



UNIVERSITÉ
DE GENÈVE



FCC Kick-Off 2014

FCC Kick-Off

“Wrap Up”



Michael Benedikt,
Frank Zimmermann

Future Circular Collider Study
Kick-off Meeting

12-15 February 2014,
University of Geneva,
Switzerland

LOCAL ORGANIZING COMMITTEE
University of Geneva
C. Blanchard, A. Blondel,
C. Doglioni, G. Iacobucci,
M. Koratzinos

CERN
M. Benedikt, E. Delucinge,
J. Gutleber, D. Hudson,
C. Potter, F. Zimmermann

SCIENTIFIC ORGANIZING COMMITTEE
FCC Coordination Group
A. Ball, M. Benedikt, A. Blondel,
F. Bordry, L. Bottura, O. Brüning,
P. Collier, J. Ellis, F. Gianotti,
B. Goddard, P. Janot, E. Jensen,
J. M. Jimenez, M. Klein, P. Lebrun,
M. Mangano, D. Schulte,
F. Sonnemann, L. Tavian,
J. Wenninger, F. Zimmermann



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



Future Circular Collider Study
Michael Benedikt
FCC Kick-Off 2014

FCC Kick-off goals

Following ESU in May 2013, creation of a small preparation group in autumn 2013 to prepare on a short time scale:

- preliminary draft baseline parameter sets for studies
- a possible work breakdown structure and study organisation
- an international kick-off meeting (now!)

Common agreement that we have achieved these goals

Kick-off event should start process of internat. collaboration

- presenting preparatory work as basis for discussion
→ **draft parameter sets & WBS documents available**
- inviting feedback and suggestions
- working towards formation of a

global design study collaboration integrating all aspects of machines, physics and detectors

Reflected in kick-off meeting programme.

General observations (i)

- There is a very broad spectrum of work in all areas physics, experiments, machines and infrastructures to be addressed within FCC
 - Many challenges in front us that can only be addressed in a wide collaboration using all expertise available
- Very positive signs from Kick-off participants towards working together on the FCC study.

General observations (ii)

- Particular attention from the beginning should be given to “global” aspects related to the overall dimension of FCC with potentially enormous impact on operation and cost:
 - Safety, operation, maintenance, overall availability
 - Energy optimisation, overall infrastructure optimisation
 - Identification of transitions in technology, cost
 - Industrialisation aspects, high multiplicity of elements
 - Scalability of solutions, assumptions vs. real parameters
 - Political acceptance and societal acceptance
 - Drive forward technologies with such a project
- **Keep this in mind and take appropriate steering when starting detailed design work!**



