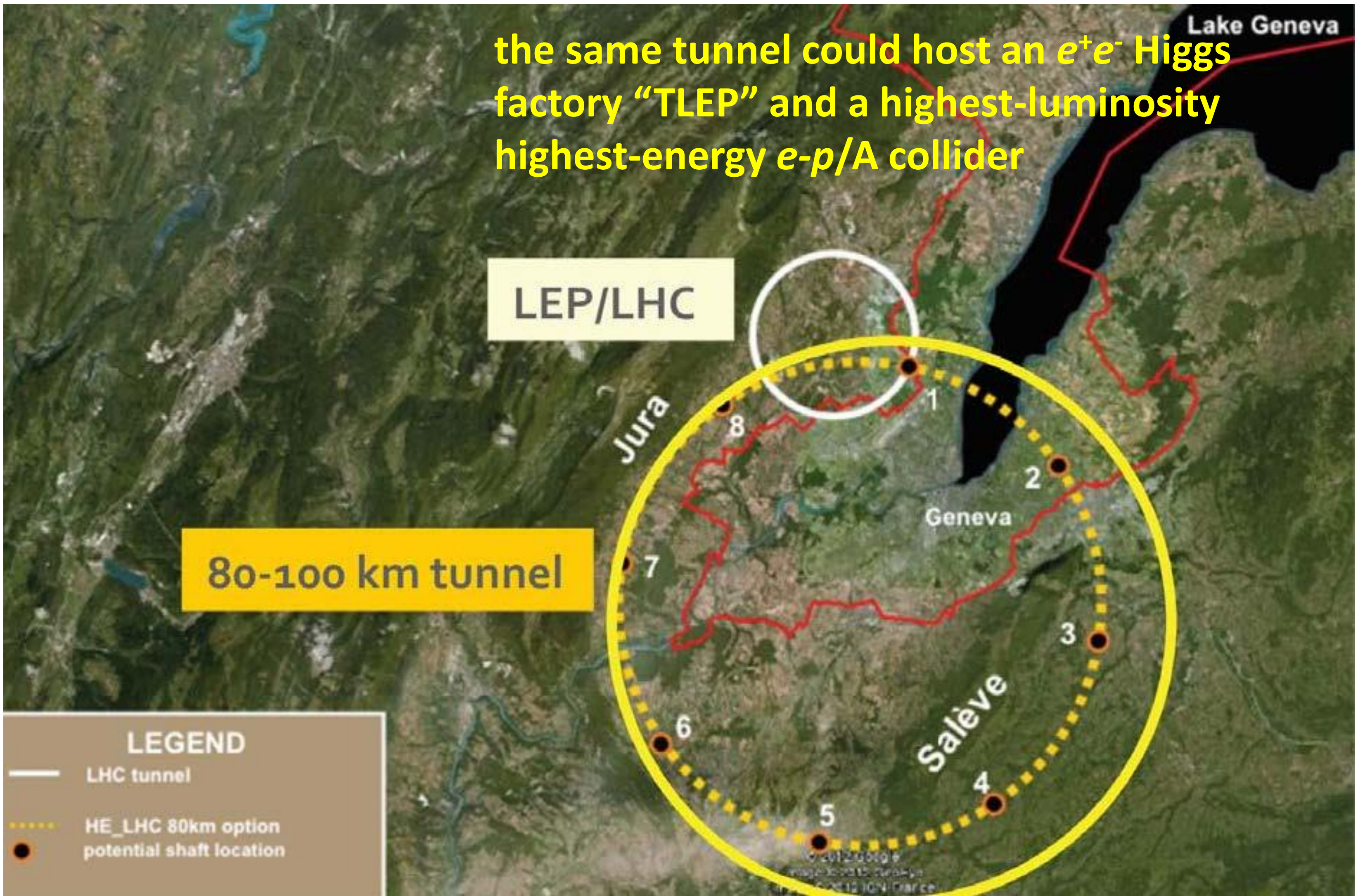
TLEP and Relevant Accelerator Expertise UK



