Лаборатория релятивистской ядерной физики в 2004 году

ОФВЭ, ПИЯФ РАН

В. Самсонов

- Введение
- PHENIX-2004 (BNL, США)
- ALICE-2004 (CERN, Швейцария)
- CBM-2004 (GSI,Германия)
- Теоретические результаты-2004
- Планы на будущее
- Заключение

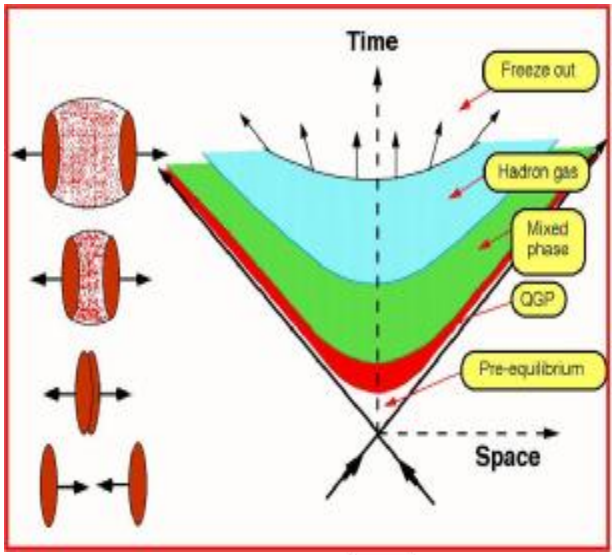
27 декабря 2004

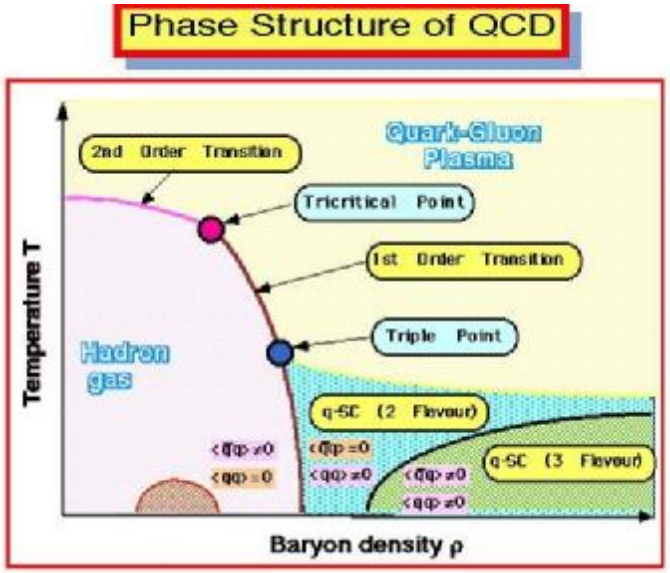
Что мы исследуем?

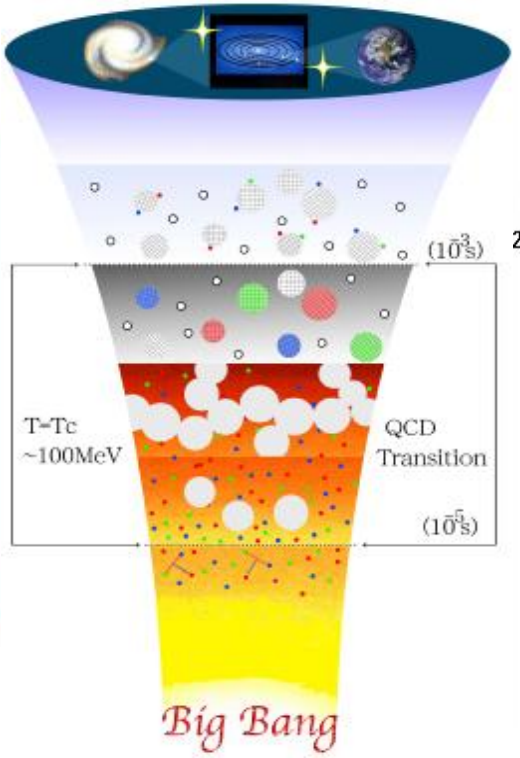
Исследуем состояния ядерной материи
в экстремальных условиях по температуре
и плотности:

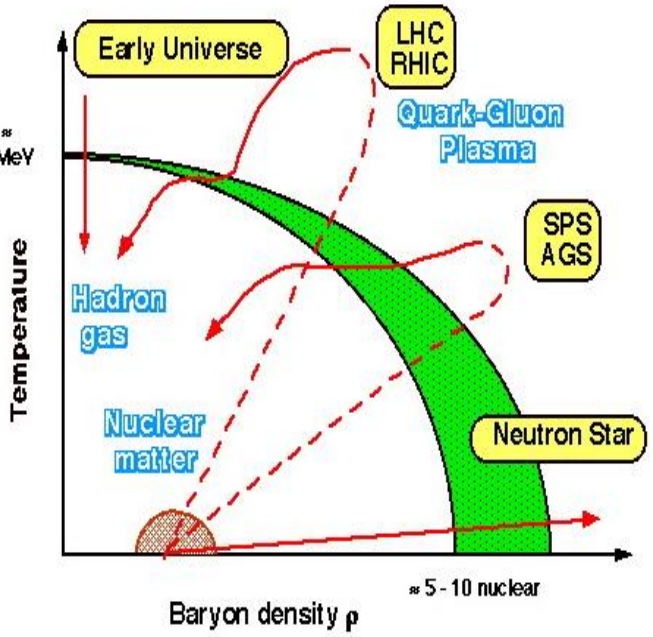
Ø Современная теория QCD предсказывает много необычных свойств у такой материи (см. диаграмму)

Ø Важно для понимания эволюции Вселенной и состояния вещества в звездах





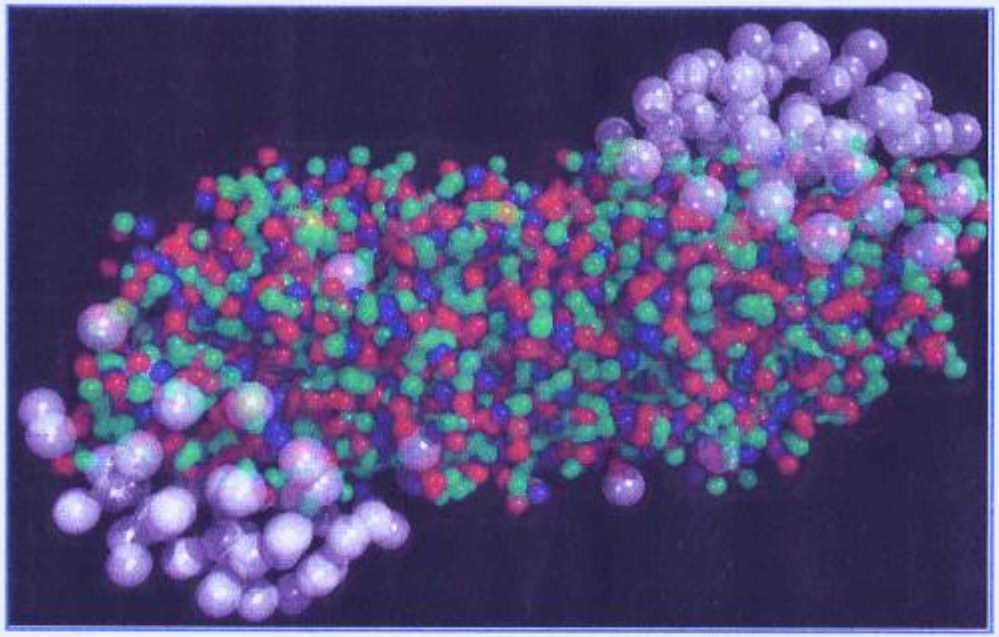




Organisation Européenne pour la Recherche Nucléaire
European Organization for Nuclear Research

PRESS RELEASE

New State of Matter created at CERN



At a special seminar on 10 February, spokespersons from the experiments on CERN* 's Heavy Ion programme presented compelling evidence for the existence of a new state of matter in which quarks, instead of being bound up into more complex particles such as protons and neutrons, are liberated to roam freely.

Theory predicts that this state must have existed at about 10 microseconds after the Big Bang, before the formation of matter as we know it today, but until now it had not been confirmed experimentally. Our understanding of how the universe was created, which was previously unverified theory for any point in time before the formation of ordinary atomic nuclei, about three minutes after the Big Bang, has with these results now been experimentally tested back to a point only a few microseconds after the Big Bang.

New Forms of QCD Matter Discovered at RHIC.

Miklos Gyulassy[a] and Larry McLerran[b]

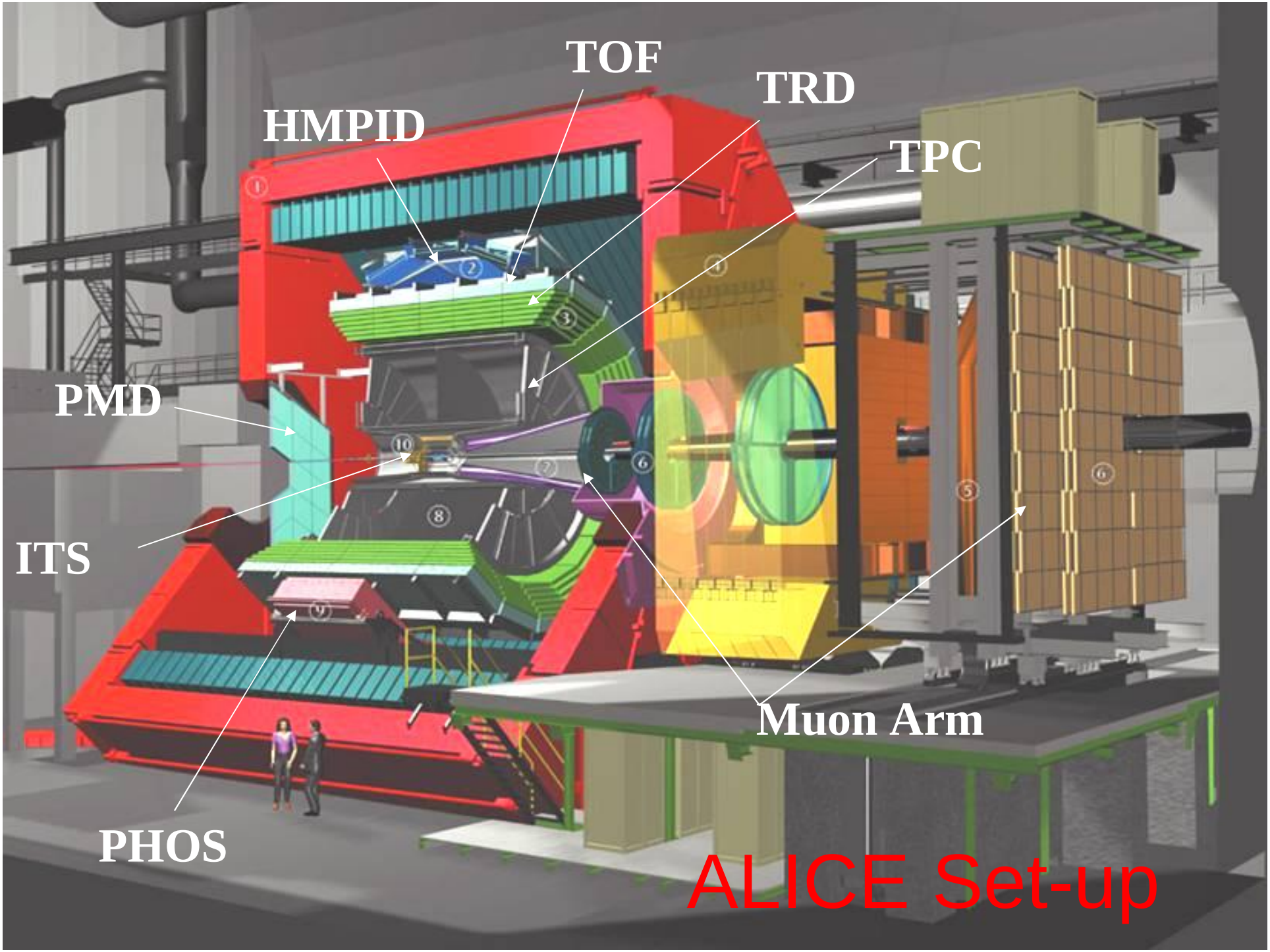
[a]*Physics Department, Columbia UniversityNew York, NY USA*

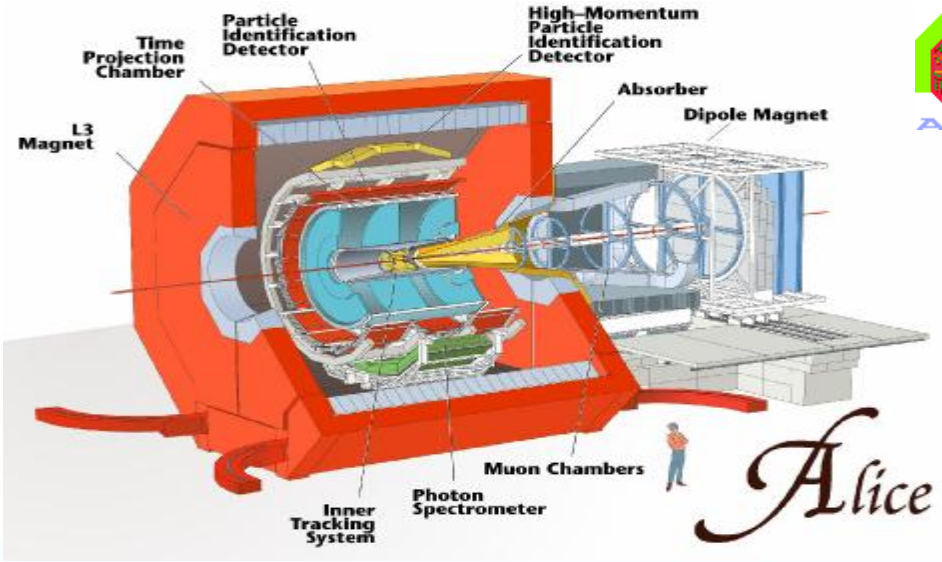
[b]*Physics Department POB 5000 Brookhaven National Laboratory Upton, NY 11973 USA*

May 5, 2004

Abstract

We discuss two special limiting forms of QCD matter which may be produced at RHIC. We conclude from the available empirical evidence that an equilibrated, but strongly coupled Quark Gluon Plasma has been made in such collisions. We also discuss the growing body of evidence that its source is a Color Glass Condensate.


