Future Collider Projects at CERN

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Daniel Schulte

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The European Strategy for Particle Physics
Update 2013

*c) Europe's top priority should be the **exploitation of the full potential of the LHC**, including the high-luminosity upgrade of the machine and detectors with a view to collecting **ten times more data than in the initial design, by around 2030**. This upgrade programme will also provide further exciting opportunities for the study of flavour physics and the quark-gluon plasma.*

HL-LHC from a study to a PROJECT

300 fb^{-1} → 3000 fb^{-1}

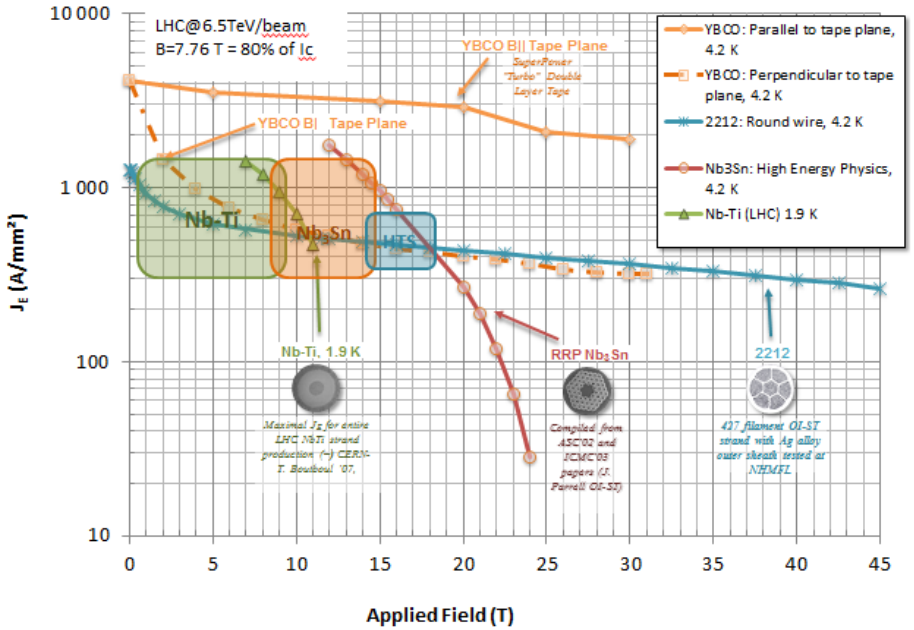
including LHC injectors upgrade **LIU**

(Linac 4, Booster 2GeV, PS and SPS upgrade)

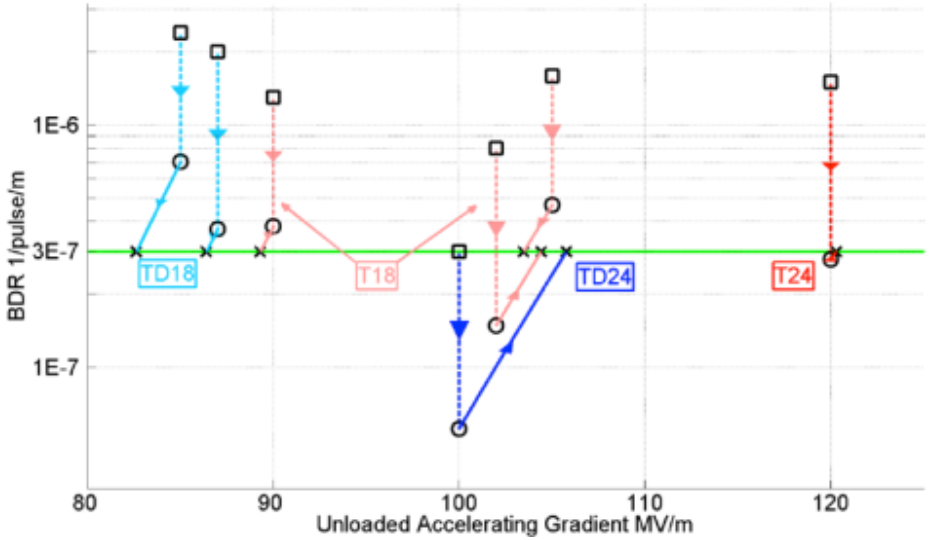
Ambitious **Post-LHC Accelerator Project at CERN**

d) *CERN should undertake design studies for accelerator projects in a global with emphasis on **proton-proton** **and** **electron-positron** **high-energy** **frontier** **machines**. These design studies should be coupled to a vigorous accelerator R&D programme, including **high-field** **magnets*** and ***high-gradient** **accelerating** **structures**, **in** **collaboration** **with** **national** **institutes, laboratories** **and** **universities** **worldwide.***

