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TLEP - The Machine

Frank Zimmermann

LAL Orsay, 22 March 2013

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special thanks to Philip Bambade & Patrick Janot

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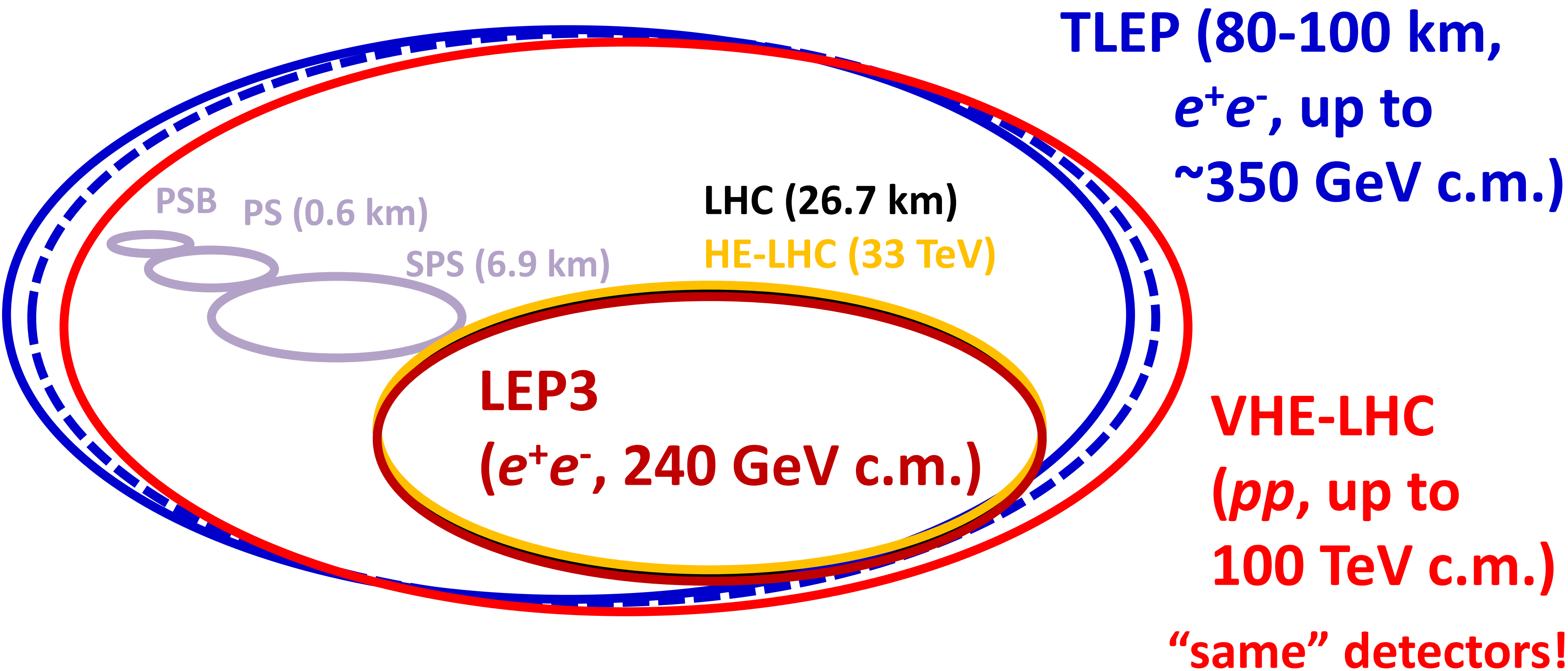
circular Higgs factories at CERN & beyond



& $e^\pm$ **(120 GeV) – *p* (7, 16 & 50 TeV)** collisions (**[(V)HE-]TLHeC**)

≥50 years of e^+e^-, *pp*, *ep/A* physics at highest energies

a long-term strategy for HEP!

circular e^+e^- Higgs factories LEP3 & TLEP

option 1: installation in the LHC tunnel "LEP3"

+ inexpensive (<0.1xLC)
+ tunnel exists
+ reusing ATLAS and CMS detectors
+ reusing LHC cryoplants
- interference with LHC and HL-LHC

option 2: in new 80-km tunnel "TLEP"

+ higher energy reach, 5-10x higher luminosity
+ decoupled from LHC/HL-LHC operation & construction
+ tunnel can later serve for VHE-LHC (factor 3 in energy from tunnel alone)
- more expensive (?)

LEP3, TLEP

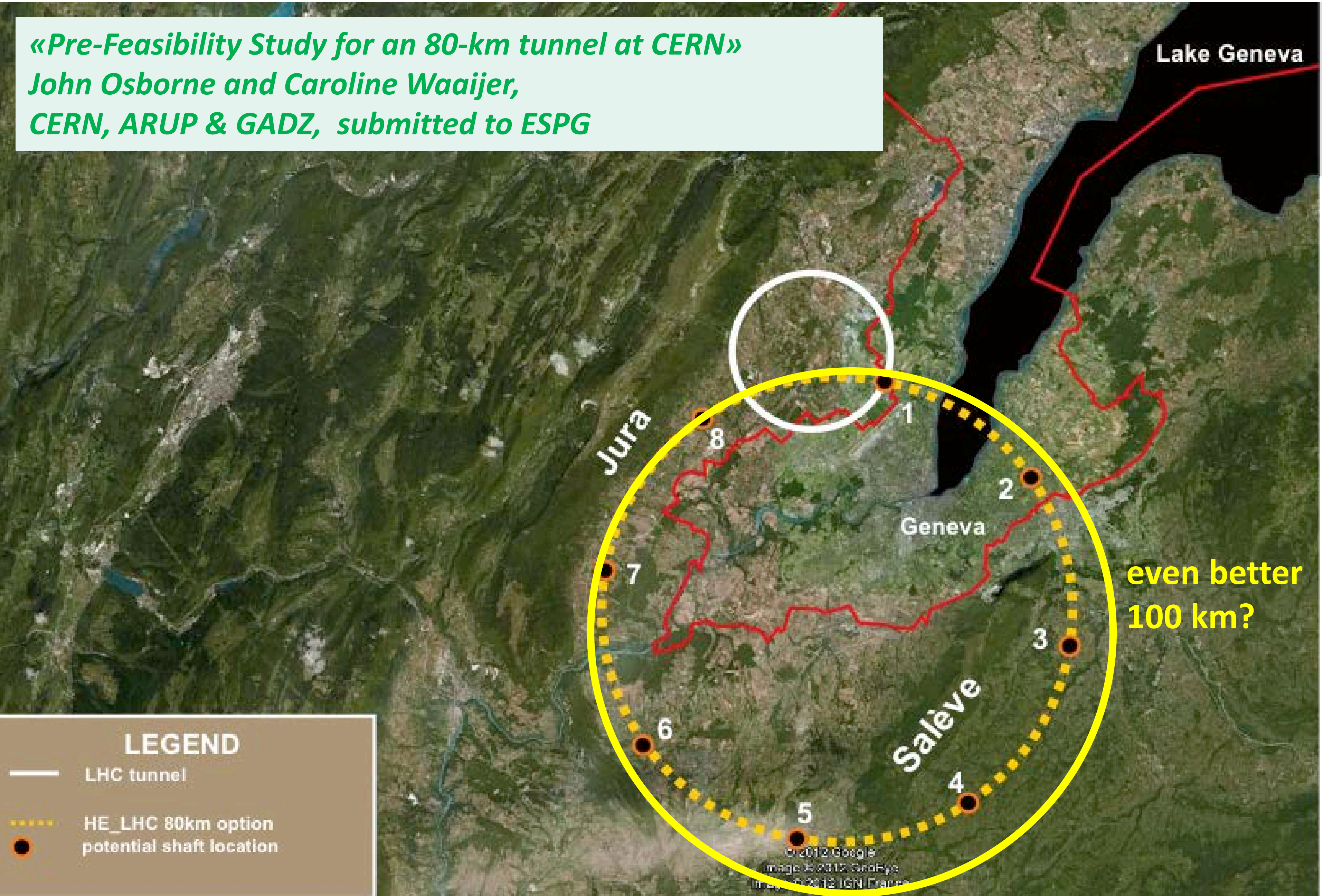
key parameters

	LEP3	TLEP
circumference	26.7 km	80 km
max beam energy	120 GeV	175 GeV
max no. of IPs	4	4
luminosity at 350 GeV c.m.	-	0.7×10^{34} cm^{-2}s^{-1}
luminosity at 240 GeV c.m.	10^{34} cm^{-2}s^{-1}	5×10^{34} cm^{-2}s^{-1}
luminosity at 160 GeV c.m.	5×10^{34} cm^{-2}s^{-1}	2.5×10^{35} cm^{-2}s^{-1}
luminosity at 90 GeV c.m.	2×10^{35} cm^{-2}s^{-1}	10^{36} cm^{-2}s^{-1}

at the Z pole repeating LEP physics programme in a few minutes…!

80-km tunnel in Geneva area – “best” option

«Pre-Feasibility Study for an 80-km tunnel at CERN»
John Osborne and Caroline Waaijer,
CERN, ARUP & GADZ, submitted to ESPG



80-km Tunnel Cost Estimate (preliminary)

- Costs
  - Only the **minimum civil requirements** (tunnel, shafts and caverns) are included
  - 5.5% for external expert assistance (underground works only)
- Excluded from costing
  - Other services like cooling/ventilation/ electricity etc
  - service caverns
  - beam dumps
  - radiological protection
  - Surface structures
  - Access roads
  - In-house engineering etc etc

CE works	Costs [BCHF]
Underground	
Main tunnel (5.6m)	
Bypass tunnel & inclined tunnel access	
Dewatering tunnel	
Small caverns	
Detector caverns	
Shafts (9m)	
Shafts (18m)	
Consultancy (5.5%)	
TOTAL	~3.1?(unofficial)

- **Cost uncertainty = 50% (→raw tunnel cost could be 4.5 BCHF)**
- Next stage should include costing based on technical drawings

luminosity formulae & constraints

$$L = \frac{f_{rev} n_b N_b^2}{4\pi\sigma_x\sigma_y} = (f_{rev} n_b N_b)\left(\frac{N_b}{\varepsilon_x}\right)\frac{1}{4\pi}\frac{1}{\sqrt{\beta_x\beta_y}}\frac{1}{\sqrt{\varepsilon_y/\varepsilon_x}}$$

$$(f_{rev} n_b N_b) = \frac{P_{SR}\,\rho}{8.8575\times10^{-5}\,\frac{\mathrm{m}}{\mathrm{GeV}^{-3}}\,E^4}$$ *SR radiation power limit*

$$\frac{N_b}{\varepsilon_x} = \frac{\xi_x 2\pi\gamma(1+\kappa_\sigma)}{r_e}$$ *beam-beam limit*

$$\frac{N_b}{\sigma_x\sigma_z}\frac{30\,\gamma r_e^2}{\delta_{acc}\,\alpha} < 1$$ *>30 min beamstrahlung lifetime (Telnov) → N_b, β_x*

