The Future Circular Collider and Physical Review Accelerators & Beams

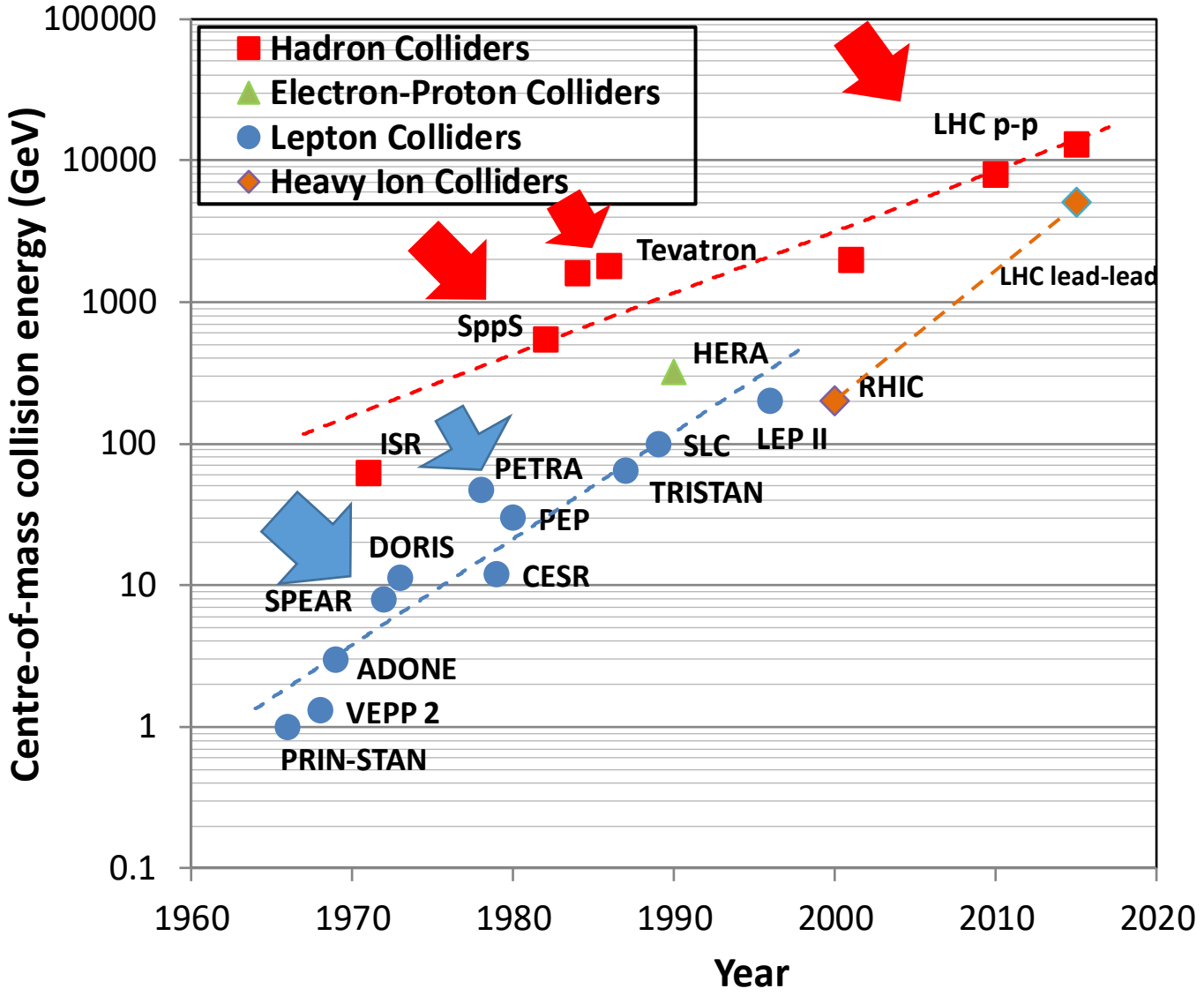
Frank Zimmermann, CERN

2019 USPAS Prize 

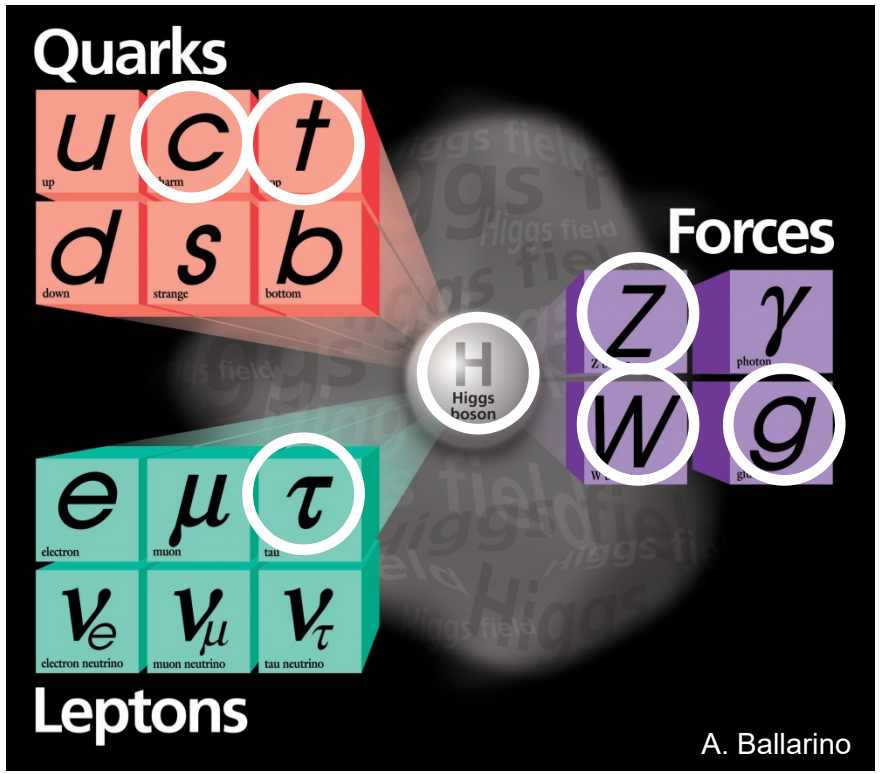
presentation

award given *"for outstanding scientific leadership in the accelerator design and beam physics of hadron colliders and dedicated editorship of professional accelerator journals"*

colliders and discoveries



Standard Model
Particles and forces



powerful instruments for discovery and precision measurement

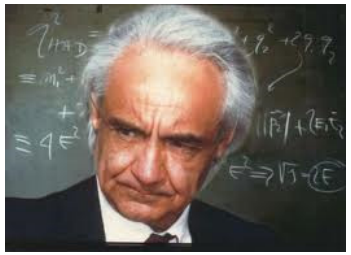
on the historical path towards 100 TeV collider …