TLEP scenario

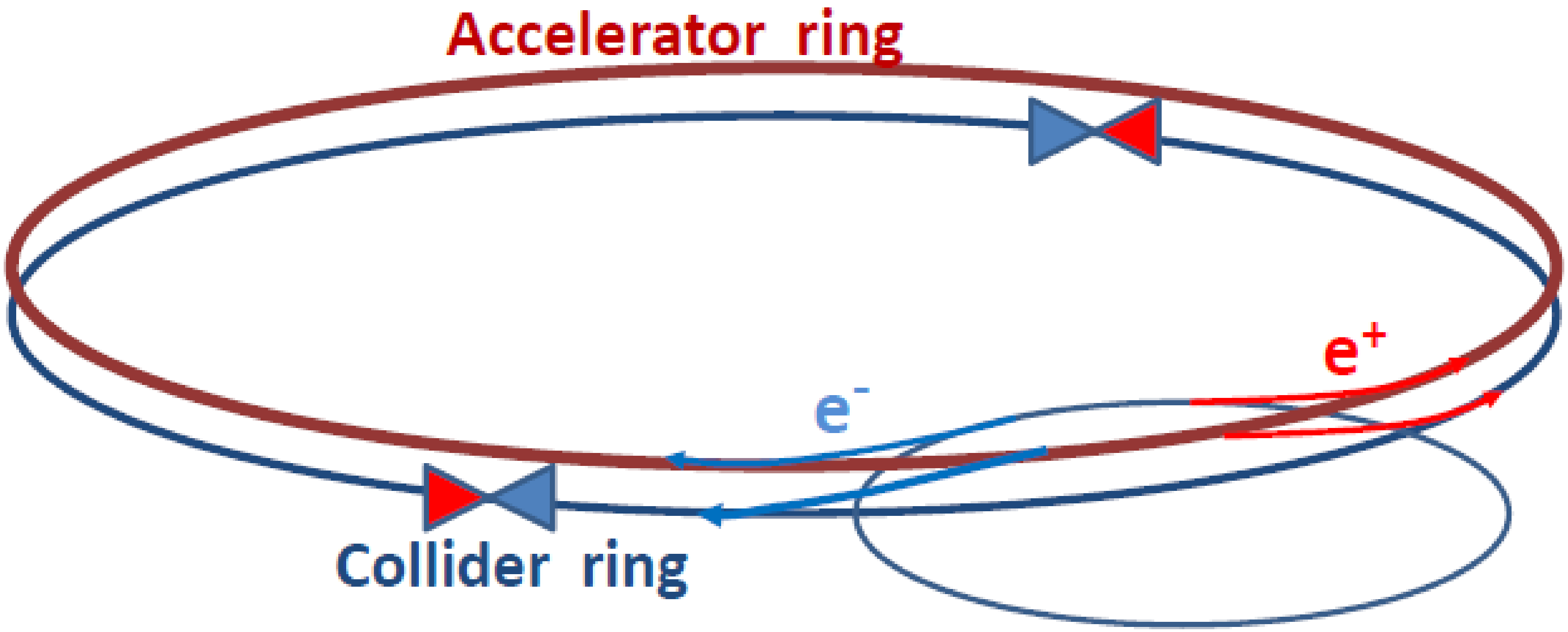
1. 2012: LHC discovers Higgs at 126 GeV

2. Potential for a circular collider "TLEP" in a new 80-100km tunnel: 300X LEP 2 luminosity in 4 IPs (precision Higgs studies)

3. High luminosity made possible by: smaller "low beta", smaller emittance and top-up injection

4. Potentially very high luminosity at Z pole and WW threshold plus polarisation and operation up to tt-threshold

TLEP : circular e^+e^- collider to study the Higgs boson



short beam lifetime ($\sim\tau_{LEP2}/40$) due to high luminosity
supported by top-up injection (used at KEKB, PEP-II, SLS,...)

