Roundtable Discussion on Future Machines – Quy Nhon, 14.08.2014

Participants:

Roy Aleksan, CEA, Chair of ESGARD

Alain Blondel, Professor of particle physics at U. Geneva

Oliver Brüning, CERN, BE/ABP Group Leader, HL-LHC Deputy Project Leader

Swapan Chattopadhyay, FNAL & NIU & CERN (former director of CI/UK)

Serguei Ganjour, CEA

Francois Le Diberder, CNRS/IN2P3/LAL

Katsunobu Oide, KEK, Director of KEK Accelerator Laboratory

Maxim Titov, CEA

Kaoru Yokoya, KEK, ILC GDE Regional Leader for Asia

Frank Zimmermann, CERN, convener

Excused: Jie Gao, Yifang Wang, Nima Arkani-Hamed, IHEP Beijing;

Tao Han, Pittsburgh

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- **Introductory presentations** (20')
- **Discussions** (30'):

  1. Do we need precision or/and high energy?
  How precisely do we need to measure various couplings? How many Higgs decays, how many Z decays should be produced? Which energy should we aim for?
  Which collider has the strongest physics case after the HL-LHC?

  2. How can we make sure that the wishes of the physics community are synchronized with the technical developments in the accelerator sector?
  How mature are the technologies for hadron collider, circular or linear e+e- , and other colliders?

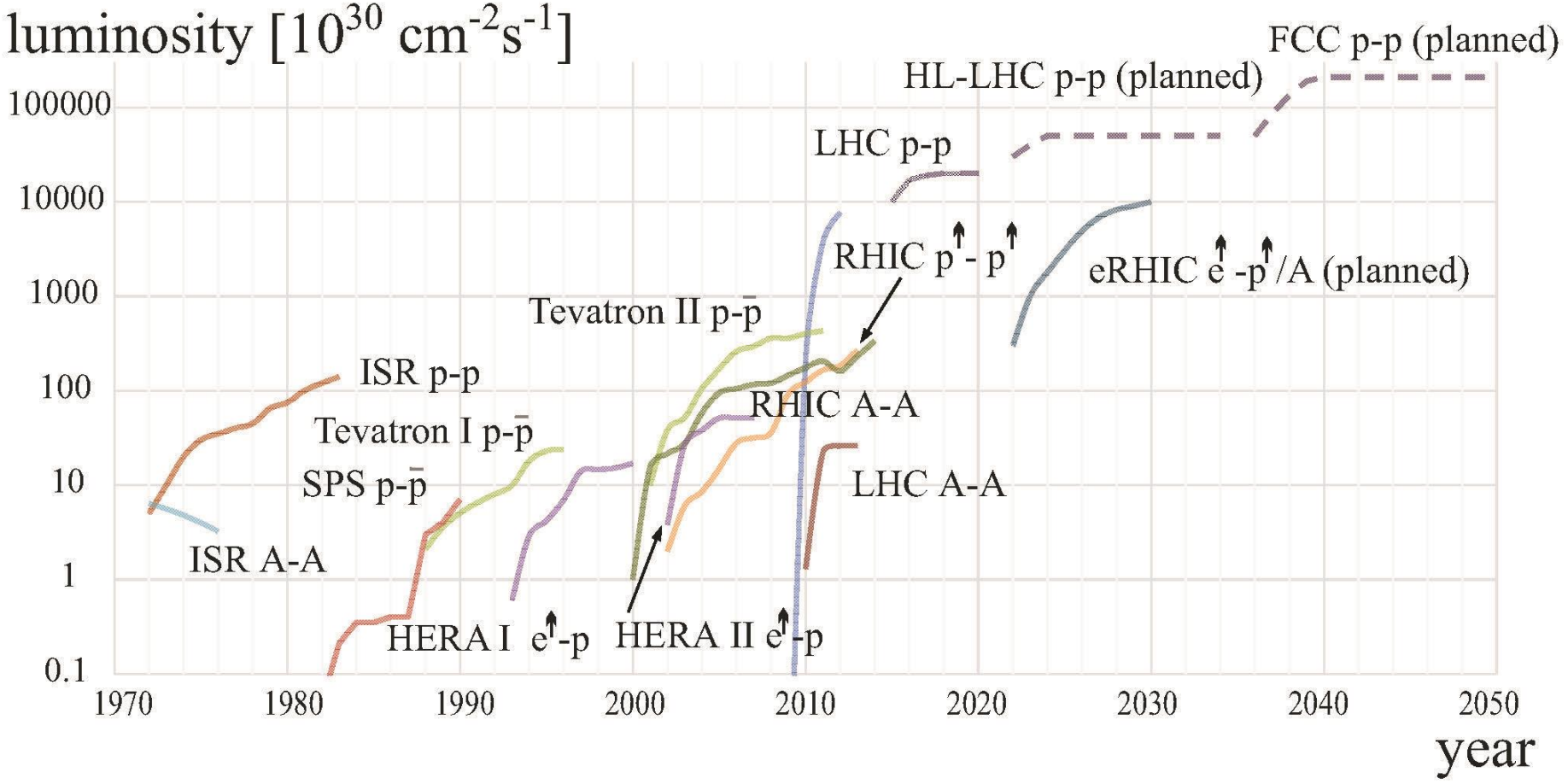
  3. What risks do we have for reaching the announced performance levels for hadron collider, circular or linear e+e- collider (or gg or muon) collider?
  How long will the commissioning take? 5

