Addendum to WISArD proposal

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Request: 10 shifts to complete beam time

Beta-decay observables

$$dW \sim dW_0\left(1 + a\frac{\boldsymbol{p}.\boldsymbol{q}}{E_e E_\upsilon} + b\frac{\gamma m_e}{E_e}\right)$$

phase-space factor

beta-neutrino angular correlation coefficient

Fierz interference term

Pure Fermi transitions

SM: Vector current

- **Preferred emission angle: θ = 0°**
- **Maximum recoil energy**

Correlation Parameters

$$a_F = 1$$

$$b_F = 0$$

Beta-decay observables

$$dW \sim dW_0\left(1 + a\frac{\boldsymbol{p}.\boldsymbol{q}}{E_e E_\upsilon} + b\frac{\gamma m_e}{E_e}\right)$$

phase-space factor

beta-neutrino angular correlation coefficient

Fierz interference term

Sensitivity to NP

$$\tilde{a} = \frac{a}{1 + \alpha \boldsymbol{b}}$$

Pure Fermi transitions

SM: Vector current
- Preferred emission angle: θ = 0°
- Maximum recoil energy

NP: Scalar current
- Preferred emission angle: θ = 180°
- Minimum recoil energy

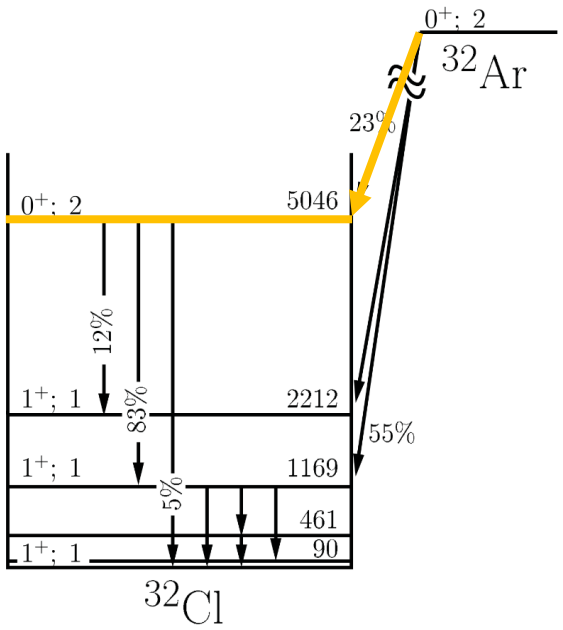
Correlation Parameters

$$a_F \cong 1 - \frac{|C_S|^2 + |C_S'|^2}{|C_V|^2}$$

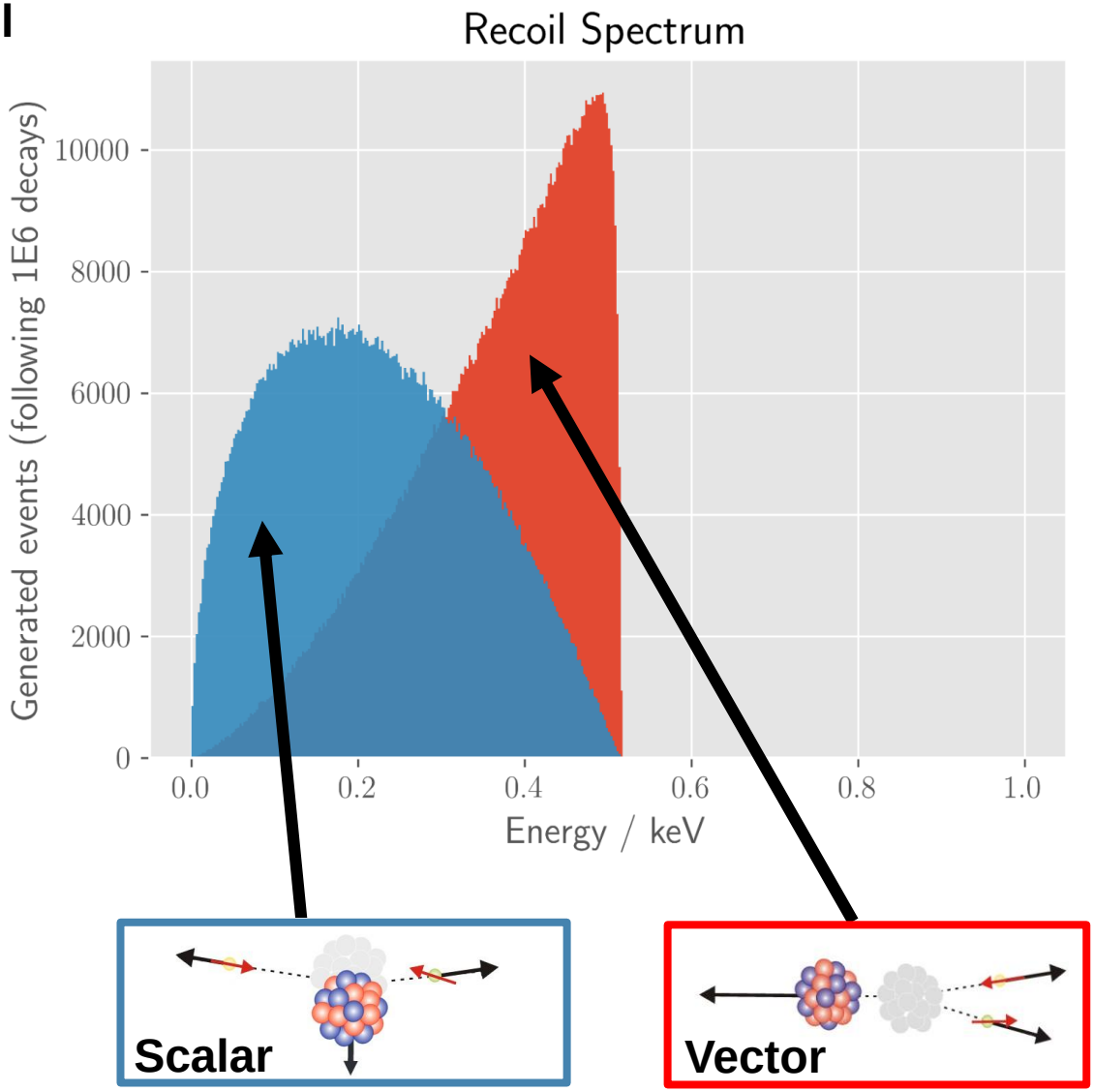
$$b_F \cong \pm Re\left(\frac{C_S + C_S'}{C_V}\right)$$