TLEP beam lifetime: two limits

1. Radiative Bhabha scattering

($\sigma \approx 0.215$ barn)

LEP2: $\tau_{beam,LEP2}$ **~ 6 h**

TLEP **with L~5x10^{34} cm^{-2}s^{-1} at 4 IPs**:

$\tau_{beam,TLEP}$~21 minutes, unavoidable

2. Beamstrahlung (synchr. rad. during the collision)

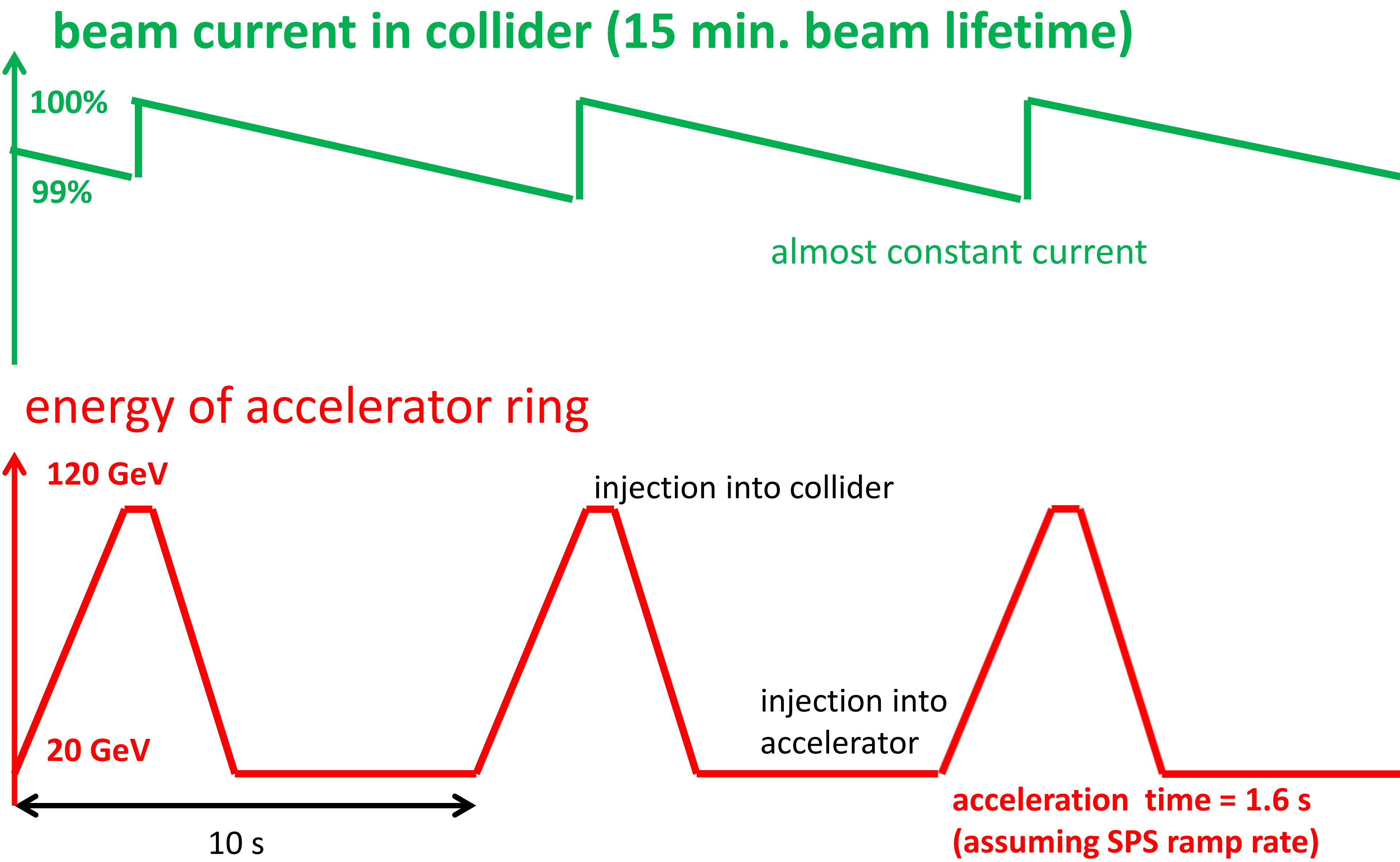
mitigated by:

(1) large momentum acceptance η

(2) flat beams [i.e. small ε_y & large β_x^*]

(3) fast replenishing

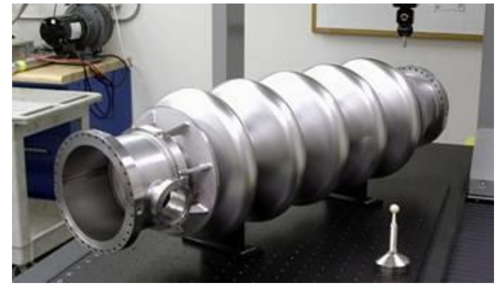
Top-up injection: schematic cycle



other TLEP challenges

- **efficient RF system**
  - need 12 GeV/turn at 350 GeV
    - **~600 m of SC RF cavities @ 20 MV/m**
      - **LEP2 had 600 m at 7 MV/m**
  - very high power : up to 200 kW / cavity in collider ring
    - **power couplers similar to ESS** – 700-800 MHz preferred

BNL 5-cell 700 MHz cavity



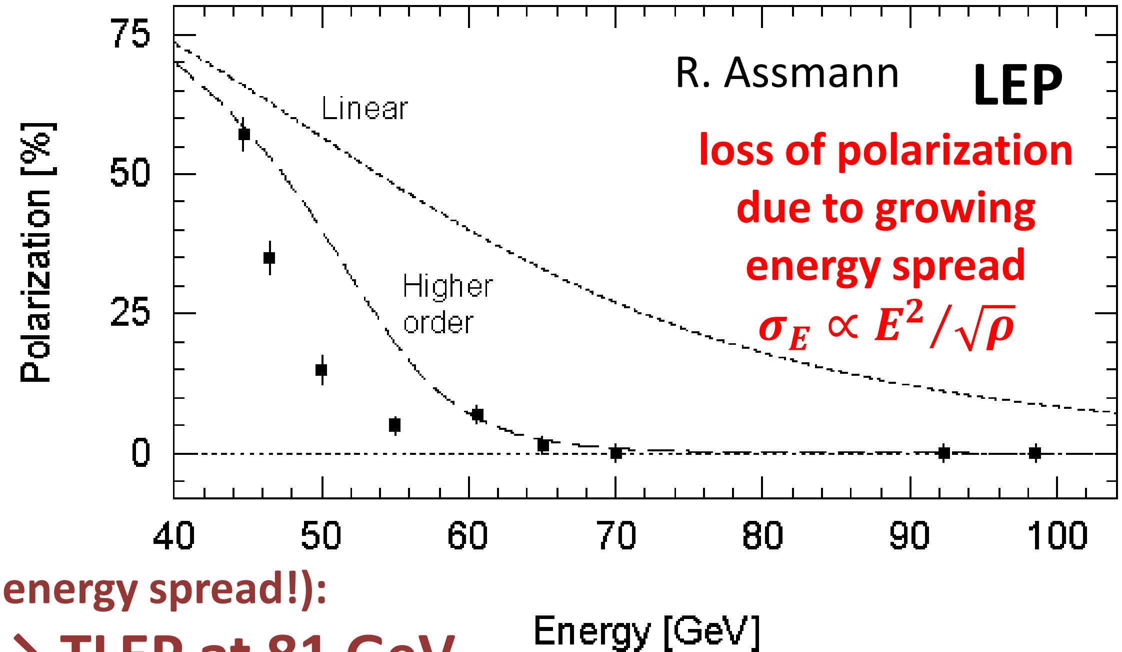
RF Coupler (ESS/SPL)

- **operation at *Z* pole**
  - 7500 bunches : e^+ source, impedance effects, parasitic collisions
    - **two separate rings for e^+ and e^- beams will help here too**

polarization

LEP

observations
+ model predictions



polarization scaling (energy spread!):