TOF
TRD
HMPID
TPC
PMD
ITS
Muon Arm
PHOS
ALICE Set-up



Alice collaboration

online system

multi-level trigger
filter out background
reduce data volume

Total weight	**10,000t**
Overall diameter	**16.00m**
Overall length	**25m**
Magnetic Field	**0.4Tesla**

8 kHz (160 GB/sec)

level 0 - special hardware

200 Hz (4 GB/sec)

level 1 - embedded processors

30 Hz (2.5 GB/sec)

level 2 - PCs

30 Hz
(1.25 GB/sec)

data recording & offline analysis

The ALICE collaboration includes 1223 collaborators from 85 different institutes from 27 countries.

ПИЯФ в эксперименте ALICE

- **Участие в создании мюонного спектрометра:**

  Ø **Трековой системы - станции 3,4,5**
  - разработка и изготовление технологического и контрольного оборудования для сборки модулей камер
  - производство ¼ части всех модулей
  - тестирование модулей в ЦЕРН перед установкой в экспериментальный зал
  - сборка камер и эксплуатация в сеансах

  Ø **Проектирование мюонного фильтра**

  Ø **Проектирование суперструктуры (конструкций закрепления камер на детекторе)**

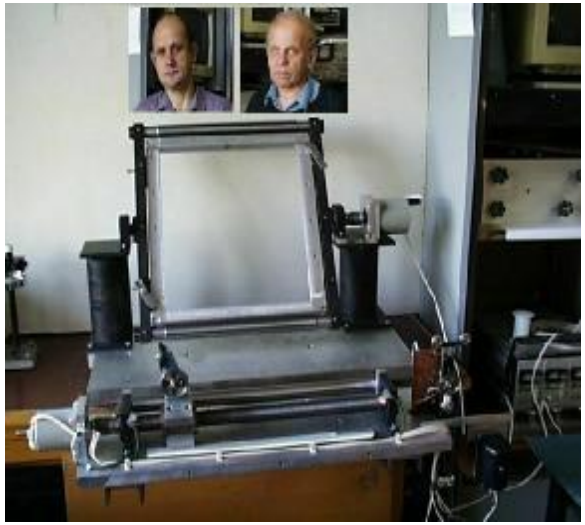
- **Обоснование и моделирование условий для исследования эффектов при ультрапериферических столкновениях ядер**

- **Участие в обработке экспериментальных данных после запуска**

Разработано и изготовлено оборудование для производства модулей мюонных камер

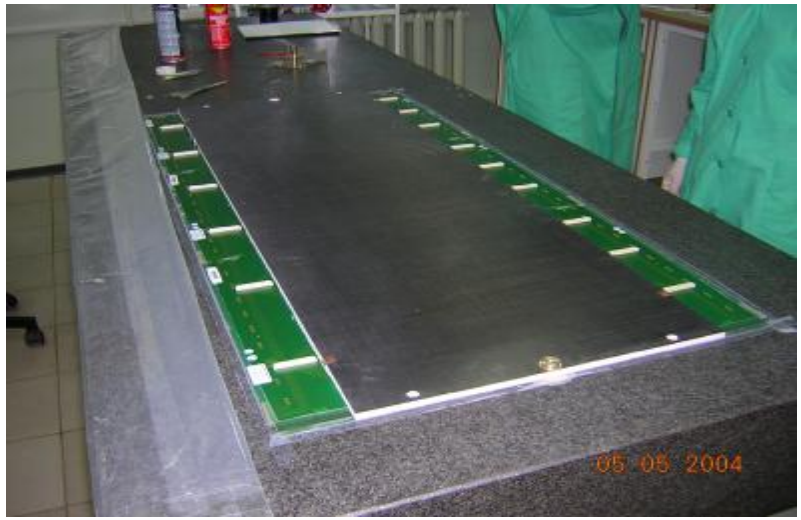






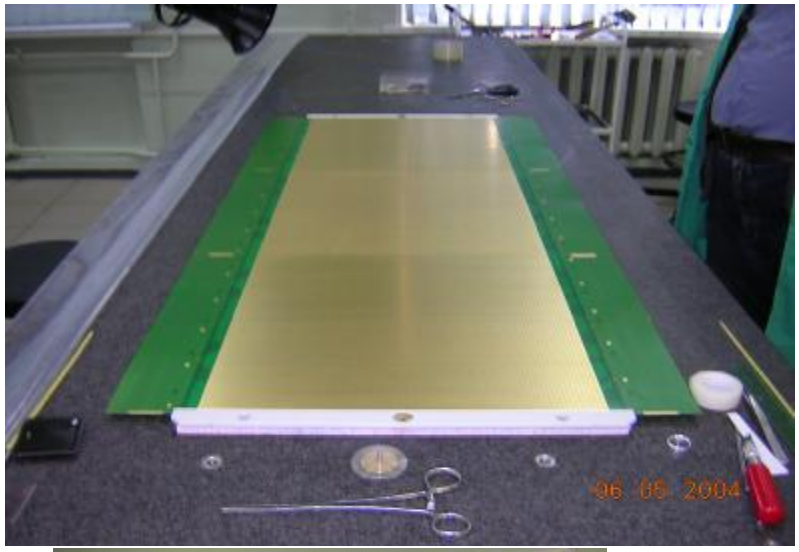

Slat 33300_GAT_001 assembling:

Sandwich panel gluing



Slat production at PNPI, Berg-en-Dal, 2004

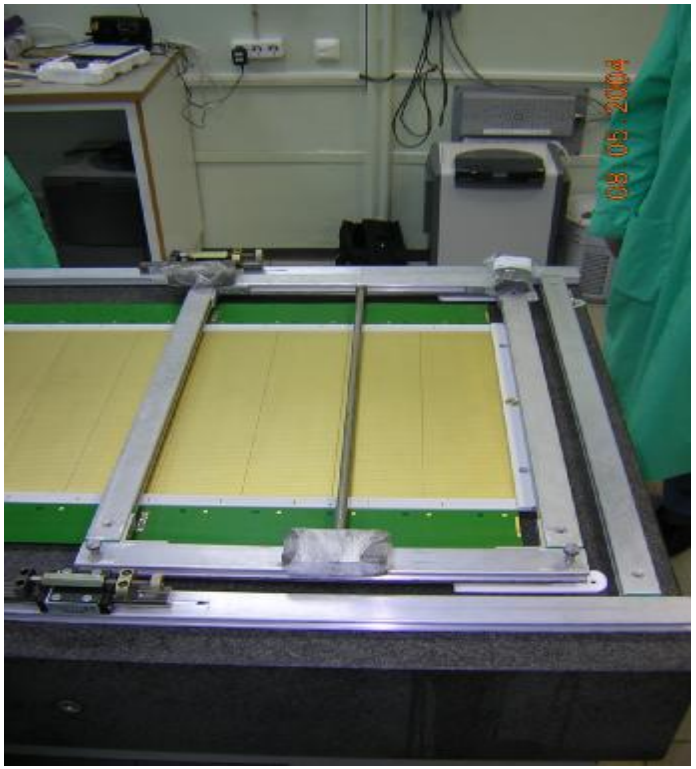
Slat 33300_GAT_001 assembling:

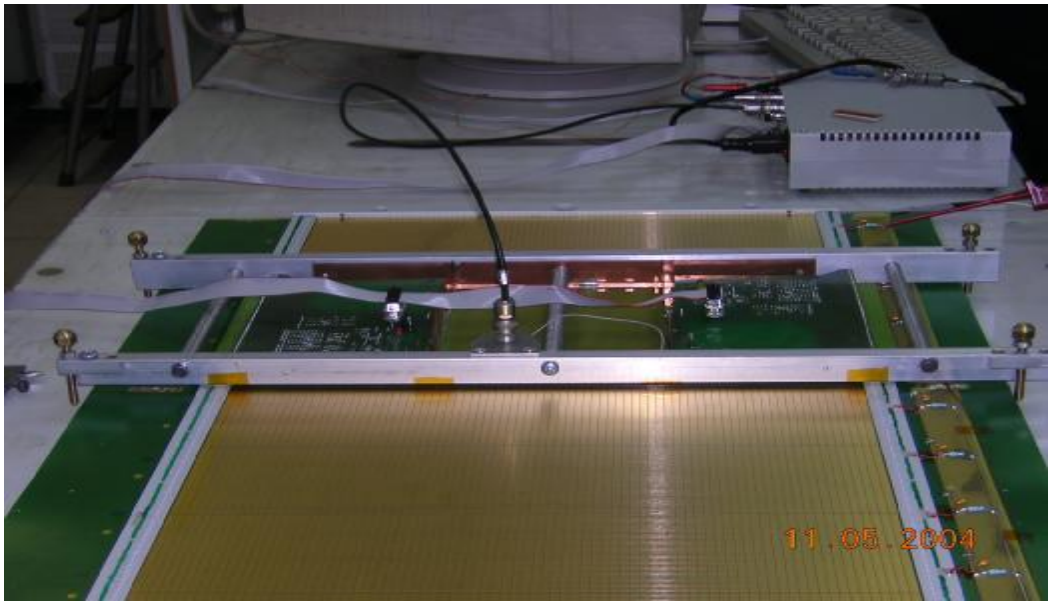


Spacers

Slat production at PNPI, Berg-en-Dal, 2004

Slat 33300 GAT_001 assembling:





Wire setting and tension checks

Slat production at PNPI, Berg-en-Dal, 2004

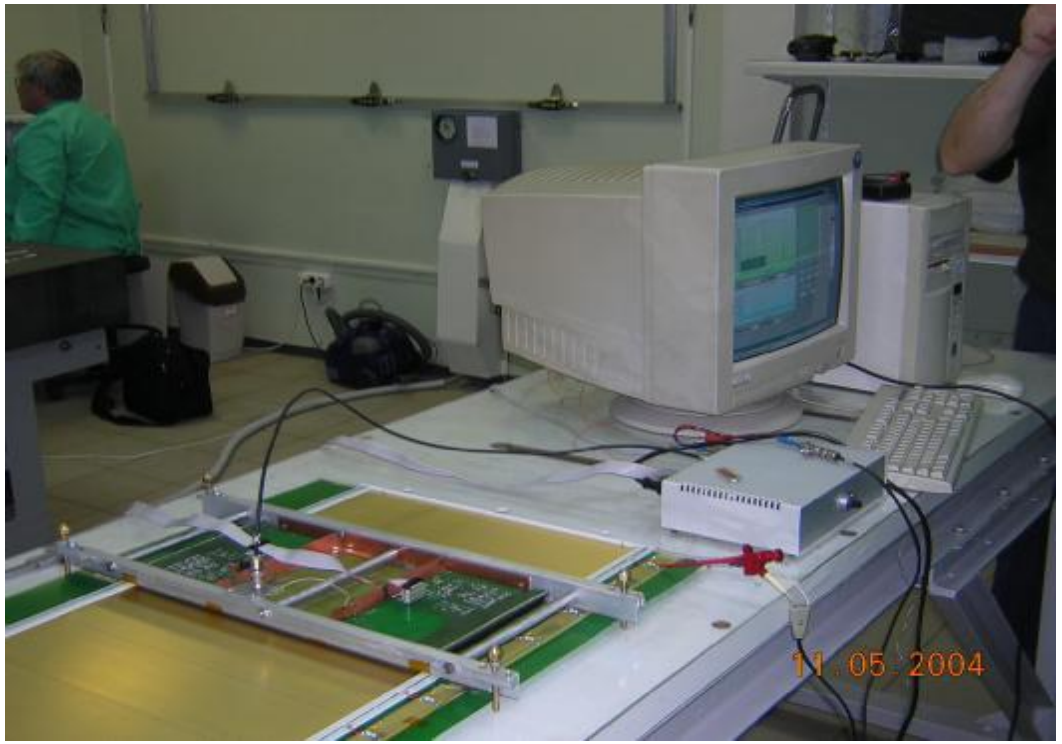
Wire tension measurement progress:

Frequency scan is replaced by Fourier analysis

- Hardware: minor upgrade required
- New (based on LabView 7.0) soft
- Measuring time improvement : 80 wire measurement takes now 20 seconds!