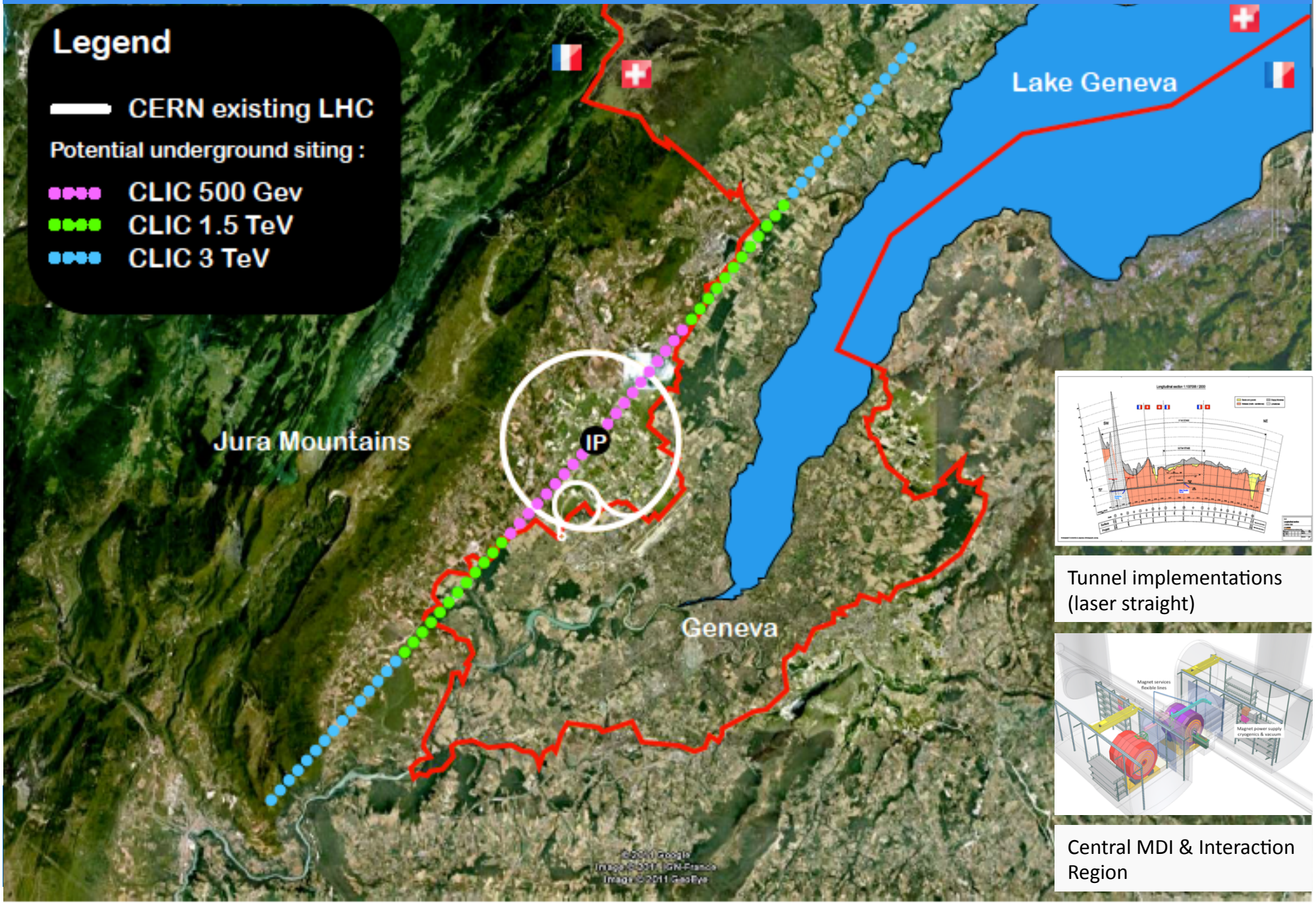
HFM



HGA



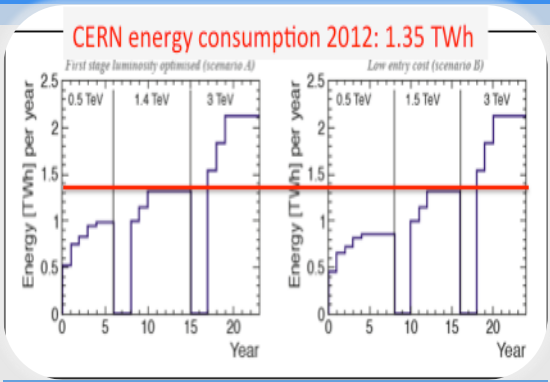
CLIC Site



Tunnel implementations (laser straight)