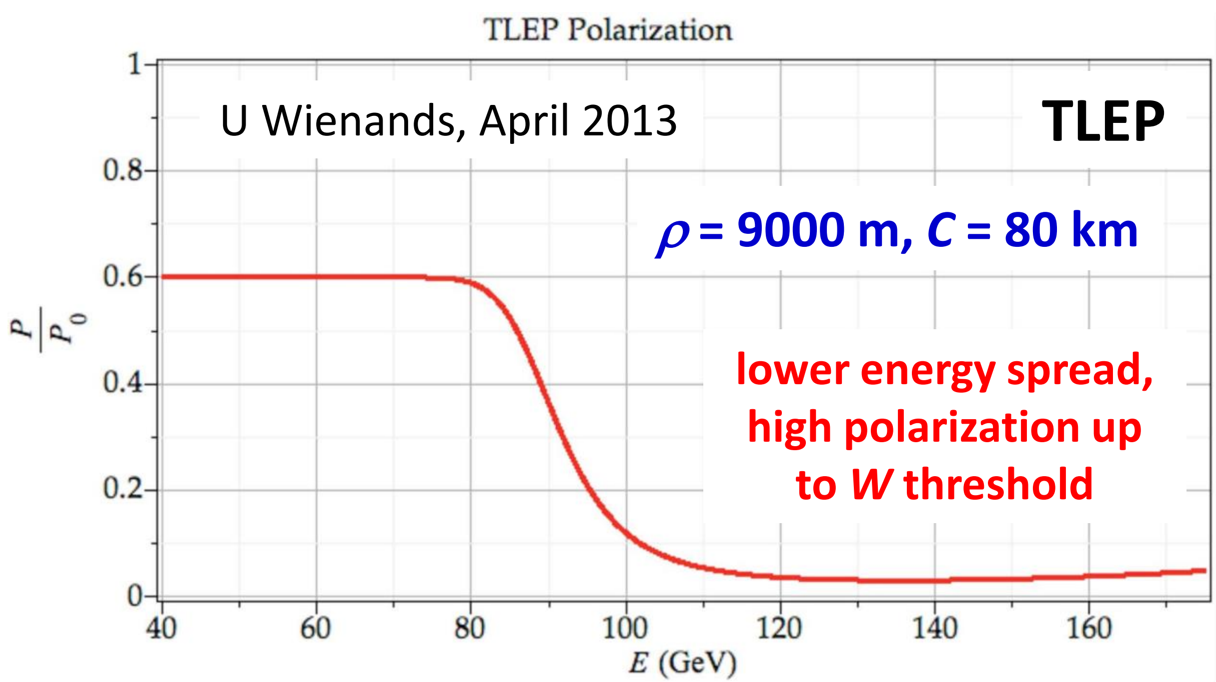
LEP at 61 GeV → TLEP at 81 GeV

TLEP

optimized scenario

➔ **100 keV beam energy calibration by resonant depolarization (using pilot bunches) around *Z* peak and *W* pair threshold:**