Recoil determination for $^{32}Ar \rightarrow {}^{32}Cl$

- ^{32}Ar decays by β-decay to ^{32}Cl

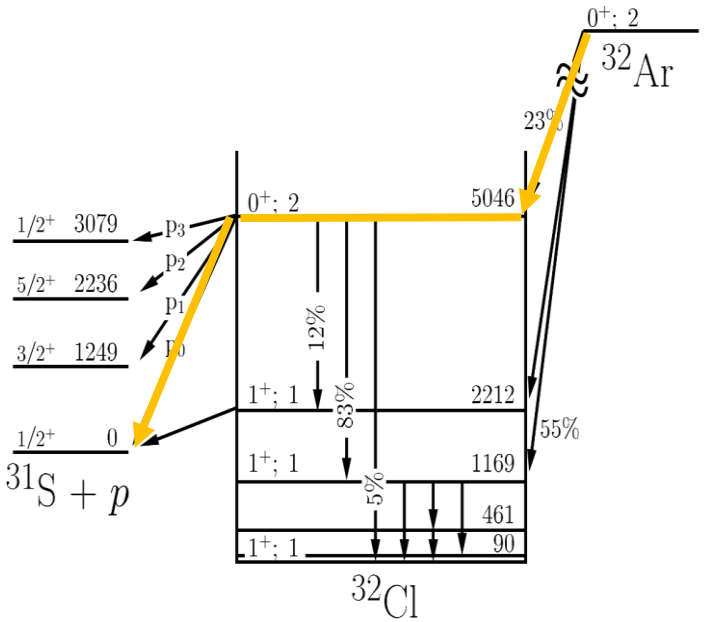


- Recoil energy ~ **hundreds eV**

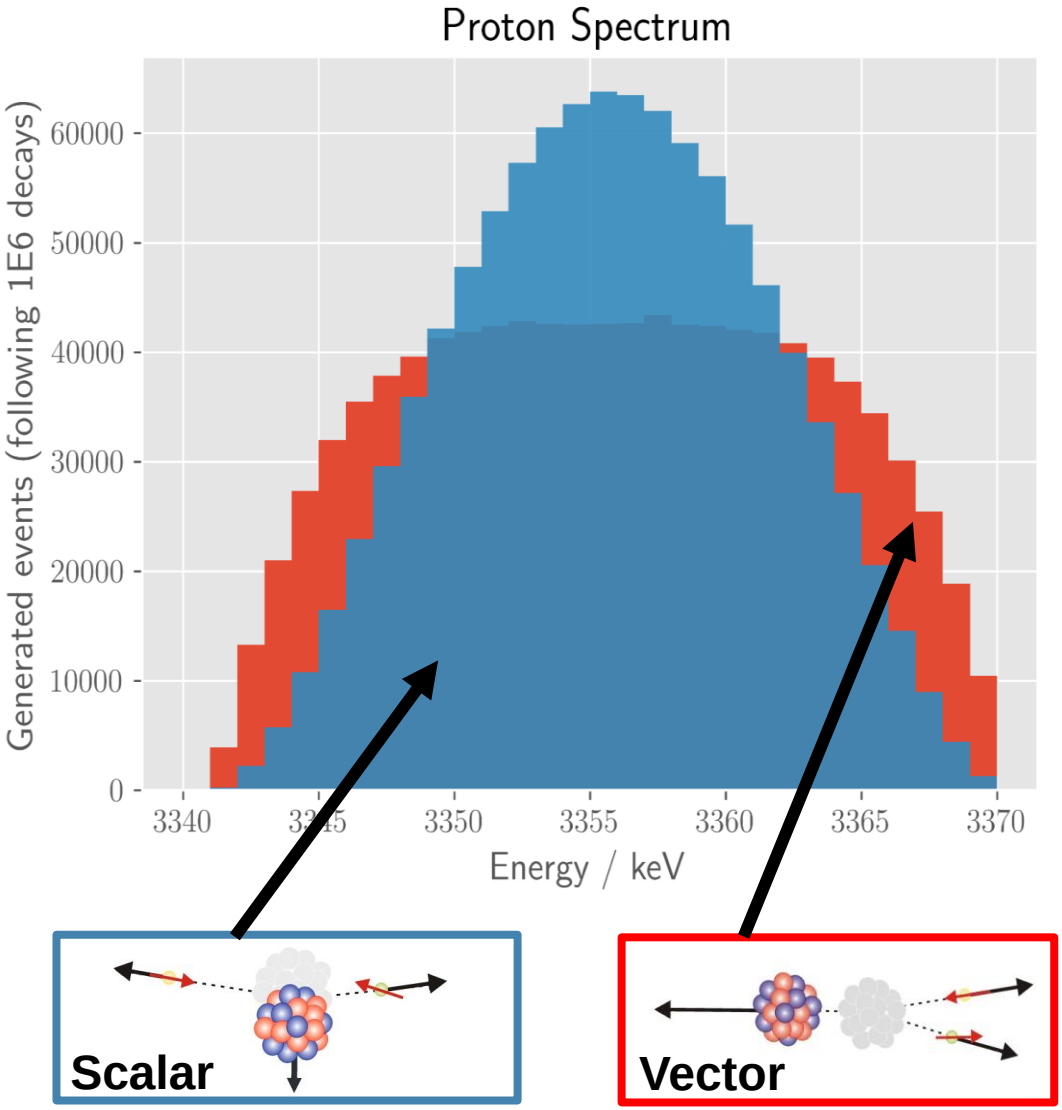


Kinematic broadening: $^{32}Ar \rightarrow ^{32}S \rightarrow ^{31}S + p$

- ^{32}Ar decays by β-decay to ^{32}Cl which subsequently decays by proton emission to ^{31}S



- Recoil energy ~ hundreds eV
- Protons energies ~ several MeV
- The energy of the emitted protons is subject to kinematic shift due to the recoiling daughter nucleus