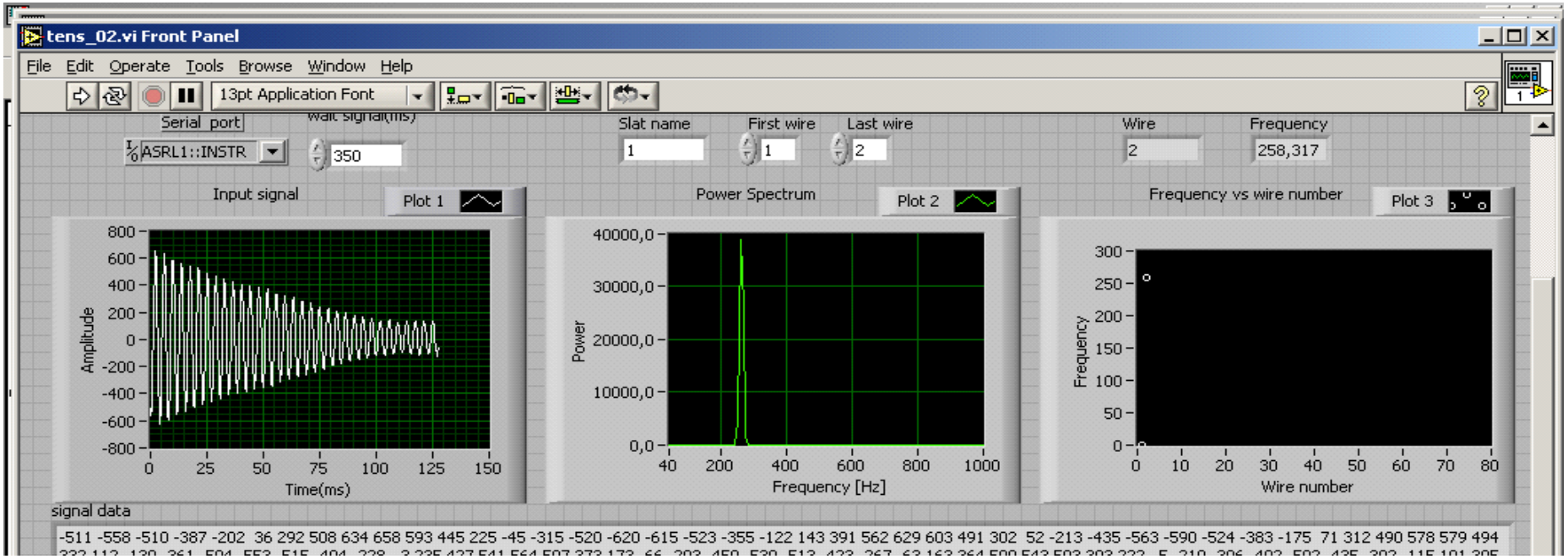
$$T = 4 f^2_{res} L^2 \rho$$

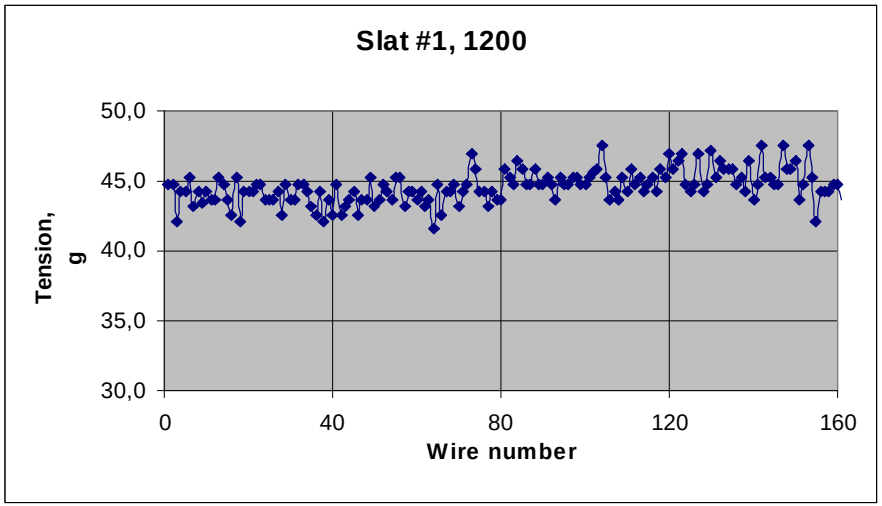
The LabView software should be purchased in each lab!



Slat production at PNPI, Berg-en-Dal, 2004

Wire tension measurement results:

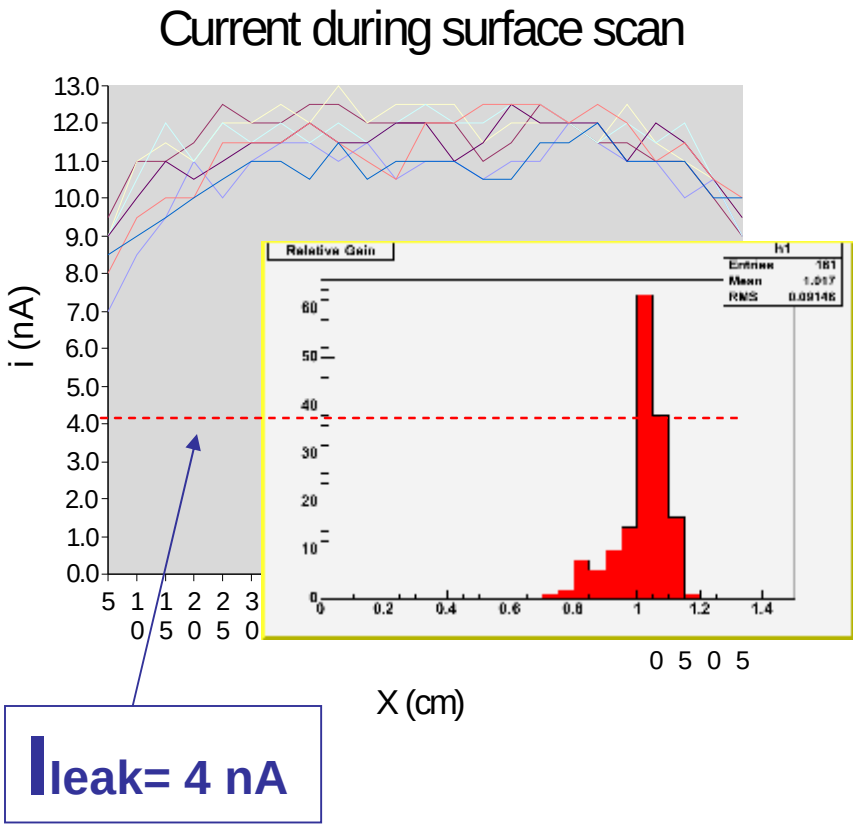




Nominal tension: 42 g.

Slat production at PNPI, Berg-en-Dal, 2004

Gas gain homogeneity checks:

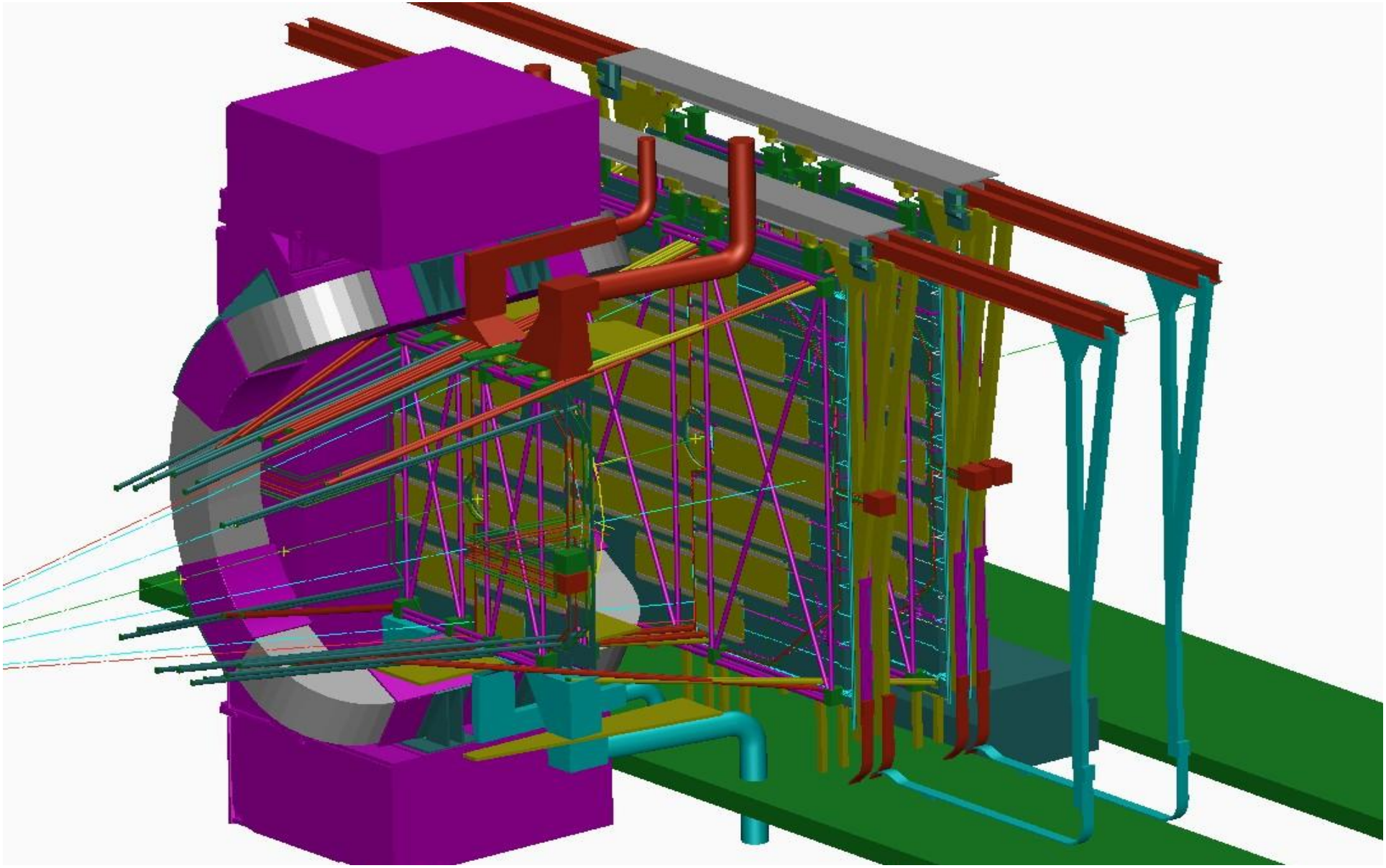


β – source test station

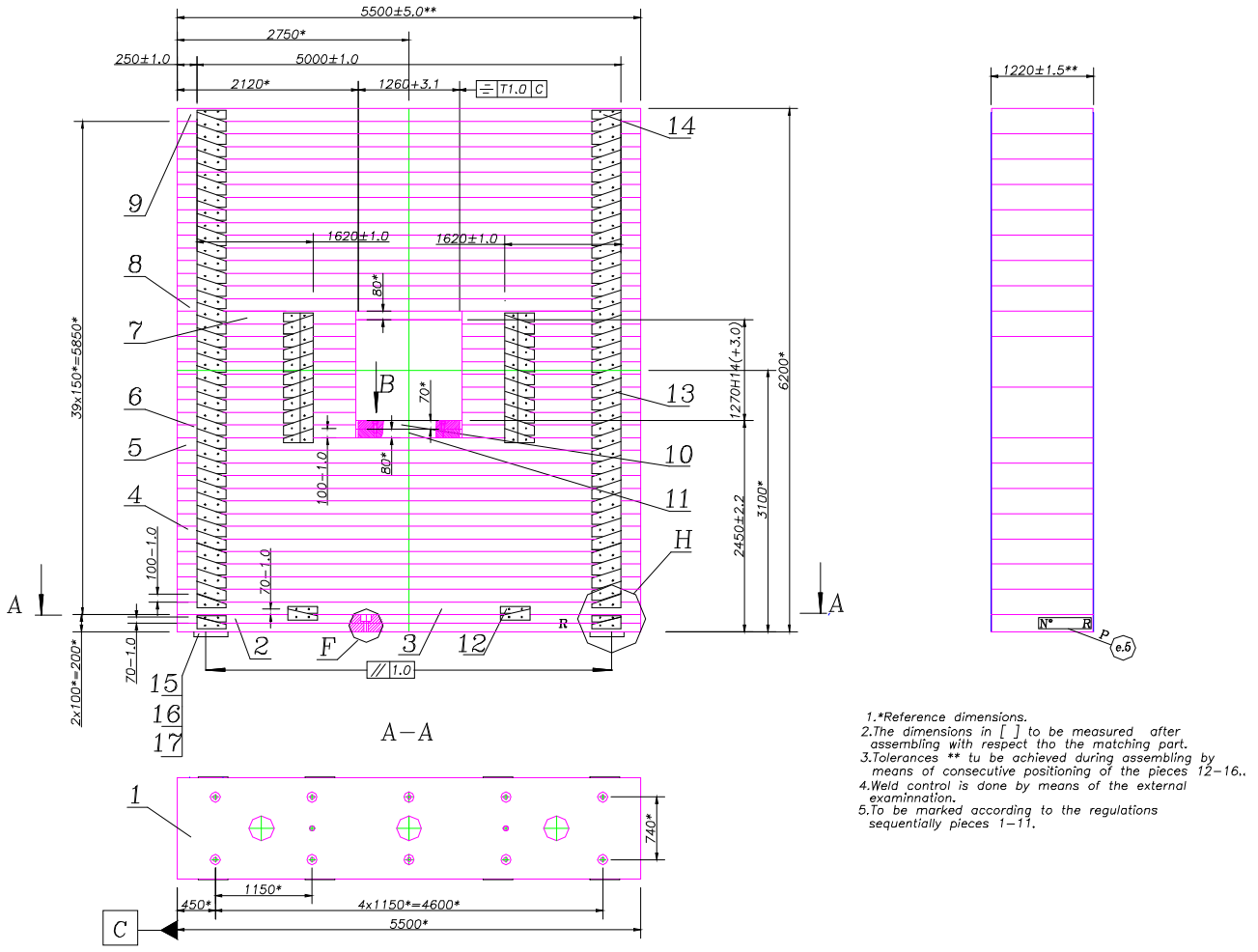
Methods: Current and Amplitude measurements

Gas gain is uniform at level of ±20%

Muon Stations 3-4-5



Выполнен полный инженерный проект Мюонного фильтра

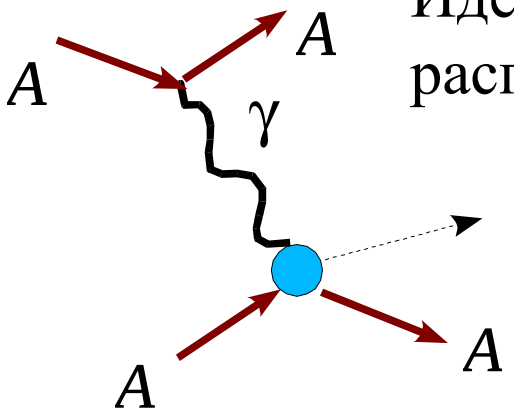


1.*Reference dimensions.
2.The dimensions in [ ] to be measured after assembling with respect tho the matching part.
3.Tolerances ** tu be achieved during assembling by means of consecutive positioning of the pieces 12-16..
4.Weld control is done by means of the external examinnation.
5.To be marked according to the regulations sequentially pieces 1-11.

