LHeC

- General Design Considerations
- Two options for the CDR:
  - -Ring-Ring collider
  - -Linac-Ring collider with Energy Recovery
- Interaction Region Layout
- Planning and Time line
- Next Steps and foreseen R&D activities

LHeC

- General Design Considerations

- Two options for the CDR:

  -Ring-Ring collid

  -Linac-R ider with Energy Recovery

- Interaction Region

- Plann ime line

- Next Steps and foreseen R&D activities

On behalf of the LHeC Collaboration!

Design Considerations

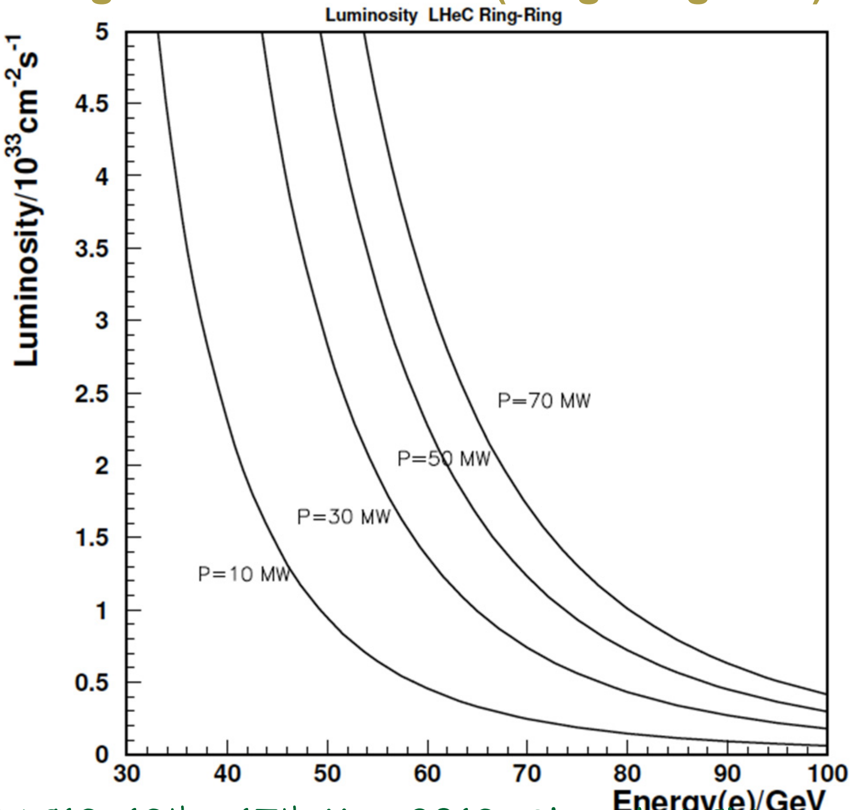
LHC beams: E_p=7 TeV; CM collision energy: $E^2_{CM} = 4\ E_e * E_{p,A}$ ➔ E_e = 50 to 150GeV

Luminosity > 10^{33} $cm^{-2}s^{-1}$ with 100 MW power consumption ➔ Beam Power < 70 MW

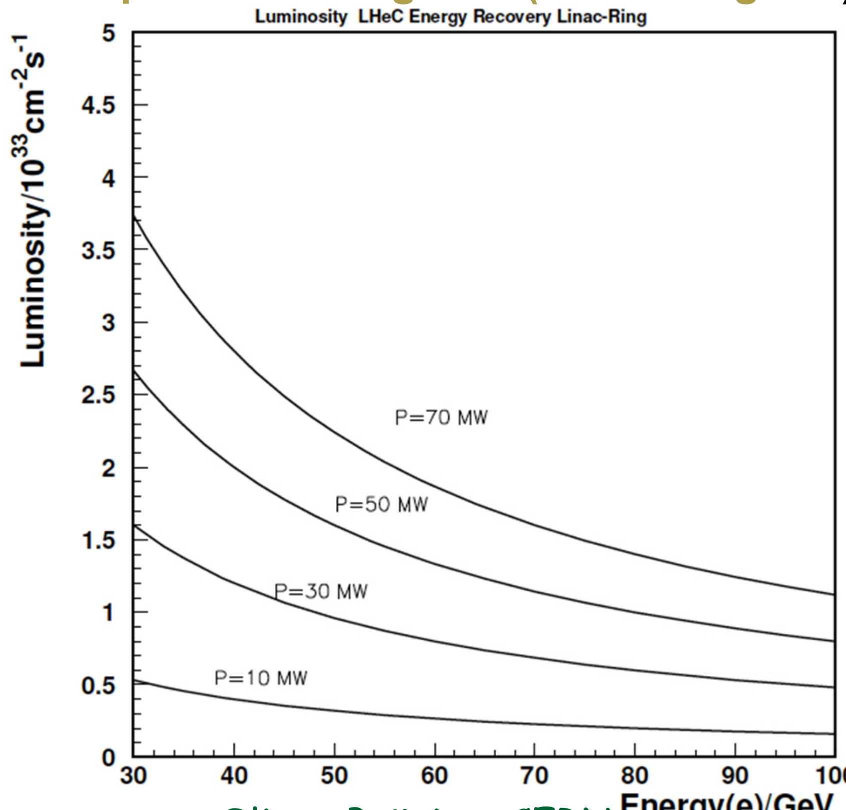
Integrated $e^{\pm}p$: O(100) fb^{-1} ≈ 100 * L(HERA) → synchronous ep and pp operation

Start of LHeC operation together with HL-LHC in 2023 (installation in LS3 in 2022)

e Ring in the LHC tunnel (Ring-Ring - RR)



Superconducting ERL (Linac-Ring -LR)



Design Considerations

LHC beams: E_p=7 TeV; CM collision energy: $E^2_{CM} = 4\ E_e * E_{p,A}$ ➔ E GeV

Luminosity > 10^{33} $cm^{-2}s^{-1}$ with 100 MW power consumption W

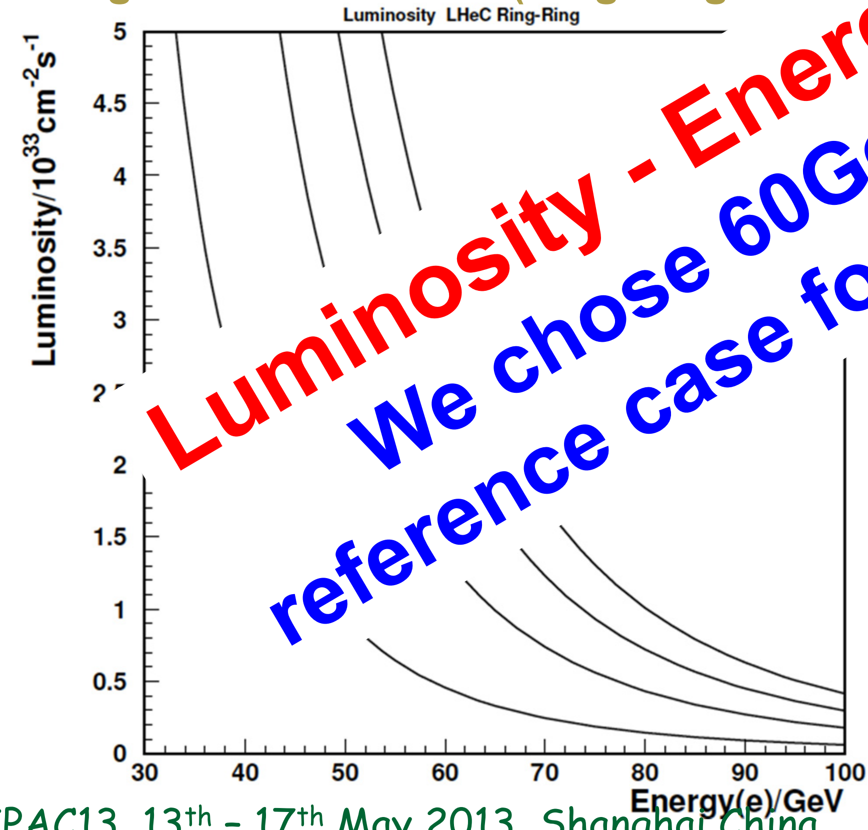
Integrated e±p : O(100) fb^{-1} ≈ 100 * L(HERA) → sync

Start of LHeC operation together with HL-LHC 022)

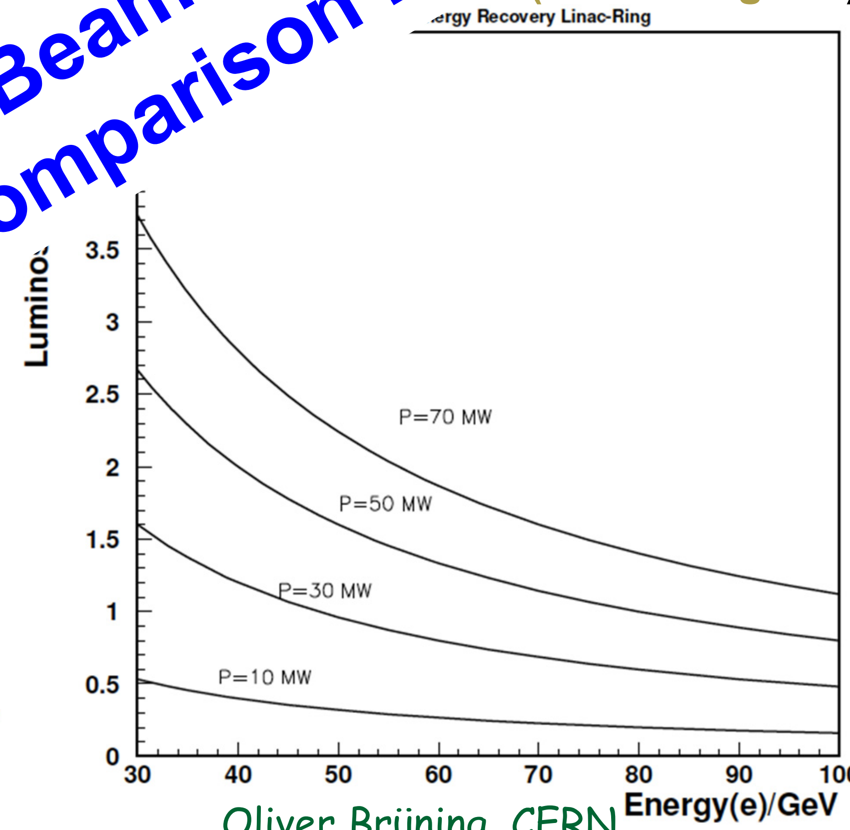
Luminosity - Energy & Power tradeoff

We chose 60GeV Beam Energy as reference case for comparison in the CDR

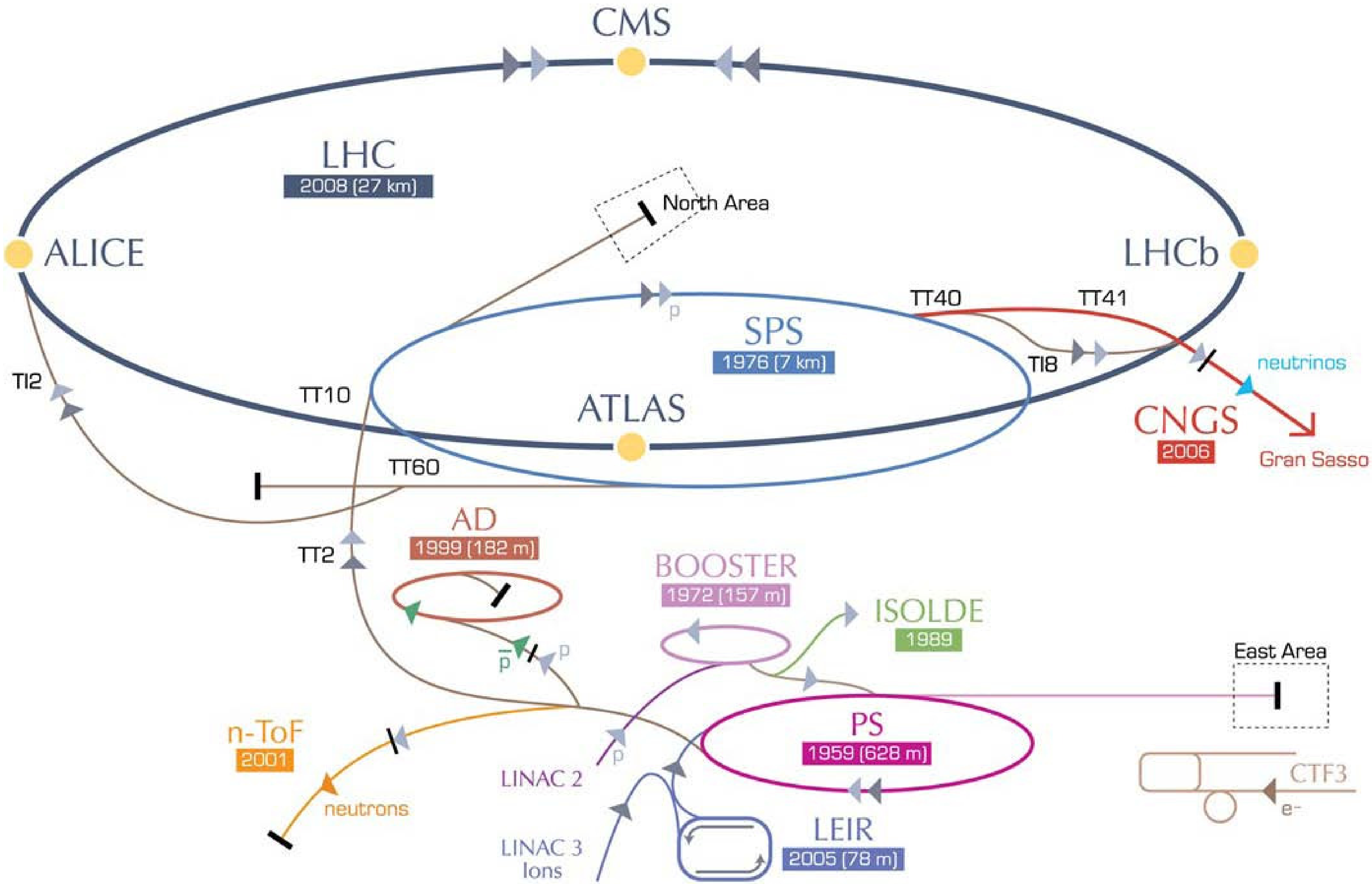
e Ring in the LHC tunnel (Ring-Ring - RR)



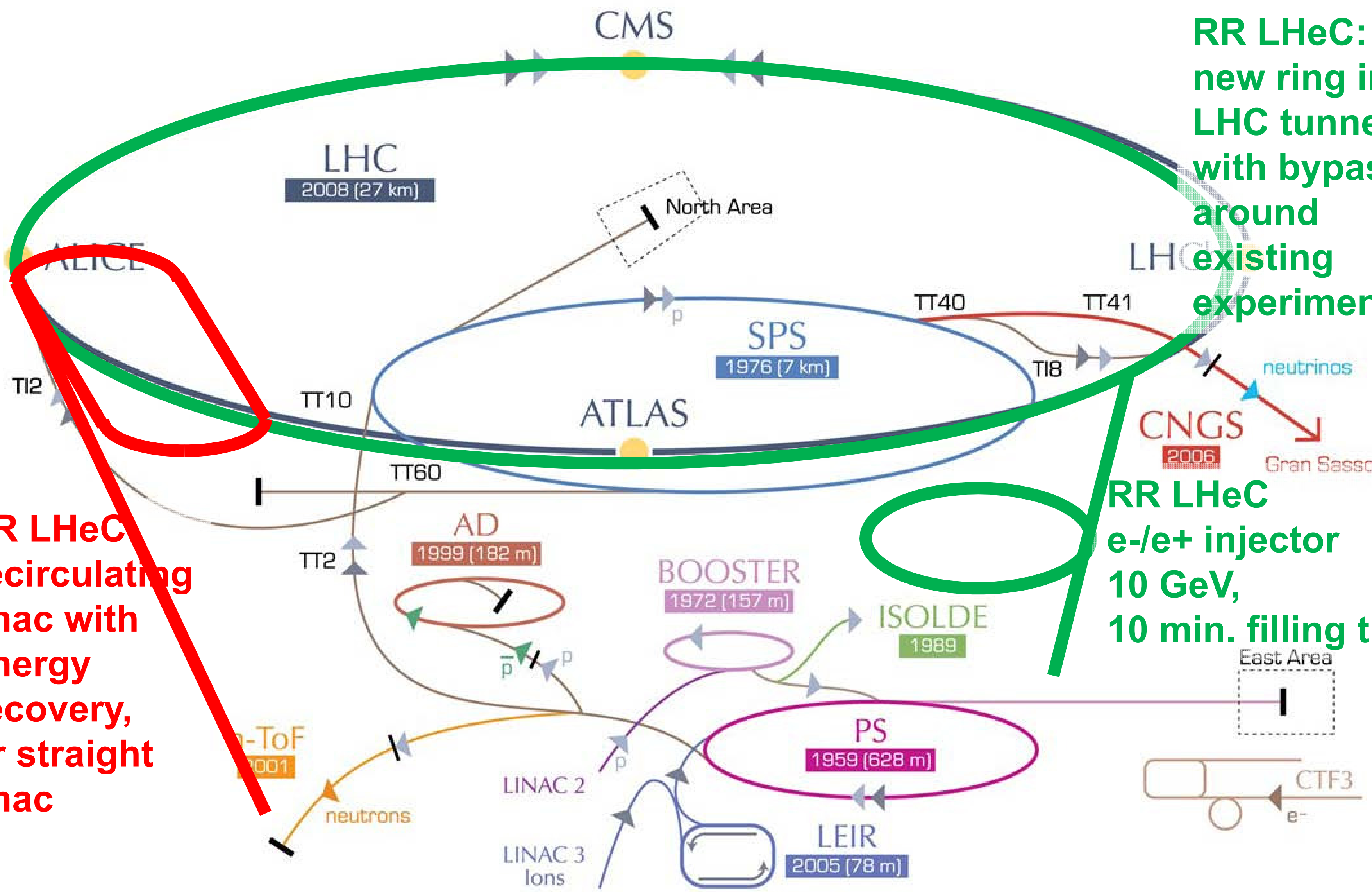
(Linac-Ring -LR)



