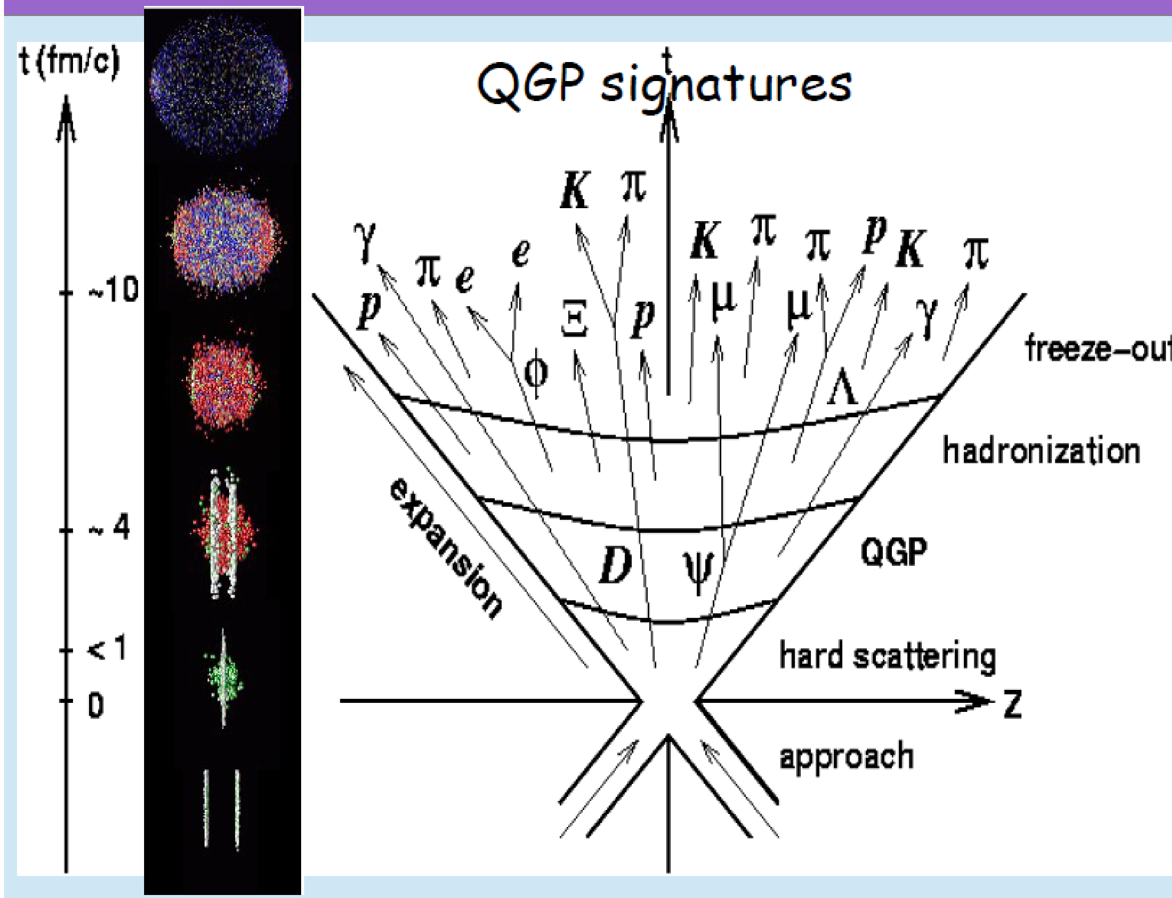
A.Stavinskiy for GDRE

Some proposals in the field of femtoscopy

1. Σ
2. NICA→LHC
3. NICA-Nuclotron

Motivation: the QGP



Kinetic: no elastic collisions

Chemical: no inelastic collisions

First bound states

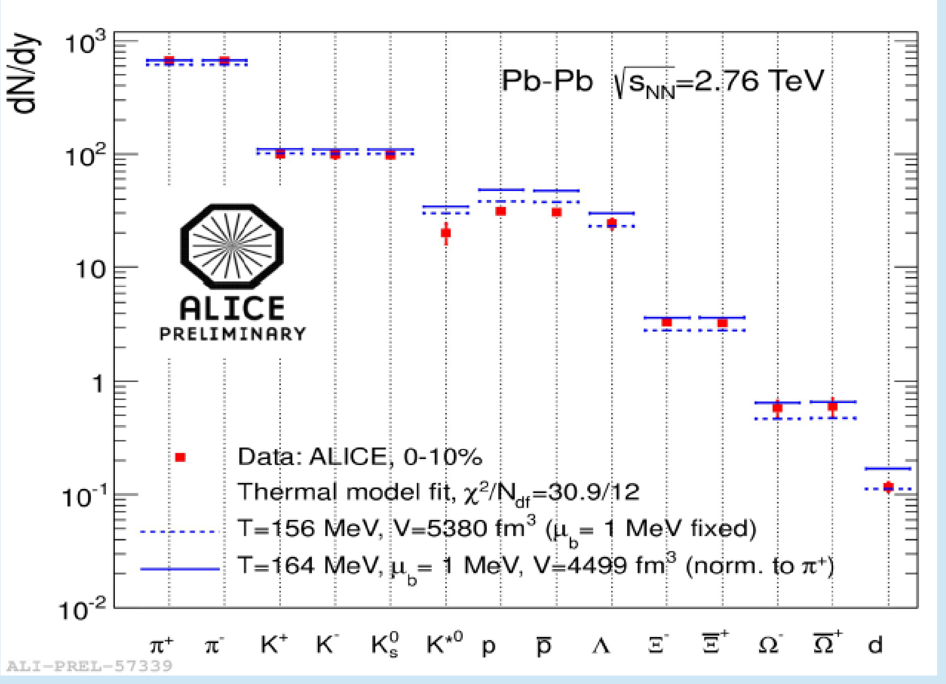
Thermalized medium

Heavy quarks + jets + direct photons

27 August 2013 16th Lomonosov Conference - Moscow - Barbara Guerzoni 4

Σ?

Pb-Pb particle ratios



K* not used in the fit, resonances can interact with hadronic medium in final state

Thermal model predictions:

- T = 164 MeV from lower energies extrapolation
- T = 156 MeV from the fit

T = 156 MeV fit better than the expected T = 164 MeV

Tension between species: unique chemical freeze-out temperature does not describe p, Λ, Ξ, Ω

A. Andronic et al., Phys. Lett. B697 (2011) 203

Σ?

Λ ?

$\Xi^0 \rightarrow \Lambda\pi^0$(99.5%), $\Xi^- \rightarrow \Lambda\pi^-$(99.9%)

$\Sigma(1385) \rightarrow \Lambda\pi$(87%), $\Sigma\pi$(12%), $\Sigma^0 \rightarrow \Lambda\gamma$(100%)

p ?