Ультра-периферические взаимодействия @ ALICE

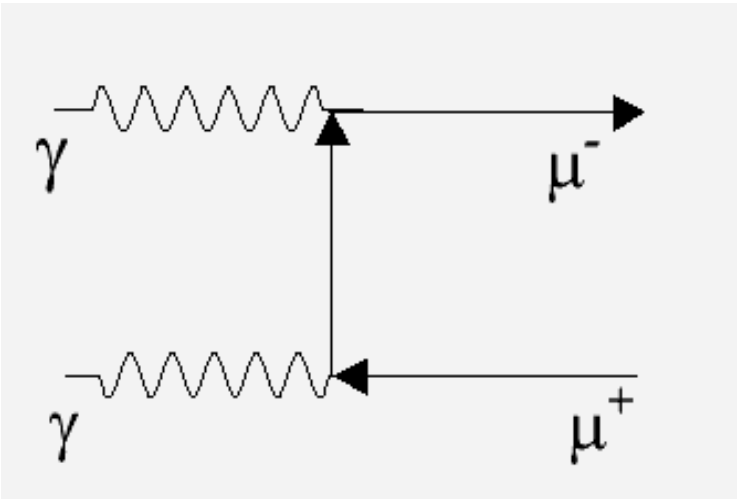
Написаны главы, посвященные фоторождению тяжелых кваркониев в следующие документы (будут опубликованы в 2005):

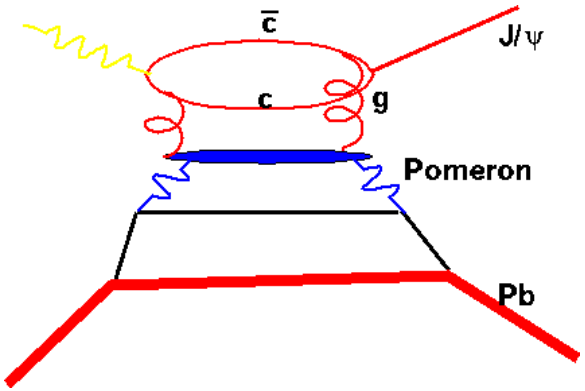
- ALICE Physical Performance Report, глава 6
- Ultra-peripheral interactions Yellow Report



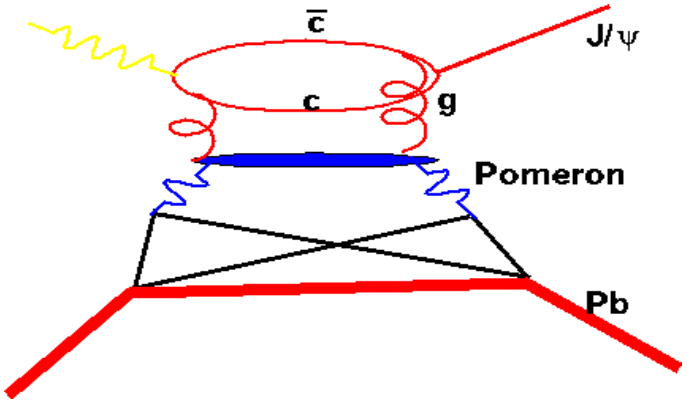
Идентификация - по распаду на 2 мюона

Дополнительно изучаем фон (калибровка):

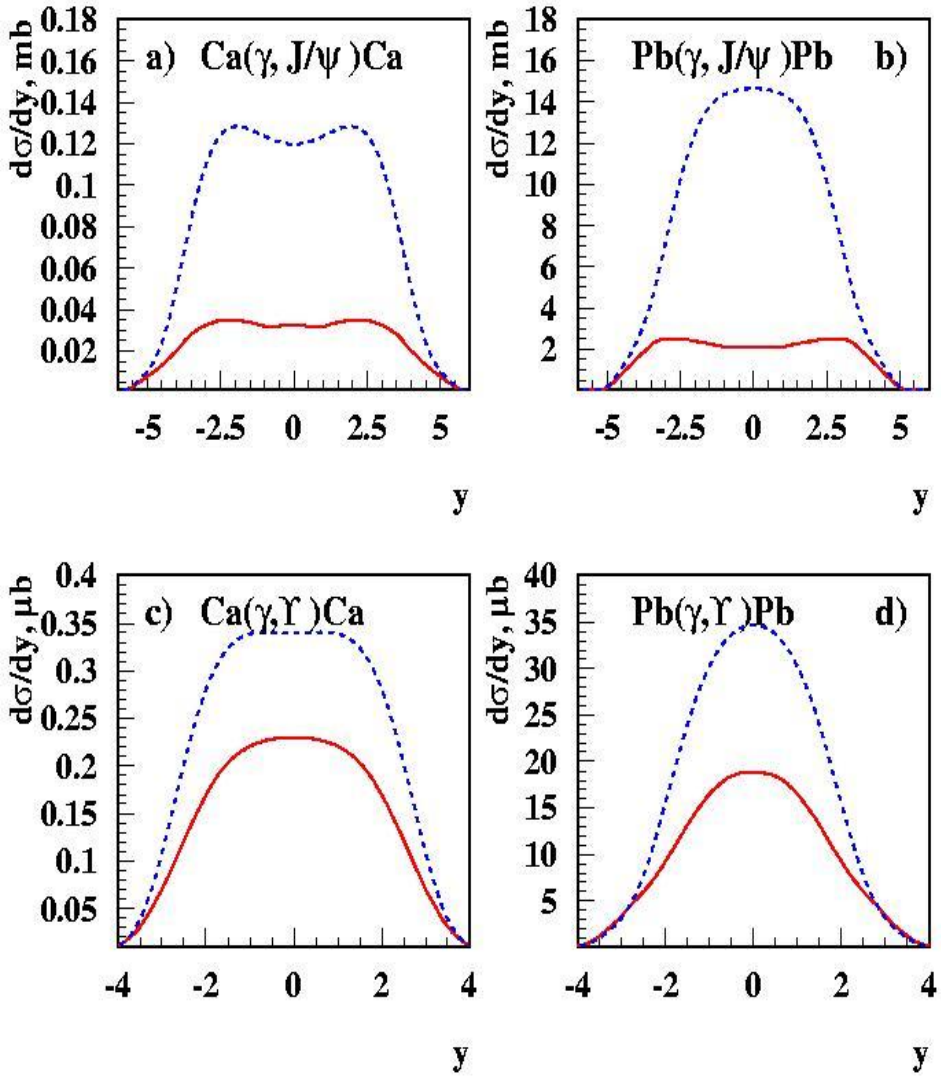




Импульсное приближение

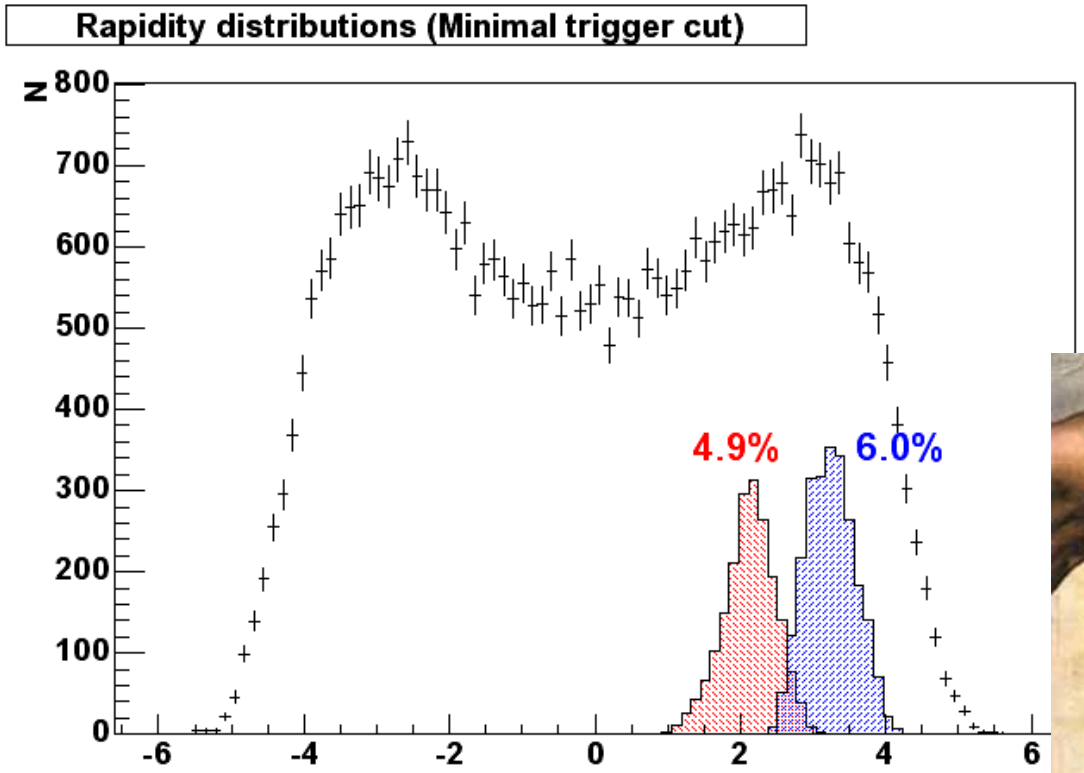


Leading twist приближение



Теория предсказывает чувствительность к глюонной плотности!

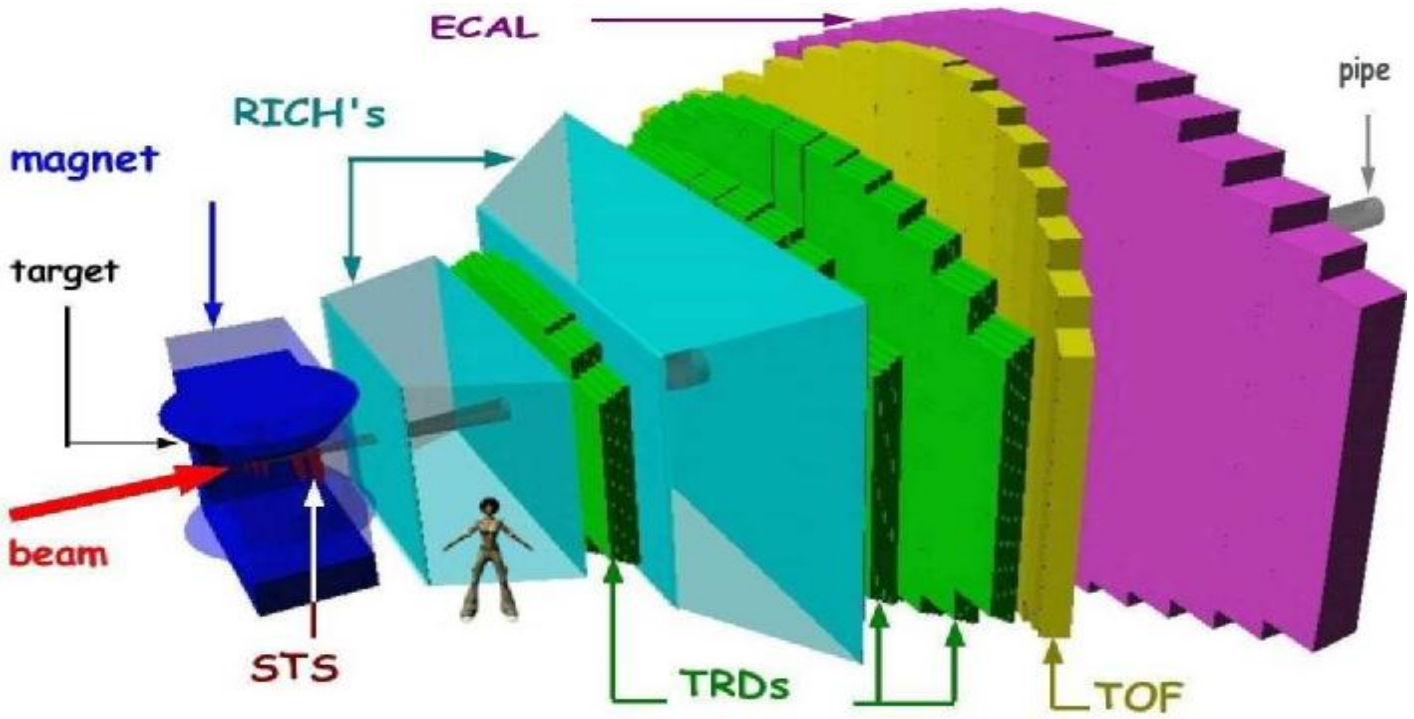
Монте-Карло симуляции (AliRoot) предсказывют разумные скорости счета и отношения сигнал/фон: ~20,000 J/ψ событий за 10^6 сек, при достоверности ~150



