Detectors of the SPASCHARM experiment at U70 accelerator

P.Semenov
(on behalf of the SPASCHARM collaboration)
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SPACHARM collaboration

- 75 people from IHEP, PINP, JINR, ITEP,MEPHI

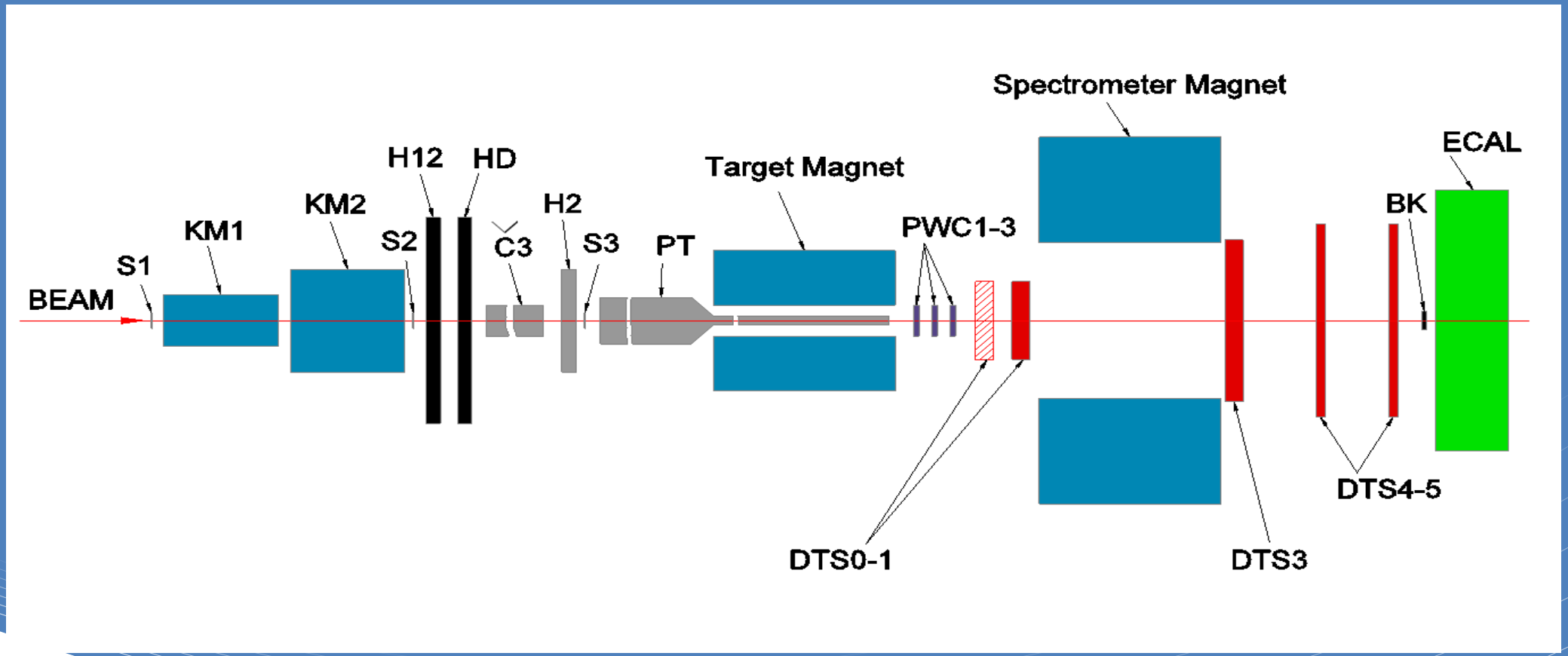
Outline

- SPASCHARM goals and current setup
- Beam detectors
- Polarized target complex
- Tracking system
- DAQ and slow controls
- Conclusions

SPASCHARM goals (current setup)

- Spin effects in inclusive reactions
- Single-spin asymmetries
- Hyperons polarization
- Elements of the spin density matrix of vector mesons
- Detailed physics program – see SPASCHARM CDR preprint IHEP 2019-12, 2019

