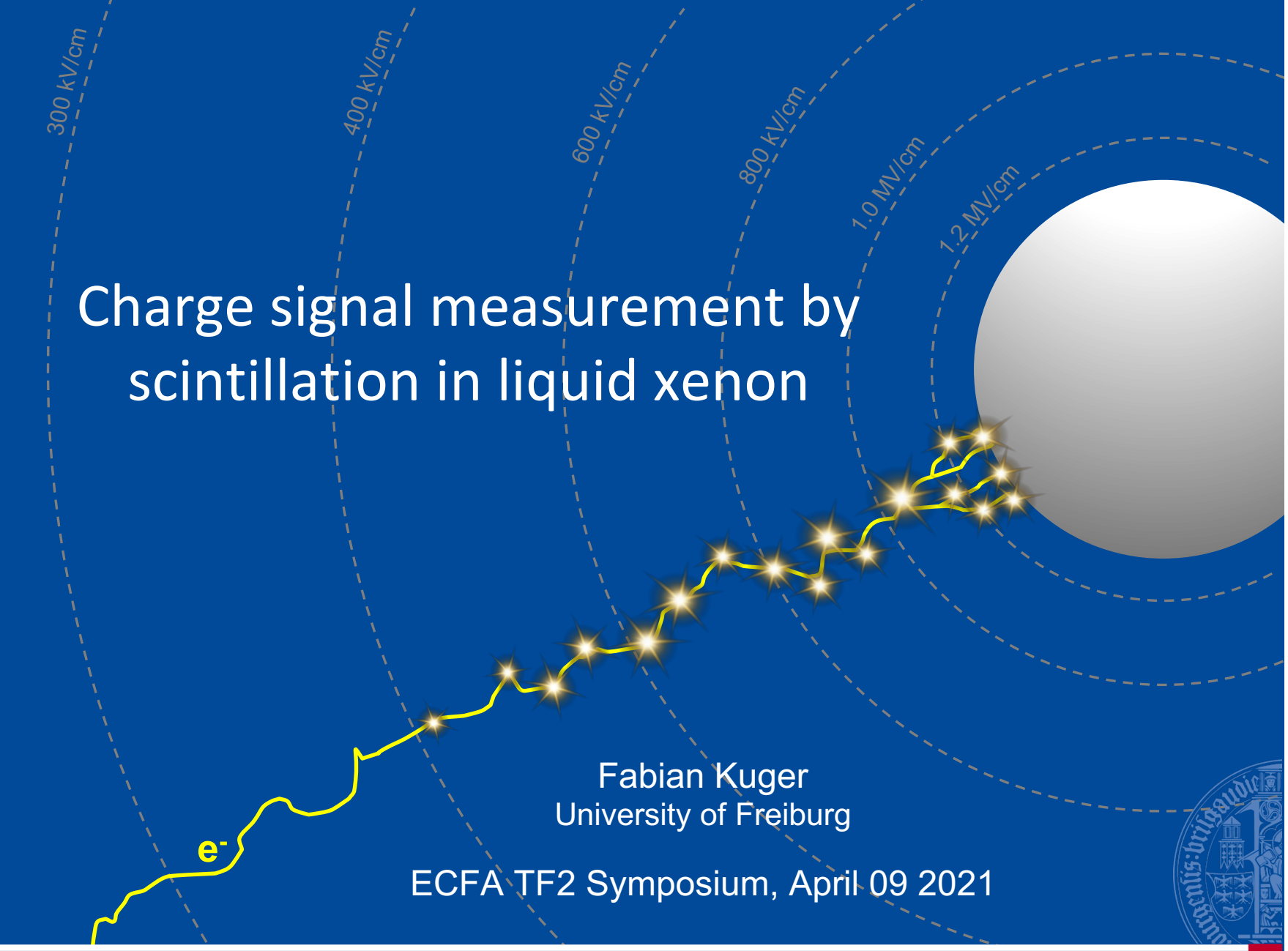

Charge signal measurement by scintillation in liquid xenon

Fabian Kuger
University of Freiburg

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