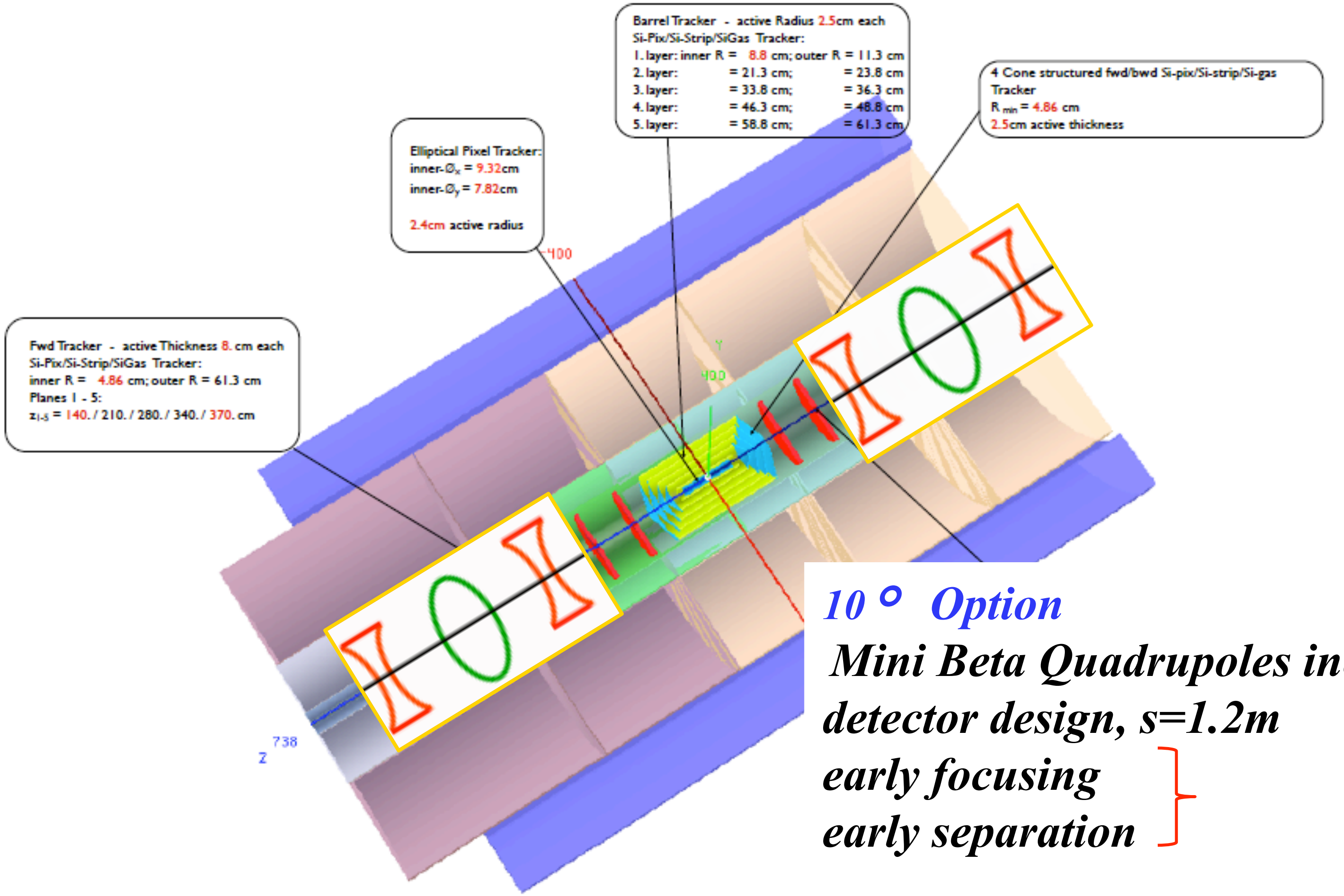
LHeC Ring-Ring Option

Introduction and Main Parameters

Bernhard Holzer

1.) The Logo

2.) The Problem



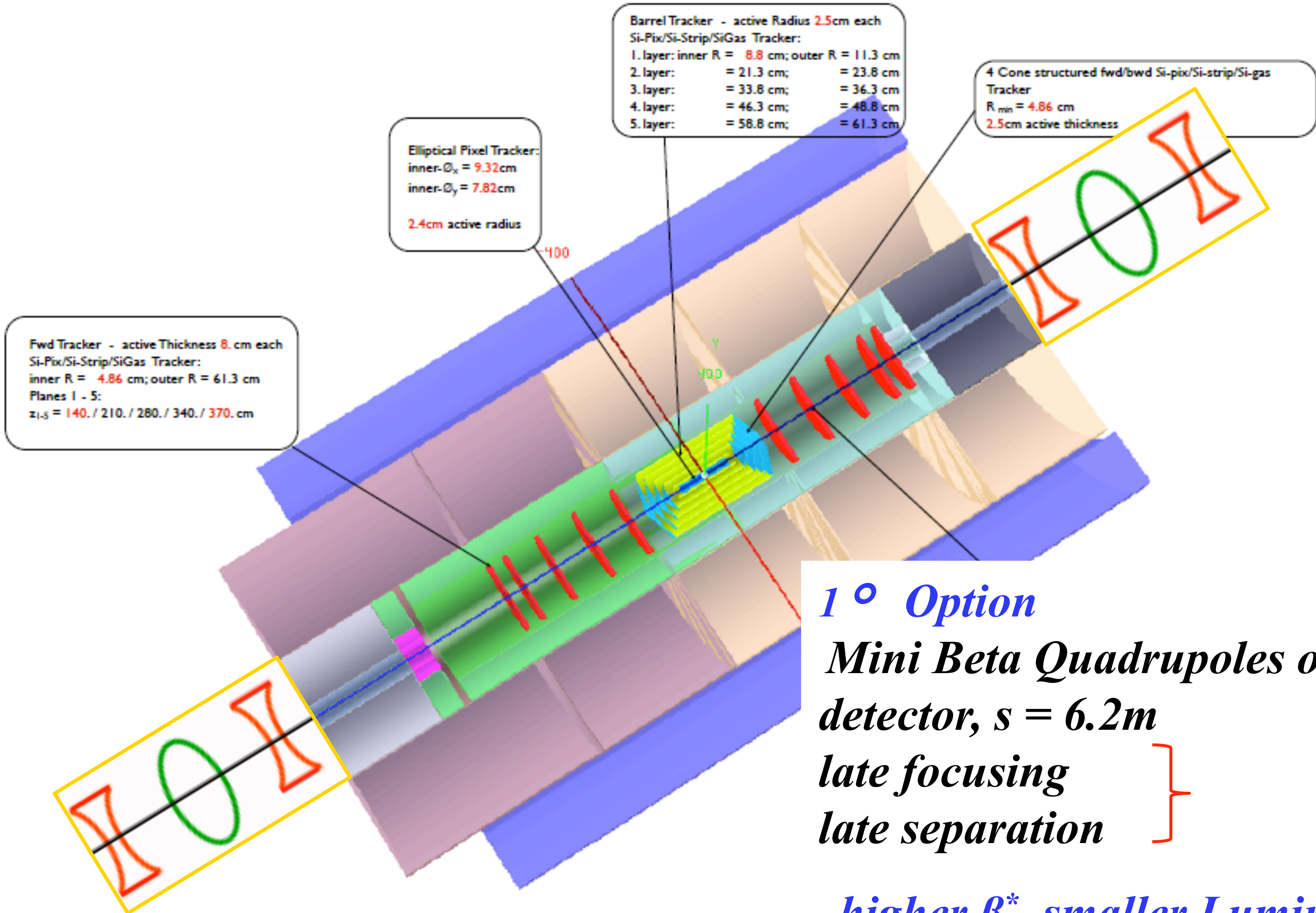
10° Option

Mini Beta Quadrupoles included in detector design, s=1.2m

early focusing
early separation

small β*, higher Luminosity
smaller synchrotron radiation

The Real Problem



1° Option

Mini Beta Quadrupoles outside detector, s = 6.2m

late focusing
late separation

