Review of IPAC 2013

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IPAC 上海 13

IPAC13

The 4th International Particle Accelerator Conference

第四屆國際粒子加速器會議

Shanghai China, 12-17 May 2013

Introduction

ThomX @ LAL

Design of Compact X-ray source

Non linear dynamics

UA9 experiment @ CERN

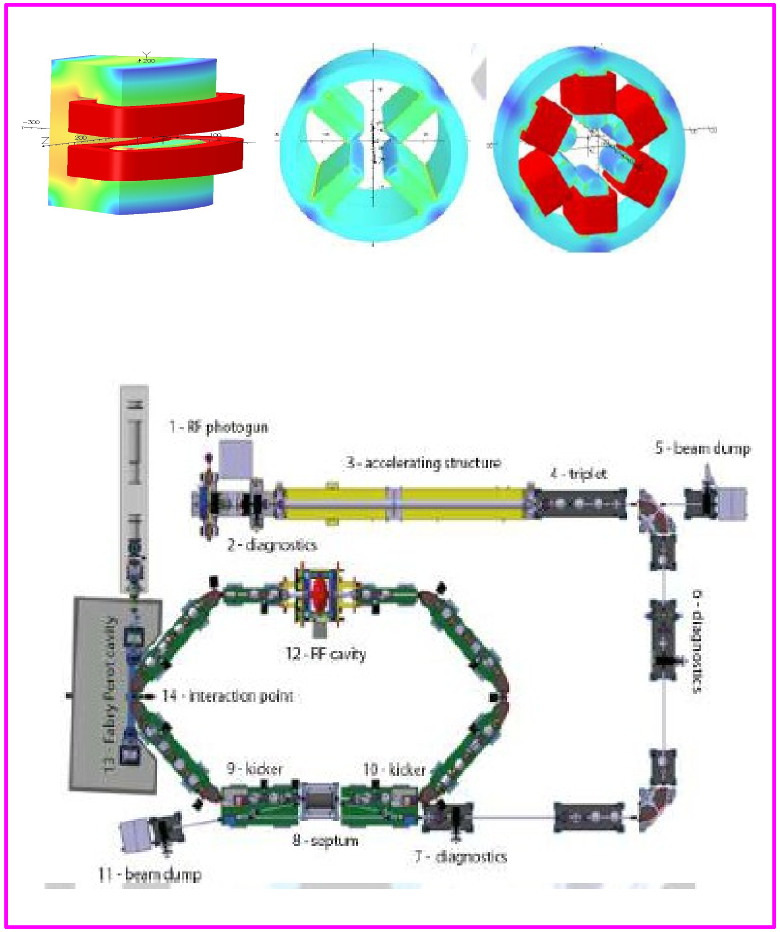
Beam simulation

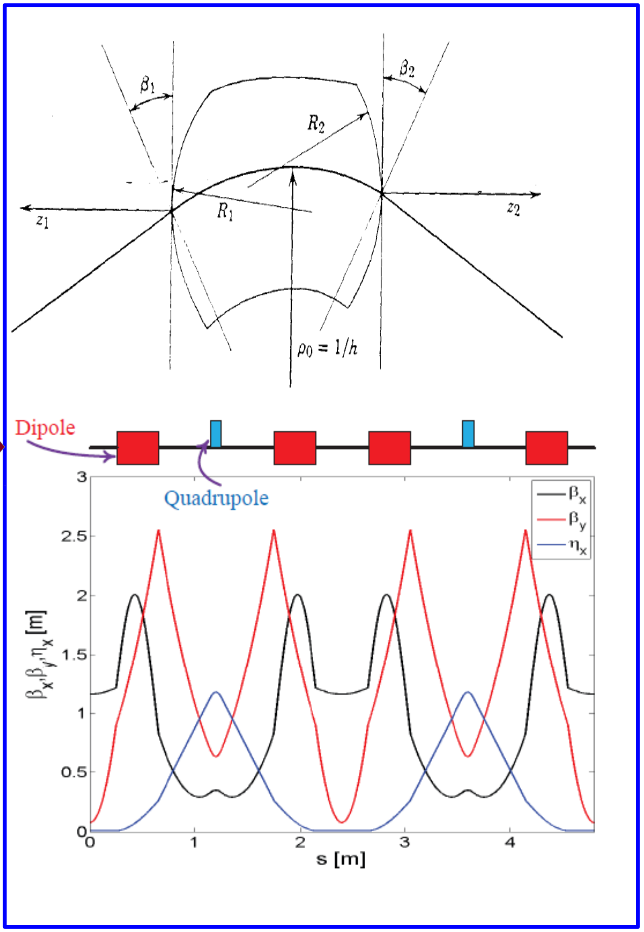
Optical design to suppress Halo

Spin physics @ colliders

Spin dynamics

Compton back-scattering based compact X-ray sources (1) ---design





Future

?????

X-ray source
@ Table?