$\Lambda \rightarrow p\pi-$(64%), $\Sigma+ \rightarrow p\pi 0$ (52%), $\Sigma 0 \rightarrow \Lambda\gamma$(100%)$\rightarrow p\pi-$(64%)

$a_{pp}(^1S_0)$=-7.8 fm; $a_{np}(^1S_0)$=-23.7 fm; $a_{nn}(^1S_0)$=-7.8 fm.

$a_{p\Lambda}(^1S_0)$=-2.7 fm; $a_{\Sigma+p}(^1S_0)$=-3.85 fm; $a_{\Lambda\Lambda}(^1S_0)$=-0.88 fm[1]

[1] Th.A.Rijken, M.M.Nagels, Y.Yamamoto,
Progress of Theoretical Physics Suppl.N0.**185**(2010),14

Σ^+ DECAY MODES	Fraction (Γi/Γ)
	$p\pi^0$ (52 %)
	$n\pi^+$ (48 %)

Σ^0 DECAY MODES	Fraction (Γi/Γ)
	$\Lambda\gamma$ (100 %)

Σ^- DECAY MODES	Fraction (Γi/Γ)
	$n\pi^-$ (100 %)

izotopic effects:

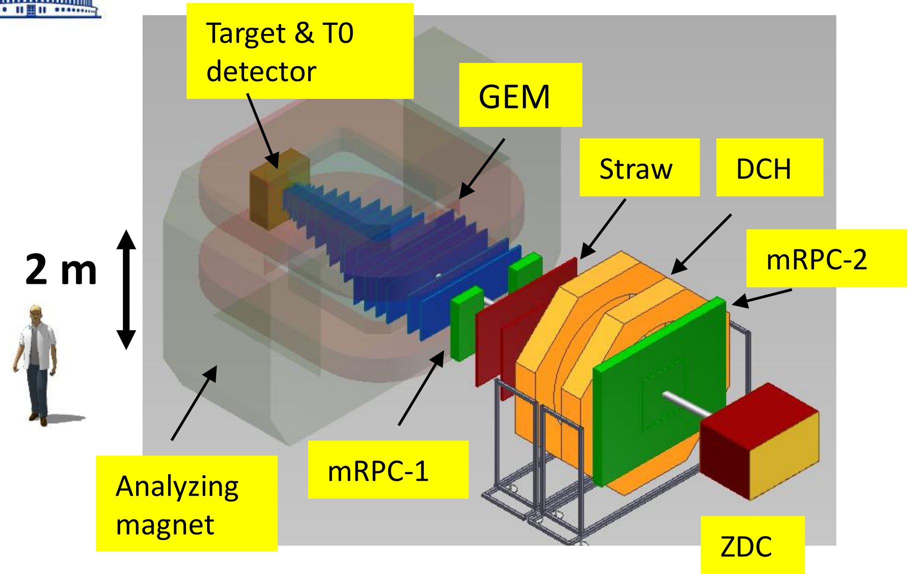
Physics:

π+(u anti d)/π-(d anti u), *p(uud)/n(udd)*, 3He/*t*, *K*+/*K*- , Σ-(sdd)/Σ+ (suu)

Methodic: n/p

$\Sigma^- \rightarrow n\pi^-$(100%))/$\Sigma^+$ ($\rightarrow n\pi$+, $\rightarrow p\pi^o$)

BM@N setup



BM@N advantage: large aperture magnet (~1 m gap between poles)

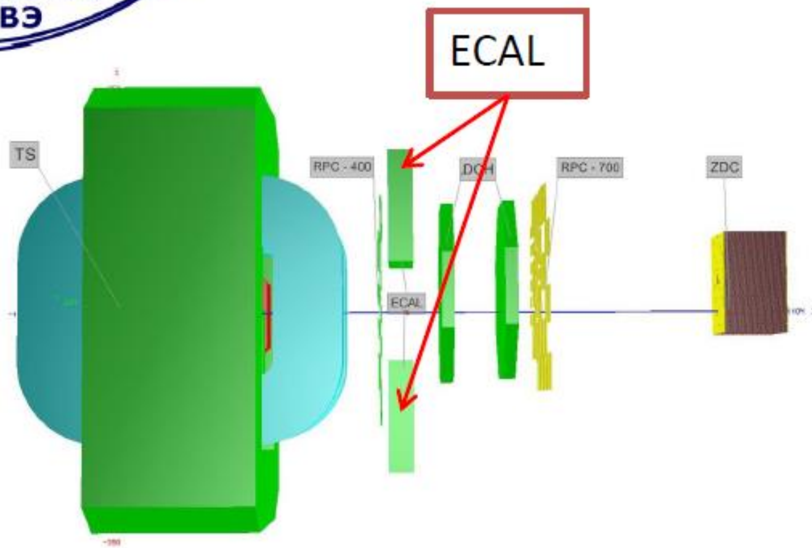
→ fill aperture with coordinate detectors which sustain high multiplicities of particles

→ divide detectors for particle identification to "near to magnet" and "far from magnet" to measure particles with low as well as high momentum (p > 1-2 GeV/c)

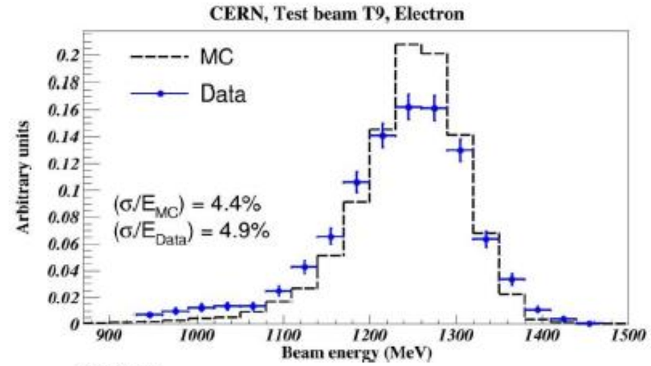
→ fill distance between magnet and "far" detectors with coordinate detectors