higher β^*, smaller Luminosity
higher synchrotron radiation

LHeC Ring-Ring Option
Arc Lattice

Proton Ring: **Ultimate LHC Parameter**

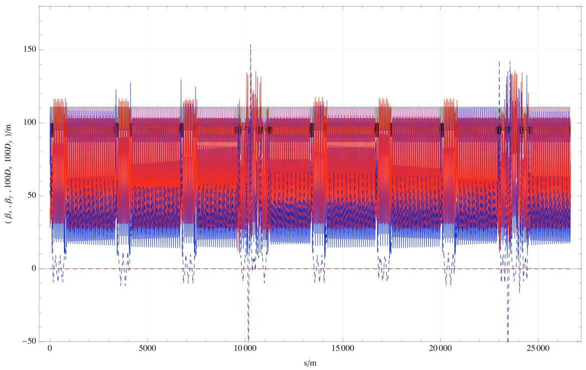
$E = 7\ TeV$

$N_p = 1.7*10^{11}$ Protons/Bunch

$\varepsilon = 5*10^{-10}$ mrad

determined by performance of dipole magnets

Electron Ring: **Miriam Parameter**



$E = 60\ GeV$

$N_p = 2*10^{10}$ Electrons/Bunch

… determined by available rf power

$\varepsilon_x = 5*10^{-9}$ mrad, $\varepsilon_y = 2.5*10^{-9}$ mrad

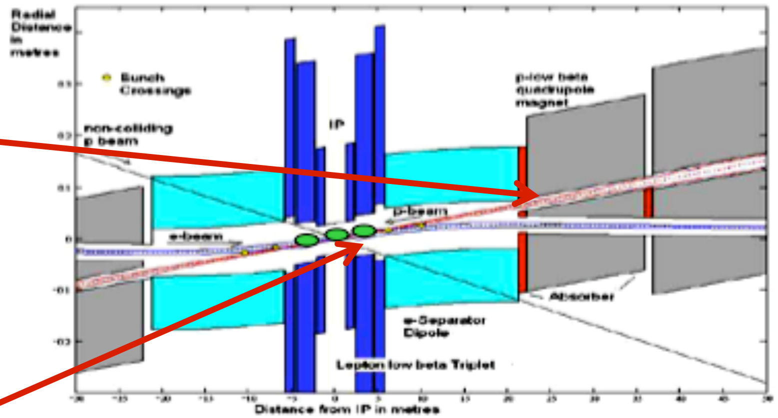
… determined by arc lattice

Miriam Fitterer

LHeC Ring-Ring Option
IR-Optics

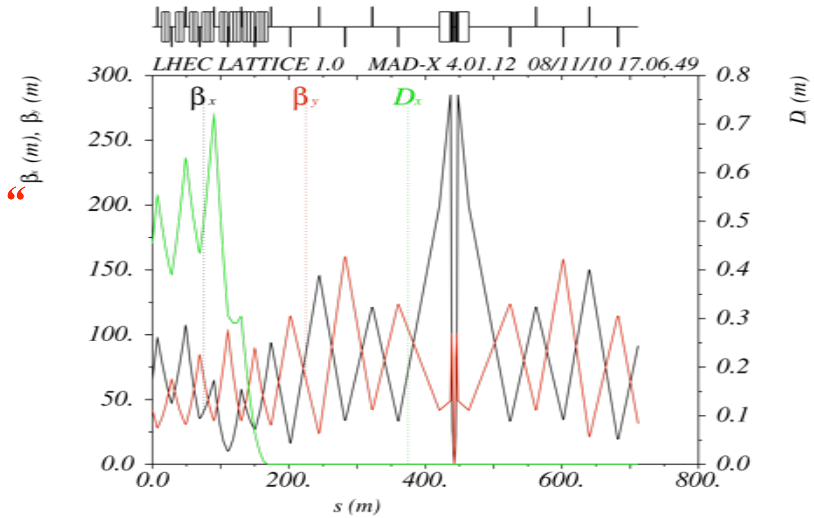
10° Optics:

Luminosity limited by β_{max} at first proton quadrupole



→ *determines the quadrupole design*
→ *determines the separation scheme*

→ *determines the crossing angle (parasitic encounters)*



Luke Thomson

Goal: "somehow in the range of L= 10^{33} "