LHeC options: RR and LR



LHeC options: RR and LR

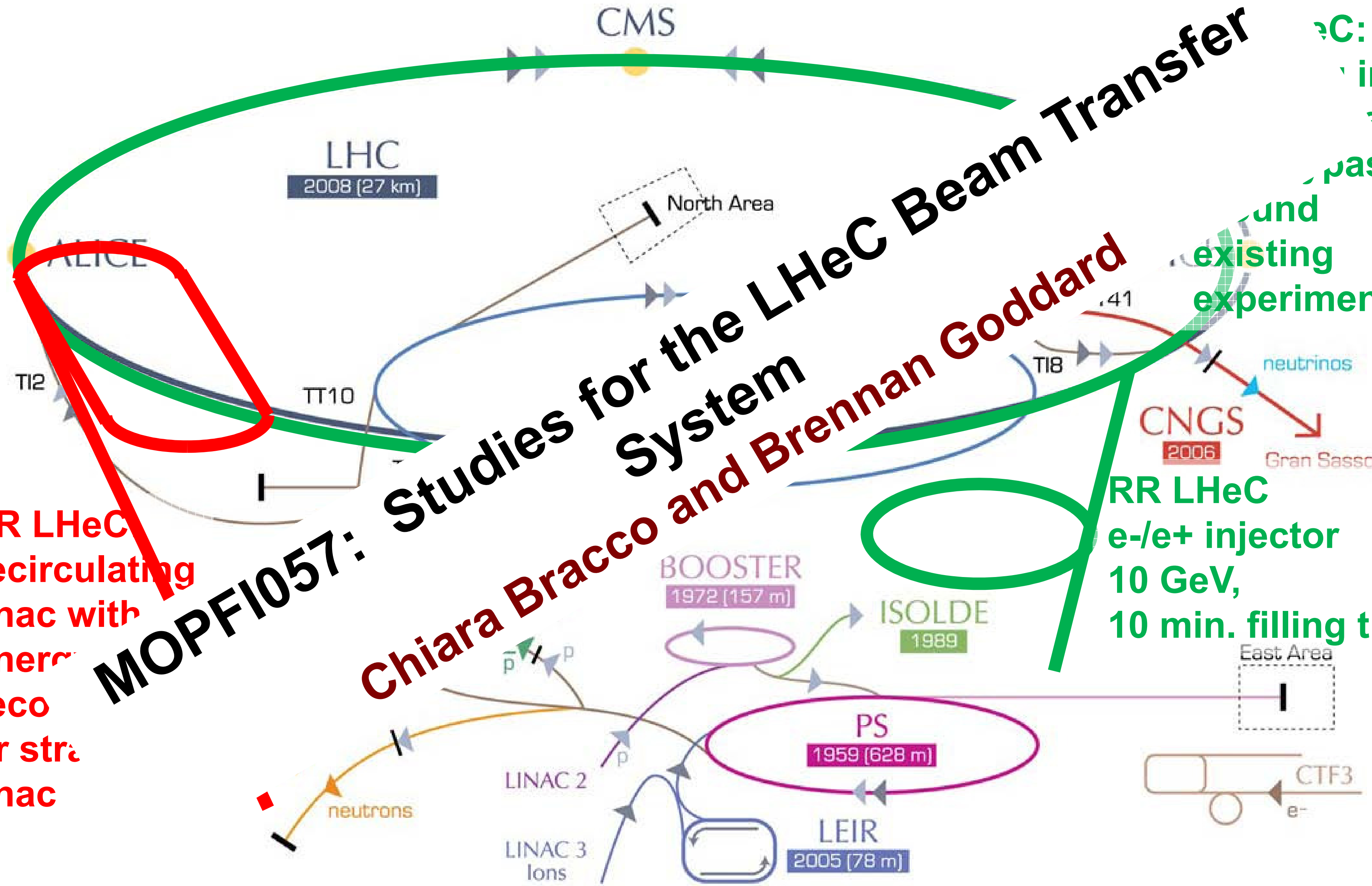


RR LHeC: new ring in LHC tunnel, with bypasses around existing experiments

RR LHeC e-/e+ injector 10 GeV, 10 min. filling time

LR LHeC recirculating linac with energy recovery, or straight linac

LHeC options: RR and LR

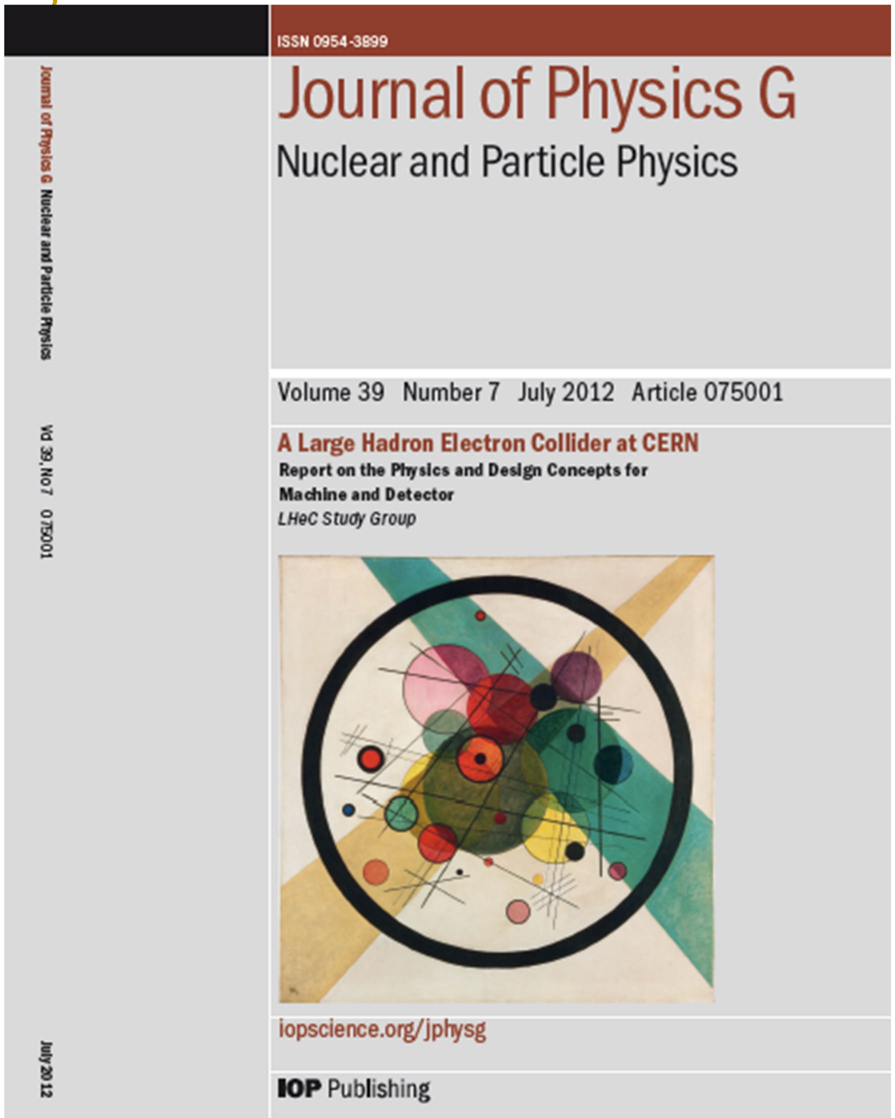


LR LHeC
recirculating
linac with
energ
reco
or stra
linac

eC:
in
el,
passes
und
existing
experiments

RR LHeC
e-/e+ injector
10 GeV,
10 min. filling time

LHeC CDR



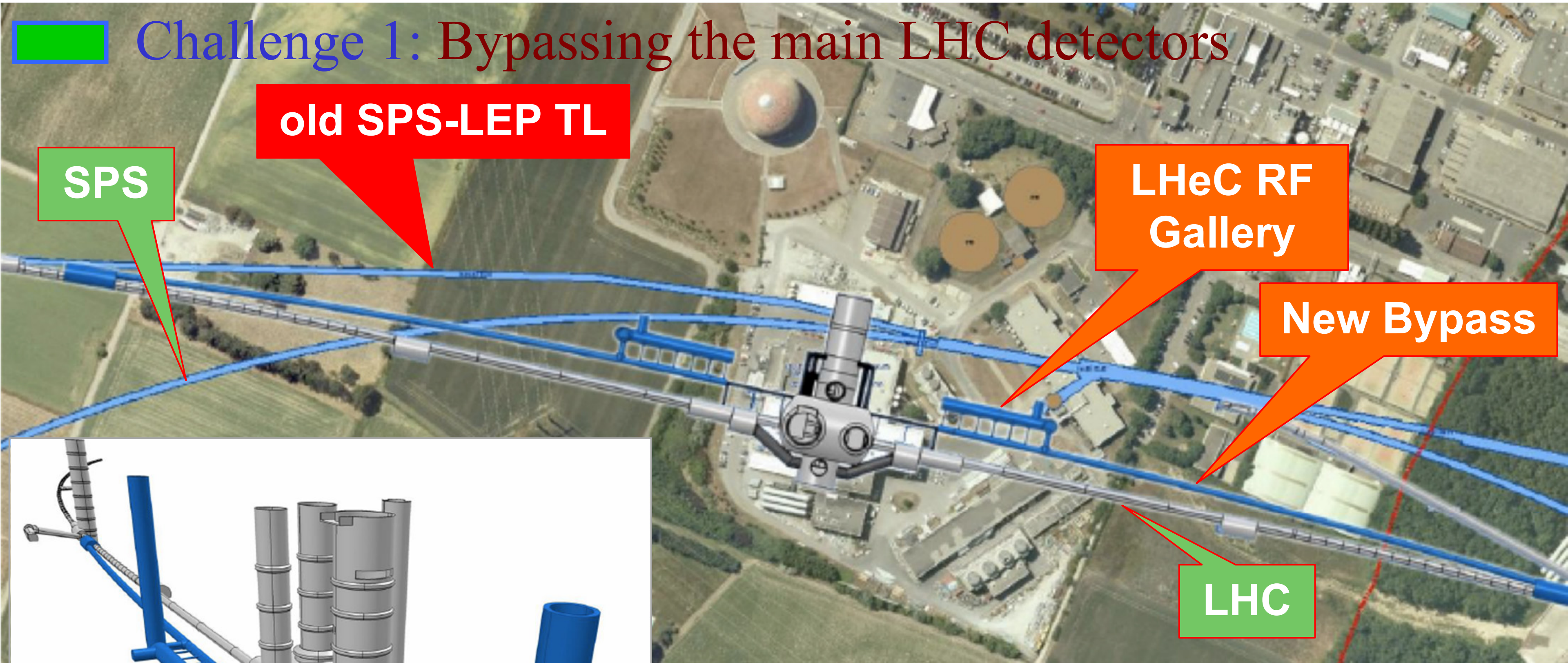
1. Design for synchronous ep and pp operation (including eA) → after LS3 which is about 2025 – no firm schedule exists for HL-LHC, but it may operate until ~2035

2. LHeC is a new collider: the cleanest microscope of the world, a complementary Higgs facility, a unique QCD machine with a striking discovery potential, with possible applications as γγ → H or
injector to TLEP or others
AND an exciting new accelerator project

3. CERN Mandate to develop key technologies for the LHeC for project decision after start of LHC Run II and in time for start parallel to HL LHC phase

LHeC: Ring-Ring Option

Challenge 1: Bypassing the main LHC detectors



Without using the survey gallery the ATLAS bypass would need to be 100m away from the IP or on the inside of the tunnel!

For the CDR the bypass concepts were decided to be confined to ATLAS and CMS

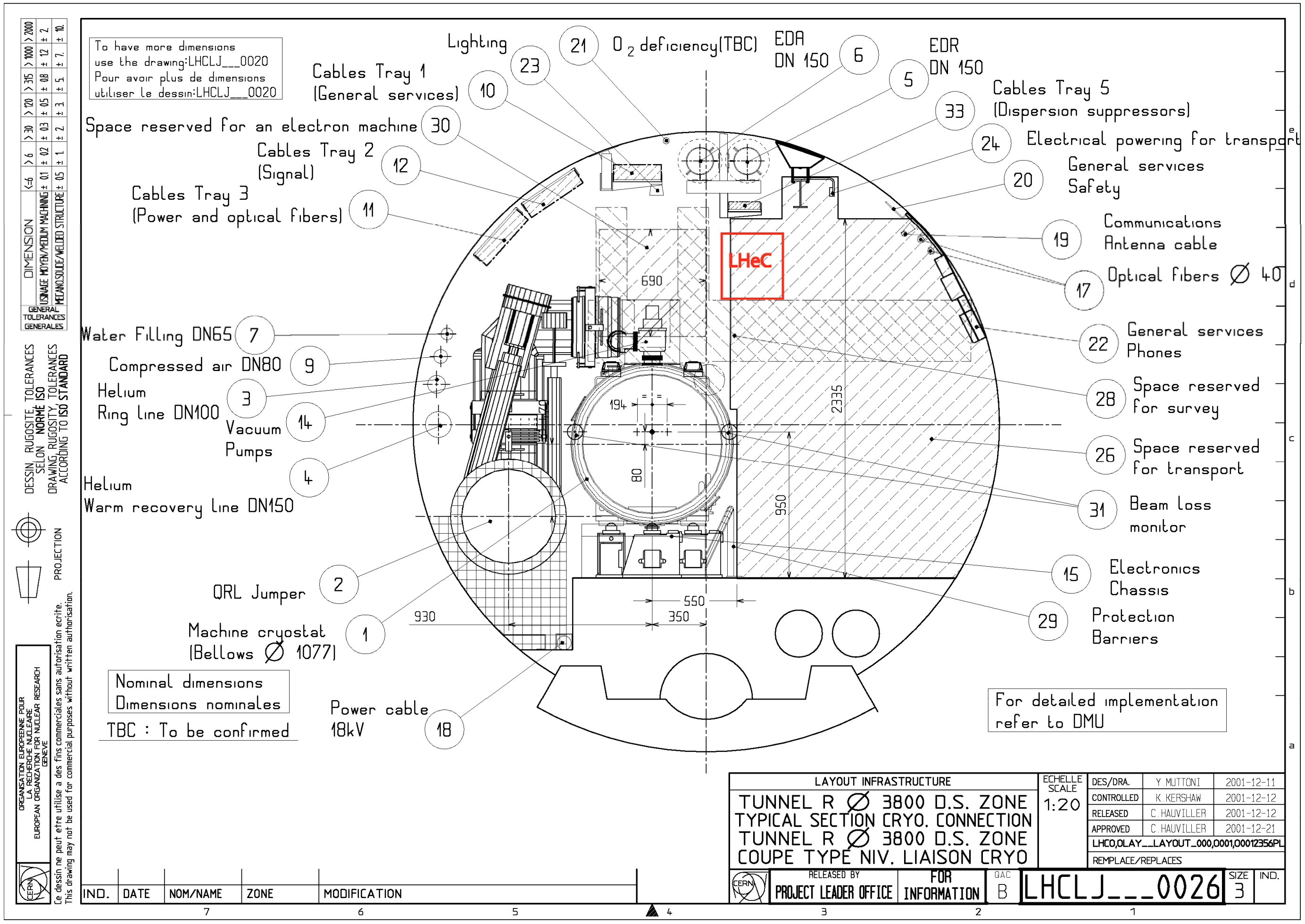
ca. 1.3 km long bypass

ca. 170m long dispersion free area for RF

LHeC: Ring-Ring Option

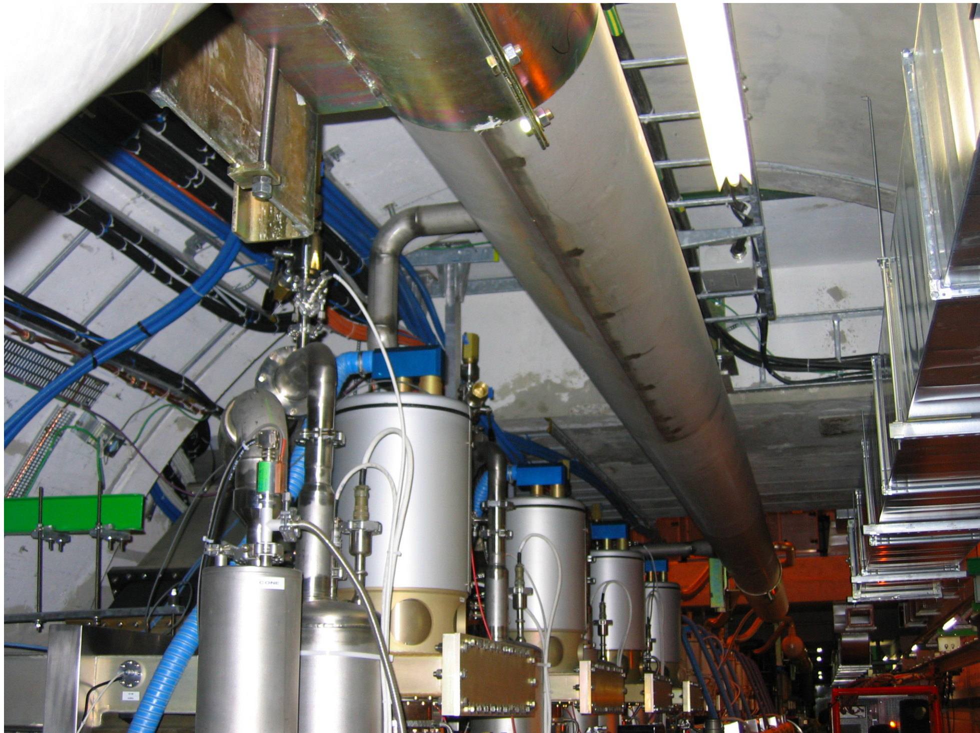
Challenge 2: Installation with LHC circumference:

requires: support structure with efficient montage and compact magnets

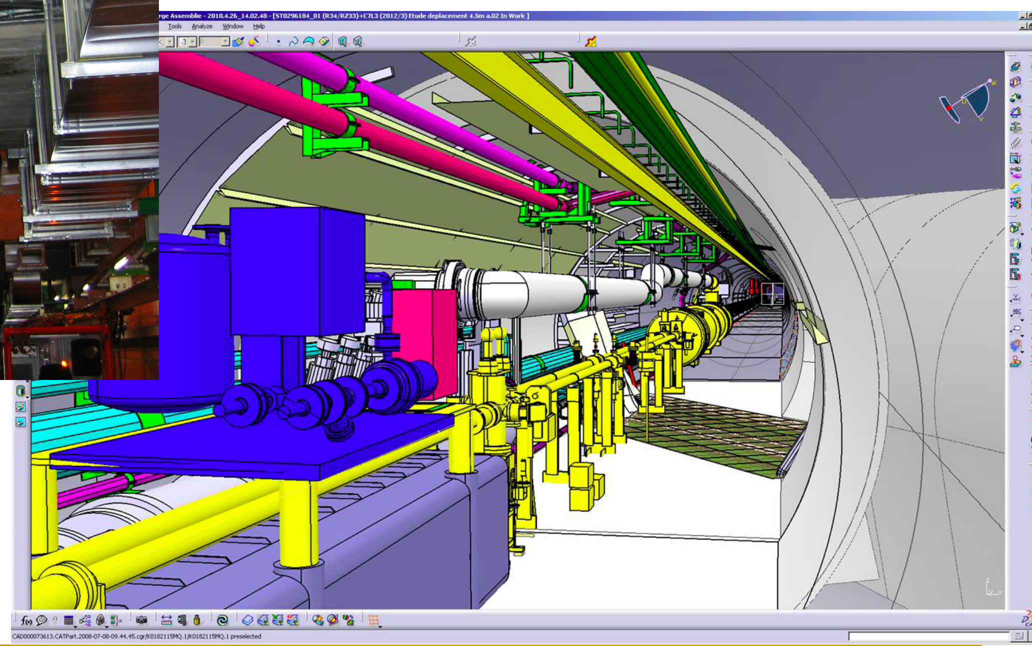


LHeC: Ring-Ring Option

Challenge 3: Integration in the LHC tunnel



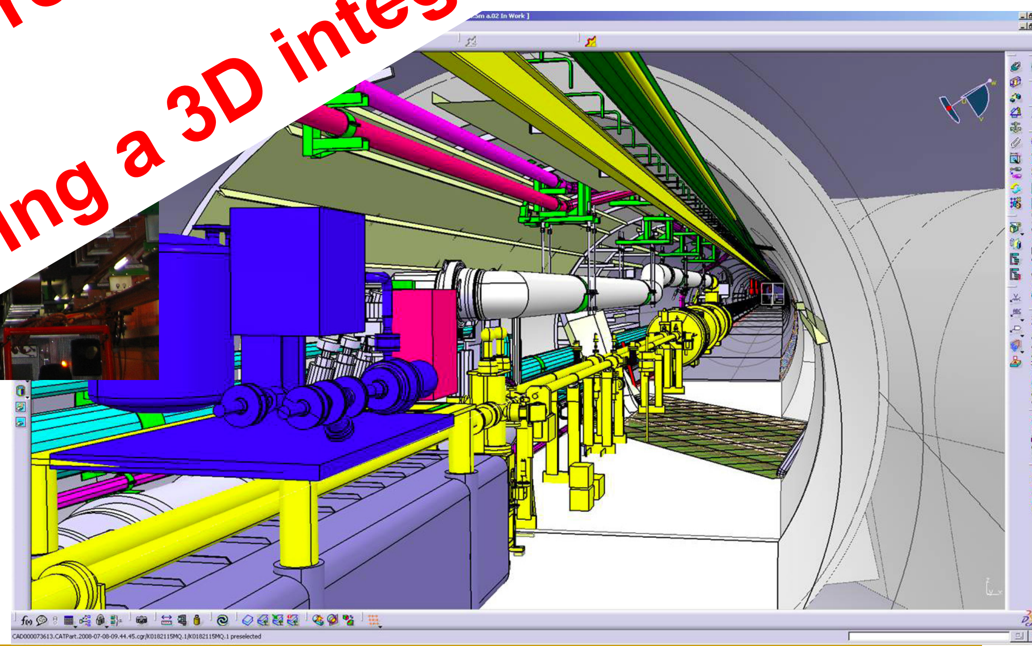
RF Installation in IR4



Cryo link in IR3

LHeC: Ring-Ring Option

Challenge 3: Integration in the LHC tunnel



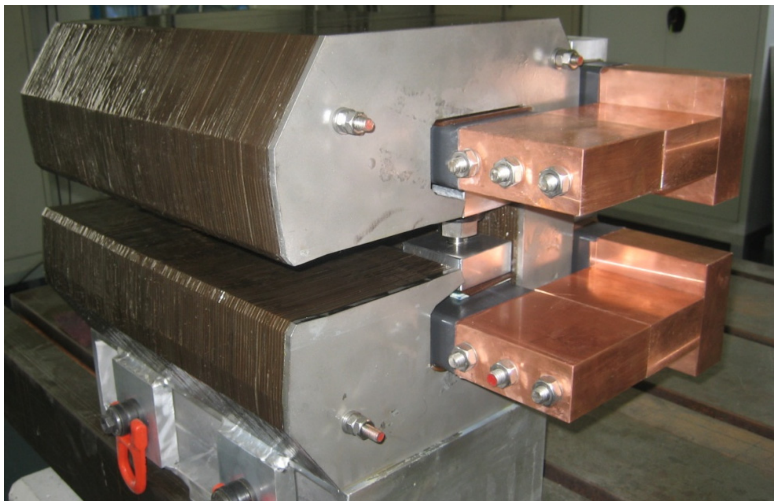
No principal problem found yet!