WISArD 2018: $^{32}Ar \rightarrow {}^{32}S \rightarrow {}^{31}S + p$

Proof of Principle: detection setup in 4T magnet

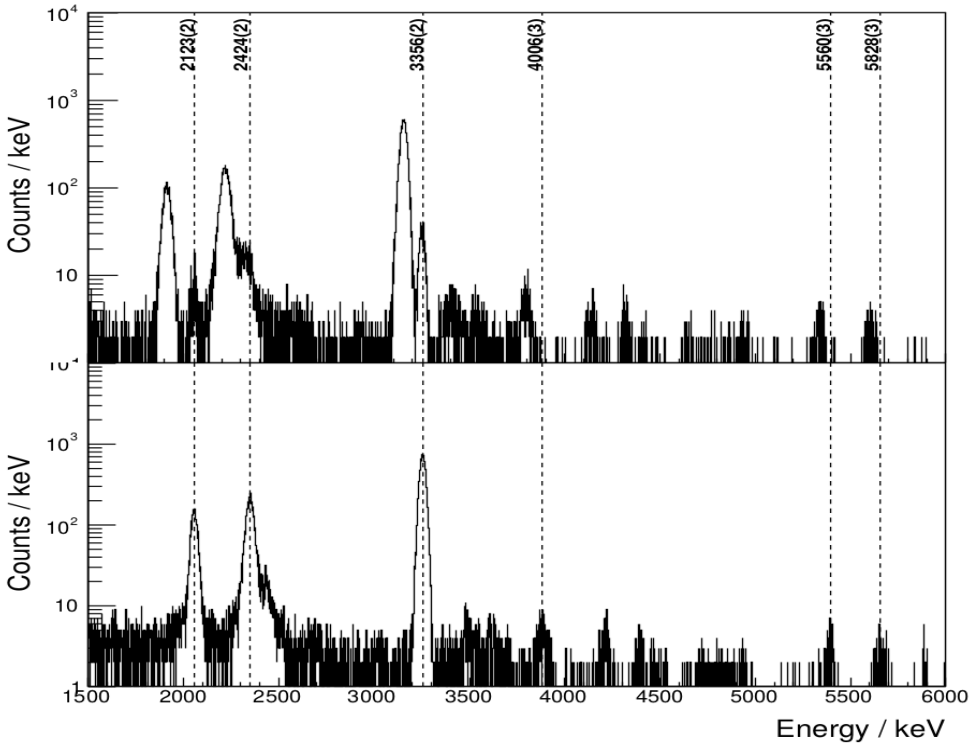
Beta detector + SiPM

proton detectors planes

Catcher

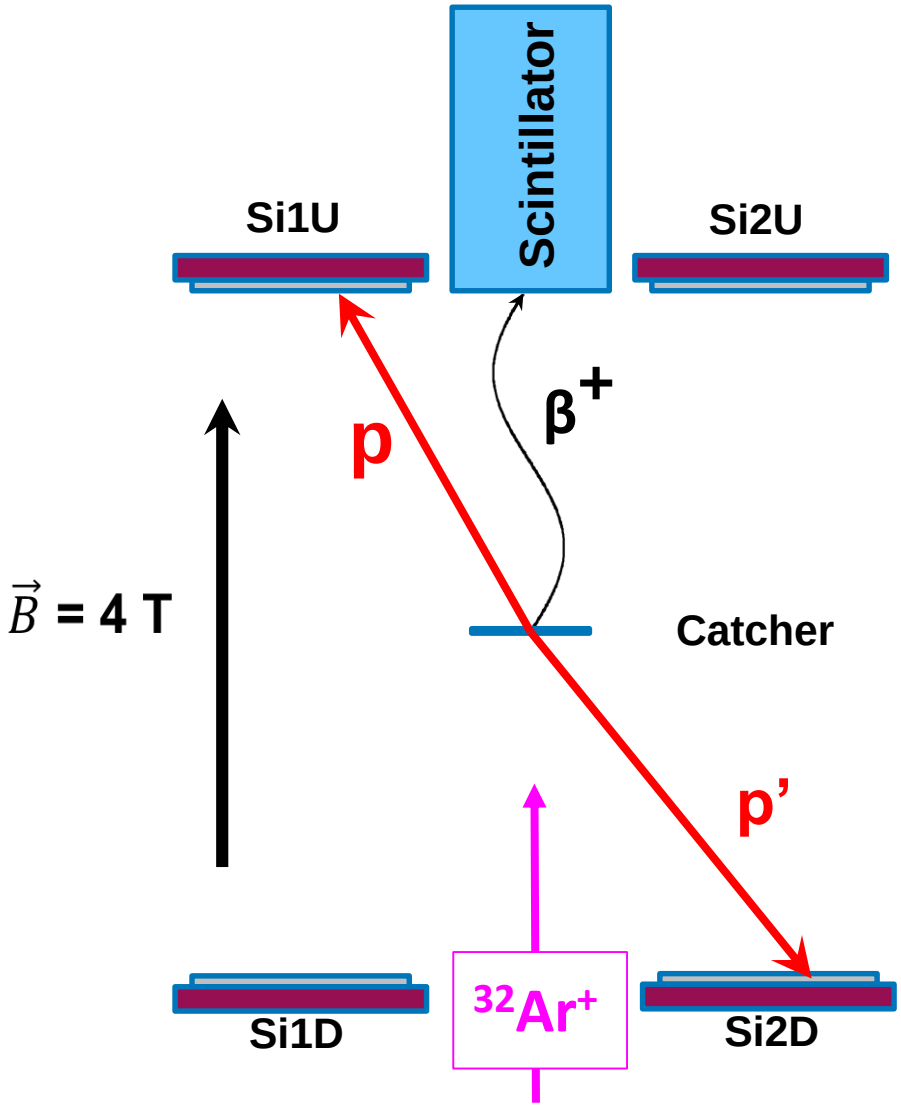
^{32}Ar

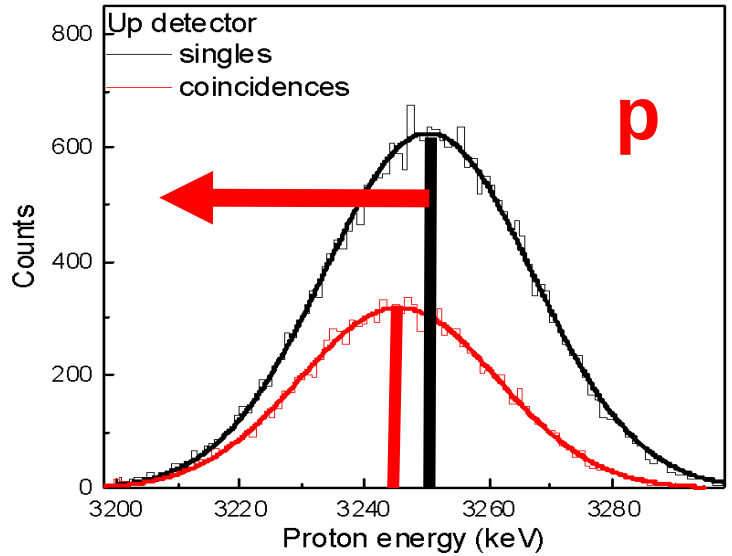
Upper detectors

