NIS-GIBS SPECTROMETER FOR HYPERNUCLEI RESERCH

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At Dubna two proposals were consolidated to form

STRANGENESS IN NUCLEON AND NUCLEI
the HyperNIS project

NIS – Nucleon Intrinsic Strangeness: search for effects of nucleon polarized strangeness in production of φ and ω mesons in pp and np scattering, comparison of production cross sections of φ and ω mesons near their thresholds

Hypernuclei – production with excitation of accelerated nuclei and decay of hypernuclei far outside of target, measurement of production cross sections, lifetimes, binding energy of loosely bound nuclei, study of matrix elements of the weak ΛN interaction

Hypernuclei + NIS $\Rightarrow$ HyperNIS

HyperNIS hypernuclei program at Nuclotron with light ion beams

1. **Lifetime and production cross sections** of light (hydrogen, helium) hypernuclei (energy dependence of the production cross section)

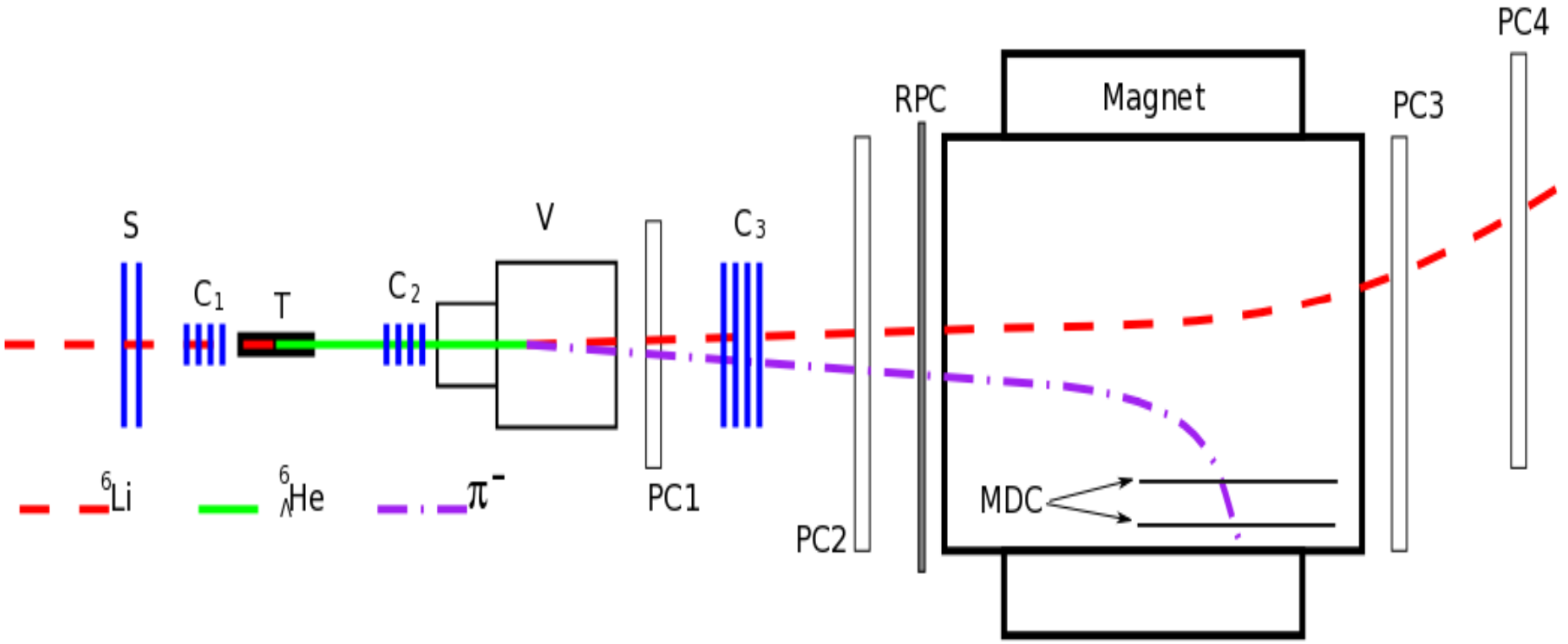
$$^{6}\mathrm{Li} \rightarrow {}^{6}_{\Lambda}\mathrm{He} \rightarrow \pi^{-} + {}^{6}\mathrm{Li}$$

$$^{7}\mathrm{Li} \rightarrow {}^{A}_{\Lambda}\mathrm{H} \rightarrow \pi^{-} + {}^{A}\mathrm{He}$$