ThomX @ LAL

TTX @ TsingHua*

WEPWA020, "LASER ELECTRON STORAGE RING FOR TTX",
Haisheng Xu,et al, Tsinghua University, Beijing, China; Shyh-Yuan Lee, Indiana University, Bloomington, IN, USA
Didier Jehanno, Fabian Zomer, LAL, Orsay, France

Compton back-scattering based compact X-ray sources (2) ---non linear dynamics

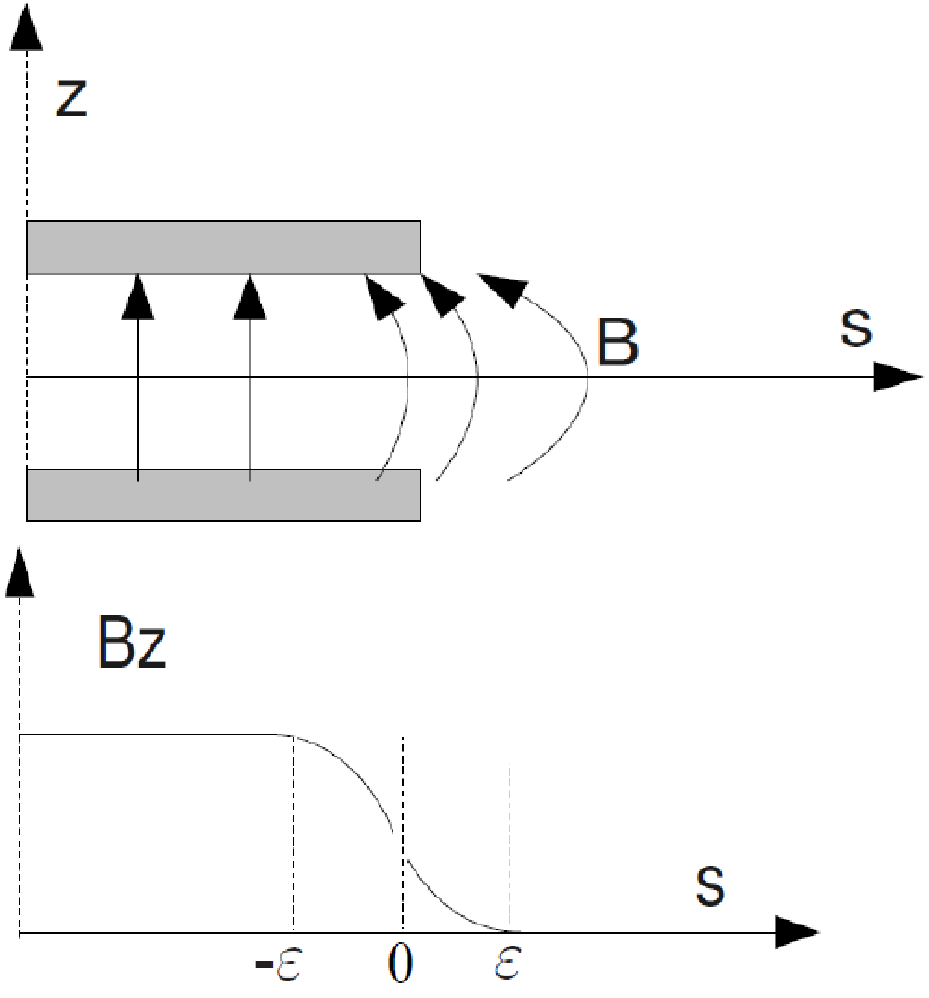
- Hamiltonian and beam dynamics

$$
\begin{aligned}
&H(x,p_x;z,p_z;-ct,\delta;s)\\
&= -\left(1+\frac{x}{\rho}\right)\sqrt{(1+\delta)^2-\left(p_x-\frac{A_x}{B\rho}\right)^2-\left(p_z-\frac{A_z}{B\rho}\right)^2}\\
&+\frac{x}{\rho}+\frac{x^2}{2\rho^2}-\frac{A_s}{B\rho}+\delta,
\end{aligned}
$$

Fringe field?

- Expanded Hamiltonian: H = H_1 + H_2 + H_3 + H_4 +...
  - High order Hamiltonian → High order chromaticities, momentum compaction factor, and other machine parameters.
  - Lie Algebra , TPSA; in Updated Tracy3?