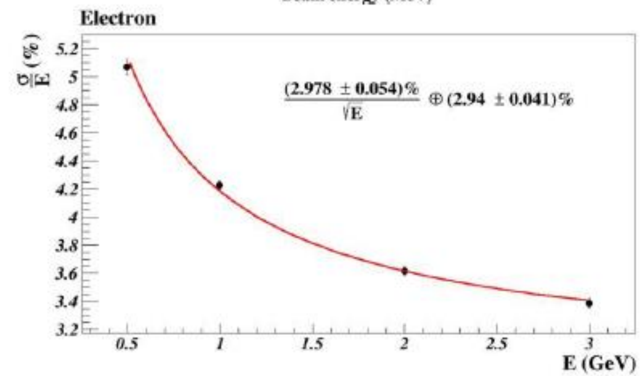
- Central tracker (GEM) inside analyzing magnet to reconstruct AA interactions
- Outer tracker (DCH, Straw) behind magnet to link central tracks to ToF detectors
- ToF system based on mRPC and T0 detectors to identify hadrons and light nucleus
- ZDC calorimeter to measure centrality of AA collisions and form trigger
- Detectors to form T0, L1 centrality trigger and beam monitors
- Electromagnetic calorimeter for γ,e+e-

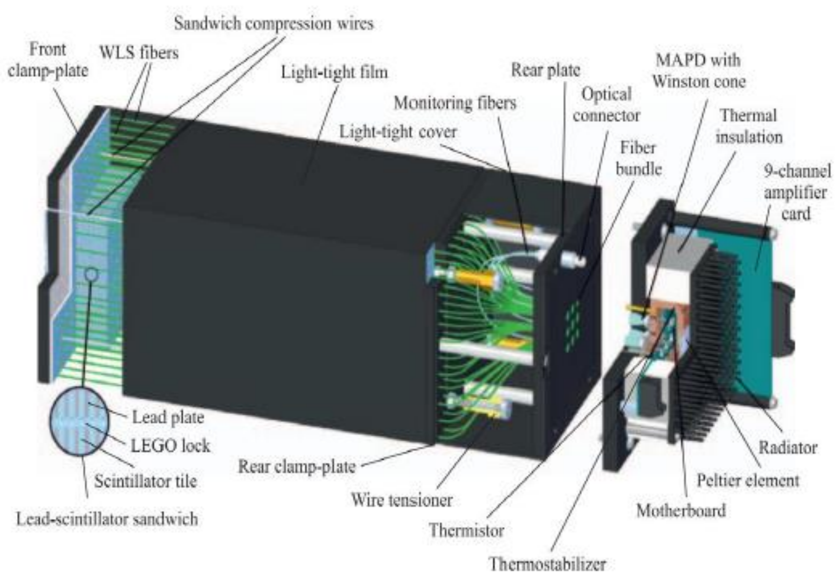
Electromagnetic calorimeter (optional)



Energy resolution







Design of the Shashlyk type calorimeter module

Parameters	
Transverse size, mm²	40x40
Module size, mm²	120x120
Number of layers	220
Lead absorber thickness, mm	0.3
Polystyrene scintillator thickness, mm	1.5
Moli'ère radius, mm	26
Radiation length, X_0	11.8

3. Neutral Pion Measurements

Photons can be reconstructed in ALICE in several ways: using traditional calorimetry with the PHOS and EMCal or by the Photon Conversion Method (PCM) via reconstructing e^+e^- tracks from photons conversion in the central tracking system[3]. PHOS has fine granularity leading to excellent energy and position resolution though it has a relatively small acceptance. PCM provides good position and energy resolution and full 2π coverage in the azimuth. However, since ALICE was constructed to minimize the material budget, the photon conversion probability before the middle of the TPC, where tracks still can be reconstructed with high efficiency, is about 8%. As a result, both methods have comparable acceptance $\times$ efficiencies.

D.Peressounko for the ALICE Collaboration, arXiv:1412.7902 v1[nucl-ex]

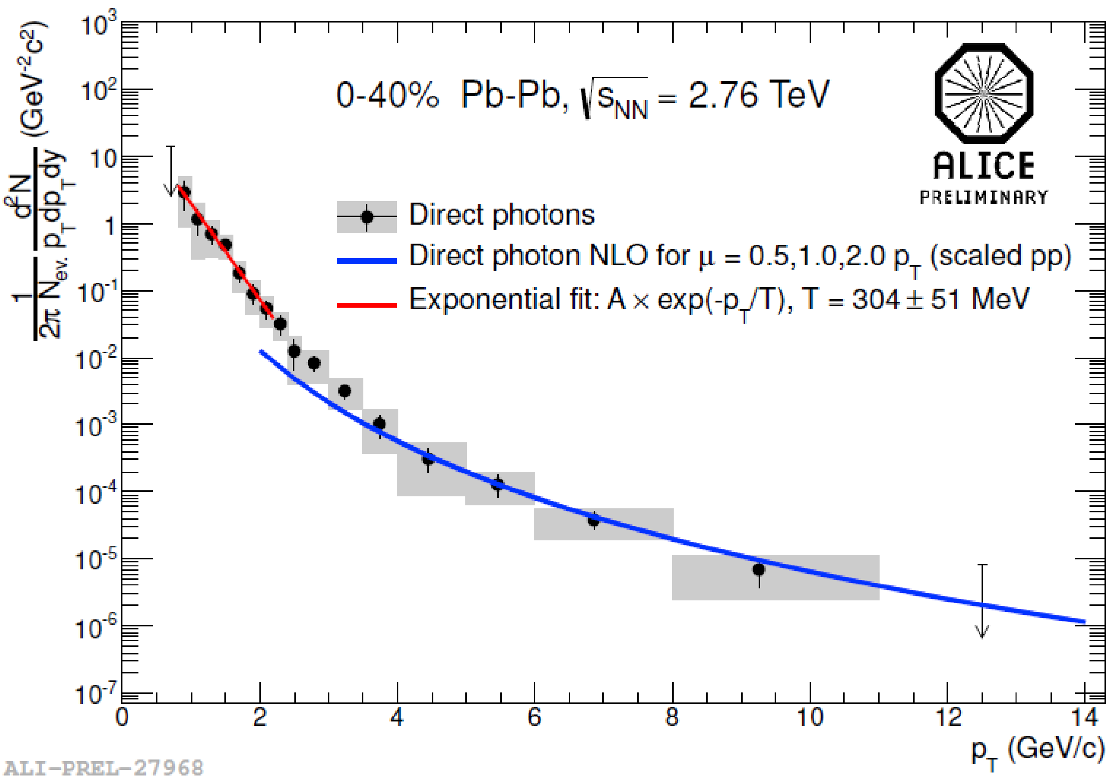


Fig. 5. Direct photon spectrum in central (0-40%) Pb–Pb collisions at $\sqrt{s_{NN}} = 2.76$ TeV. The blue line represents pQCD prompt photon predictions while the red line is an exponential fit in the range $0.9 < p_{\mathrm{T}} < 2.0$ GeV/c.