(But we are missing a 3D integration study)

link in IR3

LHeC Ring-Ring dipole 400 mm long CERN model

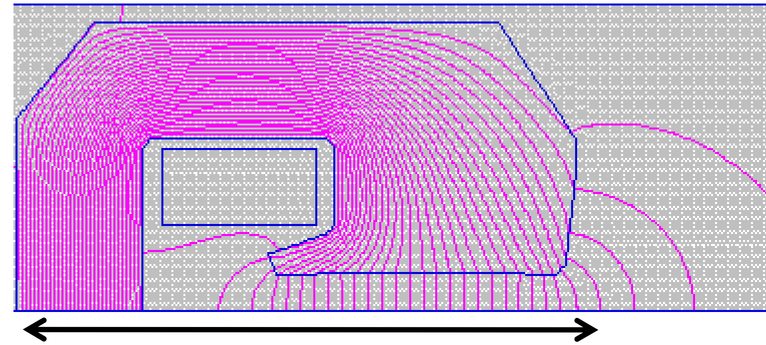
- interleaved ferromagnetic laminations
- air cooled
- two turns only, bolted bars
- 0.4 m models with different types of iron



REPRODUCIBILITY OF MAGNETIC FIELD OVER 8 CYCLES

Model	Low field	High fields
Maximum Relative Deviation from Average		
Model 1 (NiFe steel)	$5 \cdot 10^{-5}$	$4 \cdot 10^{-5}$
Model 2 (Low carbon steel)	$6 \cdot 10^{-5}$	$6 \cdot 10^{-5}$
Model 3 (Grain oriented 3.5% Si steel)	$4 \cdot 10^{-5}$	$6 \cdot 10^{-5}$
Standard Deviation from Average		
Model 1 (NiFe steel)	$3 \cdot 10^{-5}$	$3 \cdot 10^{-5}$
Model 2 (Low carbon steel)	$4 \cdot 10^{-5}$	$5 \cdot 10^{-5}$
Model 3 (Grain oriented 3.5% Si steel)	$2 \cdot 10^{-5}$	$4 \cdot 10^{-5}$

Manufacture & tests of 3 models



30 cm [Davide Tommasini]

Magnet Parameters of the full length magnet	
Beam Energy [GeV]	60 (70)
Magnetic Length [m]	5.45
Magnetic field [Gauss]	127-763
Number of magnets	3080
Vertical aperture [mm]	40
Pole width [mm]	150
Number of coils	2
Number of turns/coil	1
Current [A]	1500
Conductor section [mmxmm]	92x43
Conductor material	aluminum
Magnet Inductance [mH]	0.15
Magnet Resistance [mΩ]	0.2
Power per magnet [W]	450
Cooling	air
Weight [tons]	1.5

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Cooling	air
Weight [tons]	1.5

		4·10⁻⁵
		6·10⁻⁵
	4·10⁻⁵	6·10⁻⁵
…n Average		
	3·10⁻⁵	3·10⁻⁵
	4·10⁻⁵	5·10⁻⁵
…% Si steel)	2·10⁻⁵	4·10⁻⁵

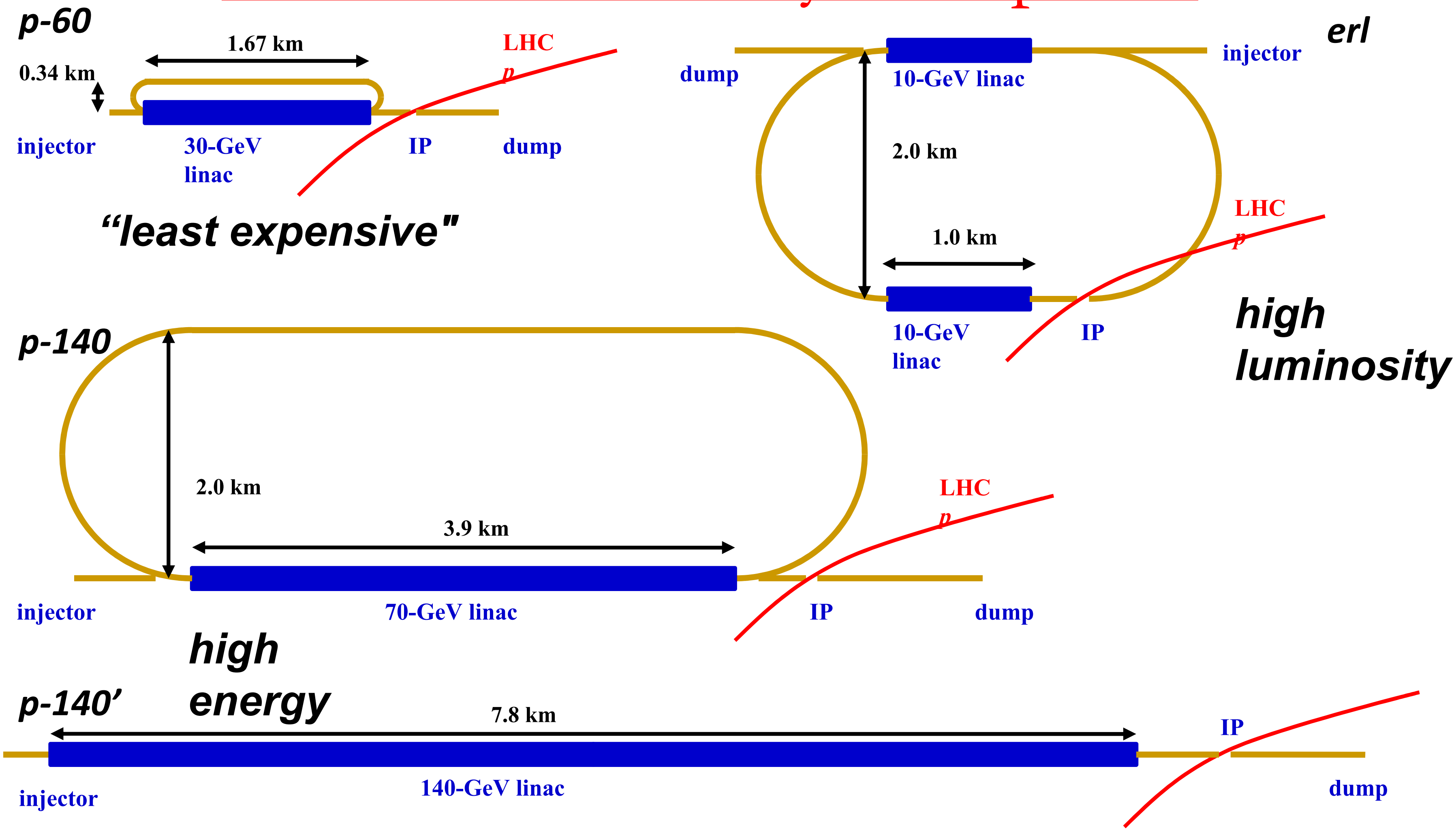
…ufacture & tests of 3 models

Similar prototype development from Novosibirsk

→ Prototypes show that the required field quality and reproducibility is feasible!

LHeC: Linac-Ring Option

Studied Various Layout Options



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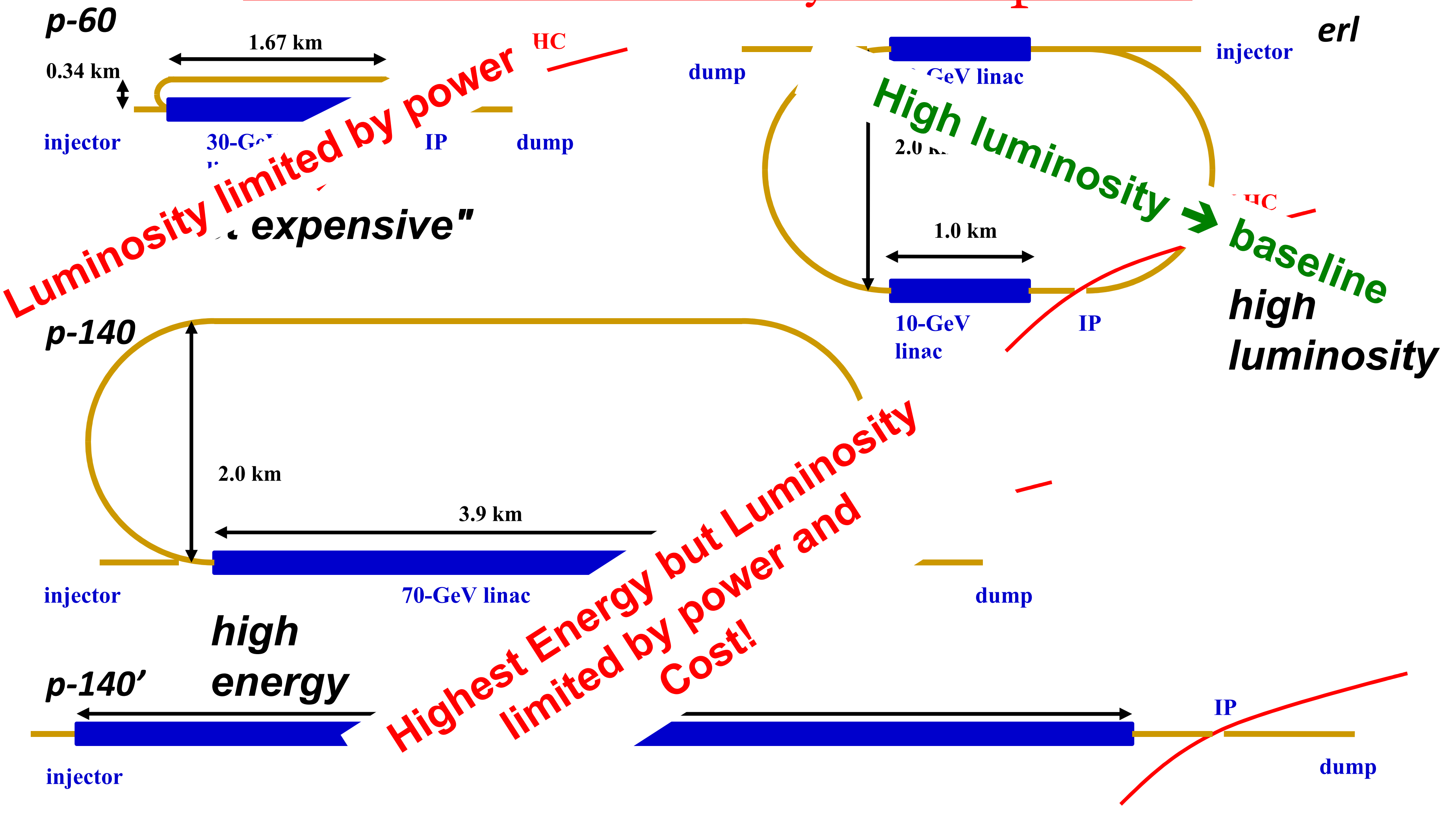
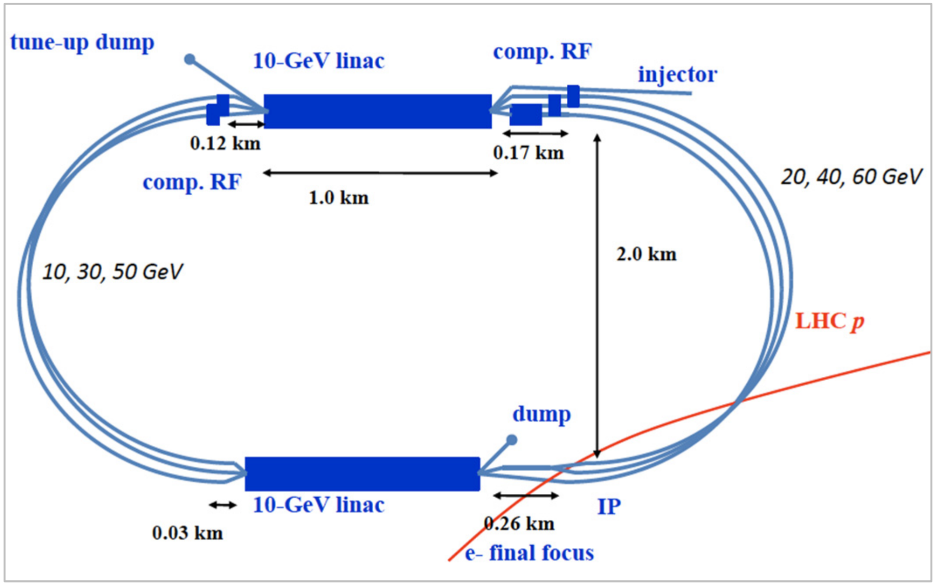


LHeC: Baseline Linac-Ring Option

LHeC

- Challenge 1: Super Conducting Linac with Energy Recovery & high current (> 6mA)



Two 1 km long SC linacs in CW operation ($Q > 10^{10}$)

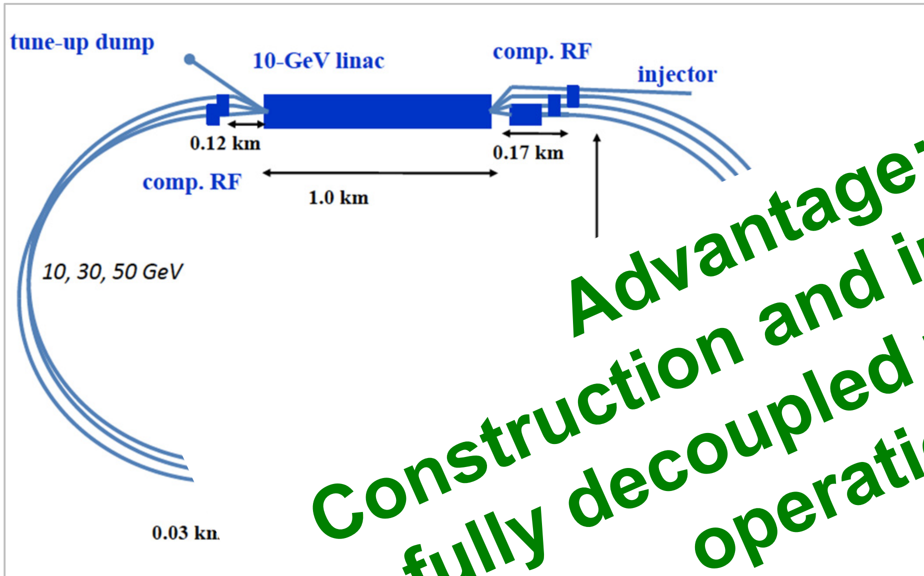
➔ $Q = 10^{10}$ requires Cryogenic system comparable to LHC system!

- Challenge 2: Relatively large return arcs
  - ➔ ca. 9 km underground tunnel installation (LHC / 3)
  - ➔ total of 19 km bending arcs
  - ➔ same magnet design as for RR option: > 4500 magnets

LHeC: Baseline Linac-Ring Option

LHeC

- Challenge 1: Super Conducting Linac with Energy Recovery & hi… …rent (> 6mA)



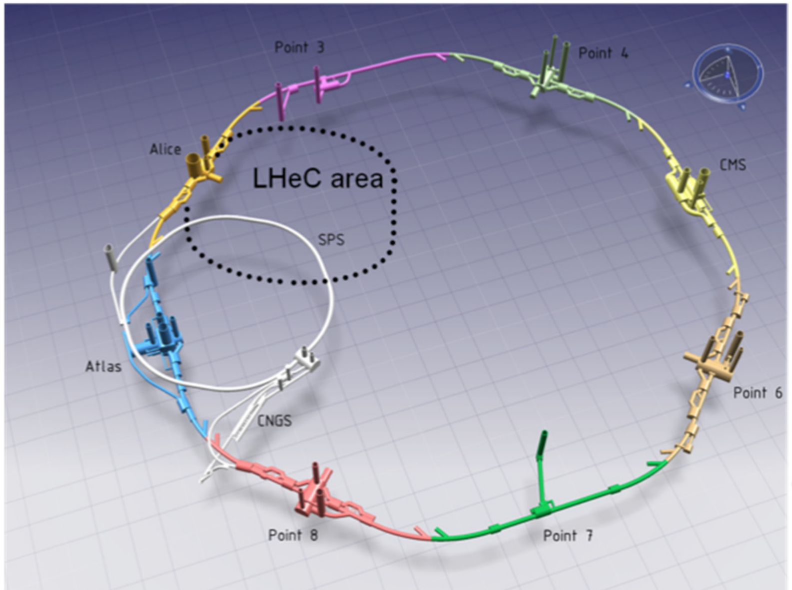
…ng SC
…operation

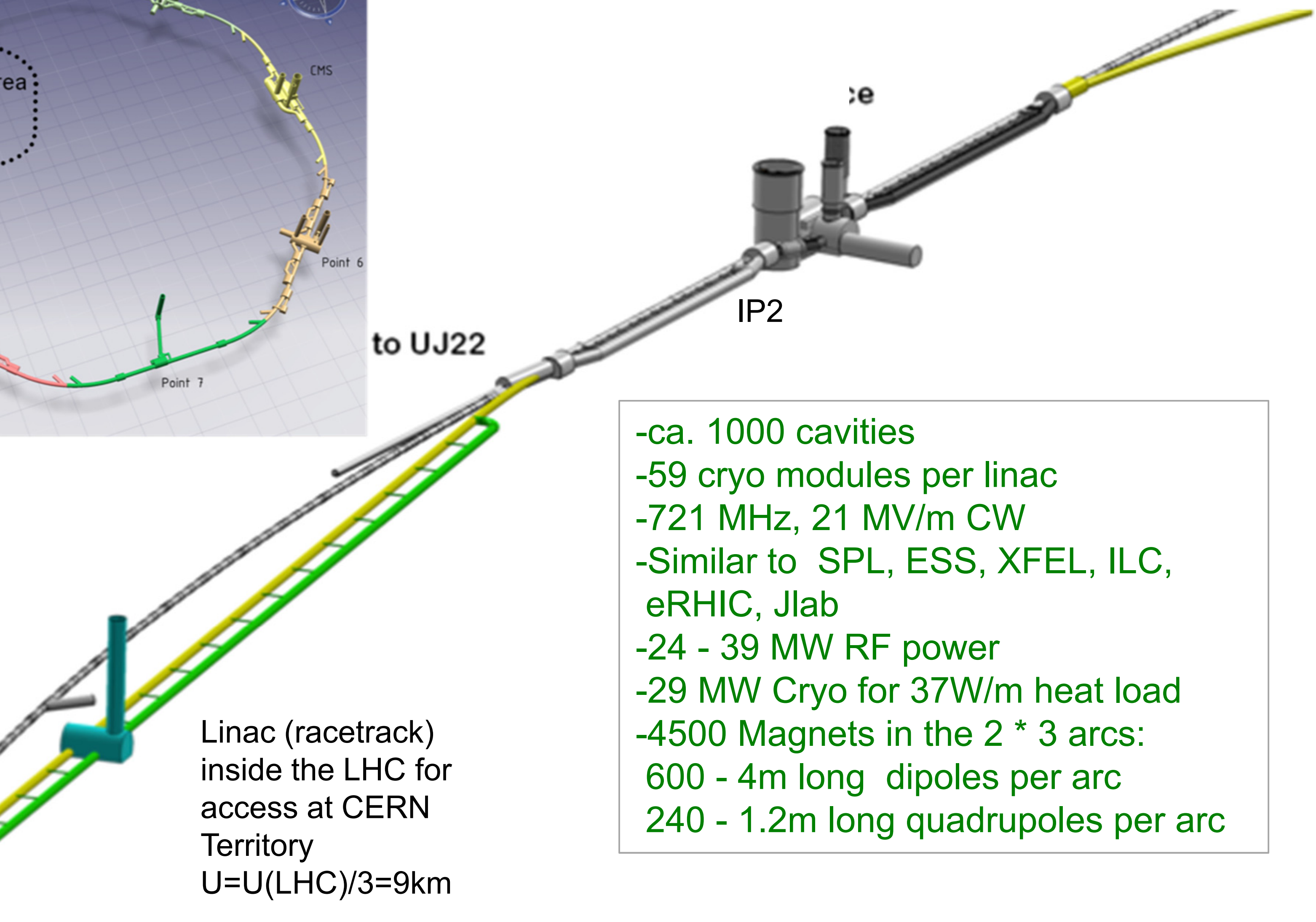
…requires Cryogenic system comparable to LHC system!