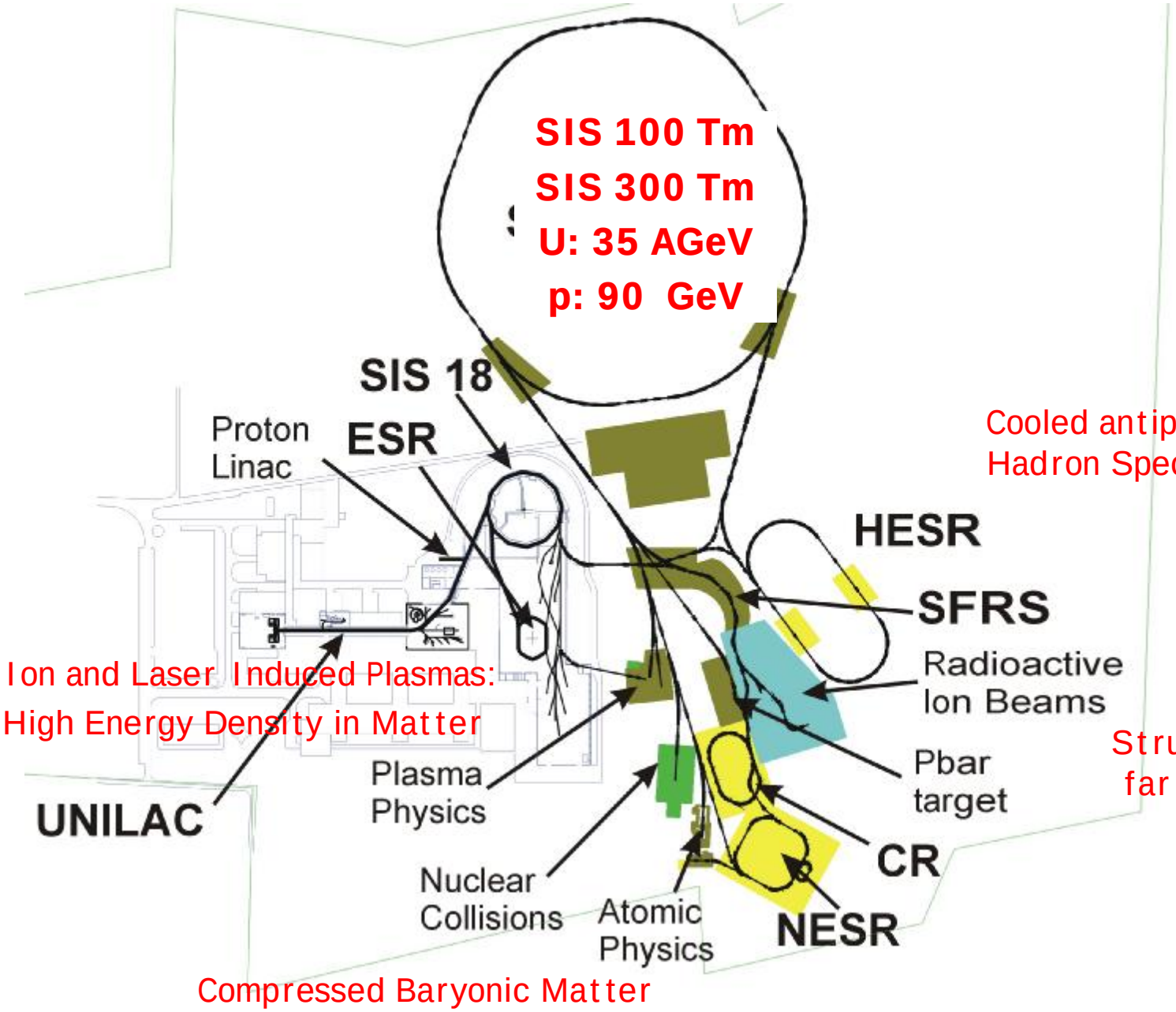
Основная проблема - выбор триггера нулевого уровня (ZDC приходит слишком поздно). Возможности:

- Димюонный триггер
- Димюонный триггер + вето от PHOS (если удастся)

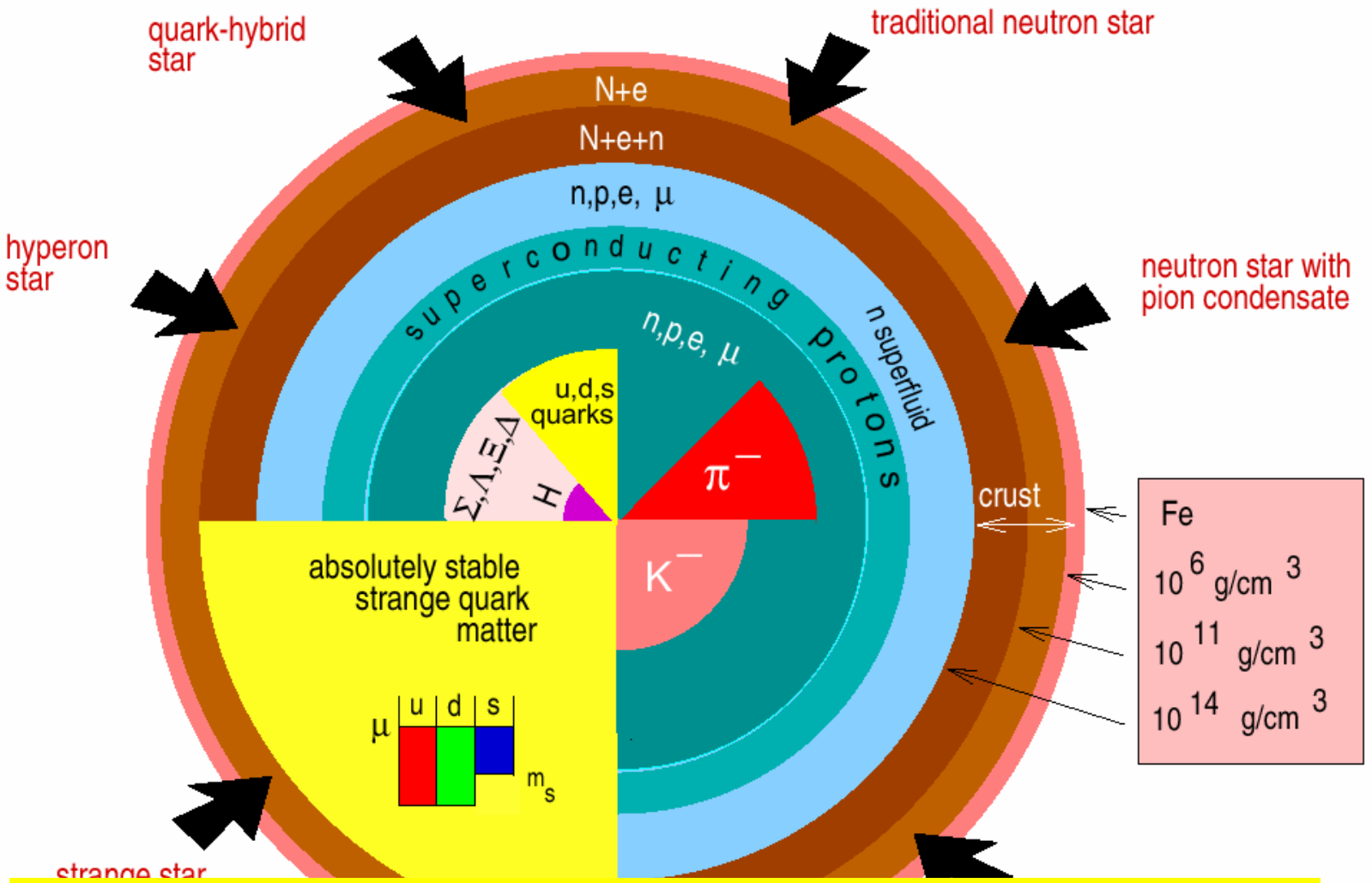
PNPI in CBM



The future Facility for Antiproton an Ion Research (FAIR)



States of strongly interacting matter



asma

"Strangeness" of dense matter ?
In-medium properties of hadrons ?
Compressibility of nuclear matter?
Deconfinement at high baryon densities ?

CBM physics topics and observables

- In-medium modifications of hadrons
  - onset of chiral symmetry restoration at high ρ_B

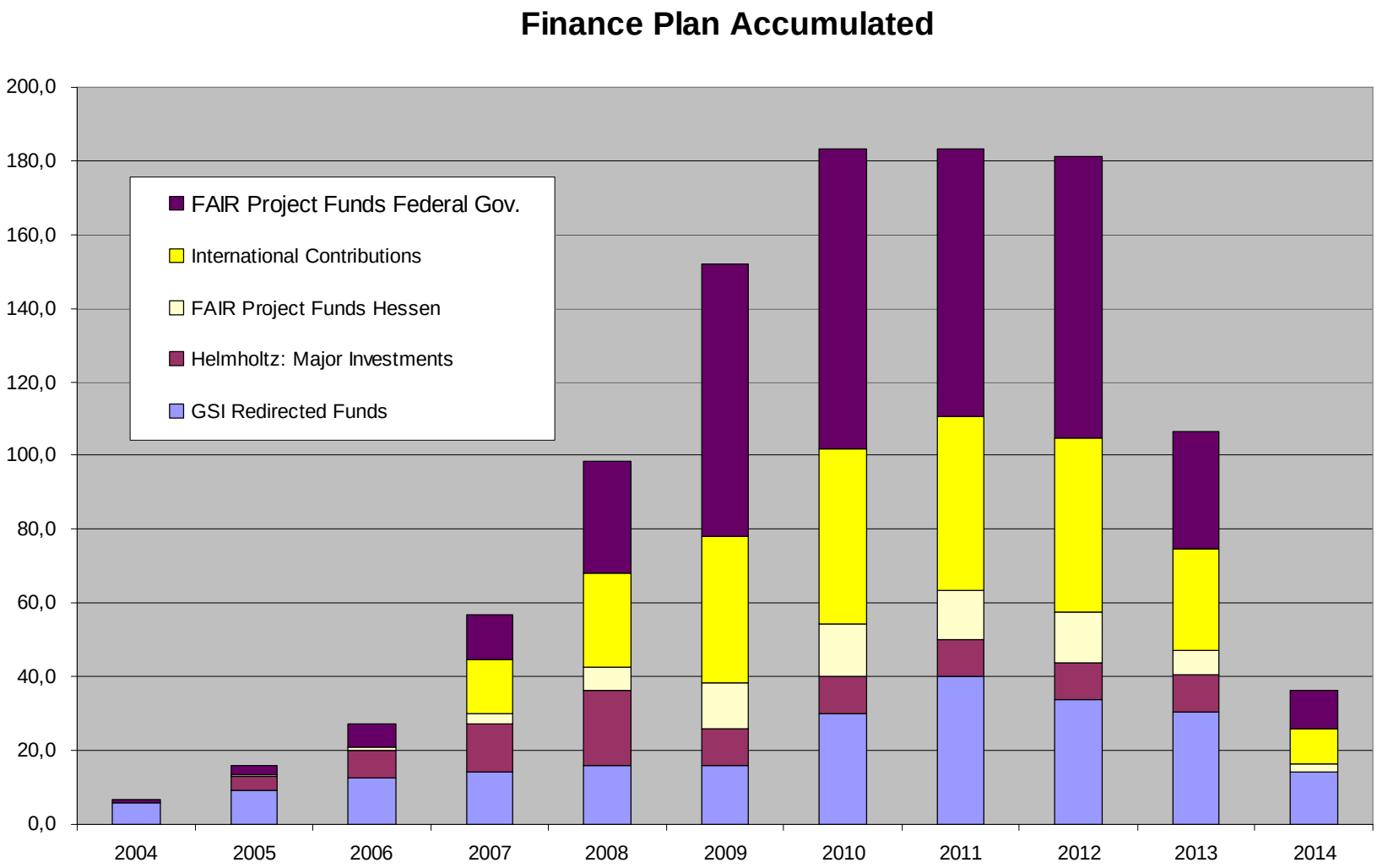
    measure: ρ, ω, $\phi \rightarrow e^+e^-$

    open charm (D mesons)
- Strangeness in matter (strange matter?)
  - enhanced strangeness production ?

    measure: K, Λ, Σ, Ξ, Ω
- Indications for deconfinement at high ρ_B
  - anomalous charmonium suppression ?

    measure: J/ψ, D
- Critical point
  - event-by-event fluctuations
- Color superconductivity
  - precursor effects ?

Recent Financing Plan of the BMBF (13.9.04)



MC feasibility studies

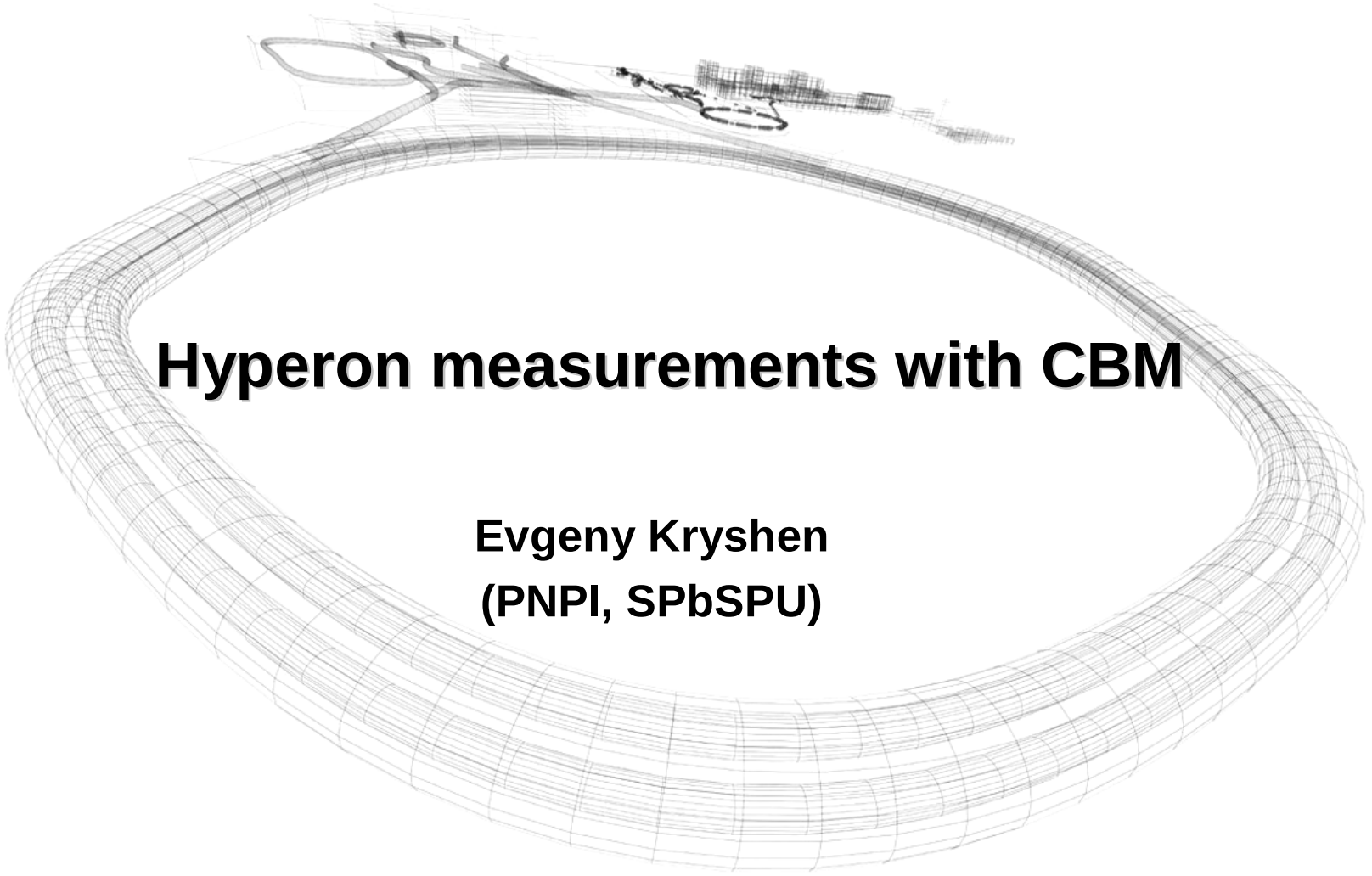
- **Charmonium identification via dimuon decay**
- **Multistrange hyperons identification**
- **Light mesons identification via hadron mode decays**