D.Peressounko for the ALICE Collaboration, arXiv:1412.7902 v1[nucl-ex]

Measurement of charged $\bar{\Sigma}$ Baryons at RHIC-PHENIX

Chris Pinkenburg (BNL) for the PHENIX Collaboration

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- Peking University, Beijing, P. R. China
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- Czech Technical University, Faculty of Nuclear Sciences and Physical Engineering, Brehova 7, 11519 Prague, Czech Republic
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- Uni
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- Bar
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- KEI Ibaraki 305-0801, Japan
- Kyoto University, Kyoto, Japan
- Nagasaki Institute of Applied Science, Nagasaki-shi, Nagasaki, Japan
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- RIKEN – BNL Researc
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- Tokyo Institute of Tec
- University of Tsukuba Japan
- Waseda University, To
- Cyclotron Application
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- Myong Ji University, Yongin City 449-728, Korea
- System Electronics Laboratory, Seoul National University, Seoul, South Korea
- Yonsei University, Seoul 120-749, Korea
- IHEP (Protvino), State Research Center of Russian Federation "Institute for High Energy Physics", Protvino 142281, Russia
- Joint Institute for Nuclear Research (JINR-Dubna), Dubna, Russia
- Kurchatov Institute, Moscow, Russia
- PNPI, Petersburg Nuclear Physics Institute, Gatchina, Leningrad region, 188300, Russia
- Skobeltsyn Institute of Nuclear Physics, Lomonosov Moscow State University, Vorob'evy Gory, Moscow 119992, Russia
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ts*

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- A 92521, USA
- 10533, USA
- JSA
- JSA
- A
- University of Illinois Urbana-Champaign, Urbana-Champaign, IL, USA
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- Los Alamos National Laboratory (LANL), Los Alamos, NM 87545, USA
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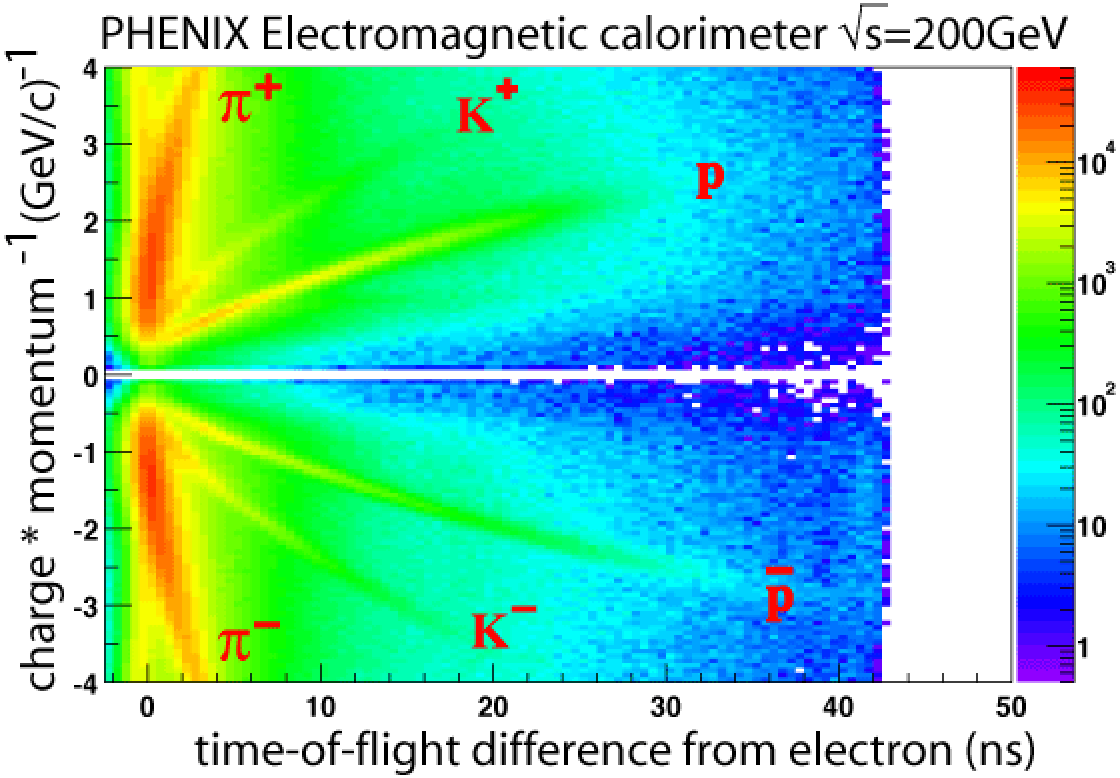
- Oak Ridge National Laboratory (ORNL), Oak Ridge, TN 37831, USA
- University of Tennessee (UT), Knoxville, TN 37996, USA
- Vanderbilt University, Nashville, TN 37235, USA