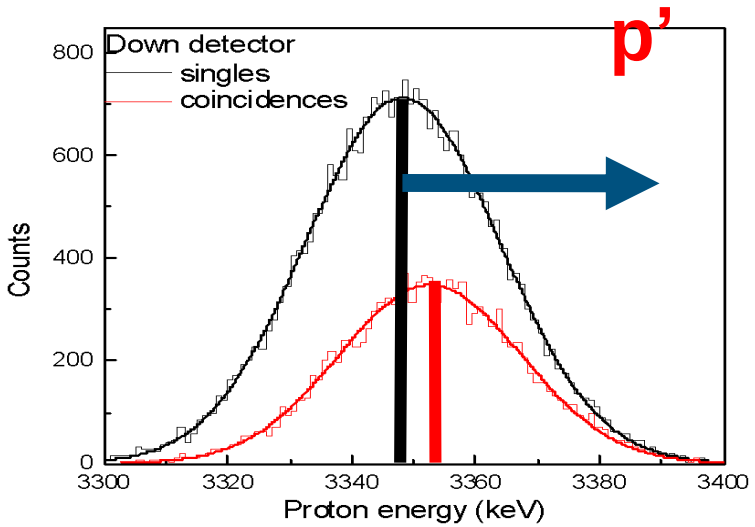


Lower detectors

WISArD 2018: $^{32}Ar \rightarrow {}^{32}S \rightarrow {}^{31}S + p$







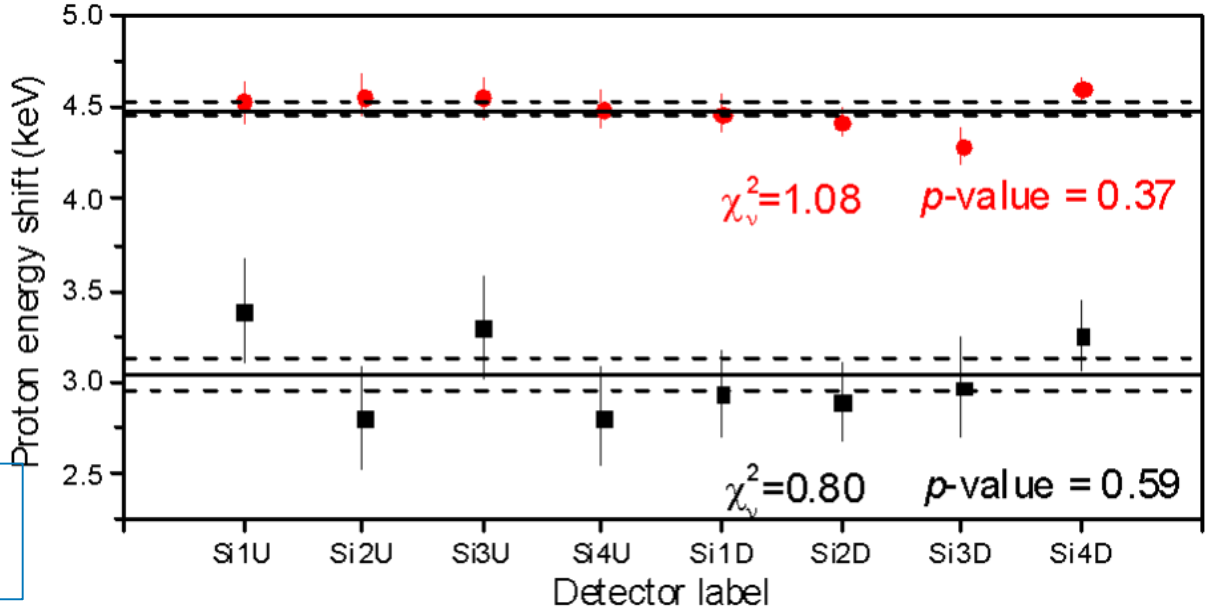
WISArD 2018: $^{32}Ar \rightarrow {}^{32}S \rightarrow {}^{31}S + p$

Weighted average energy shifts

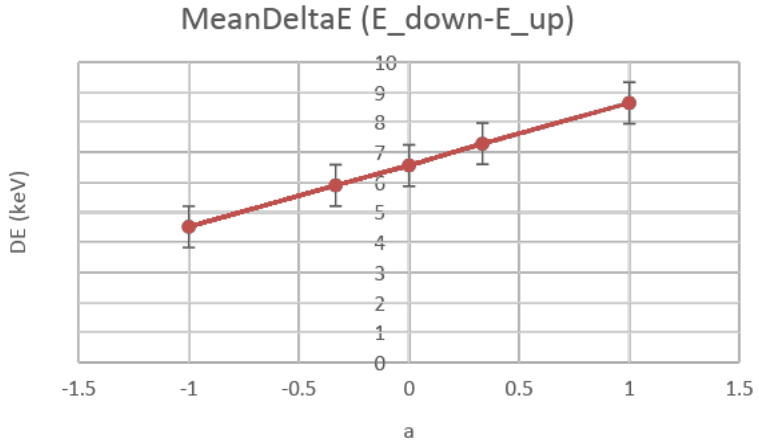