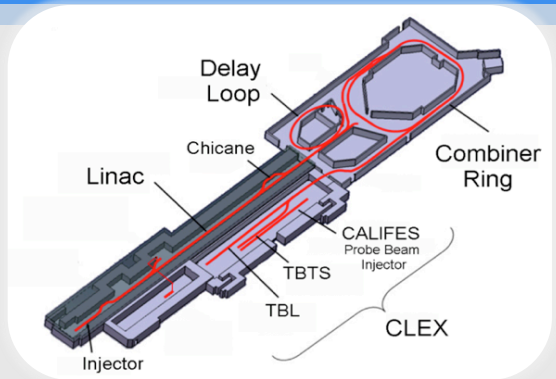
Central MDI & Interaction Region

CLIC Developments Towards 2018

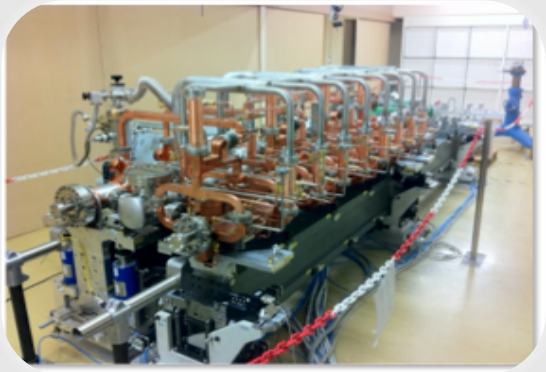


A re-baselined staged project plan, cost and power optimisation, increased industrialisation effort for cost-drivers

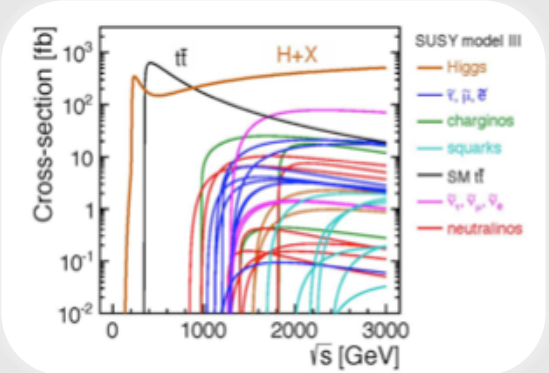
High Gradient structure development and significantly increased test-capacity for X-band RF-structures



System-test programmes in CTF3, at ATF and FACET, as well as system-tests in collaborative programmes with light-source laboratories