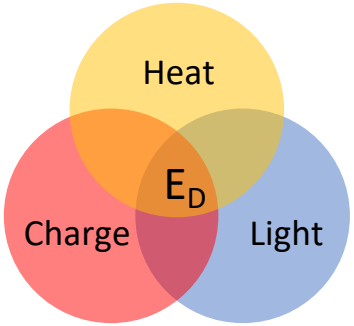
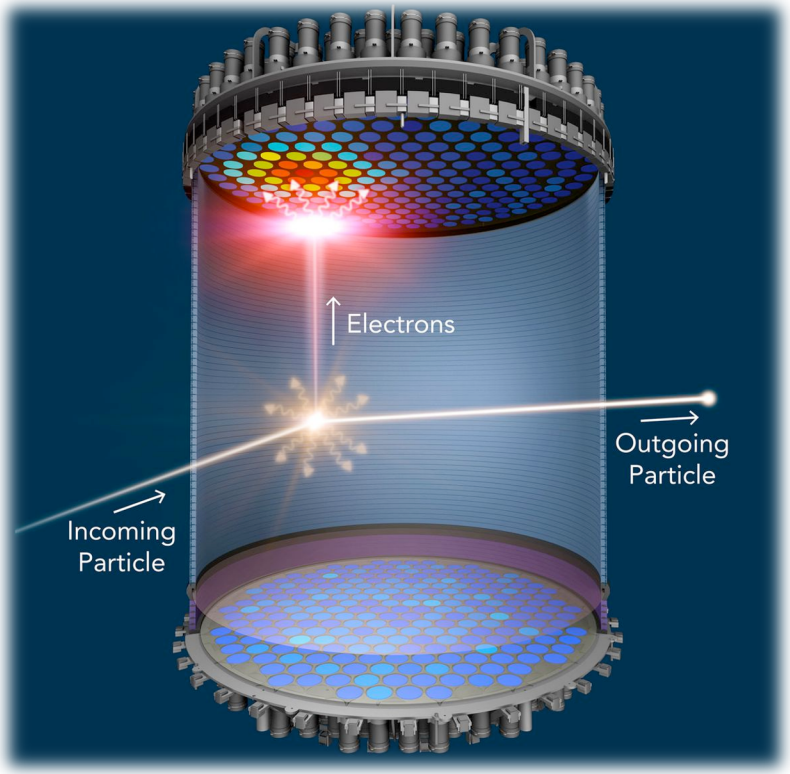
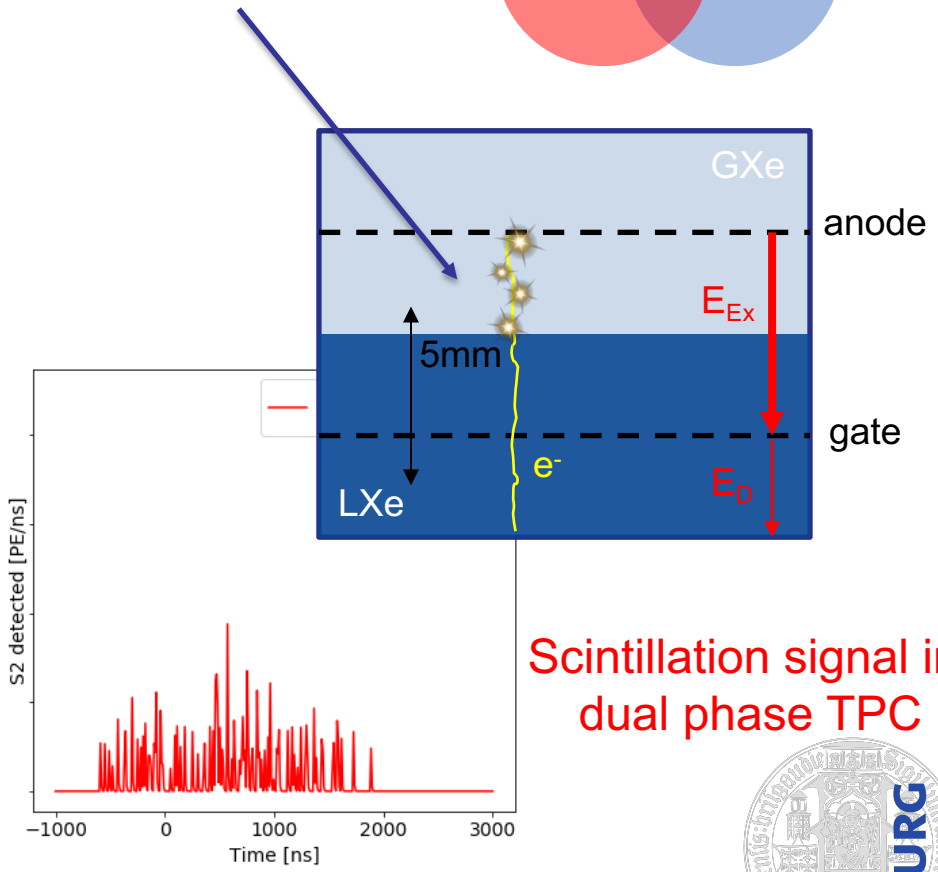
Charge measurement in liquid xenon target TPCs