→minimize $\kappa_\varepsilon=\varepsilon_y/\varepsilon_x$, $\beta_y \sim \beta_x(\varepsilon_y/\varepsilon_x)$ and respect $\beta_y \approx \sigma_z$

LEP3/TLEP parameters -1

soon at SuperKEKB: β_x^*=0.03 m, β_y^*=0.03 cm

	LEP2	LHeC	LEP3	TLEP-Z	TLEP-H	TLEP-t
beam energy E_b [GeV]	104.5	60	120	45.5	120	175
circumference [km]	26.7	26.7	26.7	80	80	80
beam current [mA]	4	100	7.2	1180	24.3	5.4
#bunches/beam	4	2808	4	2625	80	12
#e−/beam [10^{12}]	2.3	56	4.0	2000	40.5	9.0
horizontal emittance [nm]	48	5	25	30.8	9.4	20
vertical emittance [nm]	0.25	2.5	0.10	0.15	0.05	0.1
bending radius [km]	3.1	2.6	2.6	9.0	9.0	9.0
partition number J_ε	1.1	1.5	1.5	1.0	1.0	1.0
momentum comp. α_c [10^{-5}]	18.5	8.1	8.1	9.0	1.0	1.0
SR power/beam [MW]	11	44	50	50	50	50
β^*_x [m]	1.5	0.18	0.2	0.2	0.2	0.2
β^*_y [cm]	5	10	0.1	0.1	0.1	0.1
σ^*_x [µm]	270	30	71	78	43	63
σ^*_y [µm]	3.5	16	0.32	0.39	0.22	0.32
hourglass F_{hg}	0.98	0.99	0.59	0.71	0.75	0.65
ΔE^{SR}_{loss}/turn [GeV]	3.41	0.44	6.99	0.04	2.1	9.3

SuperKEKB: $\varepsilon_y/\varepsilon_x$=0.25%

even with 1/5 SR power (10 MW) still > L_{ILC}!

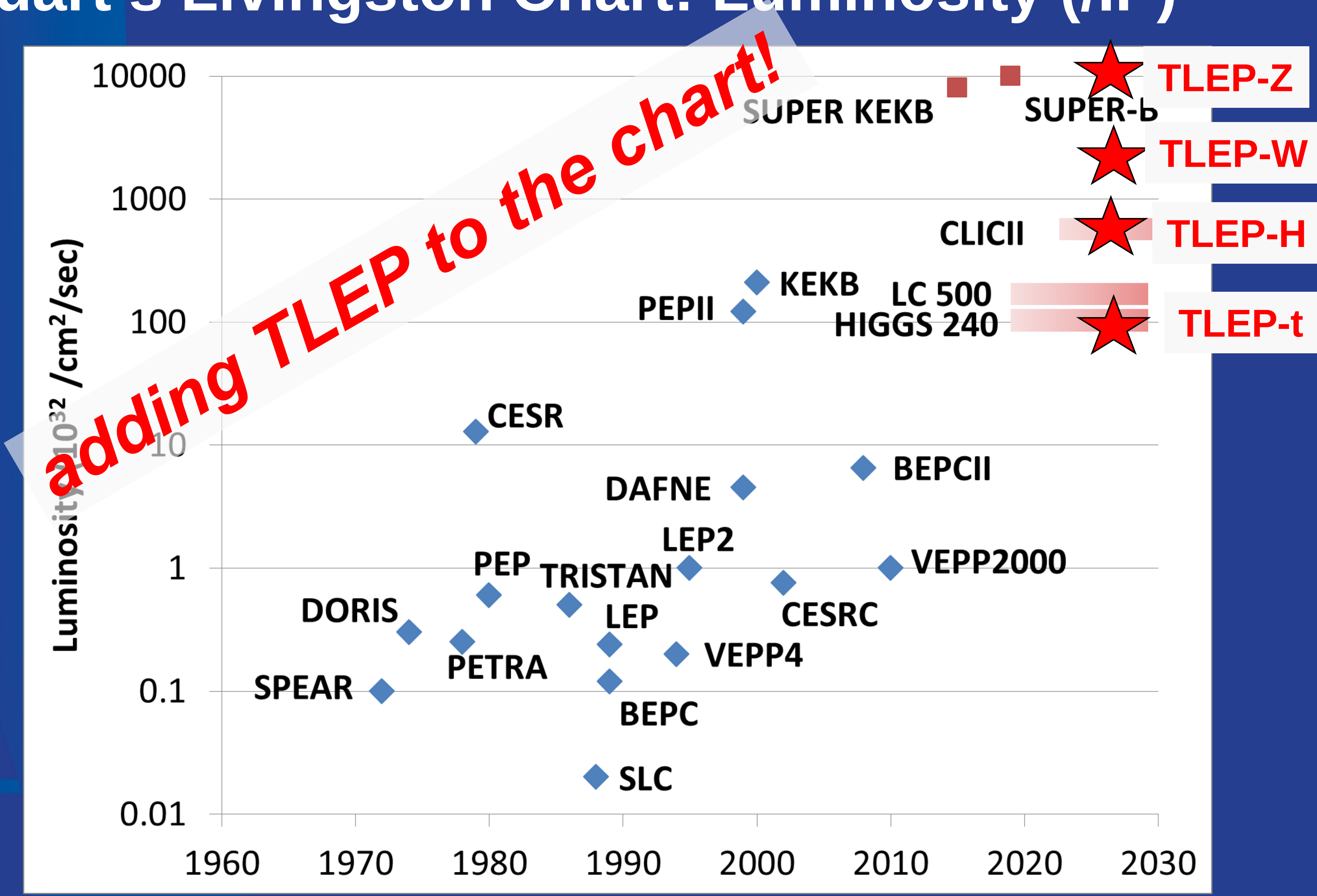
LEP3/TLEP parameters -2

LEP2 was not beam-beam limited

	LEP2	LHeC	LEP3	TLEP-Z	TLEP-H	TLEP-t
$V_{RF,tot}$ [GV]	3.64	0.5	12.0	2.0	6.0	12.0
$\delta_{max,RF}$ [%]	0.77	0.66	5.7	4.0	9.4	4.9
ξ_x/IP	0.025	N/A	0.09	0.12	0.10	0.05
ξ_y/IP	0.065	N/A	0.08	0.12	0.10	0.05
f_s [kHz]	1.6	0.65	2.19	1.29	0.44	0.43
E_{acc} [MV/m]	7.5	11.9	20	20	20	20
eff. RF length [m]	485	42	600	100	300	600
f_{RF} [MHz]	352	721	700	700	700	700
δ^{SR}_{rms} [%]	0.22	0.12	0.23	0.06	0.15	0.22
$\sigma^{SR}_{z,rms}$ [cm]	1.61	0.69	0.31	0.19	0.17	0.25
L/IP[10^{32}cm^{-2}s^{-1}]	1.25	N/A	94	10335	490	65
number of IPs	4	1	2	2	2	2
Rad.Bhabha b.lifetime [min]	360	N/A	18	37	16	27
Υ_{BS} [10^{-4}]	0.2	0.05	9	4	15	15
n_γ/collision	0.08	0.16	0.60	0.41	0.50	0.51
$\Delta\delta^{BS}$/collision [MeV]	0.1	0.02	31	3.6	42	61
$\Delta\delta^{BS}_{rms}$/collision [MeV]	0.3	0.07	44	6.2	65	95

LEP data for 94.5 - 101 GeV consistently suggest a beam-beam limit of ~0.115 (R.Assmann, K. C.)

Stuart's Livingston Chart: Luminosity (/IP)



beam-beam effect (single collision)

	TLEP-H	TLEP-t	ILC (250)	ILC (350)
beam energy [GeV]	120	175	125	175
disruption D_y	2.2	1.5	23.4	84.5
Υ_{BS} $[10^{-4}]$	15	15	207	310
n_γ/collision	0.50	0.51	1.17	1.24
$\Delta\delta^{BS}$/collision [MeV]	42	61	1265	2670
$\Delta\delta^{BS}_{rms}$/collision [MeV]	65	95	1338	2760

TLEP: negligible beamstrahlung apart for effect on beam lifetime

beam lifetime

LEP2:

- beam lifetime ~ 6 h
- due to radiative Bhahba scattering (σ~0.215 b)

TLEP:

- with L~5x10^{34} cm^{-2}s^{-1} at each of four IPs:

  $\tau_{beam,TLEP}$~16 minutes from rad. Bhabha

  SuperKEKB: τ~6 minutes!