$$\Delta E = \left|\bar{E}_{coinc} - \bar{E}_{single}\right|$$

$$\Delta E_F = 4.49(3)\ keV$$

$$\Delta E_{GT} = 3.05(9)\ keV$$



Monte Carlo simulations



Extracted modified correlation β-υ

$$\tilde{a}_F = 1.007(32)_{stat}(25)_{syst}$$

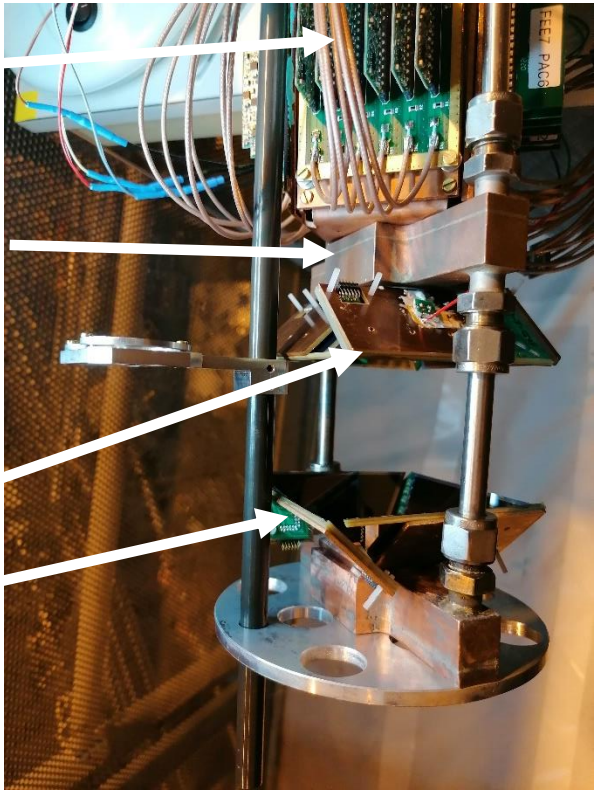
$$\tilde{a}_{GT} = -0.222(86)_{stat}(16)_{syst}$$