*as of March 2005

Charged Pid

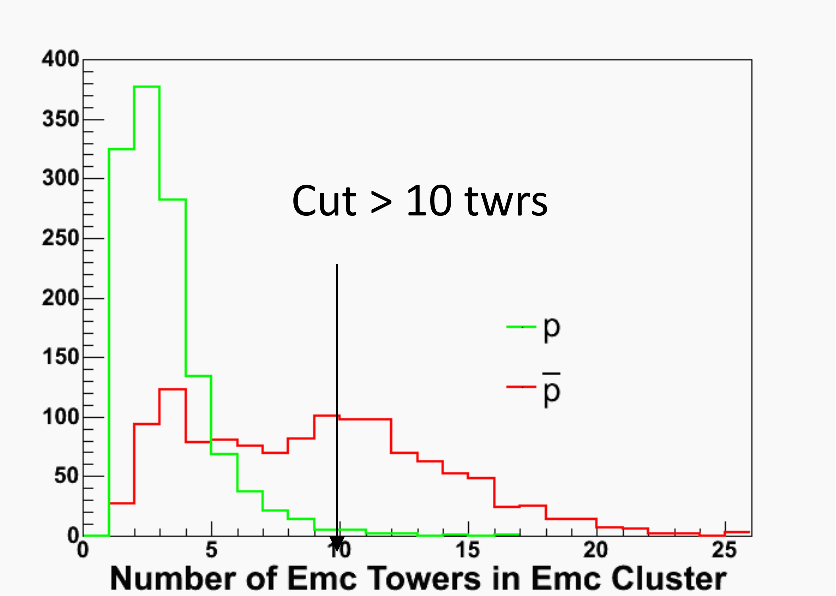


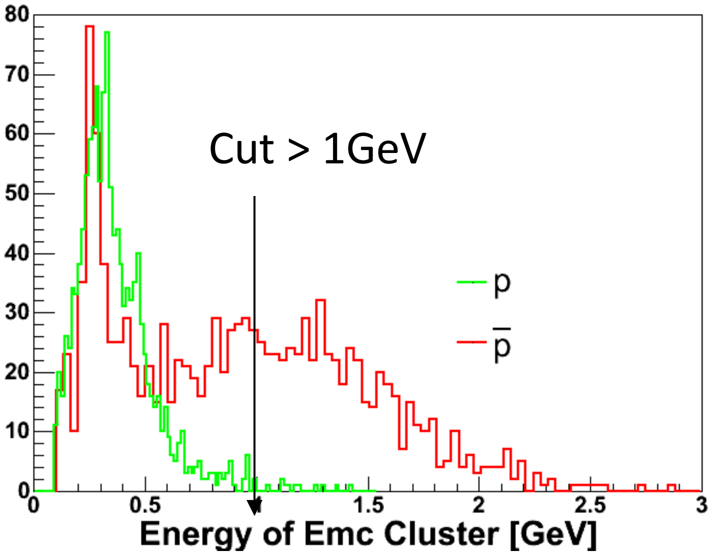
Standard Identification via Time Of Flight from the EMC and Momentum determined by Track Curvature in Magnetic Field

1.5 GeV/c Momentum cut to reduce Contamination by Pions

Guidance from (Anti)protons

Take identified Protons and Anti Protons and see how EMC-Clusters from annihilation compare to clusters created by charged hadrons



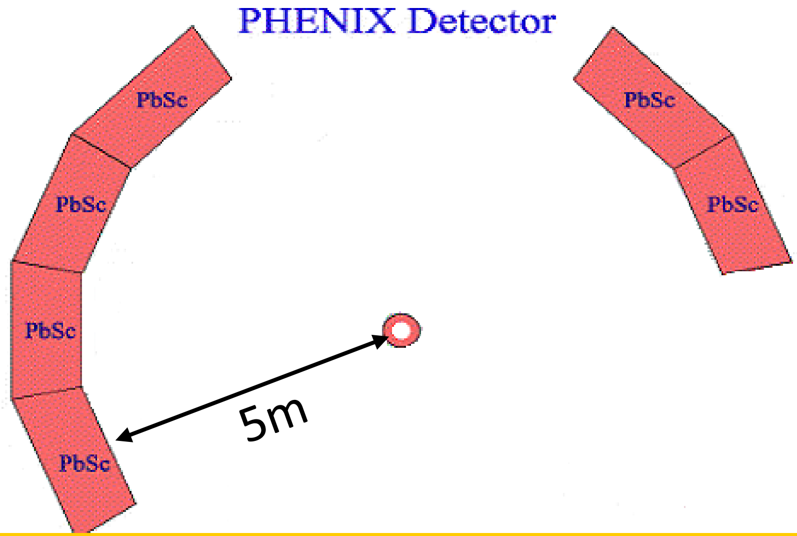


As expected the main difference is the deposited energy and the Number of towers which make up this cluster. Cut at 10 towers and 1 GeV Cluster Energy.

In addition one looks for a bad χ^2 from a fit to a photon shower shape

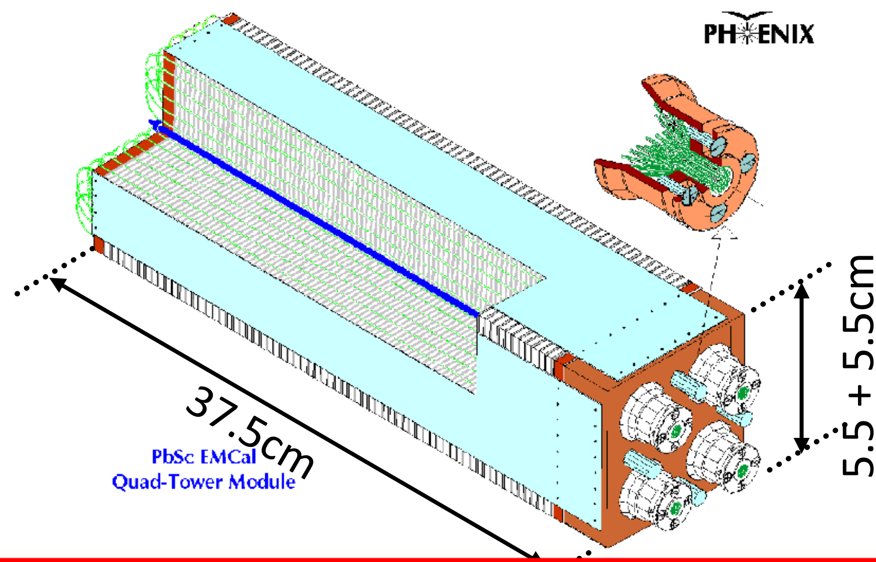
Timing cut of 3ns later than photons

Anti Neutrons in PHENIX



Lead Scintillator:
15552 towers
5 m flight path
σ_{tof} ~500ps
Dynamic timing range translates
to 0.7GeV/c < p_n <2.8GeV/c

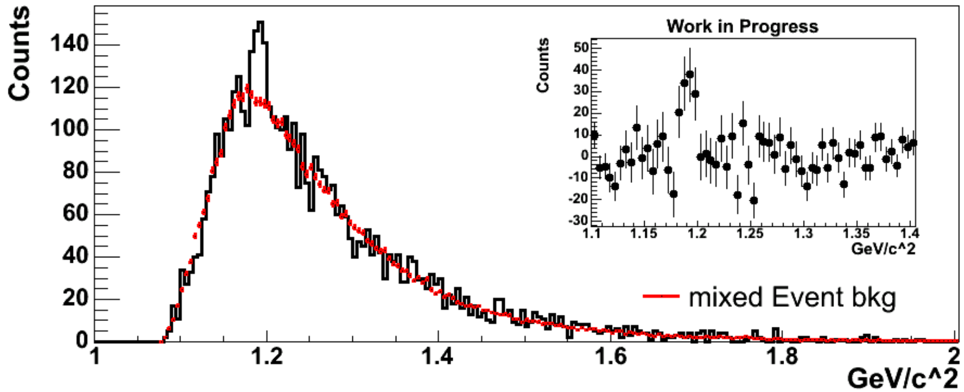
Momentum uncertainty due to
depth of annihilation?
The light guides transport the light
with 0.67c, the average β of the
Anti Neutrons is 0.7.
→Timing (and therefore the
momentum of the Anti Neutrons)
is not too dependent on annihilation depth