15 TESLA

thou shall not pass

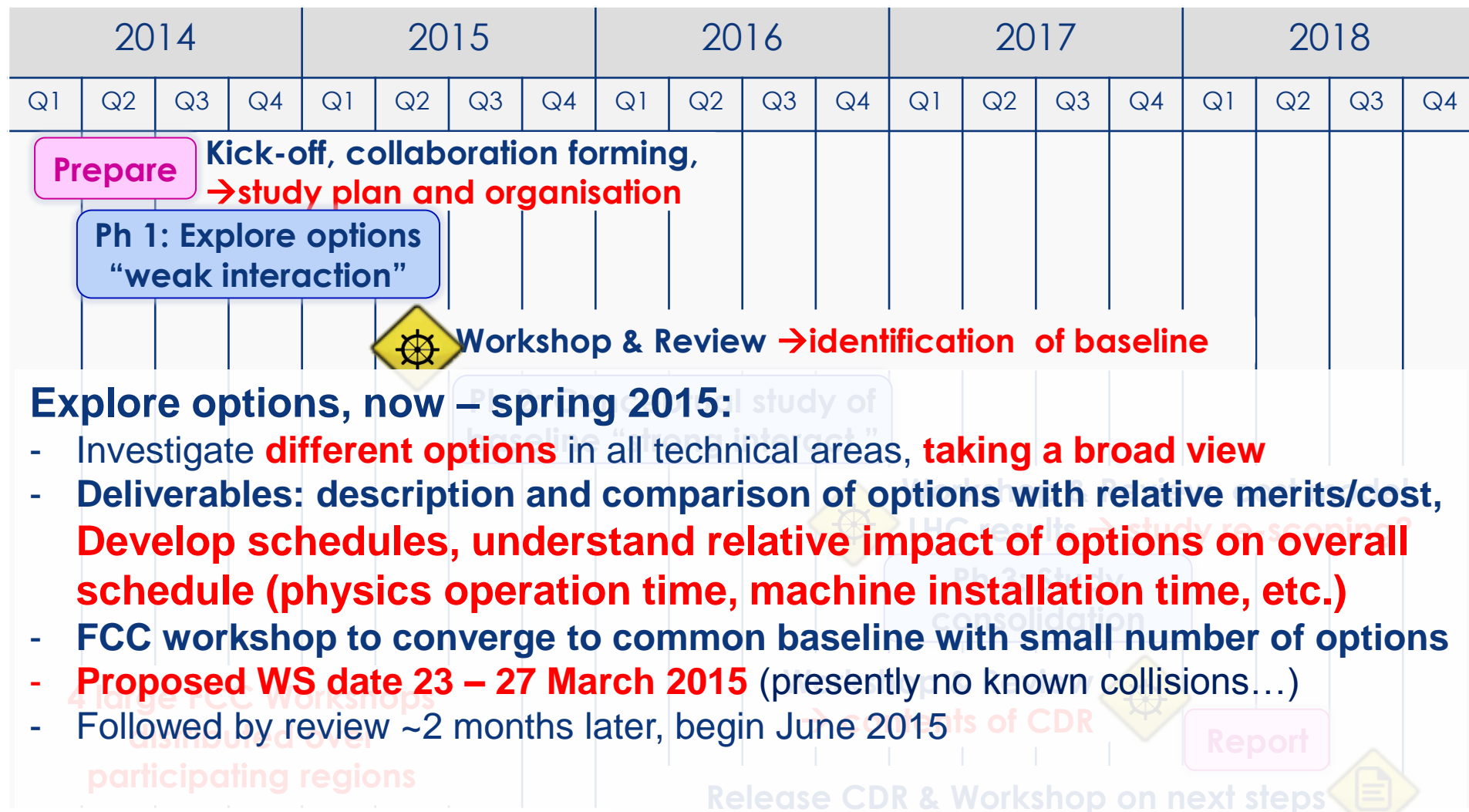


100-MW RF system at different beam energies and intensities

Erk Jensen/CERN

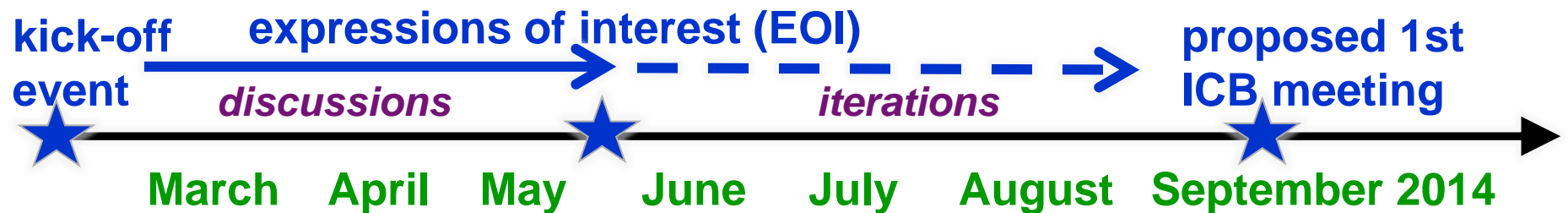
Many thanks to: A. Butterworth, O. Brunner, R. Calaga, S. Claudet, R. Garoby, F. Gerigk, P. Lebrun, E. Montesinos, D. Schulte, E. Shaposhnikova, I. Syrathev, M. Vretenar

FCC work plan study phase 1



Next steps (i)

- **Establish an international collaboration:**
- Following very positive reactions and the enthusiasm during the Kick-off meeting:
 - **Formal invitations to institutes to join collaboration**
 - Aiming at **expressions of interest by end May** to form nucleus of collaboration by September
 - Enlargement of the preparation team
 - **First international collaboration board meeting 8-10 September**



Next steps (ii)

- **Keep momentum of the meeting** and continue discussions and work started in break-out sessions
- **Start common work on informal basis for:**
 - Further identification of design drivers and work topics
 - Refinement of work topics according to interest and resources of all partners
 - Development of a work plan for exploratory phase 1

FCC EU Design Study (DS) Proposal



Horizon2020 call – design study, **deadline 02.09.2014**

Prepare proposal parallel to FCC collaboration setup

Goals fo EU DS: conceptual design, prototypes, cost estimates, ...