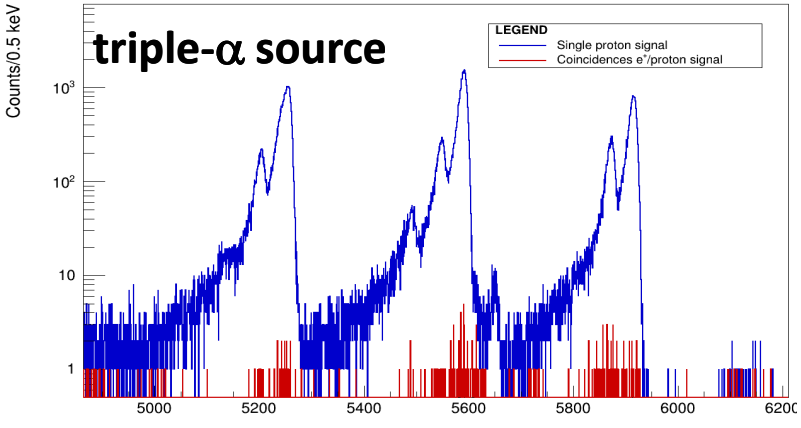
WISArD 2021: $^{32}Ar \rightarrow {}^{32}S \rightarrow {}^{31}S + p$

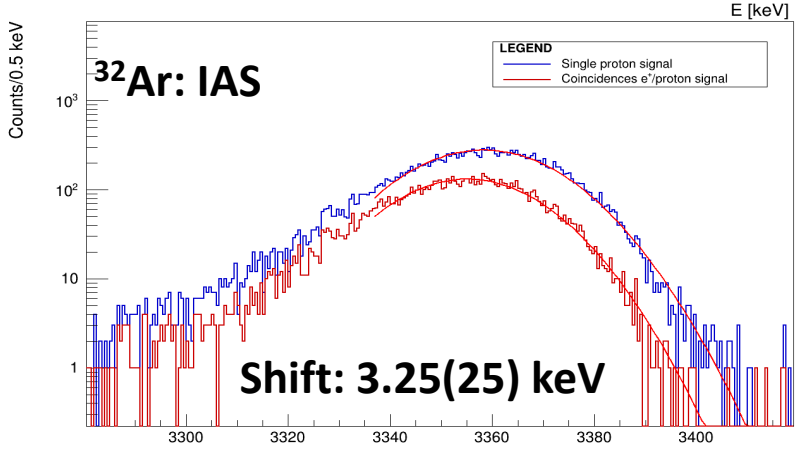
Test: October 2021, 10 shifts

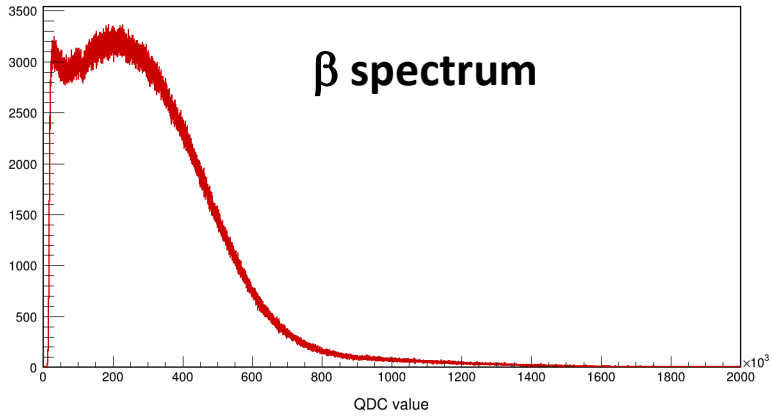
New detection setup:

- new silicon preamps
- new beta detector + 9 SiPM + preamps
- new silicon strip proton detectors
- new MCP beam position detector









