



# *FCC-he*

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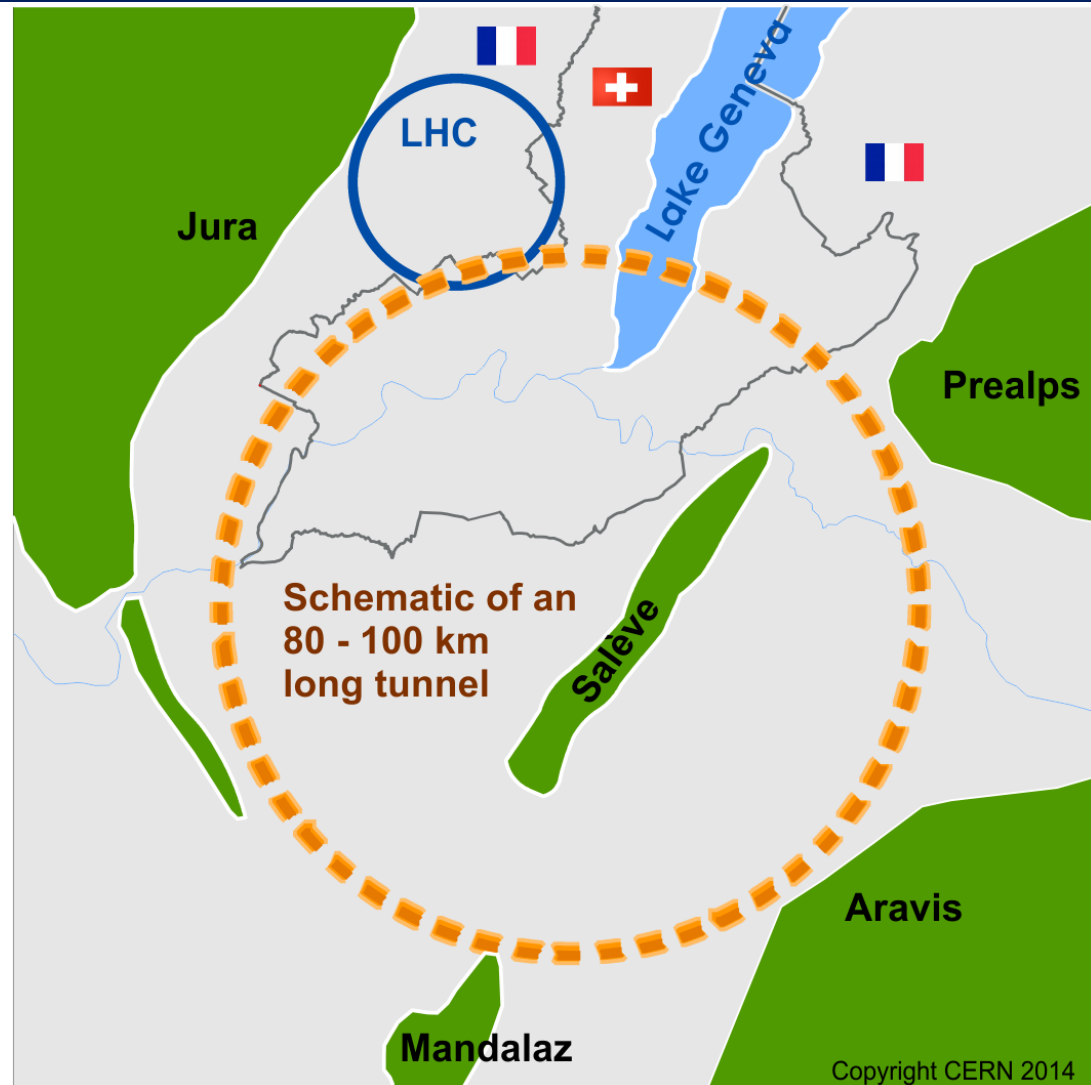
1<sup>st</sup> LHeC SG Meeting