- **additional lifetime limit due to beamstrahlung**

  (1) large momentum acceptance ($\delta_{max,RF}\geq$3%),

  (2) flatter beams [smaller ε_y & larger β_x^*,

  maintaining the same L & ΔQ_{bb} constant], or

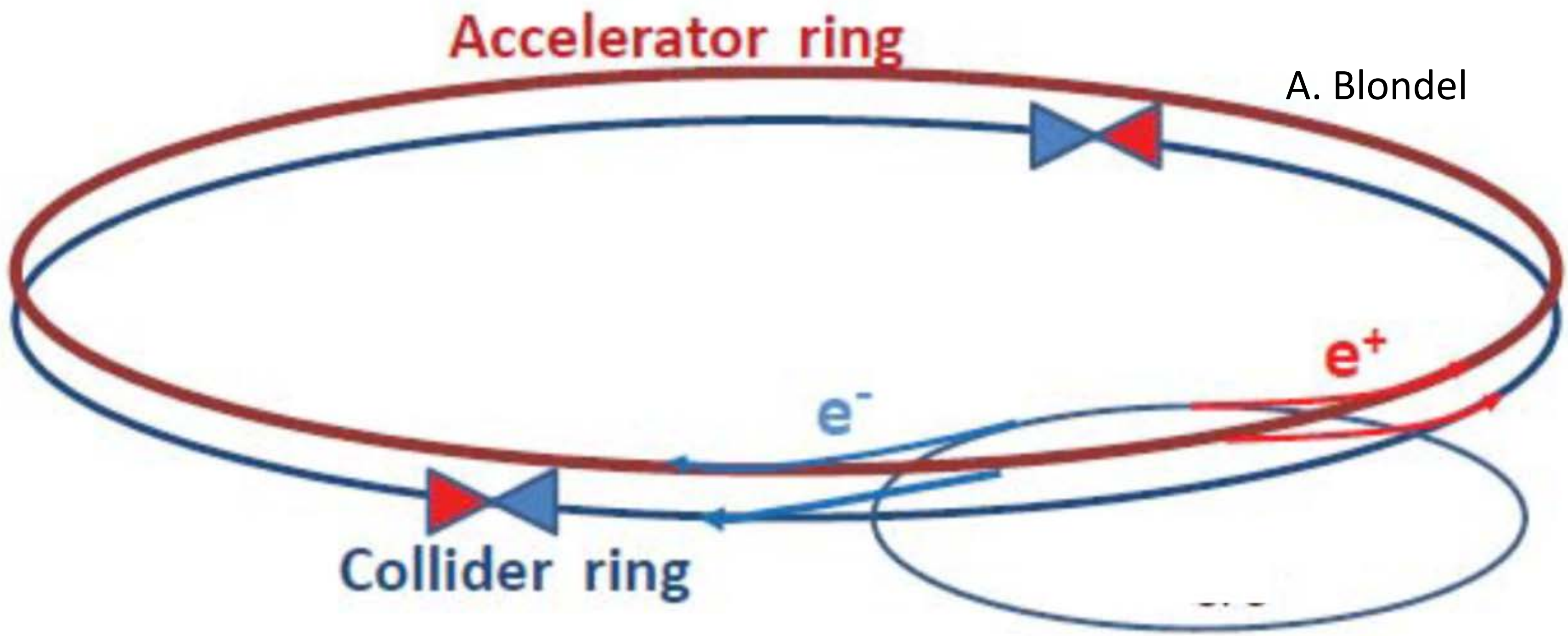
  (3) fast replenishing

  (Valery Telnov, Kaoru Yokoya, Marco Zanetti)

circular HFs – top-up injection

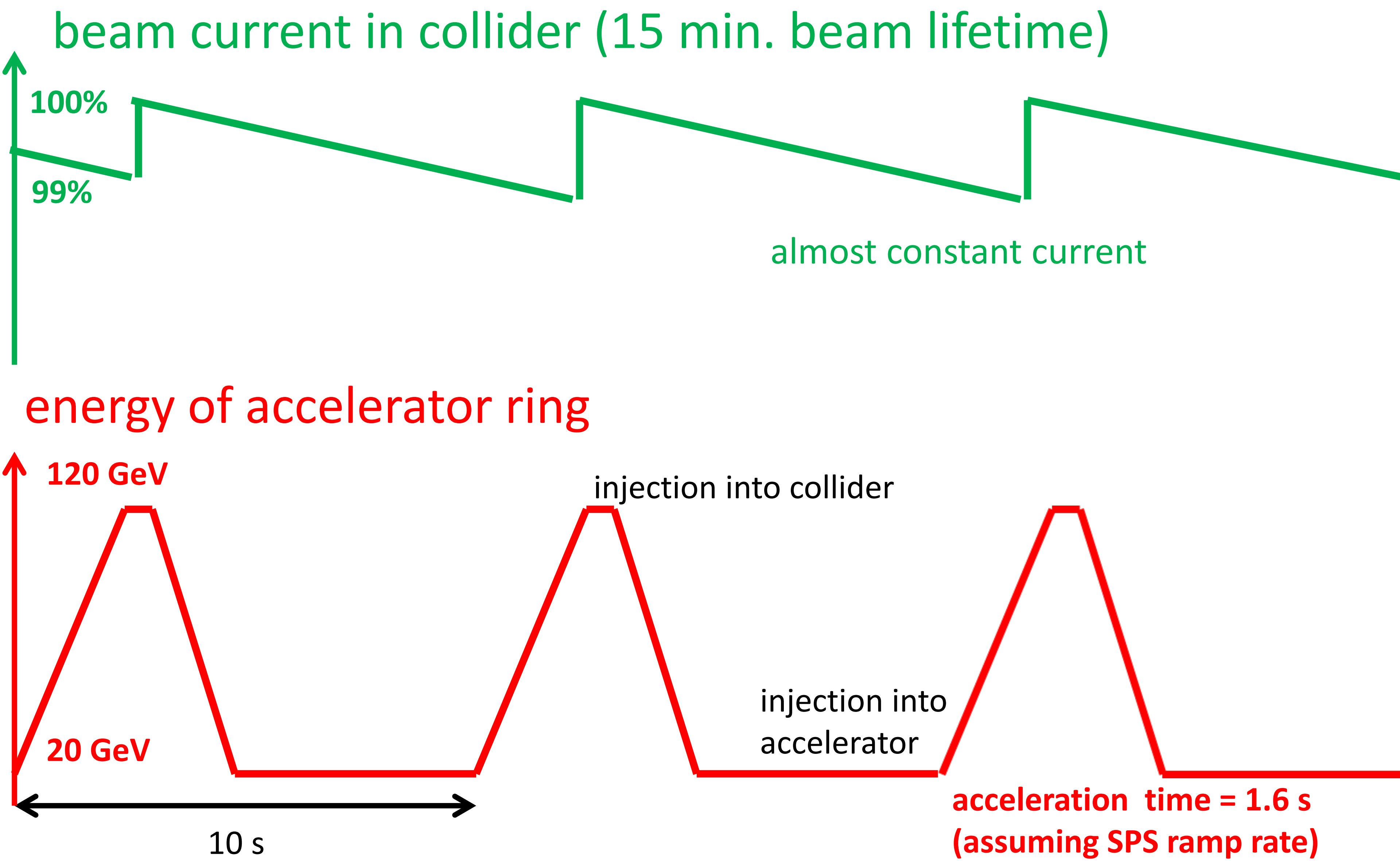
double ring with top-up injection

supports short lifetime & high luminosity



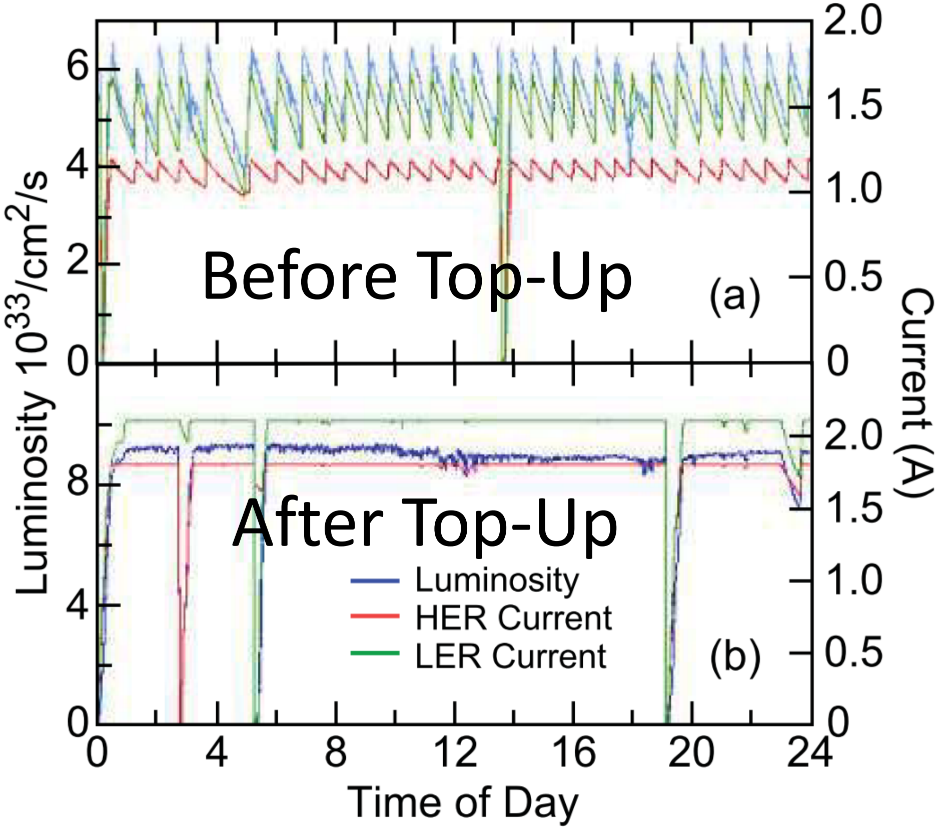
top-up experience: PEP-II, KEKB, light sources