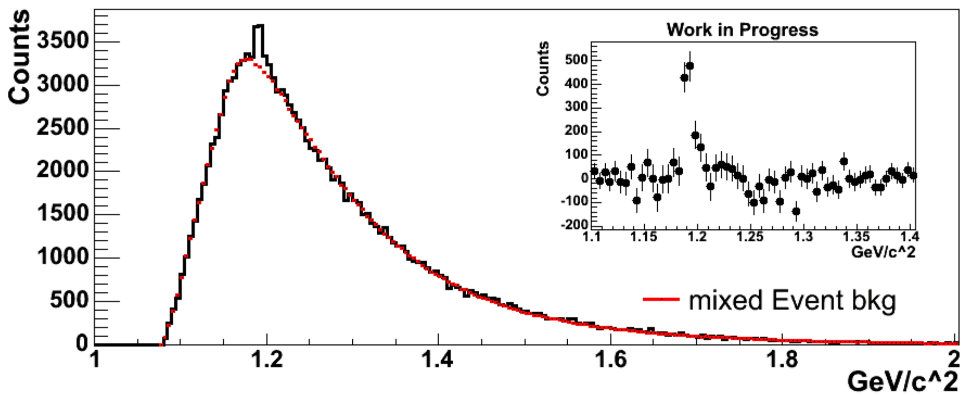
Most problematic is the removal of the Anti Proton contamination, if
its track is missed the cluster is indistinguishable from an Anti Neutron

$$\bar{\Sigma}^- \rightarrow \pi^- + \bar{n}$$

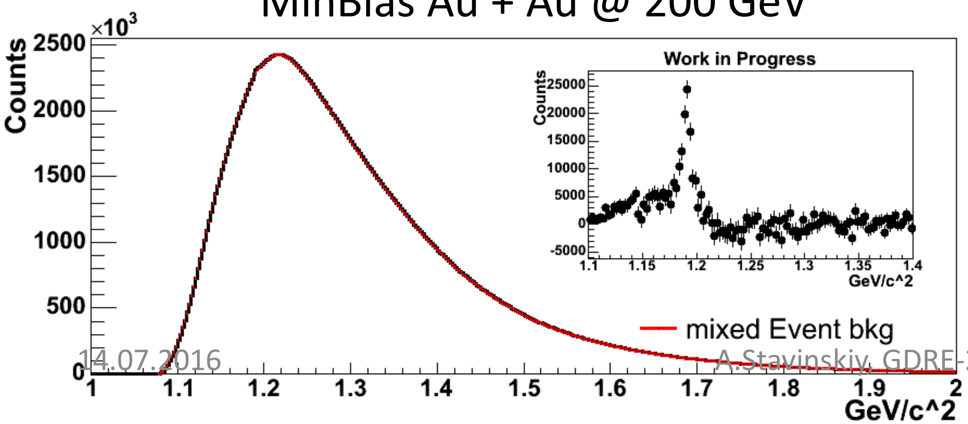
MinBias pp @ 200 GeV



MinBias d +Au @ 200 GeV



MinBias Au + Au @ 200 GeV



Particle multiplicities in line with branching ratio

$\bar{\Sigma}^- \rightarrow \pi^- + \bar{n}$ (pdg mass: 1189.37 MeV, BR 48.31%)

Mass is systematically shifted by ~ +2 MeV

NICA-Nuclotron ↔ LHC

LHC: Unknown state of matter, unknown FSI parameters,
no energy restrictions for strange particle production,
Baryon=Antibaryon

NICA-Nuclotron: ordinary nuclear matter, unknown FSI parameters,
strong energy restrictions for strange particle production

What FSI would be studied?

Λ ? Λp

$\Xi^0 \rightarrow \Lambda\pi^0$(99.5%), $\Xi^- \rightarrow \Lambda\pi^-$(99.9%)

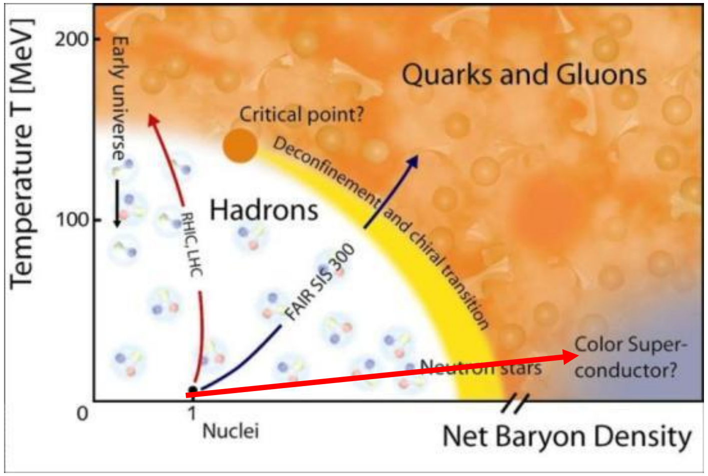
Ξ^0p, Ξ^-p

$\Sigma(1385) \rightarrow \Lambda\pi$(87%), $\Sigma\pi$(12%),
$\Sigma^0 \rightarrow \Lambda\gamma$(100%)

$\Sigma(1385)$p, Σ^0p

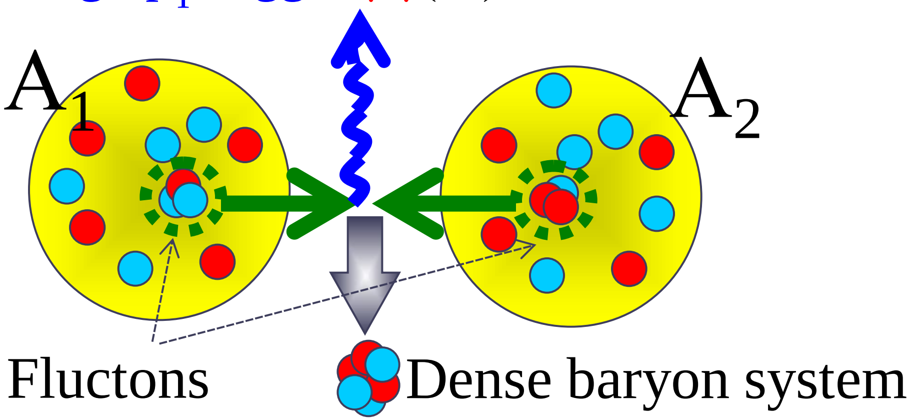
Nica-Nuclotron:
physics with femtoscopy method-
femtoscopy with special trigger(selection criteria);
variant of physical trigger-cumulative process

