THERA: Options and Parameters

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THERA Workshop
DESY
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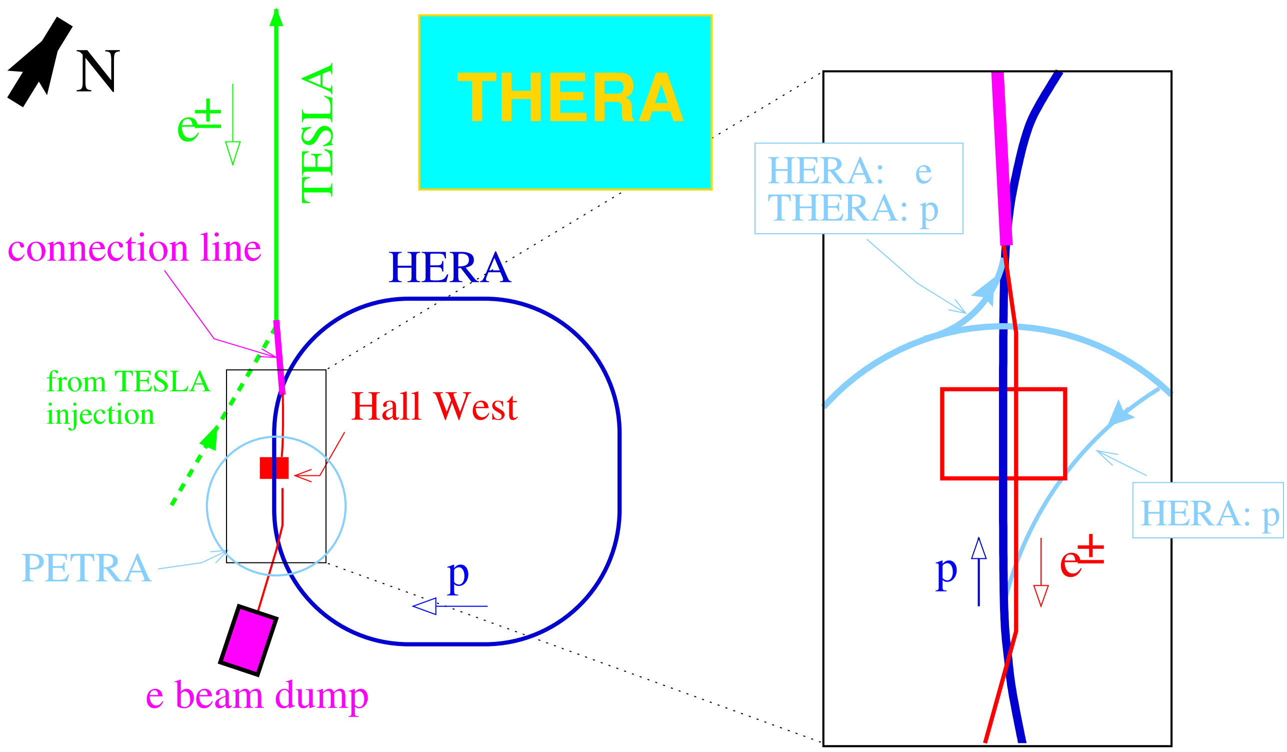
- Accelerator complex
  - Modifications of the HERA proton ring
  - New components
- THERA specifications
  - running modes
  - parameters
- Interaction zone

Results of a meeting of some THERA proponents
with F. Willeke and R. Brinkmann
on Wednesday, 12.04.2000

The THERA complex



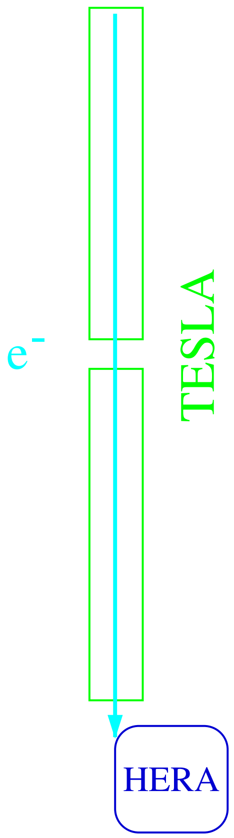
HERA p-ring and tunnel modifications

- Reverse proton direction
  - New magnets for p injection to HERA (7 T or new tunnel)
  - Move p dump or beam kickers
- ep beam separation, new p focusing
- Option: Additional RF to reduce p emittance
- Transfer e beam into and out of HERA tunnel

