In-situ polarization-sensitive detectors for ultracold neutrons **(UCN)**
…toward next-generation **neutron electric dipole moment** experiments

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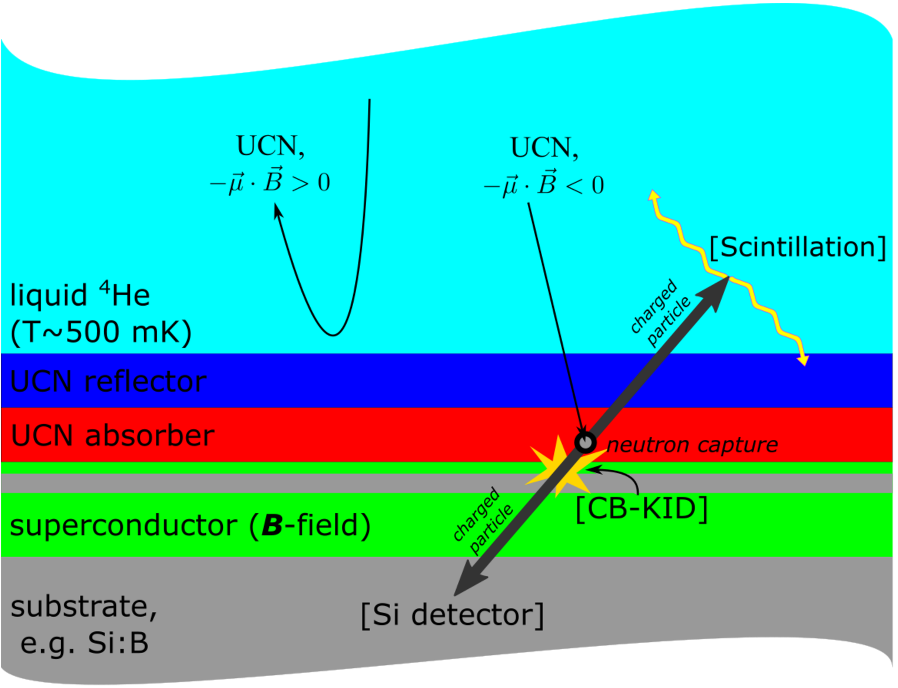
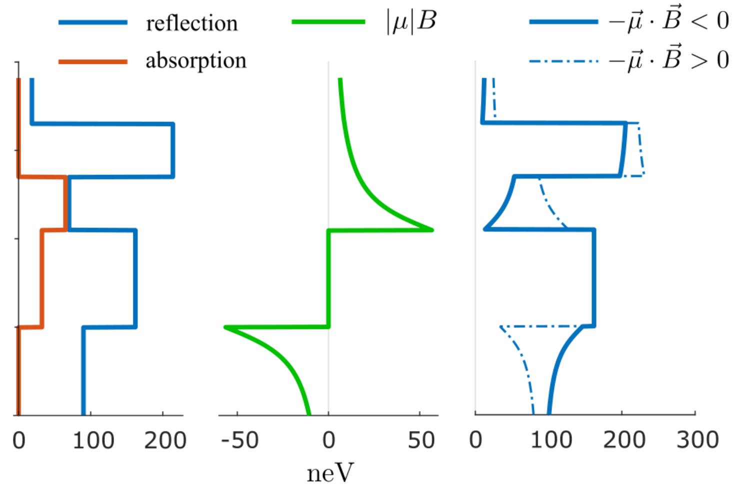
*Neutron energies < 250 × 10^-9^* eV

Present day: *1 order of magnitude lost as ~meV "cold" neutrons*
2 orders of magnitude lost via extraction from sources

…a possible solution: in-situ experiments in "Superthermal" UCN sources, using superfluid ^{4}He as production and storage medium