Nonlinear dipole fringe field and particle tracking* (1)



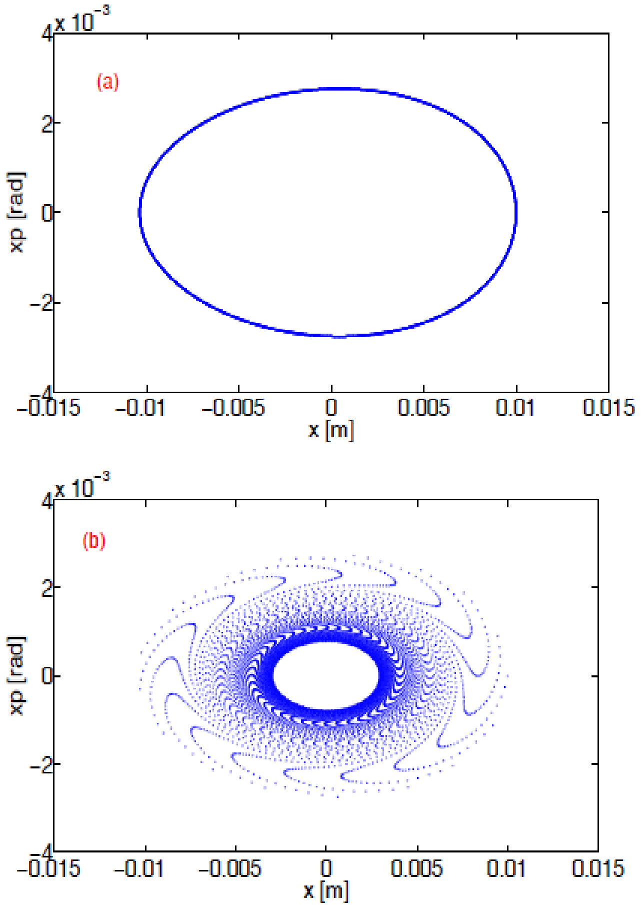


Figure 1: Phase space tracking in 1000 turns using a symplectic (a) and non symplectic model (b) in the ThomX ring without sextupoles.

WEPEA003, "DIPOLE FRINGE FIELD EFFECTS IN THE ThomX",
Jianfeng Zhang† , LAL, Universite Paris 11, IN2P3/CNRS, 91898 Orsay, France
Alexandre Loulergue, Synchrotron SOLEIL, St-Aubin, 91192 Gif-sur-Yvette, France

Nonlinear dipole fringe field and particle tracking* (2)

$$K = \int_{-\infty}^{+\infty} \frac{B_z(s)[B_0 - B_z(s)]}{g B_0^2} \mathrm{d}s,$$

$$\psi = \frac{1}{\rho} K g \frac{1 + \sin\theta^2}{\cos\theta}$$

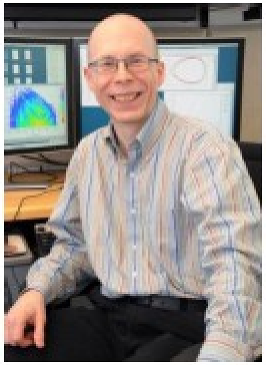
Table 2: Tunes and Natural Chromaticities of ThomX Ring

	ν_x	ν_z	ξ_x	ξ_z
Tracy 3 (Corr.)	3.175	1.64	-10.663	-10.860
Tracy 3 (Forest)	3.175	1.64	-10.663	-10.860
Tracy 3 (no corr.)	3.175	1.64	-10.663	-5.072
BETA	3.175	1.64	-10.522	-11.255
MADX	3.175	1.64	-10.522	-11.255
ELEGANT	3.175	1.64	-10.523	-10.735

$$p_x^f = p_x^i + \frac{\tan\theta}{\rho} x^i,$$

$$p_z^f = p_z^i - \frac{1}{1+\delta^i} \frac{\tan(\theta - \psi \pm \frac{p_x^i}{1+\delta^i})}{\rho} z^i.$$