$\sigma_x = 30\ \mu m$ $\beta_{xp} = 1.8\ m$ $\beta_{xe} = 18\ cm$

$\sigma_y = 15.8\ \mu m$ $\beta_{yp} = 0.5\ m$ $\beta_{ye} = 10\ cm$

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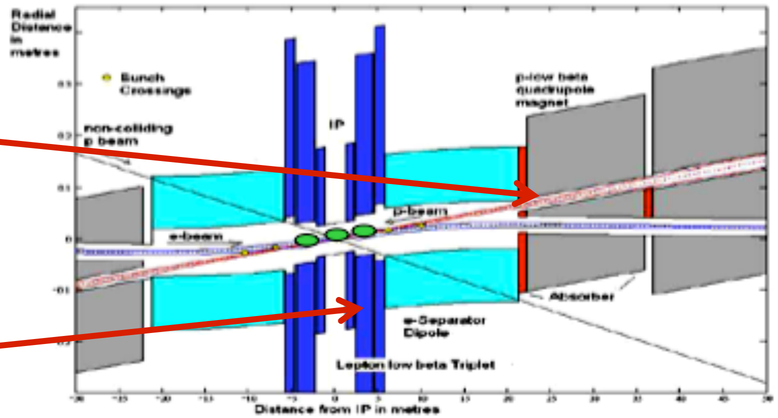
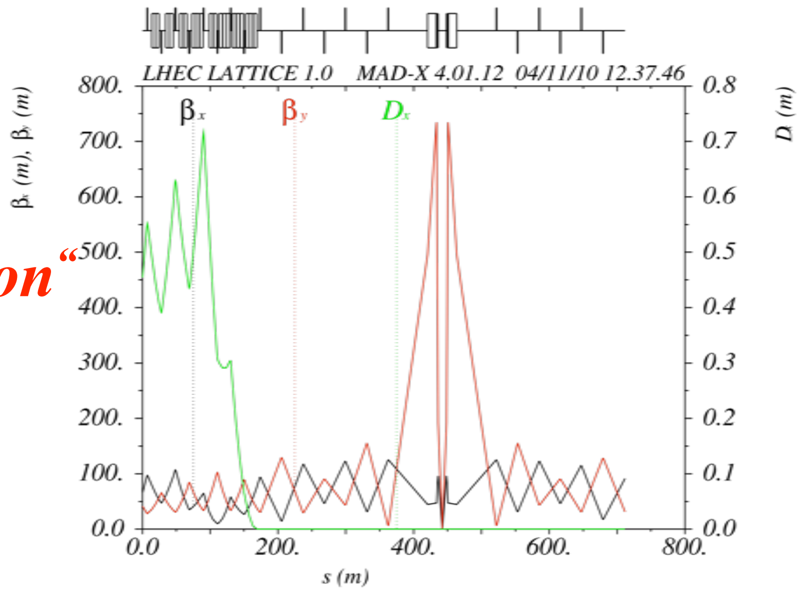
IR-Optics



1° Optics:

Luminosity limited by β_{max} at first proton quadrupole

… but more by (late) separation scheme
→ determines the synchrotron radiation power



Goal: "as close as possible to the 10° option"

$$\sigma_x = 44.7\ \mu m \quad \beta_{xp} = 3.9\ m \quad \beta_{xe} = 40\ cm$$

$$\sigma_y = 22.4\ \mu m \quad \beta_{yp} = 1.0\ m \quad \beta_{ye} = 20\ cm$$

Luke Thomson

LHeC Ring-Ring Option

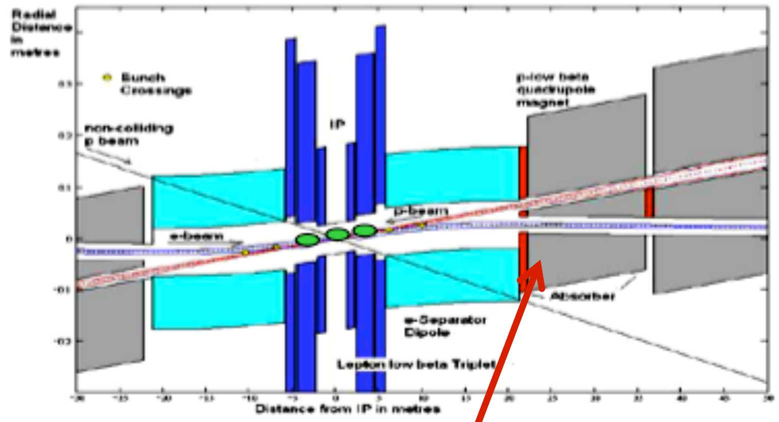
Separation Scheme and Synchrotron Radiation