Advantage: Construction and installation fully decoupled from LHC operation!

- Challenge 2 … …ely large return arcs
  - ➔ ca. 9 km underground tunnel installation (LHC / 3)
  - ➔ total of 19 km bending arcs
  - ➔ same magnet design as for RR option: > 4500 magnets

LINAC – Ring: Connection to the LHC

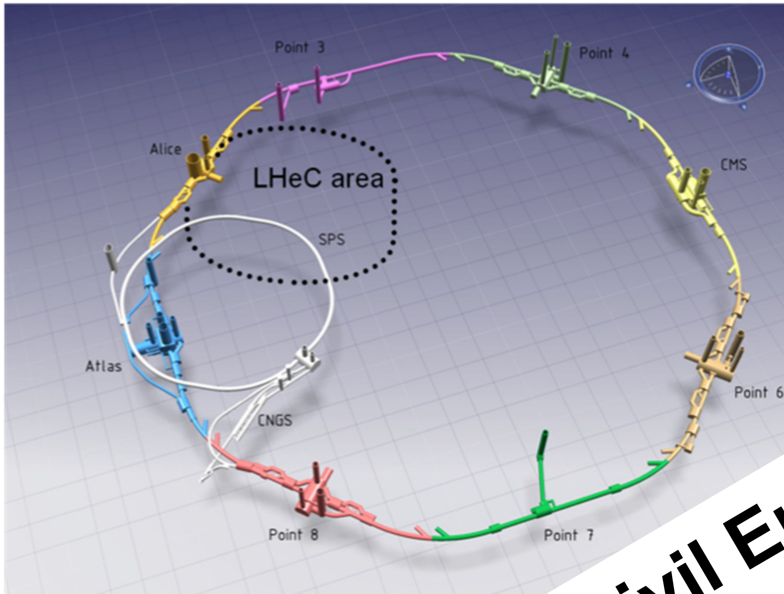




-ca. 1000 cavities
-59 cryo modules per linac
-721 MHz, 21 MV/m CW
-Similar to SPL, ESS, XFEL, ILC, eRHIC, Jlab
-24 - 39 MW RF power
-29 MW Cryo for 37W/m heat load
-4500 Magnets in the 2 * 3 arcs:
600 - 4m long dipoles per arc
240 - 1.2m long quadrupoles per arc

LINAC – Ring: Connection to the LHC

LHeC



MOPWO036: Civil Engineering Studies for Future Ring Colliders at CERN

John Osborne et al.

- -ca. 1000 cavities
- -59 cryo modules per linac
- -721 MHz, 21 MV/m CW
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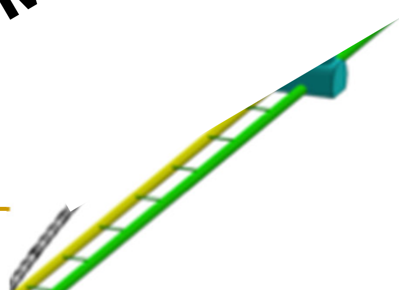
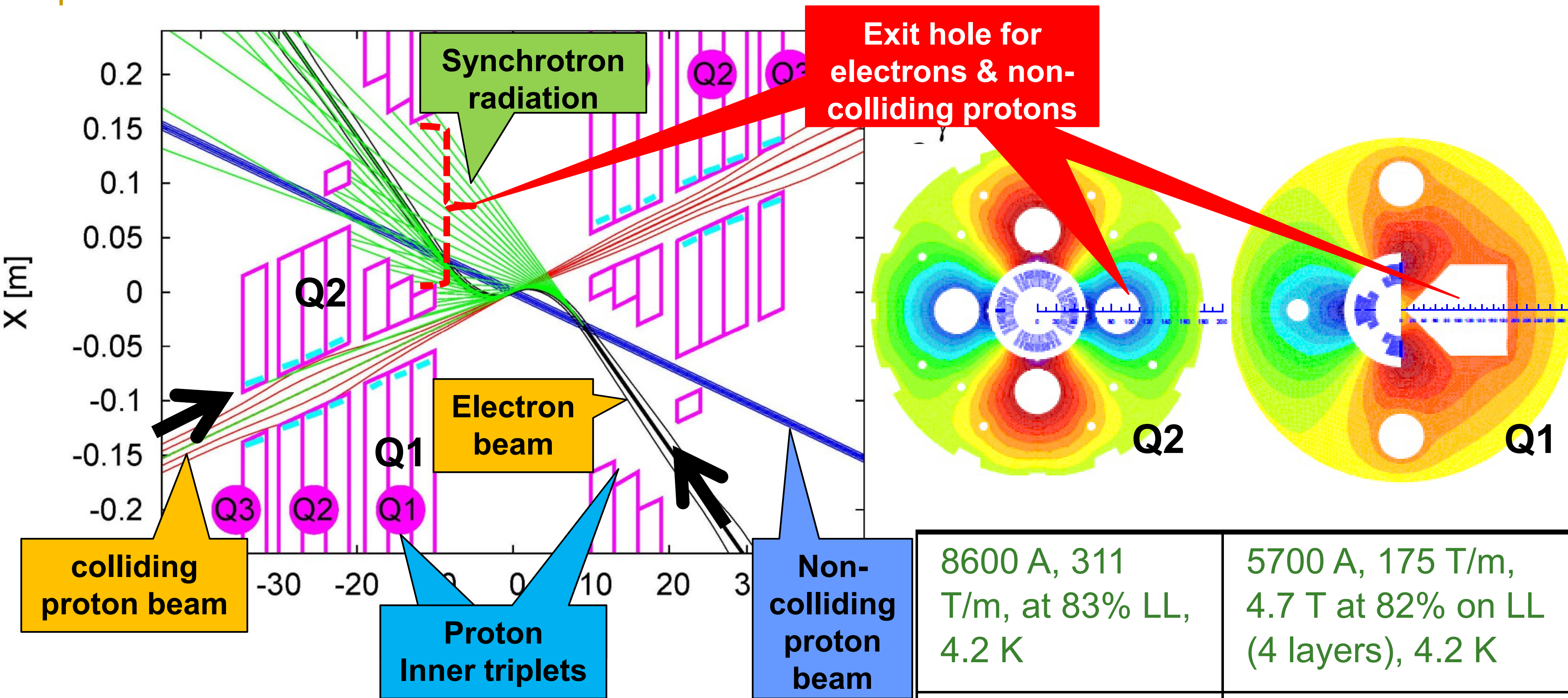


Linac (racetrack) inside the LHC for access at CERN Territory
U=U(LHC)/3=9km

LR LHeC IR layout & SC IR quadrupoles

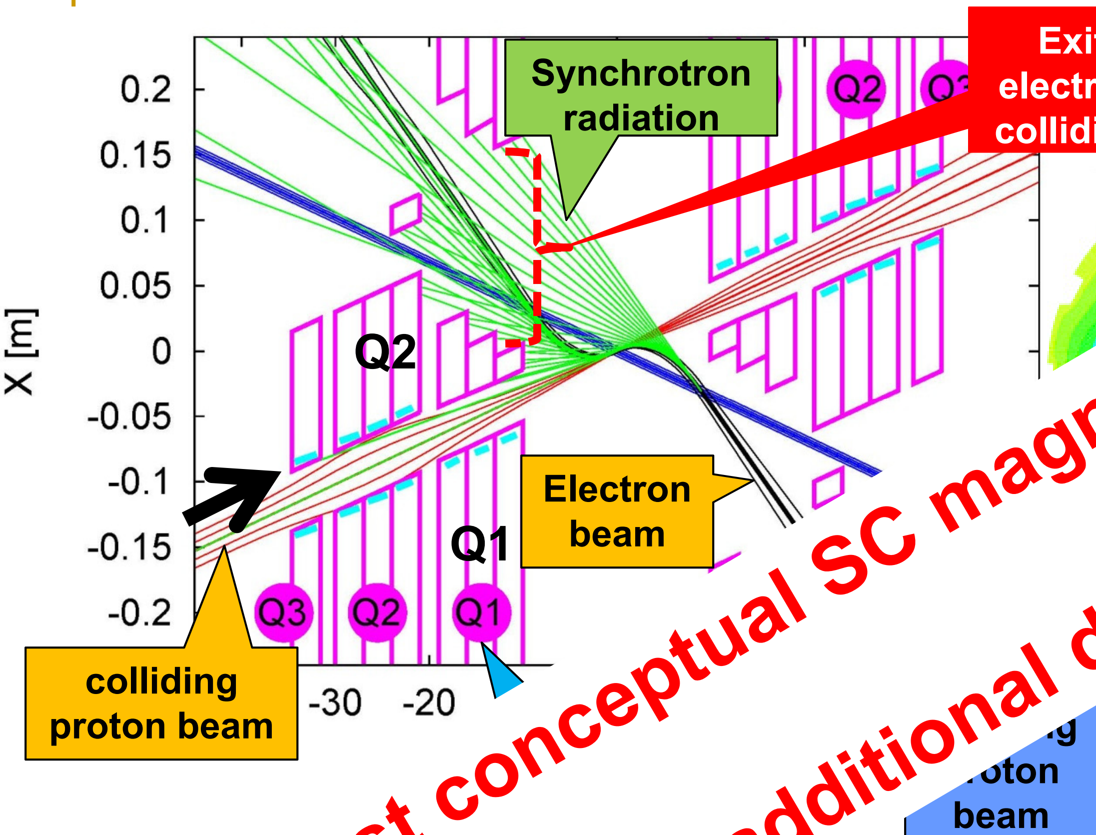


8600 A, 311 T/m, at 83% LL, 4.2 K	5700 A, 175 T/m, 4.7 T at 82% on LL (4 layers), 4.2 K
23 mm ap.. 87 mm beam sep.	46 mm (half) ap., 63 mm beam sep.
0.09 T, 9 T/m	0.5 T, 25 T/m

High-gradient SC IR quadrupoles for colliding proton beam with common low-field

As shown by F. Zimmermann at Chamonix12

LR LHeC IR layout & SC IR quadrupoles



First conceptual SC magnet designs exist

Still requires additional design work and R&D!

[illegible]600 A, 311 T/m, at 83% LL, 4.2 K	5700 A, 175 T/m, 4.7 T at 82% on LL (4 layers), 4.2 K
23 mm ap.. 87 mm beam sep.	46 mm (half) ap., 63 mm beam sep.
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High-[illegible] [illegible]adrupoles for colliding proton [illegible] [illegible]ommon low-field

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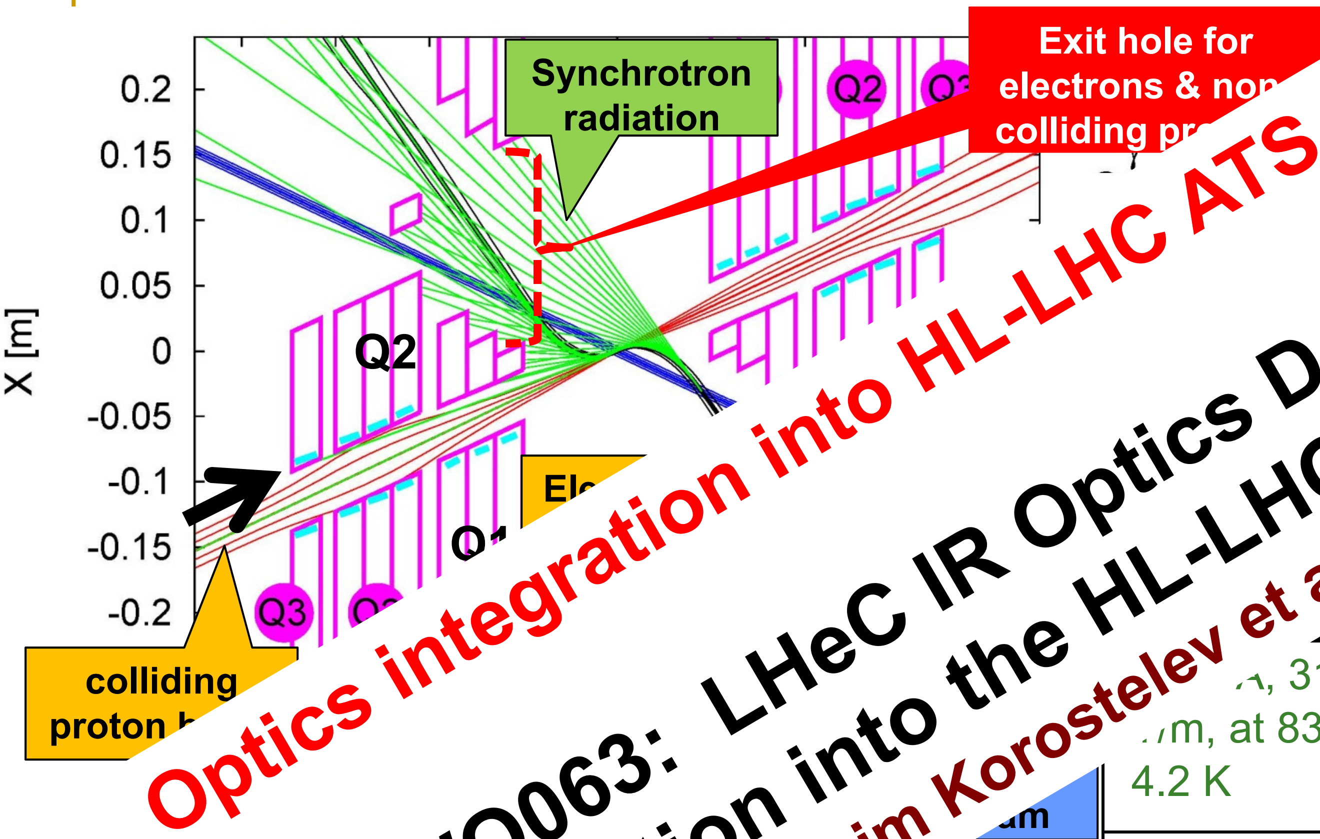
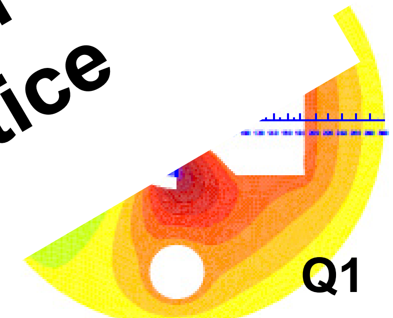




Optics integration into HL-LHC ATS optics:

MOPWO063: LHeC IR Optics Design with Integration into the HL-LHC Lattice

Maxim Korostelev et al

A, 311 m, at 83% LL, 4.2 K	5700 A, 175 T/m, 4.7 T at 82% on LL (4 layers), 4.2 K
23 mm ap.. 87 mm beam sep.	46 mm (half) ap., 63 mm beam sep.
0.09 T, 9 T/m	0.5 T, 25 T/m

High poles for colliding
proto on low-field

As shown by F. Zimmermann at Chamonix12

LR LHeC IR layout & SC IR quadrupol

Final parameter set will be developed as we gain experience with LHC operation (beam-beam, spacing etc.)

Performance reach of L > 10^{34} $cm^{-2}s^{-1}$ seems to be well within reach of the LHeC!

MOPWO054: The LHeC as a Higgs Boson Factory

Frank Zimmermann et al

As shown by F. Zimmermann at Chamonix12

LHeC Planning and Timeline

- We assume the LHC will reach the end of its lifetime with the end of the HL-LHC project:

  -Goal of integrated luminosity of 3000 fb^{-1} with 200fb^{-1} to 300fb^{-1} production per year ➔ ca. 10 years of HL-LHC operation

  -Current planning based on HL-LHC start in 2022

  ➔ end of LHC lifetime by 2032 to 2035

- LHeC operation:

  -Luminosity goal based on ca. 10 year exploitation time (➔100fb^{-1})

  -LHeC operation beyond or after HL-LHC operation will imply significant cost overhead for LHC consolidation

LHeC Options: CDR Executive Summary

LHeC

Ring-Ring option:

-We know we can do it: ➔ LEP 1.5

-Challenge 1: integration in tunnel and co-existence with LHC HW

-Challenge 2: installation within LHC shutdown schedule

Linac-Ring option:

-Installation decoupled from LHC operation and shutdown planning

-Infrastructure investment with potential exploitation beyond LHeC

-Challenge 1: technology ➔ high current, high energy SC ERL

-Challenge 2: Positron source

LHeC Options: CDR Executive Sum ry

LHeC

Ring-Ring option:

-We know we can do it: ➔ LEP 1 ⁵

-Challenge 1: integration ir   IW

-Challenge 2: instal

Linac

ation and shutdown planning

potential exploitation beyond LHeC

➔ high current, high energy SC ERL

-C   tron source

R-R Installation is very challenging within current LHC schedule!

