BEPCII BEAM FOR INTERNAL TARGET EXPERIMENTS

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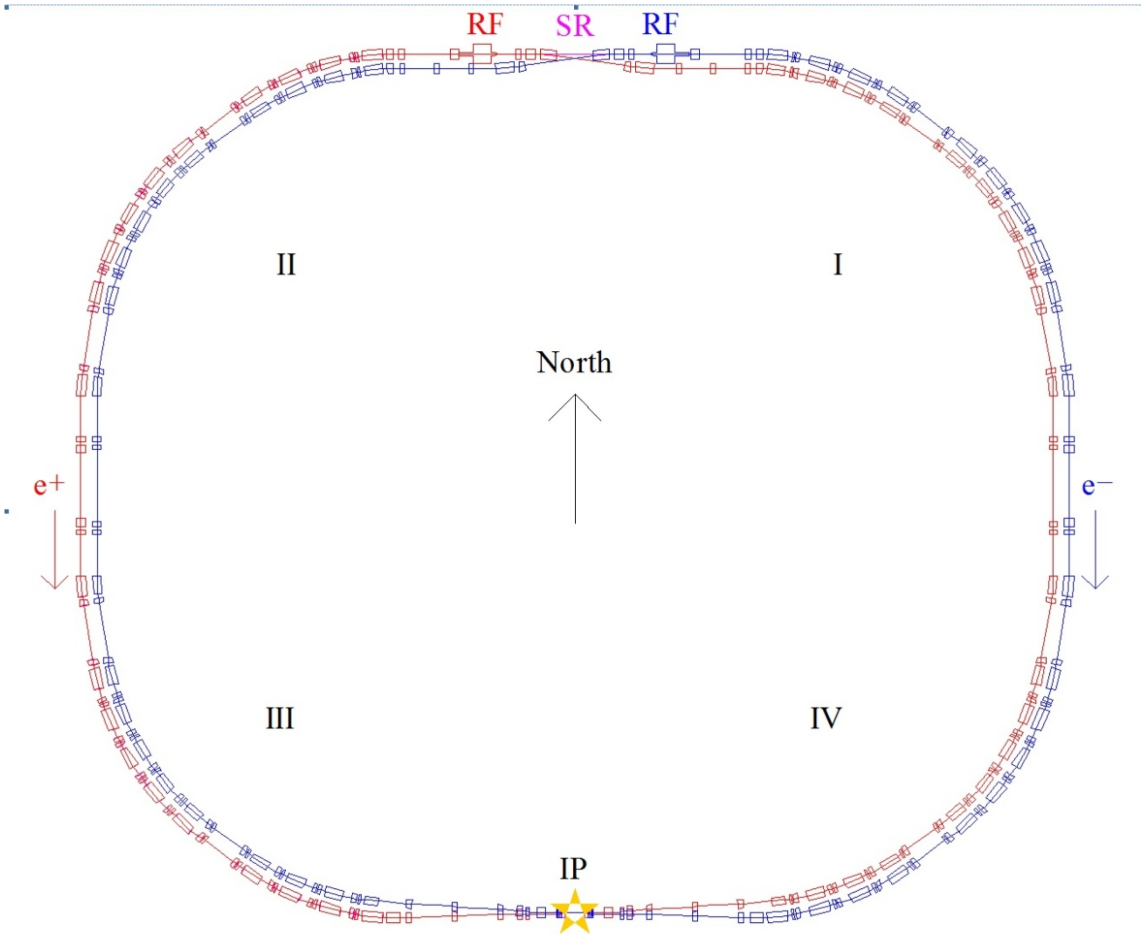
Outline

- Introduction to BEPCII machine
- Parameters for BEPCII colliding beam
- Position for the Internal target
- Energy for internal target experiments
- Beam effects from internal target
- Beam parameters for internal target experiments
- Next to do
- Summary