ISABELLE/ CBA 1972-83

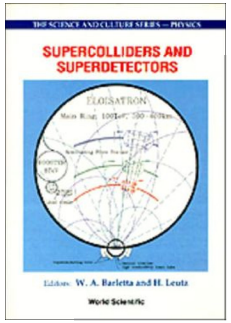
R. Palmer

Eloisatron Study since 1979

200 TeV, 300 km,
13.5 T, still ongoing



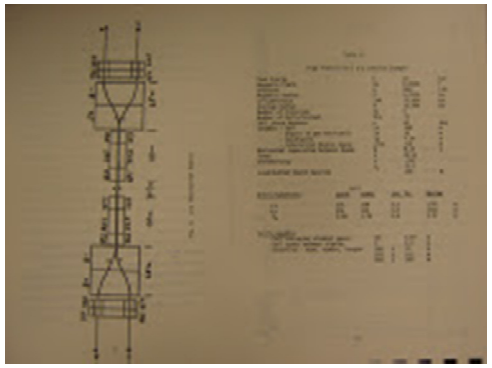
A. Zichichi



W. Barletta

E. Keil

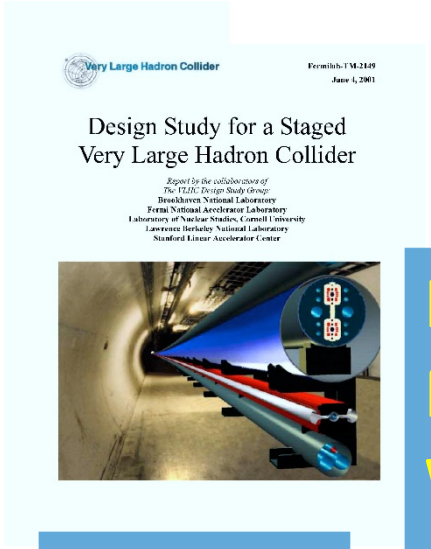
20 TeV Hadron Collider Workshop 1983



Proceedings in **Cornell Library Section of „historically valuable manuscripts“** ***together with an original manuscript of Thomas Jefferson*** **!**

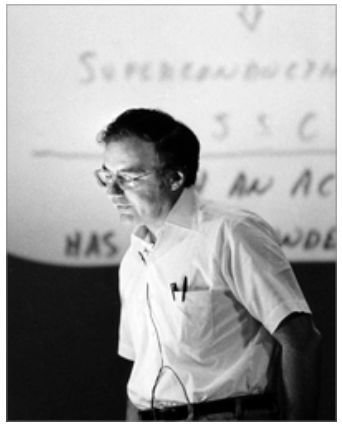
HADRON COLLIDERS BETWEEN 1 AND 100 TeV BEAM ENERGY

Eberhard Keil
CERN, Geneva, Switzerland



HE-LHC Malta Workshop 2010

SSC CDR 1986



M. Tigner

Conceptual Design of the Superconducting Super Collider

SSC Central Design Group*

March 1986

A. Chao

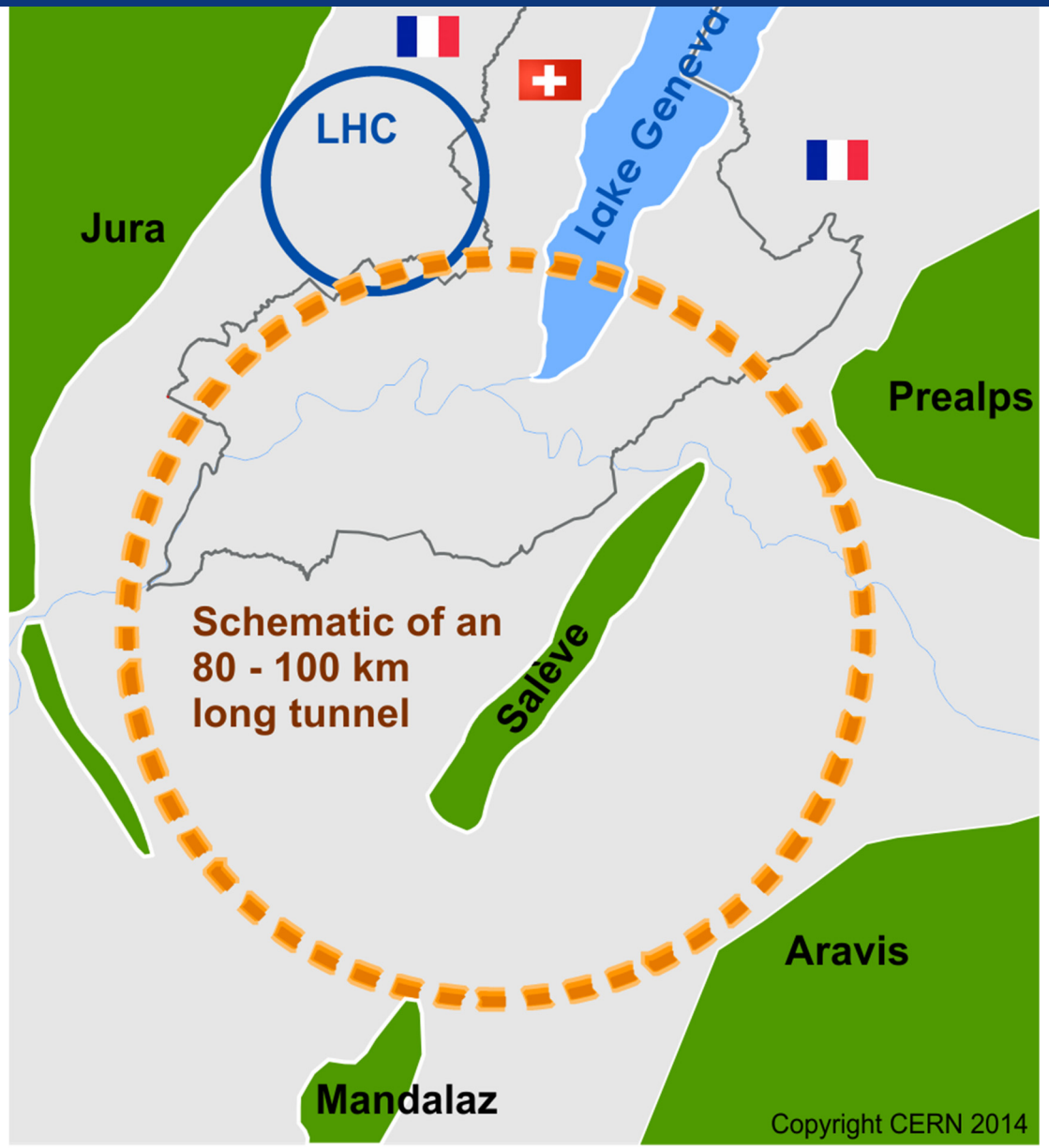
H. Edwards

VLHC design 2001

→ new tunnel & 100 TeV !

