CESR-c Vacuum Performance

Yulin Li, Yun He and Nari Mistry
Laboratory for Elementary-Particle Physics
Cornell University, Ithaca, New York, USA

The 13th ICFA Beam Dynamics Mini-Workshop

Beam Induced Pressure Rise in Rings

Brookhaven National Laboratory, Upton, NY

December 9 – 12, 2003

Outline

- *CESR Layout*
- *CESR-c Conversion*
  - *Motivation and Objective*
  - *Hardware Modifications*
  - *Status and Performance*
- *CESR-c Vacuum System and Requirements*
- *Beam Conditioning and Wall-Pumping*

CESR Layout

Principal Parameters:

768 m Circumference

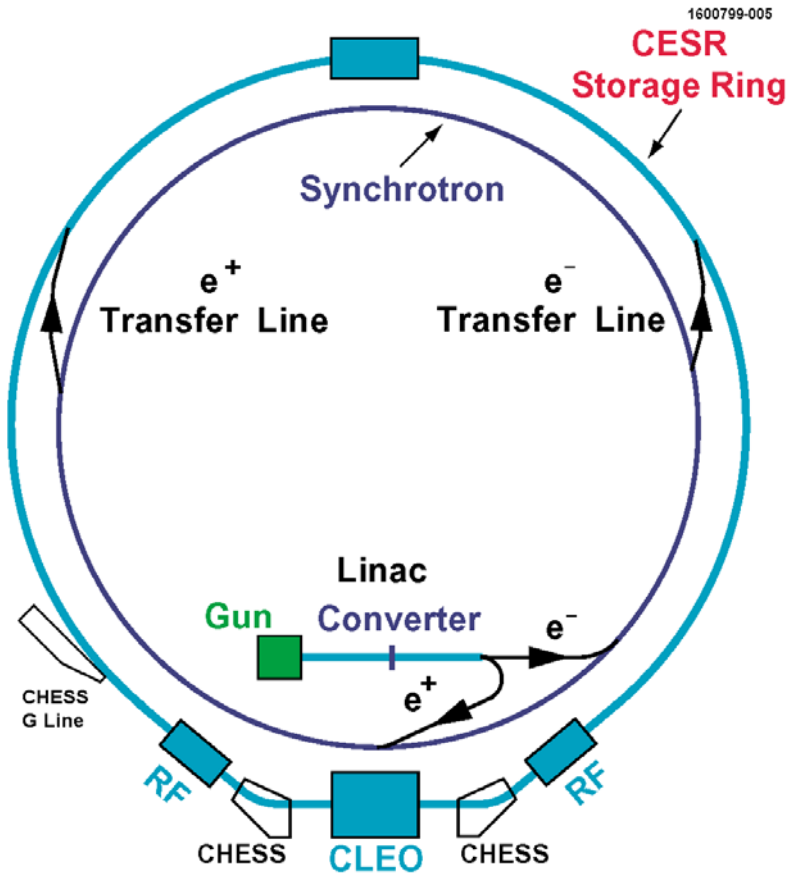
1.5-6 GeV beam energy

ξ_y > 0.06 @Υ(4S)

I_{beam} > 350 mA

L > 1.2 x 10^{33} $cm^{-2}sec^{-1}$ @Υ(4S)

45 bunches each e+, e-



CESR-c Conversion – Objectives

We propose to modify CESR to provide high luminosity colliding beams over the (beam) energy range from 1.5 to 5.6 GeV.

CESRc is designed to deliver 20-200x the world data sample in the 1.5-2.5 GeV (E_{beam}) range during it's proposed 3 year operation.

CESR will be continuing to provide beams for SR BLs to CHESS

Energies (E_{beam}) of interest and Luminosity goals:

J/ψ:	*1.55 GeV – 1.5 x 10^{32}*
Charm threshold (ψ''):	*1.885 GeV – 3.0 x 10^{32}*
Above DD threshold:	*2.1-2.5 GeV – 5.0 x 10^{32}*
Υ states:	*4.7-5.6 GeV – 10 x 10^{32}*