  4. Can one extrapolate the "LHC" collaboration models to the next machine?

  5. To what extent should the choice of the next project be driven by a long-term strategy?

- **Concluding remarks (5')**

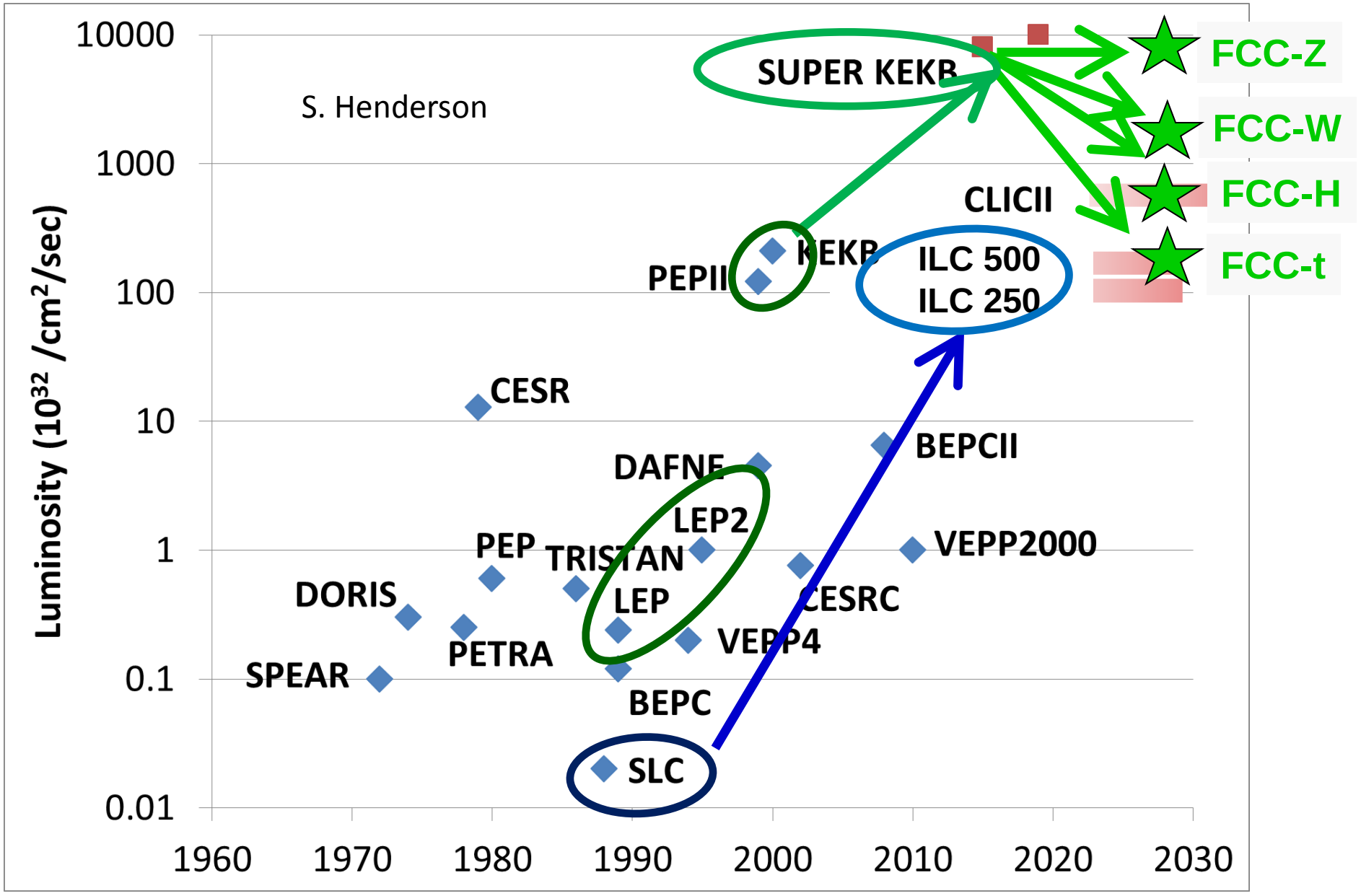
hadron-collider peak luminosity vs. year



