PRIN 2020 ideas: Background

Recall: KLEVER-CaI project for 2017 highly rated

- 74/75 for quality of research project (16/25 for PI CV in preselection)

Continued progress on KLEVER

- 2018 KLEVER test beam
- Tests of shashlyk at Protvino and DESY
- Outcome of European Strategy
- AIDAinnova project
- BTF-2 coming on line, possible beam time in 2021

Convergence with NA62x4

- NA62x4 piggybacks completely on KLEVER for calorimetry & vetoes
- More interest from NA62: new readout projects, including IRC/SAC

PRIN 2020 ideas: Possible structure

“Development of calorimeters and veto detectors for experiments with high-intensity kaon beams”

WP1: High-performance electromagnetic calorimetry

Shashlyk/MEC design, prototyping, and testing
Interface with simulation: exploration of alternative technologies

WP2: Ultra-high efficiency photon vetoes

LAV design, prototyping, and testing

WP3: Ultra-fast, high-rate forward calorimetry

Cerenkov SAC with longitudinal segmentation
Oriented crystals?

WP4: Readout systems for high-performance calorimetry

Full digitization of calorimeter signals with signal processing in front end
High-throughput, free-running readout architecture

WP5: Sensitivity and performance

Validation of calorimeter designs via simulation, feedback to other WPs

WP6: Technological transfer and outreach

WP1: Shashlyk/MEC

Construction of a larger romashka prototype (e.g. 9x9) and test with beams at LNF/DESY/CERN starting from end 2022

1. Current tests and simulations show promise, but module has too much leakage to judge time performace
2. Simulation studies for performance optimization
3. Engineering studes for spy fiber routing, mechanics
4. Readout with FADCs as per WP4
5. Endpoint: full validation of MEC solution for NA62x4/KLEVER

Related ideas:

Simulation studies of alternatives to shashlyk technology for MEC, including cost/benefit analysis

WP2: LAV

Construction of a few LAV module prototype sectors, to install next to NA62 for testing by 2023

1. Simulation and engineering studies
2. Readout with FADCs as per WP4
3. Critical need to understand if the LAVs need to be fully digitizied and at what rate
4. Possible to contemplate digitizing one or more LAV layers in NA62
5. Endpoint: full validation of LAV solution for NA62x4/KLEVER

Related ideas:

Simulation studies of economical, large-area photon veto detectors to extend LAV coverage

WP3: SAV

Construction of a fast Cerenkov SAC prototype, with multiple layers and possibly with oriented crystals

Similar in structure to our AIDAinnova project proposal

NB: Our actual role in AIDAinnova is more limited to material studies

1. Validation of materials (PbF_2 vs PWO, etc.)
2. Choice of photodetectors
3. Validation of layer structure: study γ/n separation with simulation
4. Beam tests with photon and neutral hadron beams to verify γ/n separation
5. Readout with FADCs as per WP4
6. If fully validated by 2023, possible use of new SAC in NA62
7. Question of oriented crystals to be coordinated with Laura
8. Endpoint: full validation of prototype for NA62x4/KLEVER

WP3: SAV

Related ideas:

Explore the use of fast scintillating crystals for high-rate veto calorimetry (PWO, BaF_2, LYSO)

E.g., M. Martini, Preliminary studies for AFC (Oct 2018, for ESPP)

Active final collimator made from engineered LYSO

Synergies with AIDAinnova project WP8.3.1

Possibility of attracting new collaborators

PI: Mu2E, MEG

LNF: Mu2E, RD_MUCOLL

WP4: Readout

Simulation studies to determine hit rates and expected signal characteristics from detectors

- Define needed performance from digitizers and overall DAQ system
- E.g.: Is it feasible to use free-running (trigerless) readout?

Explore potential of full-digitizing readout in NA62 and in beam tests

- Demonstration of WFD readout at 0.5-1 GHz with Gandalf (or similar)
- Data reduction (at least zero suppression) implemented in FPGA
- To be used immediately (2021) to read out the IRC and SAC in NA62, as well as in all tests in WPs 1-3

Perform detailed studies of signal processing in front end to reduce data volume using innovative solutions (e.g. APEIRON)

Combine above information to conceptually design:

- Digitizing front-end stage
- Common read-out board
- Fully pipelined trigger, if dataflow too large for free-running readout
- Networking and online computing architecture

WP5: Sensitivity

- Define calorimeter performance needed for NA62x4 and refine estimates for KLEVER

  Make contact with NA62 data to verify estimates for efficiencies, random veto, etc.

- Estimate hit and detector rates; develop trigger criteria and evaluate event rates
- Provide critical information for design of detectors and readout system
- Comparison of results from prototype tests; refinement of simulation, impacts on overall sensitivity and physics reach

Clear role for WP5 leadership by FI with Giuseppe as responsabile locale

WP6: Tech transfer and outreach

Scientific discovery potential

Scientific communication:

Participation in PBC, international topical seminars, collaboration with KOTO, etc.

Training and visibility for ECRs

Applications to particle physics

Applications to other sectors:

Radiation monitoring, materials science, metrology, medicine

Partnership with industry

Esp. for TDAQ development

Outreach to general public

Outreach to high-school and undergraduate students:

OpenLabs, stages, etc.

PRIN 2020 ideas: Tasks and groups

FIRST DRAFT: To be filled in!

WP	Principal resp.	Participation
1 MEC	INFN (LNF)	NA
2 LAV	INFN (LNF)	NA
3 SAC	INFN (FE), RM1	INFN (LNF, TO)
4 Readout	PI, RM1, INFN(RM2)	
5 Sensitivity	FI	INFN (PG, LNF)
6 Tech Trans/Outreach	NA	All?