CESR-c Modifications

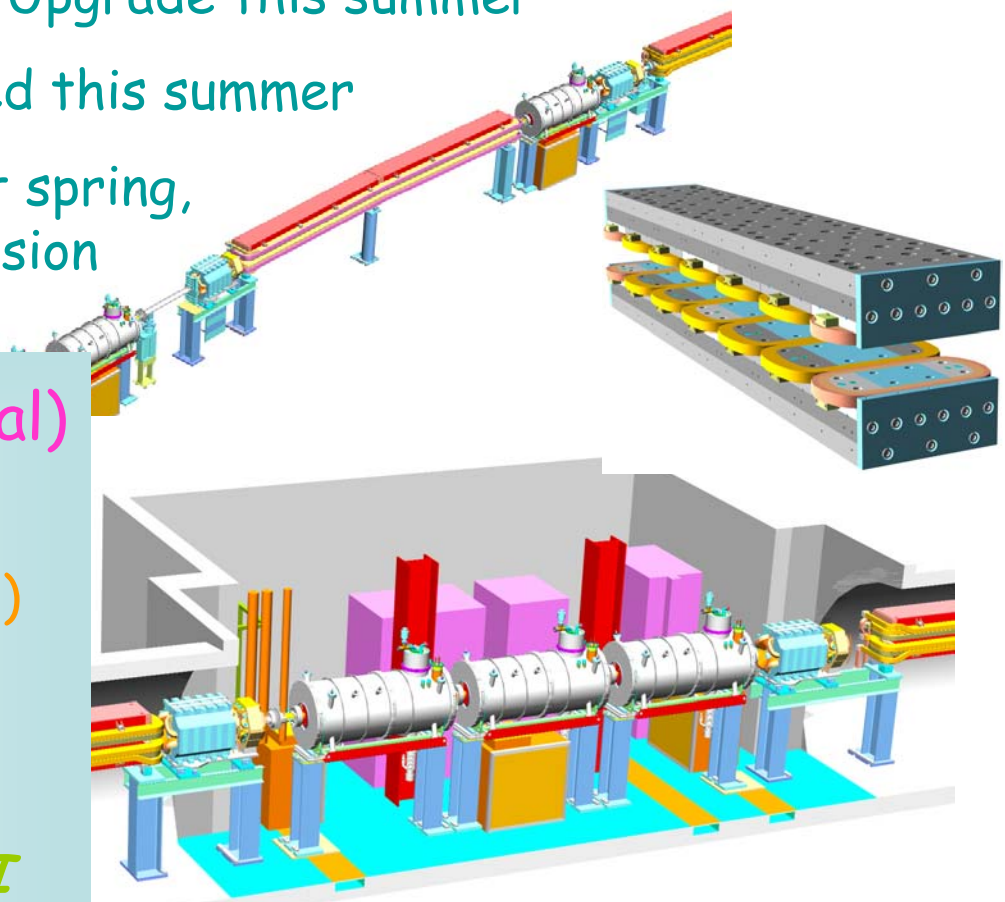
1. **Extend energy range, reduce spot size at IP.**
   Replace PM IR quads with S.C. quads for full energy range, lower β^*, p.c. separation, and better solenoid compensation.
2. **Reduce bunch length in proportion to spot size**
   Upgrade RF system to shorten bunch length in order to take advantage of smaller β^*.
3. **Recover radiation damping lost at low energy**
   Install ~18 m of 2.1 T wigglers to control emittance and damping times.

Items 1 and 2 have been previously planned and implemented as an upgrade to CESR performance.

The wigglers are the only major change specific to low energy operation.

Status and Plan

- Completed CLEO-c Detector Upgrade this summer
- Six SC wigglers were installed this summer
- Six more to be installed next spring, that completes CERS-c conversion



Performance Achieved (Goal)

@1.88 GeV

Beam Current (mA) – 135 (360)

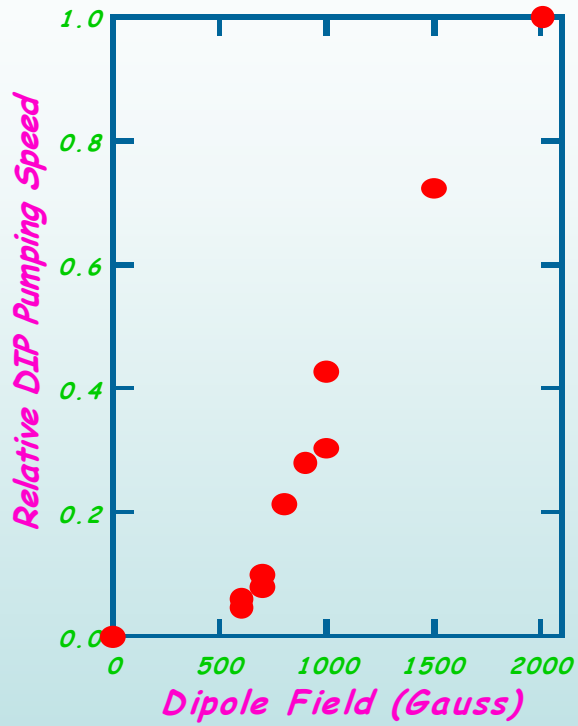
L_{peak} (10^{32} $cm^{-2}s^{-1}$) – 0.4 (3.0)