Separation Scheme:

10^{o} Option: s=1.2m

Separation starts as early as the focusing

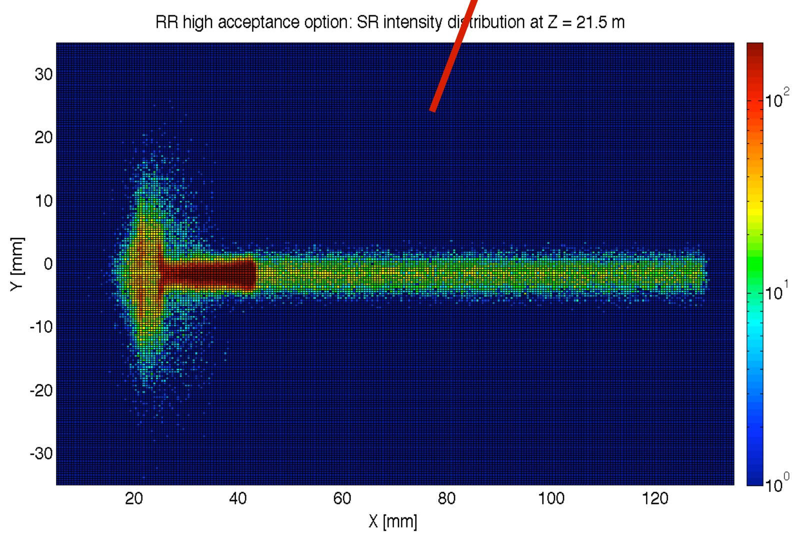
$\rho = 8\ km = const$ *from s=1.2m ... s=21m*



Goal: "keep it low ... "

$P_{\gamma} \approx 29\ kW \quad for \quad I_e = 100\ mA$

$E_{crit} = 124\ keV$



Nathan Bernard

LHeC Ring-Ring Option

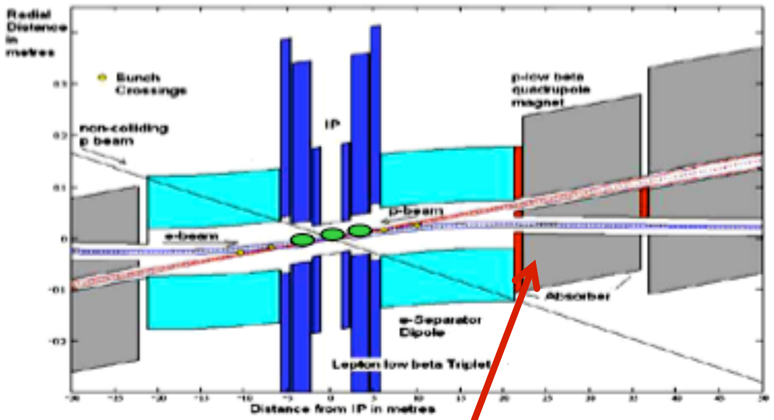
Separation Scheme and Synchrotron Radiation

Separation Scheme:

1 º Option: s=6.2m

Separation starts late

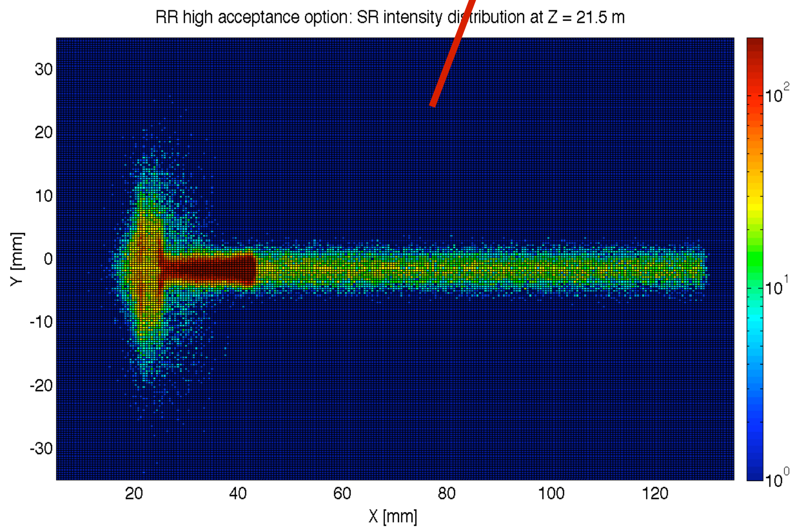
$$\rho = 4.6\ km = const$$



Goal: "keep it low ... "