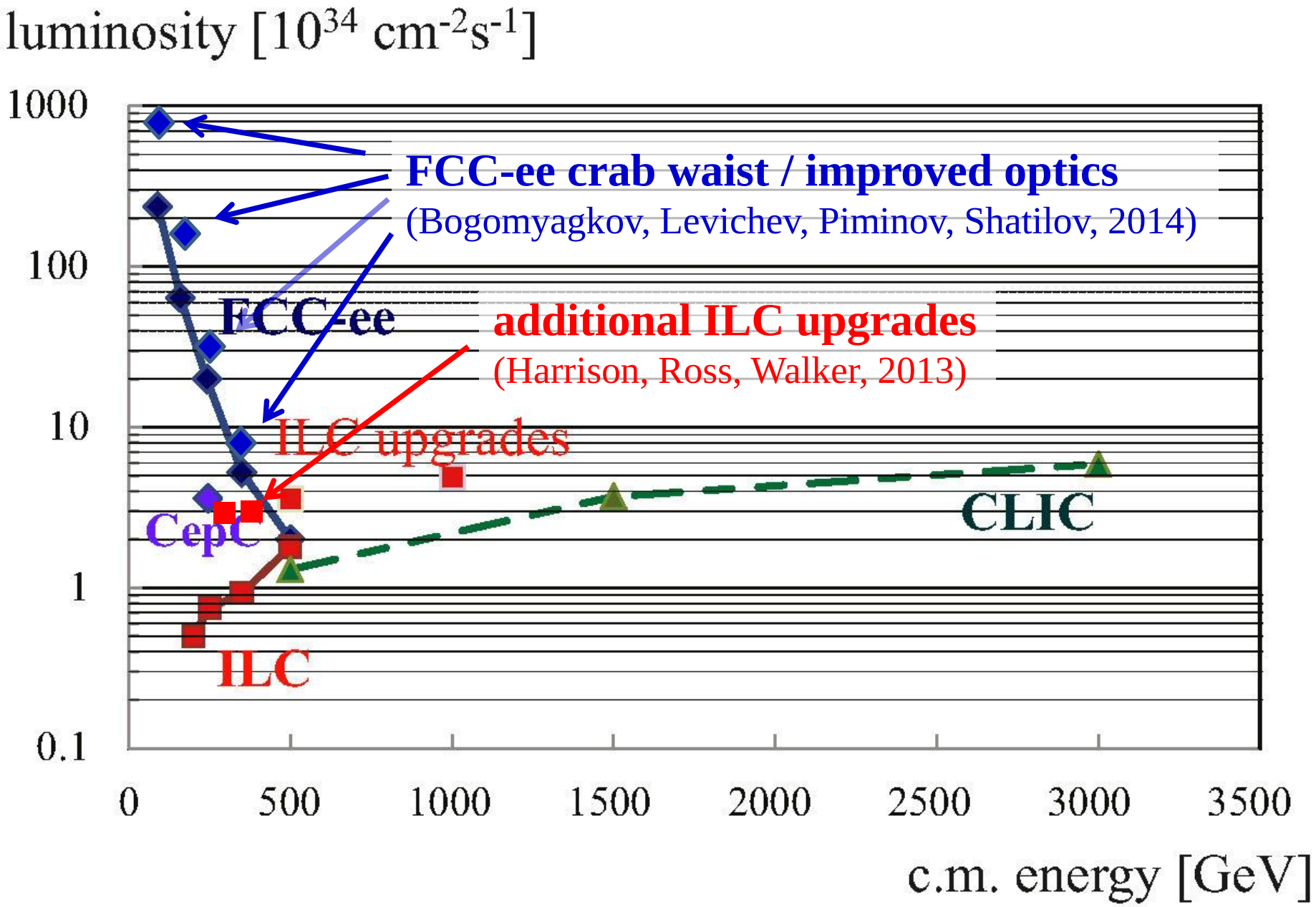
Courtesy W. Fischer

LHC run 1 (2012-13) accumulated more integrated luminosity than all previous hadron colliders together!

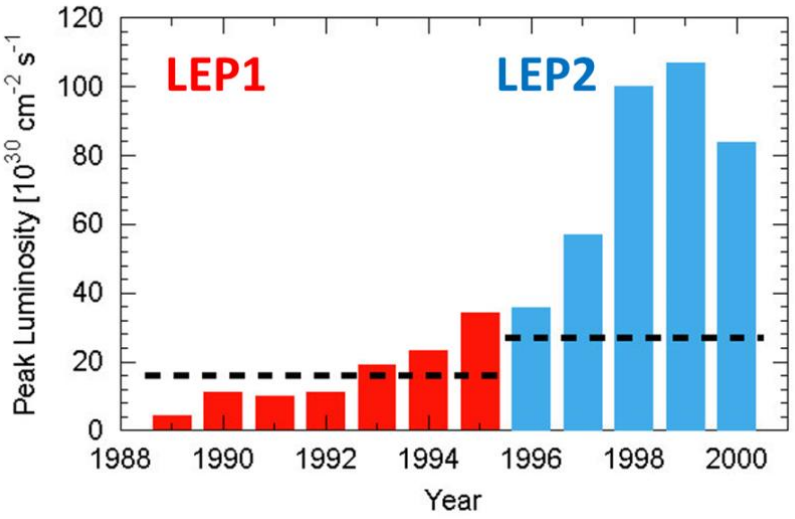
past, future & proposed e^+e^- colliders