From FP7 HiLumi LHC DS → positive experience:

- **5-6 work packages as sub-set of FCC study**
- **~10-15 beneficiaries** (signatories of the contract with EC)

Time line



Non-EU partners can join as beneficiary – signatory with or w/o EC contribution (contractual commitment) **or as associated partner – non-signatory** (in-kind contribution with own funding, no contractual commitment)

Conclusions

- **Thanks to all contributors for the excellent quality of presentations and the work already invested!**
- **Thanks to all of you for your participation, the constructive discussions and the extremely positive and enthusiastic atmosphere that you brought to this meeting.**
- **Looking forward to global collaboration with you and to meeting all together again at the first FCC collaboration workshop March 2015.**

*historical path to 100 TeV collider ...
and plenty of studies to learn from*



Mountain Path in Spring by Ma Yuan (馬遠)
Late Sung Dynasty

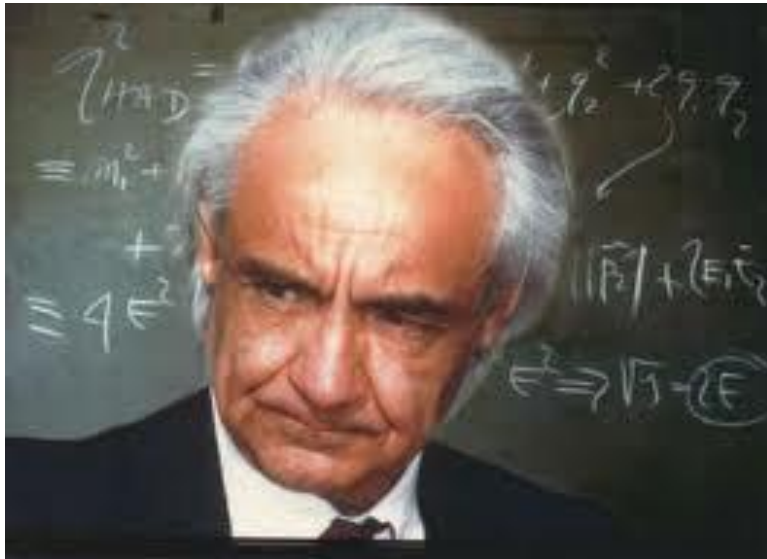
historical studies in Europe

Eloisatron = *Eurasiatic Long Intersecting Storage Accelerator*

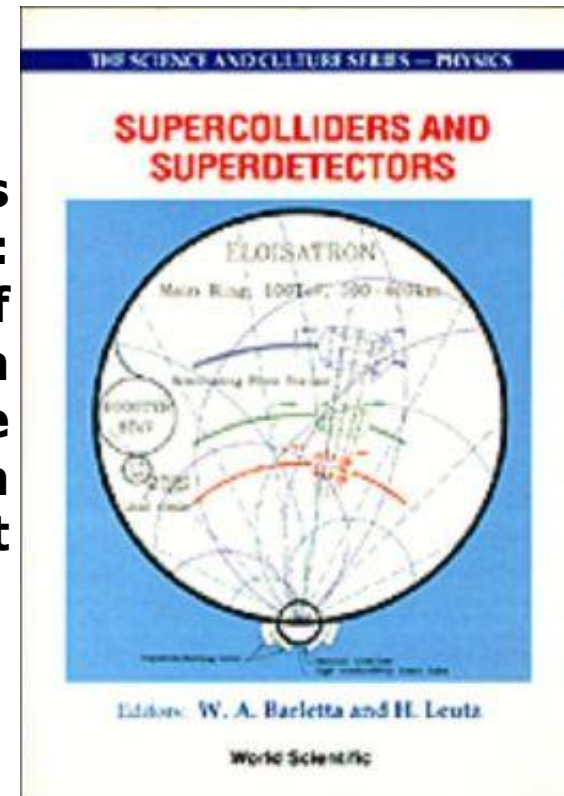
proposed by Antonino Zichichi

c.m. energy 200 TeV, circumference 300 km, 13.5 T magnets,
fitting inside Sicily

INFN study started in 1979, still ongoing

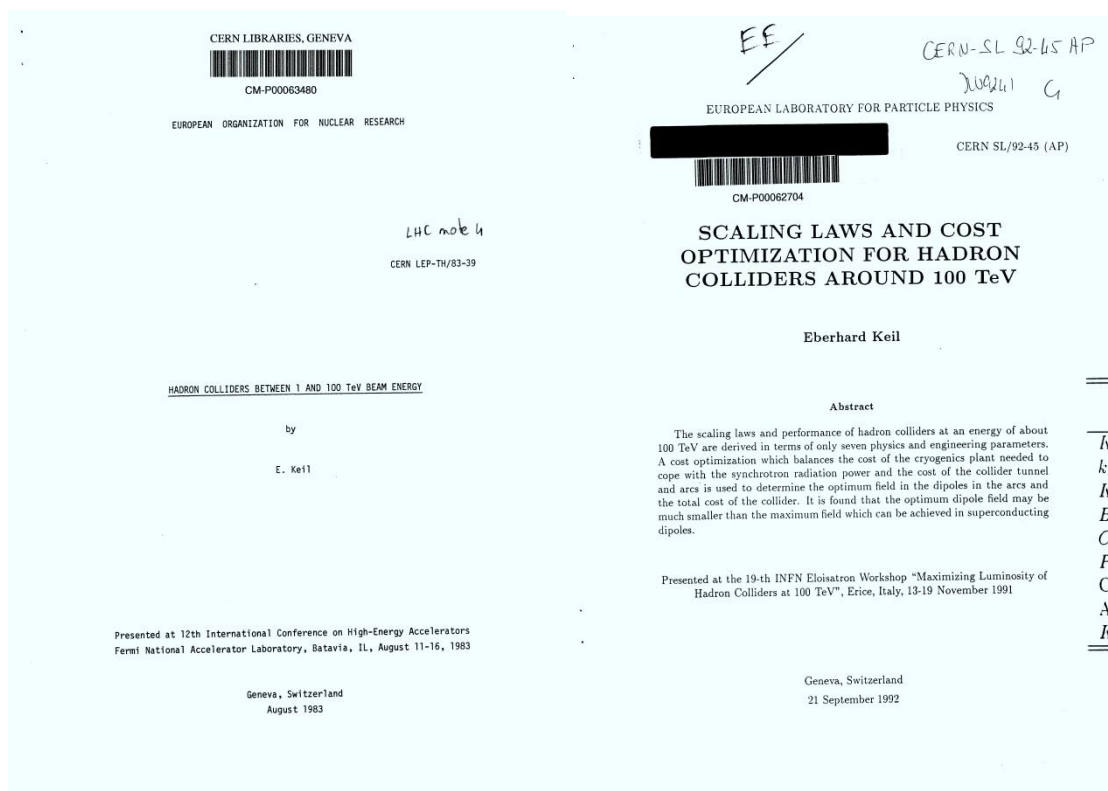


**Supercolliders
Superdetectors:
Proceedings of
the 19th and 25th
Workshops of the
INFN Eloisatron
Project**



historical studies at CERN

Eberhard Keil, “**Hadron colliders between 1 and 100 TeV beam energy,**” CERN-LEP-TH-83-39 ; LHC-NOTE-4 ; CERN-LHC-Note-4. - **1983, “Scaling laws and cost optimization for hadron colliders around 100 TeV,”** **19th** INFN Eloisatron Project **Workshop** : Maximizing luminosity of hadron colliders at 100 TeV, Erice, Italy, 13 - 19 Nov **1991**