All equipment worked more or less… still upgrades

Weak-interaction exclusion plots

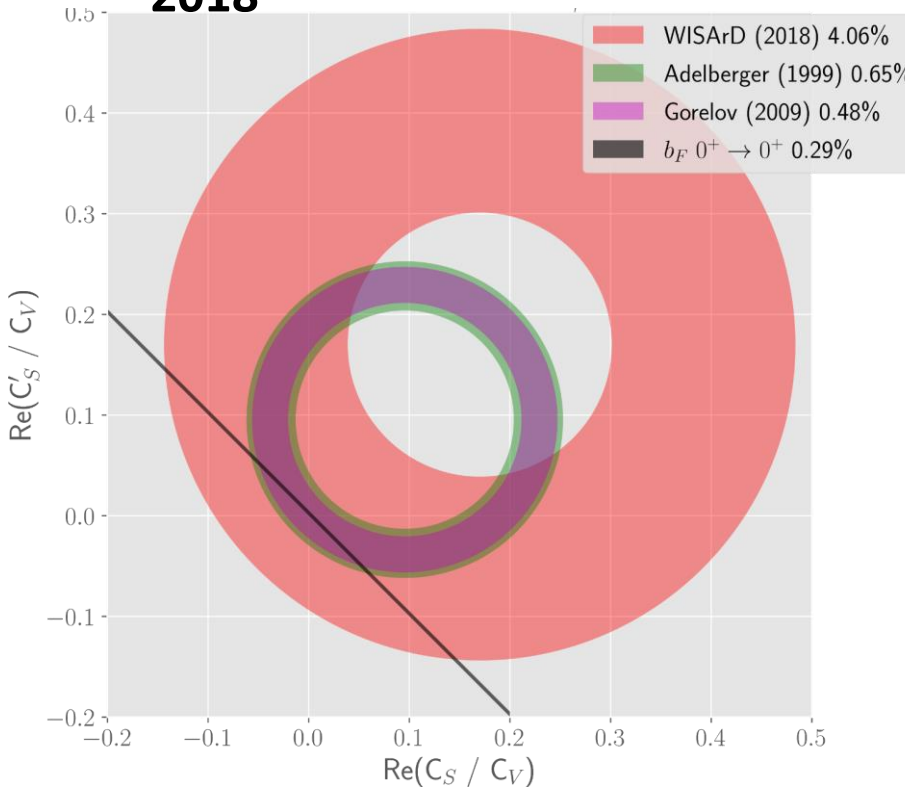
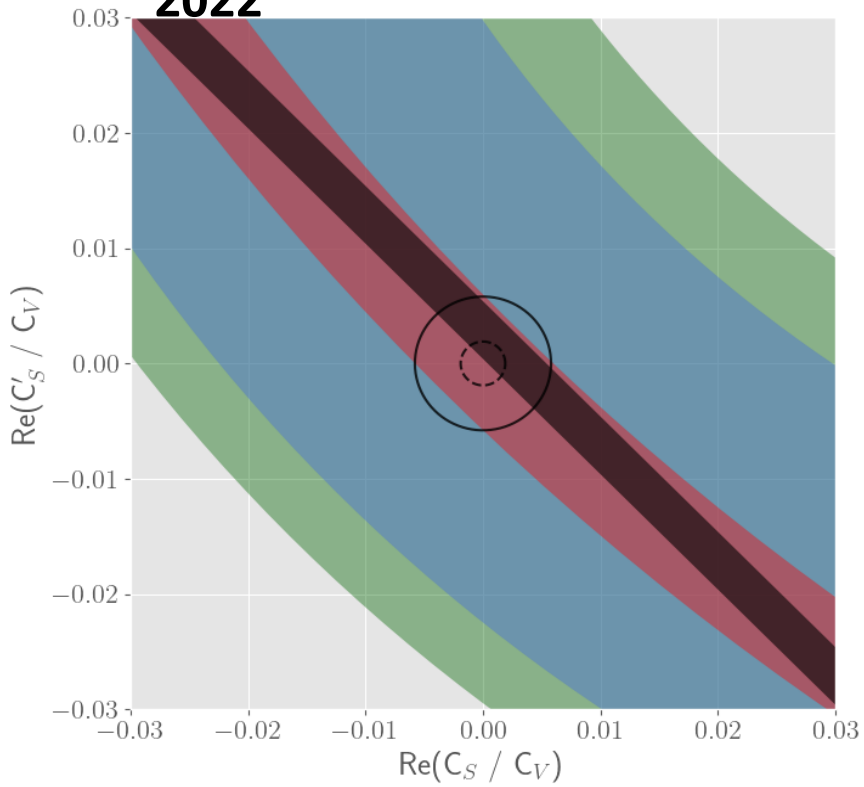
10/2018: Proof-of-principle for WISArD

11/2020: INTC accepts proposal with 24 shifts

10/2021: WISArD test with 10 shifts

02/2022: Request of 10 shifts to complete beam time

2018



2022