Δm_Z ~0.1 MeV, $\Delta\Gamma_Z$ ~0.1 MeV, Δm_W ~ 0.5 MeV



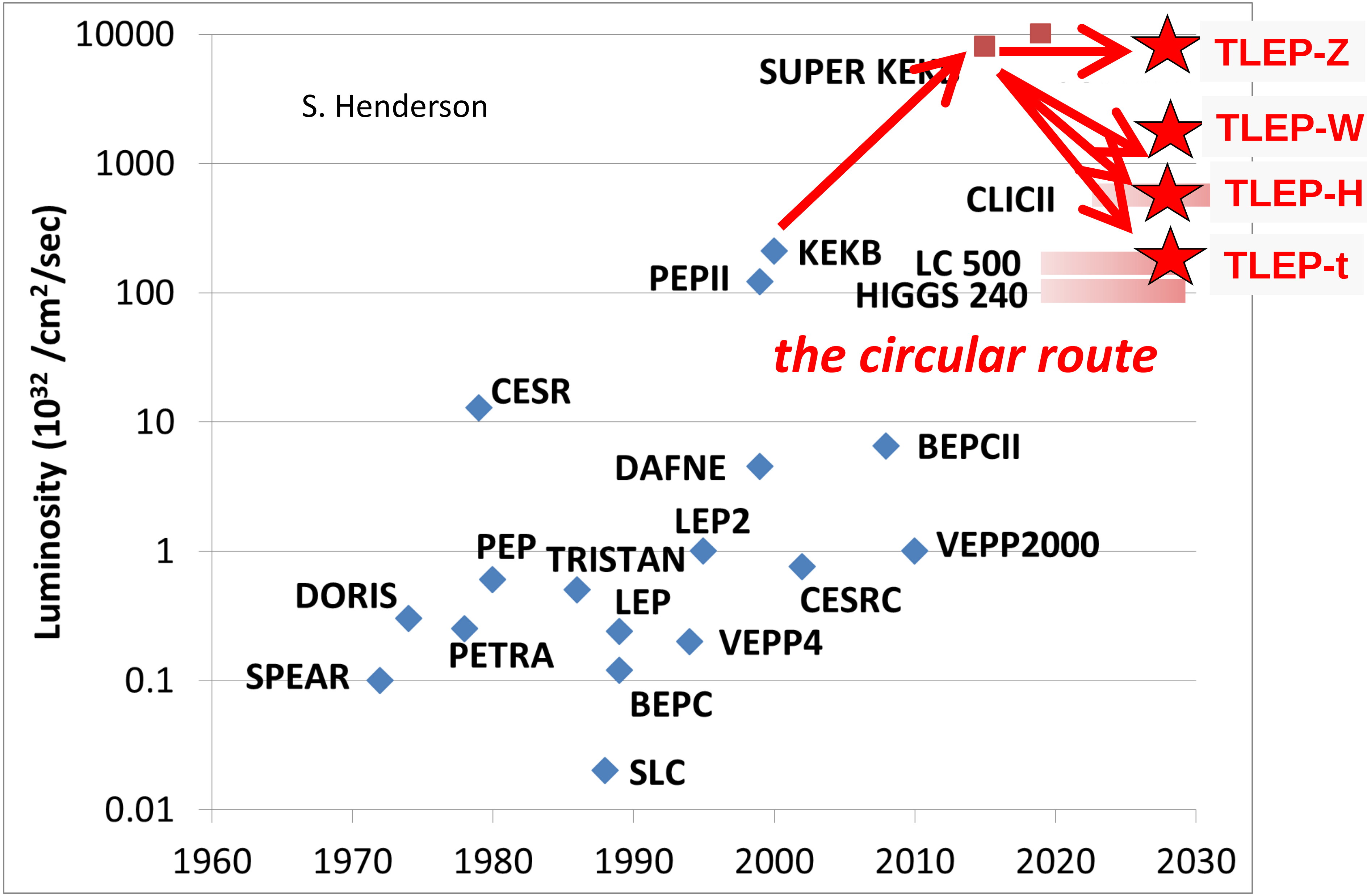
A. Blondel

parameters	TLEP Z	TLEP W	TLEP H	TLEP t	
$E_{c.m.}$ [GeV]	**91**	**160**	**240**	**350**	
beam current [mA]	**1440**	**154**	**29.8**	**6.7**	
# bunches/beam	7500	3200	167	160	20
#$e-$/bunch [10^{11}]	4.0	1.0	3.7	0.88	7.0
ε_x, ε_y [nm]	29.2, 0.06	3.3,0.017	7.5, 0.015	2, .002	
$\beta^*_{x,y}$ [mm]	500, 1	200, 1	500, 1	1000, 1	
$\sigma^*_{x,y}$[μm]	121, 0.25	26, 0.13	61, 0.12	45,.045	126,.13
$\sigma^{tot}_{z,rms}$ [mm] (w BS)	2.93	1.98	2.11	0.77	1.95
E^{SR}_{loss}/turn [GeV]	0.03	0.3	1.7	7.5	
V_{RF},tot [GV]	2	2	6	12	
$\xi_{x,,y}$/IP	0.068	0.086	0.094	0.057	
$\mathcal{L}$ /IP[10^{34}cm^{-2}s^{-1}]	**59**	**16**	**5**	**1.3**	**1.0**
#IPs	**4**	**4**	**4**	**4**	
τ_{beam}[min] (rad.B)	99	38	**24**	**21**	**26**
τ_{beam}[min] (BS,η=2%)	>10^{25}	>10^{6}	**38**	**14**	**2**

