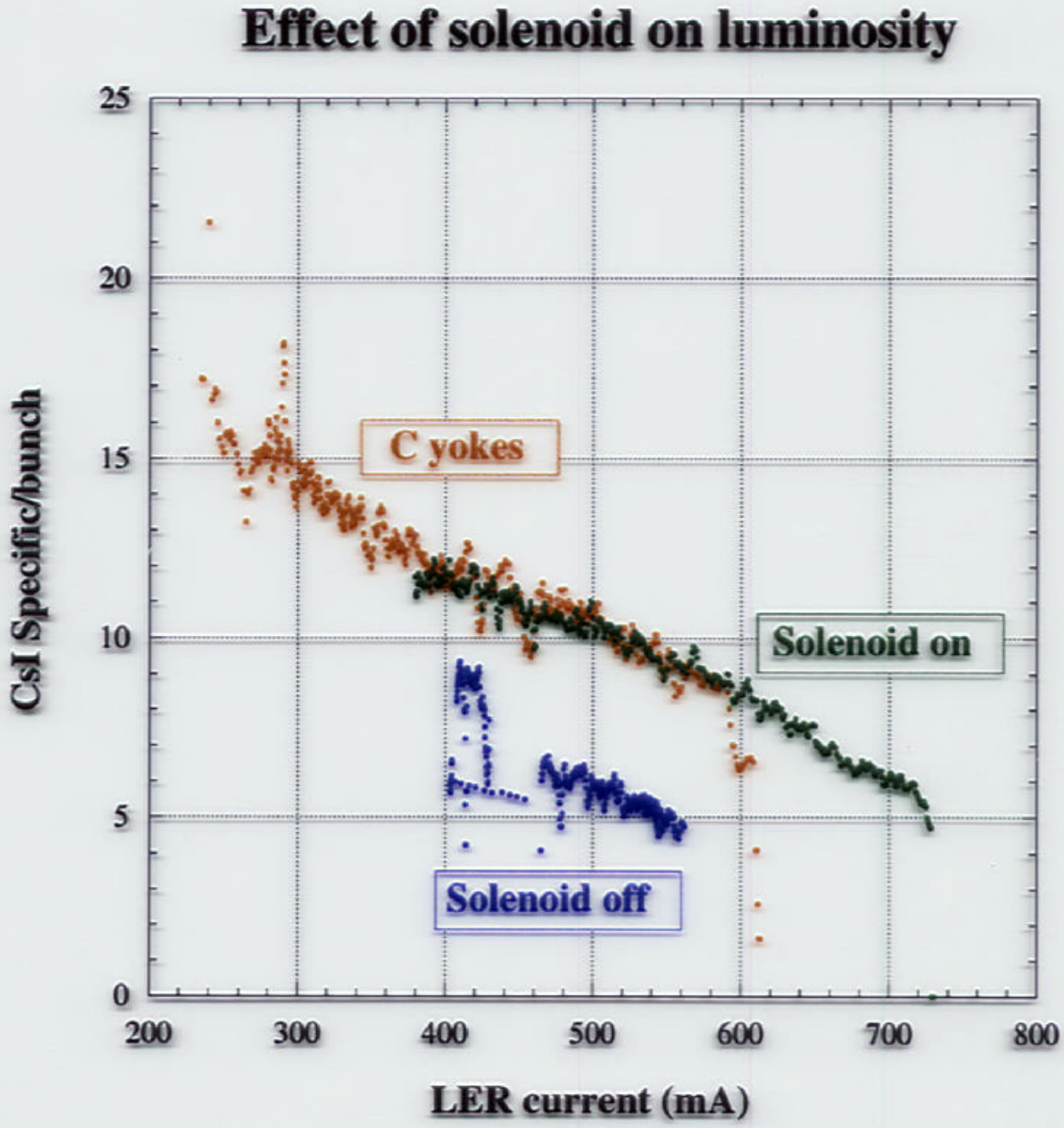
- R&D on ante-chamber has just started.