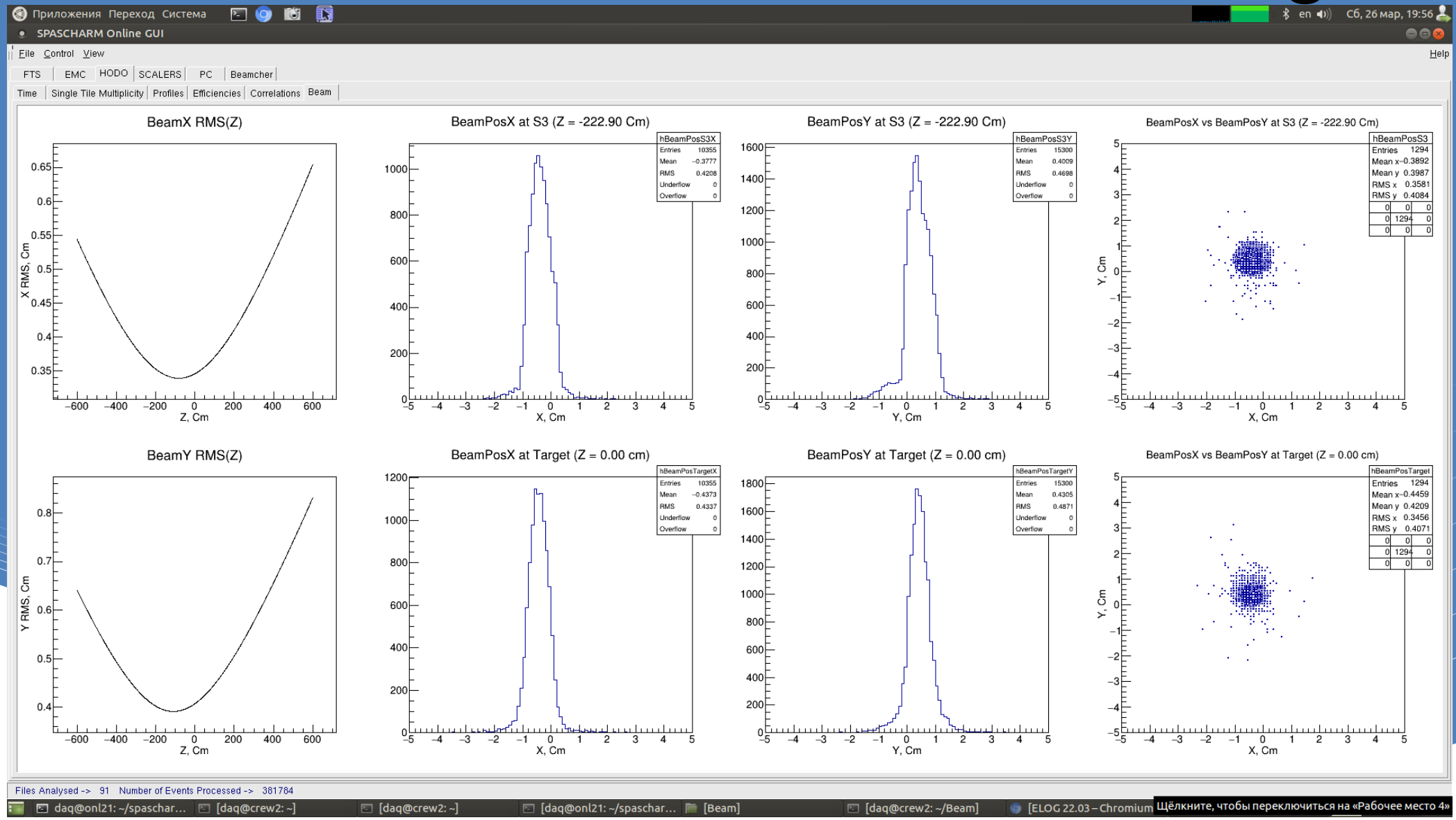
Current Experimental Setup



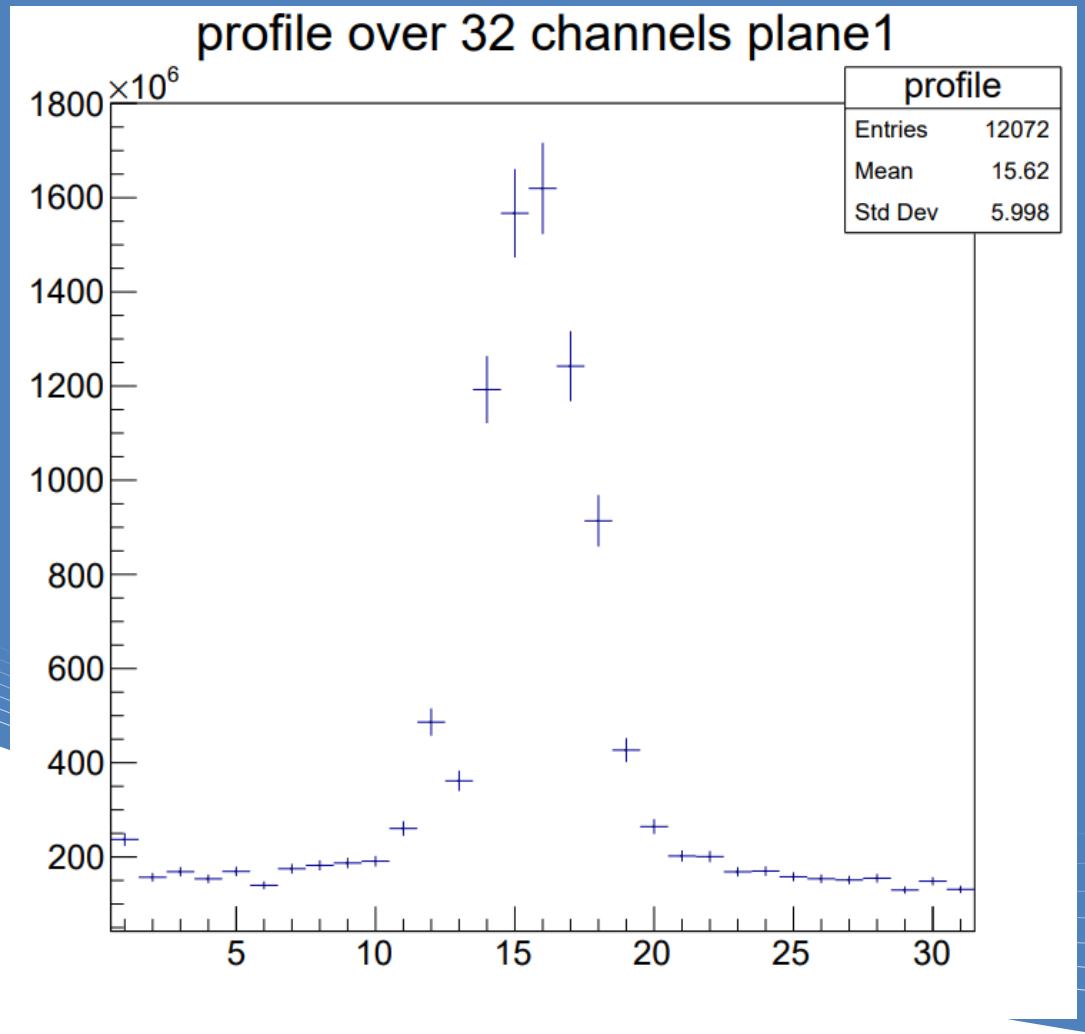
Beam parameters and detectors

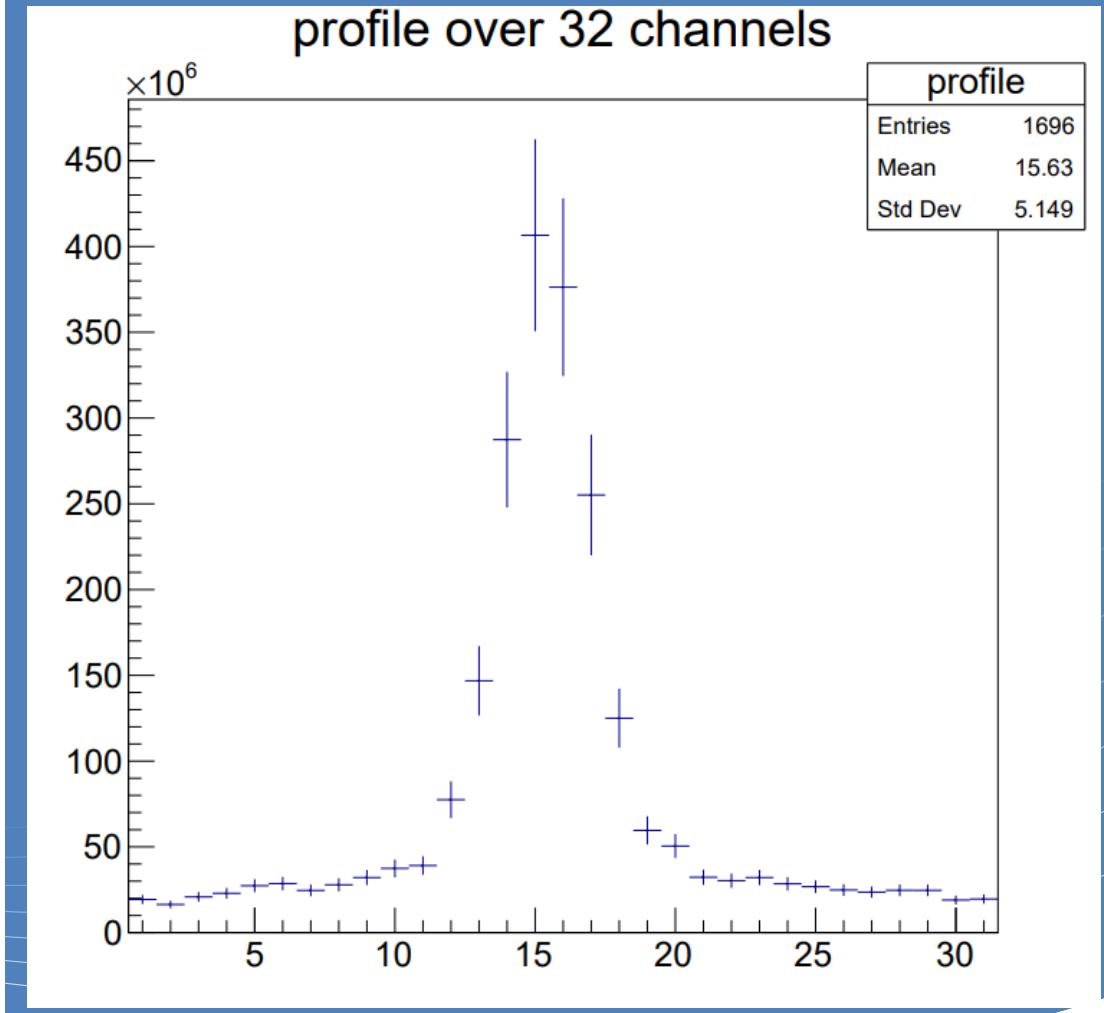
- Negative beam with momentum up to 26.5 GeV/c (when 50GeV at U70)
- Mainly pions - 98%, 1.5% kaons and 0.3% antiprotons
- Electron beam for calibration (1-19GeV)
- Beam telescope scintillating counters 100mm and 18mm
- Beam Cherenkov detectors (trigger for kaon and antiprotons beams)
- Four beam Hodoscopes (5, 2, and 0.8 mm steps)
- Beam profile target detector (32x32 SiPMs, 80x80 mm, compact sizes)