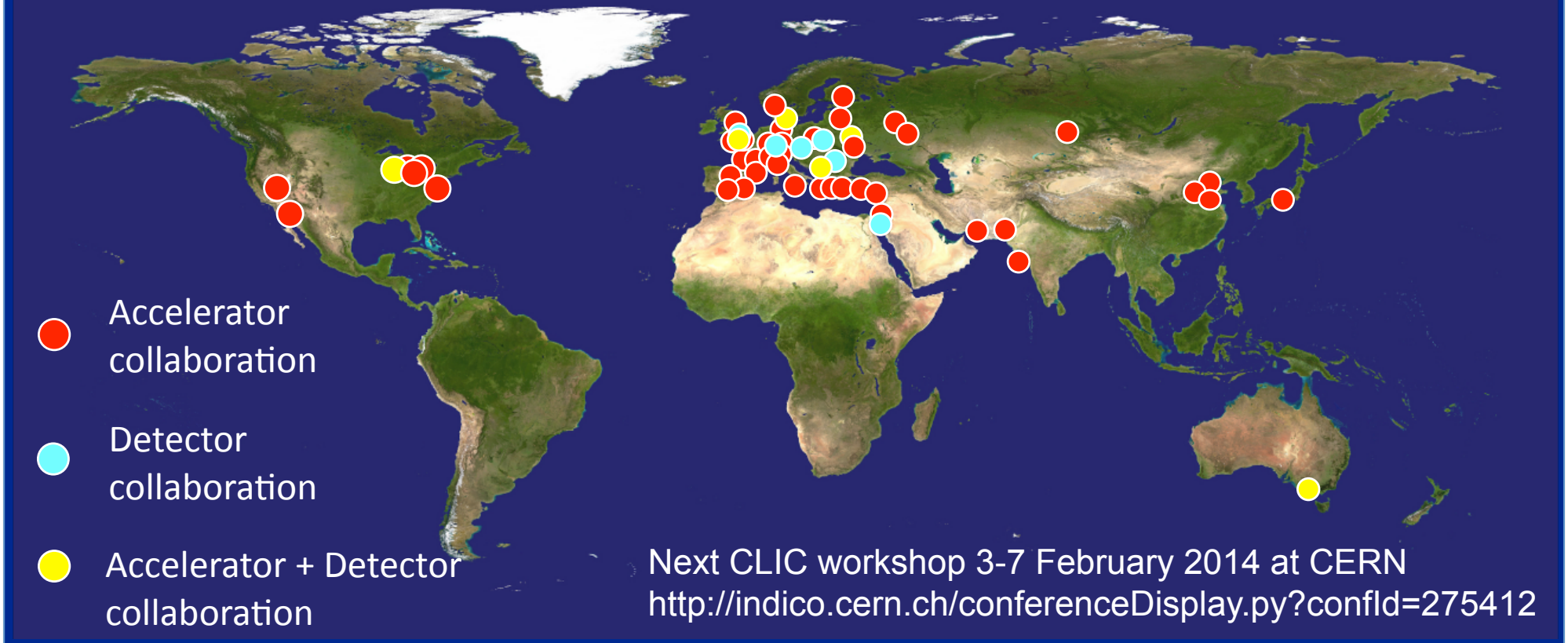
Technical systems developments, related among others to complete modules, alignment/stability, instrumentation and power sources



Physics studies related to energy frontier capabilities and potential new physics as it emerges from LHC

CLIC Collaboration

29 Countries – over 70 Institutes



Accelerator collaboration

Detector collaboration

Accelerator + Detector collaboration

Next CLIC workshop 3-7 February 2014 at CERN
http://indico.cern.ch/conferenceDisplay.py?confId=275412

FCC Study Scope and Structure

Future Circular Colliders - Conceptual Design Study for next European Strategy Update (2018)

Infrastructure

tunnels, surface buildings, transport (access roads), civil engineering, cooling ventilation, electricity, cryogenics, communication & IT, fabrication and installation processes, maintenance, environmental impact and monitoring, safety