➔ Decision to adopt L-R Option as the LHeC baseline

CERN Mandate: 5 main points

The mandate for the technology development **includes studies and prototyping of the following key technical components**:

- Superconducting RF system for CW operation in an Energy Recovery Linac (high Q_0 for efficient energy recovery)
- Superconducting magnet development of the insertion regions of the LHeC with three beams. The studies require the design and construction of short magnet models
- Studies related to the experimental beam pipes with large beam acceptance in a high synchrotron radiation environment
- The design and specification of an ERL test facility for the LHeC.
- The finalization of the ERL design for the LHeC including a finalization of the optics design, beam dynamics studies and identification of potential performance limitations

The above technological developments require close collaboration between the relevant technical groups at CERN and external collaborators. Given the rather tight personnel resource conditions at CERN **the above studies should exploit where possible synergies with existing CERN studies.**

S.Bertolucci at Chavannes workshop 6/12 based on
CERN directorate's decision to include LHeC in the MTP

Post CDR Studies: ERL Beam Dynamics

LHeC

Beam-Beam effects:

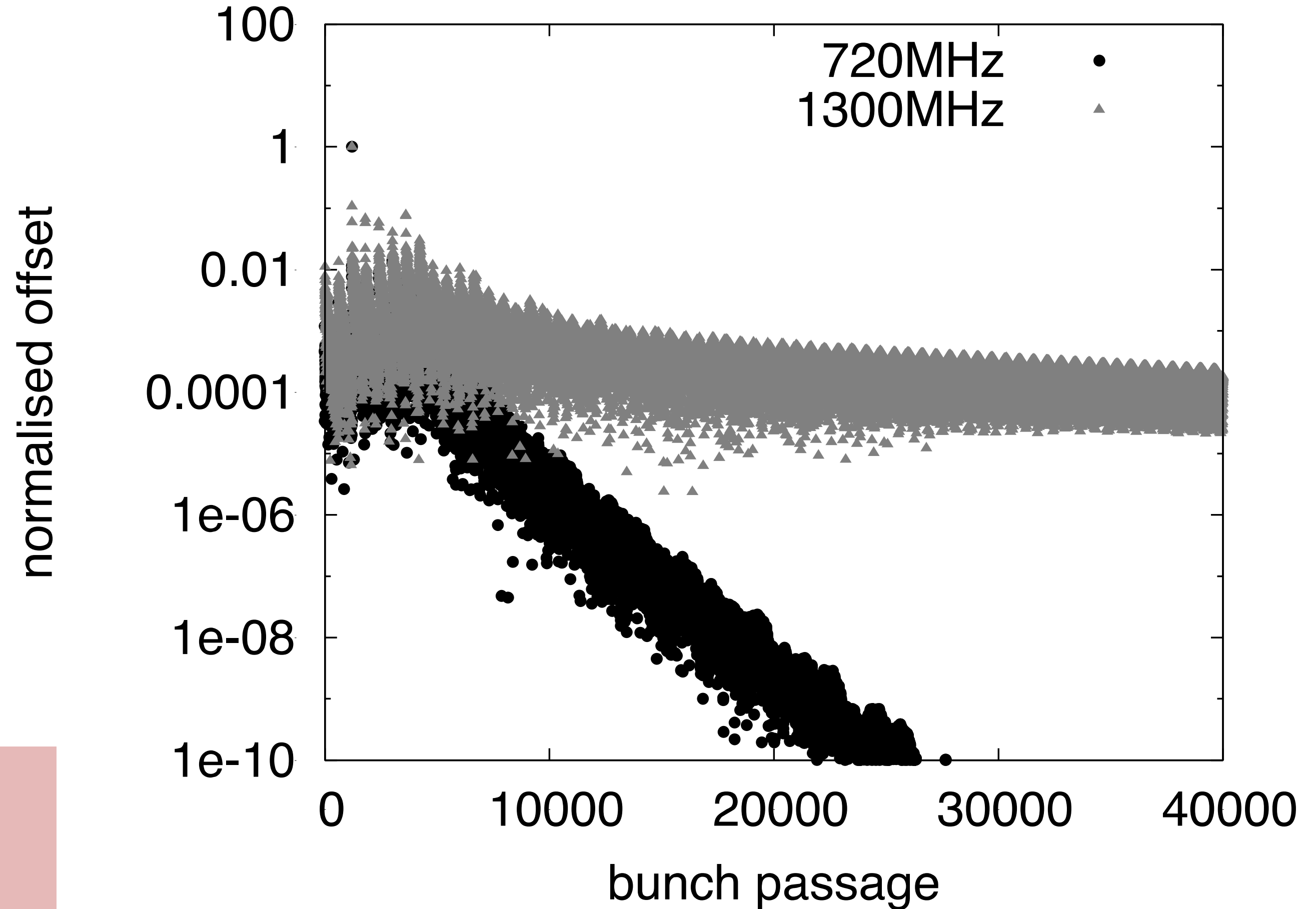
Daniel Schulte @ LHeC Seminar 12. March 2013

N=3 10^9
Beam-beam effect included as linear kick

Result depends on seed for frequency spread
"worst" of ten seed shown

F_{rms}=1.135 for ILC cavity
F_{rms}=1.002 for SPL cavity

Beam is stable but very small margin with 1.3GHz cavity



➔ Optimum choice for LHeC RF frequency? ➔ lower frequency

Post CDR Studies: RF Frequency

LHeC

Review of the SC RF frequency:

-HL-LHC bunch spacing requires bunch spacing with multiples of 25ns (40.079 MHz)

Frequency choice: *h* * 40.079 MHz

h=18: 721 MHz or h=33: 1.323GHz

SPL & ESS: 704.42 MHz; ILC & XFEL: 1.3 GHz

Frequencies are 'slightly' different (20MHz) from existing technologies!

→ SPL and ILC frequencies are too far from LHeC requirements

→ **Decision to optimize frequency for CERN needs: 801 MHz**

LHeC: Post CDR Plans

LHeC

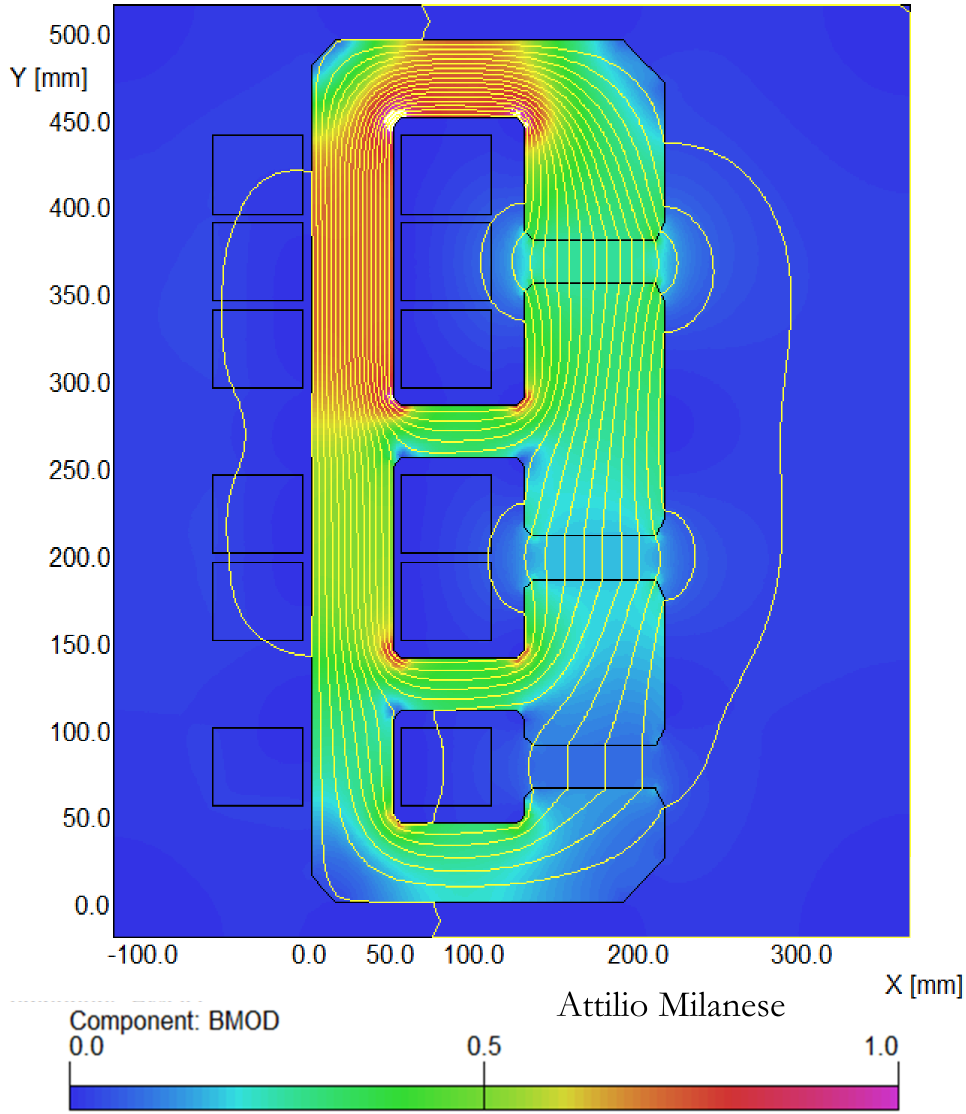
Launch SC RF and ERL R&D and Establish collaborations:

- -SC RF R&D has direct impact on cryo power consumption
  - -Synergy with HH RF for HL-LHC and TLEP!
- -ERL is a hot topic with many applications
  - -Synergy with national research plans: e.g. JLab, BNL eRHIC and MESA

Magnet R&D activities:

- -Superconducting IR magnet design
  - ➔ Detailed magnet design depends on IR layout and optics
  - ➔ Optics & IR magnet design influence experimental vacuum beam pipe
- -Normal conducting compact magnet design ✔

Next Steps: Magnet Optimization



Attilio Milanese

First conceptual cross-section

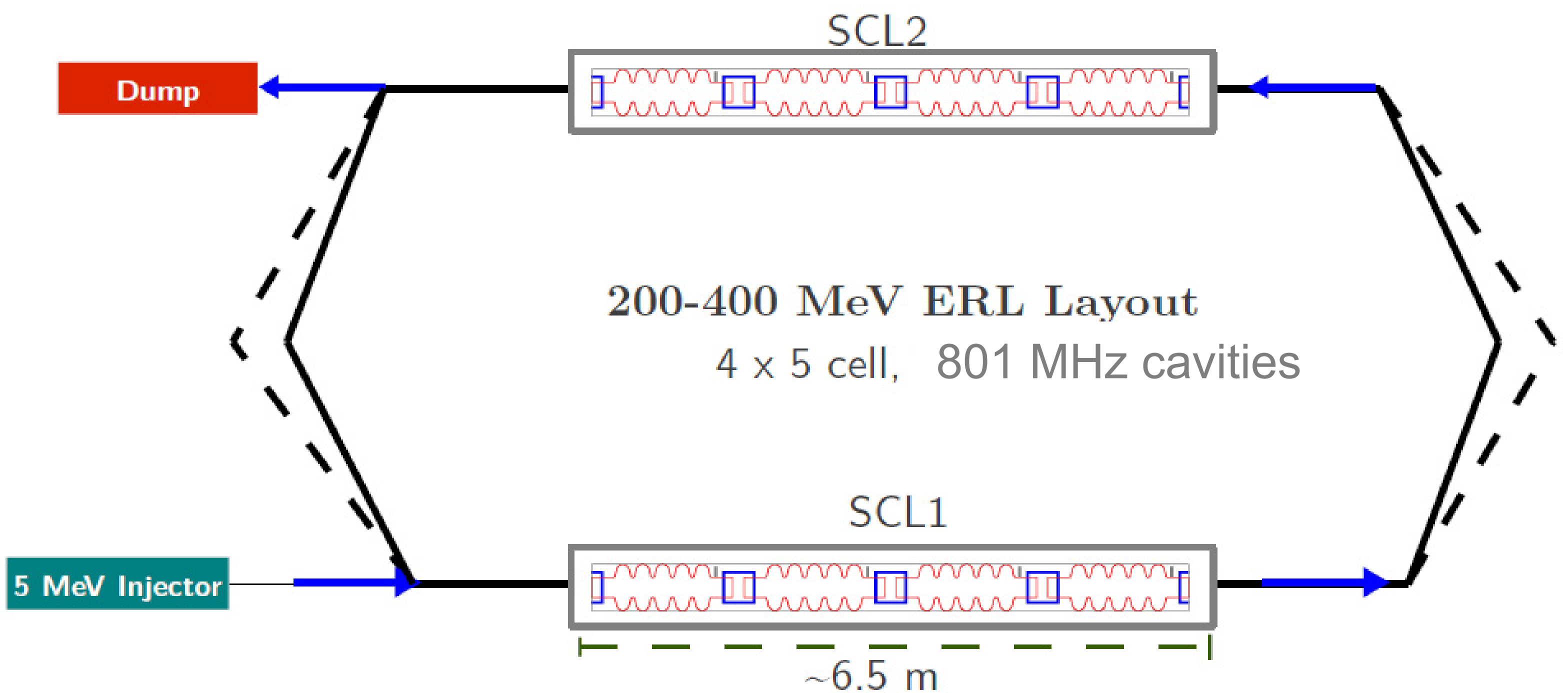
flux density in the gaps	0.264 T 0.176 T 0.088 T
magnetic length	4.0 m
vertical aperture	25 mm
pole width	85 mm
number of magnets	584
current	1750 A
number of turns per aperture	1 / 2 / 3
current density	0.7 A/mm^2
conductor material	copper
resistance	0.36 mΩ
power	1.1 kW
total power 20 / 40 / 60 GeV	642 kW
cooling	air

LHeC: Post CDR Plans

Develop an ERL test facility @ CERN:

-Beam Dynamics for ERL operation → develop expertise at CERN

-Synergy with other research plans: SC RF and TLEP



LHeC: Post CDR Pla

Develop an ERL test facility @ CE

-Beam Dynamics for ERL ope RN

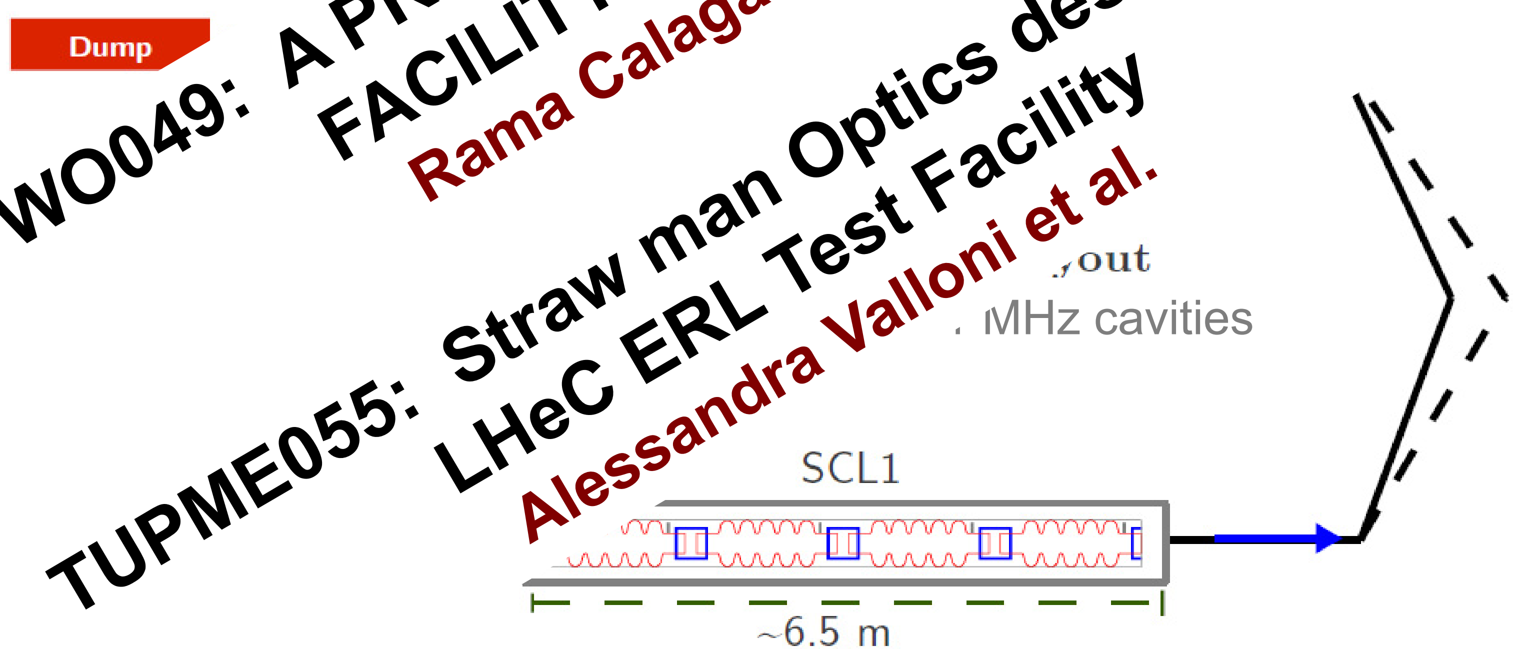
-Synergy with other re

WEPWO049: A PROPOSAL FOR AN ERL TEST FACILITY AT CERN

Rama Calaga et al.

TUPME055: Straw man Optics design for the LHeC ERL Test Facility

Alessandra Valloni et al.



Summary

LHeC

- LHeC Project is on track for operation in parallel with HL-LHC:

  -ca. 10 years for the LHeC from CDR to project start.

  (Other smaller projects like ESS and PSI XFEL plan for 8 to 9 years [TDR to project start] and the EU XFEL plans for 5 years from construction to operation start)

  HERA required ca.10 years from proposal to completion

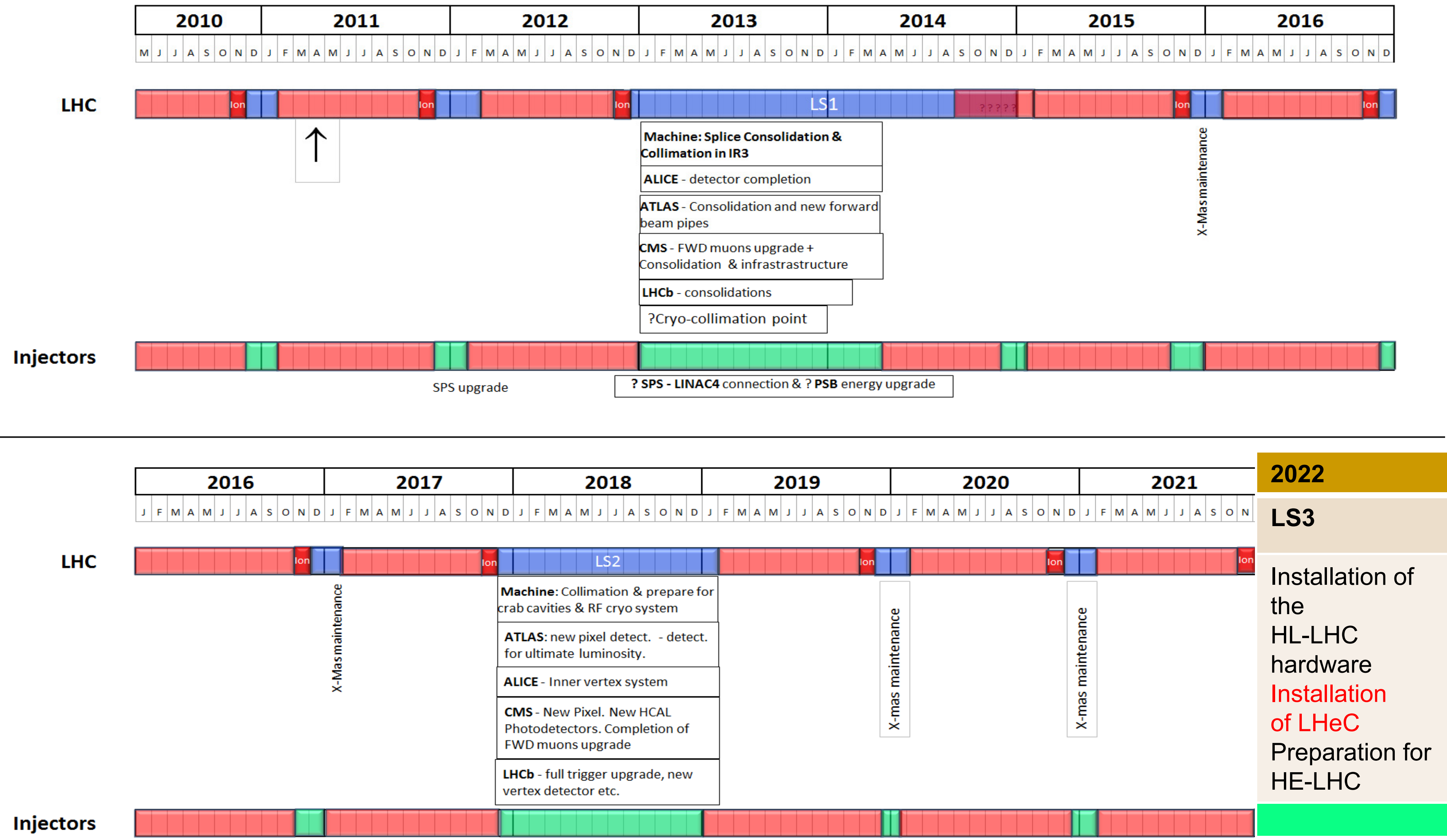
- On schedule for launching SC RF development