Liquid xenon target TPCs (XENON, LZ, nEXO) measure

- prompt light signal directly and
- delayed charge signal by scintillation in a gas gap





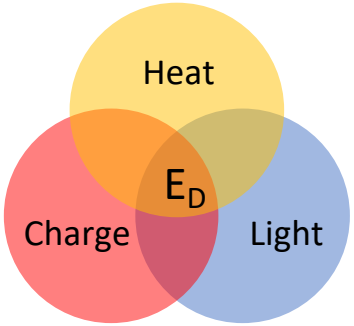


Scintillation signal in dual phase TPC

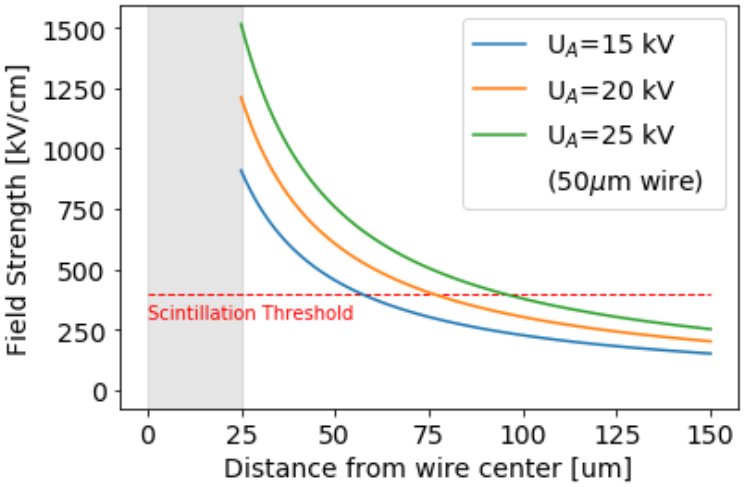
Charge signal enhancement with in-liquid-xenon scintillation

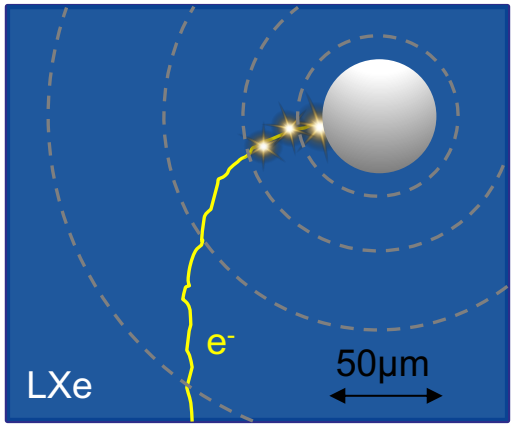
Liquid xenon target TPCs (XENON, LZ, nEXO) measure

- prompt light signal directly and
- delayed charge signal by scintillation **in liquid xenon**