Phase diagram*



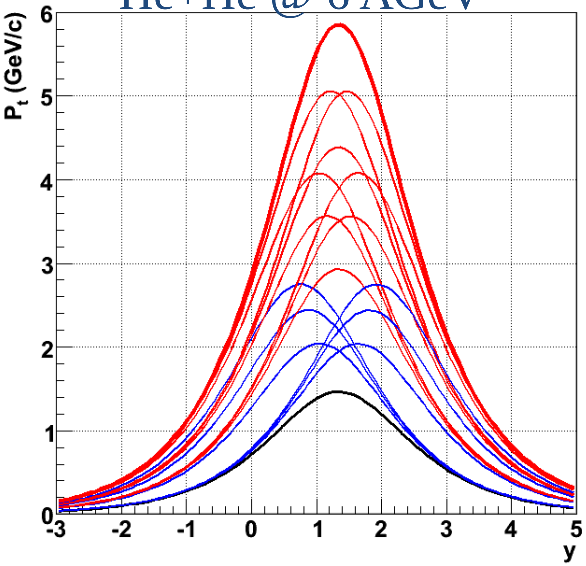
*http://www.gsi.de/forschung/fair_experiments/CBM/

Scheme of process



Kinematical limits for different subprocesses:
1N+1N(black line)
1N+Flucton(2N,3N,4N)&Flucton+1N
(blue lines)
Flucton+Flucton(red lines)

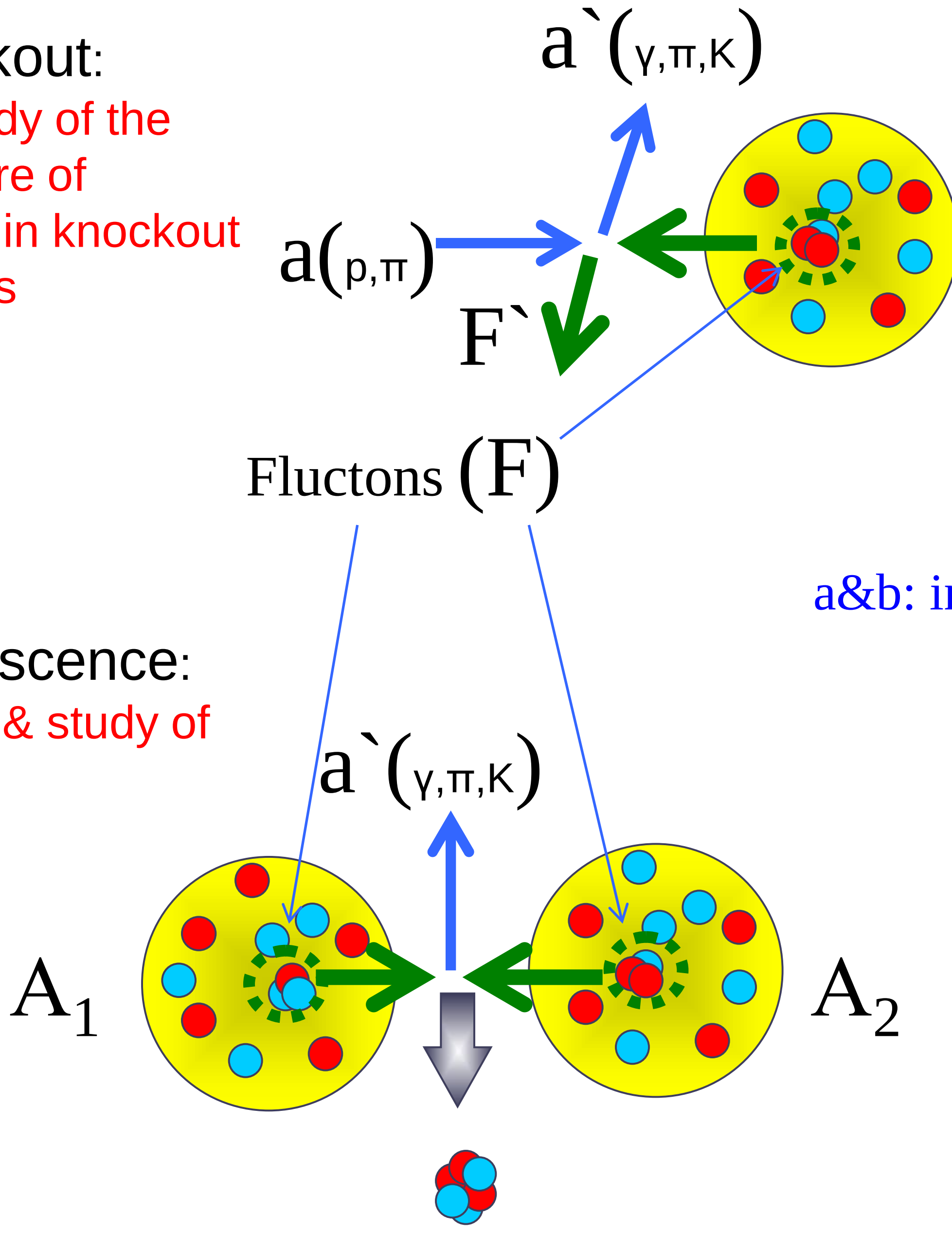
He+He @ 6 AGeV



a) Knockout:

the study of the structure of flucton in knockout process

S.S. Shimansky, in Proc. of the VIII Intern. Workshop on Relativistic Nuclear Physics:from Hundreds of MeV to TeV, May 23-28, 2005 , 297 (Dubna, 2006); nucl-ex/0604014.



a&b: in both cases high p_T trigger
(π,γ,γ(π°),K,…)

b) Coalescence:

search for & study of DCM

A_1,A_2: He,Be,C,…

Dense baryon system

Next step to improve spatial resolution from 2,5 to ~1 cm.
Prototype1 4 diodes * 1 mm^2 → Prototype2 6 diodes * 4 mm^2