- LHeC ERL Test facility as a multi-purpose installation

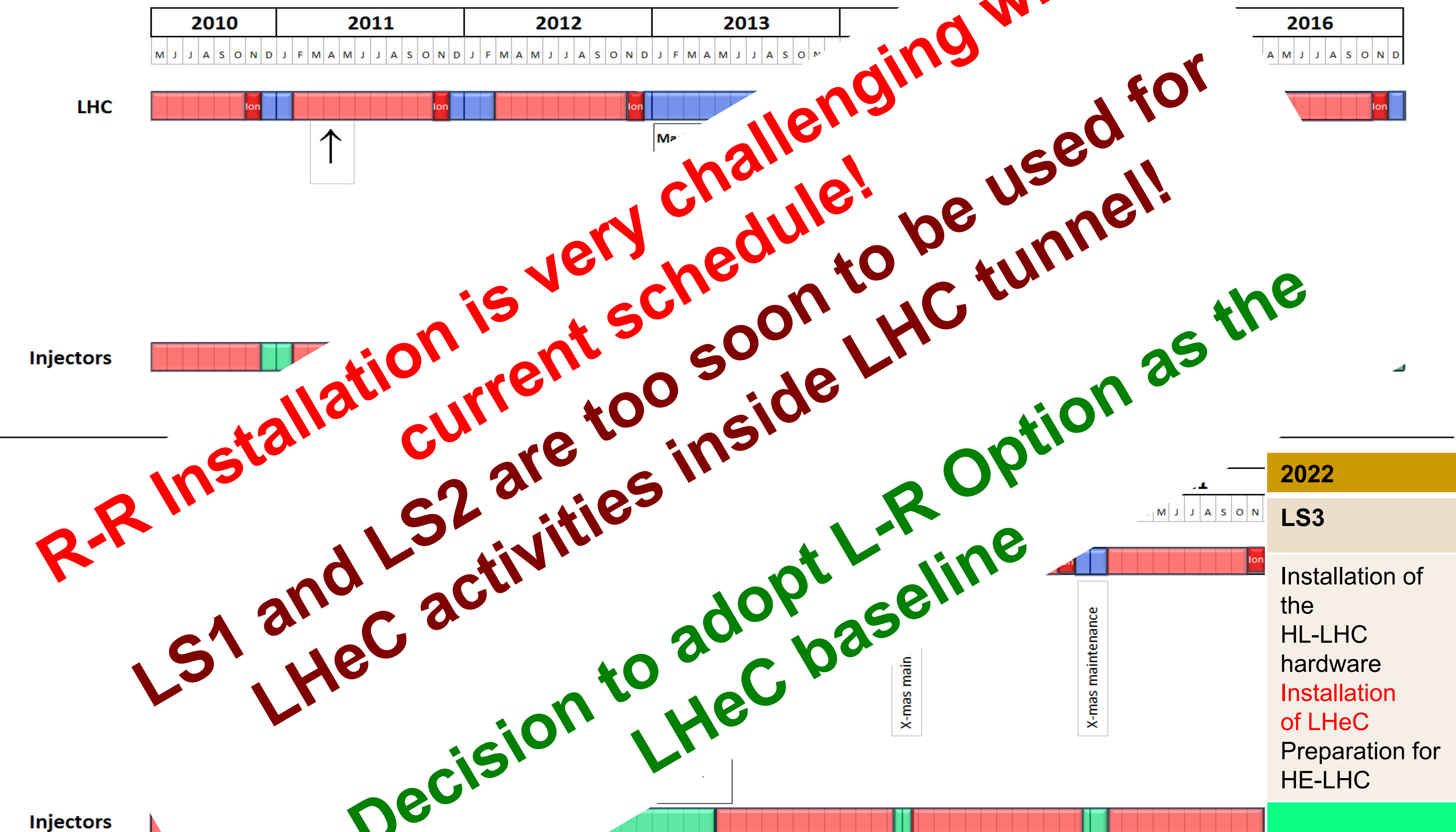
  RF studies and beam tests ➔ Synergies with HL-LHC and TLEP

Reserve Transparencies

Current 10 Year Plan for LHC Operation



Current 10 Year Plan for LHC Operation

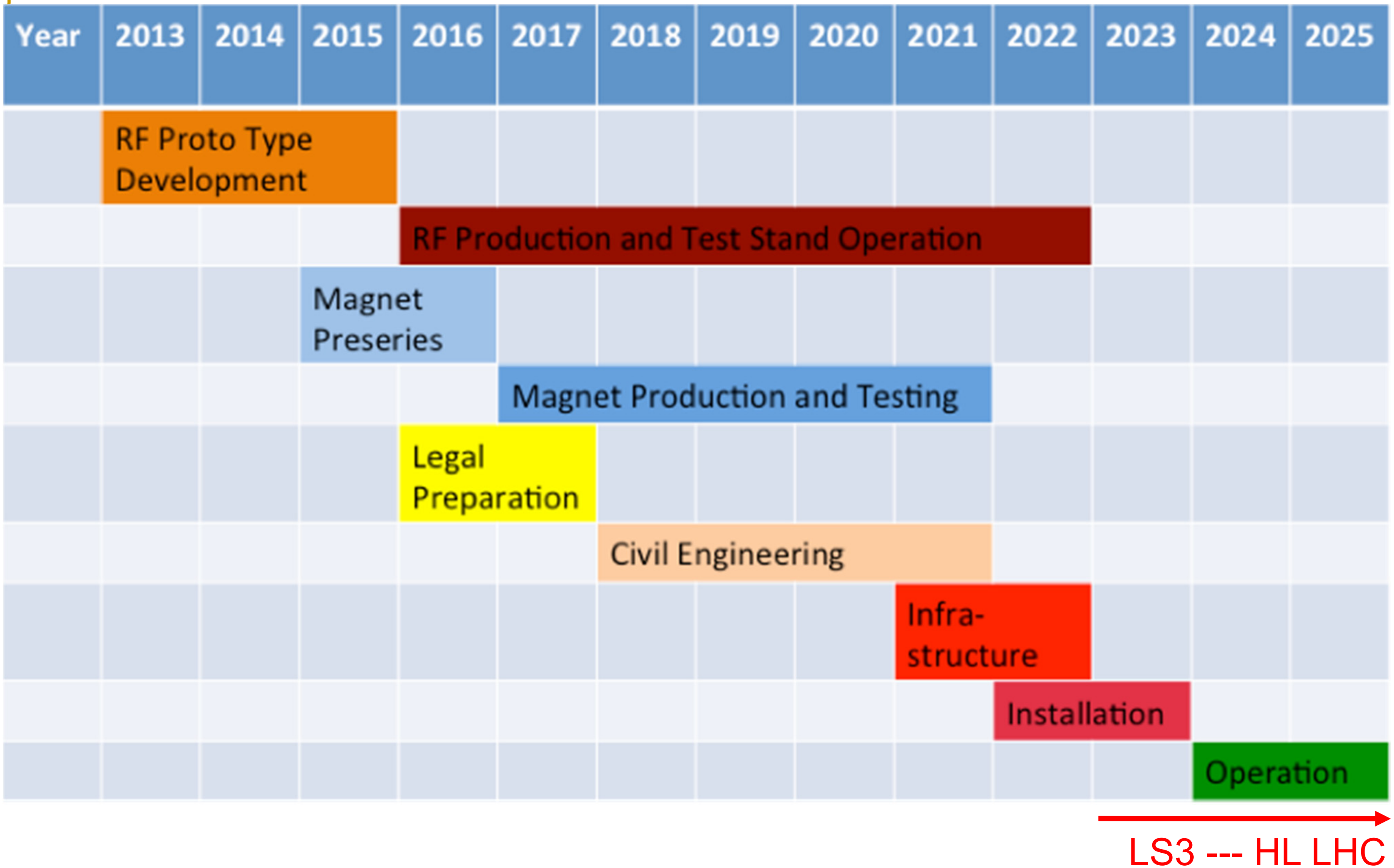


R-R Installation is very challenging within current schedule!

LS1 and LS2 are too soon to be used for LHeC activities inside LHC tunnel!

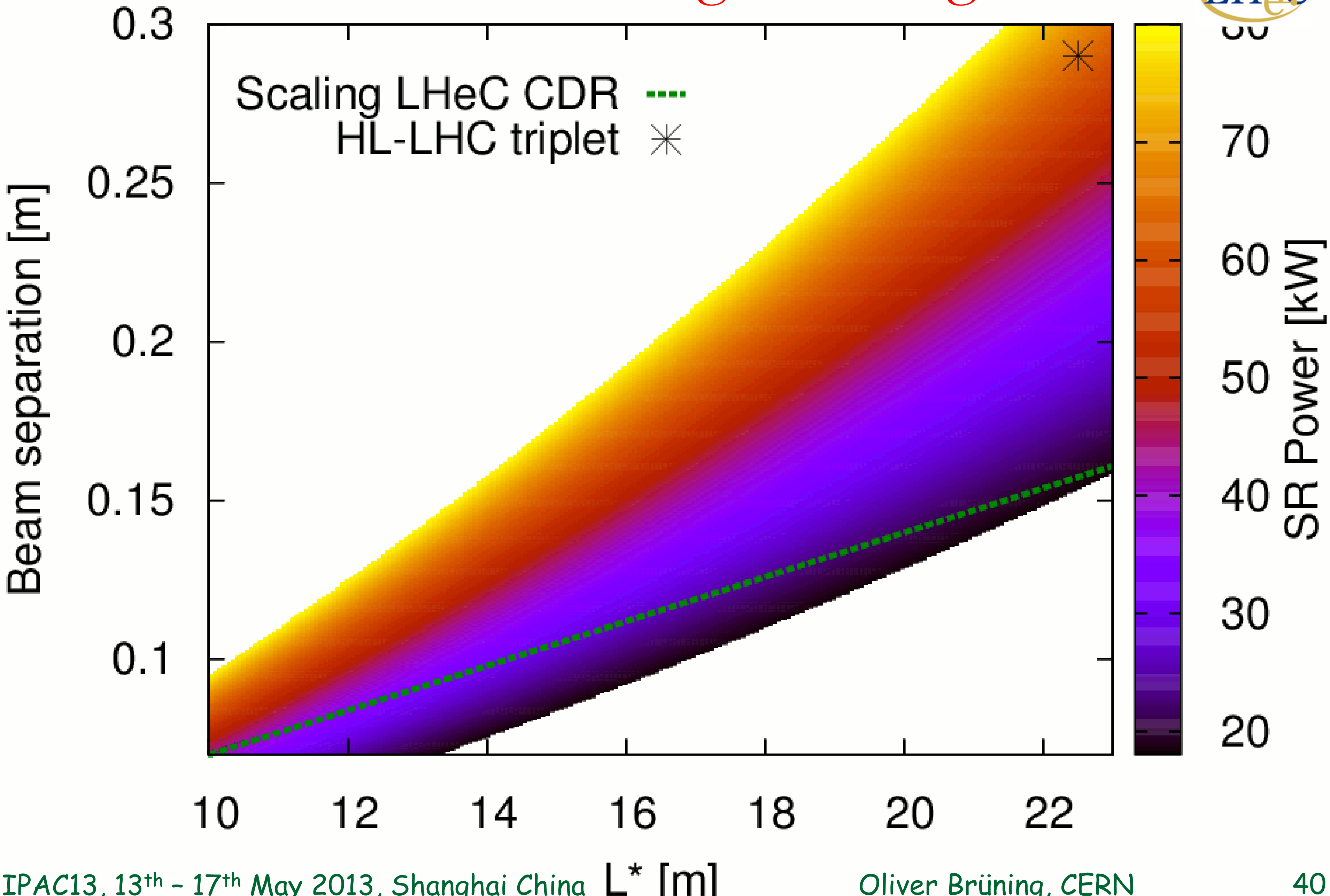
➔ Decision to adopt L-R Option as the LHeC baseline

LHeC Tentative Time Schedule

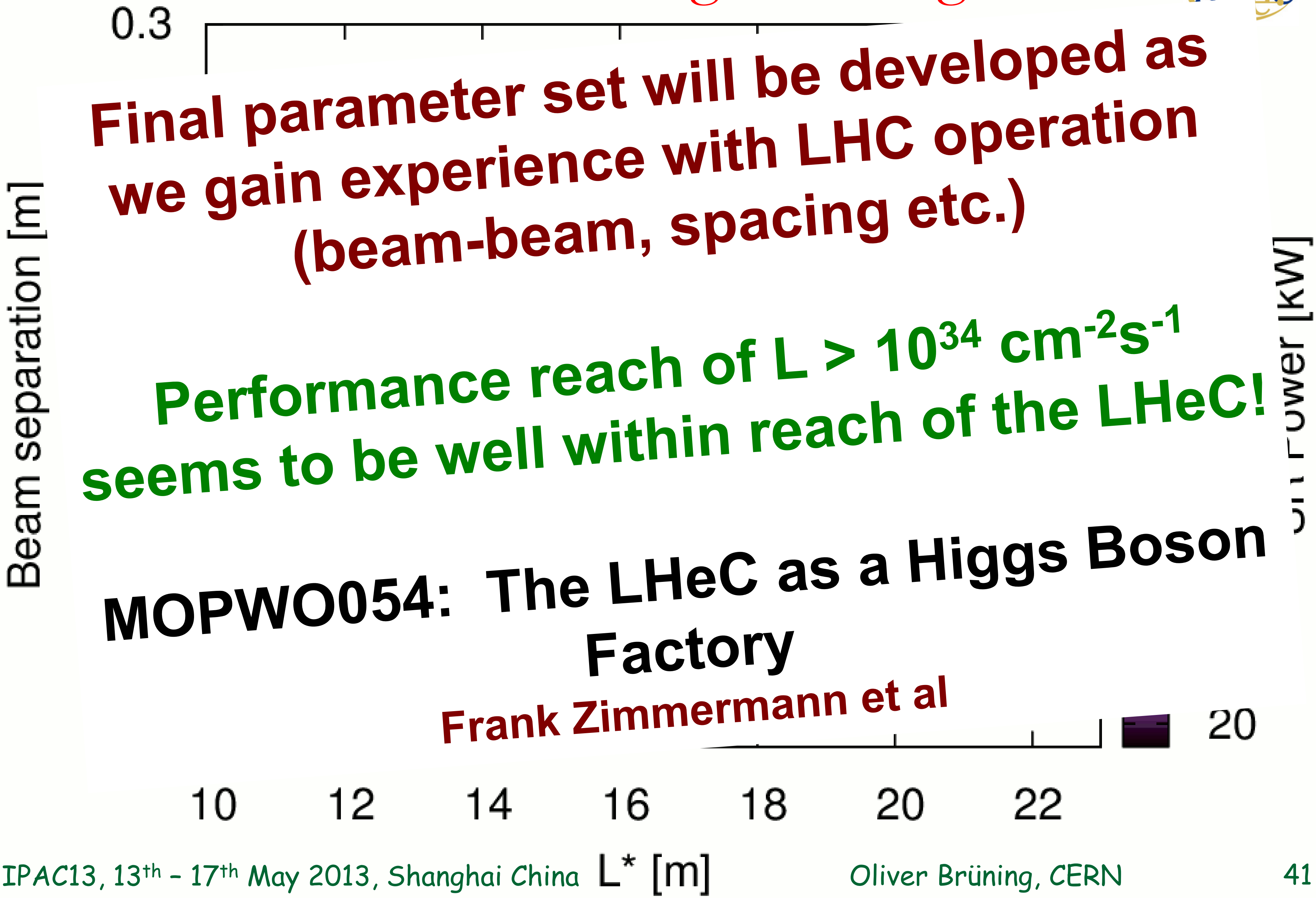


We base our estimates for the project time line on the experience of other projects, such as (LEP, LHC and LINAC4 at CERN and the European XFEL at DESY and the PSI XFEL). In

Interaction Region Design



Interaction Region Design

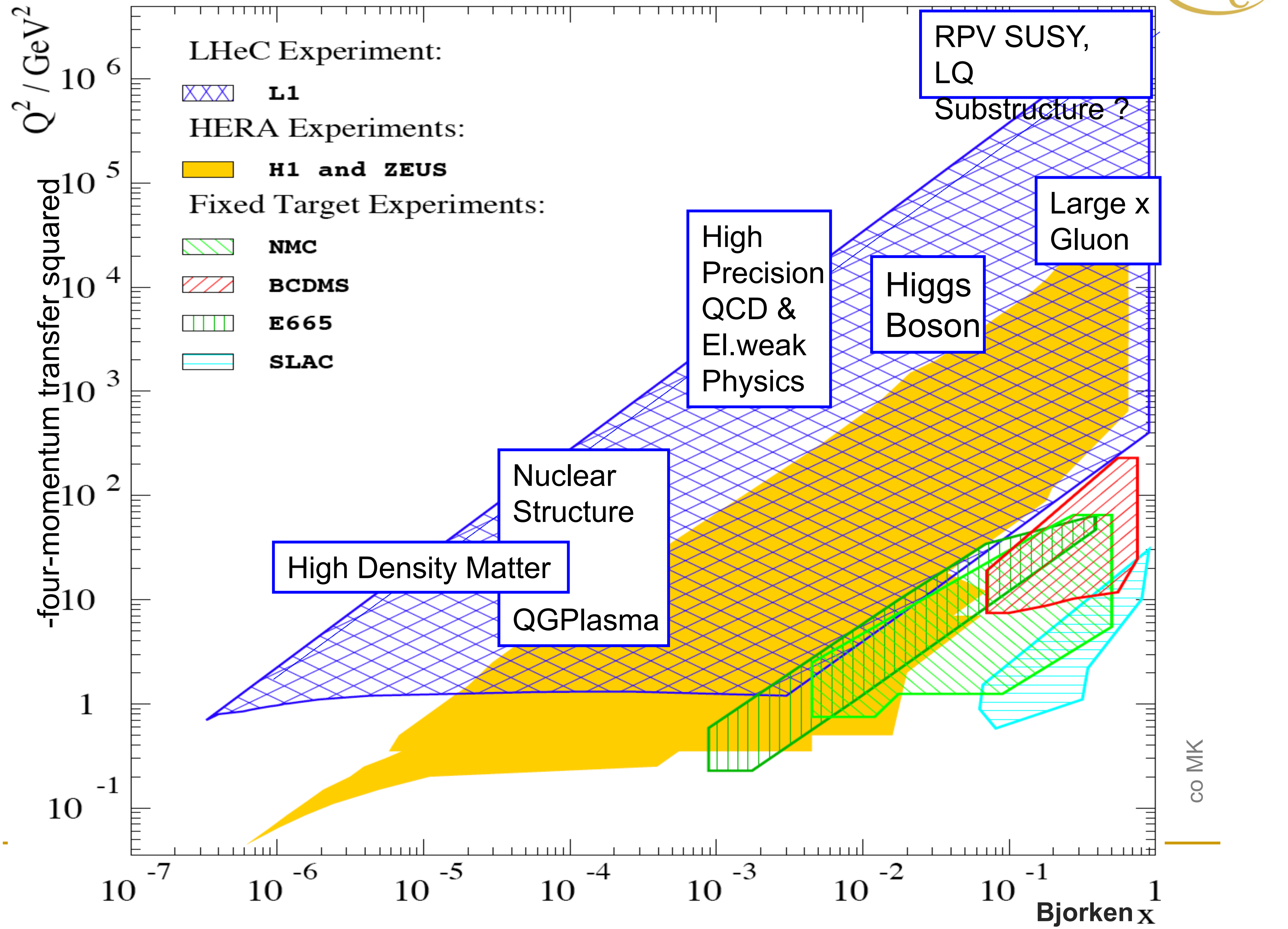


Final parameter set will be developed as we gain experience with LHC operation (beam-beam, spacing etc.)