5 February 2014

# Future Circular Collider Study

## CDR and cost review for the next ESU (2018)

- 80-100 km tunnel infrastructure in Geneva area
- $pp$ -collider ( $FCC-hh$ ) defining the infrastructure requirements
- $e^+e^-$  collider ( $FCC-ee$ ) as potential intermed. step and  $p-e$  ( $FCC-he$ ) option
- international collaboration hosted by CERN



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$\sim 16 T \Rightarrow 100 \text{ TeV } pp \text{ in } 100 \text{ km}$   
 $\sim 20 T \Rightarrow 100 \text{ TeV } pp \text{ in } 80 \text{ km}$

# key parameters for *FCC-he*

$e^\pm$  energy = 60 (*pol.*), 120, 250 GeV

$p$  energy = 50 TeV

#IPs = 1 or 2

IP spot size determined by  $p$

$e^\pm$  current from *FCC-ee*

(if built; SR power  $\leq$  50 MW)

or

$e^-$  current from pushed *LHeC ERL*

(*without FCC-ee*)

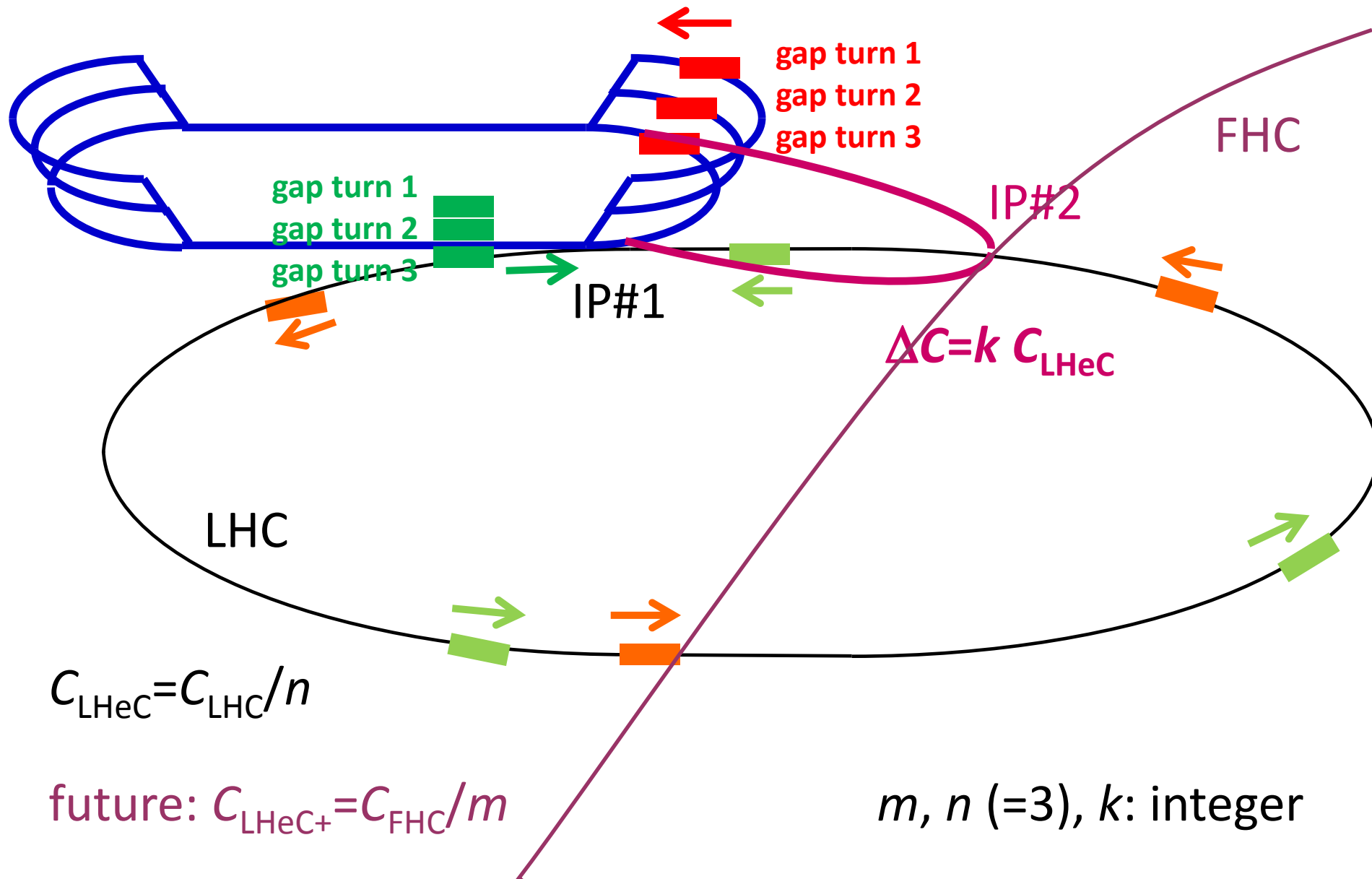
# *ambitious (!) parameters for FCC-he with FCC-ee*