Beam focus and sizes at the target



Beam profile detector





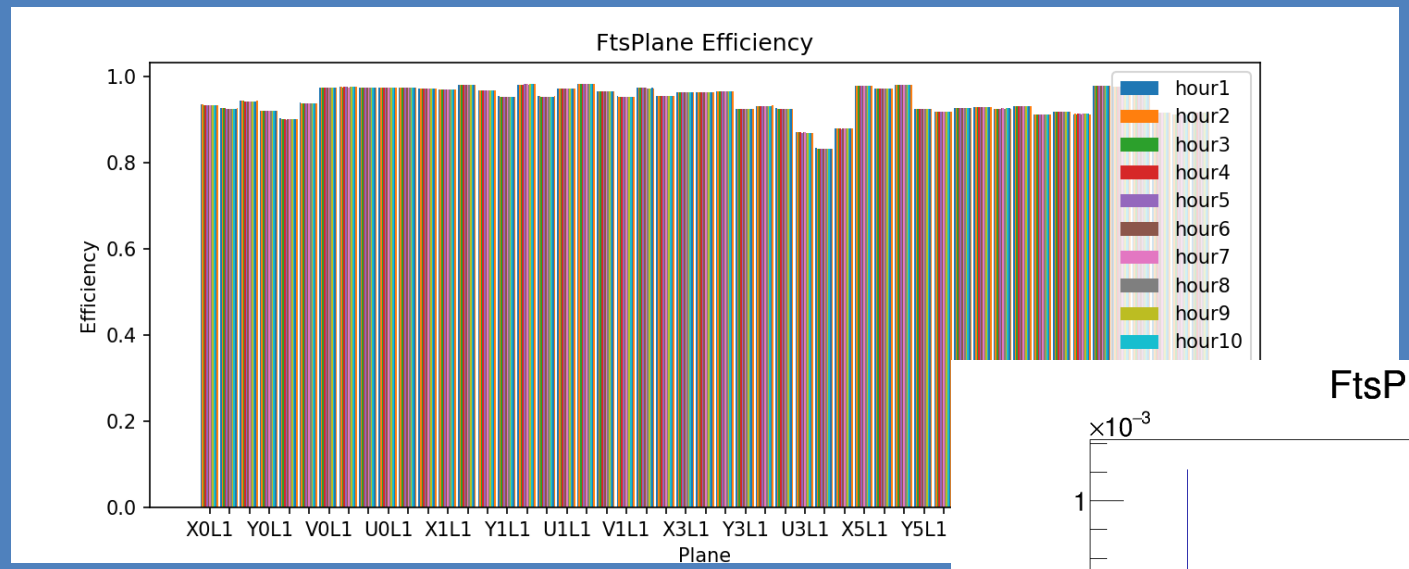
Polarized target complex

- Refrigerator to cool the target (~60 cm^3) down to 30 mK (to reach polarization relaxation time several hundred hours)
- Magnet to provide 2.4 T stable and uniform up to 10^{-4}
- MW system to polarize the target up to 75%
- Slow control system with temperature sensors and helium level meters

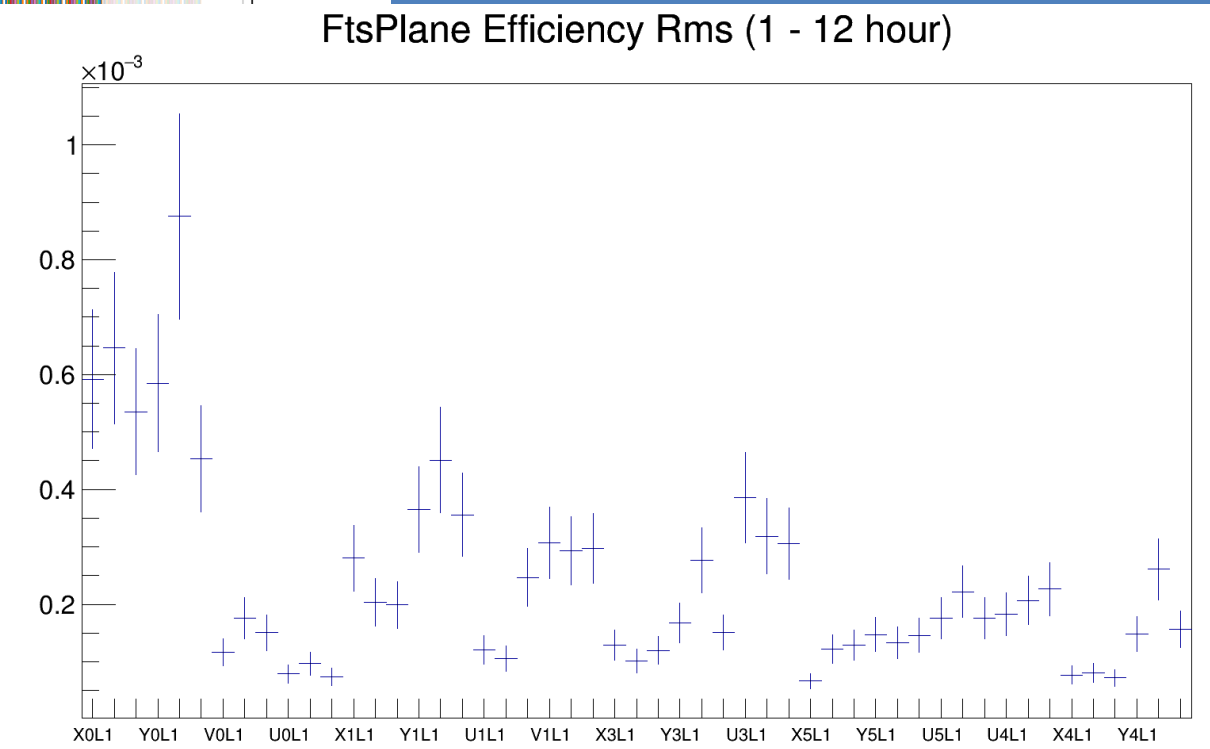
Tracking system

- Wide aperture spectrometer Magnet 2.3m x 1m (acceptance +/- 250 mrad vertically and +/- 300 mrad horizontally), magnetic field 0.6T
  - Precisely mapped
- Tracking detectors (MWPC 1 mm, Drift Tubes 15 and 30 mm diameters) ~60 planes
  - MWPC efficiency (runs 2018-2022) 97-98%
  - DT Stability of parameters depends on gas flow rate