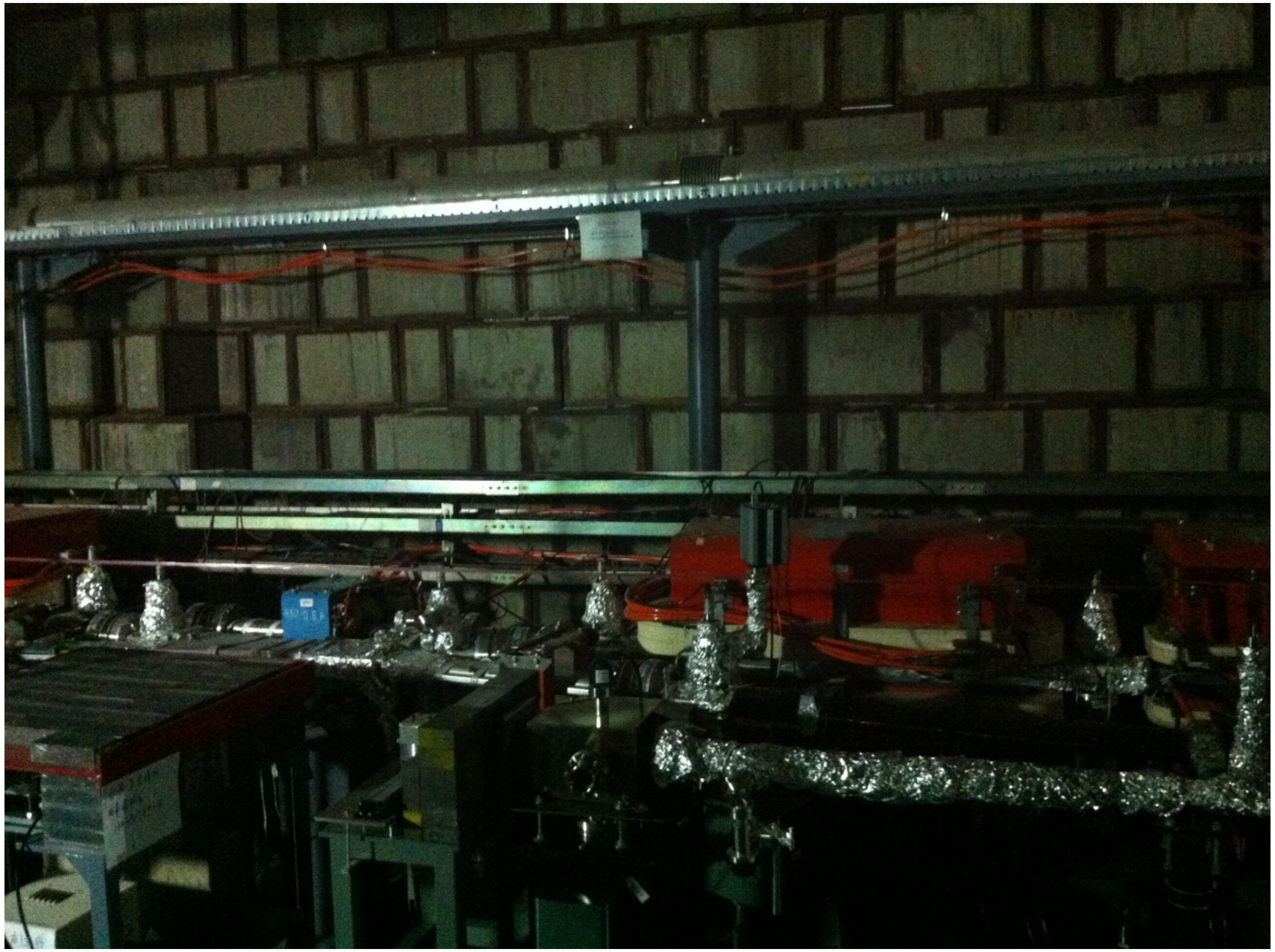
Introduction to BEPCII machine



Beam parameters for the colliding mode

Beam energy E	**GeV**	**1.89**	**Energy spread σ_ε**		**5.16×10^{-4}**
Circumference C	m	237.53	Momentum compact α_p		0.0235
Frequence f_0	MHz	1.2621	Bunch length σ_z	cm	1.5
Harmonic nymber h		396	Emittance $\varepsilon_x/\varepsilon_y$	nm·rad	144/3.2
RF frequence f_{rf}	MHz	499.8	β_x^*/β_y^*	m	1/0.015
RF Voltage V_{rf}	MV	1.5	beam size σ_x^*/σ_y^*	μm	380/5.7
Energy loss/turn U_0	keV	121	Working points $\nu_x/\nu_y/\nu_s$		6.53/7.58/0.034
Damping time $\tau_x/\tau_y/\tau_E$	ms	25/25/12.5	Natural chromaticities ν_x'/ν_y'		-12.5/-25.5
Beam current I	A	0.91	Crossing angle ϕ_c	mrad	11×2
SR Power P	kW	110	Piwinski angle Φ	rad	0.435
Particles in total N		4.5×10^{12}	Bunchspacing s_b	m	2.4
Bunch Number n_B		93	Beam-beam parameters ξ_x/ξ_y		0.04/0.04
Bunch current I_b	mA	9.8	Luminosity $\mathcal{L}$	$cm^{-2}s^{-1}$	1.0×10^{33}(0.85)

North crossing region




R3I-MB10


R2I-MB10

Possible position for the Internal target

- electron only:

  injection region of inner ring(west injection region)

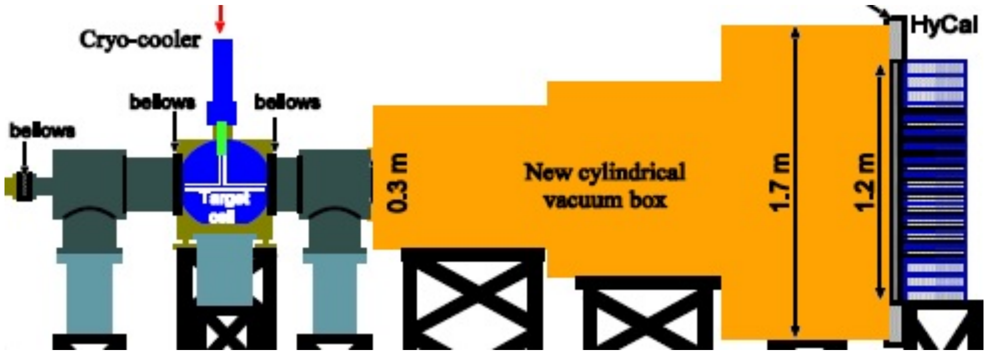
  need re-arrange several magnets in the region

- both electron and positron:

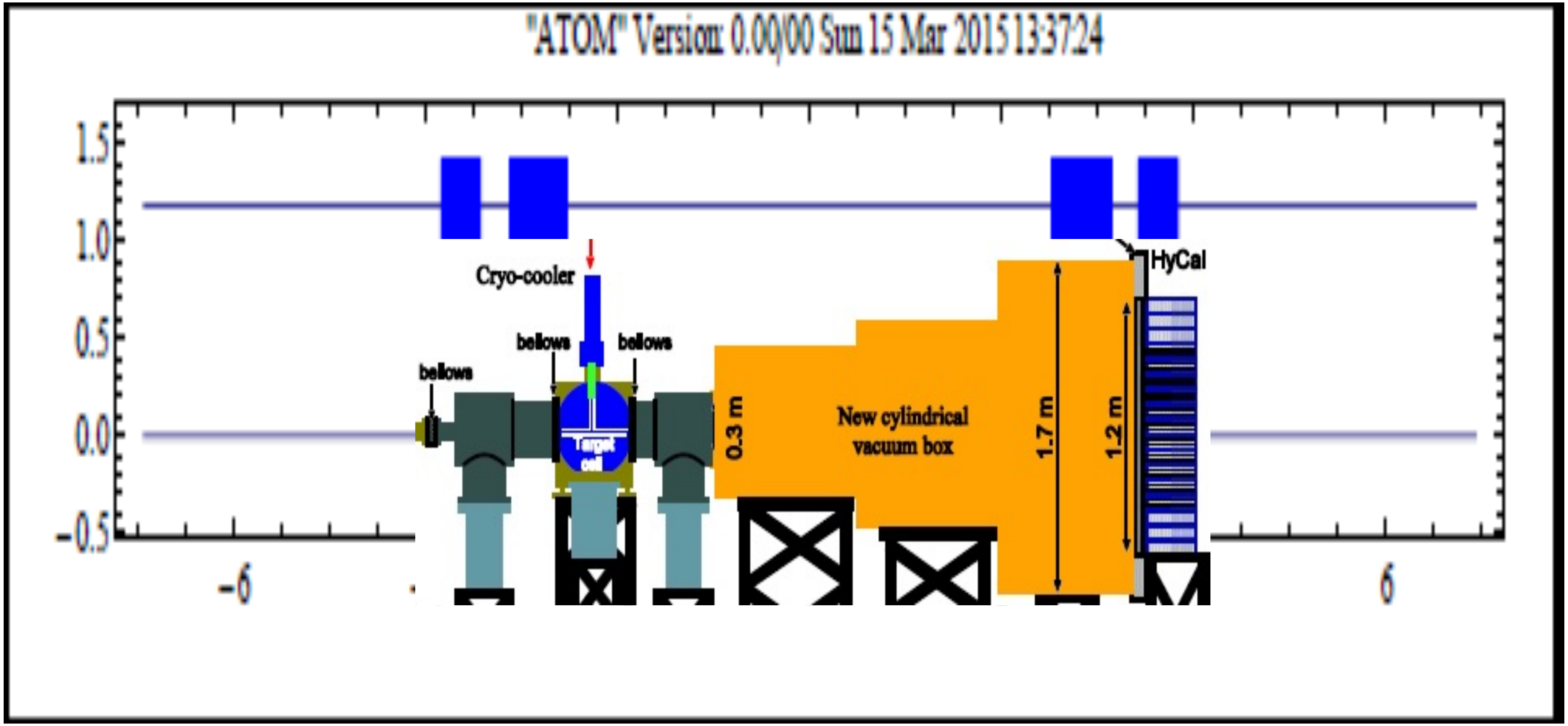
  only detector region(south IP)

  only after BESIII experiments

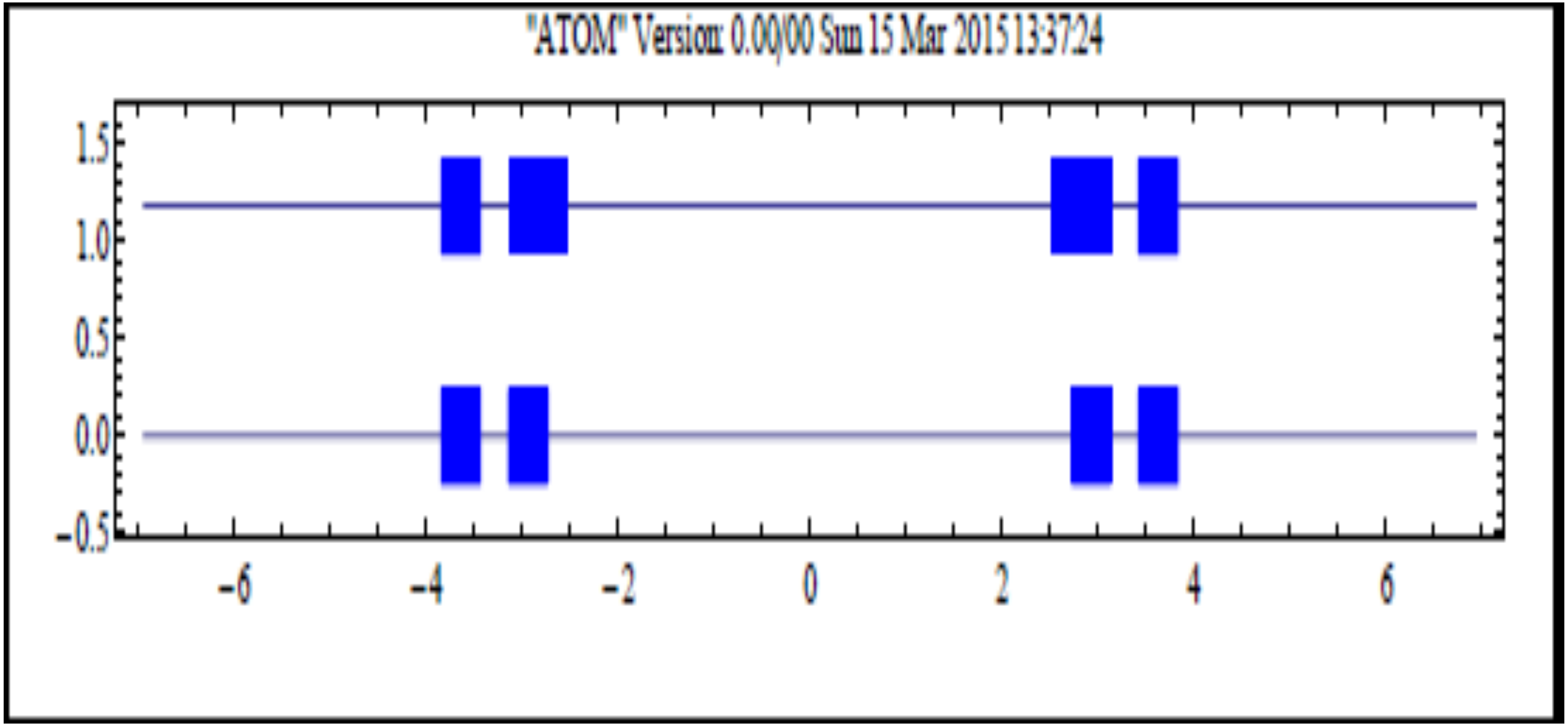
Internal target experiments(because the detector) have the directivity: it is different from colliding beam experiments(detector is symmetric about IP)