2. **Binding energy** of loosely bound hypernuclei ${}^{3}_{\Lambda}\mathrm{H}$, ${}^{6}_{\Lambda}\mathrm{He}$ to be obtained by measuring the Coulomb dissociation cross sections in different targets ($\sigma_{Coulomb}$ increases at low binding energy values!)

$$\sigma_{Coulomb} \sim Z^{1.92} \quad \sigma_{Nucl} \sim A^{0.6}$$

3. **Matrix elements of the weak ΛN interaction** (study of non-mesonic decay of hypernuclei ${}^{10}_{\Lambda}\mathrm{Be}$ and ${}^{10}_{\Lambda}\mathrm{B}$ **partial widths of nonmesonic weak decay** via intermediate chain $^{8}\mathrm{Be} \rightarrow \alpha + \alpha$)



NIS-GIBS spectrometer for ${}^{6}_{\Lambda}$He production with ^{6}Li beam. T – target (carbon 12 × 3×3 cm, 20.4 g/cm^2); S,$C_{1,2,3}$ – trigger counters; V – vacuum decay vessel; RPC wall for TOF; M – magnet; PC_{1-4} – proportional chambers, MDC - minidrift chambers (planned in 2011).

Status of Nuclotron

At Dubna experiments the energy of hypernuclei is only slightly lower than that of the beam nuclei (4 GeV per nucleon) and a significant part of hypernuclei decay far beyond the production target (2006, Mainz, we announced).

4 GeV level achieved in June 23, 2009. Really!

2.2 GeV till this date...
Nuclotron commission $\Rightarrow$ experiments in 2010 (! or ?)

Short test run with ^{6}Li beam

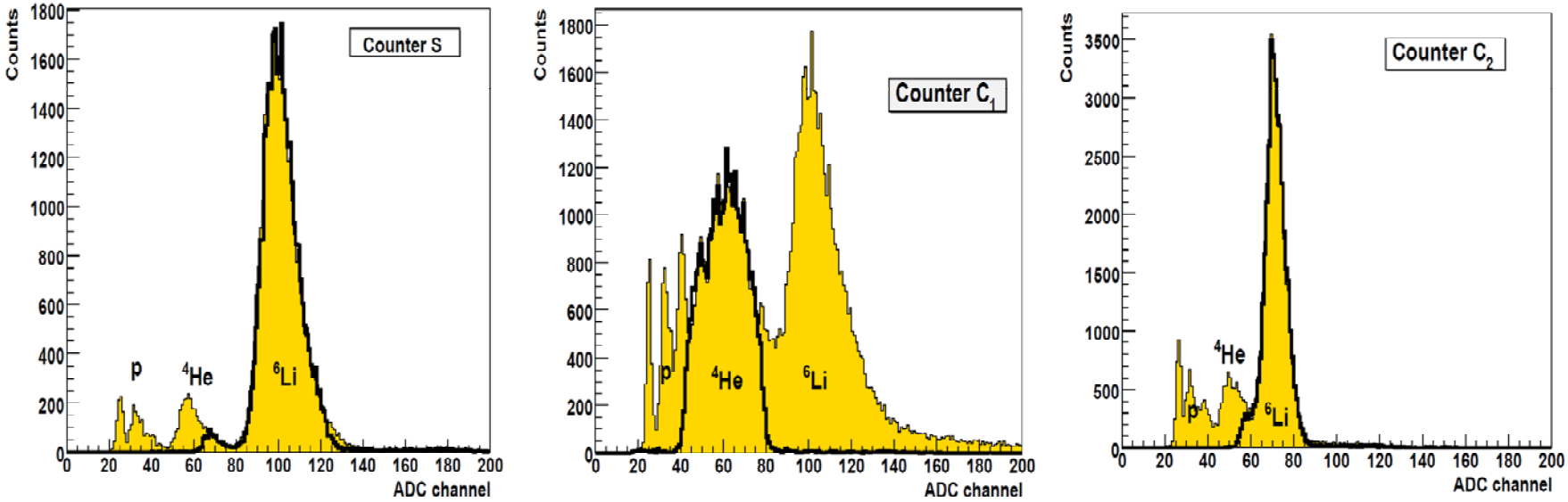
1. Li beam accelerated at the Nuclotron for the first time