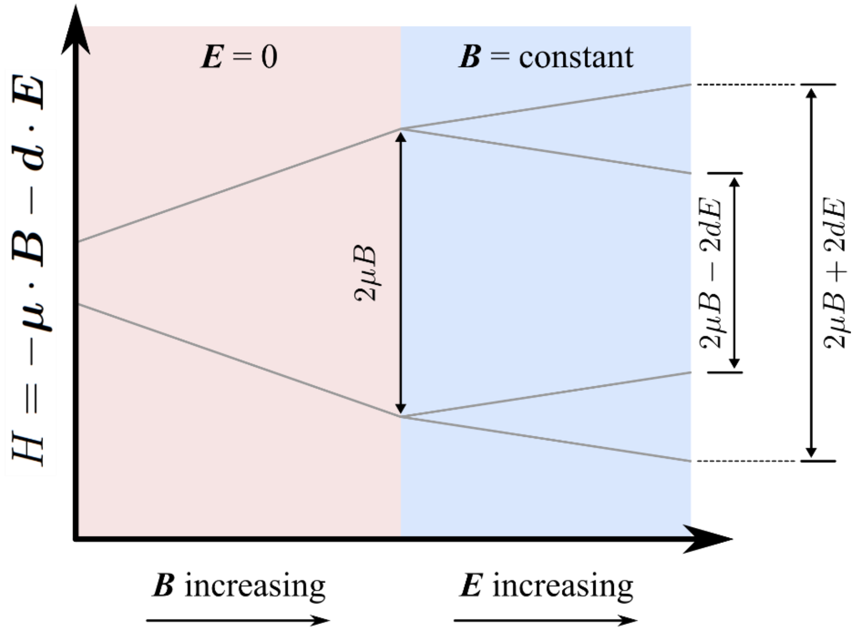


Ultracold neutron (UCN) detection with polarization-sensitivity, via applied magnetic fields partially cancelling the neutron-optical potential for one spin state. Various readout mechanisms to be explored.



Target precision: |d|~ 10^-29^ e cm,
*i.e. |dE|< 10^-24^* eV, *for E ~ 8* MV/m

In-situ detectors must distinguish spin-up and spin-down UCN:

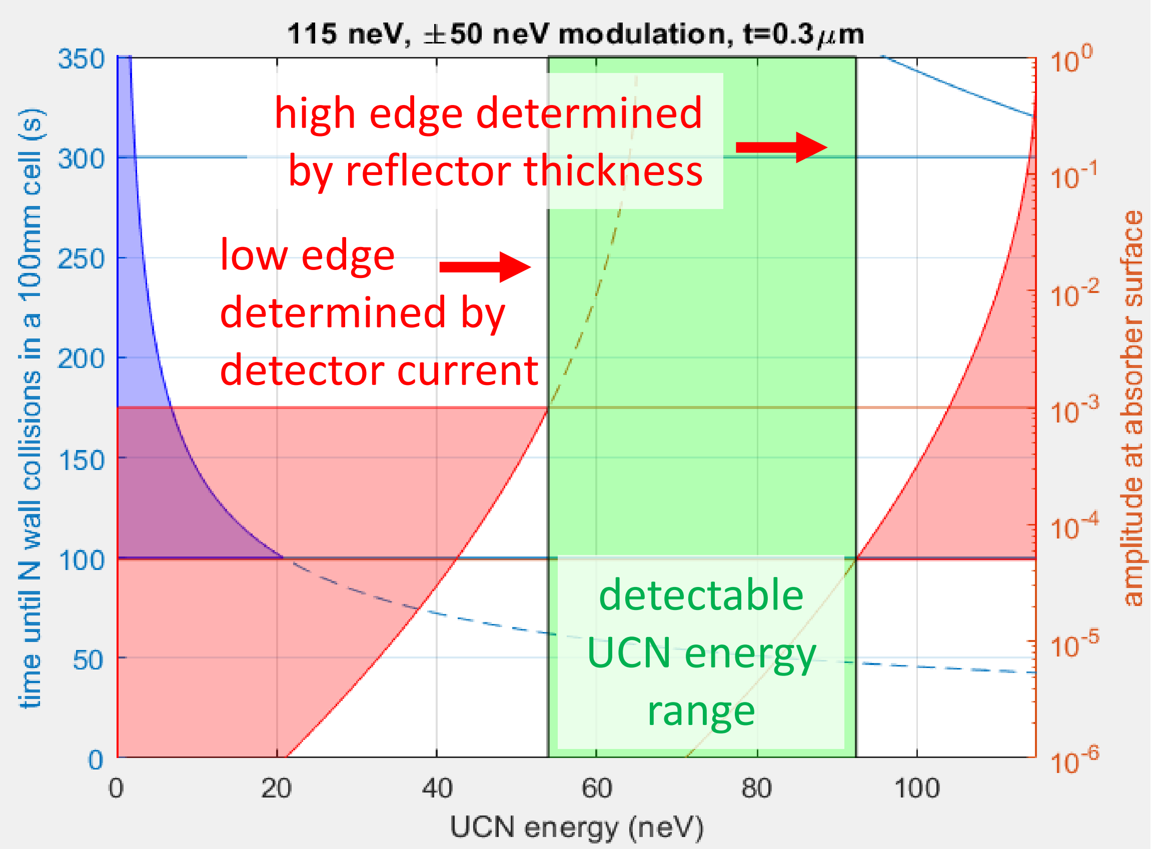


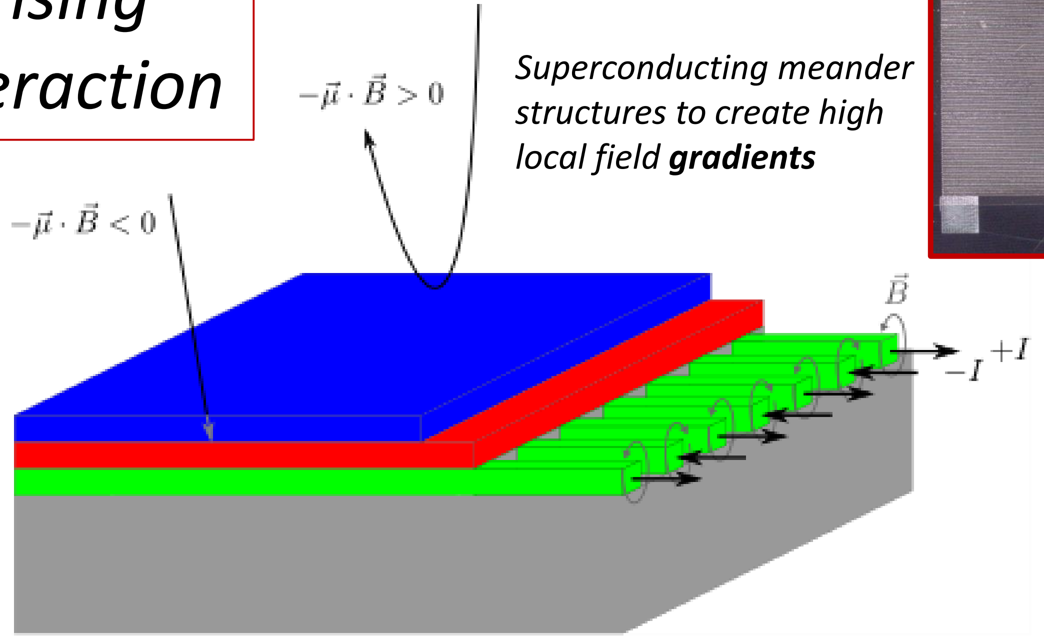
Polarization-sensitivity arising from spin-dependent interaction

Parameter space for UCN detection at different kinetic energies:

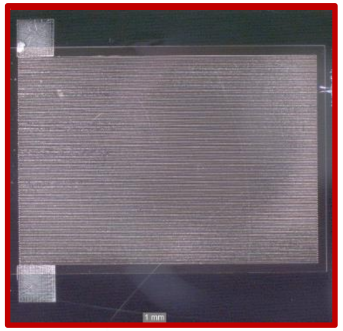
-Detection efficiency strongly affected by absorber thickness.

-Limited energy sensitivity, via choice of operating current: magnetic-field-dependent tunneling rate through reflector

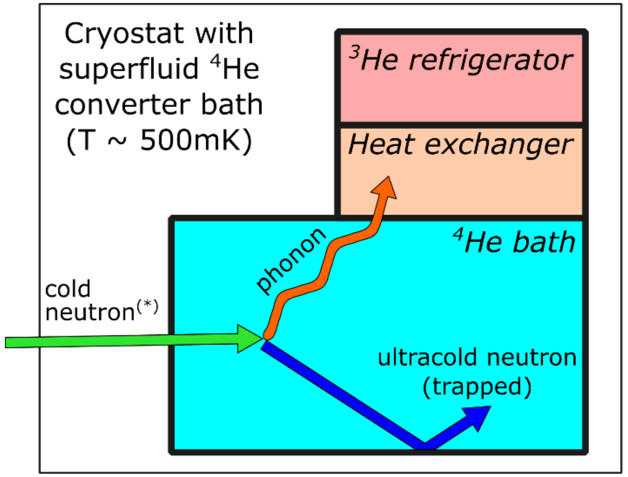




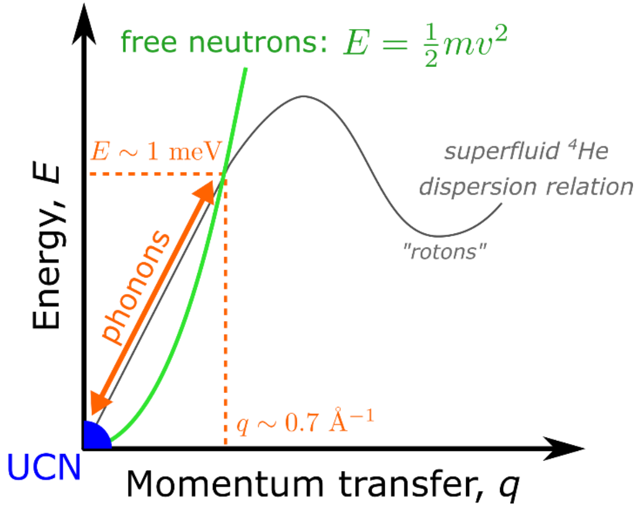
*Superconducting meander structures to create high local field **gradients***