Int. Lum. /day – 1.6 pb^{-1}

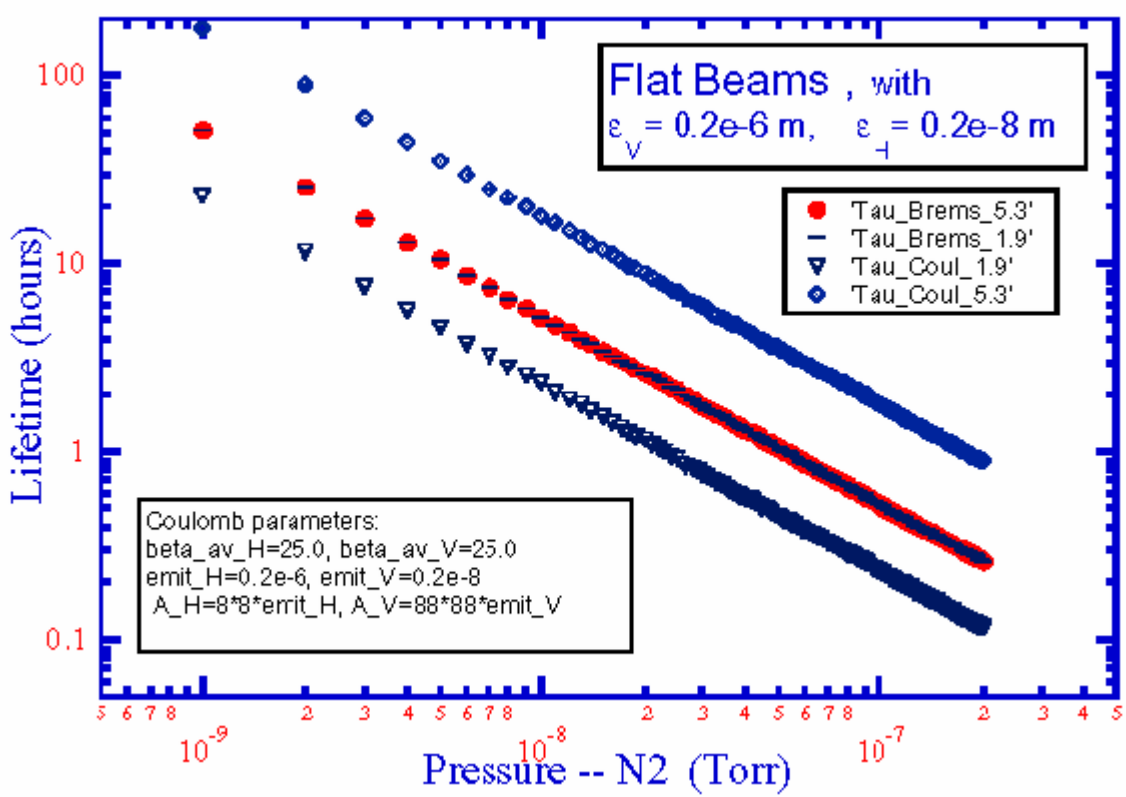
Accum. Lum. Exceeded BESII

Vacuum Pumping in CESR-c

- SR induced desorption is much smaller in the most part of CESR
- Pumping in the Interaction Region (IP ±15 m) are dominated by TiSP
- Distributed ion pumps (DIPs) in the arcs rely on dipole magnetic field and stop pumping @<700 Gauss (1.9 GeV)
- Fortunately, well-conditioned chamber walls function as effective getters (more later)