collider parameters	$e^\pm$ scenarios			protons
species	$e^\pm$	$e^\pm$	$e^\pm$	$p$
beam energy [GeV]	<b>60</b>	120	<b>250</b>	<b>50000</b>
bunch spacing [ $\mu\text{s}$ ]	0.125	2	33	<b>0.125 to 33</b>
bunch intensity [ $10^{11}$ ]	3.8	3.7	3.3	<b>3.0</b>
beam current [mA]	477	29.8	1.6	384 (max)
rms bunch length [cm]	0.25	0.21	0.18	<b>2</b>
rms emittance [nm]	6.0, 3.0	7.5, 3.75	4, 2	0.06, 0.03
$\beta_{x,y}^*$ [mm]	5.0, 2.5	4.0, 2.0	9.3, 4.5	500, 250
$\sigma_{x,y}^*$ [ $\mu\text{m}$ ]	5.5, 2.7			
beam-b. parameter $\xi$	<b>0.13</b>	0.050	0.056	0.017
hourglass reduction	<b>0.42</b>	<b>0.36</b>	0.68	
CM energy [TeV]	3.5	4.9	7.1	
luminosity [ $10^{34}\text{cm}^{-2}\text{s}^{-1}$ ]	<b>21</b>	<b>1.2</b>	<b>0.07</b>	

# baseline (!) parameters for FCC-he with FCC-ee

collider parameters	$e^\pm$ scenarios			protons
species	$e^\pm$	$e^\pm$	$e^\pm$	$p$
beam energy [GeV]	80	120	175	50000
bunches / beam	4490	1360	98	10600
bunch intensity [ $10^{11}$ ]	0.7	0.46	1.4	1.0
beam current [mA]	152	30	6.6	500
rms bunch length [cm]	0.15	0.12	0.15	8
rms emittance [nm]	3.3 (x)	0.94 (x)	2 (x)	0.04, 0.02
$\beta_{x,y}^*$ [mm]	6.0, 3.0	22, 11	10, 5	500, 250
$\sigma_{x,y}^*$ [ $\mu\text{m}$ ]	4.5, 2.3			
beam-b. parameter $\xi$	0.05	<b>0.13</b>	0.042	0.017
hourglass reduction	<b>~0.24</b>	~0.60	<b>~0.36</b>	
CM energy [TeV]	4.0	4.9	5.9	
luminosity [ $10^{34}\text{cm}^{-2}\text{s}^{-1}$ ]	<b>2.3</b>	<b>1.2</b>	<b>0.15</b>	