Future Circular Collider (FCC) Study

launched in response to 2013 ESPPU



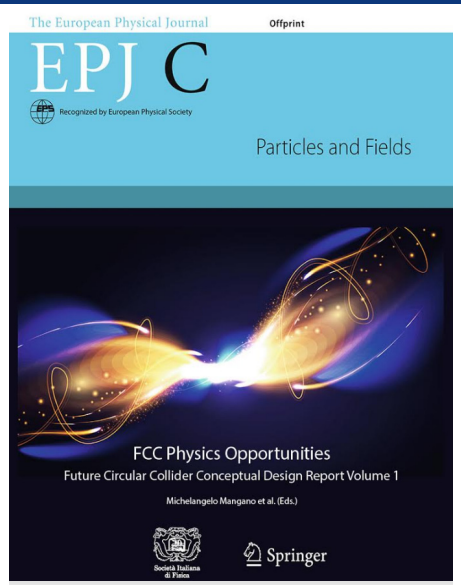
int'l collaboration hosted by CERN to study:

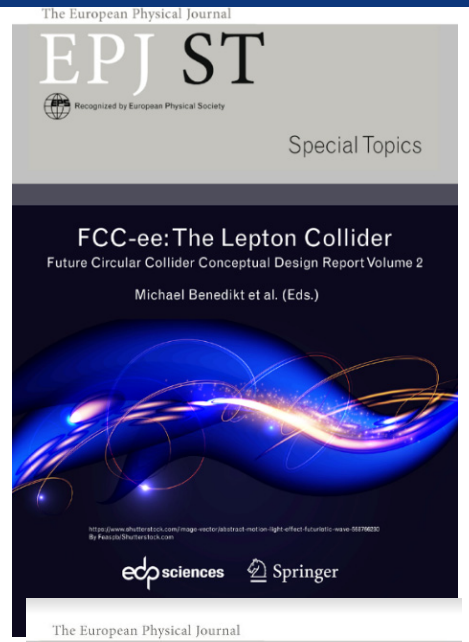
- **~100 km tunnel infrastructure** in Geneva area, linked to CERN accelerator complex
- ***e*$^+$*e*$^-$ collider (*FCC-ee*),**
  → potential first step
- ***pp*-collider (*FCC-hh*)**
  → long-term goal, defining infrastructure requirements

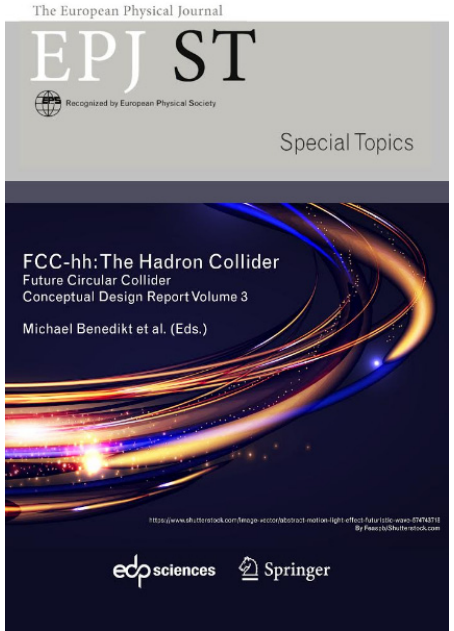
~16 T ⇒ 100 TeV *pp* in 100 km

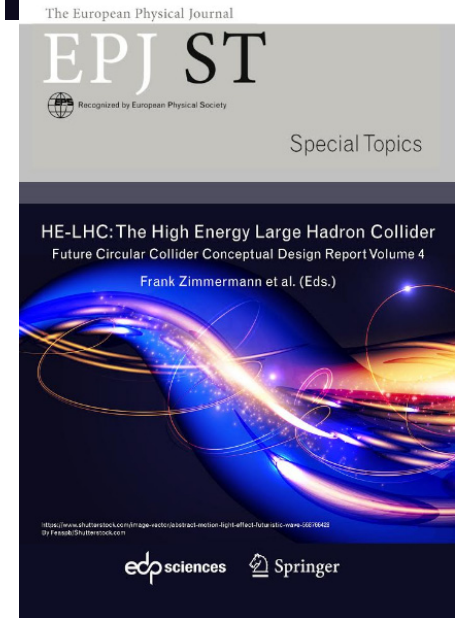
- **HE-LHC** with *FCC-hh* technology
- **ion** and **lepton-hadron** options with hadron colliders

milestone: FCC Conceptual Design Report









4 CDR volumes

published in EPJ C and EPJ ST:

- FCC Physics Opportunities
- FCC-ee
- FCC-hh
- HE-LHC

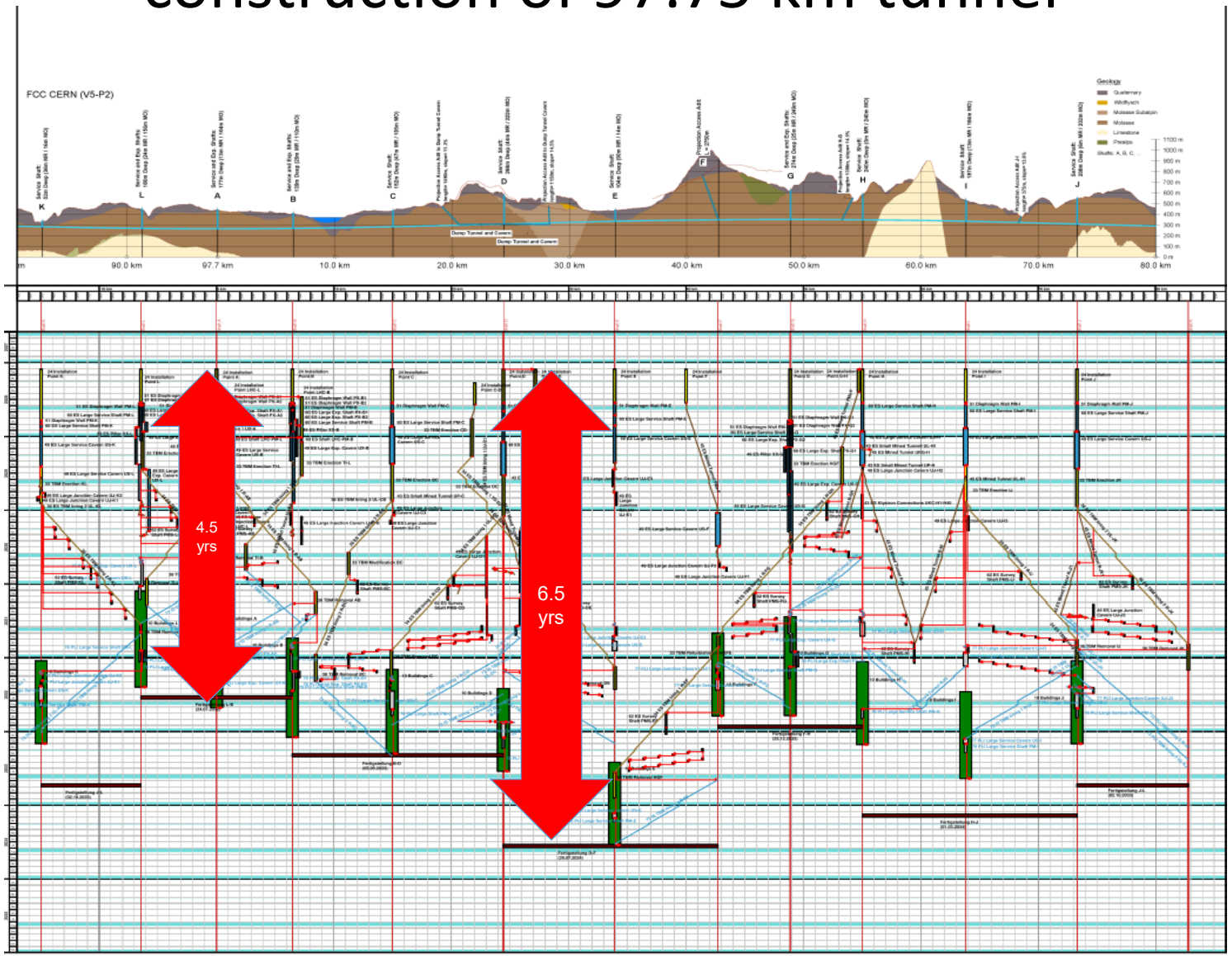
preprints available since 15 January 2019