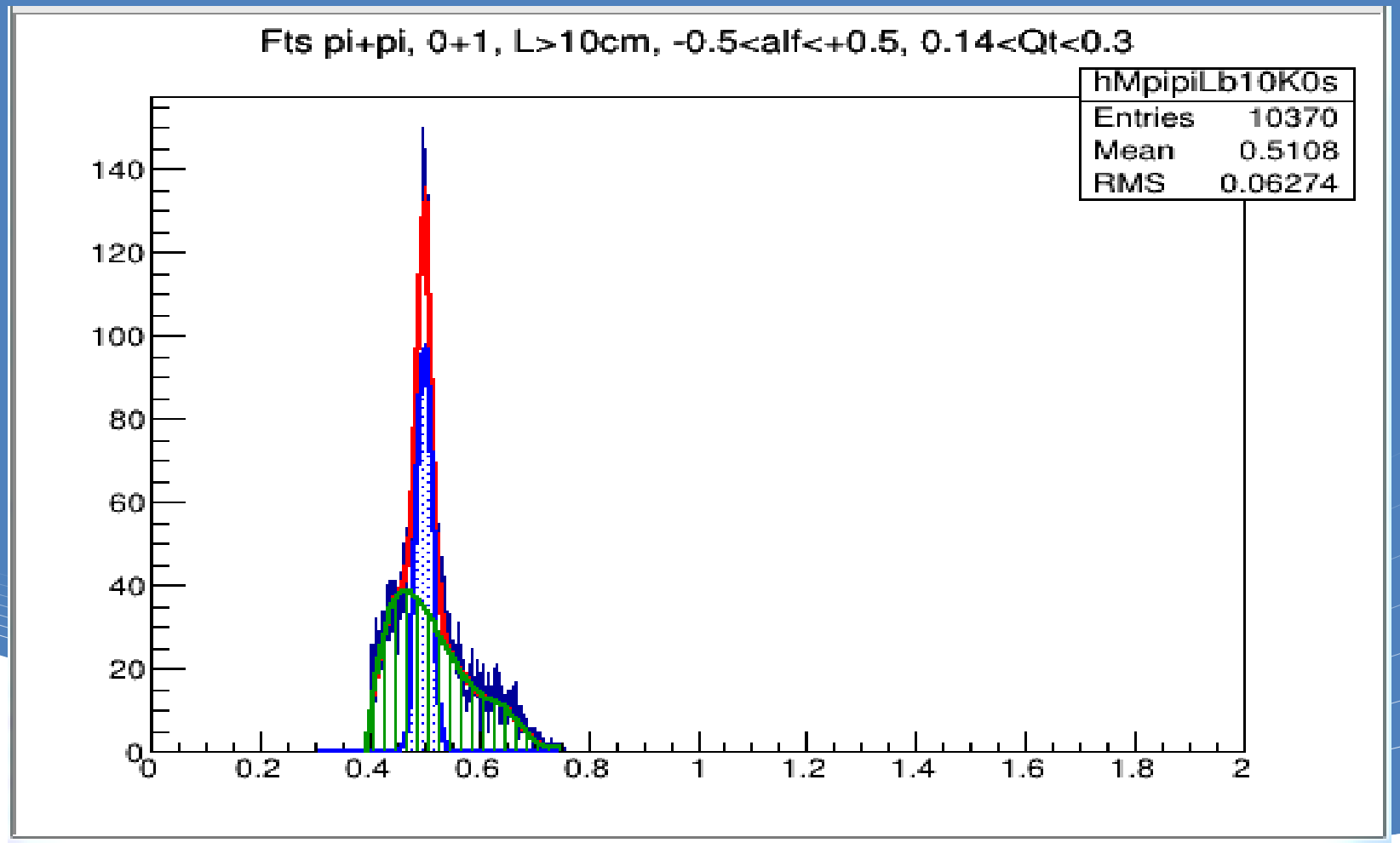
Tracking detectors efficiency and stability