Charmonium identification via dimuon decay

Anna Kiseleva

GSI, Darmstadt, Germany

PNPI, Gatchina, Russia



Hyperon measurements with CBM

Evgeny Kryshen

(PNPI, SPbSPU)

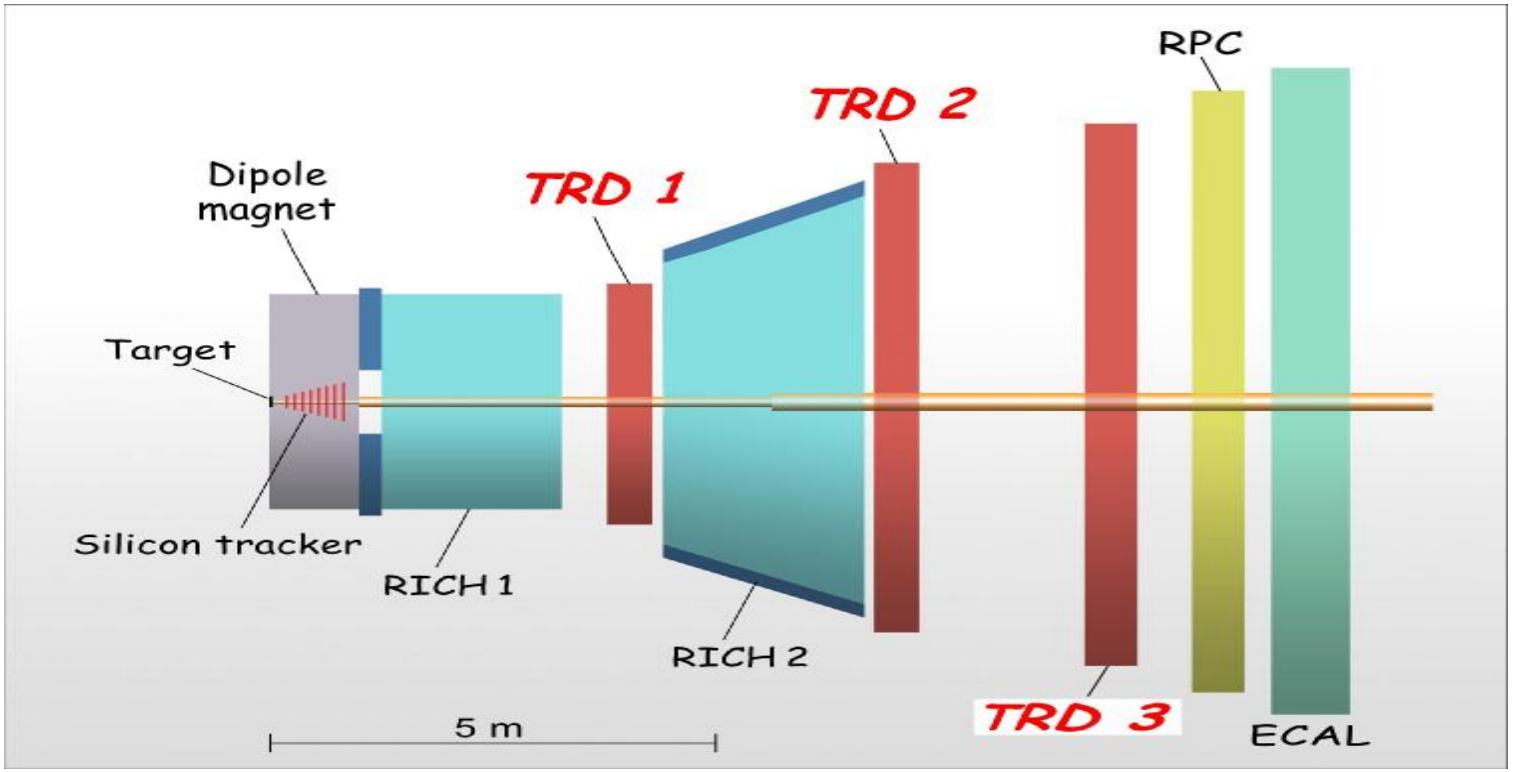
Light mesons identification via hadron mode decays

Feasibility study low-mass mesons decay- $\eta, \omega, \varphi, K_s$

For this task we plan to involve one student from SPbSPU

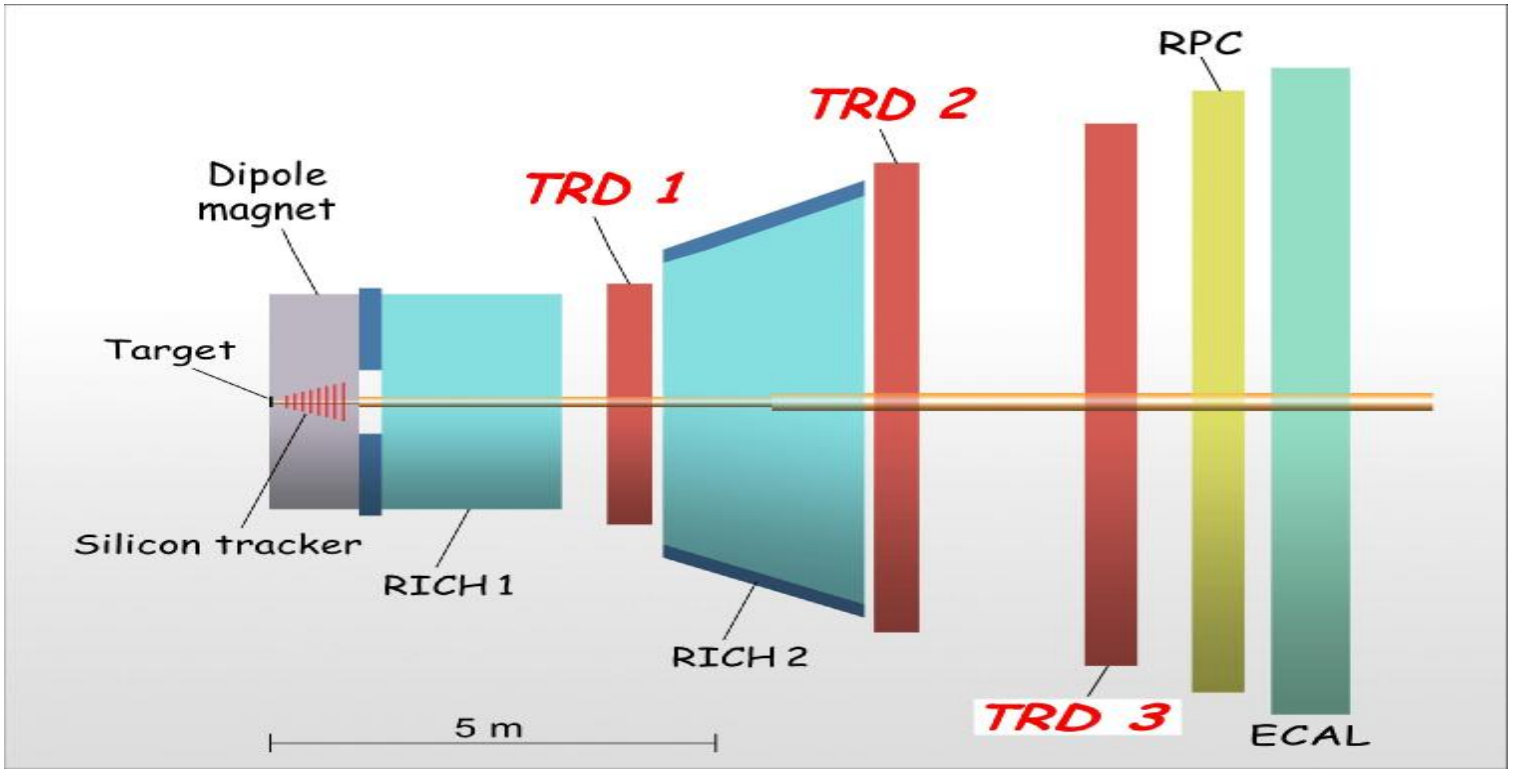
Gas detectors

- **chambers (TRT)**
- **gas systems (TRT,RICH)**



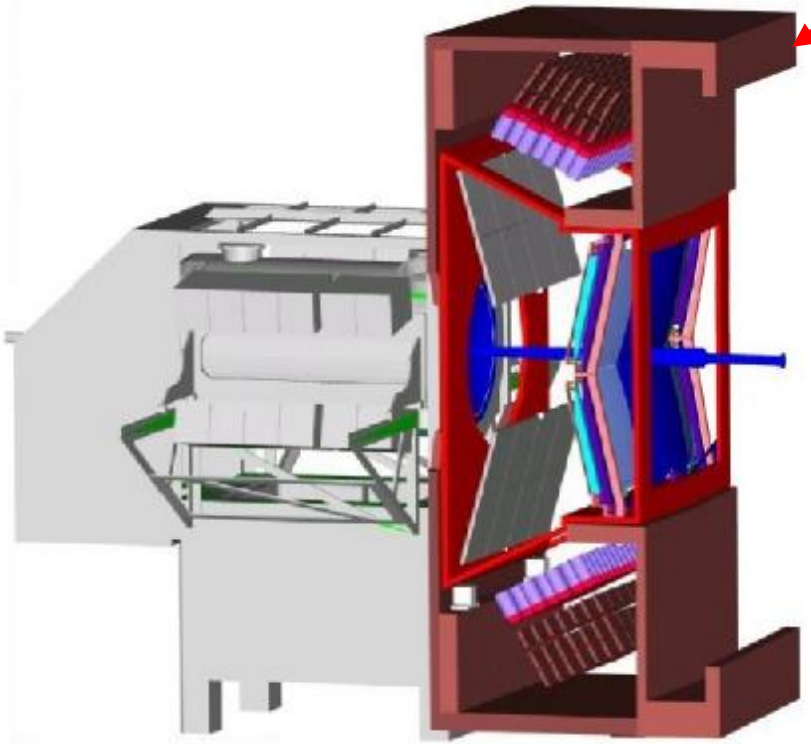
Electronics

TRT Front-End Electronics
Multi-purpose Front-End Chip
ECAL readout electronics

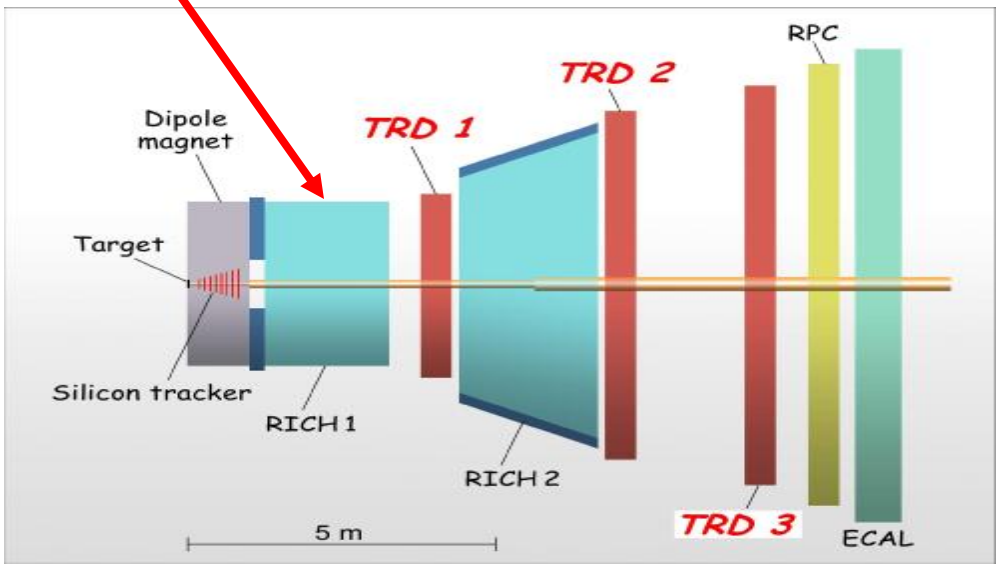


RICH

Design and Construction of the mechanics



Multi-anode PMT



Muon Identification System
(Proposal)