UCN production and storage in superfluid helium:



(*)not trappable: E~1 meV vs. U_{wall}~200 neV



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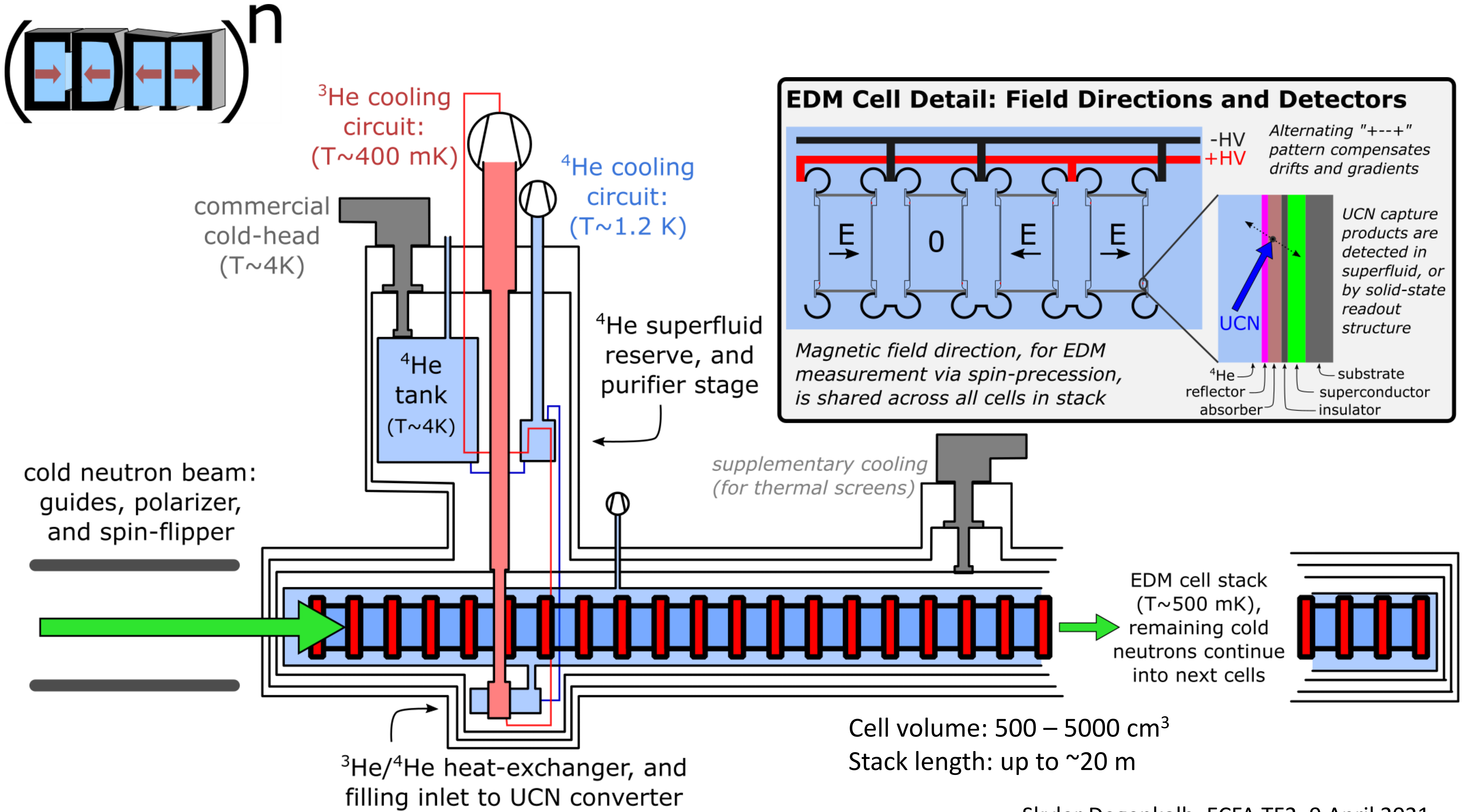

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- Major challenge: production of high magnetic fields at reflector surface
  - Alternative: UCN absorption on ^{3}He impurities (concentration must be less than 10^{-10}), see arXiv:1908.09937

- Different approaches to charged-particle detector to be explored:
  - Current-biased kinetic-inductance detector, see DOI: 10.1088/1742-6596/1590/1/012036
  - Si detector at low temperature, possibility to use Si:B substrate as absorber
  - Scintillation in superfluid helium: 80 nm with d-TPB wavelength shifter (deuterated, for neutron storage)

- Separately address three required functions:
  - UCN reflection
  - UCN absorption
  - Polarization-sensitivity