http://fcc-cdr.web.cern.ch/

more than 1350 contributors from 350 institutes, a truly global collaboration and effort as suggested by the EPPSU 2013

FCC implementation studies

construction of 97.75 km tunnel



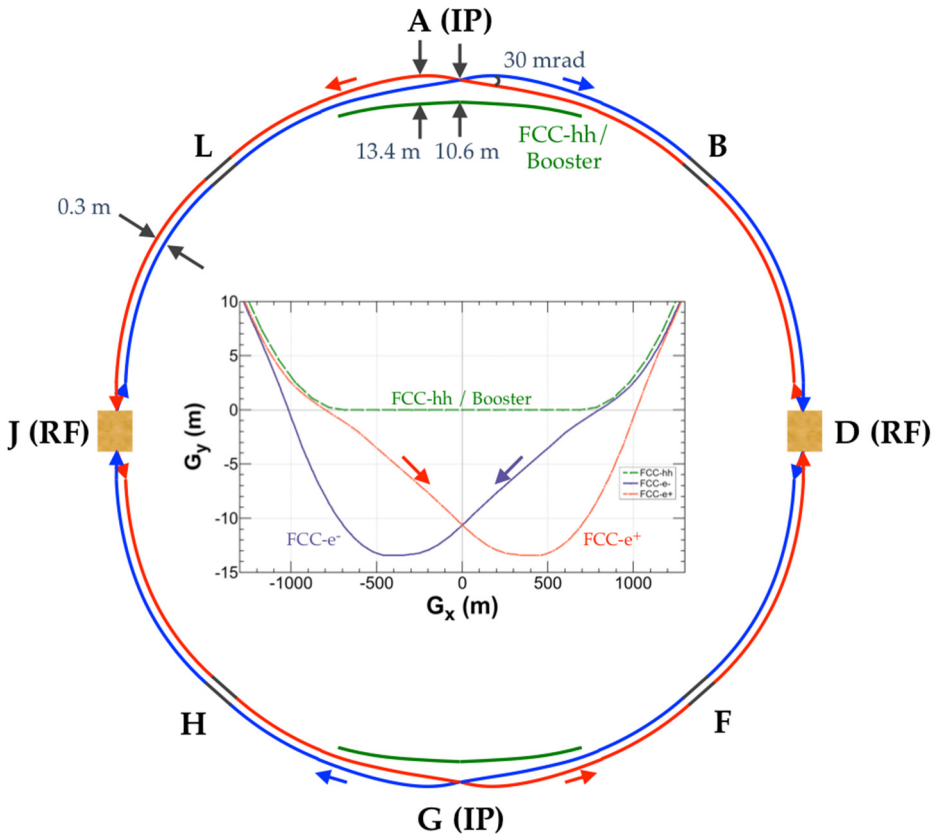
- **stage 1: FCC-ee (Z, W, H, $t\bar{t}$) as e^+e^- Higgs factory, EW and top factory at highest luminosities**
- **stage 2: FCC-hh (~100 TeV) as natural continuation at energy frontier, with ion and eh options**
- common civil engineering & shared technical infrastructures
- based on existing CERN complex

- **total construction duration 7 years**
- **first sectors ready after 4.5 years**

common layouts for hh & ee

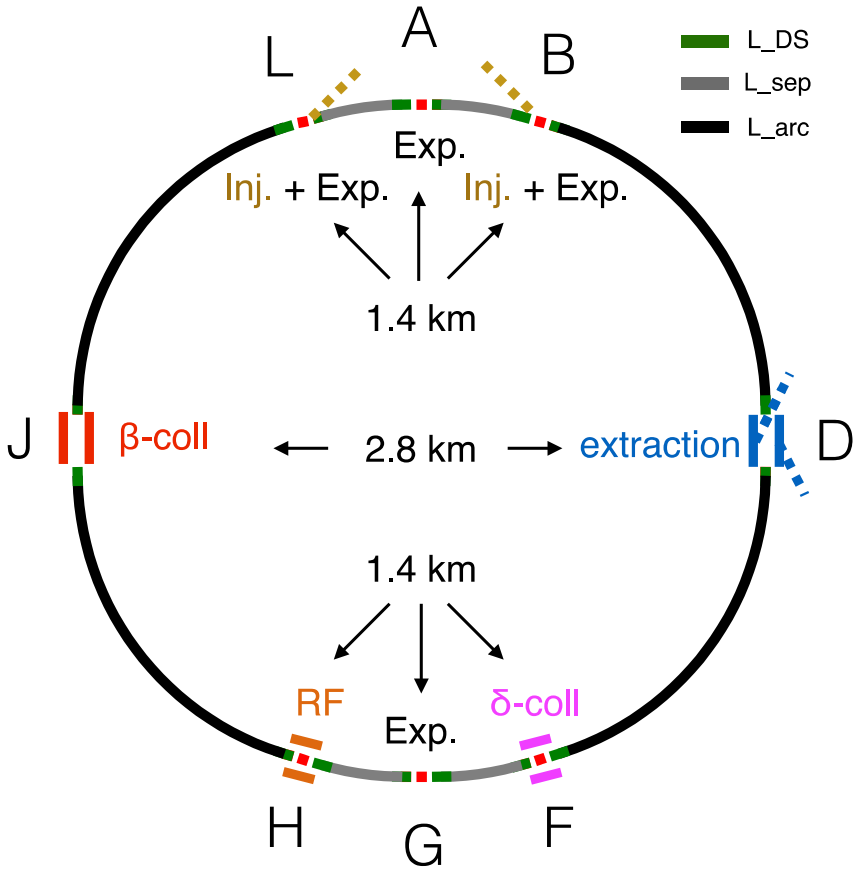
- **two main IPs in A, G for both machines; common footprint except around IPs**
- **FCC-ee asymmetric IR layout** to limit synchrotron radiation