optimized parameters & cost

Table 2: Optimum Parameters for a 100 TeV Collider

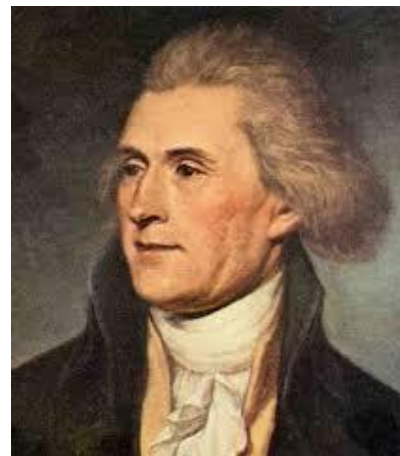
	High-Field Model Cost Optimized		High-Field Model With $B = 10$ T		Low-Field Model Cost Optimized		
K_s	0.5	2.0	0.5	2.0	0.5	2.0	Msfr@1kW
k_s	1.0	0.7	1.0	0.7	1.0	0.7	
K_e	100	100	7	7	7	7	Msfr/km
B	12.4	44.5	10.0	10.0	3.3	9.3	T
C	222	61	274	274	838	294	km
P_s	22.2	79.9	18.0	18.0	5.9	16.7	MW
Cryogenics	22.2	8.8	18.0	3.1	5.9	2.9	Gsfr
Arcs	22.2	6.1	27.4	27.4	5.9	2.1	Gsfr
$K - K_0$	44.3	14.9	45.3	30.5	11.7	5.0	Gsfr

historical studies in the US

Report of the **20 TeV Hadron Collider Technical Workshop:**

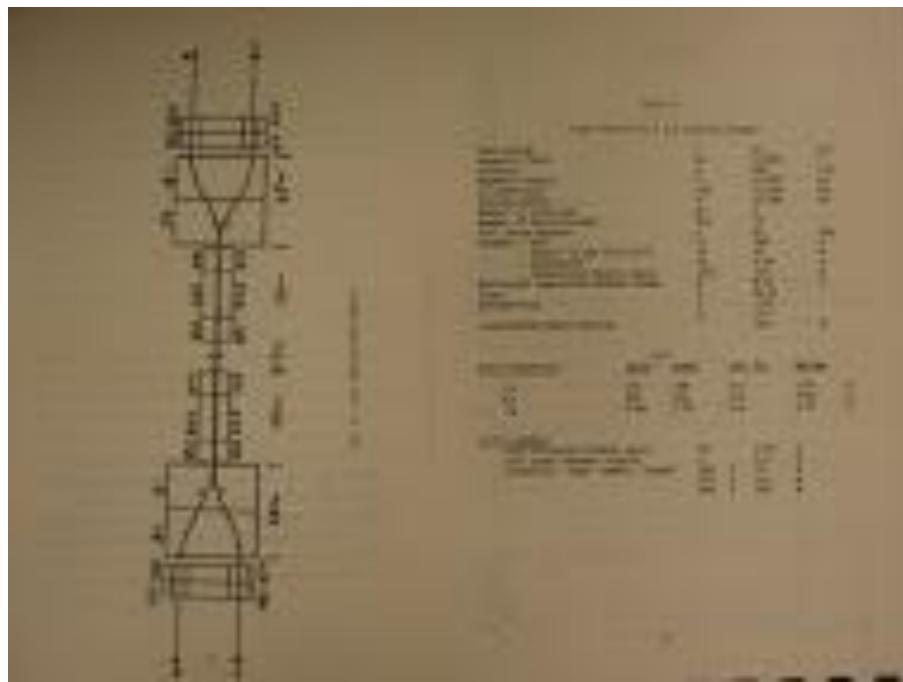
Held at Cornell University, March 28-April 2, **1983**, Cornell University
Floyd R. Newman Laboratory of Nuclear Studies, Cornell University

At Cornell these proceedings are stored in
the **Library Section of „historically valuable
manuscripts“ together with an original
manuscript of Thomas Jefferson !**



→ access requires application,
identification, ...
**x-ray security scans,... & copies
strictly forbidden!**

Cornell colleagues Ralf Eichhorn
& Stephen Markham kindly took
and sent some photos of these
proceedings ...