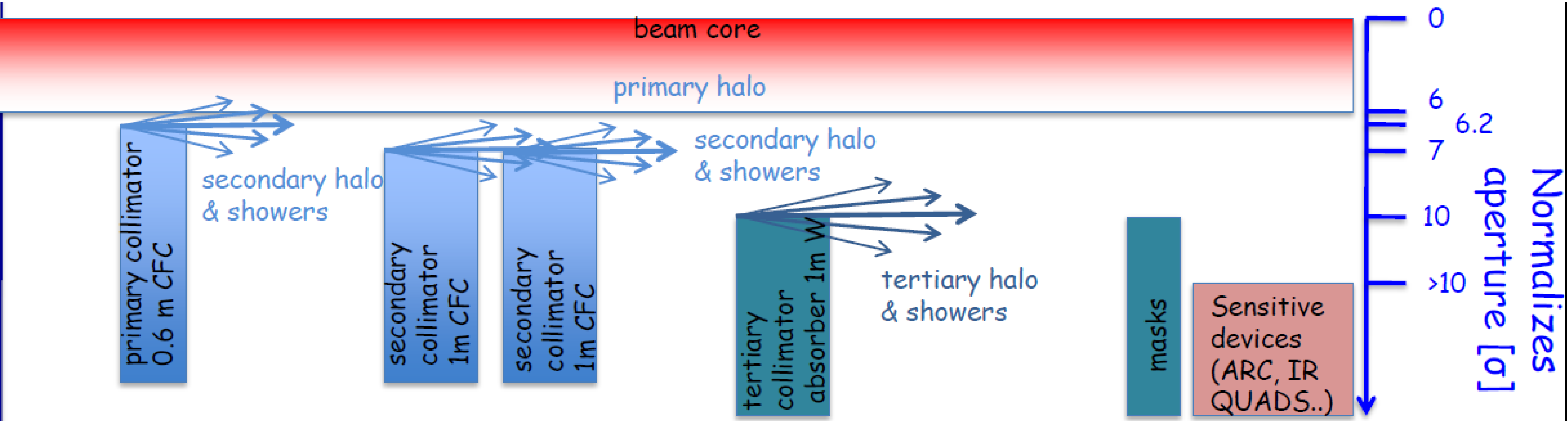
ELEGANT



Dr. Michael Borland

WEPEA003, “DIPOLE FRINGE FIELD EFFECTS IN THE ThomX”,
Jianfeng Zhang† , LAL, Universite Paris 11, IN2P3/CNRS, 91898 Orsay, France
Alexandre Loulergue, Synchrotron SOLEIL, St-Aubin, 91192 Gif-sur-Yvette, France

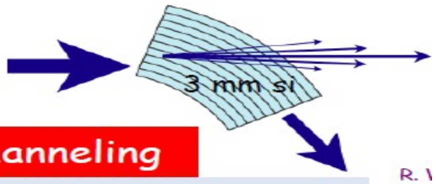
UA9 experiment @ CERN



- ❑ Collimation efficiency in LHC ≅ 99.98% @ 3.5 TeV
  - ✓ Probably not enough in view of a luminosity upgrade
  - ✓ Basic limitation of the amorphous collimation system
    - ✧ p: single diffractive scattering
    - ✧ ions: fragmentation and EM dissociation

amorphous

$\langle\theta\rangle_{MCS} \cong 3.6\,\mu rad$ @ 7 TeV



channeling

$\theta_{optimal\ @7TeV} \cong 40\ \mu rad$

R.
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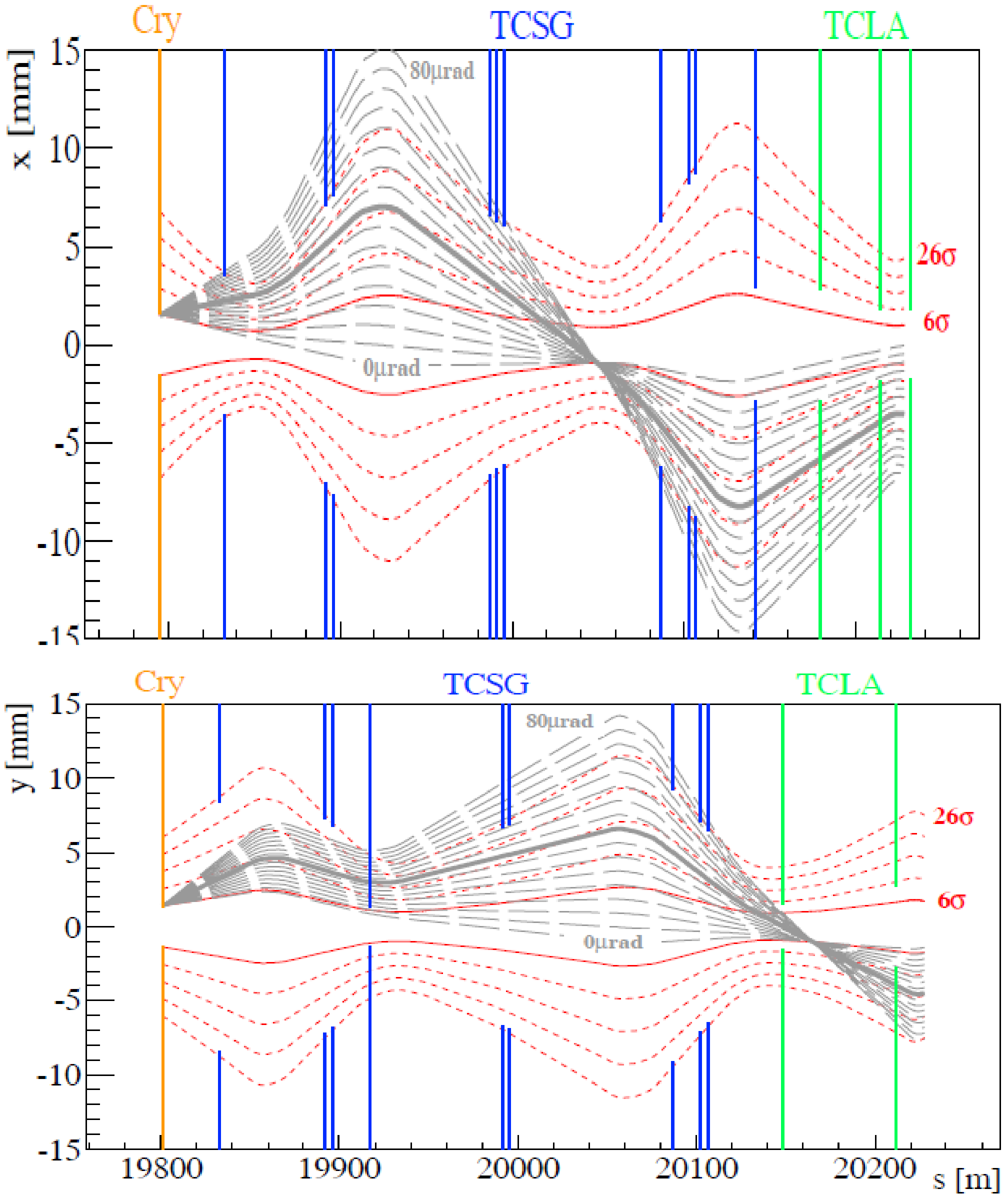
UA9 experiment @ LHC simulation of crystal and beam halo*