$$P_\gamma \approx 44\ kW \quad for \quad I_e = 100\ mA$$

$$E_{crit} = 156\ keV$$



Separation Scheme:

crossing angle (1mrad) could be reduced but it is needed to support the overall separation at s=21 m

Nathan Bernard

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Magnet Design

Electron Triplet:

1º Option: Quadrupoles outside the detector

-> null problemo

$$g = 90\ T/m$$

$$B_0 = 3.2\ T$$

10º Option: Quadrupoles inside the detector

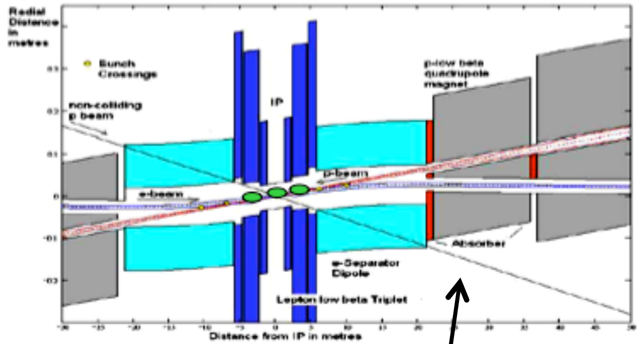
compact design needed

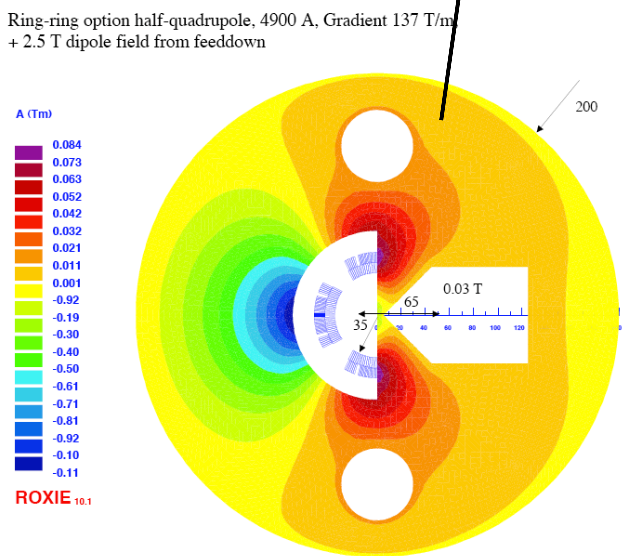
$$g = 102\ T/m$$

$$B_0 = 2.0\ T$$

Proton Triplet:

beam separation needed ≈ 55 mm





Stephan Russenschuck

LHeC Ring-Ring Option

Main Parameters

	Electrons	Protons		
Energy	60 GeV	7 TeV		
Current	100mA	860mA		
Part. per Bunch	$2*10^{10}$	$1.7*10^{11}$		
ε_x	$5*10^{-9}$ m	$5*10^{-10}$ m		
ε_y	$2.5*10^{-9}$ m	$5*10^{-10}$ m		
P_γ	43.5 MW			
	1 degree		10 degree	
	Electrons	Protons	Electrons	Protons
β_x	40cm	4.05 m	18 cm	1.8 m
β_y	20cm	0.97 m	10 cm	0.5 m
σ_x	45μm		30μm	
σ_y	22μm		15.8μm	
L_0	$8.5*10^{32}$		$1.8*10^{33}$	
crossing angle	0.7mrad		1mrad	
loss factor	92 %		75%	
P_γ	44kW		28kW	
L_{eff}	$7.9*10^{32}$		$1.34*10^{33}$	