Performance reach of L > 10^{34} $cm^{-2}s^{-1}$ seems to be well within reach of the LHeC!

MOPWO054: The LHeC as a Higgs Boson Factory

Frank Zimmermann et al


LHeC
LHeC Experiment:
L1
HERA Experiments:
H1 and ZEUS
Fixed Target Experiments:
NMC
BCDMS
E665
SLAC
RPV SUSY,
LQ
Substructure ?
Large x
Gluon
High
Precision
QCD &
El.weak
Physics
Higgs
Boson
Nuclear
Structure
High Density Matter
QGPlasma
Q^2 / GeV^2
-four-momentum transfer squared
Bjorken x
co MK

Design Parameters

electron beam	RR**	LR	LR*
e- energy at IP[GeV]	60	60	140
luminosity [10^{32} $cm^{-2}s^{-1}$]	0.9	10	0.44
polarization [%]	40	90	90
bunch population [10^9]	20	2.0	1.6
e- bunch length [mm]	6.88	0.3	0.3
bunch interval [ns]	25	50	50
transv. emit. $\gamma\varepsilon_{x,y}$ [mm]	0.26, 0.15	0.05	0.04
rms IP beam size $\sigma_{x,y}$ [μm]	30, 16	7	7
e- IP beta funct. $\beta^*_{x,y}$ [m]	0.4, 0.2	0.12	0.14
full crossing angle [mrad]	1.0	0	0
geometric reduction H_{hg}	0.86	0.91	0.94
repetition rate [Hz]	N/A	N/A	10
beam pulse length [ms]	N/A	N/A	5
ER efficiency	N/A	94%	N/A
average current [mA]	100	6.4	5.4
tot. wall plug power[MW]	100	100	100

proton beam	RR	LR
bunch pop. [10^{11}]	1.7	1.7
tr.emit.$\gamma\varepsilon_{x,y}$ [μm]	3.75	3.75
spot size $\sigma_{x,y}$ [μm]	30, 16	7
$\beta^*_{x,y}$ [m]	1.8,0.5	0.1
bunch spacing [ns]	25	25

"ultimate p beam"
1.7 probably conservative

Design also for deuterons (new) and lead (exists)

RR= Ring – Ring
LR =Linac –Ring

Ring uses 1° as baseline : L/2
Linac: clearing gap: L*2/3

*) pulsed, but high energy ERL not impossible; **) 1° acceptance optics

Design Parameters

LHeC

Final parameter set to be developed as we gain experience with LHC operational (beam-beam, spacing etc)

The goal here is to demonstrate that realistic sets exist for both LHeC versions

electron beam	RR**	LR	LR*
e- energy at IP[GeV]	60	60	140
luminosity [10^{32} cm^{-2}s^{-1}]	0.9	10	
polarization [%]	40	90	
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bunch interval [ns]			
transv. emit. $\gamma\varepsilon_{x,y}$ [m			
rms IP beam si			
e- IP bet			
full			
g			
rep			
beam			5
ER effic		%	N/A
average c		6.4	5.4
tot. wall plu	100	100	100

	RR	LR
		1.7
		3.75
		7
		.1

...servative

... also for deuterons ...ew) and lead (exists)

RR= Ring – Ring
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Ring uses 1° as baseline : L/2
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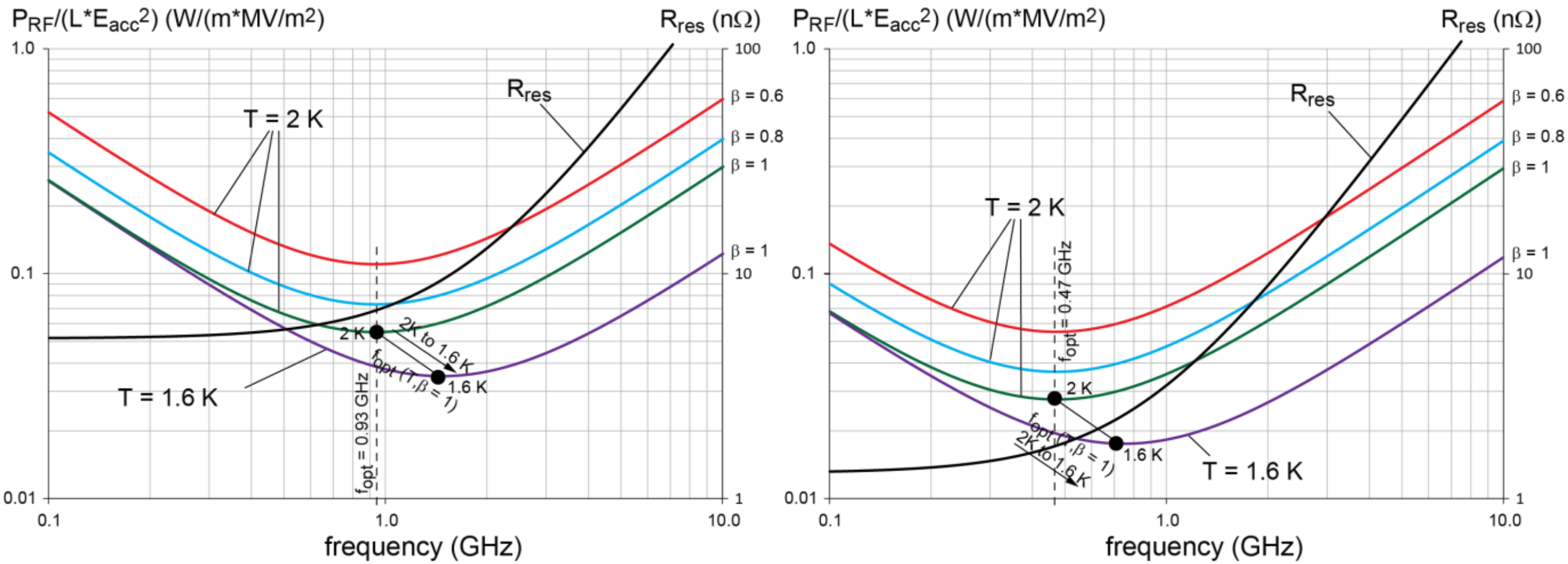
*) pulsed, but hig... ...t impossible; **) 1° acceptance optics

Optimum RF Frequency: Power Considerations

Results from F. Marhauser

Erk Jensen at Daresbury meeting 12 March 2013

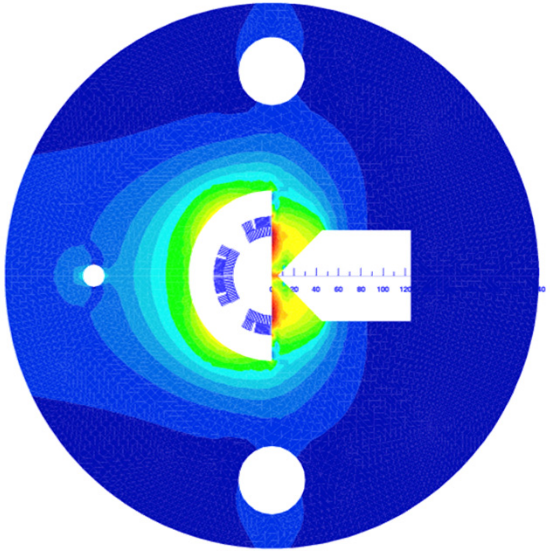


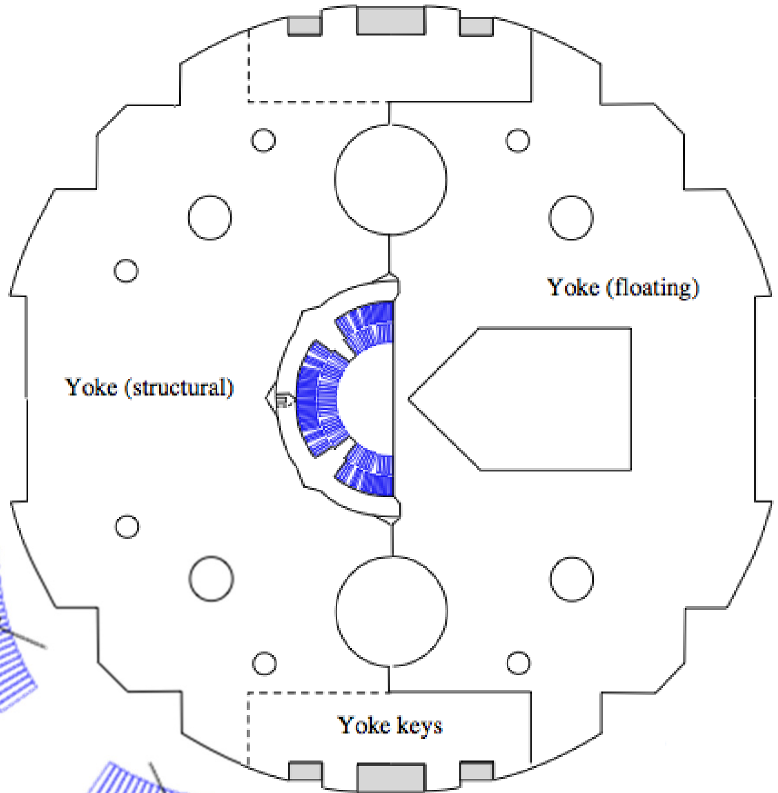
Small-grain (normal) Nb:
Optimum frequency at 2K between 700 MHz and 1050 MHz
Lower T shift optimum f upwards

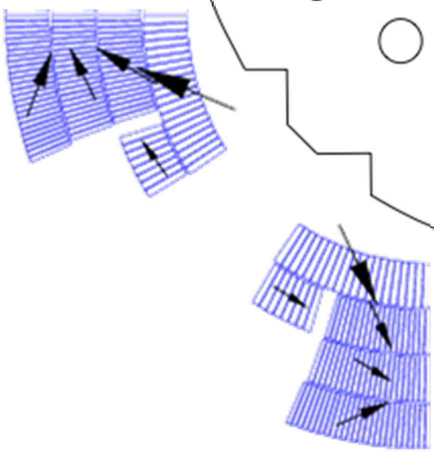
Large-grain Nb:
Optimum frequency at 2K between 300 MHz and 800 MHz
Lower T shift optimum f upwards

Next Steps: LHeC IR Quadrupole

Luca Bottura @ Chamonix 2012





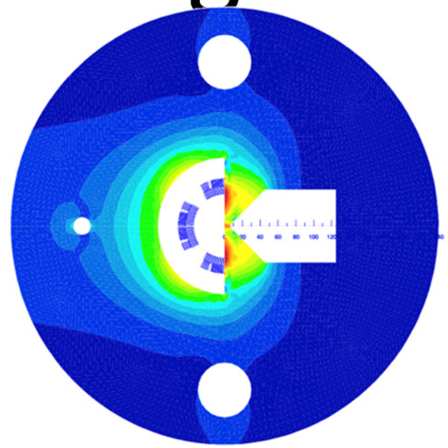


- Half-quad with field-free region, assembled using MQXC coils
  - 2.5 FTE
  - 500 kCHF
  - approx. 2 years till test

Large forces on the magnetic wedge (> 50 tons/m)

IR magnets

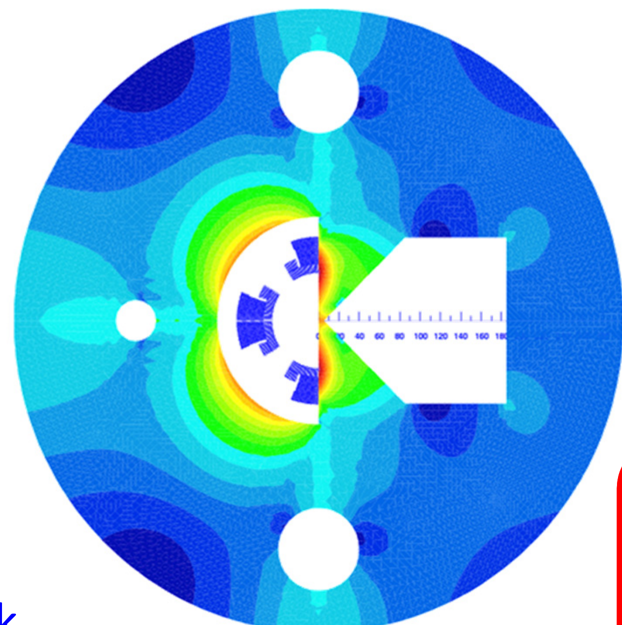
- Ring-ring
  - G=140 T/m
  - A=70 mm
  - **B_{fringe} = 30 mT**
  - **O(15) kW SR power in the proton aperture**

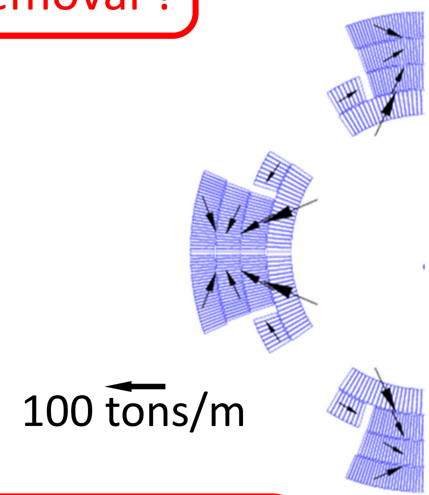


NbTi suitable for this *medium gradient* option

Mechanics ?
Heat removal ?

- Linac-Ring
  - **G=250-300 T/m**
  - **A=90 mm**
  - B_{fringe} = 500 mT
  - **O(2) kW SR power in the proton aperture**

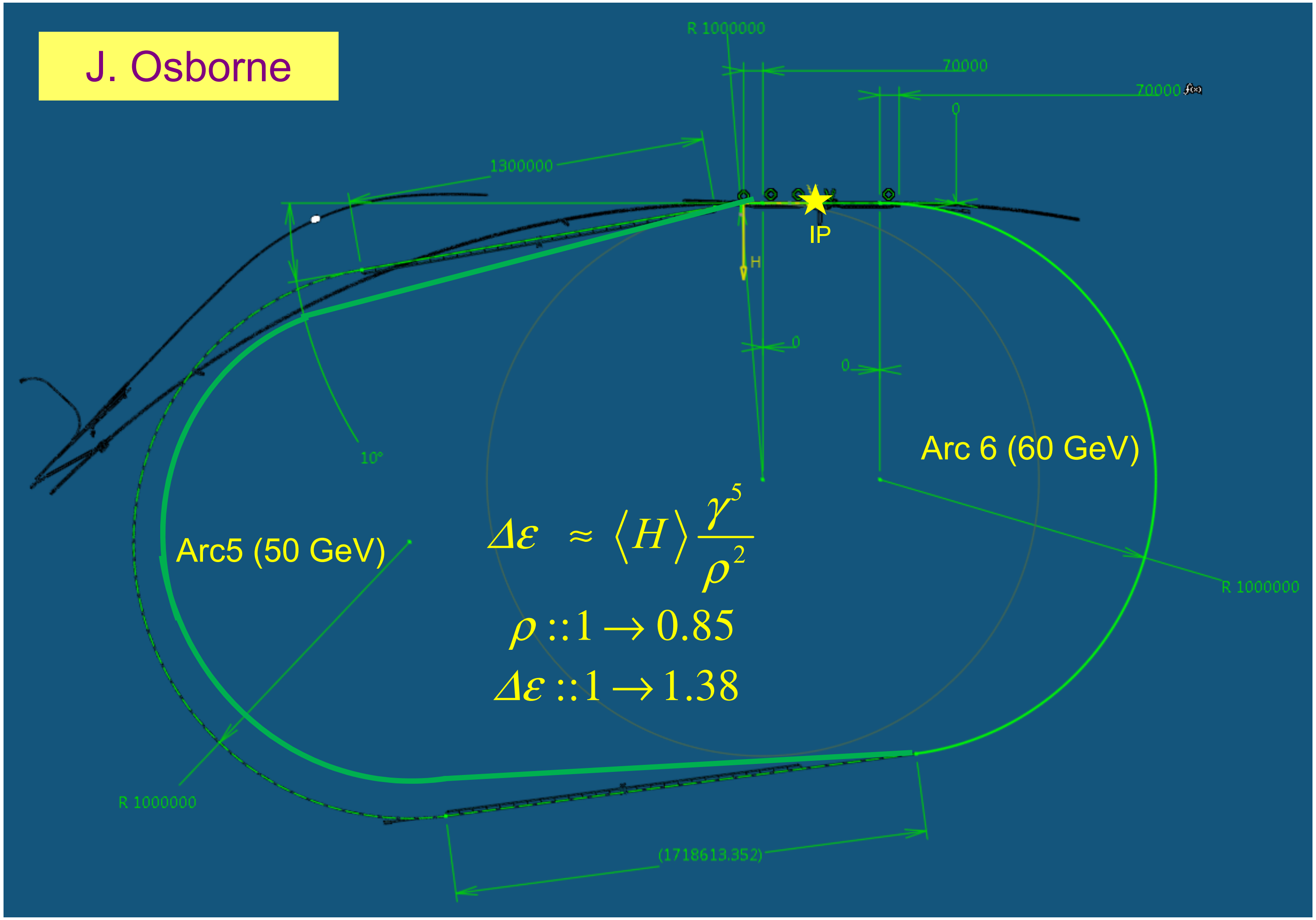




NbTi or Nb3Sn ?
Large aperture ?
Mechanics ?
Heat removal ?