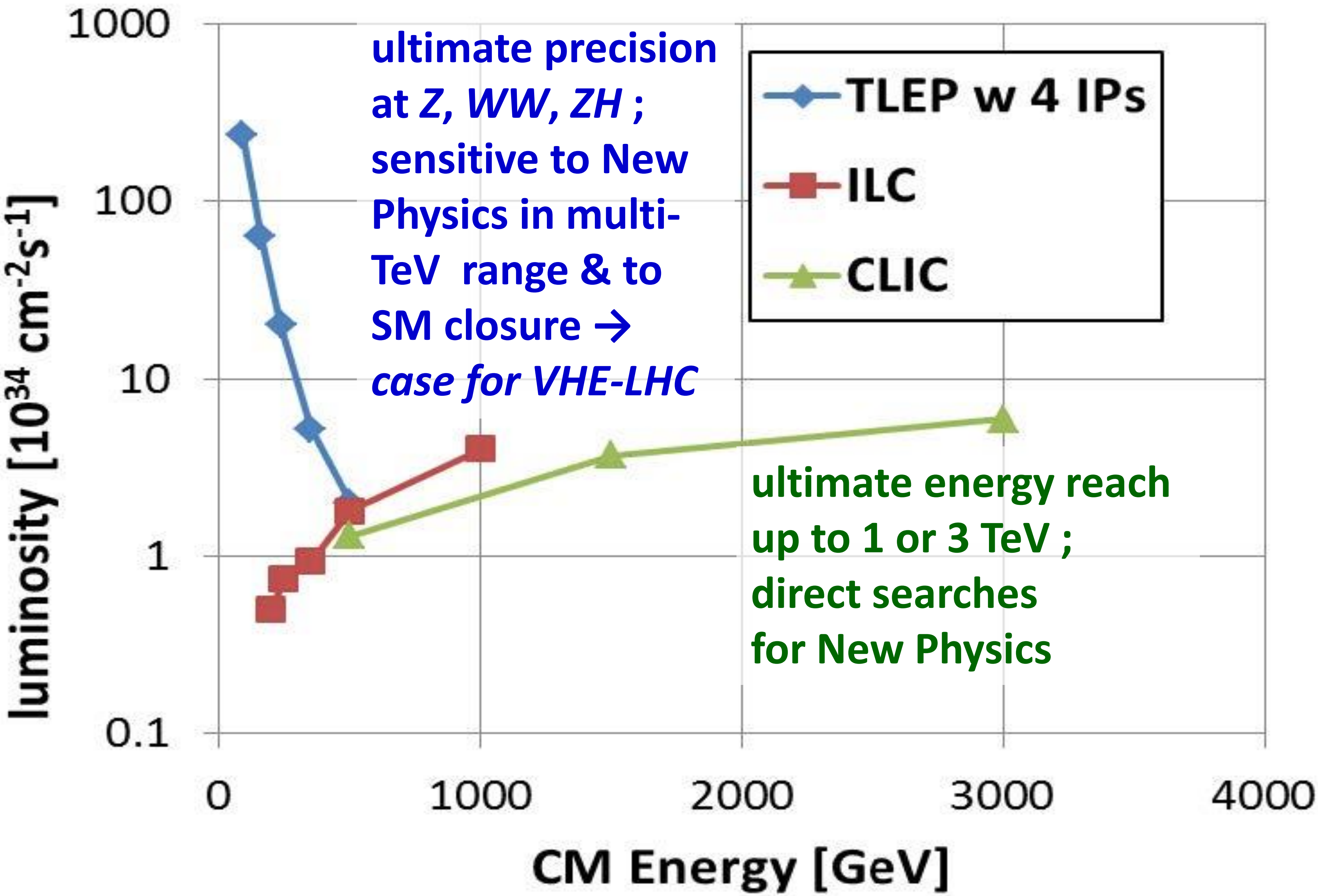
parameters	TLEP W	TLEP H	TLEP t		ZHH&ttH
$E_{c.m.}$ [GeV]	160	240	350		**500**
beam current [mA]	154	29.8	6.7		**1.6**
# bunches/beam	3200	167	160	20	10
#$e-$/bunch [10^{11}]	1.0	3.7	0.88	7.0	3.3
ε_x, ε_y [nm]	3.3,0.017	7.5, 0.015	2, .002		4., 0.004
$\beta^*_{x,y}$ [mm]	200, 1	500, 1	1000, 1		1000, 1
$\sigma^*_{x,y}$[μm]	26, 0.13	61, 0.12	45,.045	126,.13	63, 0.063
$\sigma^{tot}_{z,rms}$ [mm] (w BS)	1.98	2.11	0.77	1.95	1.81
E^{SR}_{loss}/turn [GeV]	0.3	1.7	7.5		31.4
V_{RF},tot [GV]	2	6	12		35
$\xi_{x,,y}$/IP	0.086	0.094	0.057		0.075
$\mathcal{L}$ /IP[10^{34}cm^{-2}s^{-1}]	16	5	1.3	1.0	**0.5**
#IPs	4	4	4		**4**
τ_{beam}[min] (rad.B)	38	24	21	26	**13**
τ_{beam}[min] (BS,η=2%)	>10^6	38	14	2	**3 (η=3%)**