fill with liquid --- use thin wires --- apply high voltage



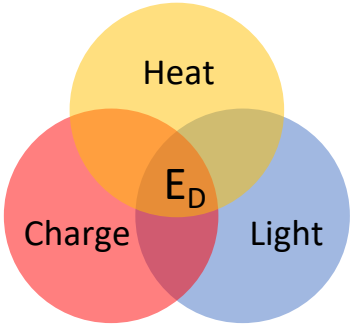


Scintillation signal in single phase TPC

Charge signal enhancement with in-liquid-xenon scintillation

Liquid xenon target TPCs (XENON, LZ, nEXO) measure

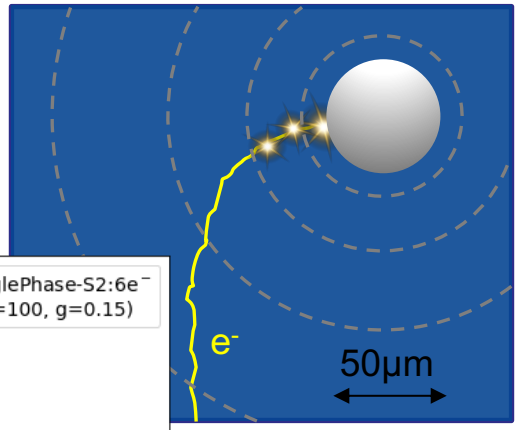
- prompt light signal directly and
- delayed charge signal by scintillation in a gas gap

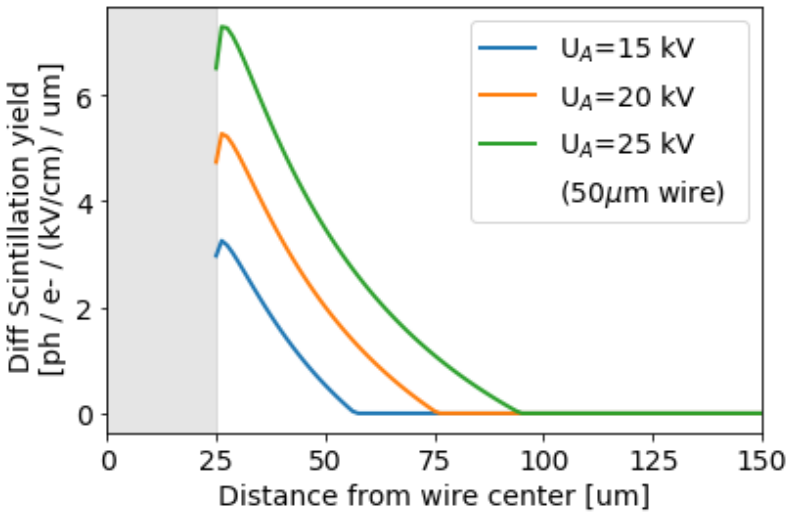


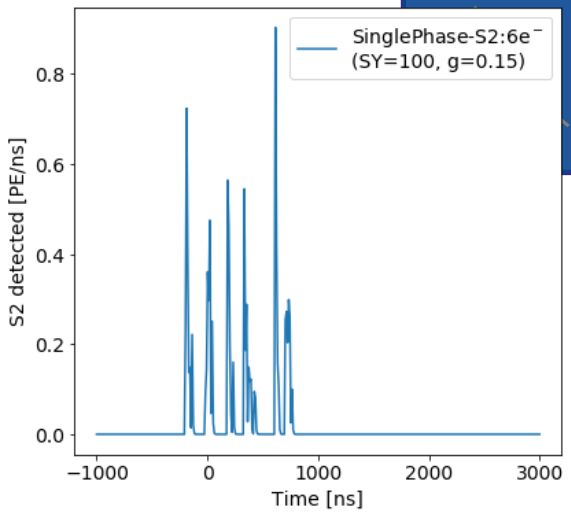
fill with liquid --- use thin wires --- apply high voltage

➔ **Fast scintillation very close to the wire**

> 100 photons / e^{-}, (50µm wire, 20kV)