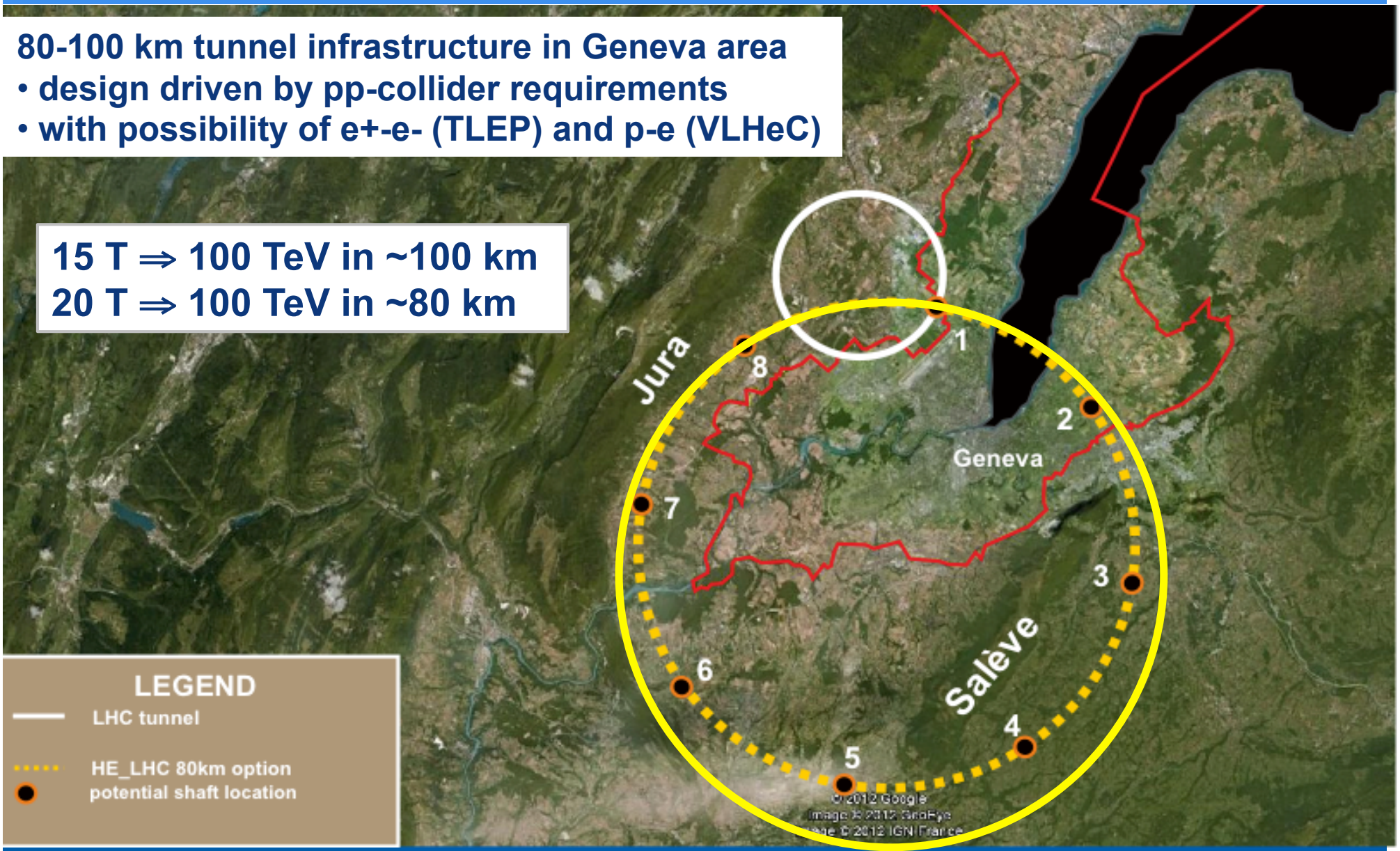
Hadron injectors	**Hadron collider**	**e+ e- collider**
Beam optics and dynamics	Optics and beam dynamics	Optics and beam dynamics
Functional specs	Functional specifications	Functional specifications
Performance specs	Performance specs	Performance specs
Critical technical systems	Critical technical systems	Critical technical systems
Operation concept	Related R+D programs	Related R+D programs
	HE-LHC comparison	Injector (Booster)
	Operation concept	Operation concept
	Detector concept	Detector concept
	Physics requirements	Physics requirements

e- p option: Physics, Integration, additional requirements

Tentative Site Layout

80-100 km tunnel infrastructure in Geneva area
- **design driven by pp-collider requirements**
- **with possibility of e+-e- (TLEP) and p-e (VLHeC)**

15 T ⇒ 100 TeV in ~100 km
20 T ⇒ 100 TeV in ~80 km



Prel. Parameters for FHC *(VHE-LHC)*

- **CMS energy = 100 TeV**
- **Peak luminosity = 1-5x10^{34} $cm^{-2}s^{-1}$ per main IP**
- **# main IPs = 2**
- **Bunch spacing = 25ns**
  - **Range 5-50 ns being explored**
  - **Pile-up of 34, 170, 340 for 5, 25, 50ns and 5x$10^{34}$$cm^{-2}s^{-1}$**

- **Dipole field = 15 T (baseline)**
  - 20 T option, using high temperature superconductor
- **Circumference ~100 km**
- Total beam-beam tune shift = 0.01 (conservative)
- β^* = 1.1 m *[2 m conservative option]* linked to total beam current (~0.5-1 A)

FHC Challenges

- Dipole and other magnets
- Heat load at beam screen, cryogenics, beam pipe design
- Machine protection, failures, radiation, collimation
- Electron cloud
- Machine detector interface
- Operation with significant damping
- …

- Cost
  - To reduce cost will have to push parameters
  - Need to find an optimised design

Prel. Parameters for FEC *(TLEP)*

- **Energy =** 91, 160, **240,** 350 **GeV c.m.**
  (energy upgrade 500 for ZHH/ttH)
- **Peak luminosity / IP**
  - **$5x10^{34}$ $cm^{-2}s^{-1}$ at Higgs**
  - ~$1x10^{34}$ $cm^{-2}s^{-1}$ at top
  - ~$50x10^{34}$ $cm^{-2}s^{-1}$ Z
- **#IPs = 2 or 4**

- **Circumference ~100 km (from FHC)**
- **Total SR power ≤ 100 MW** (design limit)
- Beam-beam tune shift / IP scaled from LEP
- Top-up injection required
- $\beta_y^* = 1$ mm ~ σ_z