# LHeC - ion gaps & circumference



# *preliminary (!) parameters for FCC-he-ERL w/o FCC-ee*

parameter [unit]		
species	<i>e-</i>	<i>p</i>
beam energy (/nucleon) [GeV]	<b>60</b>	<b>50000</b>
bunch spacing [ns]	25	25
<b>bunch intensity (nucleon) [<math>10^{10}</math>]</b>	<b>0.4</b>	<b>10</b>
<b>beam current [mA]</b>	<b>25.6</b>	<b>500</b>
normalized rms emittance [ $\mu\text{m}$ ]	<b>20</b>	<b>2.0</b>
<b>geometric rms emittance [nm]</b>	<b>0.17</b>	<b>0.04</b>
<b>IP beta function <math>\beta_{x,y}^*</math> [m]</b>	<b>0.10</b>	<b>0.4</b>
IP rms spot size [ $\mu\text{m}$ ]	<b>4.0</b>	<b>4.0</b>
<b>lepton <math>D</math> &amp; hadron <math>\xi</math></b>	<b>32</b>	<b>0.0002</b>
hourglass reduction factor $H_{hg}$		<b>0.94</b>
pinch enhancement factor $H_D$		1.35
<b>luminosity / nucleon [<math>10^{33} \text{ cm}^{-1}\text{s}^{-1}</math>]</b>		<b>6.4</b>

# ERL electrical power budget

system	wall plug power	
	baseline	<b>LHeC-HF</b>
cryogenics	21 MW ( $Q_0=2.5 \times 10^{10}$ )	<b>11 MW</b> ( $Q_0=5 \times 10^{10}$ )
RF operation & microphonics control	24 MW (802 MHz)	<b>12 MW</b> ( <b>401 MHz</b> )
addt'l RF power to compensate SR losses	24 MW ( $I_e=6.4$ mA)	<b>96 MW</b> ( $I_e=25.6$ mA)
injector	7 MW	<b>7 MW</b>
magnets (arcs + IR)	4 MW	<b>4 MW</b>
total	~80 MW	<b>~130 MW</b>



spare slides

# LHeC Higgs factory (LHeC-HF) parameters

parameter [unit]		
species	$e^-$	$p$
beam energy (/nucleon) [GeV]	60	7000
bunch spacing [ns]	25	25
<b>bunch intensity (nucleon) [<math>10^{10}</math>]</b>	<b>0.1 <math>\rightarrow</math> 0.4</b>	<b>17 <math>\rightarrow</math> 22</b>
<b>beam current [mA]</b>	<b>6.4 <math>\rightarrow</math> 25.6</b>	<b>860 <math>\rightarrow</math> 1110</b>
normalized rms emittance [ $\mu\text{m}$ ]	50 $\rightarrow$ 20	3.75 $\rightarrow$ 2.5
<b>geometric rms emittance [nm]</b>	<b>0.43 <math>\rightarrow</math> 0.17</b>	<b>0.50 <math>\rightarrow</math> 0.34</b>
<b>IP beta function <math>\beta_{x,y}^*</math> [m]</b>	<b>0.12 <math>\rightarrow</math> 0.10</b>	<b>0.10 <math>\rightarrow</math> 0.05</b>
IP rms spot size [ $\mu\text{m}$ ]	7.2 $\rightarrow$ 4.1	7.2 $\rightarrow$ 4.1
<b>lepton <math>D</math> &amp; hadron <math>\xi</math></b>	<b>6 <math>\rightarrow</math> 23</b>	<b>0.0001 <math>\rightarrow</math> 0.0004</b>
hourglass reduction factor $H_{hg}$	0.91 $\rightarrow$ 0.70	
pinch enhancement factor $H_D$	1.35	
<b>luminosity / nucleon [<math>10^{33} \text{ cm}^{-1}\text{s}^{-1}</math>]</b>	<b>1.3 <math>\rightarrow</math> 16</b>	

# Future Circular Collider Study Kick-off Meeting

12-15 February 2014,  
University of Geneva,  
Switzerland

## LOCAL ORGANIZING COMMITTEE

### University of Geneva

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F. Sonnemann, L. Tavian,  
J. Wenninger, F. Zimmermann

# FCC Kick-off Meeting in Geneva next week

<http://indico.cern.ch/e/fcc-kickoff>



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