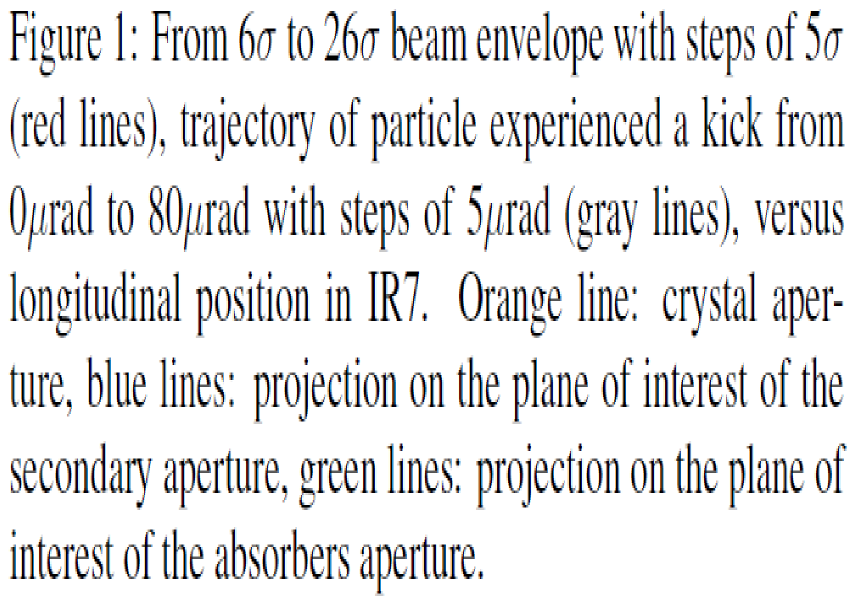


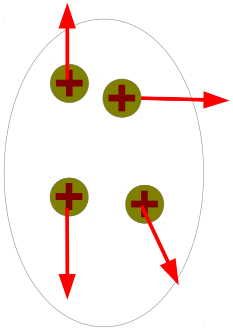
Figure 1: From 6σ to 26σ beam envelope with steps of 5σ (red lines), trajectory of particle experienced a kick from 0μrad to 80μrad with steps of 5μrad (gray lines), versus longitudinal position in IR7. Orange line: crystal aperture, blue lines: projection on the plane of interest of the secondary aperture, green lines: projection on the plane of interest of the absorbers aperture.

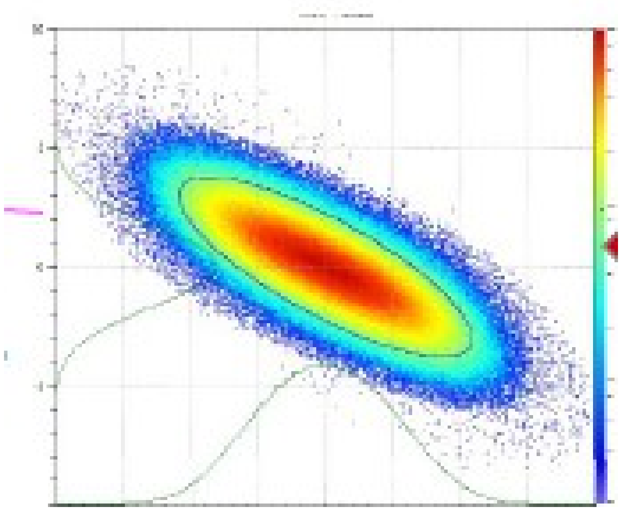
MOPWO035, "LAYOUTS FOR CRYSTAL COLLIMATION TESTS AT THE LHC",

Daniele Mirarchi , CERN, Geneva, Switzerland, Imperial College London, London, UK
Stefano Redaelli, Walter Scandale, CERN, Geneva, Switzerland
Valentina Previtali, Fermilab, Batavia, USA