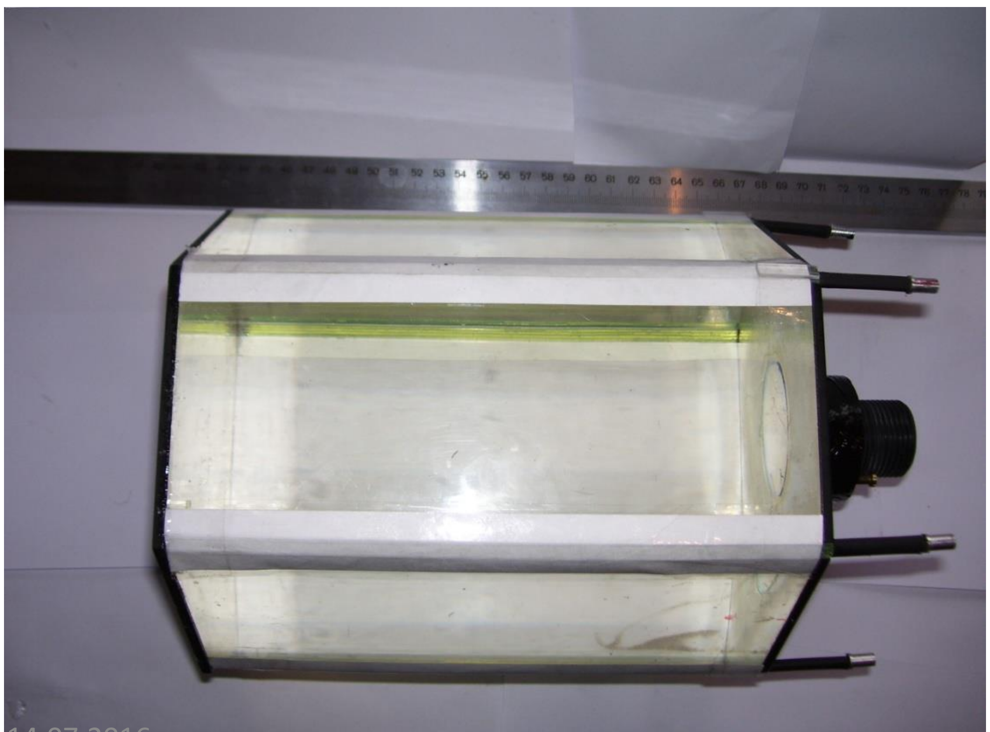
-registration of neutrons with energies in the range 10-200 MeV

-expected dimensional resolution ~ 1 sm

-used avalanche photodiodes

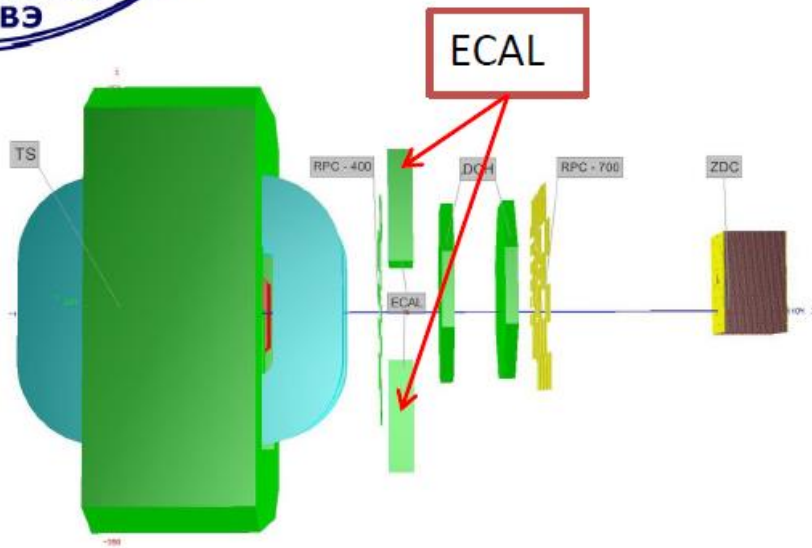
-possibility to work in magnetic field

-small space for the module and compact packing

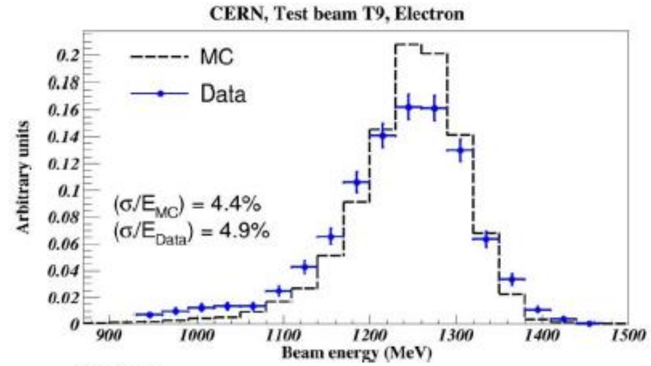


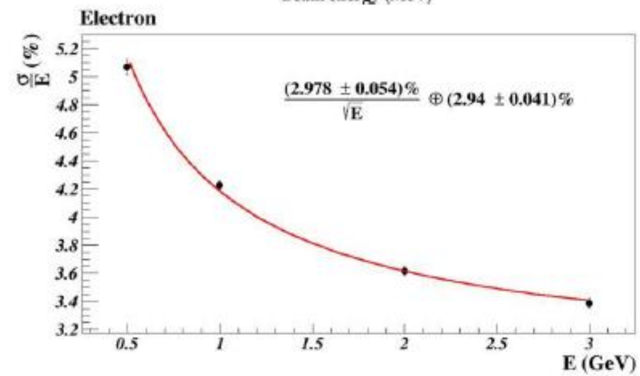
version without PMT

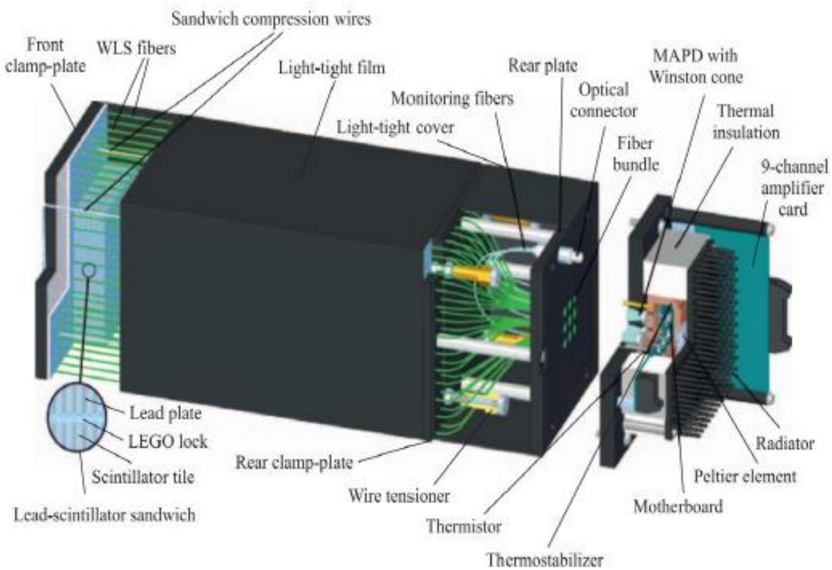
Electromagnetic calorimeter (optional)



Energy resolution







Design of the Shashlyk type calorimeter module

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Polystyrene scintillator thickness, mm	1.5
Moli'ère radius, mm	26
Radiation length, X_0	11.8

Thank you for attention!

POsitionSEnsitiveIDentificationOfNeutrons = POSEIDON

Detector module

in consctruction