New components

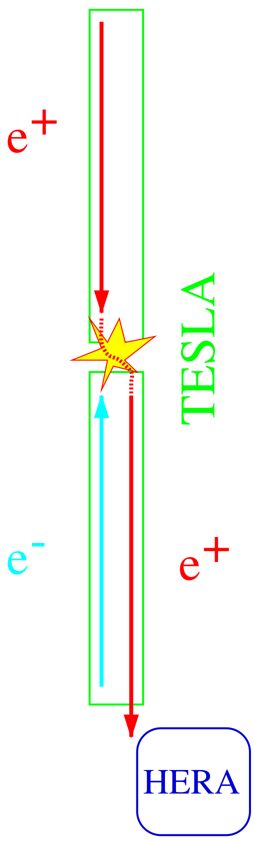
- Transfer line from TESLA to HERA
  - civil engineering, not on DESY area
  - no active beam line elements
  - "thin" tube might be sufficient
- e beam dump
  - $1 \times 1 \times 8\,\mathrm{m}^3$ H_2O in 4 m concrete walls
  - tunnel HERA→dump
  - not clear whether sufficient space on DESY area

THERA running modes



Dedicated mode

+ Use full length of TESLA, get maximal energy and beam power
+ No modification of TESLA necessary
− TESLA (e^+e^-) and THERA (ep) operation mutually exclusive
− Only e^- available, e^+ production needs high-energy e^- beam at "far end" of TESLA (reduces luminosity by factor 2)
− Full TESLA energy probably not usable (beam separation)



