BSM physics opportunities at 100 TeV

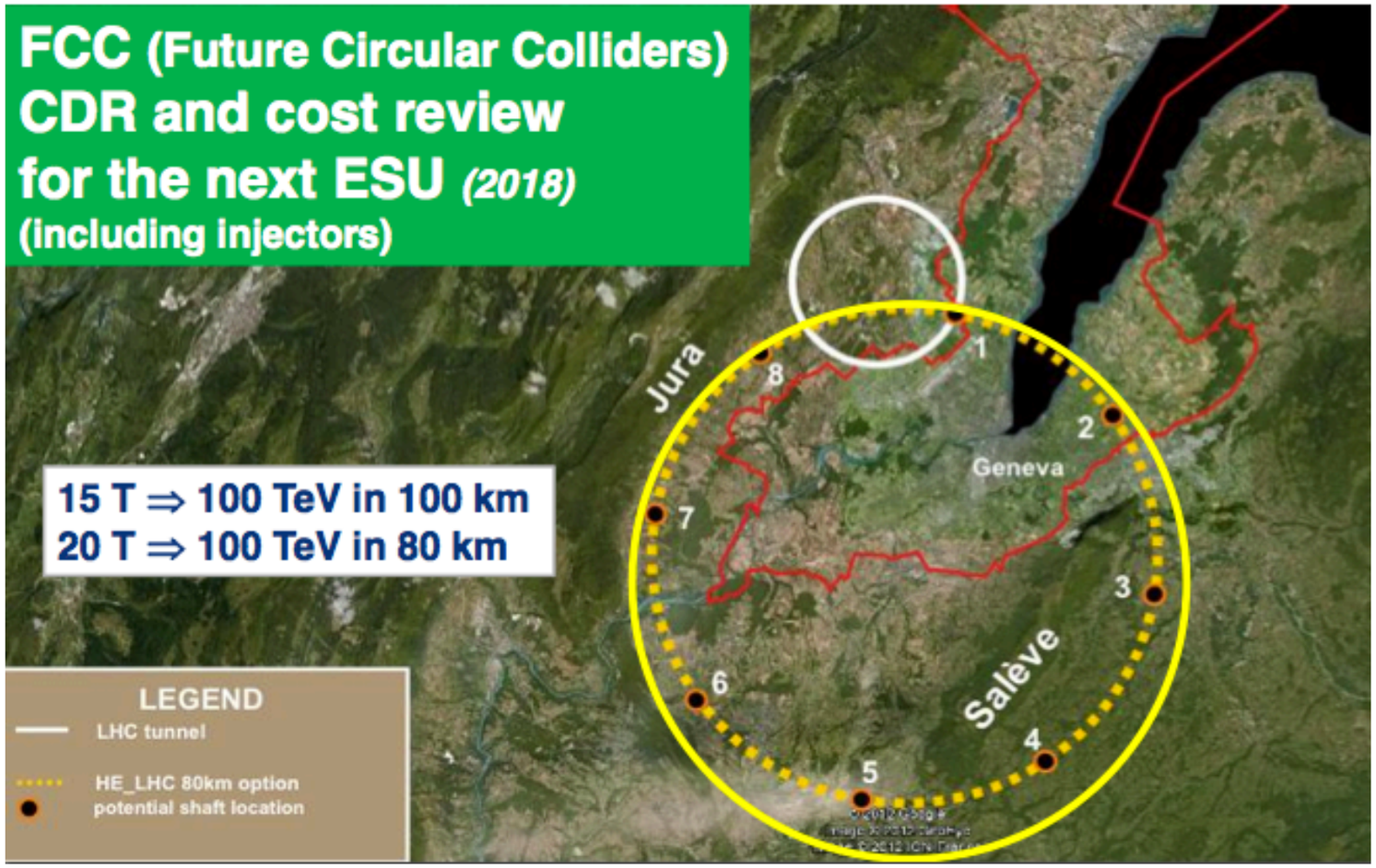
CERN, February 10-11 2014

Introduction:

- the framework
- the goals of this workshop

Design study for Future Circular Colliders

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



UNIVERSITÉ DE GENÈVE CERN FCC

Future Circular Colliders Study Kickoff Meeting

12-15 February 2014
University of Geneva, Geneva
Europe/Zurich timezone

Search

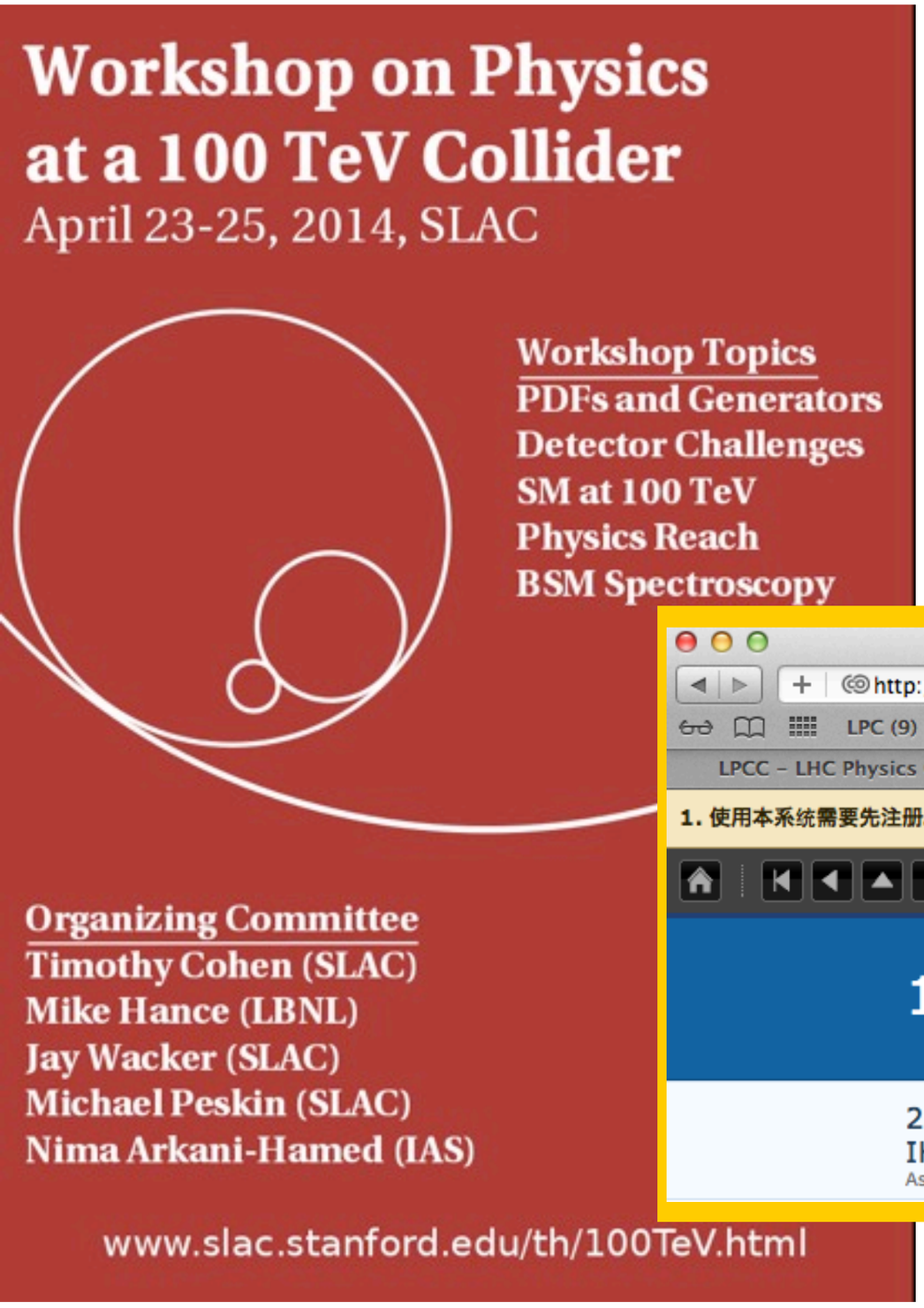
Webcast: Please note that this event will be available live via the Webcast Service.

Future Circular Collider Kickoff Meeting

Machines and infrastructure conceptual designs	Technologies R&D activities Planning	Physics experiments detectors	
Infrastructure	High-field magnets	Hadron physics experiments interface, integration	MLM F.Gianotti A.Ball
Hadron collider conceptual design	Superconducting RF systems	e^+ e^- coll. physics experiments interface, integration	J. Ellis P. Janot A. Blondel
Hadron injectors	Cryogenics		
Lepton collider conceptual design	Specific technologies	e^- - p physics and integration aspects	M. Klein
Safety, operation, energy management environmental aspects	Planning		

Target: conceptual design report (CDR) ready for the next Strategy Group assessment (~2018)