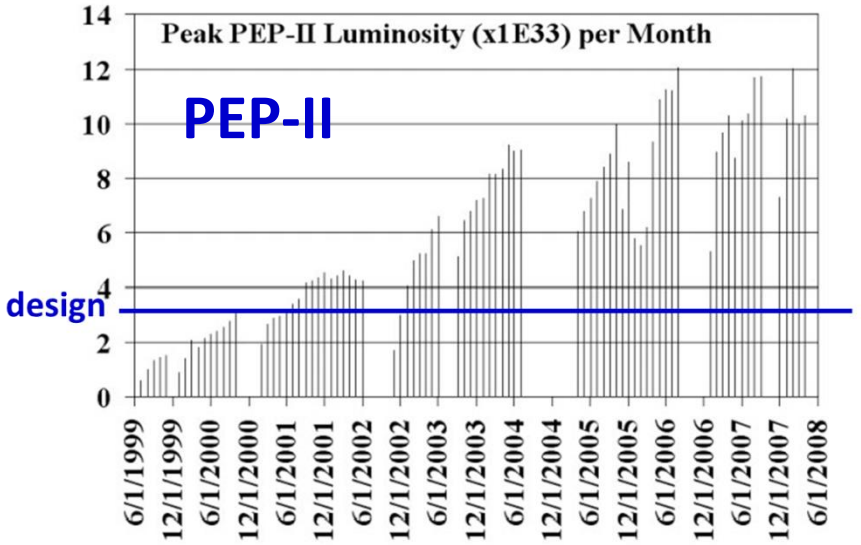


e^+e^- luminosity vs energy

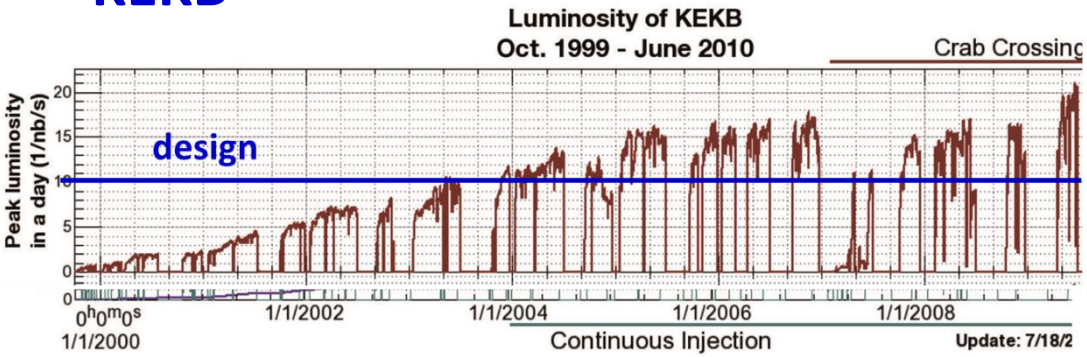


commissioning times & performance of circular e^+e^- colliders

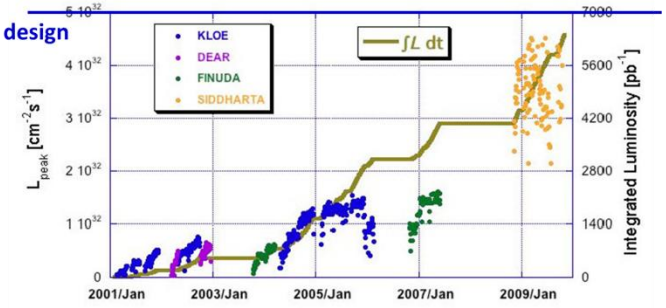




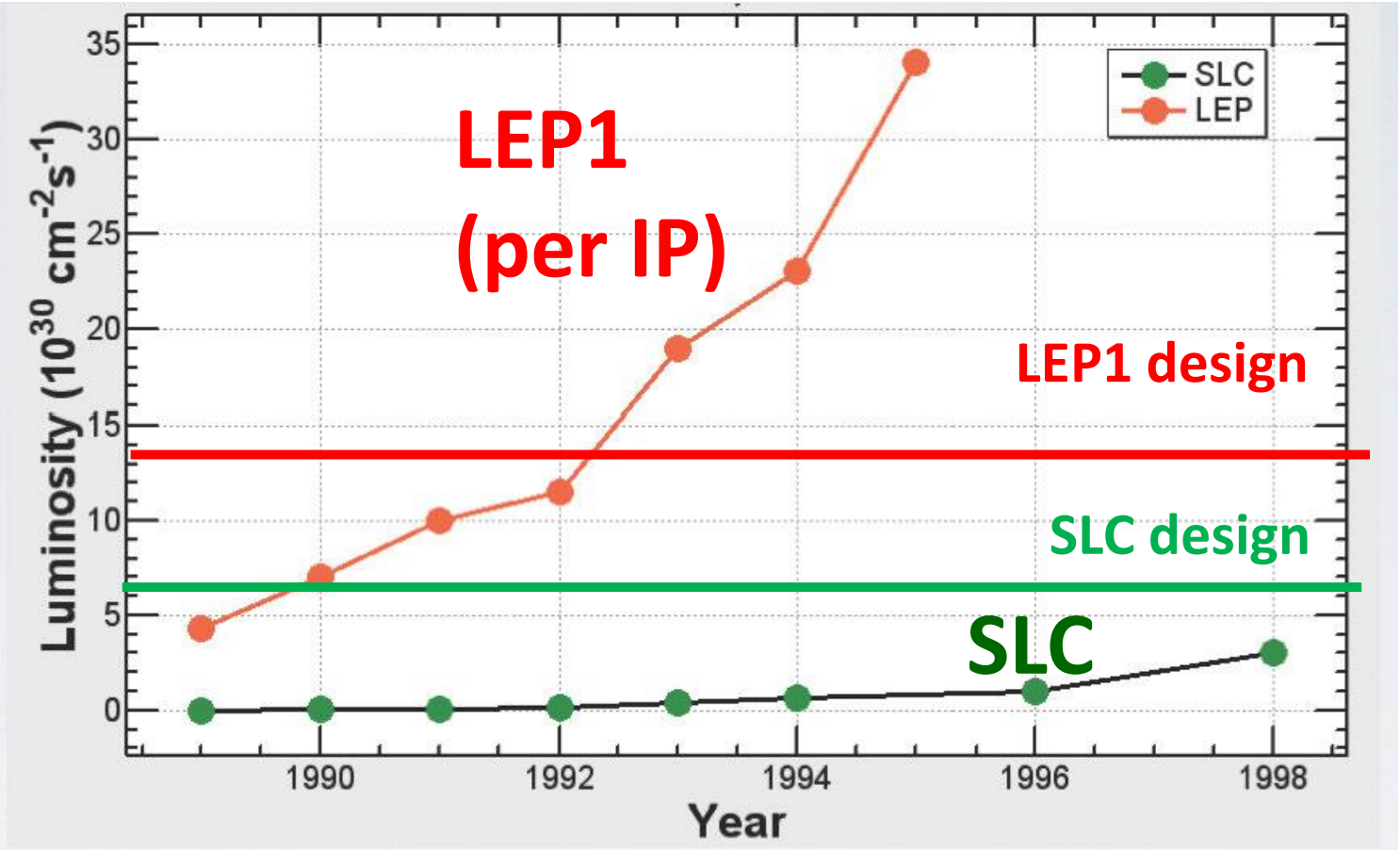
KEKB