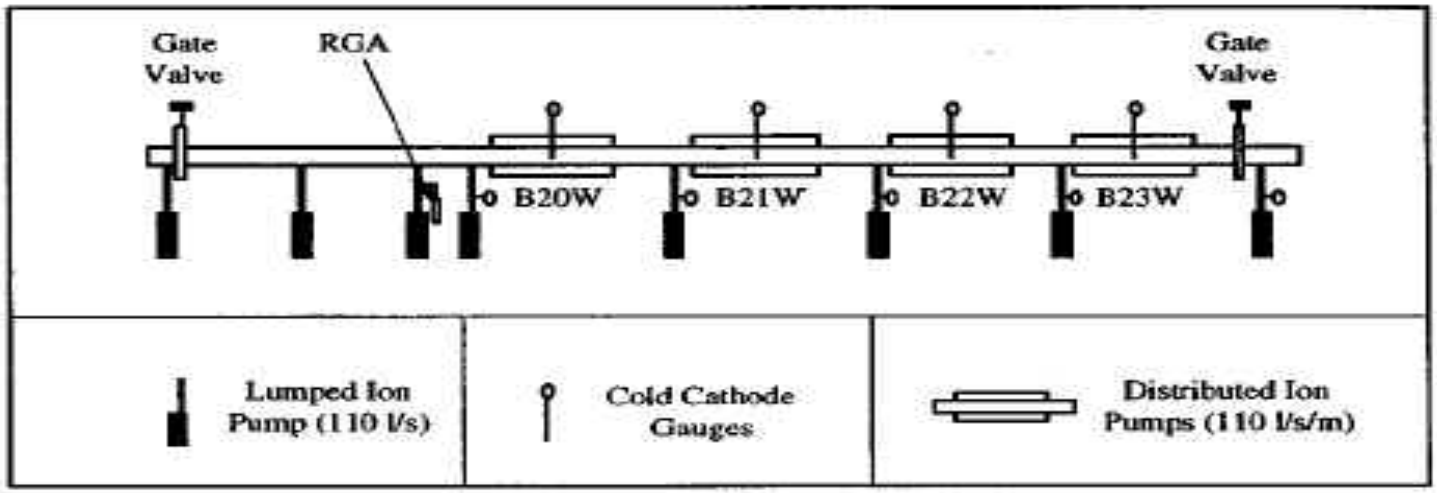


Beam-Gas Loss Lifetime



Average pressure of ≤1 x 10^{-9} torr required

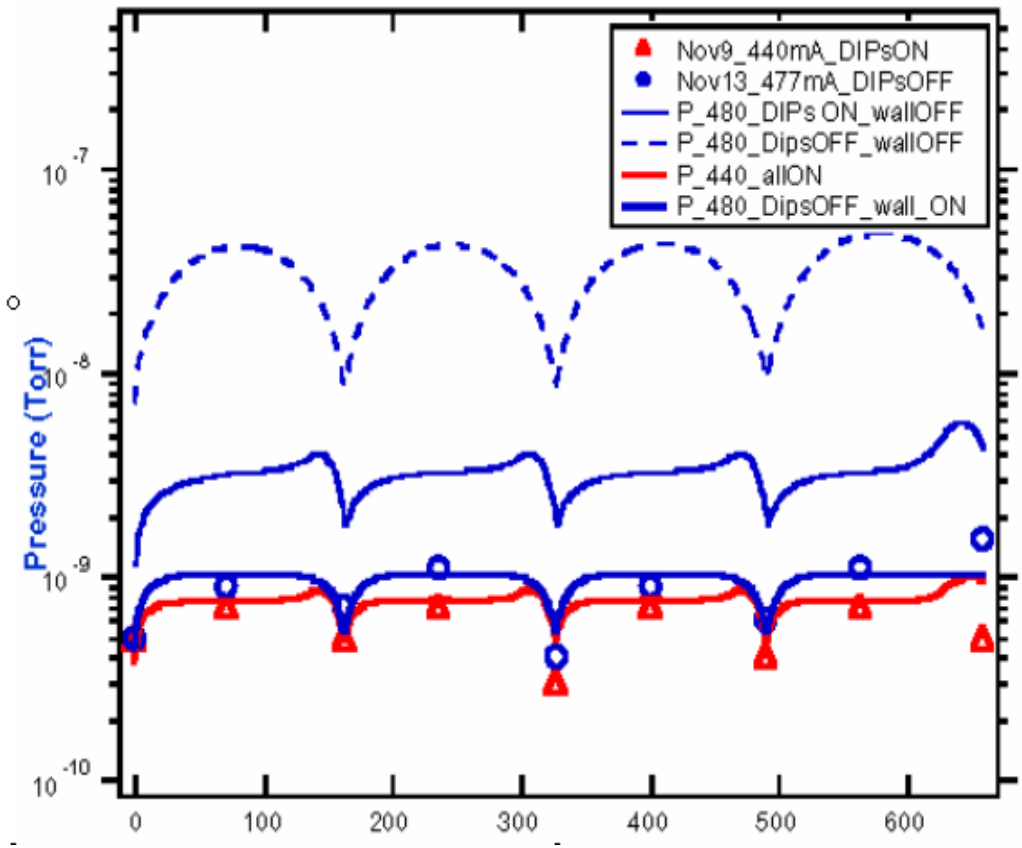
"Wall Pumping" Experiment



- Tests were made by turning off/on DIPs in a well instrumented sector of CESR while operating at 5.3 GeV.