FCC-ee



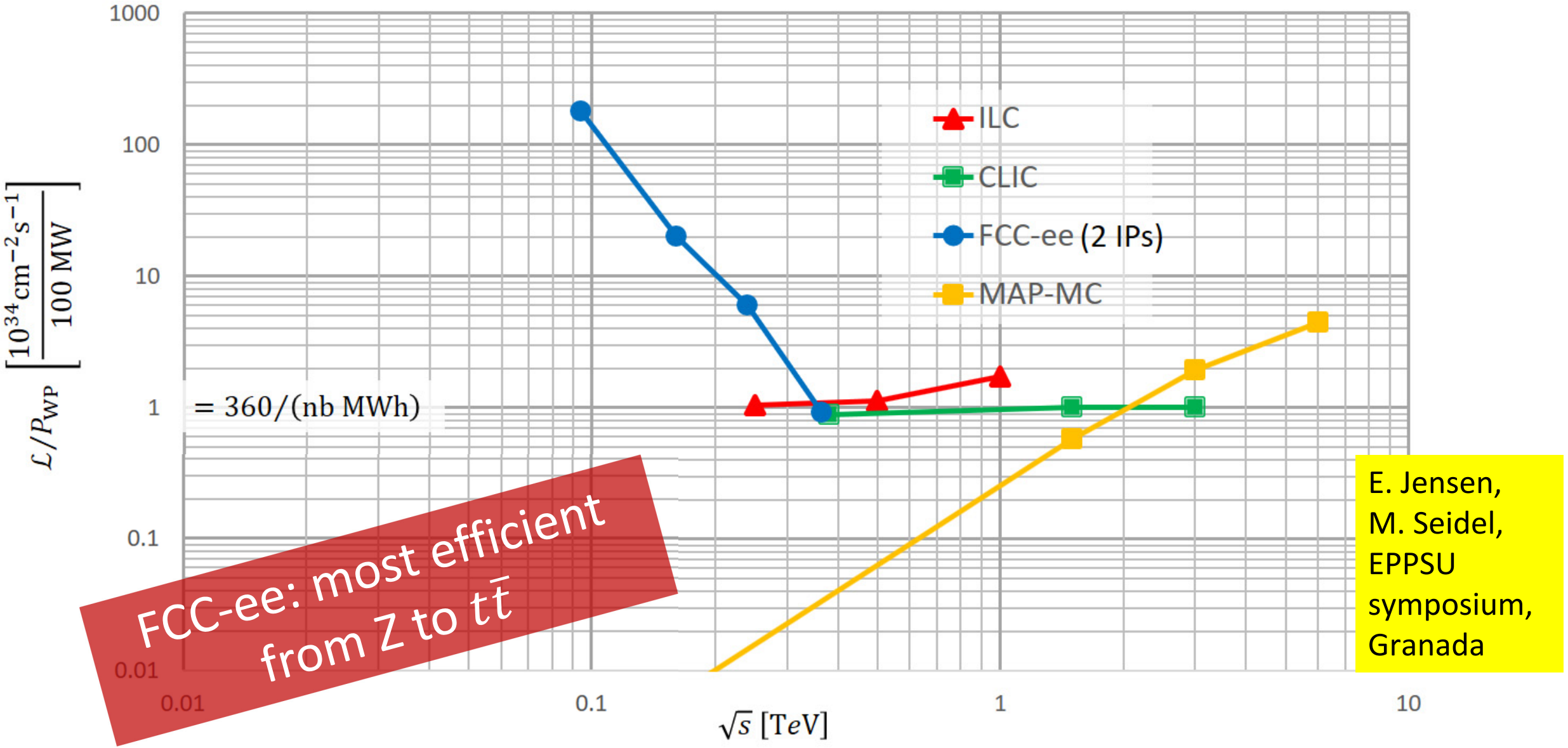
K. Oide

FCC-hh

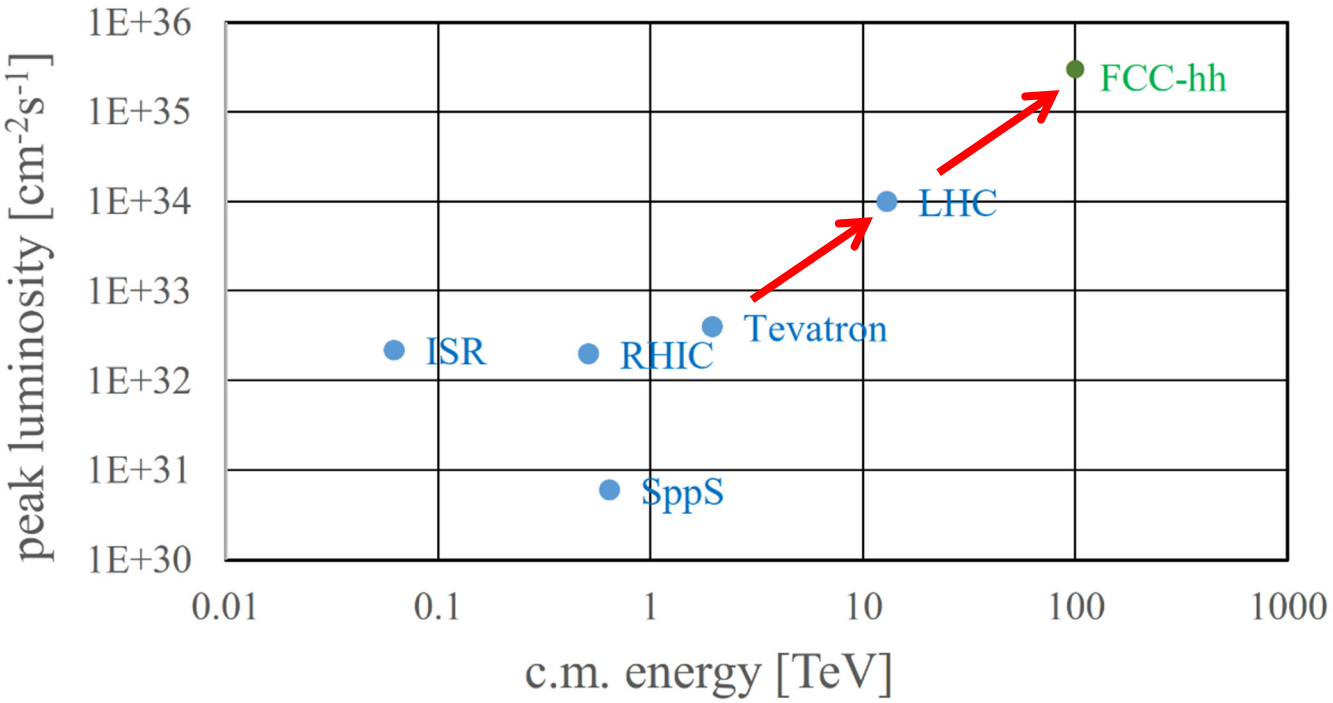


similar solutions for a project in China (CEPC/SppC)

a figure of merit for lepton colliders: luminosity/power



FCC-hh: performance



order of magnitude performance increase in both **energy & luminosity**

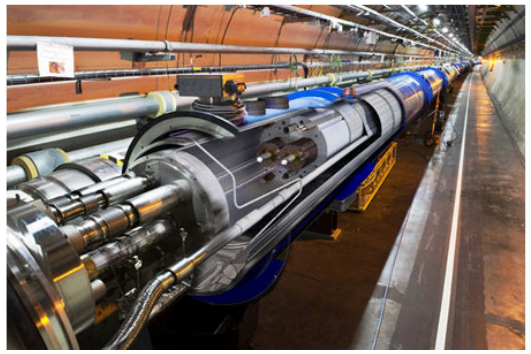
100 TeV cm collision energy (vs 14 TeV for LHC)