Parallel activities in the world



FCC physics activities documented on:

- pp and AA phyics:
  - o http://indico.cern.ch/categoryDisplay.py?categId=5258
  - o https://twiki.cern.ch/twiki/bin/view/LHCPhysics/FutureHadroncollider
- e^+e^- physics: http://tlep.web.cern.ch/
- ep physics: http://www.ep.ph.bham.ac.uk/exp/LHeC/

Mailing list exist (see e.g. header of this mtg's agenda) =>
register to be kept uptodate

On hadron collider physics, so far:

- 5 preparatory mtgs of the pp WG
- 2 preparatory mtgs of the HI subgroup

PLAN: prepare a report documenting the physics opportunities at 100 TeV, on the time scale of end-2015.
It will be updated for the delivery of the final CDR.

FHC: physics topics list => WG structure (preliminary)

FHC.1.1 Exploration of EW Symmetry Breaking (EWSB)

FHC.1.1.1 High-mass WW scattering, high mass HH production

FHC.1.1.2 Rare Higgs production/decays and precision studies of Higgs properties

FHC.1.1.3 Additional BSM Higgs bosons: discovery reach and precision physics programme

FHC.1.1.4 New handles on the study of non-SM EWSB dynamics (e.g. dynamical EWSB and composite H, etc)

FHC.1.2 Exploration of BSM phenomena

FHC.1.2.1 discovery reach for various scenarios (SUSY, new gauge interactions, new quark and leptons, compositeness, etc.)

FHC.1.2.2 Theoretical implications of discovery/non-discovery of various BSM scenarios,
e.g. address questions such as:

- FHC.1.2.2.1 what remains of Supersymmetry if nothing is seen at the scales accessible at 100 TeV?
- FHC.1.2.2.2 which new opportunities open up at 100 TeV for the detection and study of dark matter?
- FHC.1.2.2.3 which new BSM frameworks, which are totally outside of the HL-LHC reach, become accessible/worth-discussing at 100 TeV ?

FHC.1.3 Continued exploration of SM particles
FHC.1.3.1 Physics of the top quark (rare decays, FCNC, anomalous couplings, ...)
FHC.1.3.2 Physics of the bottom quark (rare decays, CPV, ...)
FHC.1.3.2 Physics of the tau lepton (e.g. tau -> 3 mu, tau -> mu gamma and other LFV decays)
FHC.1.3.2 W/Z physics
FHC.1.3.3 QCD dynamics

FHC.1.4 Opportunities other than pp physics:
FHC.1.4.1 Heavy Ion Collisions
FHC.1.4.2 Fixed target experiments:
FHC.1.4.2.1 "Intensity frontier": kaon physics, mu2e conversions, beam dump experiments and searches for heavy photons, heavy neutrals, and other exotica...
FHC.1.4.2.2 Heavy Ion beams for fixed-target experiments

FHC.1.5 Theoretical tools for the study of 100 TeV collisions
FHC.1.5.1 PDFs
FHC.1.5.2 MC generators
FHC.1.5.3 N^nLO calculations
FHC.1.5.4 EW corrections

Goals for this meeting:

Focus on exposing what are the qualitative changes brought by the access to the 100 TeV region. Address obvious questions such as:

- if we haven't seen something by 14 Tev, why should it show up by 100 Tev?
- what are the origins and the motivations of mass scales in the range beyond the LHC, but within the reach of 100 TeV?
- what are the new rare processes that become interesting to explore with the increased statistics possible at 100 TeV?
- are there BSM scenarios for which one can formulate sort of no-lose theorems at 100 Tev? E.g. Is there any conclusive statement that we'll be able to make on DM after 1-10 ab^{-1} at 100 TeV ?

For phenomena that could already be probed at the LHC, which new observables and states that may open up for exploration at 100 TeV. How do these interplay with other probes that could be available 30 years from now (e.g. from the cosmos, or maybe from an e+e– collider, etc)?

Forget for the time being about detector constraints. We have no clue as to what the 100 Tev detectors will be like. Ideally the design of the detectors will adapt to the physics opportunities, so let's not bias ourselves early on with projected detector performance assumptions.

10 ab^{-1} at 100 TeV imply, e.g.:

10^{10} Higgs bosons => 10^4 x today

10^{12} top quarks => 5 10^4 x today

=>10^{12} W bosons from top decays

10^4 $pp \rightarrow W^* \rightarrow$ top+ bottom with M(tb) > 7 TeV

....

Let's be ambitious, visionary and creative !