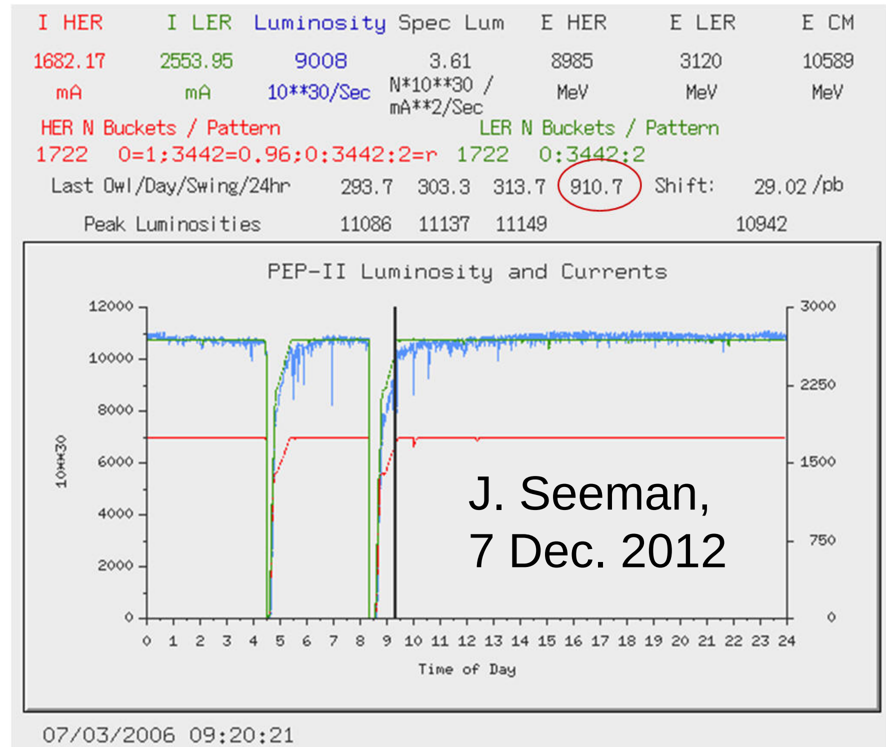
top-up injection: schematic cycle



top-up performance at PEP-II/BaBar

J. Seeman





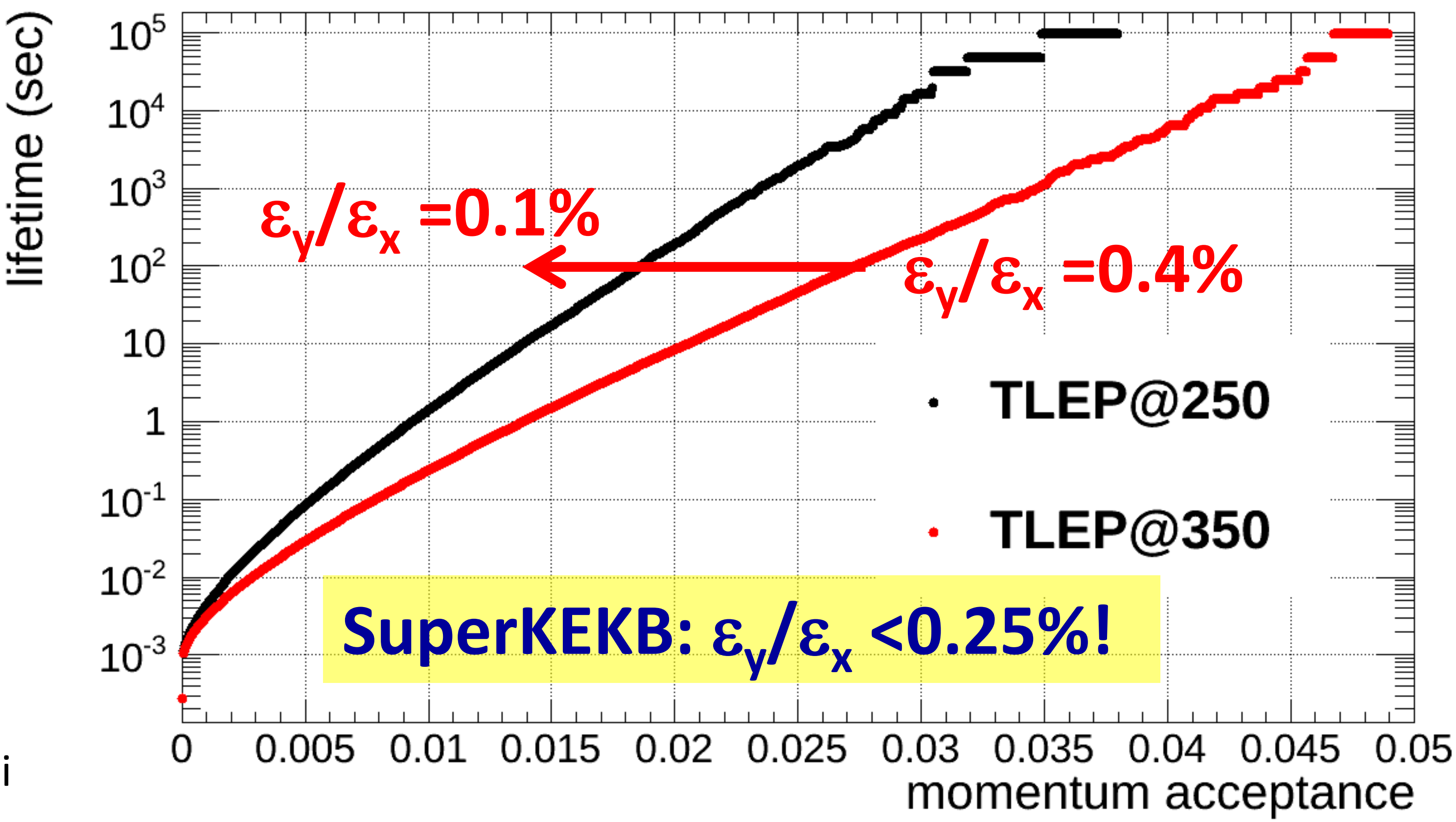
Hübner factor *H* not from 1:

- for one day (July 3, 2006): $H \approx 0.95$
- for one month (August 2007): $H \approx 0.63$

beamstrahlung lifetime

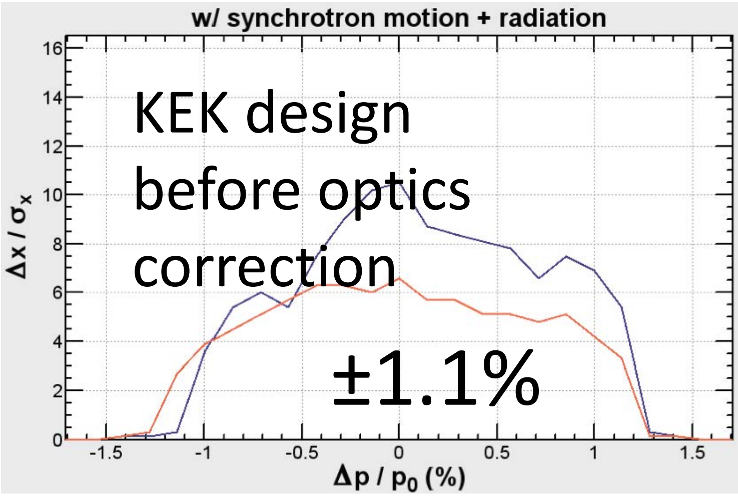
- simulation w 360M macroparticles
- τ varies exponentially w energy acceptance η
- post-collision *E* tail → lifetime τ

beam lifetime versus acceptance δ_{max} for 4 IPs:

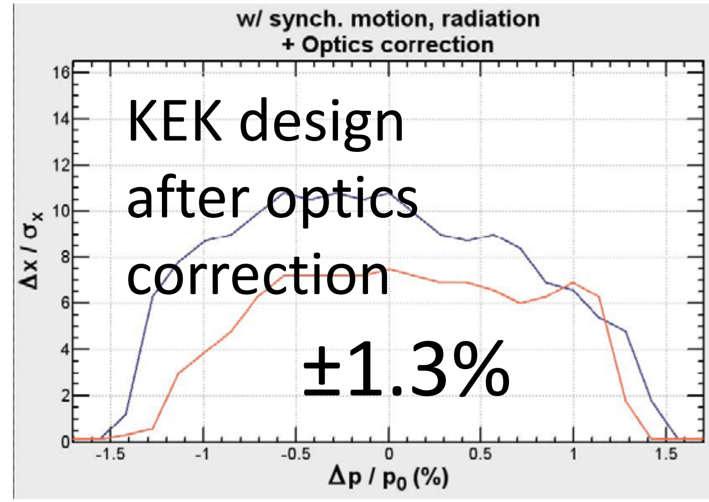


M. Zanetti

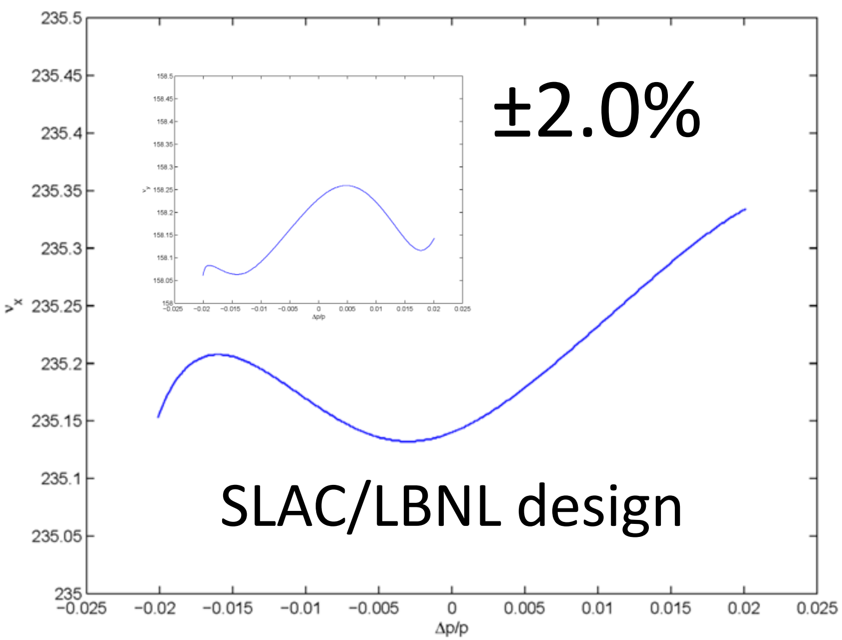
circular HFs - momentum acceptance

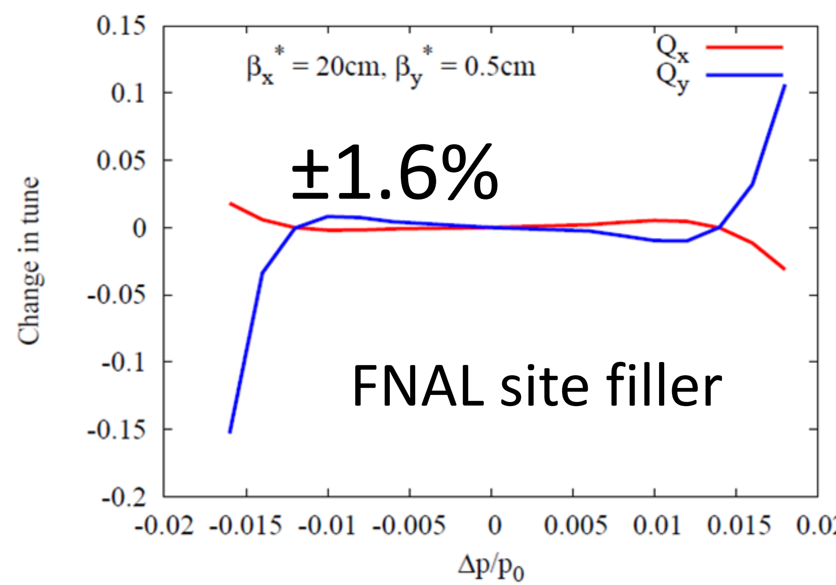


with
synchrotron
motion &
radiation
(sawtooth)