DAΦNE



commissioning time & performance of the first linear collider



LEP1+2 total integrated luminosity ~1 fb^{-1} (x4 IPs)

SLC total integrated luminosity ~2 pb^{-1}

CERN-SL-2002- 009 (OP), SLAC–PUB–8042 [K. Oide, 2013]

SLC

- **½ design value reached after 11 years**

"Of course, it should not be the size of an accelerator, but its costs which must be minimized."

Gustav-Adolf Voss,
builder of PETRA
at PAC1995 Dallas
† 5. October 2013

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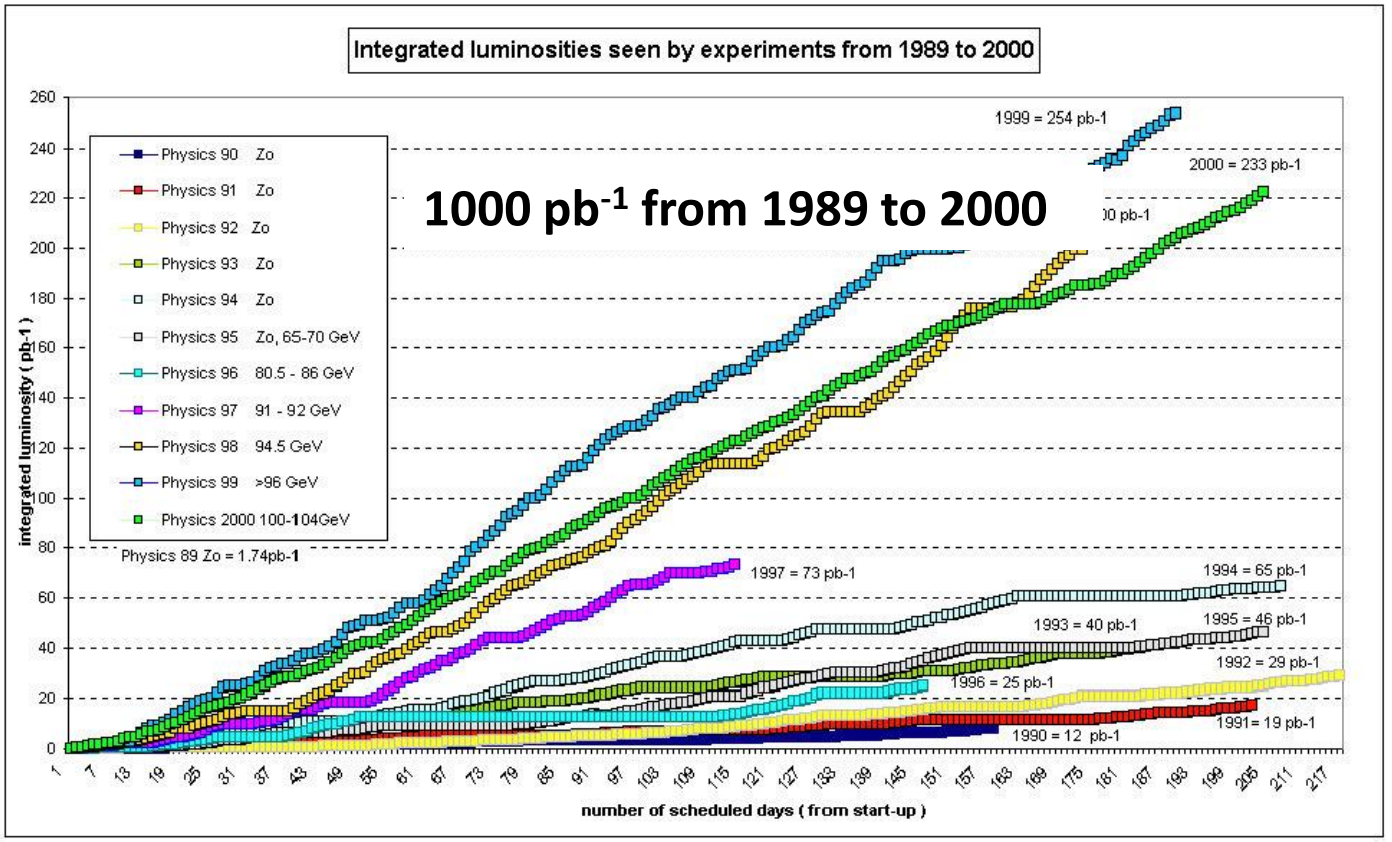
back up