20 ab^{-1} per experiment collected over 25 years of operation (vs 3 ab^{-1} for LHC)

similar to performance increase Tevatron → LHC

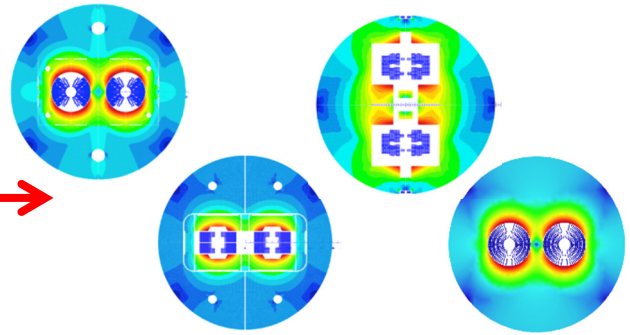
key technology: high-field magnets

from LHC technology 8.3 T NbTi



via HL-LHC 11 T Nb_3Sn

to FCC 16 T Nb_3Sn
EuroCirCol, Chart, US MDP



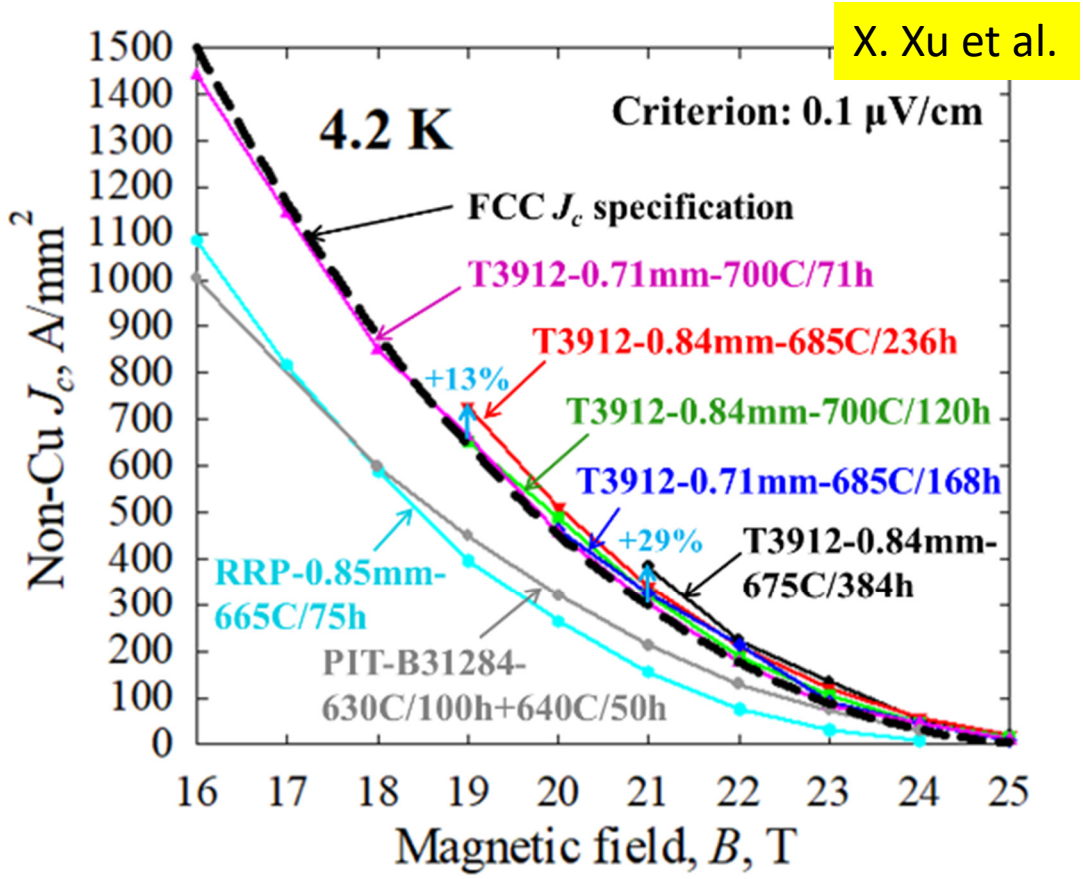
+ BINP

CEA,
CERN,
CIEMAT,
FNAL,
INFN,
LBNL,
PSI, …

superconductor for 16 T

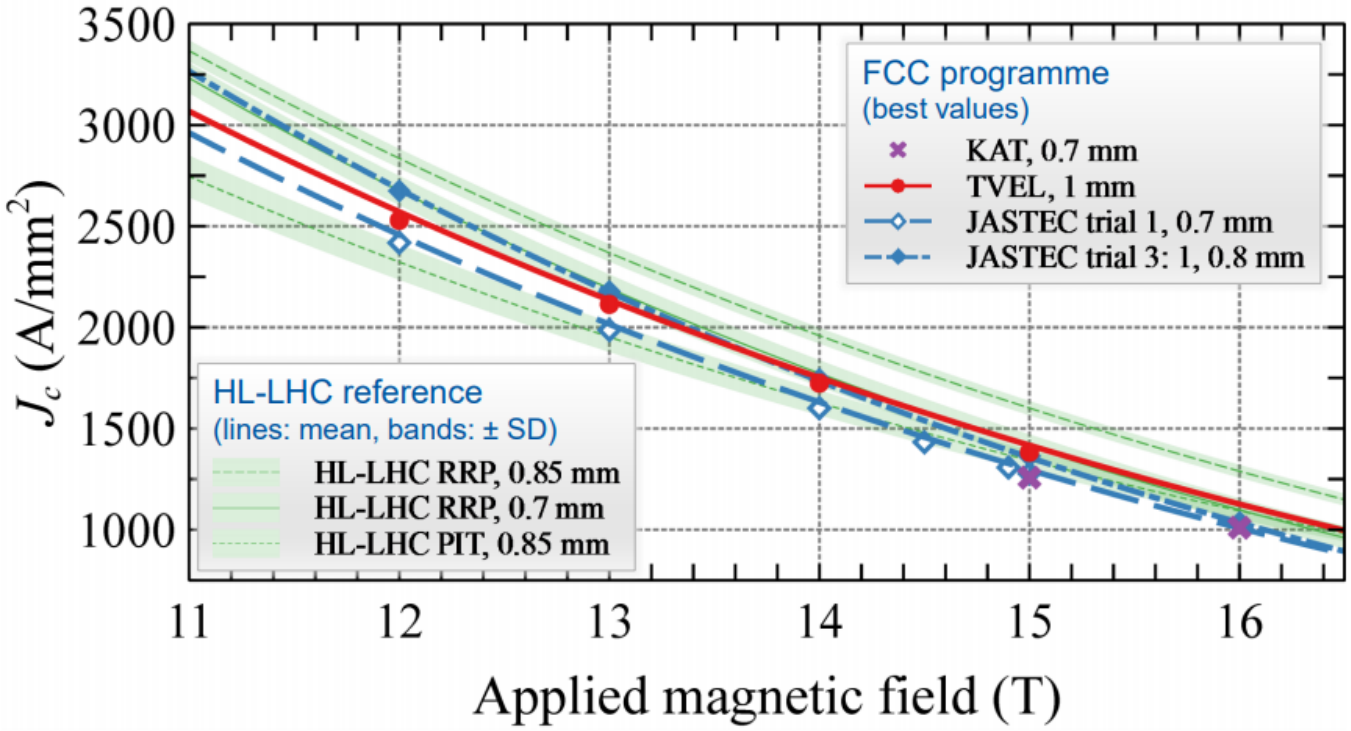
recent US wires with Artificial Pinning Centres "APCs" have reached FCC target J_c (50% above HL-LHC wire) …