2. Trigger tuned to search for

$$^{6}\mathrm{Li} \rightarrow {}^{6}_{\Lambda}\mathrm{He} \rightarrow \pi^{-} + {}^{6}\mathrm{Li}$$

3. Trigger performance was stable at beam intensity of 150×10^{3} s^{-1}, background rejection ratio 5×10^{3} will be increased (factor 4-5) by switching on two additional counters.

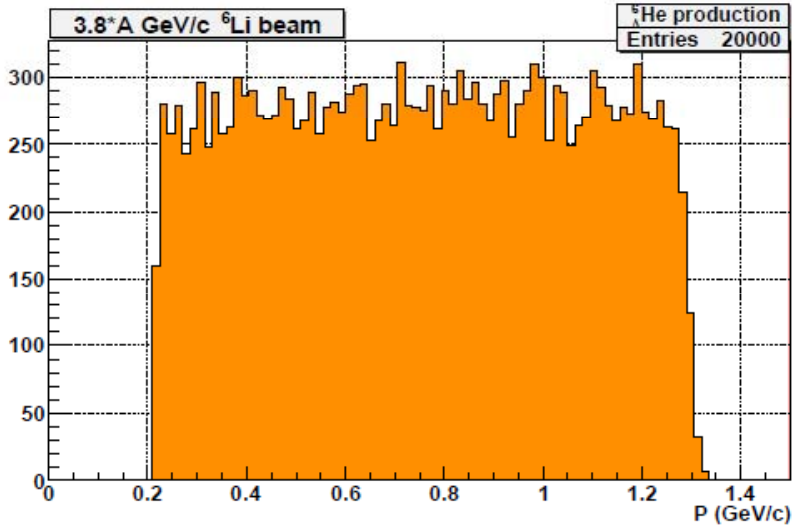
4. Possible increase of data flow – use of off-line trigger to take into account photo multiplier amplitude beam intensity dependence.