LEP – largest circular e^+e^- collider so far



comparing commissioning times & performance

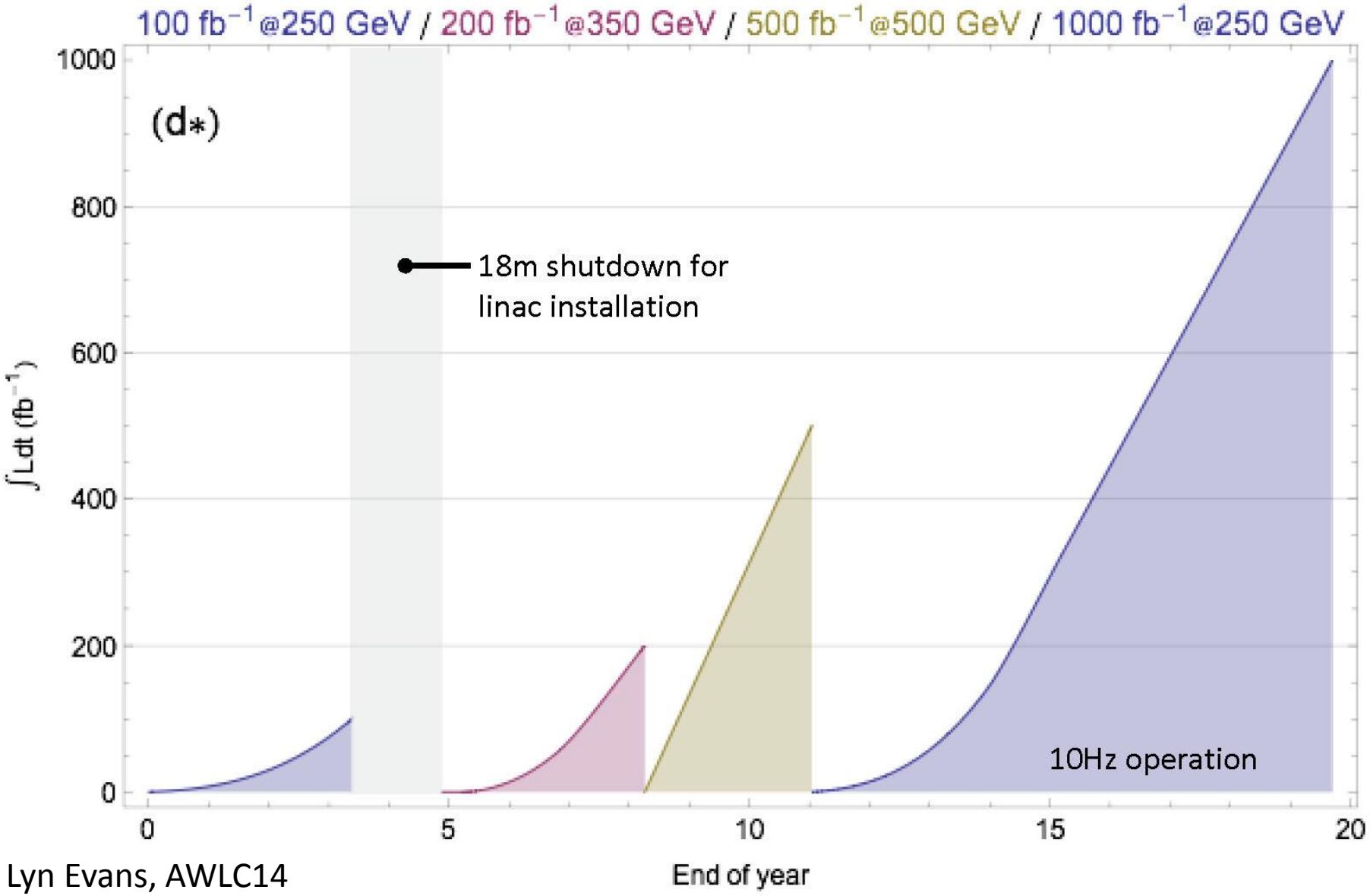
	beam energy [GeV]	design luminosity [10^{32} $cm^{-2}s^{-1}$]	peak luminosity /design	time to achieve design [y]
LEP1	45	0.13	**2**	**5**
SLC	45	0.06	**0.5**	**- (>10)**
LEP2	60-104.5	0.26	**3**	**<0.5**
DAFNE	0.5	5.0	**0.9**	**- (>10)**
PEP-II	9, 3.1	30	**4**	**1.5**
KEKB	8, 3.5	100	**2**	**3.5**
ATF-2	1.28	0.000001(eff.)	**0.005 (eff.)**	- [>4*]