Injection region



Injection region



Beam energy

- Colliding ring: 1~2.3GeV
- SR ring 1~2.5GeV
- The electron and positron can not be switched in a short time because our power supply is not bipolar. Changing the polarity may take a couple of weeks.

Beam effects of internal target

- Life time decrease

  electron gas H_2 Coulomb scattering: elastic, inelastic

  electron gas H_2 nucleus elastic scattering
- Beam halo increase

Electron-Gas scattering

- Inelastic

  Scattering with nucleus σ_A

  Scattering with outer electrons σ_B

- Elastic

  Scattering with nucleus σ_C

  Scattering with outer electrons σ_D ($\sigma_C >> \sigma_D$)

Inelastic scattering

Scattering with nucleus

$$\left(\frac{d\sigma}{d\varepsilon}\right)_A = \alpha\ \frac{4Z^2 r_0^{\,2}}{\varepsilon}\ \left\{\left[\frac{4}{3}\left(1-\frac{\varepsilon}{E}\right)+\frac{\varepsilon^2}{E^2}\right]\left[\frac{\varphi_1(0)}{4}-\frac{1}{3}\ln Z\right] + \left[\frac{1}{9}\left(1-\frac{\varepsilon}{E}\right)\right]\right\}$$

Scattering with outer electrons

$$\left(\frac{d\sigma}{d\varepsilon}\right)_B = \alpha\ \frac{4Z\, r_0^{\,2}}{\varepsilon}\ \left\{\left[\frac{4}{3}\left(1-\frac{\varepsilon}{E}\right)+\frac{\varepsilon^2}{E^2}\right]\left[\frac{\psi_1(0)}{4}-\frac{2}{3}\ln Z\right] + \left[\frac{1}{9}\left(1-\frac{\varepsilon}{E}\right)\right]\right\}$$

Elastic scattering σ_C

$$\frac{d\sigma}{d\Omega} = 4Z^2 r_e \frac{1}{(\theta^2+\theta_{min}^2)^2}\left(\frac{m_e c}{\beta p}\right)^2$$

$$\theta_{min} \approx \alpha Z^{\frac{1}{3}}\left(\frac{m_e}{p}\right)$$

$$\sigma = \frac{2\pi Z^2 r_0{}^2}{\gamma^2} \cdot \frac{\bar{\beta}\,\hat{\beta}}{H^2}$$