SSC design

C.T. Murphy
SSC-SR-2020

thanks to Swapan Chattopadhyay

Conceptual Design of the Superconducting Super Collider

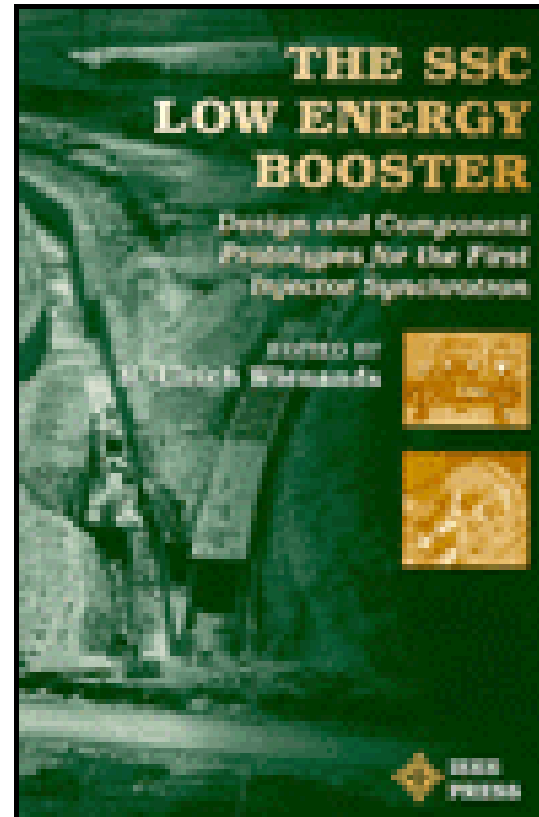
SSC Central Design Group*

March 1986

SSC CDR 1986

*Operated by Universities Research Association under contract with the U.S. Department of Energy

H. Ulrich Wienands, **The SSC Low Energy Booster: Design and Component Prototypes for the First Injector Synchrotron**, IEEE Press, 01.01.1997



historical plan for an "SSC" in Japan,
Ibaraki prefecture (F. Takasaki,
private communication)

VLHC design 2001

Design Study for a Staged Very Large Hadron Collider

VLHC Design Study Group Collaboration
June 2001. 271 pp.

SLAC-R-591, SLAC-R-0591, SLAC-591,
SLAC-0591, FERMILAB-TM-2149

<http://www.vlhc.org/>

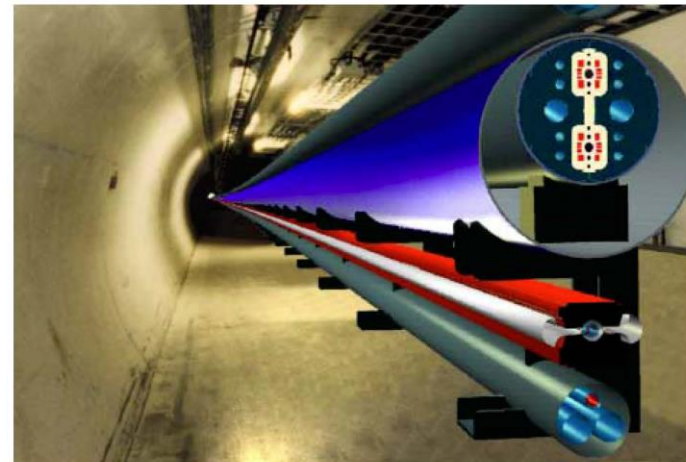


Fermilab-TM-2149

June 4, 2001

Design Study for a Staged Very Large Hadron Collider

*Report by the collaborators of
The VLHC Design Study Group:*
Brookhaven National Laboratory
Fermi National Accelerator Laboratory
Laboratory of Nuclear Studies, Cornell University
Lawrence Berkeley National Laboratory
Stanford Linear Accelerator Center



HE-LHC study & Malta workshop 2010

CERN-2011-003
EuCARD-Conf-2011-001
8 April 2011

ORGANISATION EUROPÉENNE POUR LA RECHERCHE NUCLÉAIRE
CERN EUROPEAN ORGANIZATION FOR NUCLEAR RESEARCH

EuCARD-AccNet-EuroLumi Workshop
The High-Energy Large Hadron Collider

Villa Bighi, Malta, 14–16 October 2010

Proceedings
Editors: E. Todesco
F. Zimmermann

GENEVA
2011

EuCARD-AccNet-EuroLumi Workshop: The High-Energy Large Hadron Collider - HE-LHC10
HE-LHC 10, E. Todesco and F. Zimmermann, (eds.), EuCARD-CON-2011-001; arXiv:1111.7188; CERN-2011-003 (2011)