K. Oide





Y. Cai

T. Sen, E. Gianfelice-Wendt, Y. Alexahin

circular collider & SR experience

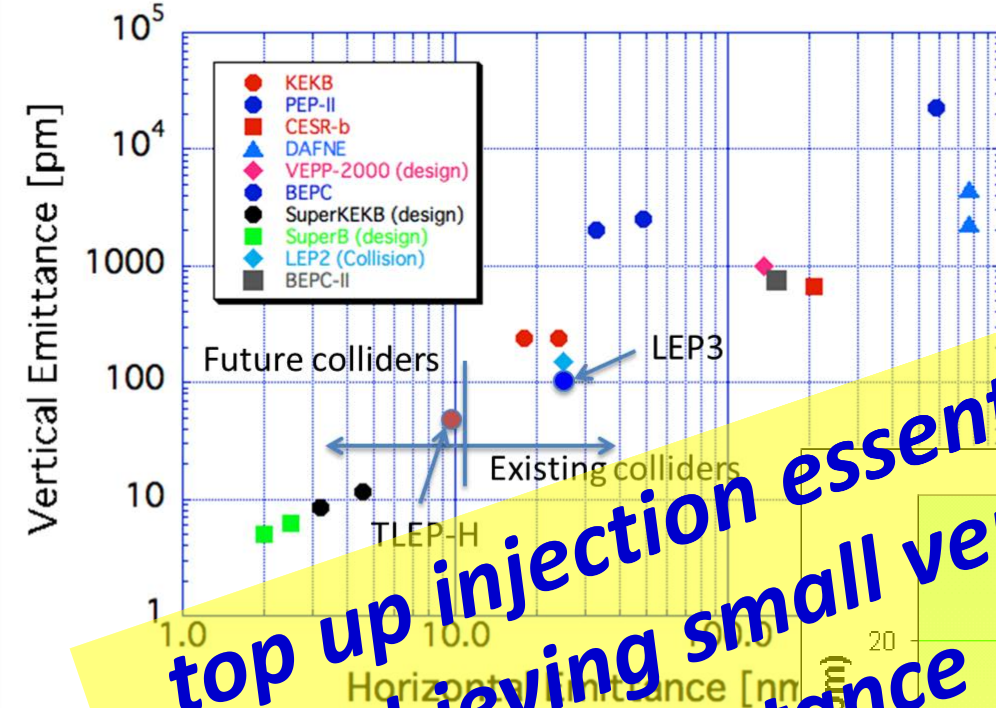
…
CESR
BEPC
LEP
Tevatron
LEP2
HERA
DAFNE
PEP-II
KEKB
BEPC-II
LHC
SuperKEKB (soon)

3rd generation light sources

1992	**ESRF**, France (EU)	6 GeV
	ALS, US	1.5-1.9 GeV
1993	**TLS**, Taiwan	1.5 GeV
1994	**ELETTRA**, Italy	2.4 GeV
	PLS, Korea	2 GeV
	MAX II, Sweden	1.5 GeV
1996	**APS**, US	7 GeV
	LNLS, Brazil	1.35 GeV
1997	**Spring-8**, Japan	8 GeV
1998	**BESSY II**, Germany	1.9 GeV
2000	**ANKA**, Germany	2.5 GeV
	SLS, Switzerland	2.4 GeV
2004	**SPEAR3**, US	3 GeV
	CLS, Canada	2.9 GeV
2006:	**SOLEIL**, France	2.8 GeV
	DIAMOND, UK	3 GeV
	ASP, Australia	3 GeV
	MAX III, Sweden	700 MeV
	Indus-II, India	2.5 GeV
2008	**SSRF**, China	3.4 GeV
2009	**PETRA-III**, Germany	6 GeV
2011	**ALBA**, Spain	3 GeV

well understood technology &
typically exceeding design performance
within a few years

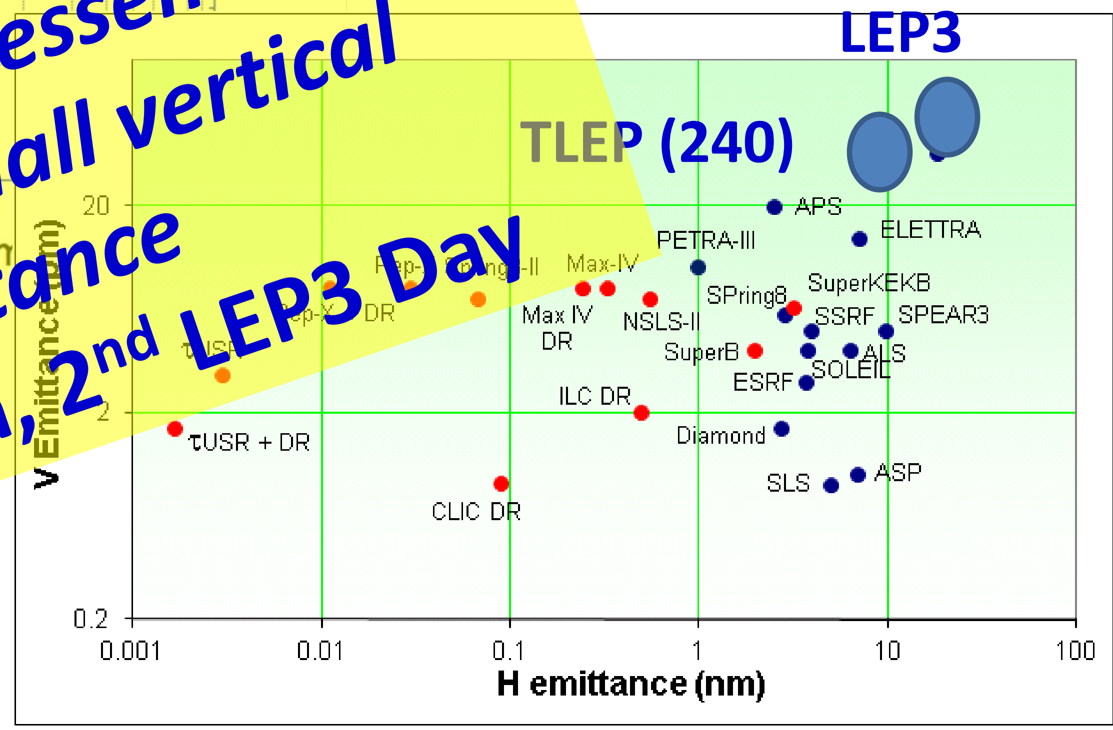
emittances in circular colliders & modern light sources



Y. Funakoshi, KEK

top up injection essential for achieving small vertical emittance

Lenny Rivkin, 2nd LEP3 Day



R. Bartolini, DIAMOND

circular HFs: synchroton-radiation heat load

	PEPII	SPEAR3	LEP3	TLEP-Z	TLEP-H	TLEP-t
E (GeV)	9	3	120	45.5	120	175
I (A)	3	0.5	0.0072	1.18	0.0243	0.0054
rho (m)	165	7.86	2625	9000	9000	9000
Linear Power (W/cm)	101.8	92.3	30.5	8.8	8.8	8.8

LEP3 and TLEP have 3-10 times less SR heat load per meter than PEP-II or SPEAR! (though higher photon energy)