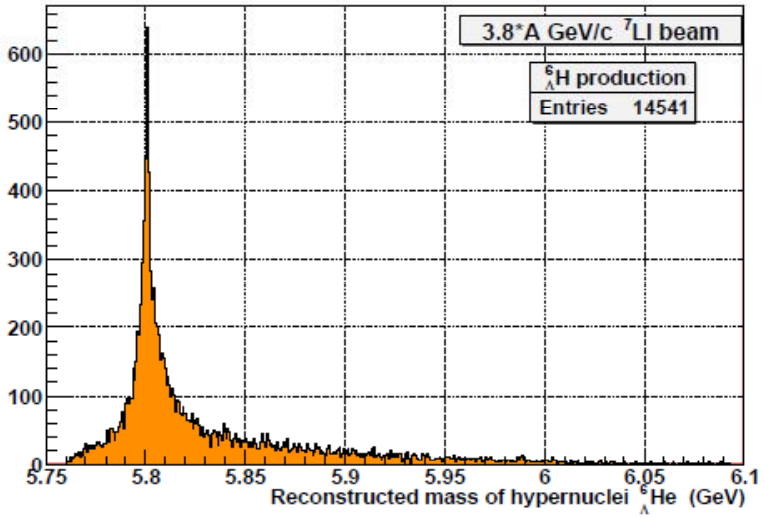


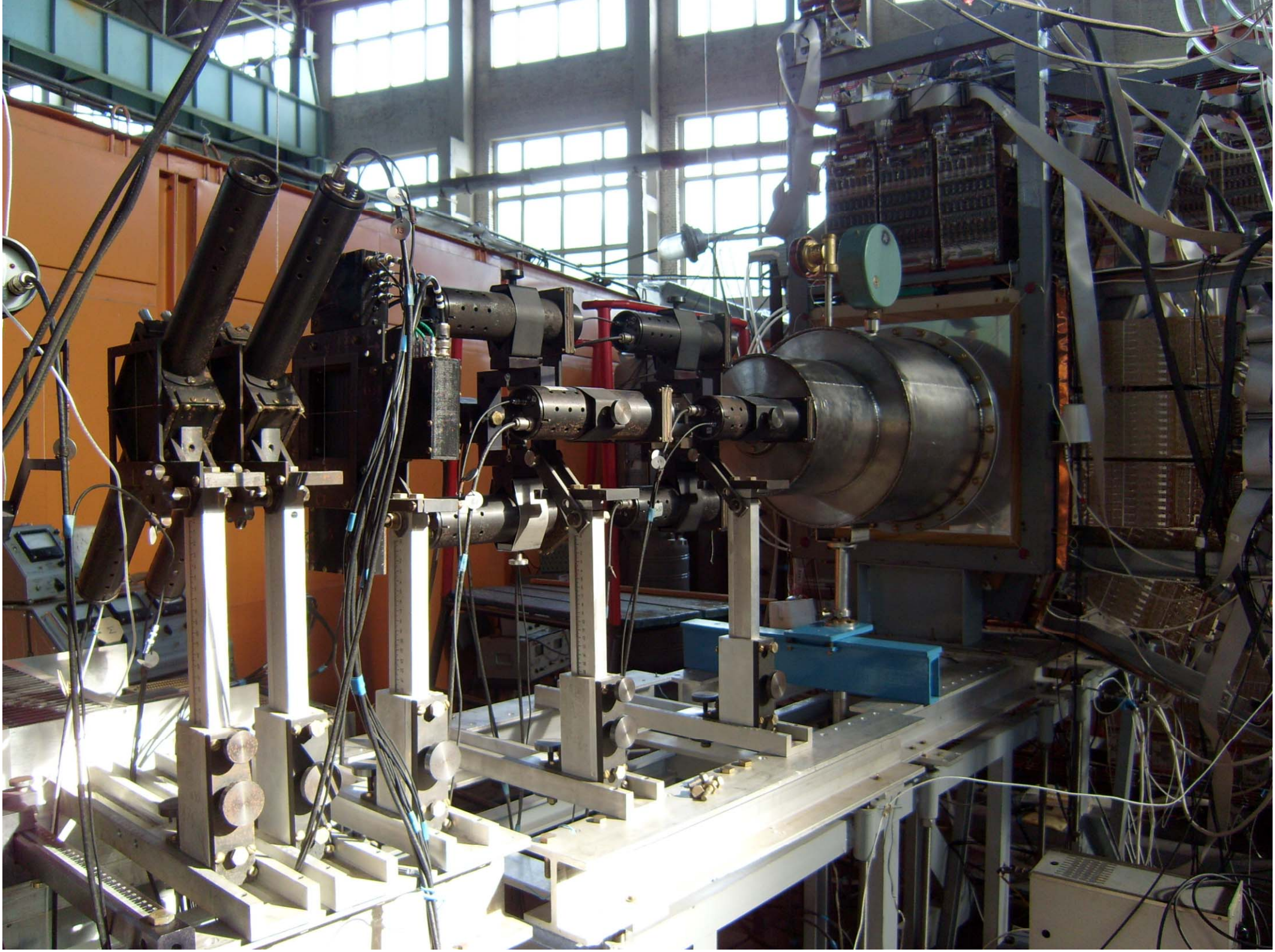
Tuning of trigger counters. Example of signal amplitude spectra obtained for counters of beam monitors S, counters of sets C_1 and C_2 correspondingly. Signal amplitude peaks correspond to lithium beam and its fragments from interactions with target – helium, protons, deuterons. Thick line contours part of spectrum determined by discriminators. Counters S and C_2 are tuned to register lithium, counters C_1 – helium.