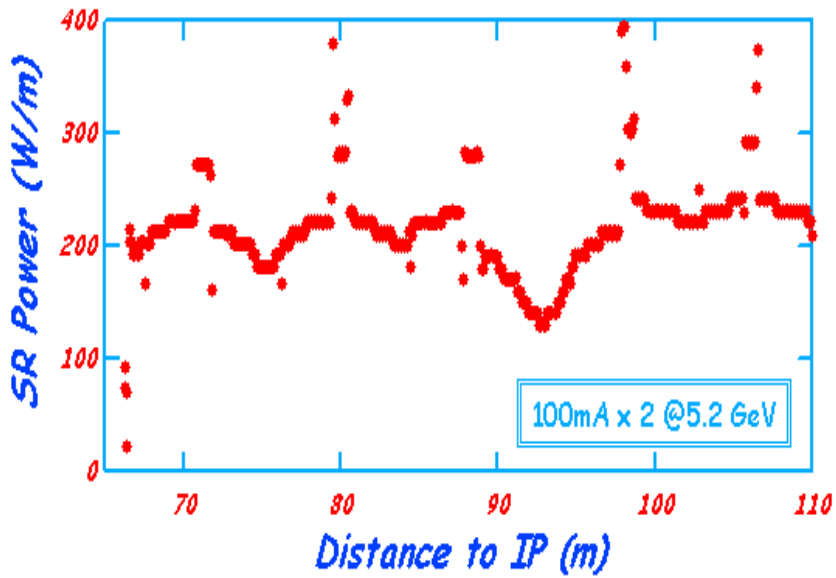
"Wall Pumping" Experiment

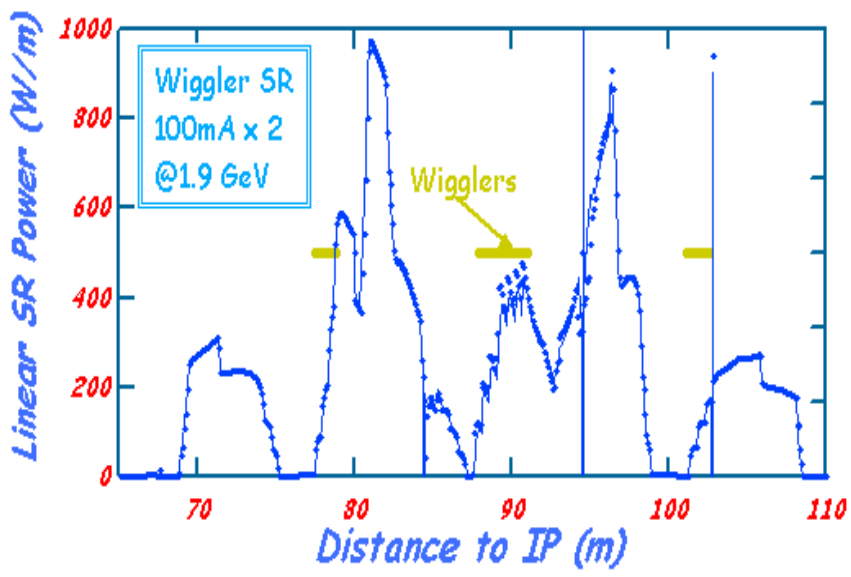
- Measured pressure profiles are compared with one-dimensional calculations
- A 'wall-pumping' speed of ~110 *l/s/m* gives the best fits to the measured profiles
- DIPs were left off for several weeks



