More on ERL machine parameter list
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Ultimate Storage Ring's (USRLS) impressive list of projected parameters:

Emittance_hor = 300 pm-rad;
Emittance_ver = 3 pm-rad;
Current = 200 mA;
Energy spread $\geq 5 \cdot 10^{-4}$
Bunch length = 21 ps

USRLS is an Ultimate **Limit** Storage Ring Light Source.

What is the Ultimate Limit for ERL machine?

Key issue is the brightness of ERL electron gun

Claimed normalized rms gun emittance in the white paper 100 mA (@ 77 pC / bunch) was **2 mm-mrad**. But we believe that there is <u>room for considerable improvement!</u>

JLAB DC gun measured emittance @ 80 pC is 1 mm-mrad at the exit of the injector. They need only 13 mm-mrad.

<u>Space for improving ERL injector emittance</u>

Here are the results of the first round studies of the limit to the achievable emittance from injector (operated at 1.3 GHz):

100 mA (@ 77 pC / bunch) …………………………… **0.3 mm-mrad**
25 mA (@ 20 pC / bunch) …………………………… **0.15 mm-mrad**

Thus, accelerator physics figures of merit (independent of IDs specifications) expected from the envisioned ERL machine at 5 GeV are <u>by no means trivial</u>:

- @ 77 pC / bunch (100 mA of CW operation)
  Ave. current / (Emittance_hor*Emittance_ver) = **100 mA / (30 pm-rad)^2**
- @ 20 pC / bunch (25 mA of CW operation)
 Ave. current / (Emittance_hor*Emittance_ver) = **40 mA / (15 pm-rad)^2**

Also, ERL parameters mentioned earlier:
  Energy spread $\leq$ **10^{-4}**
  Pulse length $\leq$ **1 ps**

Once again, some advantages distinctive for ERL concept:

➢ Short pulses & flexibility of operation
➢ Emittance can be scaled with current (e.g. 3 guns with 77 pC, 40 pC, 10 pC charge / bunch)
➢ Flexible layout design (some of the ideas now under investigation)

Two pass machine

Four / Six pass machine

Tadpole machine

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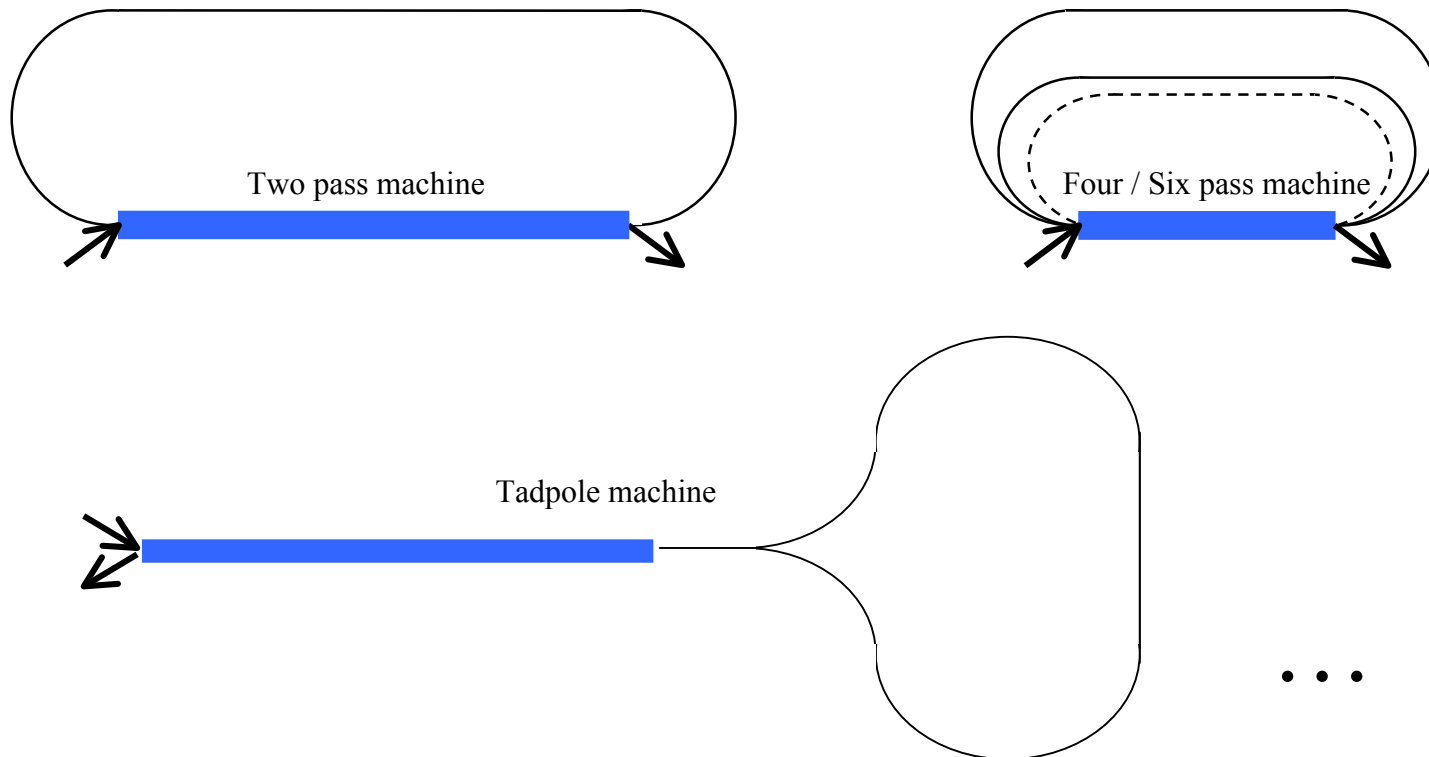
Yesterday
What science can benefit from ERL machine?

Today
What science can ERL machine benefit from?

Science that utilizes the following wonderful features of ERL machine in suggested priority order:

➤ Short pulses ($\leq$ 1 ps)

➤ High repetition rate (1.3 GHz)

➤ Time pulse structure variability

➤ High Brightness / Partial Coherence

➤ High Flux