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12-15.02.2014



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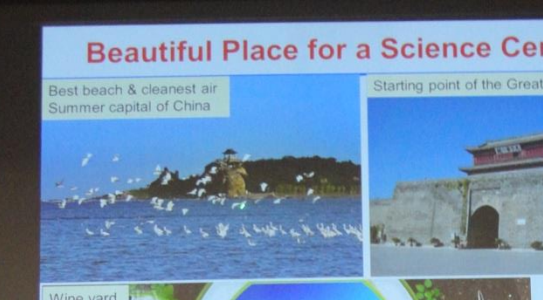


[http://indico.cern.ch/
e/fcc-kickoff](http://indico.cern.ch/e/fcc-kickoff)



momentum correction similar to SuperKEKB,
momentum acceptance will be similar, about $\pm 1.4\%$.

"Bière de l'amitié"



FCC-ee



FCC-hh



Power Limitation

- Synchrotron radiation
- Beam power given by RF
- Limits the total beam current I

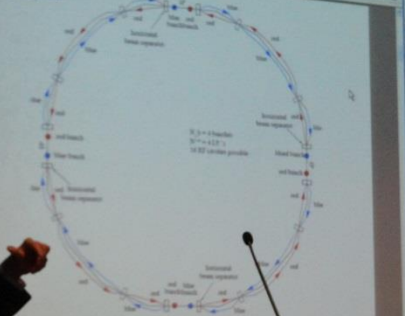
$$U_s = \frac{4\pi}{3} r_e mc^2 \gamma^4$$

$$P_b = U_s I / e$$

For example, $E_0=120$ GeV, $p=2.6$ km, $U_s=6.97$ GeV, $I=7.2$ mA, lead to $P_b=50$ MW in our design.

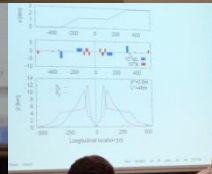
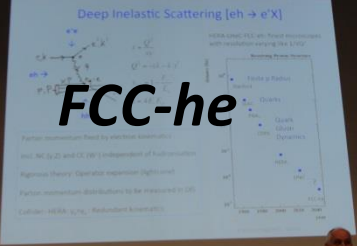
Yusuf Iqbal, DESY, Hamburg, September 2015