Typical value for BEPCII

- $\sigma_A \sim 10^{-29}$
- $\sigma_B \sim 10^{-29}$
- $\sigma_C \sim 10^{-24}$
- Main effect of gas is from elastics scattering with nucleus

Beam lifetime

- For BEPCII, dynamic pressure is 10^{-9}Torr consist of 10% N2(or CO) and 90% H2, the life time from gas scattering is about 10hrs, the main contribution come from N2(Z~7*2)
- For 10cm 10^{-4}Torr H2 target, it is equivalent gas pressure increase to

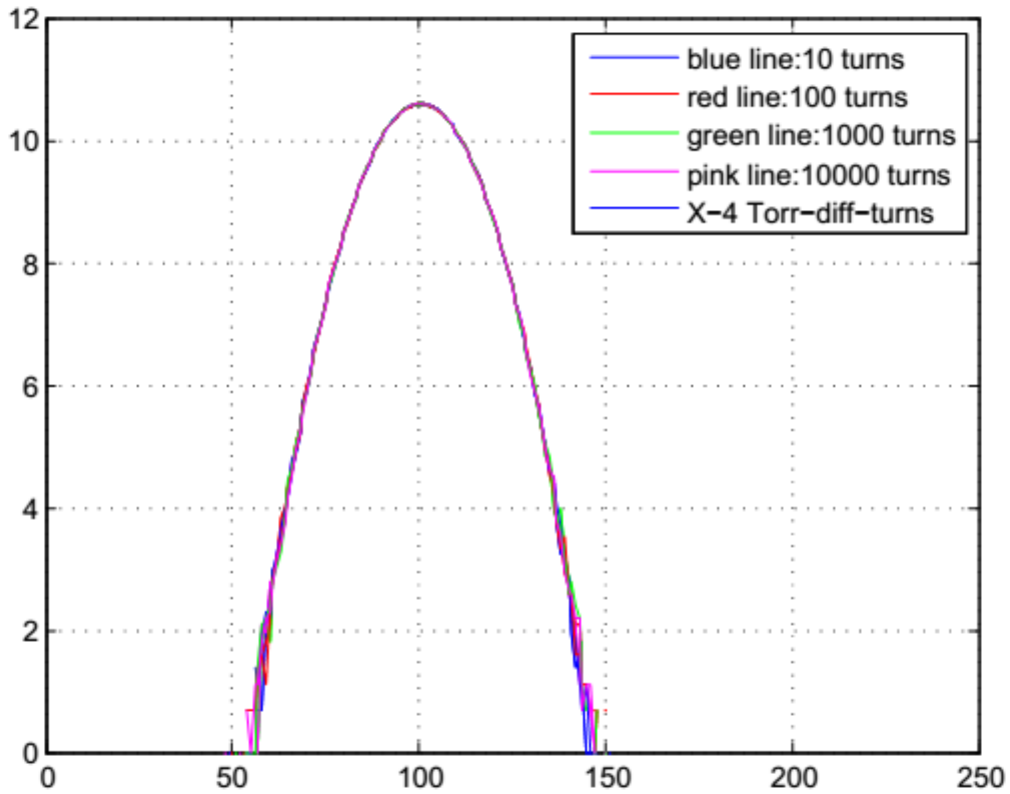
  10^{-4} * 10cm / 24000cm ~ 10^{-7}Torr H2~10^{-8}Torr N2~1hrs lifetime
- So even with internal gas target the beam will not lose immediately.

Halo issue

- Since beam still has a certain lifetime, and due to damping effect, the core of beam should be a Gaussian beam, and the halo could be simulated by Monte Carlo method.
- Similarly to lifetime issue, Halo issue is also considered the elastic scattering from nucleus
- Preliminary results: See nothing from accelerator view. Need help from experiment physicist or cooperation with them.