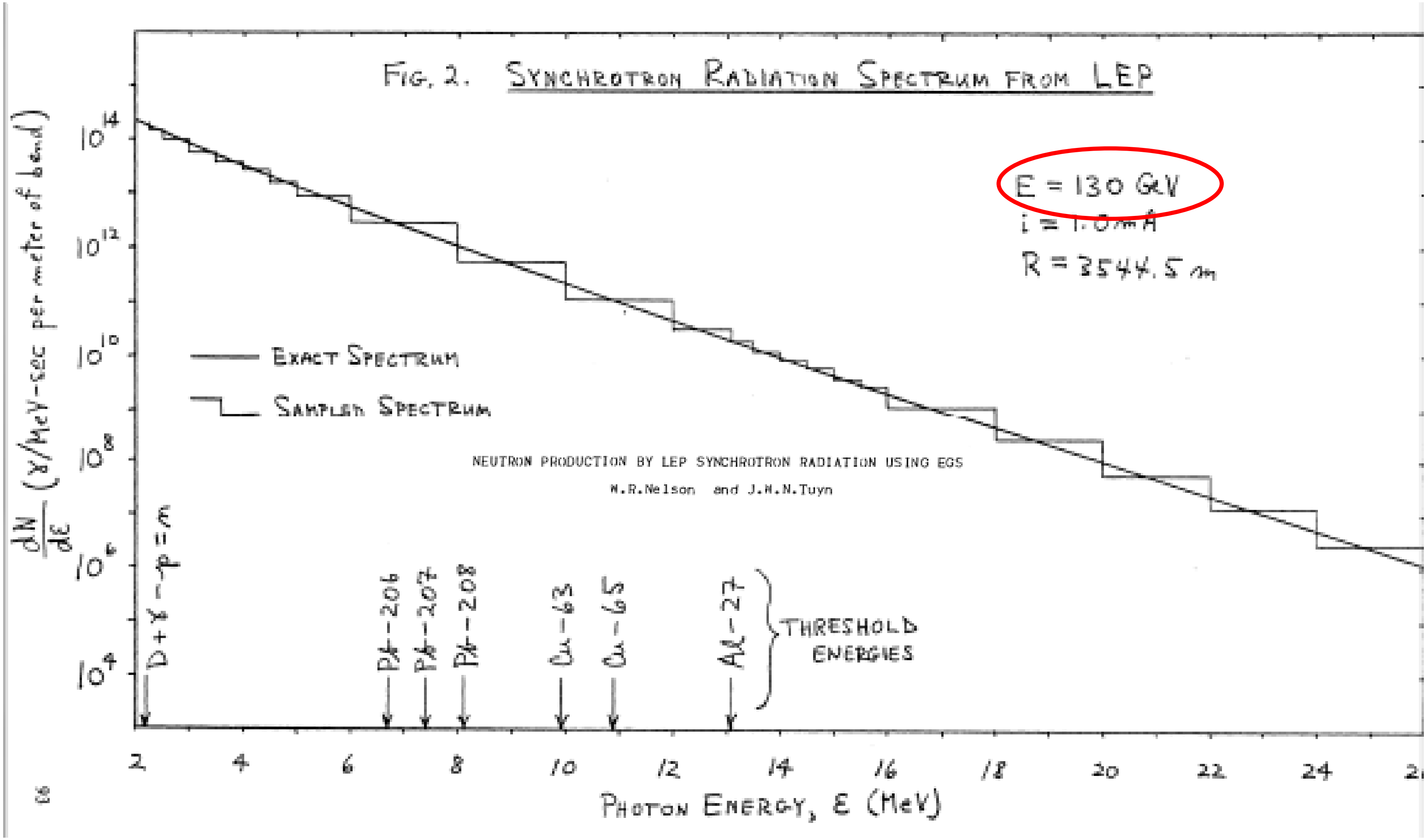
N. Kurita, U. Wienands, SLAC

synchrotron radiation - activation

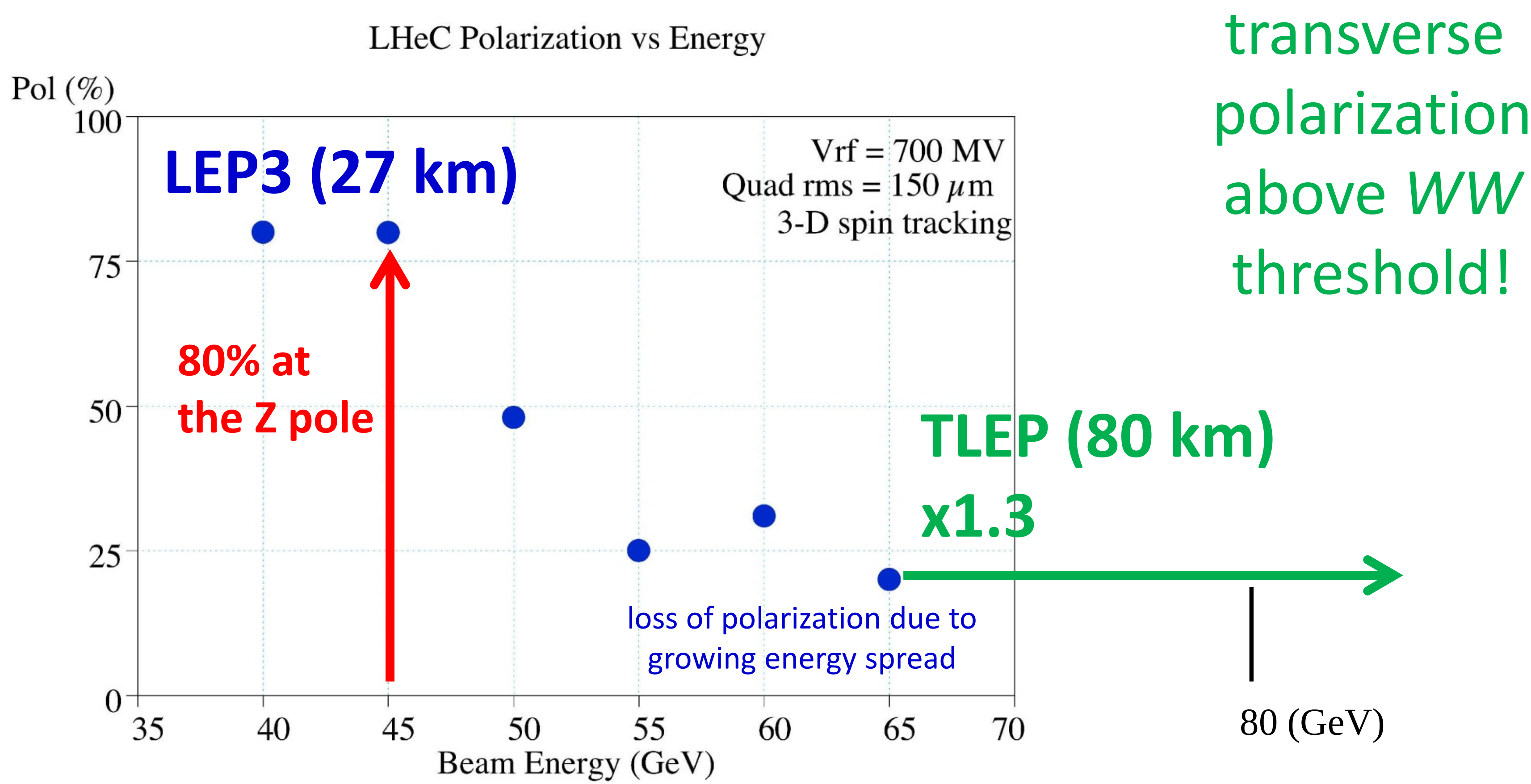
NEUTRON PRODUCTION BY LEP SYNCHROTRON RADIATION USING EGS

W.R.Nelson and J.W.N.Tuyn

A. Fasso
3rd TLEP3 Day



LHeC/LEP3 polarization



LHeC equilibrium polarisation vs ring energy, full 3-D spin tracking results (D. Barber, U. Wienands, in LHeC CDR, J. Phys. G: Nucl. Part. Phys. 39 075001)

"… by adopting the levels of alignment that are now standard for synchrotron-radiation sources and by applying harmonic closed-orbit spin matching, there is reason to hope that high polarisation in a flat ring can … be obtained"

TLEP key components

- tunnel
- high power SRF system
- cryoplants
- magnets
- injector ring
- detectors

tunnel is main cost

RF system & magnets call for R&D

TLEP/LEP3 key issues

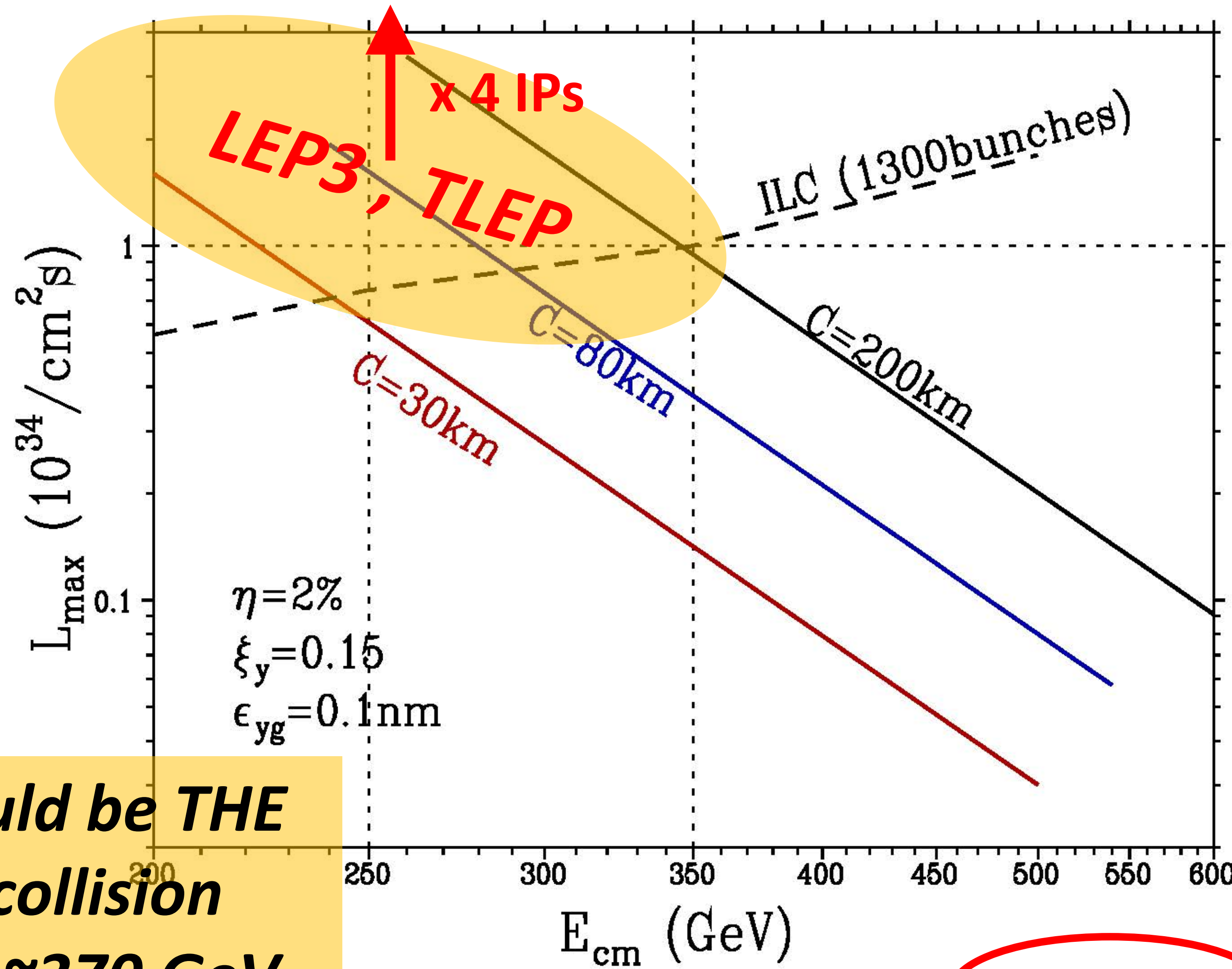
- SR handling and **radiation shielding**
- optics effect of **energy sawtooth** [separate arcs?! (K. Oide)]
- beam-beam interaction for **large Q_s** and significant **hourglass effect**
- **β_y*=1 mm IR with large acceptance**
- **TERA-Z operation** (impedance effects & parasitic collisions)

→ Conceptual Design Study by 2014/15!

circular & linear HF: peak luminosity vs energy

example with

- $\eta=2\%$
- $\xi_y=0.15$
- $\varepsilon_{gy}=0.1\text{nm}$



***LEP3/TLEP* would be THE choice for e^+e^- collision energies up to ~370 GeV**

K. Yokoya, KEK

risk?

extrapolation from past experience

	LEP2→TLEP-H	SLC→ILC 250
peak luminosity	x400	x2500
energy	x1.15	x2.5
vertical geom. emittance	x1/5	x1/400
vert. IP beam size	x1/15	x1/150
e^+ production rate	x1/2 !	x65
commissioning time	<1 year → ?	>10 years →?