Duodecapole (m = 6) and beam halo suppression (1)*

Coulomb forces





Beam core & beam halo

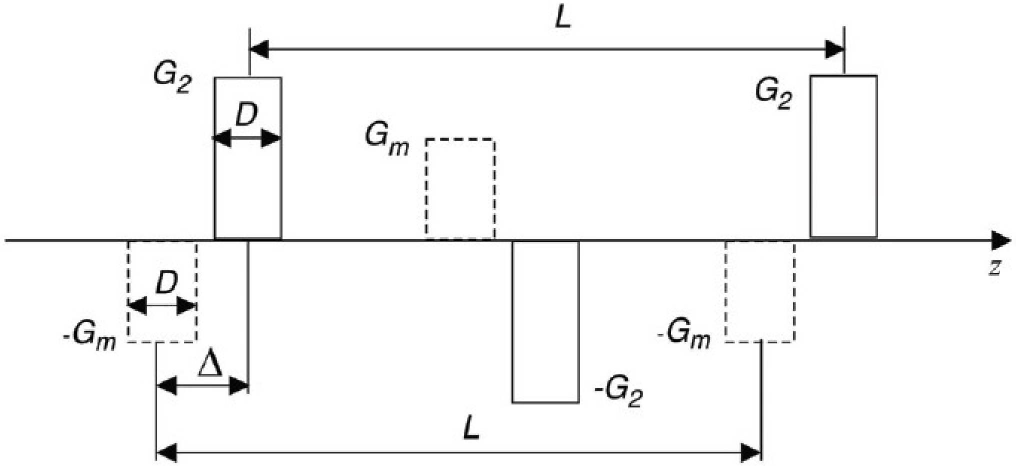


Figure 1. Combined FODO stricture with quadrupoles $_2G$ and multipoles G_m lenses. $\Delta = L/4$

Effective potential:

$$U_{eff}(r) = (\frac{\mu_o \beta c}{L})^2[\frac{r^2}{2} + \varsigma^2 \frac{r^{2(m-1)}}{2}]$$

$$\mu_o = \frac{L}{2D}\sqrt{1-\frac{4}{3}\frac{D}{L}\frac{qG_2D^2}{mc\beta\gamma}} \qquad \varsigma = \frac{G_m}{G_2}$$

TUPWA064, “SUPPRESION OF HALO FORMATION IN FODO CHANNEL WITH NONLINEAR FOCUSING”,
Y.K. Batygin, A. Scheinker, LANL, Los Alamos, NM 87545, USA

Duodecapole (m = 6) and beam halo suppression (2)*

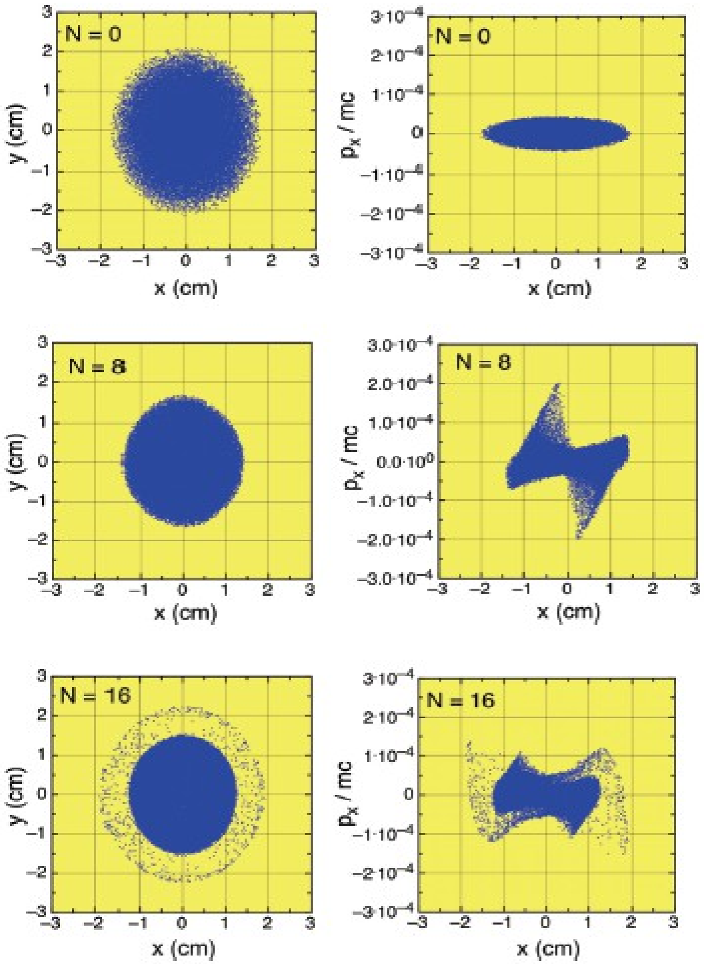


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Figure 3. Emittance growth and halo formation of the 35 keV, 11.7 mA, 0.045 π cm mrad proton beam in a FODO quadruple channel with the period of $L = 15$ cm, lens length of $D = 5$ cm, and quadrupole field gradient of $G_2 = 0.03579$ T/cm. Numbers indicate FODO periods.