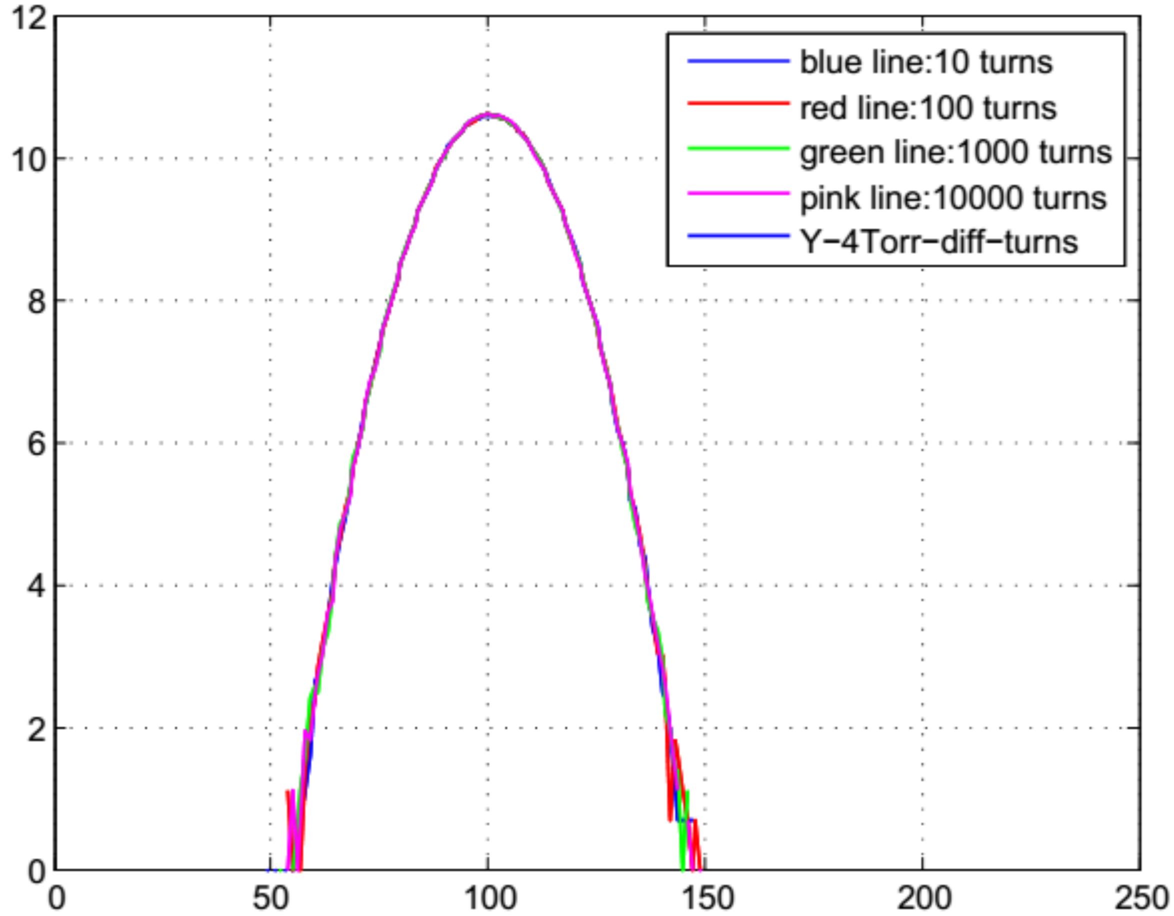
horizontal-halo

f[x]=N0*exp[-X2/2], Log[f[x]]=$-x^2/2$



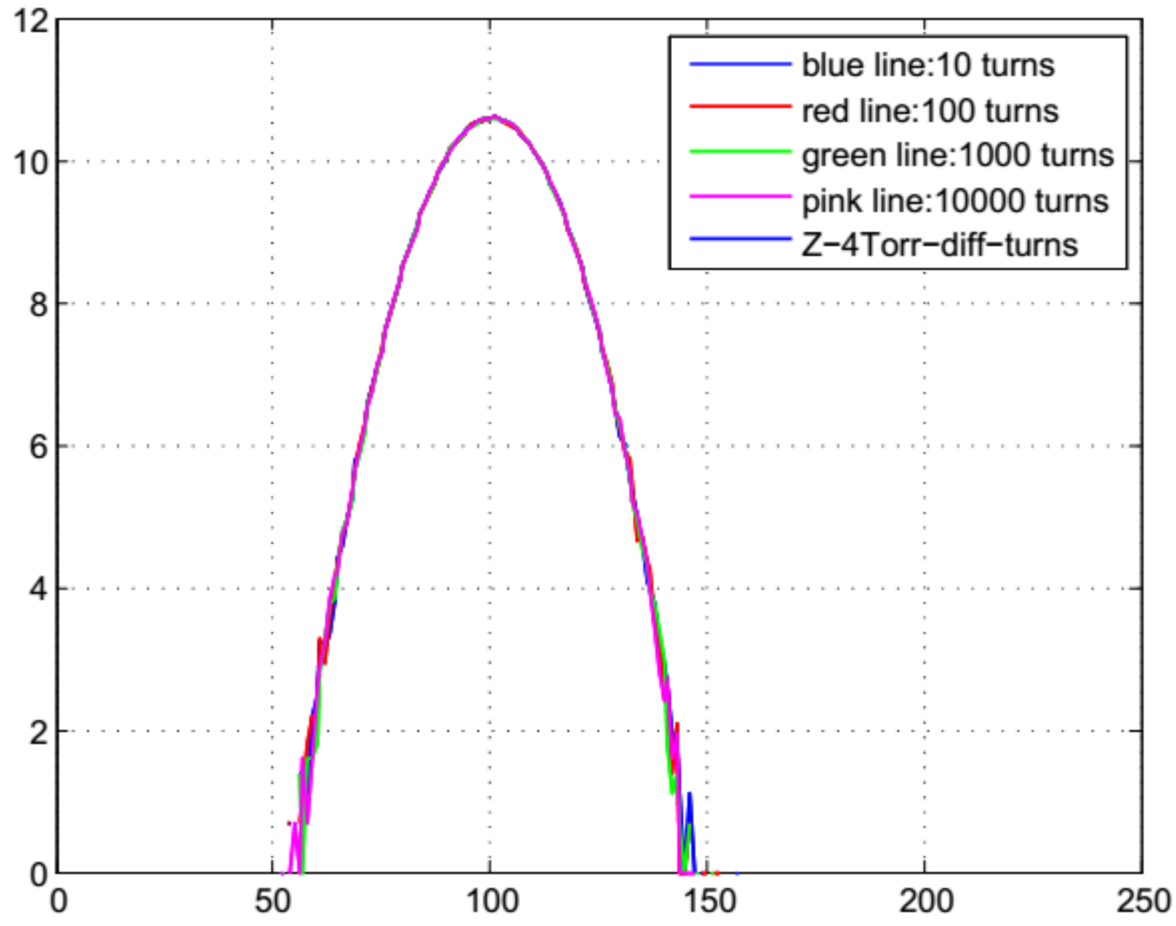
H2 pressure 10^{-4}Torr， different turns

vertical-halo



H2 pressure 10^{-4}Torr， different turns

longitudinal-halo



H2 pressure 10^{-4}Torr，different turns

Beam parameters for internal target experiments

- In the previous simulation, the beam parameters except the beta function($\beta_{x,y}^*$ are replaced by injection region value i.e. β_x~β_y~20m) are same as the parameters' table.
- Since all quadrupoles are independently powered, the beta functions at the target are tunable. Many other parameters are also tunable although the tuning range is different
- Some parameters need input from experiments
- The luminosity for internal target is depend on beam current and thickness of target. But it will be limited by detector capability including time resolution, background requirement(γ from beamstrahlung and e from halo), etc
- 900mA， 10^{15}A/cm^2， L～5E33. In previous the thickness of target is 2＊10^{13}A/cm^2， L～10^{32}

Next to do

- Communication with experiment physicist get more input
- Cooperation with experiment to improve the halo simulation
- How about the radiation damage to the detector during BEPCII and BSRF operation?

Summary

- The possible positions where the internal target will be placed have been located for different experiments
- The target will reduce the beam lifetime
- The preliminary simulation for the halo have been made, further work is necessary
- Communication between accelerator and experiment people need enhance