vertical rms IP spot sizes in nm

in regular font: achieved

in italics: design values

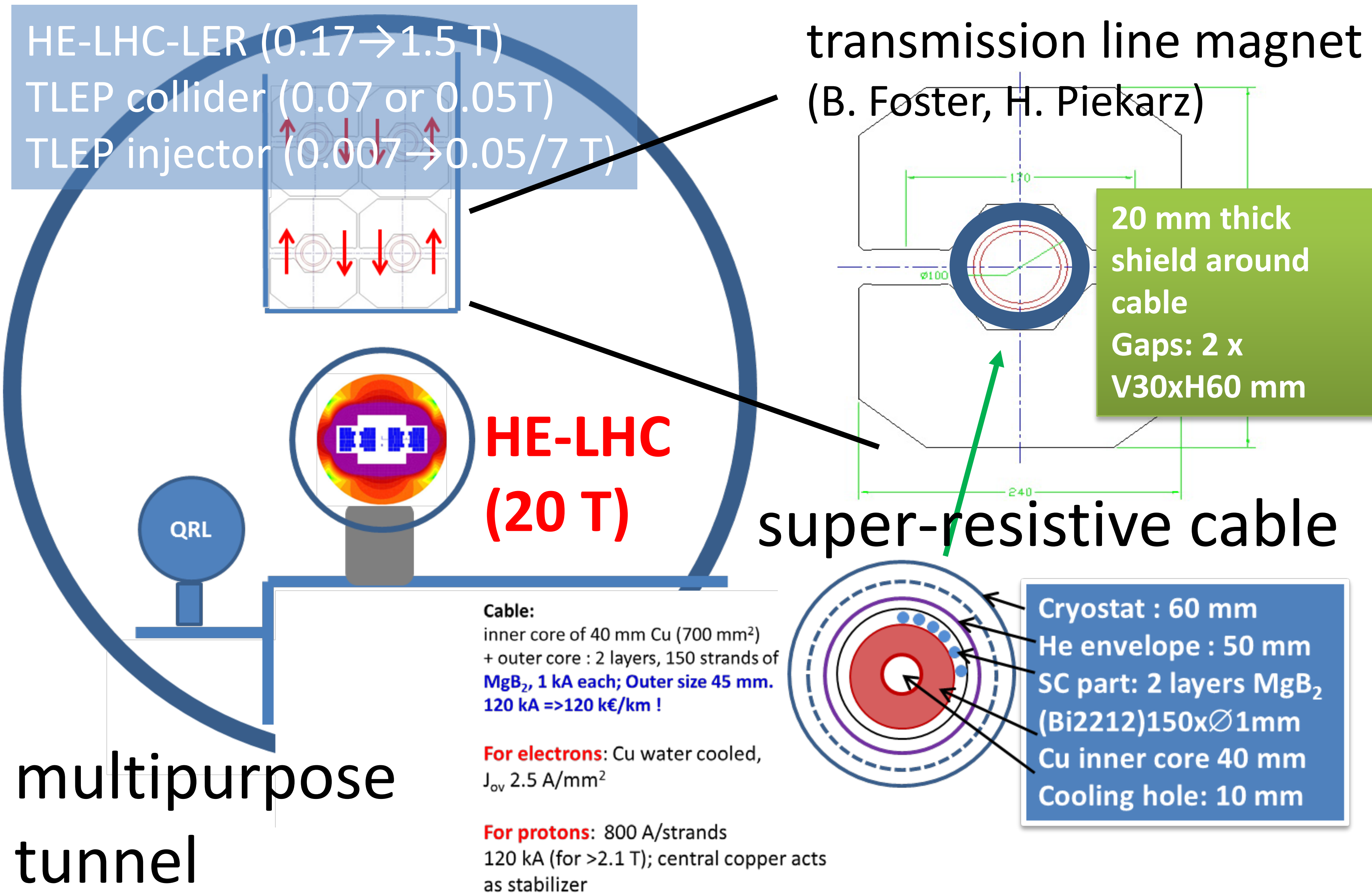
LEP2	3500
KEKB	940
SLC	500
LEP3	***320***
TLEP-H	***220***
ATF2, FFTB	73 (35), 77
SuperKEKB	*50*
ILC	*5 – 8*
CLIC	*1 – 2*

β_y^*: 5 cm → 1 mm

LEP3/TLEP will learn from ATF2 & SuperKEKB

VHE-LHC + TLEP

L. Rossi



personal conclusions

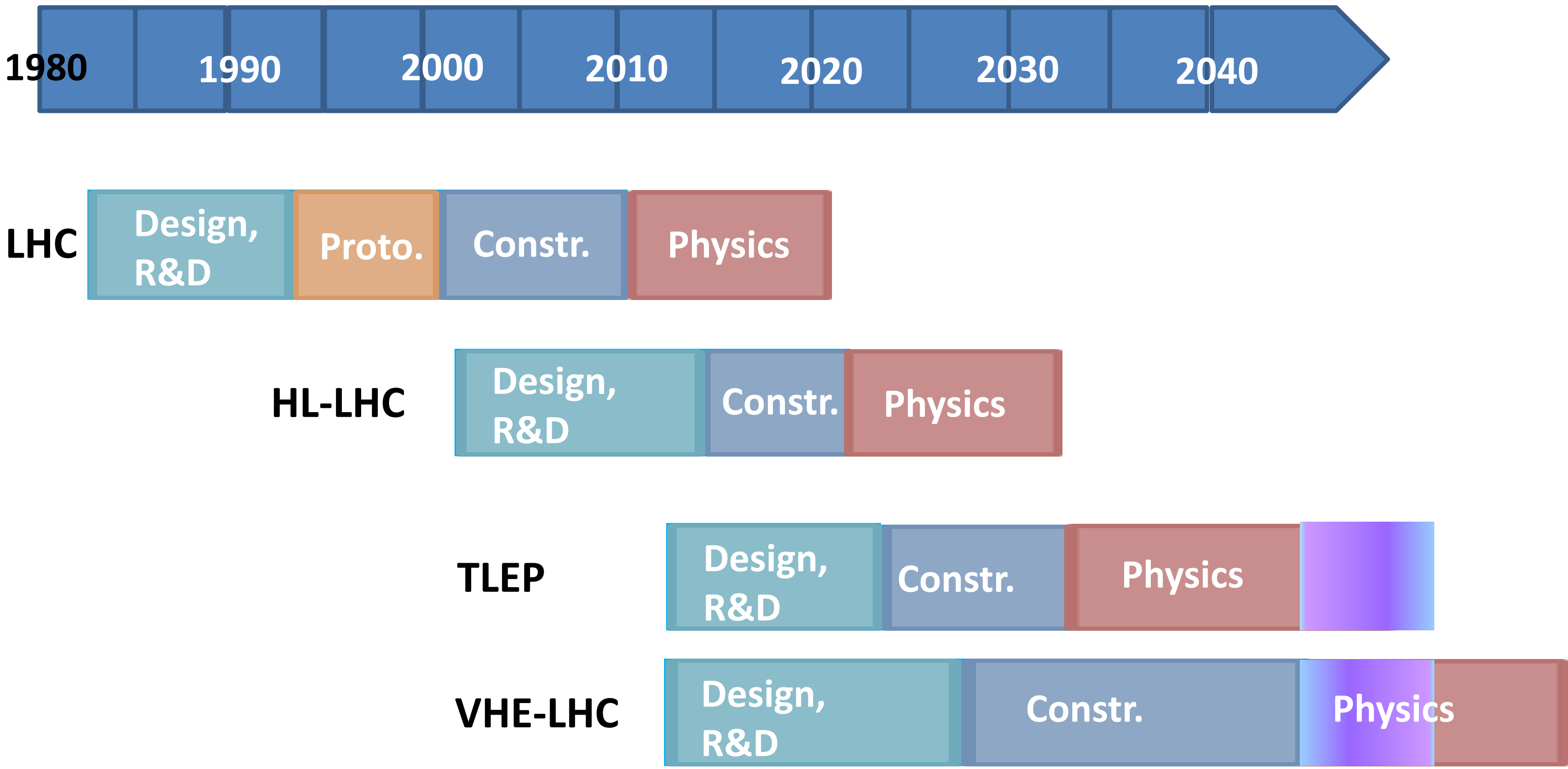
- need to pursue vigorous accelerator R&D to be ready to propose new project by 2017/18
- TLEP and VHE-LHC are exciting options with large synergies
- TLEP excellent in terms of energy & luminosity, and extendable towards VHE-LHC, preparing ≥50 years of e^+e^-, *pp*, *ep/A* physics at highest energies
- TLEP comes for "free" (tunnel, magnets, & detectors "the same" as for VHE-LHC)
- SuperKEKB will be important TLEP demonstrator!

HF Accelerator Quality (My Opinion)

	Linear C.	Circular C.	LHeC	Muon C.	γ–γ C.
maturity	☺	☺ ☺	☺ ☺	☹	☹
size	☹	☹	☺	☺☺	☺
cost	☹	☺ - 😐	☺	☹	☺
power	😐	😐	😐	😐	😐
#IPs	1	4	1	1	1
com. time	10 yr	2 yr	2 yr	10 yr	5 yr
H factor	0.2 (SLC)	0.5 (1/2 PEP-II)	0.2?	0.1?	0.1?
Higgs/IP/yr	7 k [10 k]	20-100 k	5 k	5 k	10 k
expanda-bility	1-3TeV e^+e^-, γγ C.	100 TeV *pp*	γγ C.	10 TeV μμ	LC later

inspired by S. Henderson, FNAL

tentative time line



TLEP/LEP3 events & references

A. Blondel, F. Zimmermann, *"A High Luminosity e^+e^- Collider in the LHC Tunnel to study the Higgs Boson,"* arXiv:1112.2518v1, 24.12.'11

K. Oide, *"SuperTRISTAN - A possibility of ring collider for Higgs factory,"* KEK Seminar, 13 February 2012

1st EuCARD LEP3 workshop, CERN, 18 June 2012

A. Blondel et al, *"LEP3: A High Luminosity e+e- Collider to study the Higgs Boson,"* arXiv:1208.0504, submitted to ESPG Krakow

P. Azzi et al, *"Prospective Studies for LEP3 with the CMS Detector,"* arXiv:1208.1662 (2012), submitted to ESPG Krakow

2nd EuCARD LEP3 workshop, CERN, 23 October 2012

P. Janot, *"A circular e^+e^- collider to study H(125),"* PH Seminar, CERN, 30 October 2012

ICFA Higgs Factory Workshop: Linear vs Circular, FNAL, 14-16 Nov. '12

A. Blondel, F. Zimmermann, *"Future possibilities for precise studies of the X(125) Higgs candidate,"* CERN Colloquium, 22 Nov. 2012

3rd TLEP3 Day, CERN, 10 January 2013

4th TLEP mini-workshop, CERN, 4-5 April 2013

5th TLEP mini-workshop, 25-26 July 2013, Fermilab

https://tlep.web.cern.ch   https://cern.ch/accnet

HE-LHC &VHE-LHC events & references

R. Assmann, R. Bailey, O. Brüning, O. Dominguez, G. de Rijk, J.M. Jimenez, S. Myers, L. Rossi, L. Tavian, E. Todesco, F. Zimmermann, "First Thoughts on a Higher-Energy LHC," CERN-ATS-2010-177

E. Todesco, F. Zimmermann (eds), **"EuCARD-AccNet-EuroLumi Workshop: The High-Energy Large Hadron Collider,"** Proc**. EuCARD-AccNet workshop HE-LHC'10 , Malta, 14-16 October 2010**, arXiv:1111.7188 ; CERN Yellow Report CERN-2011-003

HiLumi LHC WP6 HE-LHC

Joint Snowmass-EuCARD/AccNet-HiLumi meeting `Frontier Capabilities for Hadron Colliders 2013,' CERN, 21-11 February 2013

http://hilumilhc.web.cern.ch/HiLumiLHC/activities/HE-LHC/WP16/

https://cern.ch/accnet

Appendix

- example parameters for HL-LHC, HE-LHC, VHE-LHC, TLHeC, VHE-TLHeC
- ERC consolidation grant request THALES
- TLEP work topics & TLEP draft design study proposal

(V)HE-LHC parameters – 1

smaller?! (x1/4?)