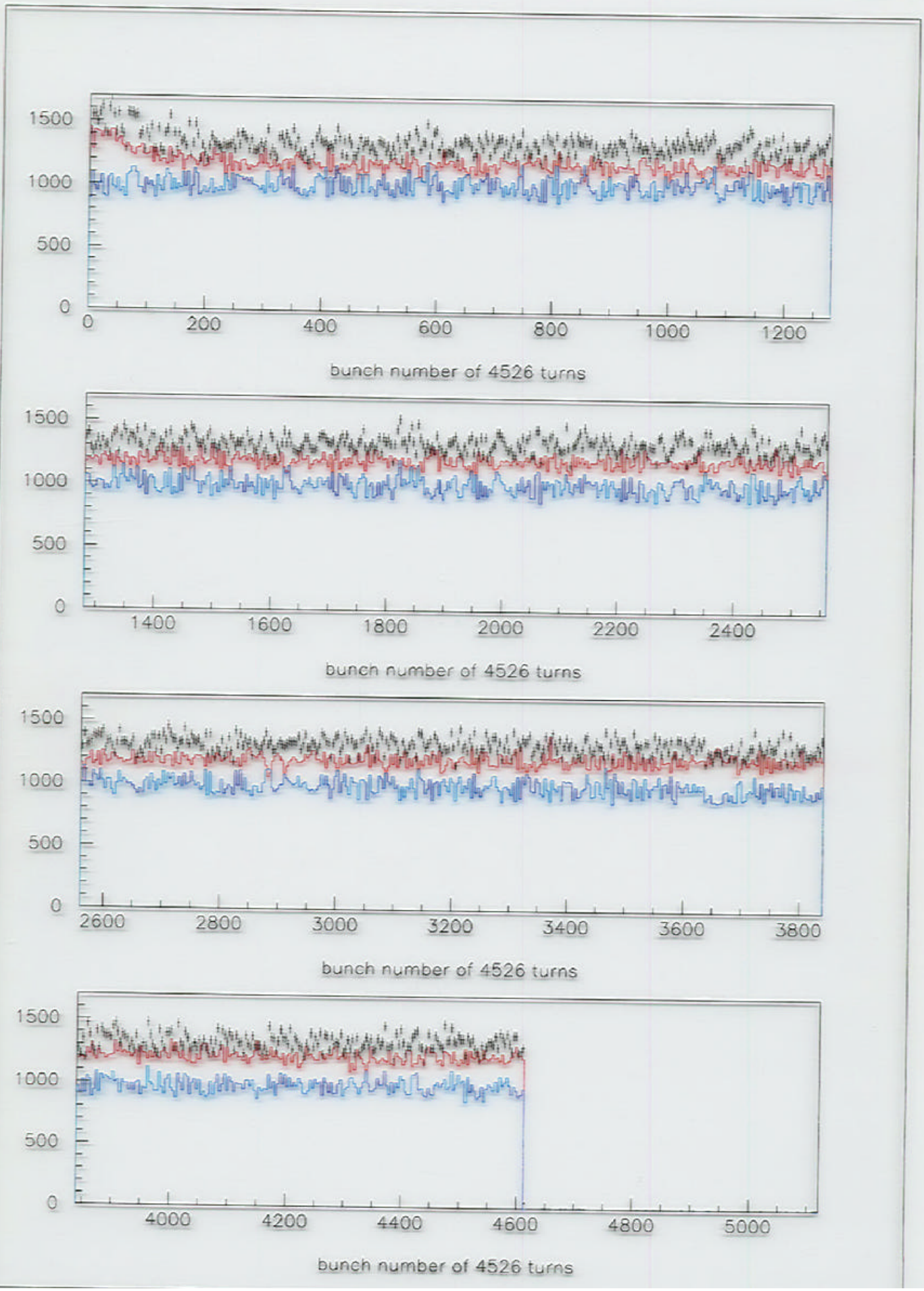
5. Prospects of luminosity increase

- By the summer of 2003, luminosity will go up by increasing currents an decreasing bunch spacing, even with mild beam-beam tuneshift of 0.03 up to $7 \times 10^{33} cm^{-2} s^{-1}$. We assume that beam blow-up will be cured.


Effect of solenoid on vertical beam size (LER)
Vertical beam size @ IP (micron)
6.0
5.0
4.0
3.0
2.0
1.0
0.0
20
30
40
50
60
70
80
90
100
Beam current (mA)
0A, all off
5A, 1/2 on
3A, all on
5A, all on
2/60/4
ξy=7.0
Vc=6 MV


Taken by the gated camera
2 trains
60 bunches/train
4 rf buckets-spacing
Bunch current 0.67 mA
ξ_y =9.88
Solenoid : 0A
Solenoid : 5A
Vertical beam size (arbitrary unit)
Bunch
0
5
10
15
20
0
10
20
30
40
50
60
70


Effect of solenoid on luminosity
CsI Specific/bunch
LER current (mA)
C yokes
Solenoid on
Solenoid off
0
5
10
15
20
25
200
300
400
500
600
700
800


1500
1000
500
0
0
200
400
600
800
1000
1200
bunch number of 4526 turns
1500
1000
500
0
1400
1600
1800
2000
2200
2400
bunch number of 4526 turns
1500
1000
500
0
2600
2800
3000
3200
3400
3600
3800
bunch number of 4526 turns
1500
1000
500
0
4000
4200
4400
4600
4800
5000
bunch number of 4526 turns

とらぬ狸の皮算用

Sell the bear's skin
before one has caught
the bear

Prospects of Performance improvement

		Peak Luminoity ($cm^{-2}s^{-1}$)	Yearly Integrated Luminosity (fb^{-1})	Accumulated Luminosity (fb^{-1})
I↑	2000 fall-2001 summer	3×10^{33}	25	32
	2001 fall-2002 summer	5×10^{33}	41	73
	2002 fall-2003 summer	7×10^{33}	58	131
	2003 summer shutdown	Installation of crab cavities		
5↑	2003 fall-2004 summer	8×10^{33}	67	198
	2004 fall-2005 summer	10×10^{33}	83	281
	2005 fall-2006 summer	12×10^{33}	100	381

on the basis of two assumptions:

(1) photo-electron instabilities are cured,

(2) ξ_y goes up by crab-crossing

- **During summer shutdown of 2003 crab cavities will be installed. With high beam-beam tuneshift of 0.05, luminosity will reach 12 x $10^{33}cm^{-2}s^{-1}$ in 2006.**

- **More than 300/fb is expected to be accumulated before LHC-B produce physics.**

- **Discussion on super KEKB of $10^{35}cm^{-2}s^{-1}$ has just started.**