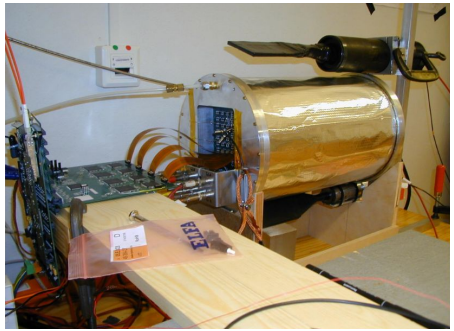
Work Package 3: Detector prototypes

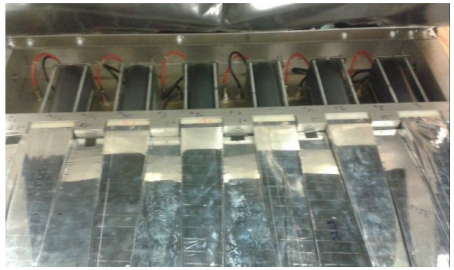
- Construction and tests of annihilation detector components described in detector options 1, 2, 3 in WP2
- Validation of simulations in WP2 in order to make final design choices
- Especially useful concerning background simulations
  - Cosmics
  - Spallation backgrounds
  - Gammas from neutron capture
- Led by S. Silverstein (SU) and A. Kupsc (UU)
- WP3 discussions are covered in our Bi-weekly prototype meetings
  - recordings/slides posted on indico
  - Starting back up in August

Prototypes (SU, LU, CTU, ESS, Oak Ridge)



Time Projection Chamber (LU)

- Repurposed prototype TPC at Lund read out with GEMs
- Gaseous Ar/CO2 mixture
- Studies on response to thermal/fast neutrons, GEM pad shapes using cosmics

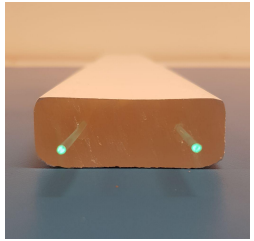


WASA Scintillating EM Calorimeter (UU)

- 24 CsI WASA Experiment crystals being recommissioned for studies of Detector Option 3

Hybrid Scintillator - Lead Glass Calorimeter (SU)

- Development not part of RFI grant - but integration with TPC at ESS TBL is
- Hadronic Range Detector
  - Plastic staves readout with WLS + SiPMs
- Lead glass EM calorimeter
  - Lead glass blocks read out with SiPM arrays



Deliverables

Deliverables	Description	Y1	Y2
D1	TPC construction and assembly with calorimeter prototype and DAQ		
D2	Preparation of WASA components and cosmic and gamma tests		
D3	TPC/calorimeter prototype cosmic, gamma and thermal neutron tests		
D4	Spallation tests of WASA components + TPC/Calo prototype + background summary		

- Focusing mostly on deliverables 1 and 2 today
- Brief discussion on deliverables 3 and 4 which come later in 2023

D1 - TPC Construction & assembly with calorimeter prototype & DAQ

TPC Construction

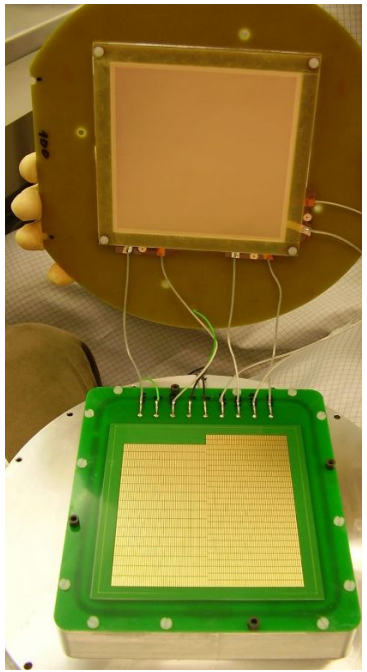
- TPC has been constructed with gas system and HV supply
- Now designing new pad planes with zig-zag geometry
  - Increases charge sharing while reducing number of channels
- Use ILC/AIDA readout system