X. Xu et al.



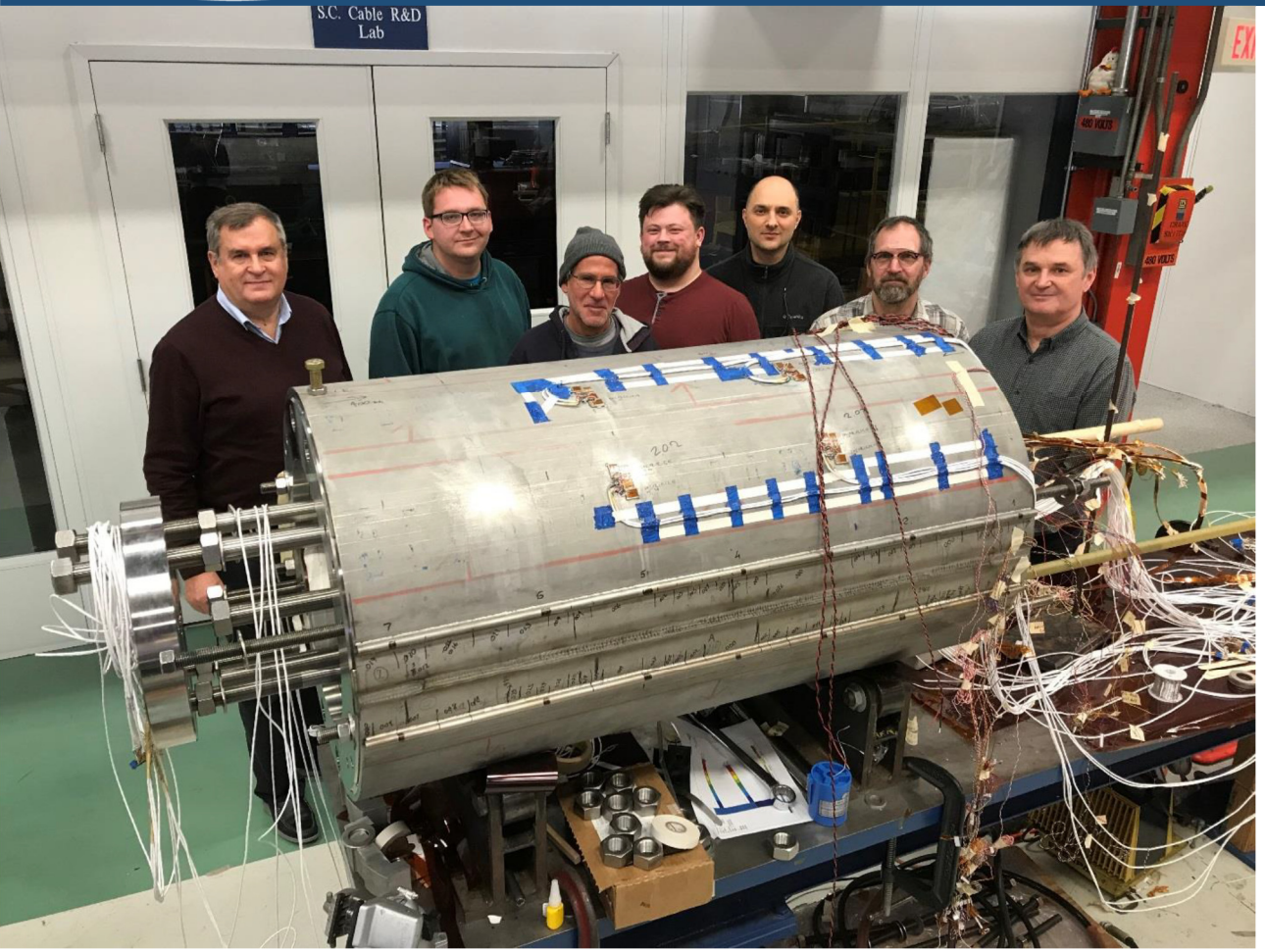
… and after less than one year, new suppliers from Japan, Korea and Russia already achieve HL-LHC specification

- high B_{c2} (28.8 T at 4.2 K)