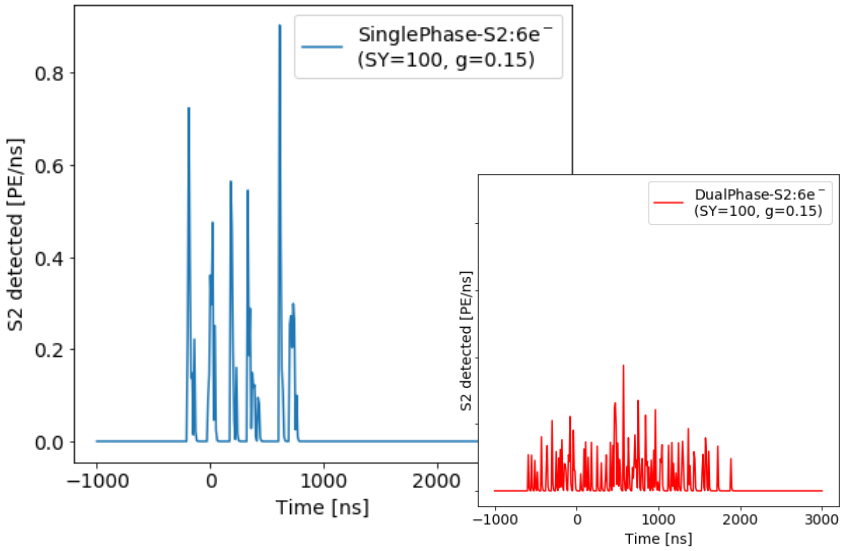




Scintillation signal in single phase TPC

Advantages of in-liquid-xenon scintillation + single phase TPCs

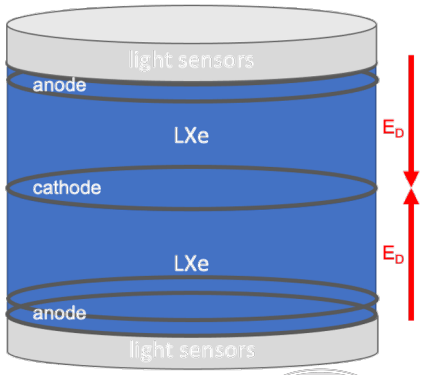
fast scintillation per e^-



- single electron counting
  → improved resolution for small signals
- electron arrival time measurement
  → *z*-reconstruction by diffusion
  (fiducialization, background rejection)

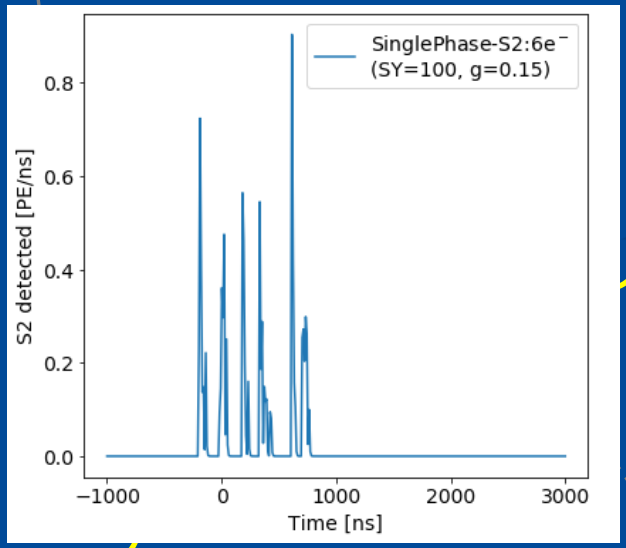
no gas gap

- no liquid/gas interface
  - no total reflection
  - no delayed electron extraction
- uniform scintillation in *xy*-plane
- LXe self shielding from top
- simplified operation
- segmented TPC
  → lower voltage
  / higher drift fields
- free orientiation
  towards gravity
- …



Charge signal measurement by scintillation in liquid xenon

- maintains the successful principle of LXe TPCs
- obsoletes the gas phase + corresponding limitations
- exploits the fast signal generation per electron



➢ Potential to improve future LXe TPCs and expand their science reach

R&D Outline (Backup)

Small scale R&D

- Existing Detector: XeBRA at UniFr
- Proof full TPC functionality
- Optimize scintillation yield / resolution by wire and voltage selection

Large Scale Demonstation

- large wire grids (Pancake - UniFr):
  - scintillation uniformity (*xy*-plane)
  - mechanical proof-of-principle
- long drift (Xenoscope - UZH)
  - S2 signal: electron counting & *z*-position inference

Process Modelling

- Scrutinize empirical, data driven models for scintillation & ionization
- Validate wire-shadowing model
- Establish microscopic process model

Science impact

MC studies for DARWIN / G3 DM TPC

- WIMP Dark Matter
- solar neutrinos
- solar axions
- $0\nu\beta\beta$
- Sterile neutrinos via $2\nu\beta\beta$