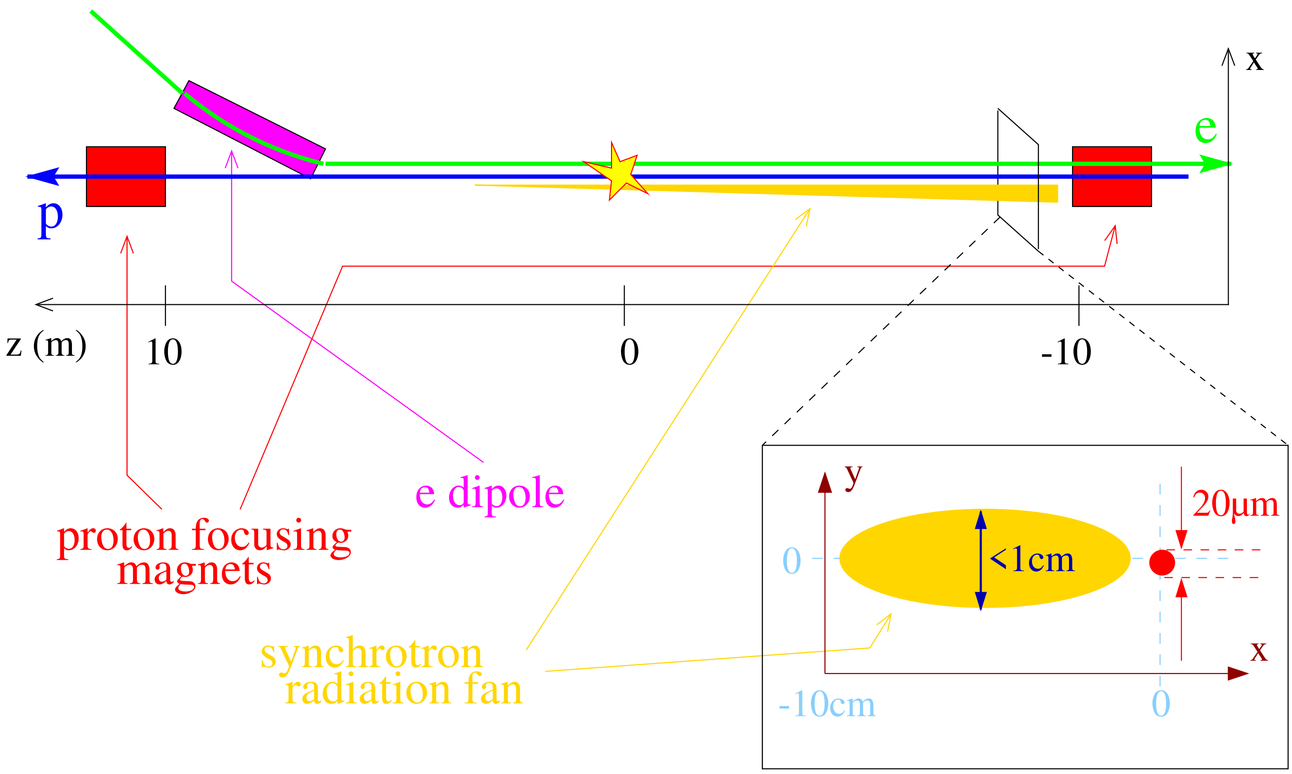
Parasitic mode

+ Simultaneous operation of, TESLA and THERA, no efficiency or luminosity loss for TESLA
+ Relaxes time constraints for THERA
− Requires extra beam line in one TESLA arm (moderate effort)
− Only e^+ available
− Maximal e energy and beam power 50% lower than for dedicated mode
− Transport of e^+ beam through e^+e^- interaction region difficult, induces radiation and energy spread

THERA parameters

bunch structure	TESLA: trains of 2800 bunches, Δt=337 ns, 950 µs/train, repetition rate 5 Hz; HERA: time structure enforced by DESY3: Δt=96 ns $\times$ $(11/n)$ (Δt=352 ns for n=3); HERA and TESLA can be matched
e beam energy	Parasitic: limited to $\sim$ 400 GeV Dedicated: TESLA allows $\sim$ 800 GeV But: $E_e \lesssim$ 500 GeV required for beam separation
luminosity	Standard: $10^{30}\,\mathrm{cm^{-2}\,s^{-1}}$ ($10\,\mathrm{pb^{-1}}$/y) Possible: enhancement by factor $2-4$ by reducing p emittance; substantial effort (RF, ...) Further increase: R&D beyond current concepts (proton cooling) Warning: $\mathcal{L} \times E_e \sim$ const.
polarization	Electrons: no obvious problems to transfer polarization from TESLA to THERA Protons: studied as future HERA option; active R&D program at DESY; slightly easier for THERA since no vertical bends?

THERA interaction region



beam elements:	protons: $\sim$ 10 m from IP preferred: symmetric setup, superconducting lenses
interaction zone:	longitudinal: proton-dominated, like in HERA ($\sim$ 10 cm) transverse: circular, diameter $\sim$ 20 μm
sync. radiation:	a fan of ca. 10 cm $\times$ 1 cm at 10 m distance from I.P.
crossing angle:	head-on collisions preferred

- √ measurements at $\theta \sim 0.5^\circ$ possible with (almost) 2π coverage
- √ e, γ and p taggers possible
- √ vertex constraint useful for heavy-flavor measurements

Conclusions

Construction of THERA appears to require moderate extra effort compared to TESLA project

No obvious show-stoppers from machine side

THERA and TESLA could run concurrently ("parasitic mode"), implies e^+ mode

Dedicated THERA mode possible with e^-, maybe e^+

Luminosity of 10 $\mathrm{pb}^{-1}/\mathrm{y}$ seems feasible, more will need extra effort and dedicated R&D

e polarizatrion seems possible, p polarizatrion maybe

Interaction region will allow to measure at 0.5°

Accessible region $\sim$ 10 m from I.P.

e, γ and p taggers possible

We need good physics arguments to trigger large efforts!