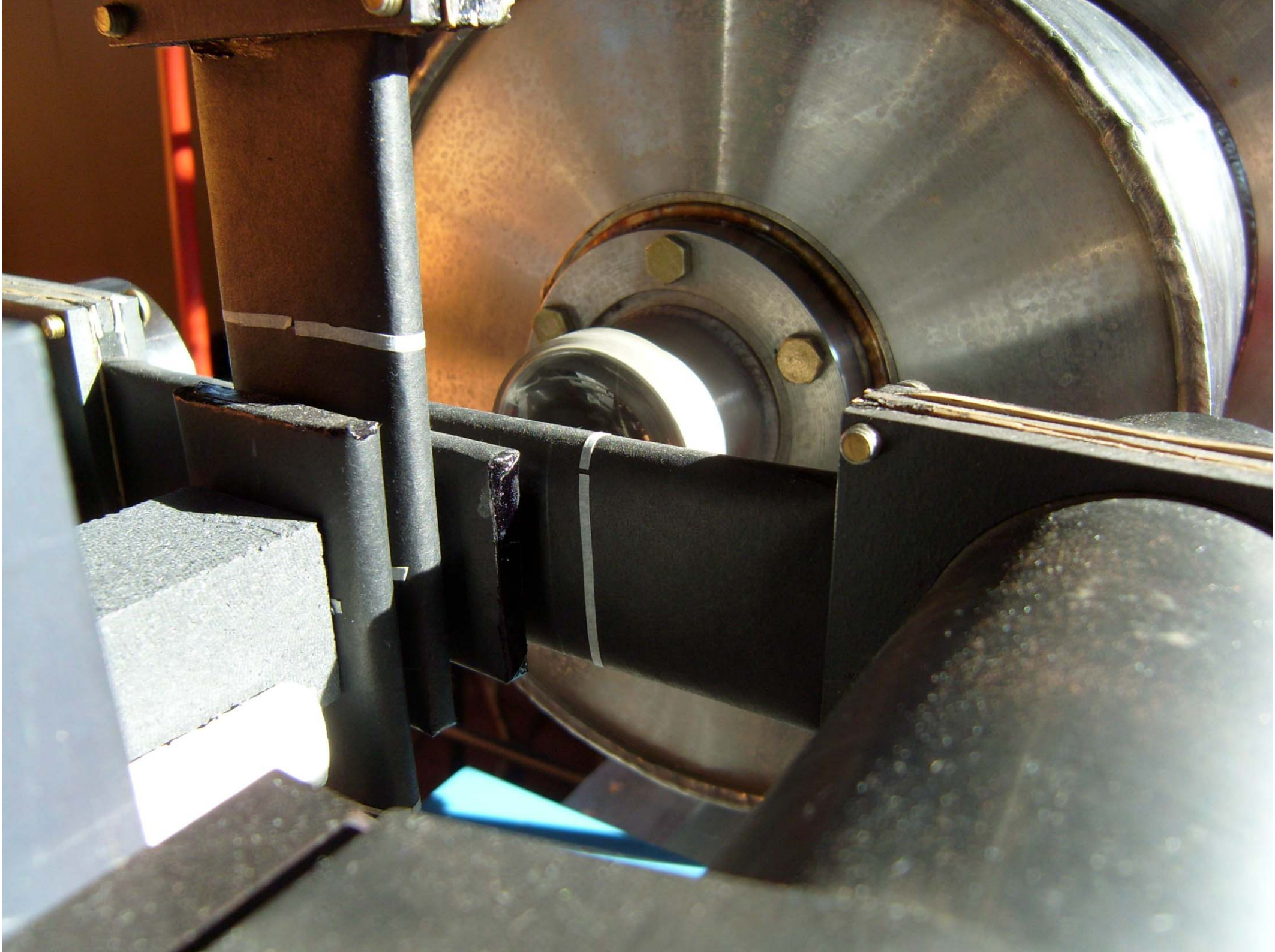
New option of the spectrometer - TOF system. START – scintillation counter ($\sigma \approx 50$ ps). STOP – 6 RPC detectors (48 pads, 20×15 cm, $\sigma \approx 200$ ps) form 1.9×0.9 m wall at distance of 3.5 m, large enough to register hits of all pions. TOF resolution allows to measure momenta of 50% pions.