PNPI-ITEP-GSI-SPbSTU-…

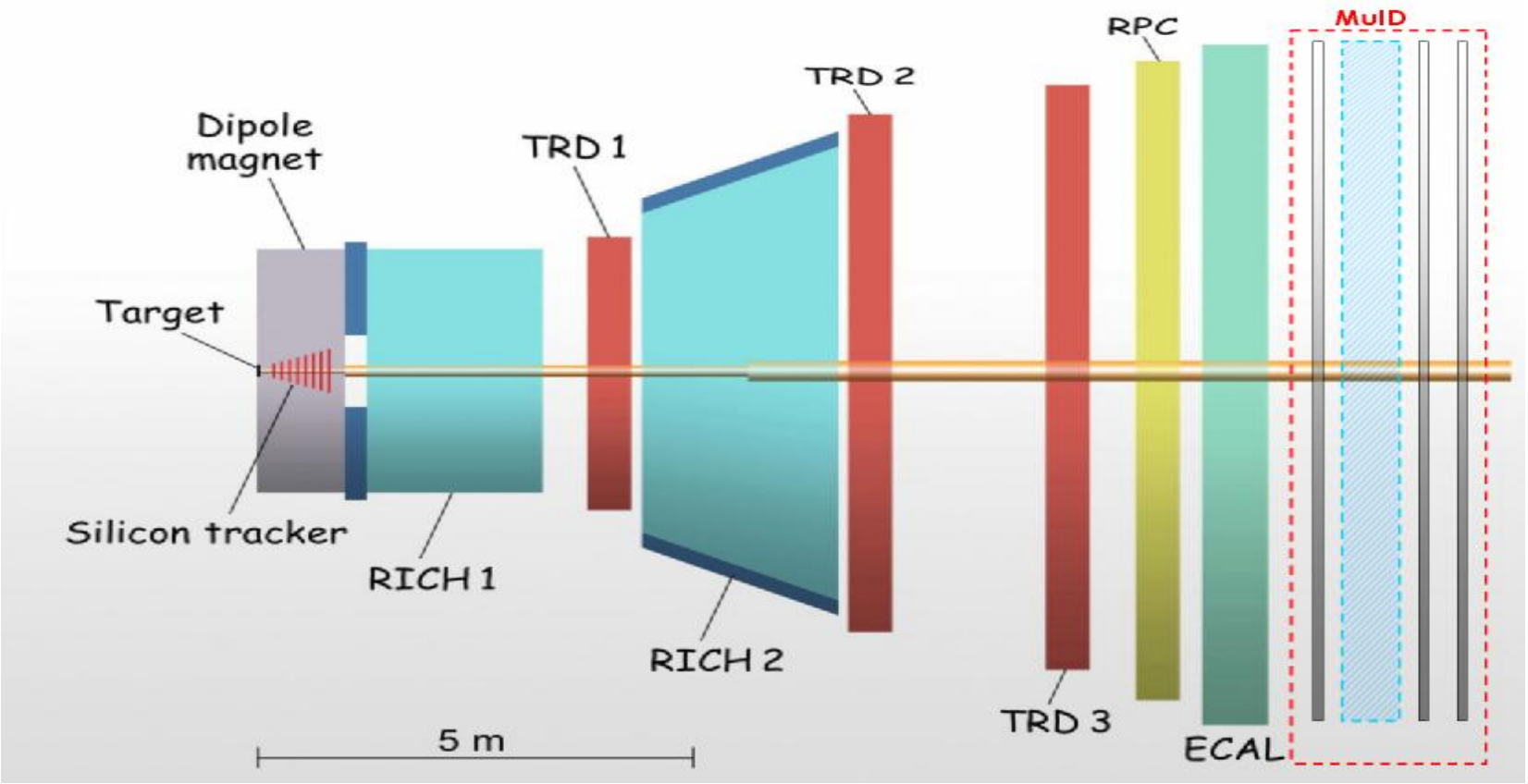
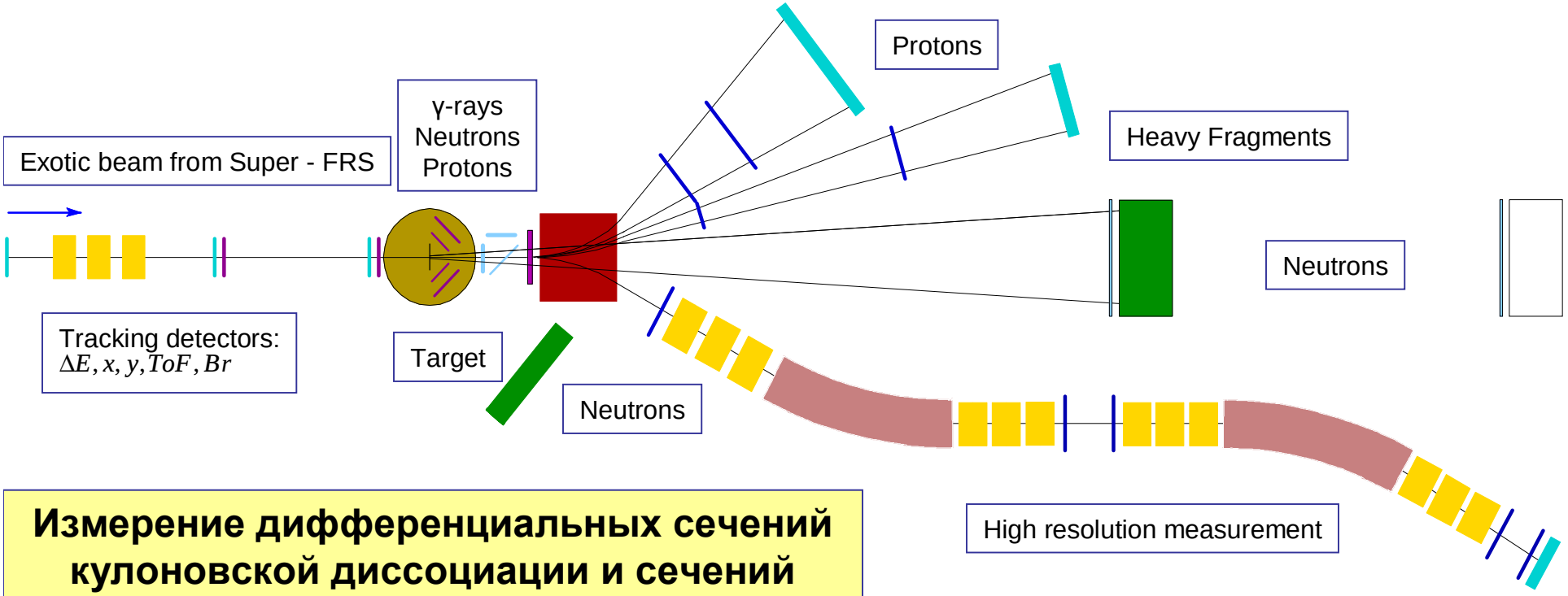


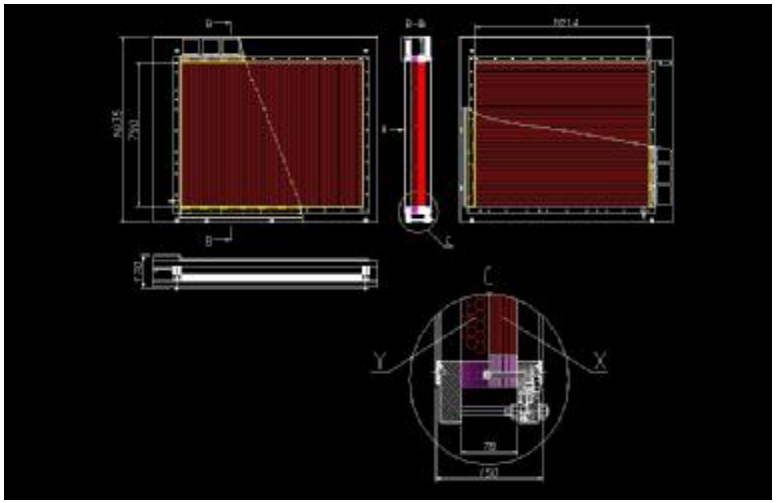
Table 21.2: Responsibilities

Work package	Institution
Simulation and analysis framework	GSI Darmstadt
Track, vertex and momentum reconstruction	KIP Univ. Heidelberg, Univ. Mannheim, JINR-LHE Dubna, JINR-LIT Dubna
Simulations hadron identification via TOF, critical fluctuations	Heidelberg Univ., Kiev Univ., NIPNE Bucharest, INR Moscow, RBI Zagreb
Feasibility study low-mass vector meson identification via dilepton pairs	Univ. Krakow, JINR-LHE Dubna
Feasibility study charmonium identification via dielectron and dimuon pairs	INR Moscow. GSI, PNPI St. Petersburg, GSI, RBI Zagreb
Feasibility study D-Meson identification	GSI Darmstadt, Czech Acad. Science Rez, Techn. Univ. Prague
Feasibility study hyperons	Polytech. Univ. St. Petersburg, JINR-LHE Dubna
Delta electrons	GSI Darmstadt
Silicon Pixel Detector	IReS Strasbourg, Frankfurt Univ., GSI Darmstadt, RBI Zagreb, Krakow Univ.
Silicon Strip Detector	Univ. Obninsk, SINP Moscow State Univ., CKBM St. Petersburg, KRI St. Petersburg RPC
TOF detector system with read-out electronics	LIP Coimbra, Univ. Santiago de Compostela, Univ. Heidelberg, GSI Darmstadt, NIPNE Bucharest, INR Moscow, FZ Rossendorf, IHEP Protvino, ITEP Moscow, Korea Univ. Seoul, RBI Zagreb, Univ. Krakow, Univ. Marburg
Transition Radiation Detector (TRD)	JINR-LHE Dubna, GSI Darmstadt, Univ. Münster, PNPI St. Petersburg, NIPNE Bucharest
Straw tube tracker (TRT)	JINR-LPP Dubna, FZR Rossendorf, Tech. Univ. Warsaw
Ring Imaging Cherenkov Detector (RICH)	IHEP Protvino, GSI Darmstadt, Pusan Nat. Univ., PNPI St. Petersburg
Electromagnetic Calorimeter (ECAL)	ITEP Moscow, IHEP Protvino
Forward Calorimeter	INR Moscow
Diamond Microstrip Start Detector with read-out electronics	GSI, Univ. Mannheim
Front-End Electronics, Trigger and Data Acquisition	KIP Univ. Heidelberg, Univ. Mannheim, JINR LIT Dubna, GSI Darmstadt, Univ. Bergen, KFKI Budapest, Silesia Univ. Katowice, PNPI St. Petersburg, Univ. Warsaw
Design of a superconducting dipole magnet	JINR-LHE Dubna, GSI Darmstadt
Calculation of radiation doses	Kiev Univ.
Modification of HADES for 8 AGeV	Czech Acad. Science Rez

Эксперимент LAND (R3B)

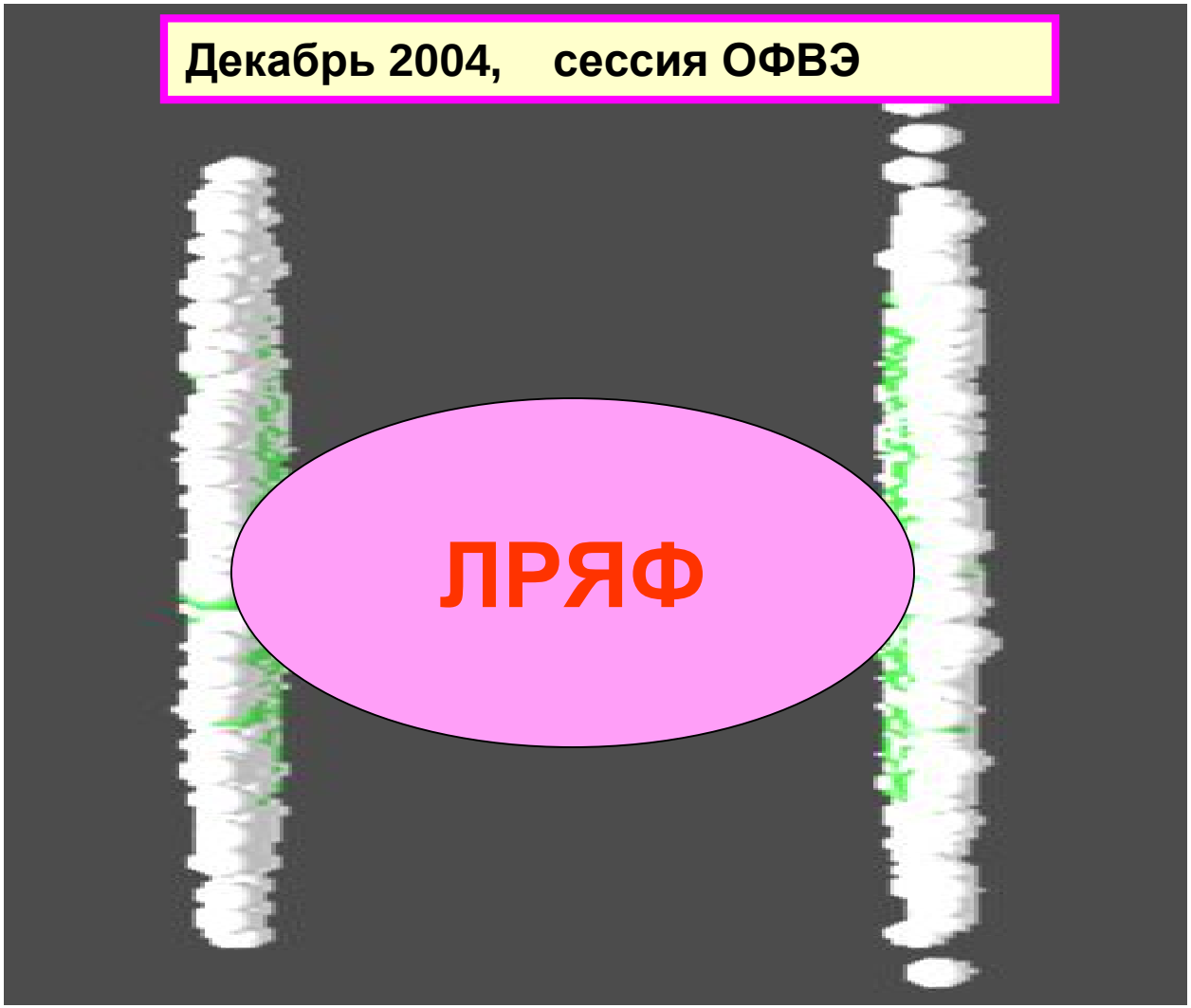


Измерение дифференциальных сечений кулоновской диссоциации и сечений реакции 23Al(γ,p).