TLEP energy upgrade

luminosity - past&planned e^+e^- colliders



e^+e^- Higgs factories: luminosity



UK Expressions of Interest

Leonidopoulos Christos, University of Edinburgh ;
Glover Nigel, Durham University ;
Burt Graeme, Cockcroft Institute (Lancaster);
Owen Hywel, Cockcroft Institute (Manchester);
Krauss Frank, Durham University ;
Wolski Andrzej, Cockcroft Institute (Liverpool);
Boehm Celine, Durham University ;
Campanelli Mario, University College London ;
Ellis John, King's College London ;
Khoze Valeri, Durham University ;
Sanz Veronica, University of Sussex ;
Chattopadhyay Swapan, Cockcroft Institute ;
Moretti Stefano, University of Southampton ;
Oh Alexander, University of Manchester ;
Appleby Robert, Cockcroft Institute (Manchester);
Lenz Alexander, Durham University ;
Kar Deepak, University of Glasgow
Susan Smith, Cockcroft Institute (STFC/ASTeC)

UK Accelerator Expertise

1. General High Energy Collider Designs (e.g. LHC, HL-LHC, ILC, CLIC, Super-B,…)
2. Accelerator Lattice and Optics Optimization
3. Linear and Nonlinear Beam and Collision Dynamics
4. Low and High Power Radio Frequency Design and Systems
5. Machine-Detector Interface
6. Collimation
7. Polarization

TLEP UK capacity at present

1. There is comprehensive expertise in UK in all aspects of high energy lepton and hadron colliders;

2. This expertise resides in UK at many places: Cockcroft Institute, John Adams Institute, STFC/ASTeC, Imperial College, UCL, Rutherford and Daresbury Labs, etc;

3. About half a dozen well known international accelerator experts from the Cockcroft Institute, UK have shown interest in TLEP and are keeping abreast of the developments. Potentially, there could be many more that could be registered;

4. Despite this existing "capability", the UK "capacity" to contribute to TLEP developments directly is very limited due to significant involvement of UK accelerator scientists in other accelerator developments at CERN (e.g. Hi-Lumi LHC, CLIC, proton-driven plasma acceleration experiment AWAKE, anti-proton facility developments, accelerators for medicine, etc.) as well as off-shore activities such as COMET and g-2 experiments etc.

5. The accelerator experts in UK will support the initiatives taken by the UK particle physicists as prioritised by the community and as financially enabled by the funding bodies such as the UK research councils (STFC) and by CERN directly.