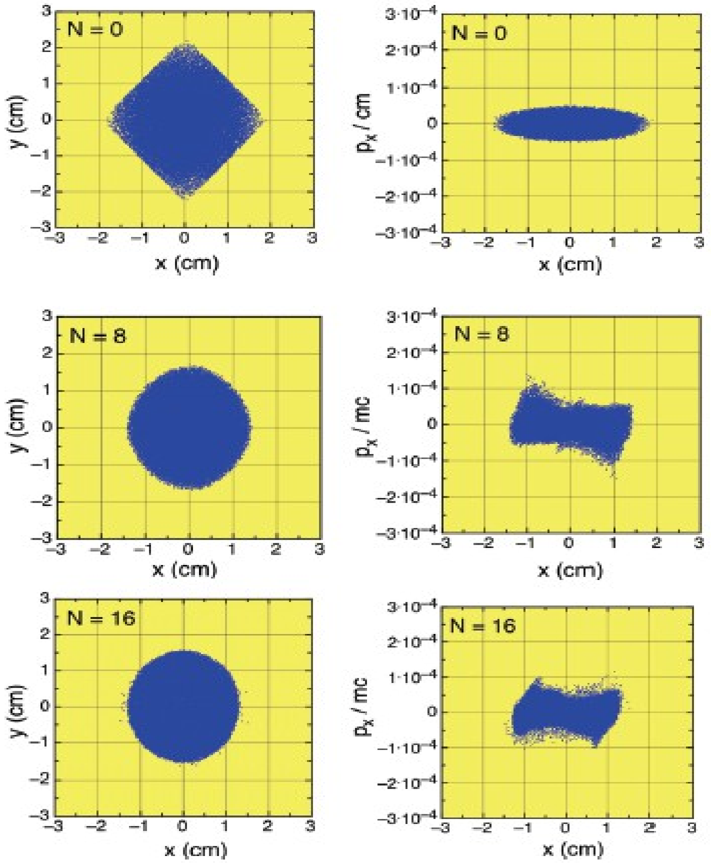


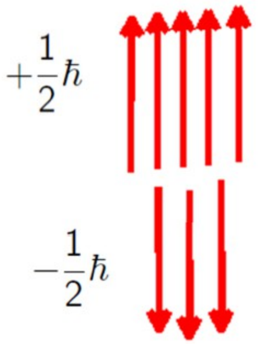
Figure 4. Adiabatic matching utilized to avoid halo formation of a 35 keV, 11.7 mA, 0.045 π cm mrad proton beam in a FODO quadruple-dodecapole channel. The channel is characterized by the period of $L = 15$ cm, lens length of $D = 5$ cm, quadrupole field gradient of $G_2 = 0.03579$ T/cm and adiabatic decline of duodecaple component from $G_6 = -1.756\cdot10^{-4}$ T/cm^5 to zero at the distance of 7 periods. Numbers indicate FODO periods.

TUPWA064, “SUPPRESION OF HALO FORMATION IN FODO CHANNEL WITH NONLINEAR FOCUSING”,
Y.K. Batygin, A. Scheinker, LANL, Los Alamos, NM 87545, USA

Beam polarization and energy ramp* (1)

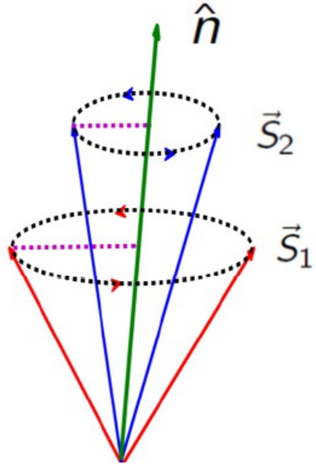
- Spin physics (colliders) from particle physicists
- Super KEKB, TLEP?

quantum mechanical



$$P = \frac{N_\uparrow - N_\downarrow}{N_\uparrow + N_\downarrow}$$

classical



Projection of spin $\vec{S}$ on $\hat{n}$ contributes to the beam polarization ***P***

Thomas-BMT equation

$$\frac{\mathrm{d}}{\mathrm{d}t}\vec{S} \approx c \cdot \vec{S} \times \left[(1 + a\gamma)\vec{B'}_\perp + (1 + a)\vec{B'}_\parallel\right]$$

$$B'(t) \approx \sum_{i=0}^{i_\text{max}} A_i \cos(\omega_i t + \phi_i) \quad \text{with } \omega_i = i \cdot \omega_\text{rev}$$

Runge-Kutta method

MOPWO005,"SIMULATING SPIN DYNAMICS AND DEPOLARIZATION USING POLE",
J. F. Schmidt† , O. Boldt, F. Frommberger, W. Hillert, ELSA, Bonn, Germany

Spin dynamics* (2)