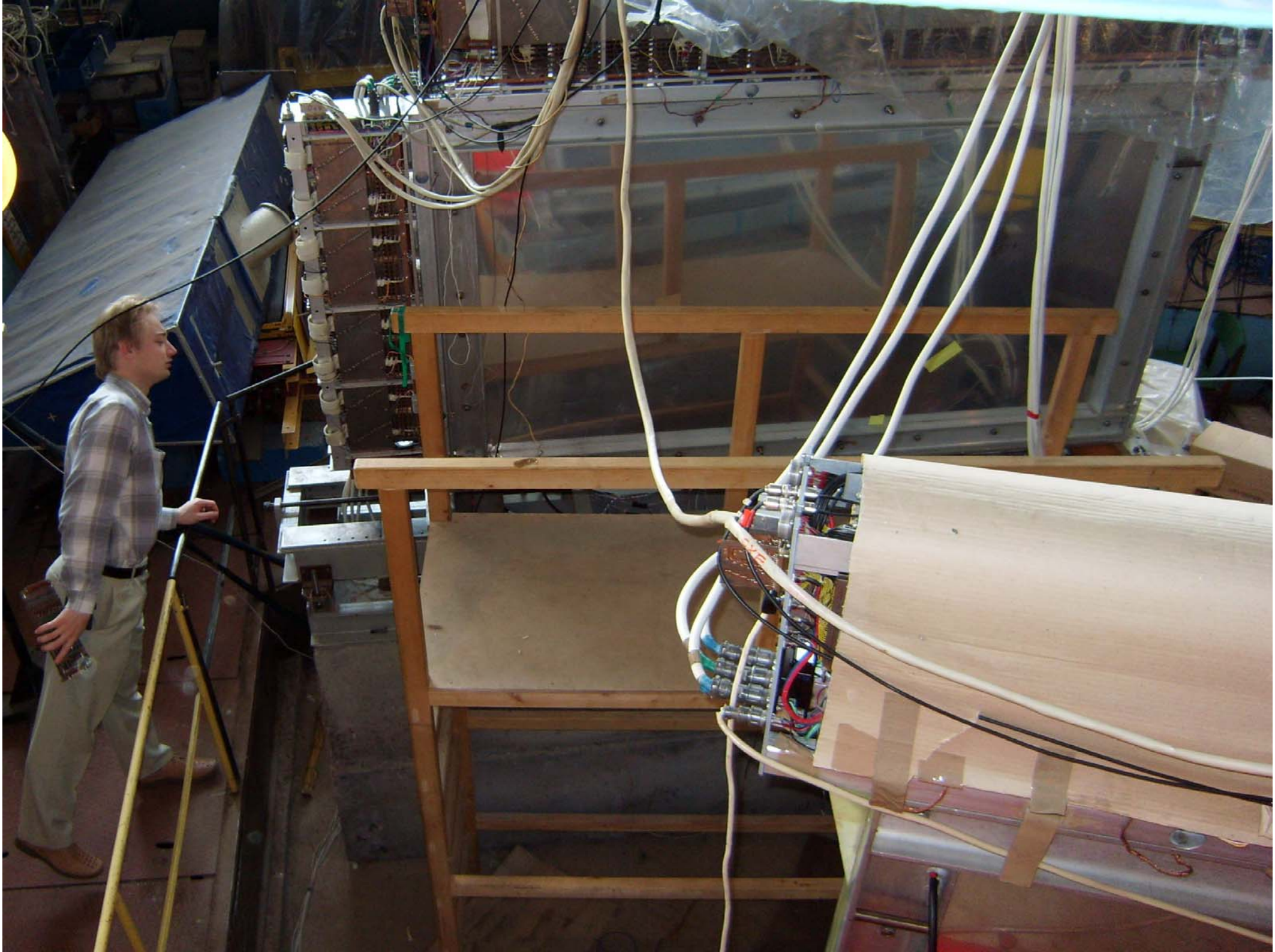
Calculated pion momenta (3.8 GeV/c Li beam) and expected effective mass distribution











HyperNIS

- 1. Spectrometer ready for hypernuclear experiments
- 2. Successful beam and trigger test was carried out
- 3. Nuclotron for physics? 2010 ?

Thank you!