Ring Layout

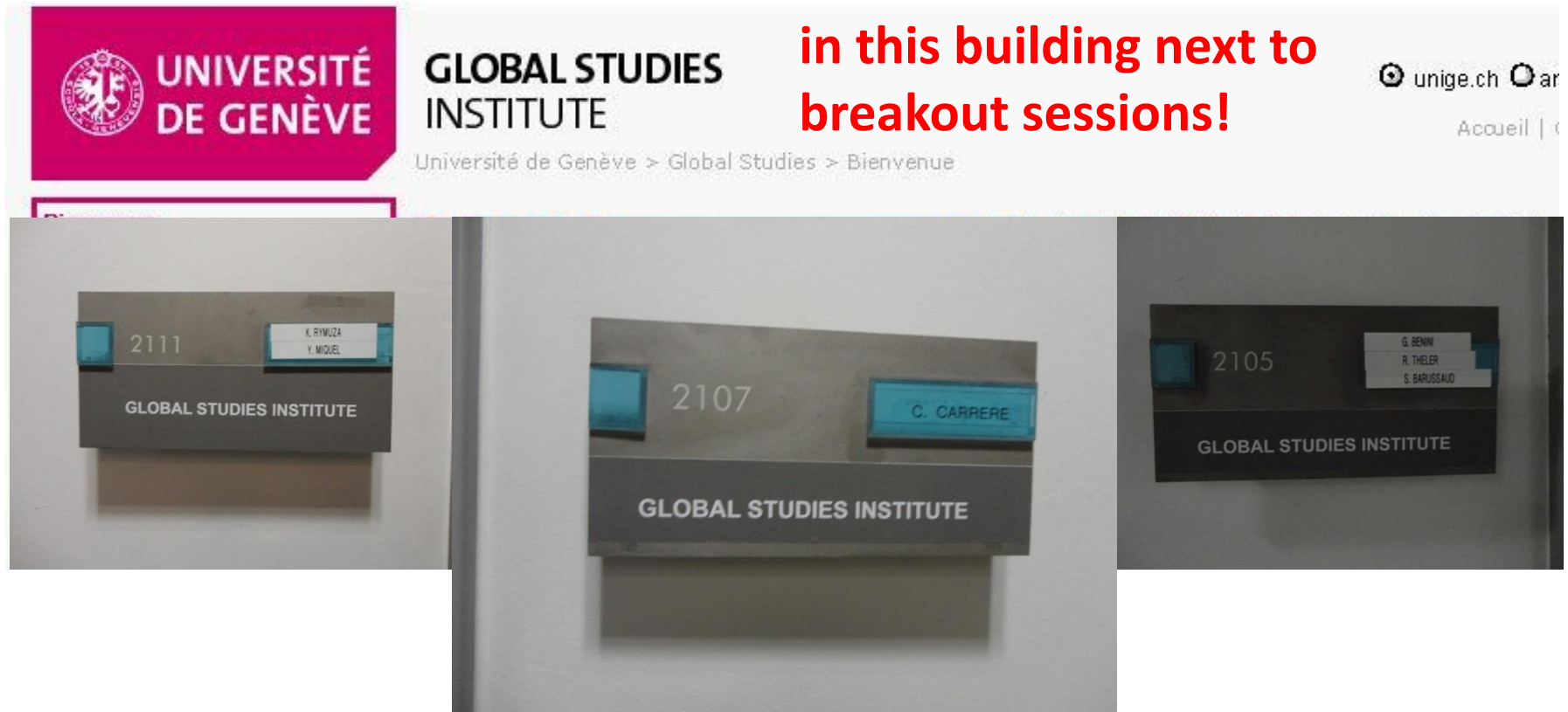


Deep Inelastic Scattering [eh → e'X]

FCC-he



FCC will be a global study



we started at the right place!

“Need to have **excellent communication and outreach** accompanying the study”



J. Womersley

Riesiger Teilch
Nachfolger

キーワードを入力



NEWS | REAL ES
JAPAN

トップ 速報 写真 映像 雑誌 個人 Buzz 意識調査 ランキング

国内 国際 経済 エンタメ スポーツ **IT・科学** ライフ 地域

[PR] あなたのホームページを、もっとビジネスに活かし

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CERN、大型円形加速器の建設を検討 出力はLHCの7倍

A F P = 時事 2月9日(日)18時4分配信



【AFP＝時事】欧州合同原子核研究所（European Organisation for Nuclear Research、CERN）は6日、「神の粒子」とも呼ばれる有名なヒッグス粒子（Higgs Boson）を発見した装置の7倍の出力を持つ粒子衝突型円形加速器の建設を視野に入れていると発表した。

【図解】宇宙創生と粒子衝突型円形加速器

■衝突エネルギーは100兆電子ボルト前後に

FCCはおそらくLHCと同じ区域内に設置される
込まれるかもしれない、とCERNは声明で述べ

overhaul.
lig
und gr
nötige

Sciences

SCIENCES Vidéos Archéologie Biologie Cosmos Géologie Mathématiques Médecine

Discussions sur un nouvel
accélérateur de particules géant

Sport Property
Freitag, 14. Februar 2014
HLER, GÜNTHER NONNENMACHER, FRANZ
Frankfurter Allgemeine Wissen
THEMEN BLOGS ARCHIV MEIN FAZ.1
Sport Lebensstil Technik & Motor
ssport Skisport Zeitplan Ergebnisse

great interest & fascination around the world!

the physics case is obvious

* Tuning probe $\propto E_{\text{cm}}^2$

* Higgs + nothing else @ 100 TeV

$\Rightarrow \sim 10^{-4}$ tuning!

* Never seen this level of tuning
in particle physics.

* Qualitatively new, mortal blow to
naturalness



design for success!

Schematic of an
80 - 100 km
long tunnel

J. Womersley