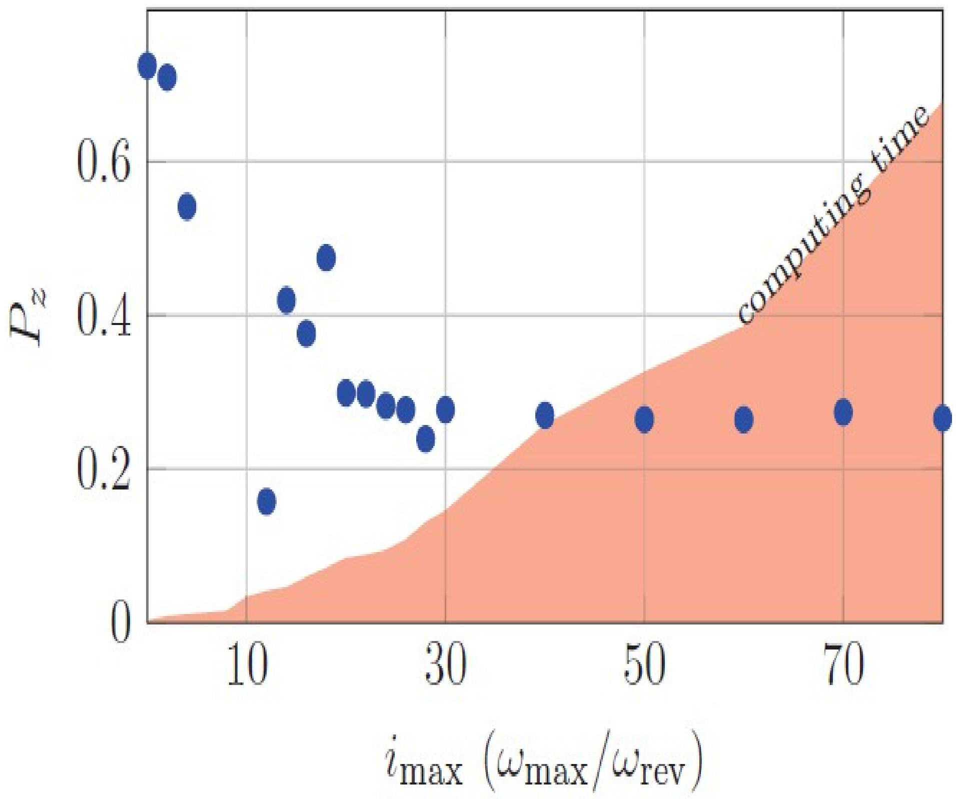


Figure 1: Simulated vertical polarization after crossing of integer resonance $a\gamma = 3$ as a function of the maximum considered frequency of the magnetic field spectrum

No energy ramp.

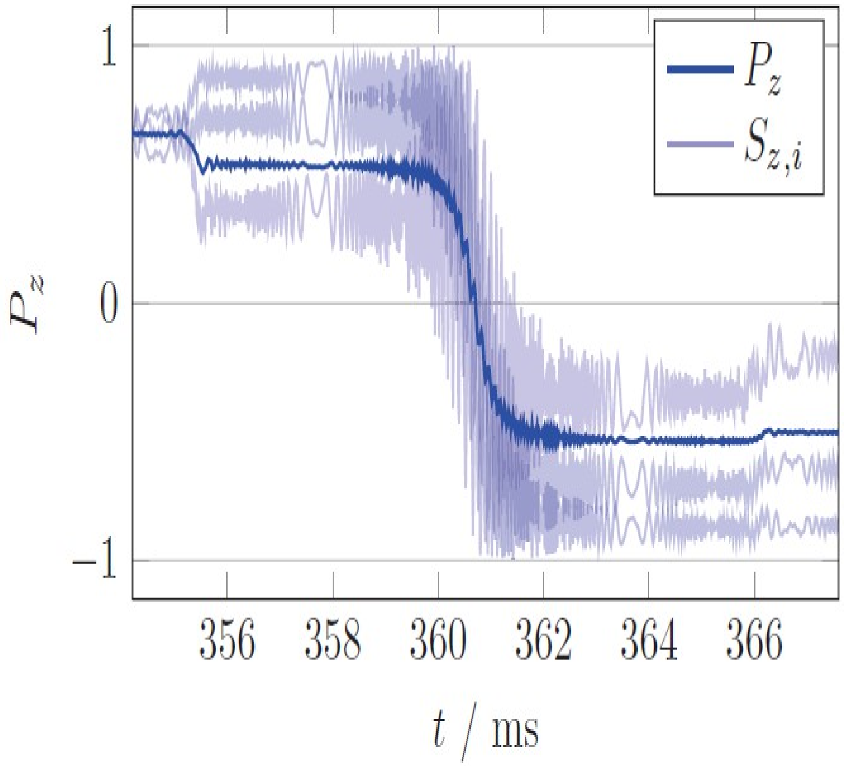


Figure 2: Simulated vertical polarization with synchrotron side-bands during crossing of integer resonance $a\gamma = 6$

With energy ramp, 4 GeV/s

$$\gamma_i(t) = \gamma_{\text{ramp}}(t) + A_i \cos(\omega_i t + \phi_i)$$

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