Parameter	LHC	HL-LHC		HE-LHC	VHE-LHC
c.m. energy [TeV]	14			33	100
circumference C [km]	26.7				80
dipole field [T]	8.33			20	20
dipole coil aperture [mm]	56			40	≤ 40
beam half aperture [cm]	2.2 (x), 1.8 (y)			1.3	≤ 1.3
injection energy [TeV]	0.45			>1.0	>3.0
no. of bunches	2808	2808	1404	2808	8420
bunch population [10^{11}]	1.125	2.2	3.5	0.81	0.80
init. transv. norm. emit. [μm]	3.73,	2.5	3.0	1.07	1.70
initial longitudinal emit. [eVs]	2.5			3.48	13.6
no. IPs contributing to tune shift	3	2	2	2	2
max. total beam-beam tune shift	0.01	0.021	0.028	0.01	0.01
beam circulating current [A]	0.584	1.12	0.089	0.412	0.401
RF voltage [MV]	16			16	22
rms bunch length [cm]	7.55			7.55	7.55
IP beta function [m]	0.55	$0.73 \rightarrow 0.15$		0.3	0.9
init. rms IP spot size [μm]	16.7	$15.6 \rightarrow 7.1$	$24.8 \rightarrow 7.8$	4.3	5.3

O. Dominguez, L. Rossi, F.Z.

(V)HE-LHC parameters – 2

Parameter	LHC	HL-LHC		HE-LHC	VHE-LHC
full crossing angle [μrad]	285	590		171	71
Piwinski angle	0.65	3.13 (0)	2.86 (0)	1.5	0.5
geometric luminosity loss	0.84	> 0.9	> 0.9	0.55	0.89
stored beam energy [MJ]	362	694	552	601	5410
SR power per ring [kW]	3.6	6.9	5.5	82.5	2356
arc SR heat load [W/m/aperture]	0.21	0.40	0.32	3.7	35.6
energy loss per turn [keV]	6.7			201.3	5857
critical photon energy [eV]	44			575	5474
photon flux [10^{17}/m/s]	1.0	1.9	1.5	1.6	1.5
longit. SR emit. damping time [h]	12.9			1.0	0.32
horiz. SR emit. damping time [h]	25.8			2.0	0.64
init. longit. IBS emit. rise time [h]	57	23.6	18.3	35	367
init. transv. IBS emit. rise time [h]	103	20.4	19.1	14	118
peak events per crossing ($\sigma = 85$ mbarn)	27	135 (lev.)	135 (lev.)	135	135
peak luminosity [10^{34} cm^{-2}s^{-1}]	1.0	5.0	2.5	5.0	5.0
beam lifetime due to burn off [h] **(σ=100 mb)**	45	17.2	27.3	6.3	18.6
optimum run time [h]	15.2	11.2	20.1	5.9	12.1
opt. av. int. luminosity / day [fb^{-1}]	0.47	2.9	1.7	1.5	2.2

numbers for lifetime and average integrated luminosity need to be updated for ~40% higher cross section at 100 TeV

O. Dominguez, L. Rossi, F.Z.

parameters for *TLHeC* & *VHE-TLHeC* (e^- at 120 GeV)

collider parameters	TLHeC		VHE-TLHeC	
species	$e^{\pm}$	p	$e^{\pm}$	p
beam energy [GeV]	**120**	**7000**	**120**	**50000**
bunch spacing [μs]	3	3	3	3
bunch intensity [10^{11}]	5	3.5	5	3.5
beam current [mA]	24.3	51.0	24.3	51.0
rms bunch length [cm]	0.17	4	0.17	2
rms emittance [nm]	10,2	0.40	10,2	0.06
$\beta_{x,y}$*[cm]	2,1	60,5	0.5,0.25	60,5
$\sigma_{x,y}$* [μm]	15, 4		6, 2	
beam-beam parameter ξ	0.05, 0.09	**0.03,0.01**	0.07,0.10	**0.03,0.007**
hourglass reduction	**0.63**		**0.42**	
CM energy [TeV]	1.8		4.9	
luminosity [10^{34}cm^{-2}s^{-1}]	**0.5**		**1.6**	

European Research Council

ERC Consolidator Grant 2013

Research proposal [Part B1]

(to be evaluated in Step 1)

Towards a Higgs factory Accepting Large Energy Spread

THALES

Cover Page:

Name of the Principal Investigator (PI): Rogelio Tomas Garcia

- Name of the PI's host institution for the project: CERN
- Proposal full title: Towards a Higgs factory Accepting Large Energy Spread
- Proposal short name: THALES
- Proposal duration in months: 60 months

A key issue for particle accelerators is to focus beams with the largest possible intensity so as to maximize collision rates. This issue has gained importance with the discovery in 2012 at the LHC of a Higgs-like particle. Among recent proposals for studying this particle are a new generation of circular e^+e^- colliders (Higgs factories) with higher energies and collision rates (luminosities) than LEP2. Achieving unprecedented Higgs production event rates will require squeezing the vertical beam sizes at the Interaction Point (IP) to a few 100 nm, requiring about a factor 50 lower vertical beta function at the collision point than at LEP2. This proposal will show how to meet this requirement, making technical advances that also have applications to a wide range of other accelerators. The performance of high-luminosity machines will be restricted by beamstrahlung, i.e., synchrotron radiation in the field of the opposing beam emitted during the collision, coupled with a limited momentum acceptance. Therefore, the first goal of the proposed project is to develop a low-beta interaction region (IR) and the associated non-linear ring optics for a circular Higgs factory collider with large momentum acceptance, so that particles with an energy error of 3% or more, suddenly introduced by the emission of highly-energetic beamstrahlung photons, circulate until they are damped back into the core of the beam by conventional synchrotron radiation in the collider arcs. The proposed study will produce a new type of final-focus design together with additional non-linear elements in the collider arcs to control remaining aberrations. In parallel, an IR design for a very-high-energy proton collider in the same tunnel with up to 100 TeV in the centre of mass will also be developed. This will open the way to a next-generation collider complex at the energy frontier. The novel IR concepts developed for these circular machines will have significant spin-offs that could be used to improve the design and performance of linear colliders, muon storage rings, light sources, and medical accelerators. In particular, there is a strong synergy with the laser-beam collision IR in the Compton storage ring for a polarized positron source, in which circulating electrons undergo large energy changes when they collide with the laser beam. This project is therefore of broad interest for a wide range of future accelerators with applications beyond high-energy physics.

ERC Consolidation Grant Proposal "THALES"

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PI: Rogelio Tomas

includes international network for feeding new ideas, guidance, local support for experimental tests, review & collaboration

draft work topics: TLEP accelerator

- parameter optimization with regard to lifetime and luminosity, at different energies, & different tunnels
- RF system design, prototyping & integration for collider and accelerator ring
- optics design for collider ring including low-beta IRs, off-momentum dynamic aperture, different energies
- beamstrahlung: lifetime, steady state beam distribution, dependence on tune etc.
- beam-beam interaction with large hourglass effect
- emittance tuning studies, errors, tolerances, etc.
- optics design and beam dynamics for the accelerator ring, ramping speed etc
- impedance budget, CSR, instabilities
- cryogenics system design
- magnets design: collider ring dipole, accelerator ring dipole, low-beta quadrupole
- radiation, shielding, cooling for 100 MW SR power
- vacuum system design
- engineering study of 80-km tunnel
- design of injector complex including e+ source, and polarized e- source
- machine detector interface, integration of accelerator ring at detector (s), low-beta quadrupoles, shielding (e.g. against beamstrahlung)?
- injection scheme
- polarization, Siberian snakes, spin matching, acceleration & storage, polarized sources

(19 September 2012)

Draft 2.0

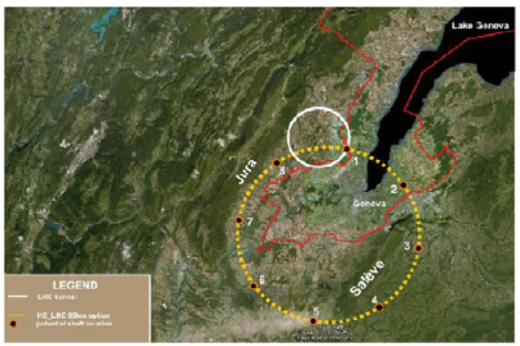
CERN, 13 February 2013

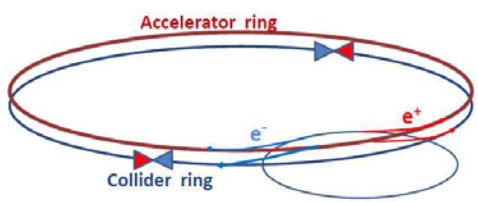
TLEP

A design study of high-luminosity e^+e^- circular colliders for precise measurements of the properties of the Higgs-like H(126) boson and physics at the electroweak scale

(DRAFT)

Author list to be expanded and ordered by institute: R. Aleksan (CEA-Saclay), Alain Blondel (Geneva), John Ellis (King's College London), Patrick Janot (CERN-PH), Mike Koratzinos (Geneva), Marco Zanetti (MIT), Frank Zimmermann (CERN-BE) … … …





Possible site layout and schematic for the TLEP collider

Abstract

We propose to carry out the design study of a high-energy, high-luminosity electron-positron storage ring collider operating in the energy range 90-350 GeV. Such a study was recommended as an outcome of the ICFA beam dynamics workshop on Higgs Factories and is in line with the proposed update of the European Strategy for Particle Physics. If situated in a 80km tunnel, this machine could be the precursor of a 80-100 TeV hadron collider as part of a possible long-term vision for CERN.

TLEP Design Study Proposal (*draft*)

to be submitted to ECFA

TLEP design study –preliminary structure for discussion

Institutional board

Steering group
web site, mailing lists, speakers board, etc..

International Advisory board

Accelerator

1. Optics, low beta, alignment and feedbacks
2. Beam beam interaction
3. Magnets and vacuum
4. RF system
5. Injector system
6. Integration w/(SHE)-LHC
7. Interaction region
8. Polarization &E-calib.
9. Elements of costing

Experiments

1. H(126) properties
2. Precision EW measurements at the Z peak and W threshold
3. Top quark physics
4. Experimental environment
5. Detector design
6. Online and offline computing

Physics

1. Theoretical implications and model building
2. Precision measurements, simulations and monte-carlos
3. Combination + complementarity with LHC and other machines ; global fits

a new tunnel for TLEP in the Geneva area?