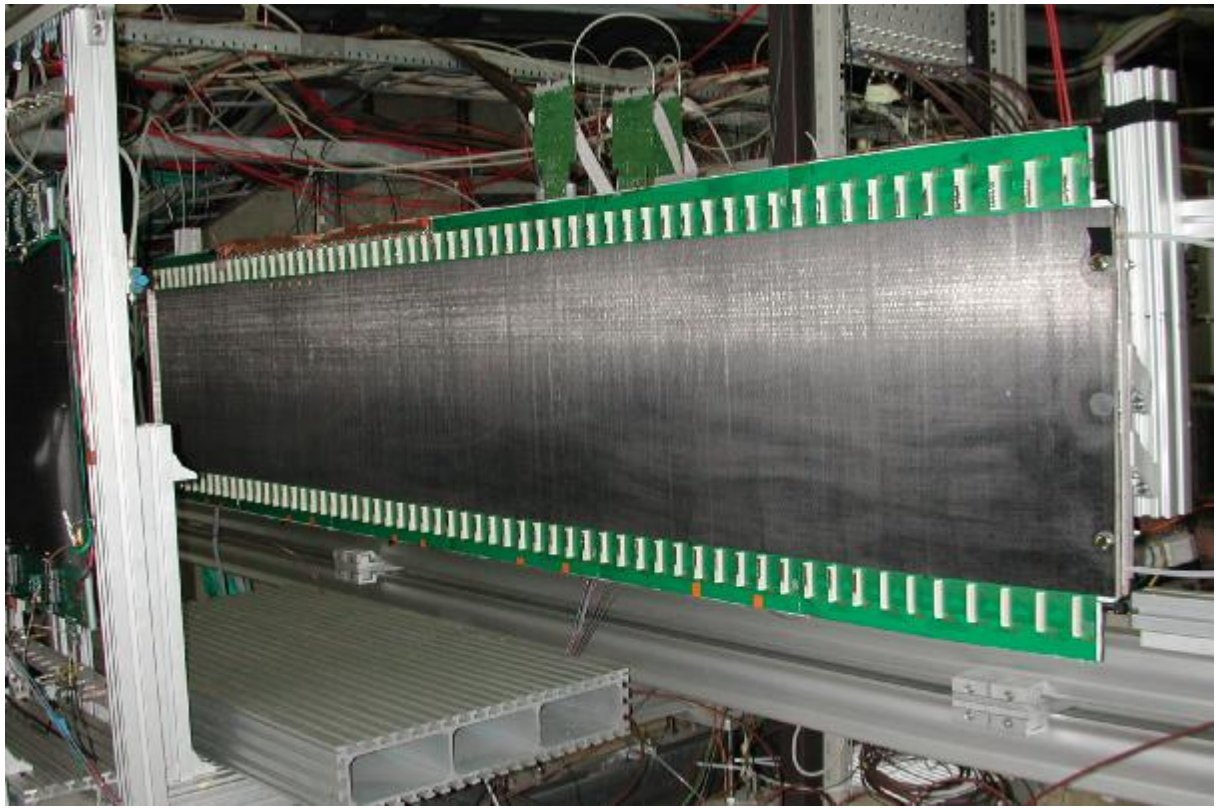
Дрейфовые камеры+CROSS4

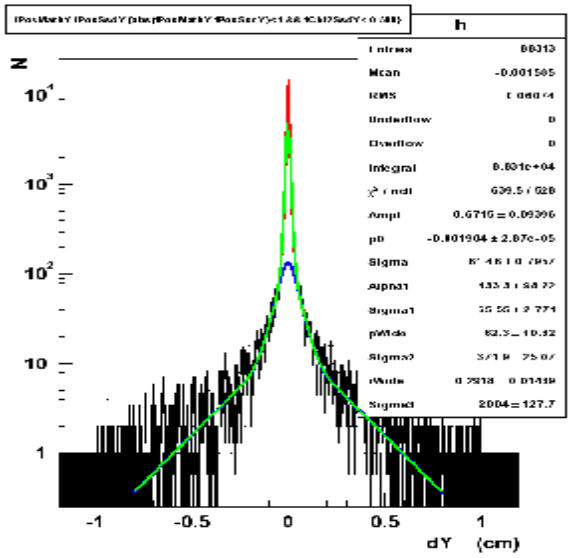
- размер рабочей зоны 100×80 см2
- измерение X и Y координат
- разрешение σ ≤ 200 μ
- эффективность ~98%
- загрузки < 2·104 1/сек.



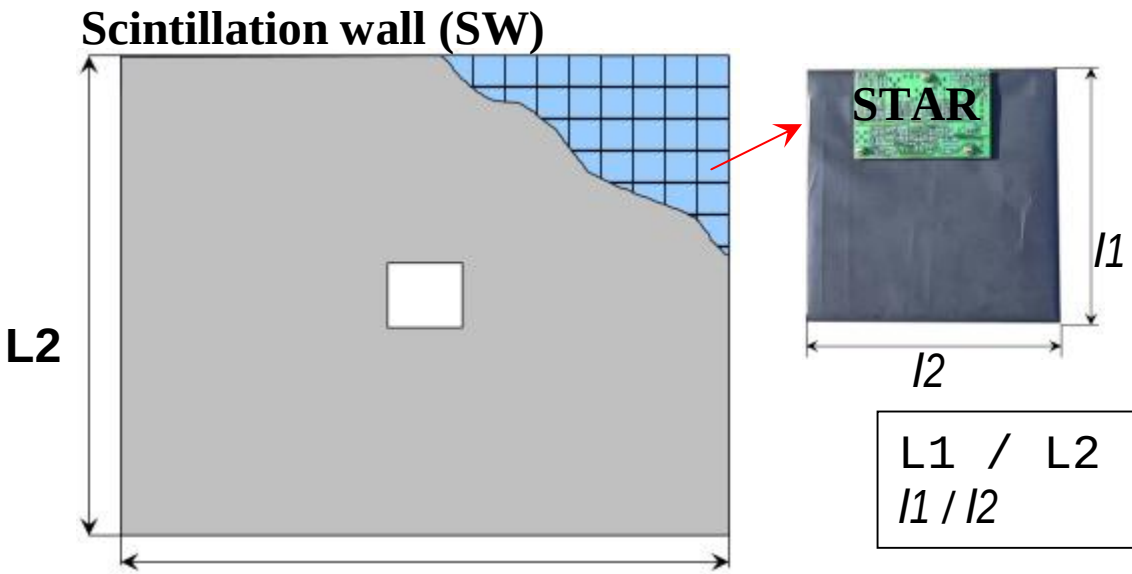
Спасибо за внимание

Full size (2400 mm) slat prototype on T10 beam line





General conception of MuID system

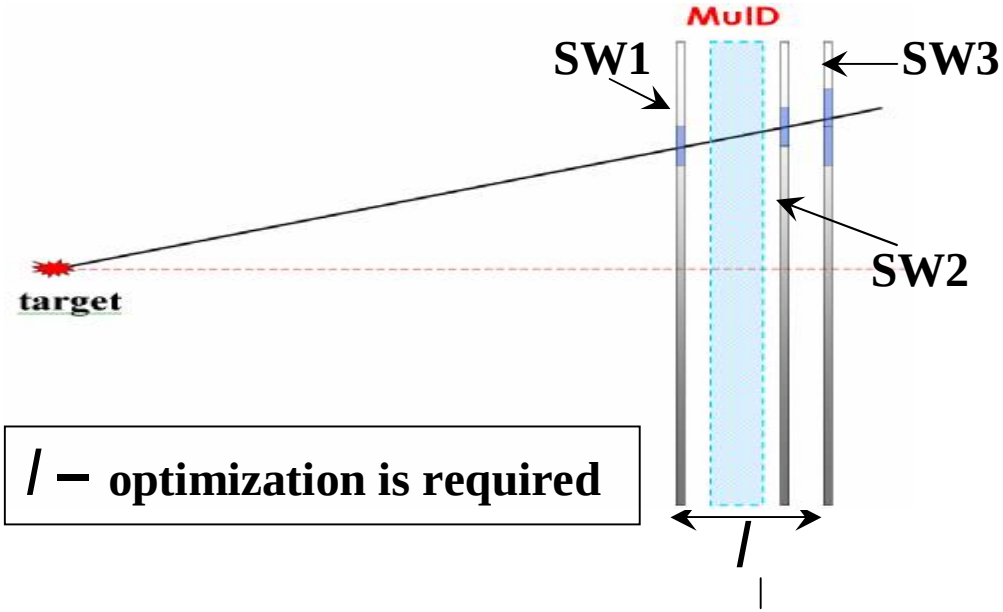


STAR

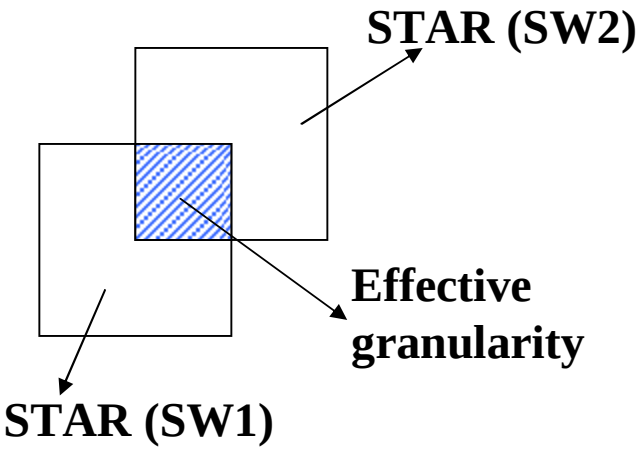
$l1 \times l2 = 15 \times 15\ cm^2$

Cost ~ 2-3 k$/m^2

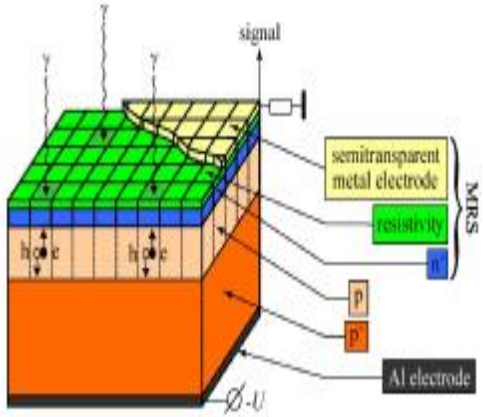
L1 / L2 – **depend on cost of system**
l1 / l2 – **optimization is required**



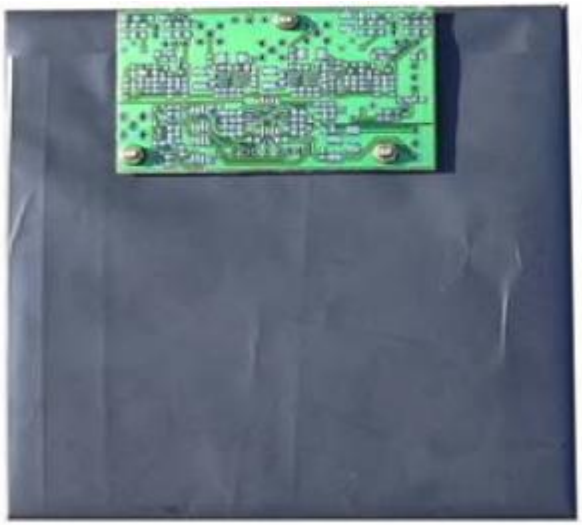
l – **optimization is required**



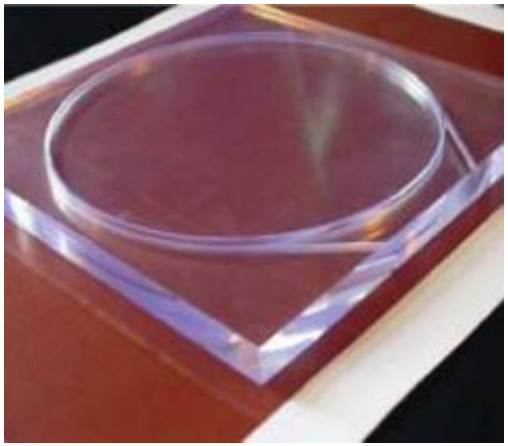
MIP registration by scintillating plate with MRS APD light readout (Preprint ITEP 05-04)



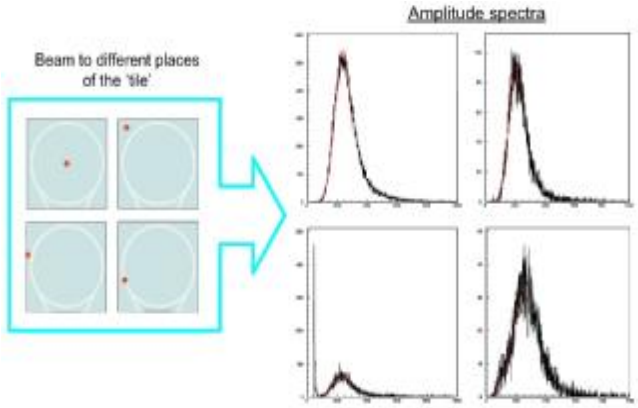
MRS APD constraction



Scintillating plate-STAR (wrapped in black paper)



Plastic plate with WLS fiber and two MRS APDs



STAR surface properties