* not counting the year of the earthquake; ATF-2 operating only for fraction of calendar time

parameter	LEP2	FCC-ee					CepC
		Z	Z (c.w.)	W	H	t	H
E_{beam} [GeV]	104	45	45	80	120	175	120
circumference [km]	26.7	100	100	100	100	100	54
current [mA]	3.0	1450	1431	152	30	6.6	16.6
$P_{SR,tot}$ [MW]	22	100	100	100	100	100	100
no. bunches	4	16700	29791	4490	1360	98	50
N_b [10^{11}]	4.2	1.8	1.0	0.7	0.46	1.4	3.7
ε_x [nm]	22	29	0.14	3.3	0.94	2	6.8
ε_y [pm]	250	60	1	1	2	2	20
β^*_x [m]	1.2	0.5	0.5	0.5	0.5	1.0	0.8
β^*_y [mm]	50	1	1	1	1	1	1.2
σ^*_y [nm]	3500	250	32	130	44	45	160
$\sigma_{z,SR}$ [mm]	11.5	1.64	2.7	1.01	0.81	1.16	2.3
$\sigma_{z,tot}$ [mm] (w beamstr.)	11.5	2.56	5.9	1.49	1.17	1.49	2.7
hourglass factor F_{hg}	0.99	0.64	0.94	0.79	0.80	0.73	0.61
L/IP [10^{34} cm^{-2}s^{-1}]	0.01	28	212	12	6	1.7	1.8
τ_{beam} [min]	300	287	39	72	30	23	40

parameter	LHC	HL-LHC	FCC-hh	SppC (May14)
c.m. energy [TeV]	14		100	63
dipole magnet field [T]	8.33		16 (20)	20
circumference [km]	26.7		100 (83)	50
luminosity [10^{34} cm^{-2}s^{-1}]	1	5	5 [→20?]	12
bunch spacing [ns]	25		25 (5)	25
events / bunch crossing	**27**	**135**	**170 (34)**	**373**
bunch population [10^{11}]	1.15	2.2	1 (0.2)	2
norm. transverse emitt. [μm]	3.75	2.5	2.2 (0.44)	3.3
IP beta-function [m]	0.55	0.15	1.1	0.75
IP beam size [μm]	16.7	7.1	6.8 (3)	8.5
synchrotron rad. [W/m/aperture]	0.17	0.33	28 (44)	46
critical energy [keV]	0.044		4.3 (5.5)	2.2
total syn.rad. power [MW]	**0.0072**	**0.0146**	**4.8 (5.8)**	**3**
longitudinal damping time [h]	**12.9**		**0.54 (0.32)**	**1.0**

ILC Energy Staging (example scenario)



Lyn Evans, AWLC14