Stability better 0.1% over 12 hours



Tracking system results (kaons reconstruction)



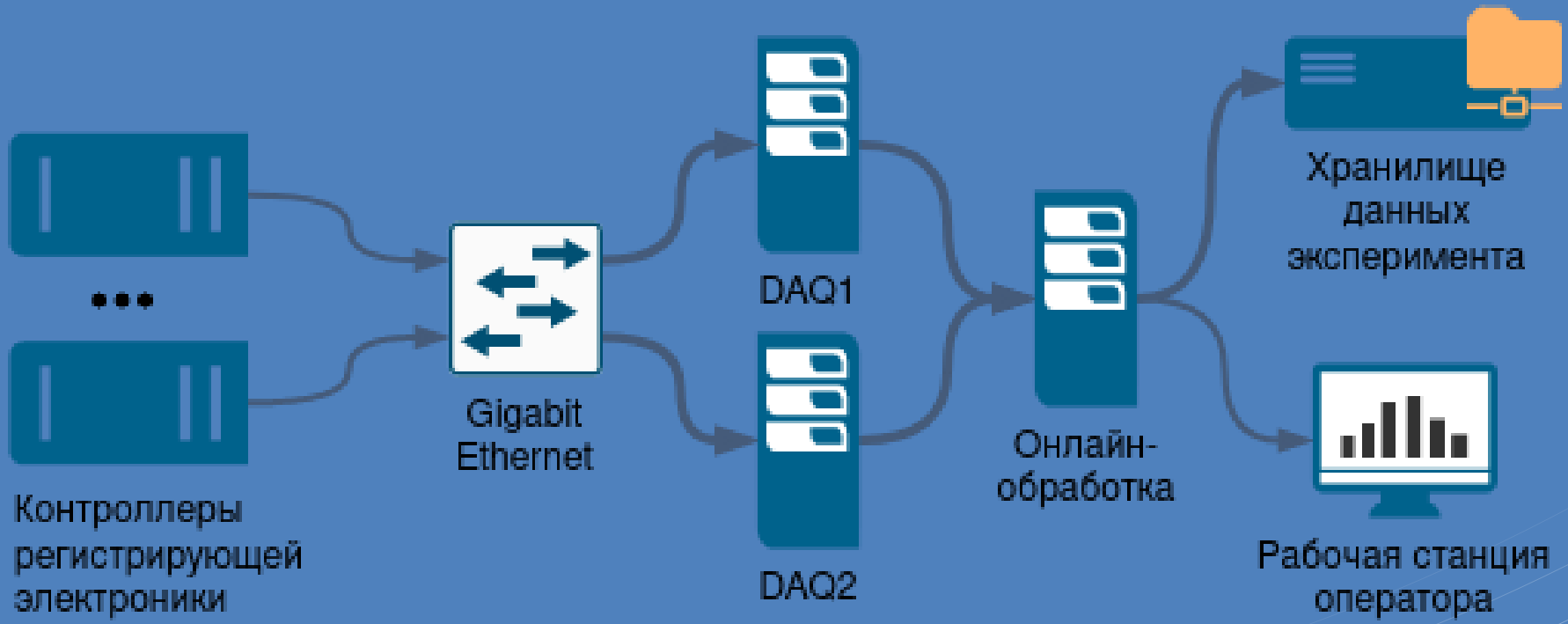
Sigma 14 MeV
Green line – Background

Blue - signal

DAQ system

- Data driven architecture
- 1Gb Ethernet, 10Gb switch
- Each detector (or part) has its own data stream to take data in parallel, each event has a time mark to build the complete event later

DAQ architecture



- Run 2018-2022 showed DAQ rate up to 20000 events per second

Slow Control system

- EPICS based
- Distributed over the experiment detectors (Ethernet, RaspberryPis, Modbus, CAN)
- Control HV, temperature, humidity
- Electronics thresholds, crates power
- Useful – front-end electronics FPGA reprogramming

Conclusions

- Current setup of the SPASCHARM detectors showed good performance and provided data taking in 2018 with polarized target (approx 10^9 events) and 2021 with nuclear targets (approx $1.5*10^9$ events)
- 2018-2022 runs allowed us to optimize detector parameters and reach required performance to continue SPASCHARM physics program