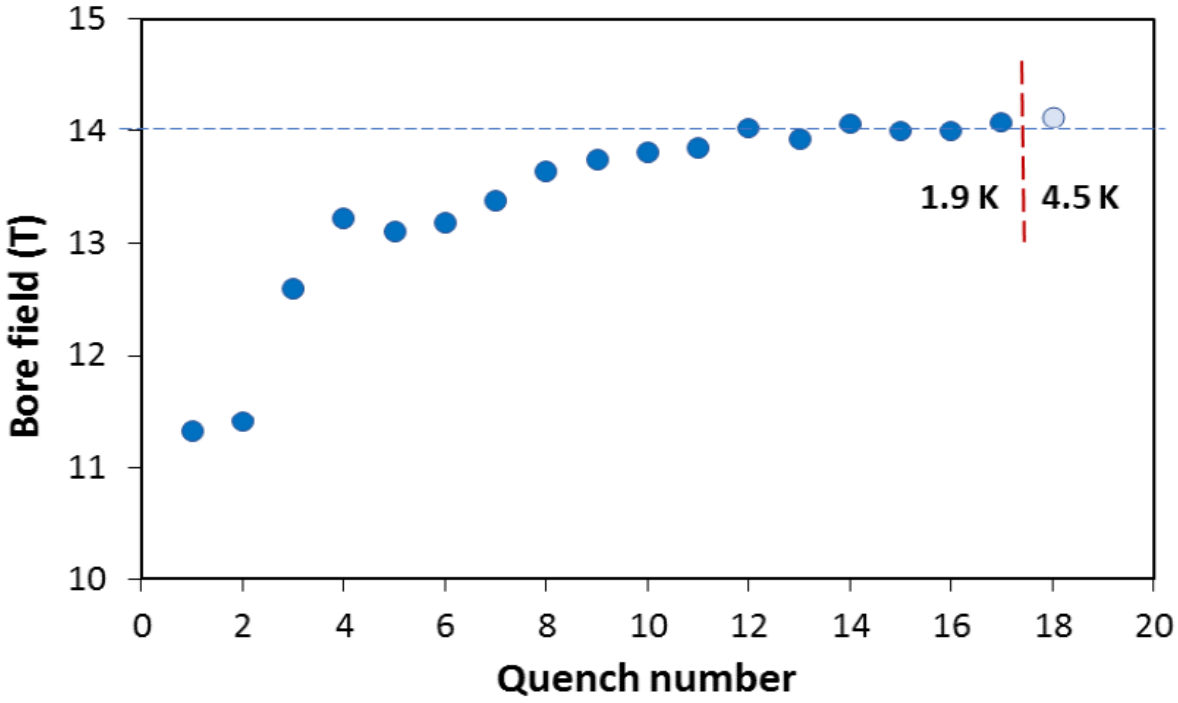


FNAL, Hyper Tech Research Inc., and Ohio State, X. Xu et. al., https://arxiv.org/abs/1903.08121 ;
NHMFL, FAMU/FSU: S. Balachandran et al. https://arxiv.org/ftp/arxiv/papers/1811/1811.08867.pdf

14 T accelerator dipole at FNAL !



→ A. Zlobin et al., NAPAC2019, MOPL020



- 15 T dipole demonstrator
- staged approach: in first step pre-stressed for 14 T
- second test in fall 2019 with additional pre-stress for 15 T

60-mm aperture
4-layer graded coil

Physical Review Accelerators & Beams

Robert H. Siemann

Founding Editor of PR(ST-)AB, 1997-2007

2019 Robert H. Siemann Award conveyed to Stan Schriber

Martin Blume

APS Editor-in-Chief, 1997-2007

understood the connection between accelerator science and technology;

departing from Physical Review tradition, willing to champion a journal covering the full spectrum of accelerator science and technology

Gene D. Sprouse

APS Editor-in-Chief, 2007-2015

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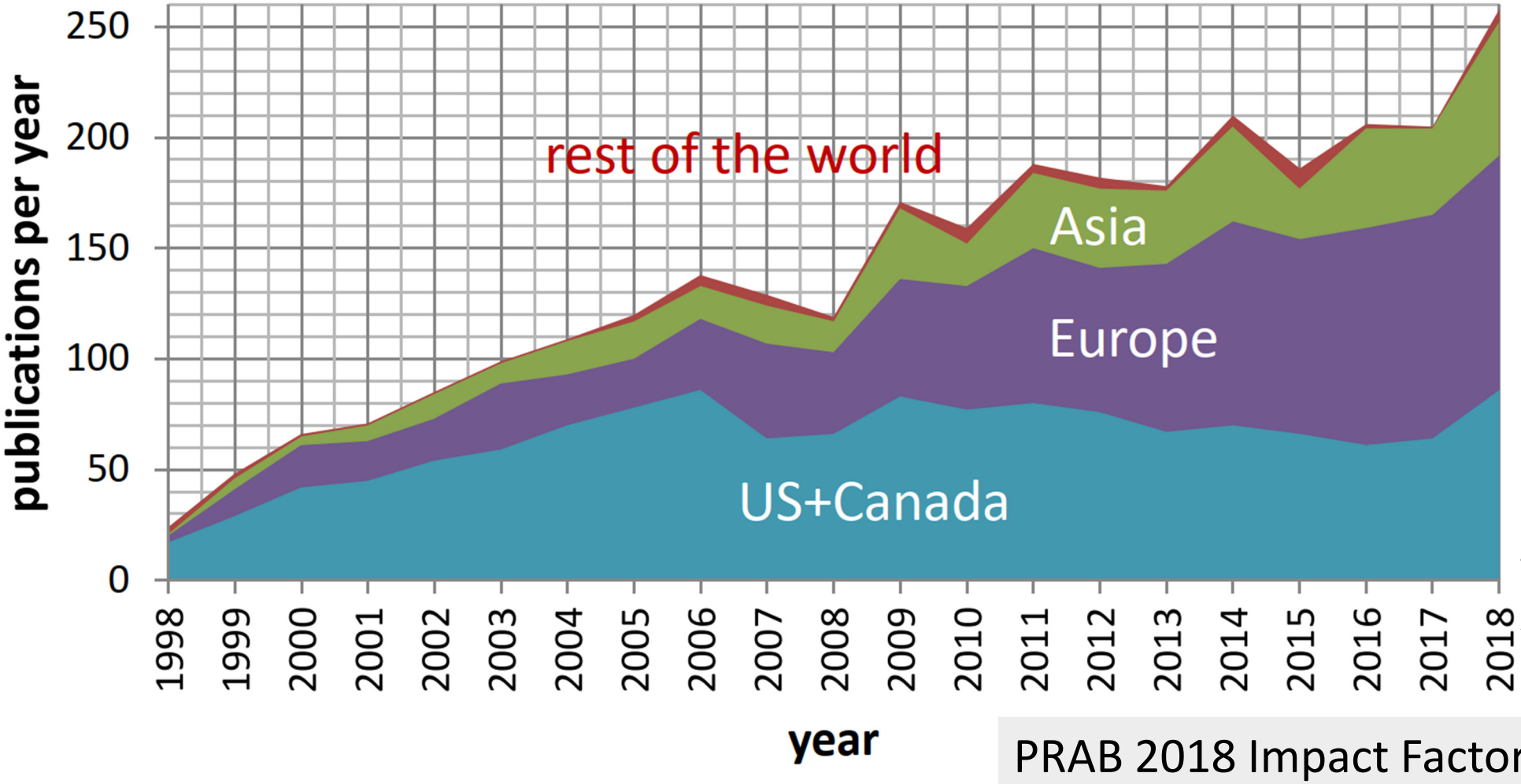
for more than a decade PRAB was the ***fastest growing APS journal***; in parallel PRAB became ever more ***international***



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IFIC INSTITUT DE FÍSICA CORPUSCULAR

INFN Istituto Nazionale di Fisica Nucleare Laboratori Nazionali di Frascati

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recent PRAB Prize Articles

Anton Piwinski, James D. Bjorken and Sekazi K. Mtingwa, "***Wilson Prize article: Reflections on our experiences with developing the theory of intrabeam scattering***," Phys. Rev. Accel. Beams 21, 114801 (2018); 10.1103/PhysRevAccelBeams.21.114801

Vladimir Shiltsev, "***Nishikawa Prize article: Electron lenses, Tevatron, and selected topics in accelerators***," Phys. Rev. Accel. Beams 22, 074801 (2018) ; 10.1103/PhysRevAccelBeams.22.074801

APS breakfast tutorial for authors & referees

Friday, September 6, 2019, 7:00-8:30 am

Lansing Center, Room 201

thank you all &
see some of you tomorrow morning !

Serena Dalena,
Physical Review Letters,
Associate Editor,
in charge of accelerators

Debbie Brodbar, Wolfram Fischer, and I will also be there