Prel. Parameters FHEC *(VHELHC-TLEP)*

- **Lepton energy = 60, 120, 250 GeV**
- ***p* energy = 50 TeV**
- **#IPs = 1 or 2**

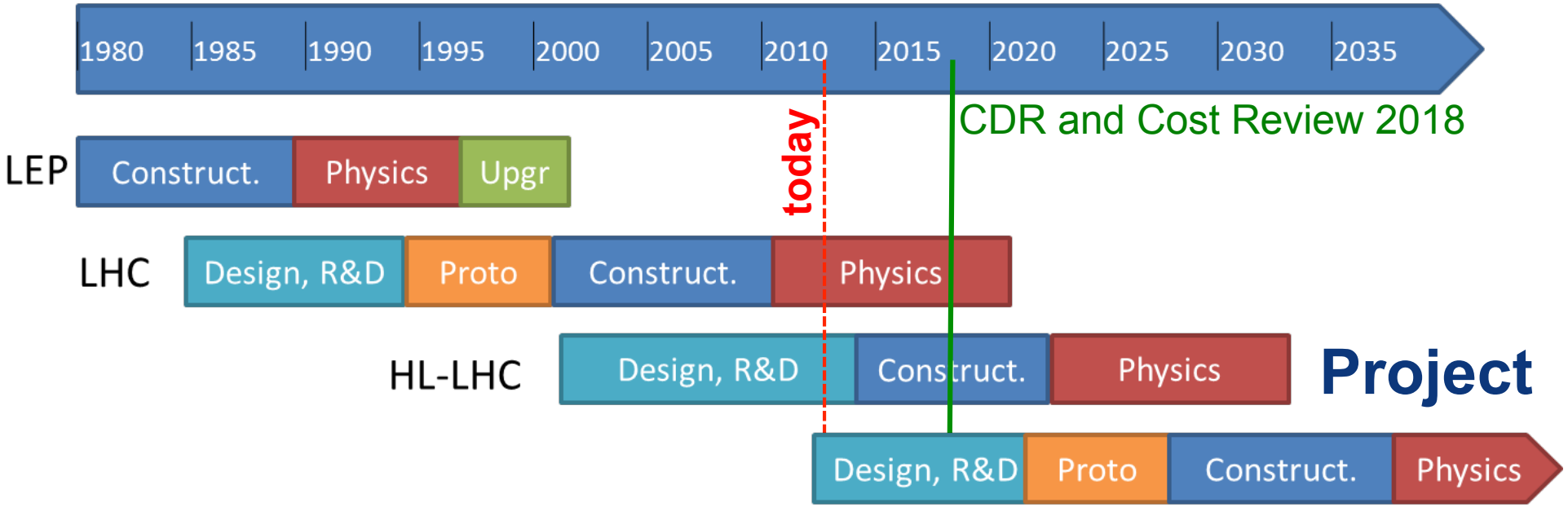
- Spot size determined by protons
- Lepton current from FEC (SR power ≤ 50 MW)

Main areas for design study

Preparatory group for a kick-off meeting => Steering committee

Machines and infrastructure conceptual designs	Technologies R&D activities Planning	Physics experiments detectors
Infrastructure	High-field magnets	Hadron physics experiments interface, integration
Hadron collider conceptual design	Superconducting RF systems	e^+ e^- coll. physics experiments interface, integration
Hadron injectors	Cryogenics	e^- - p physics, experiments, integration aspects
Lepton collider conceptual design	Specific technologies	
Safety, operation, energy management environmental aspects	Planning	

Timeline



FCC Study : p-p towards 100 TeV

Kick-off meeting: 12th-14th Feb. 2014

FCC: Future Circular Colliders

Summary

- The CLIC study is continued to be ready for decision in 2018
  - Also contributions to ILC
  - CLIC meeting 3.-7. February at CERN

- CERN is starting a new international study of future circular colliders (FCC): CDR and cost review for the next ESU (target 2018)
- The study is driven by the hadron collider at the energy frontier, determining also the infrastructure.
- The study will also contain an e^+e^- collider, as potential intermediate step, and look at an e-p option.
- *FCC kick-off meeting: 12-14. February 2014 in Geneva area*
  - *Establishing international collaborations*
  - *Set-up study groups and study committees*
  - *International Advisory Committee (IAC)*

Thanks to Michael Benedikt and Steinar Stapnes for some slides