SR Power Comparison

5.2 GeV vs. 1.9 GeV





$$P_{beam} \propto F_{photon}, \eta_{SR}, 1/S_{Total}$$

Beam Conditioning

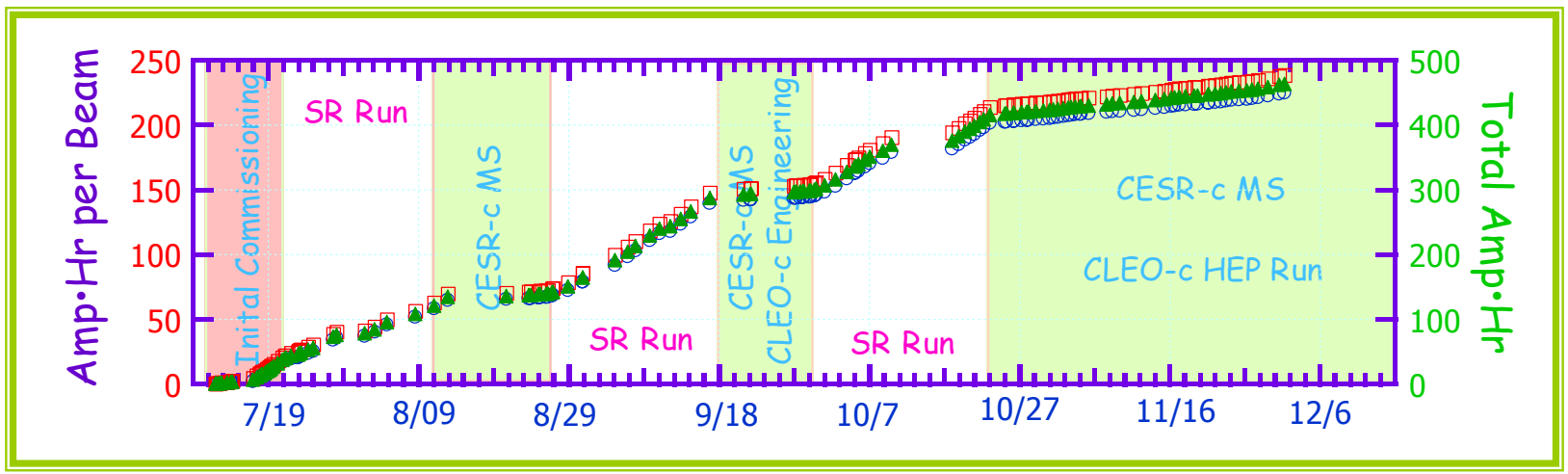
Two-Stage Beam Conditioning :

- *Primary (direct) 'beam-scrubbing"*
  - *Reducing* η_{SR} *on SR main-strip (* $height \propto \sigma_v$ *)*
- *"Activate" wall-pumping via scattered photons*

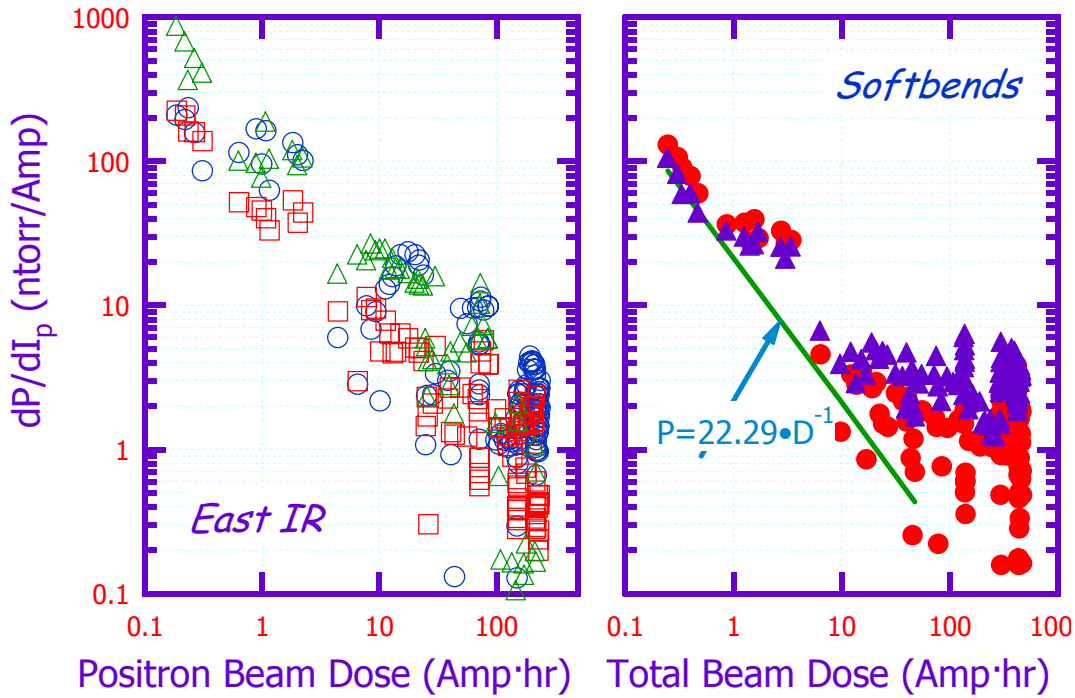
$$P_{beam} \propto F_{photon}, \eta_{SR}, 1/S_{Total}$$