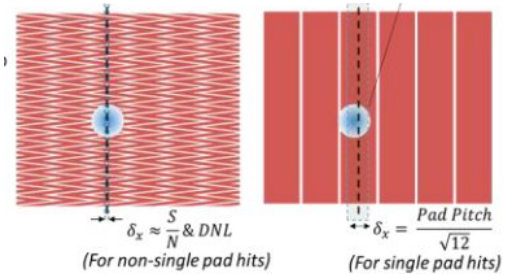
Integrating with calorimeter prototype

- Integration of TPC with the calorimeters will be useful for data taking at the ESS test beam line in 2023
- Ahead of that, makes sense to do tests of detector systems separately

DAQ

- For readout - planning to use boards already at LU - developed for ILC/AIDA system
- Integrated TPC/calo DAQ for test beams will require a trigger fed into the datateam
- According to grant, prototype DAQ will be simplified version of WP2 - discussion later





D2 - Preparation of WASA components and cosmic and gamma tests

Preparation of WASA components

- 24 CsI crystals confirmed as functioning (turned on and give signals)
- Transport from storage to dedicated lab space has just been completed
- Renewal of optical coupling between PMTs and crystals (validation with gamma source)

Cosmic, gamma and neutron tests

- Gamma (137Cs,207Bi) and cosmic tests in dedicated lab space
- Gamma tests: homogeneity, resolution
- Cosmic test (charged particles with scintillator coincidence)
- Neutron response in cooperation with TK division at UU: AmBe source combined with gamma trigger (from 13C decay), exp setup complete

D3 - TPC/calo prototype cosmic, gamma, thermal neutron tests

TPC

- Charged particles with cosmics
  - Optimize field cage wall
  - Pad shapes
- Thermal neutrons at LU
  - Fast/thermal neutrons at LU

HLC (hadronic range + lead glass calo)

- Cosmics + low energy gamma sources
  - Detector response as function of angle of incidence
- Protons at PSI (<500 MeV)
- Electrons at Frescati (<700 MeV)
- Thermal neutrons at LU

D4 - Spallation tests of WASA components + TPC/Calo prototype + background summary

Spallation tests

- Prototypes for all detector options to be installed at ESS TBL (possibly ORNL?)

Background summary

- Final report summarizing prototype background studies and implications for the detector design

Conclusion

- WP3 is on schedule
- First year focused on building up different detector prototypes
- 2023 focused on test with cosmics, gammas, neutrons

Milestone + Deliverables

1-4	M1	Design of a small TPC prototype (30cm drift length and a 10*10 cm^2 standard GEM stack) with read-out.
1-6	M2	Preparation of 24 WASA detector modules, including HV supply, readout and initial testing.
	M3	Design of integrated DAQ.
3-12	D1	Construction of the TPC prototype and assembly with the calorimeter prototype, with HV supply and integrated DAQ.
6-12	M4	Bench test of WASA detector modules with cosmic rays and gamma sources available at UU and data analysis.
	M5	Bench test of prototype calorimeter with cosmic rays and gamma sources available at SU.
12-16	D2	Thermal neutron response for the WASA modules at the thermal neutron test facility in Lund leading to a summary of all background tests (thermal neutrons, cosmics and gammas) in a written report.
	D3	The response of the complete prototype with cosmics and gammas studied (SU sources) and thermal neutrons at the test facility in Lund. The background tests are summarised in a written report.
16-22	M5	Tests and analysis of WASA modules and the complete prototype to spallation source background. Fast neutrons and other spallation-related backgrounds can be studied at the TBL. Should the TBL be delayed other options, such as JPARC can be considered.
20-22	M6	Findings from background tests are used to inform continued detector optimisation and performance assessment.
22-24	D4	Contribution to final report summarising prototype background and their influence on the detector design.