By courtesy of S. Russenschuck

Next Steps: ERL Layout Finalization



John Osborne

LHeC - Participating Institutes: A very rich collaboration

LHeC

CERN

SLAC NATIONAL ACCELERATOR LABORATORY

NTNU
Norwegian University of Science and Technology

CLIC

The Cockcroft Institute
of Accelerator Science and Technology

Jefferson Lab
Thomas Jefferson National Accelerator Facility

ANKARA ÜNİVERSİTESİ

ANKARA ÜNİVERSİTESİ 1946

NİĞDE ÜNİVERSİTESİ 1992

ULUDAĞ ÜNİVERSİTESİ 1975

TOBB ETU

INFN
Istituto Nazionale di Fisica Nucleare
Laboratori Nazionali di Legnaro

DESY

LAL Physique des accélérateurs

ECFA

EPFL
ÉCOLE POLYTECHNIQUE FÉDÉRALE DE LAUSANNE

UNIVERSITY OF LIVERPOOL

BROOKHAVEN NATIONAL LABORATORY

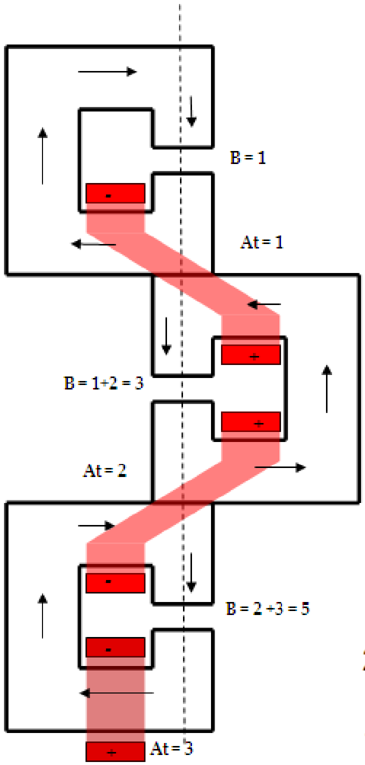
СИБИРСКОЕ ОТДЕЛЕНИЕ РАН
ИНСТИТУТ ЯДЕРНОЙ ФИЗИКИ
им. Г.И.Будкера
630090 Новосибирск

KEK

Next Steps: Test Facility and Magnets

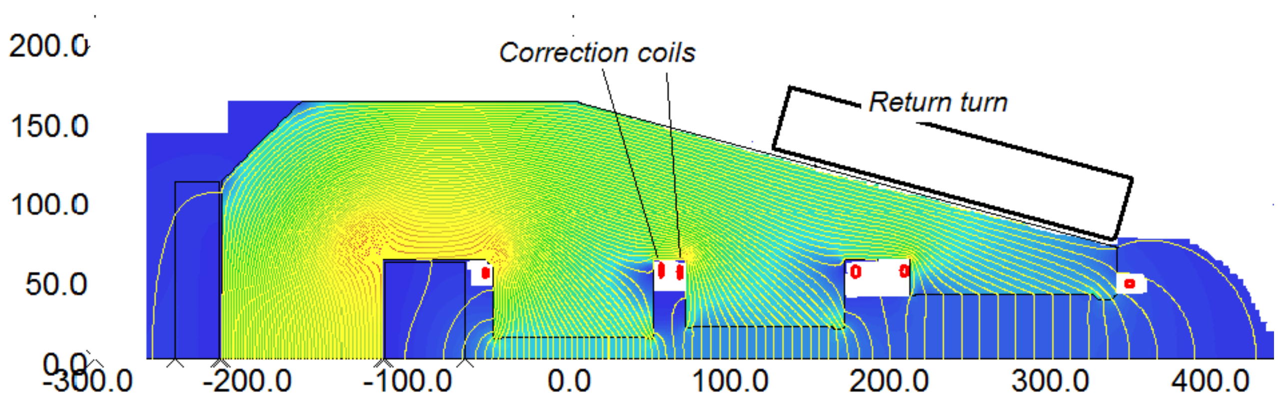
Intend to build Collaboration of CERN Magnet Group for the dipole and possibly further arc magnets for the Test Facility (two turns) and the LHeC.

Initial designs for Linac magnets in CDR and further discussions/thoughts from Daresbury, CERN and BINP colleagues.



Neil Marks 7/12

Attilio Milanese and Yuri Pupkov 11/12



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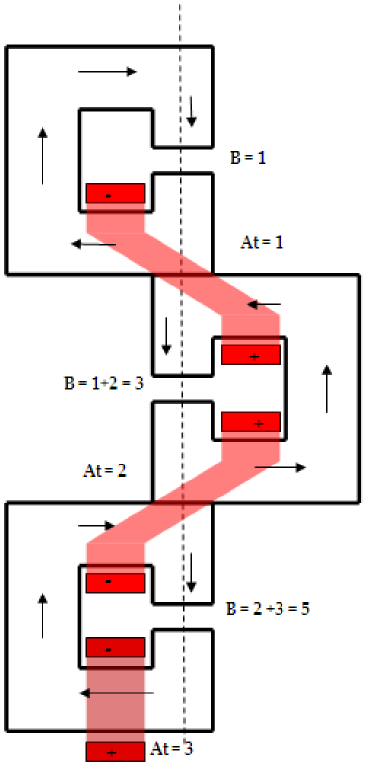
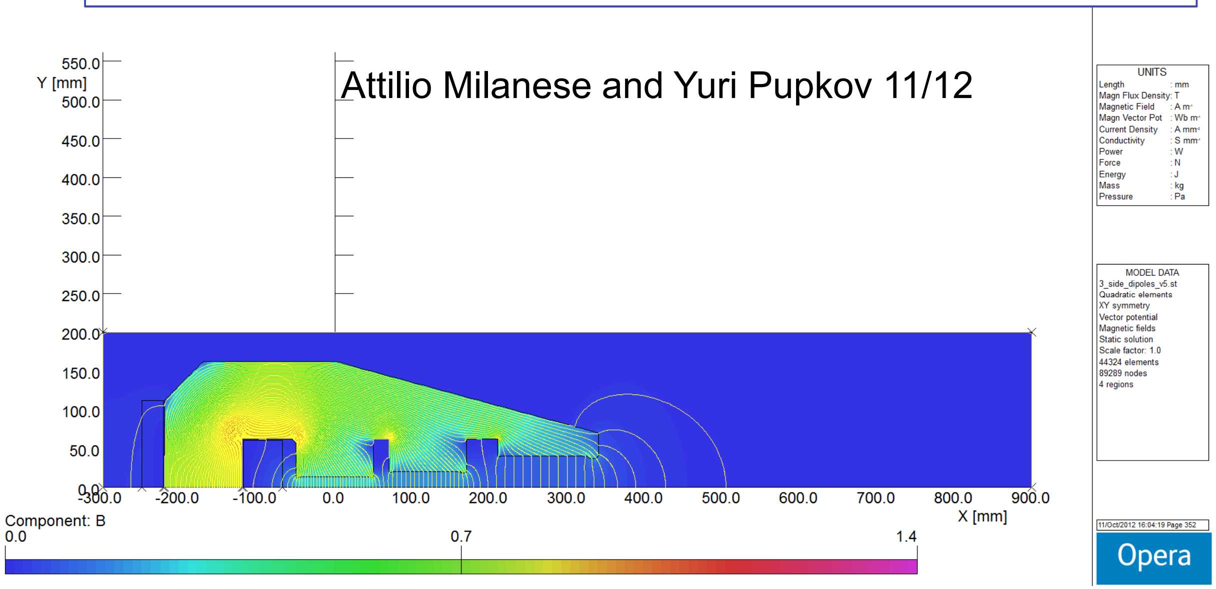


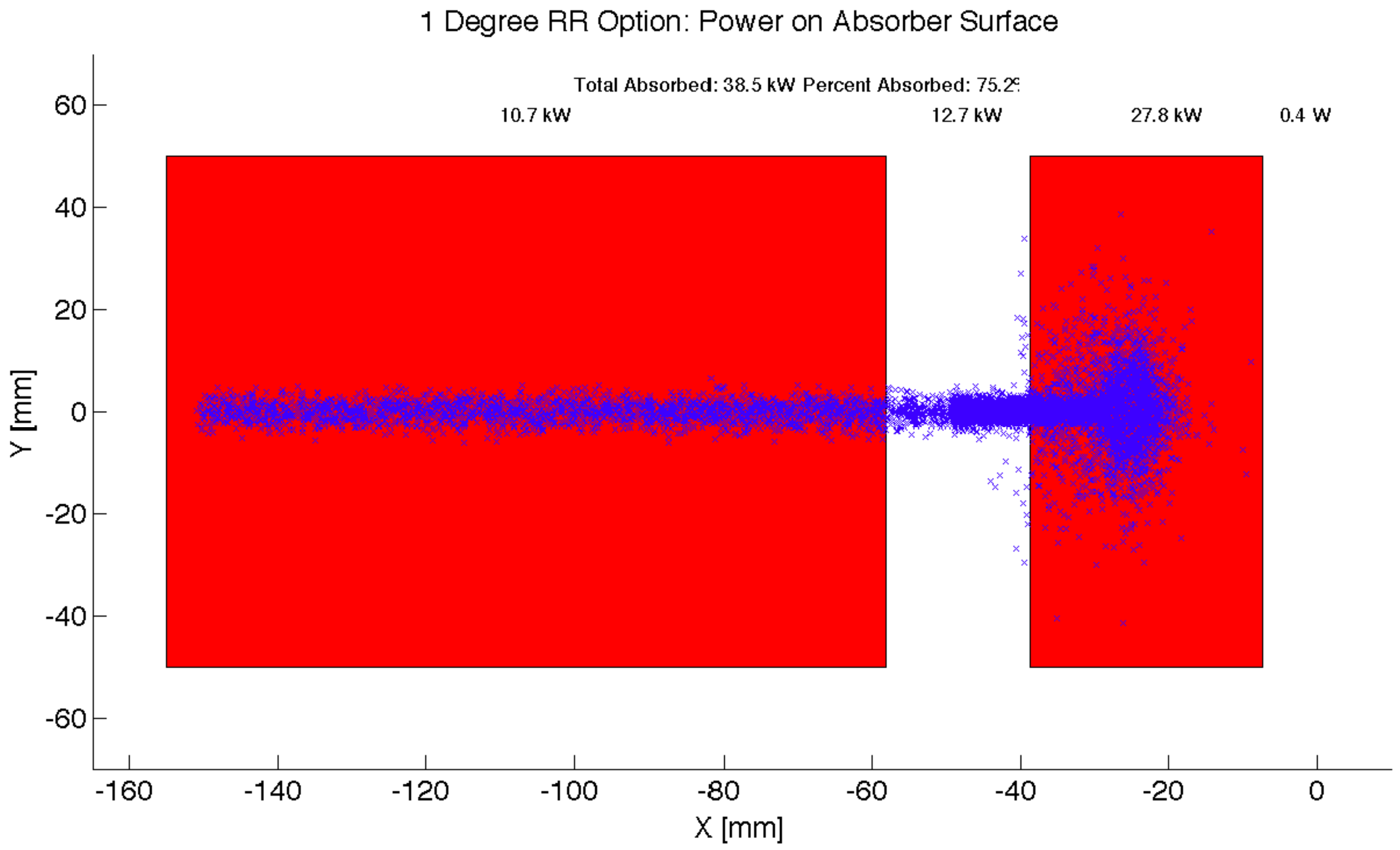
Neil Marks 7/12



Attilio Milanese and Yuri Pupkov 11/12

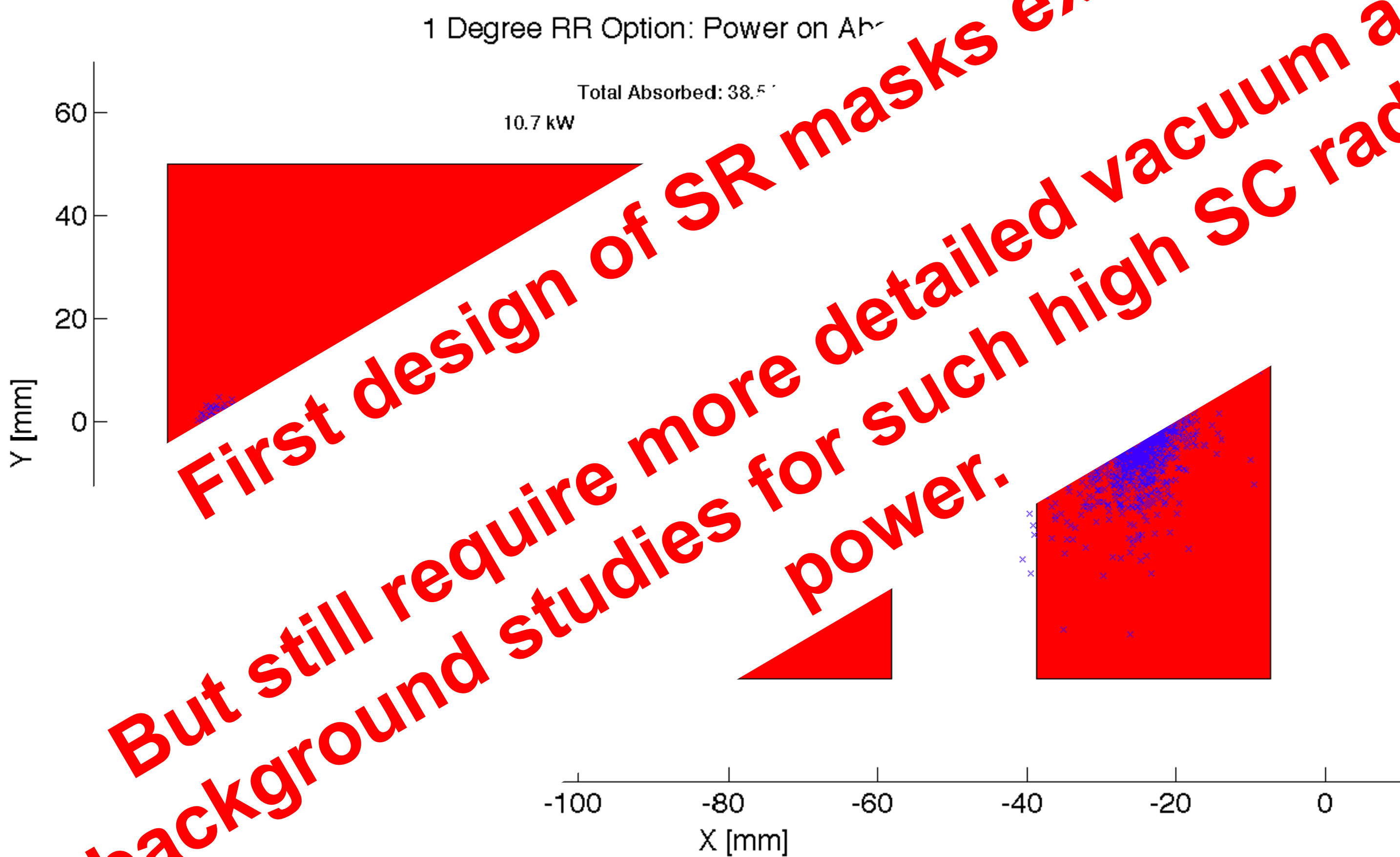
Interaction Region: Synchrotron Radiation

Significant power: > 20 kW. Example Ring-Ring



Interaction Region: Synchrotron R… tion

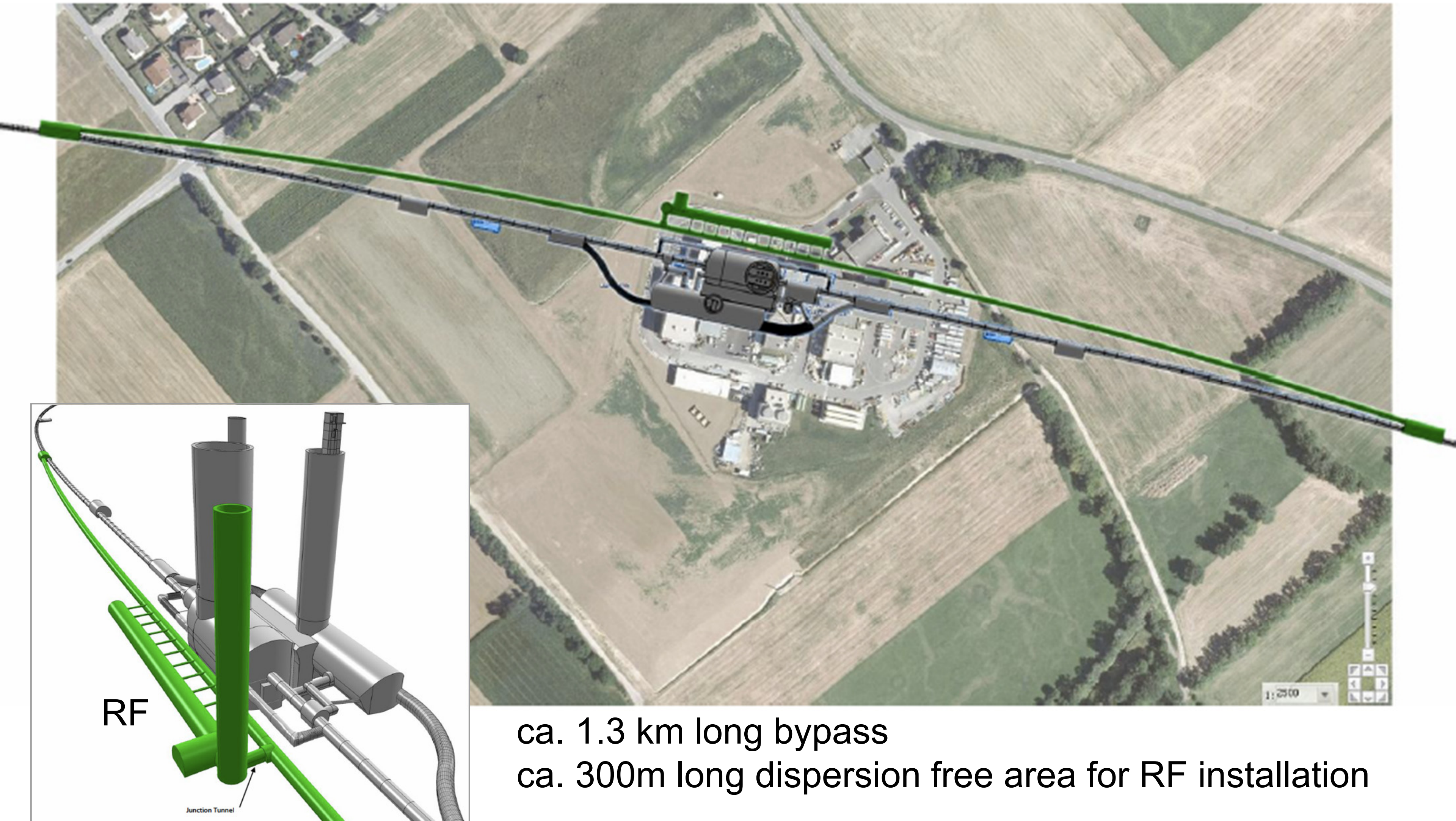
Significant power: > 20 kW. Example Ring-Ring



First design of SR masks exists.

But still require more detailed vacuum and background studies for such high SC radiation power.

Bypassing CMS: 20m distance to Cavern



ca. 1.3 km long bypass

ca. 300m long dispersion free area for RF installation

LHeC organisation

Scientific Advisory Committee

Guido Altarelli (Rome)
Sergio Bertolucci (CERN)
Stan Brodsky (SLAC)
Allen Caldwell -chair (MPI Munich)
Swapan Chattopadhyay (Cockcroft)
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John Ellis (CERN)
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Urs Wiedemann (CERN)
Frank Zimmermann (CERN)

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Accelerator Design [RR and LR]
Oliver Bruening (CERN),
Max Klein (Liverpool)
Interaction Region and Fwd/Bwd
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Uwe Schneekloth (DESY),
Pierre van Mechelen (Antwerpen)
Detector Design
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Rainer Wallny (U Zurich),
Alessandro Polini (Bologna)
New Physics at Large Scales
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Georg Weiglein (Durham)
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Brian Cole (Columbia),
Paul Newman (Birmingham),
Anna Stasto (MSU)

Review Panel with experts on physics, detector, accelerator, specific systems

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Guido Altarelli, Alan Martin, Vladimir Chekelyan

BSM:
Michelangelo Mangano, Gian Giudice, Cristinel Diaconu

eA/low x
Al Mueller, Raju Venugopalan, Michele Arneodo

Detector
Philipp Bloch, Roland Horisberger

Interaction Region Design
Daniel Pitzl, Mike Sullivan

Ring-Ring Design
Kurt Huebner, Sasha Skrinsky, Ferdinand Willeke

Linac-Ring Design
Reinhard Brinkmann, Andy Wolski, Kaoru Yokoya

Energy Recovery
Georg Hoffstatter, Ilan Ben Zvi

Magnets
Neil Marx, Martin Wilson

Installation and Infrastructure
Sylvain Weisz

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F. Zimmermann (CERN)
F. Zomer (Orsay LAL)

LHeC CDR:

- Total of ca. 500 pages: Detailed coverage of many topics:

Accelerator:
- Sources
- Damping rings and injector complex
- Injection and injector complex
- Collective effects and Beam-Beam
- Cryogenic system
- Polarization
- Beam Dump
- Vacuum
- Power generation and distribution, etc…..

➔ LHeC-Note-2011-003 GEN

LHeC CDR:

Total of ca. 500

•**Details remain to be addressed**

•**Decision to focus R&D work on LR technologies over coming 4 years**

➔**Main Conclusion so far: LHeC can be realized in parallel with HL-LHC if necessary studies are not delayed!**