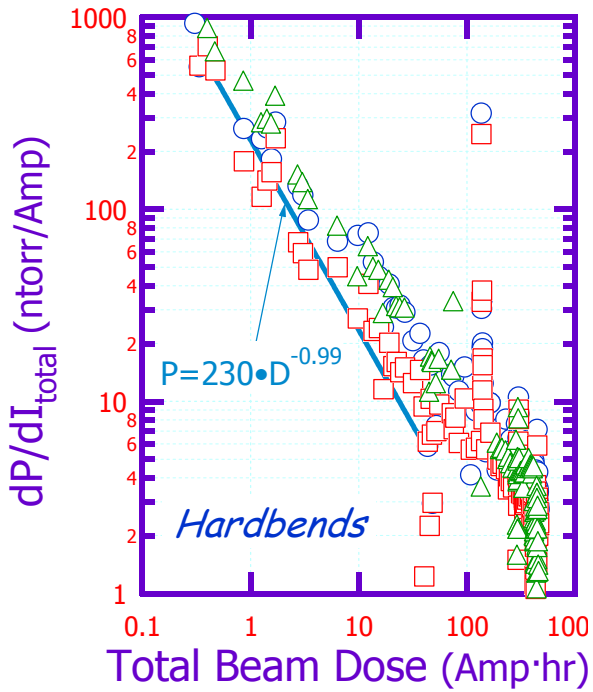
CESR-c Commissioning & Operation

- Starting commissioning in July 10, 2003
- Alternating SR and CESR-c runs
- Two CESR-c / CLEO-c 'engineering runs'
- Started 2.5-month CESR-c - CLEO-c 'production' run



Beam Conditioning – IR





0 – 8 m from I.P.

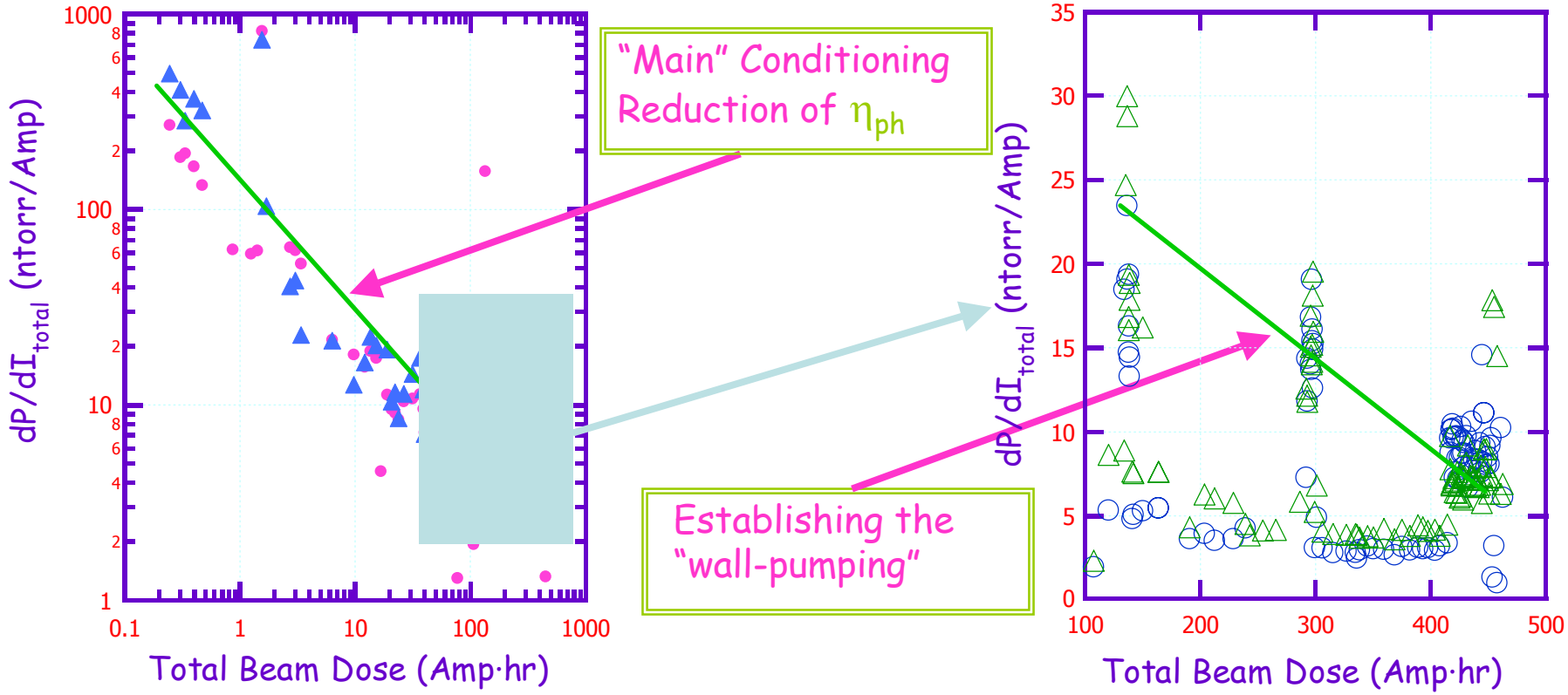
8 – 15 m from I.P.

15 – 35 m from I.P.

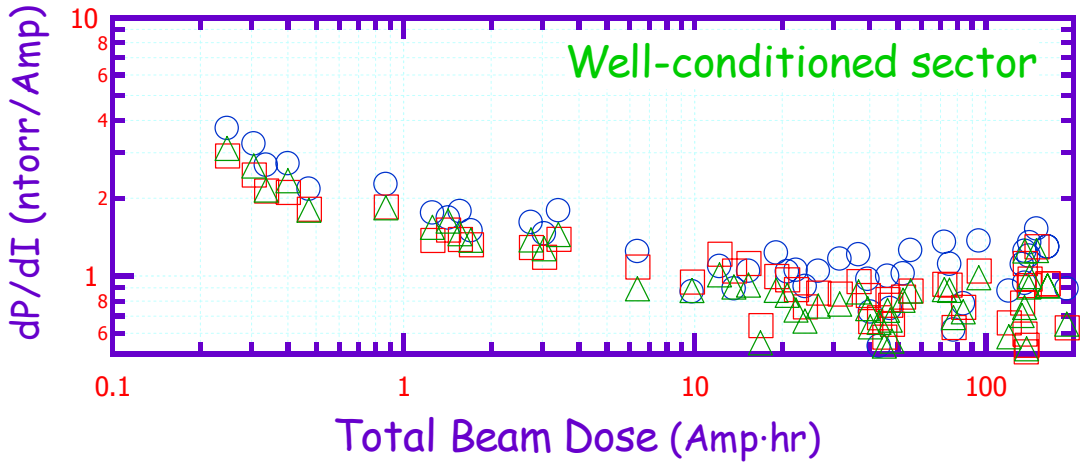
TiSP Pumped, Independent of E_{beam}

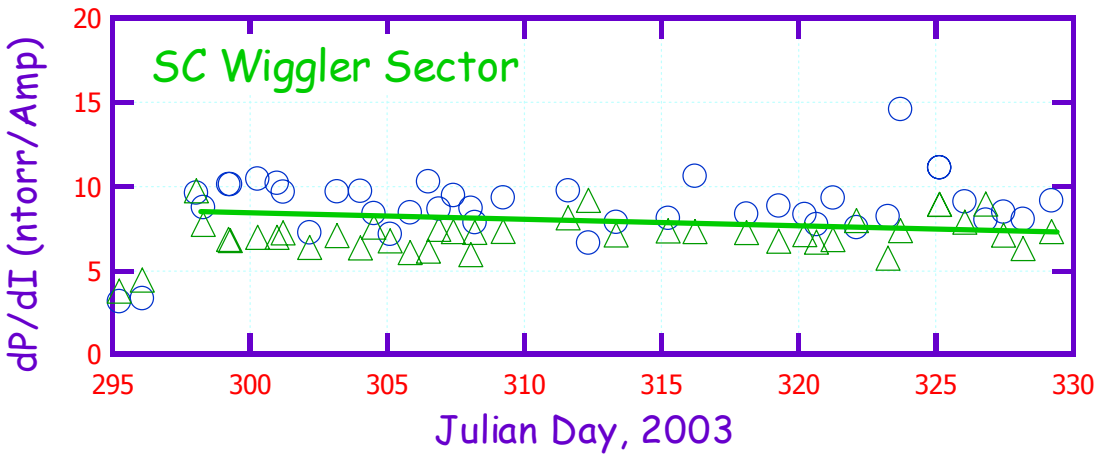
Reduced Pumping @ L.E.

Beam Conditioning – Arc



Sustainable "Wall Pumping"





In sectors where VCs have been fully conditioned, we do not see difference between the H.E. and L.E. operations

In sectors where VCs only been partially conditioned, NO deterioration over the current long L.E. run

Summary

- With installation of six SC wigglers in CESR and upgrade of CLEO-c detectors, CESR-c / CLEO-c program is performing well and on schedule
- The operation mode of alternating between the SR Run and L.E. HEP Run worked well (where H.E. SR Run acts as VCs conditioning)
- Vacuum 'wall-pumping' from conditioned VCs proved to be effective and lasting for the planned HEP program