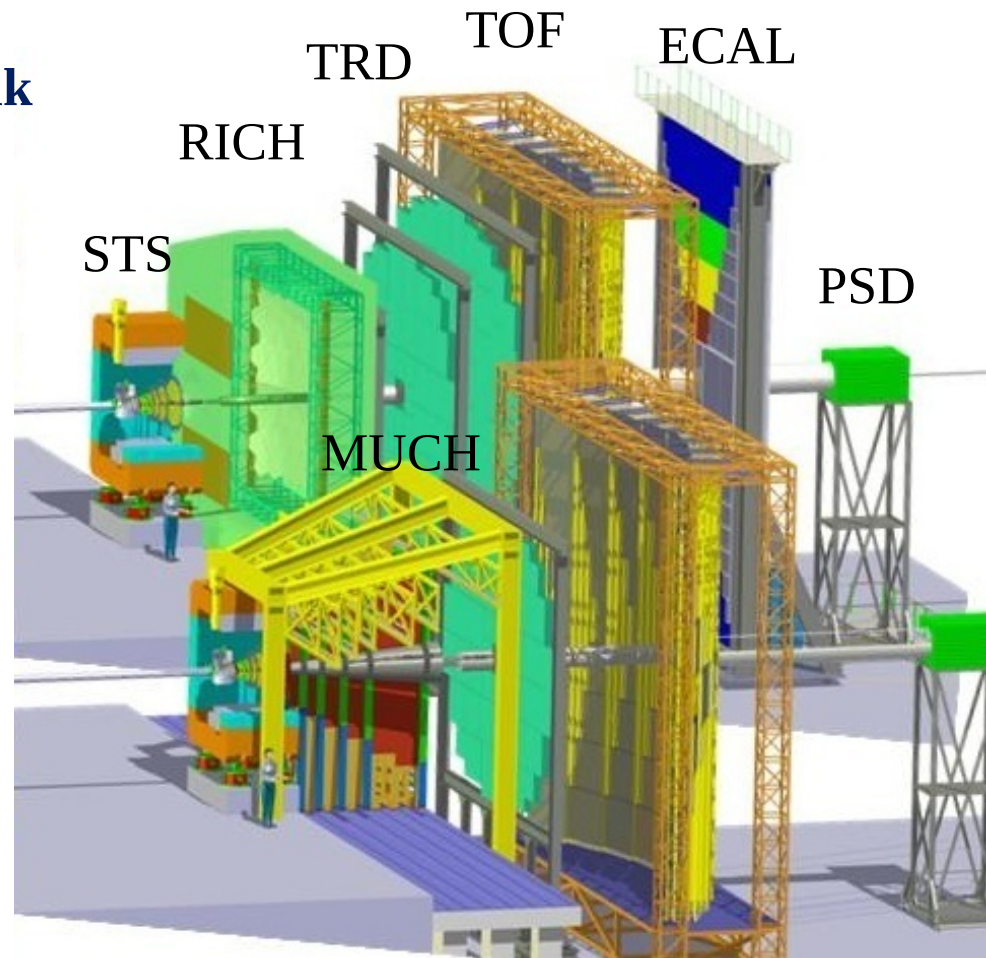


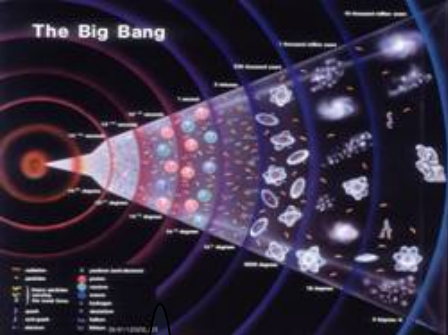
Multi-strange Hyperons and Hypernuclei reconstruction at the CBM experiment



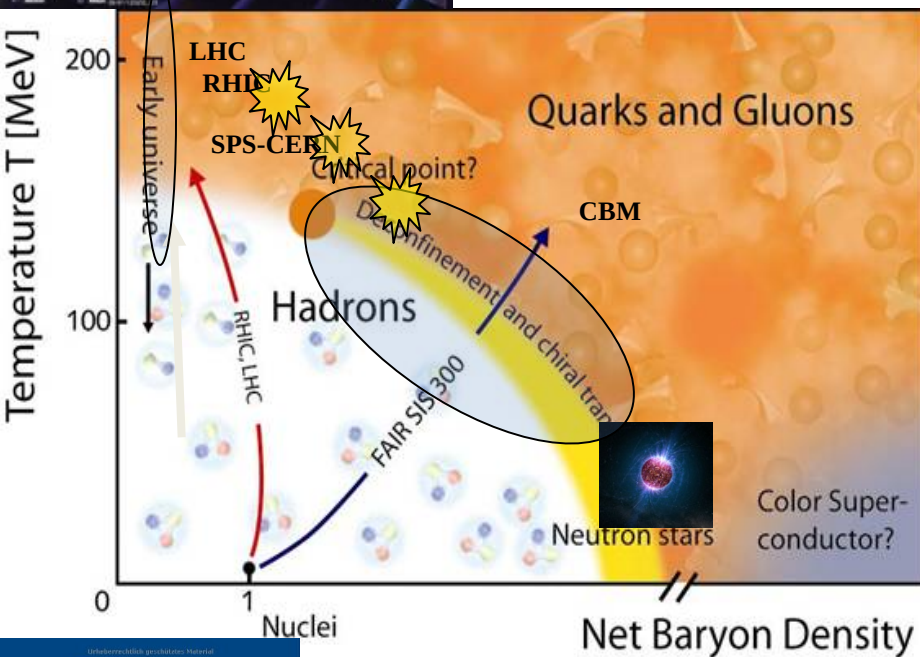
Iouri Vassiliev , I. Kisel and M. Zyzak
for the CBM Collaboration



DPG Darmstadt March 2016



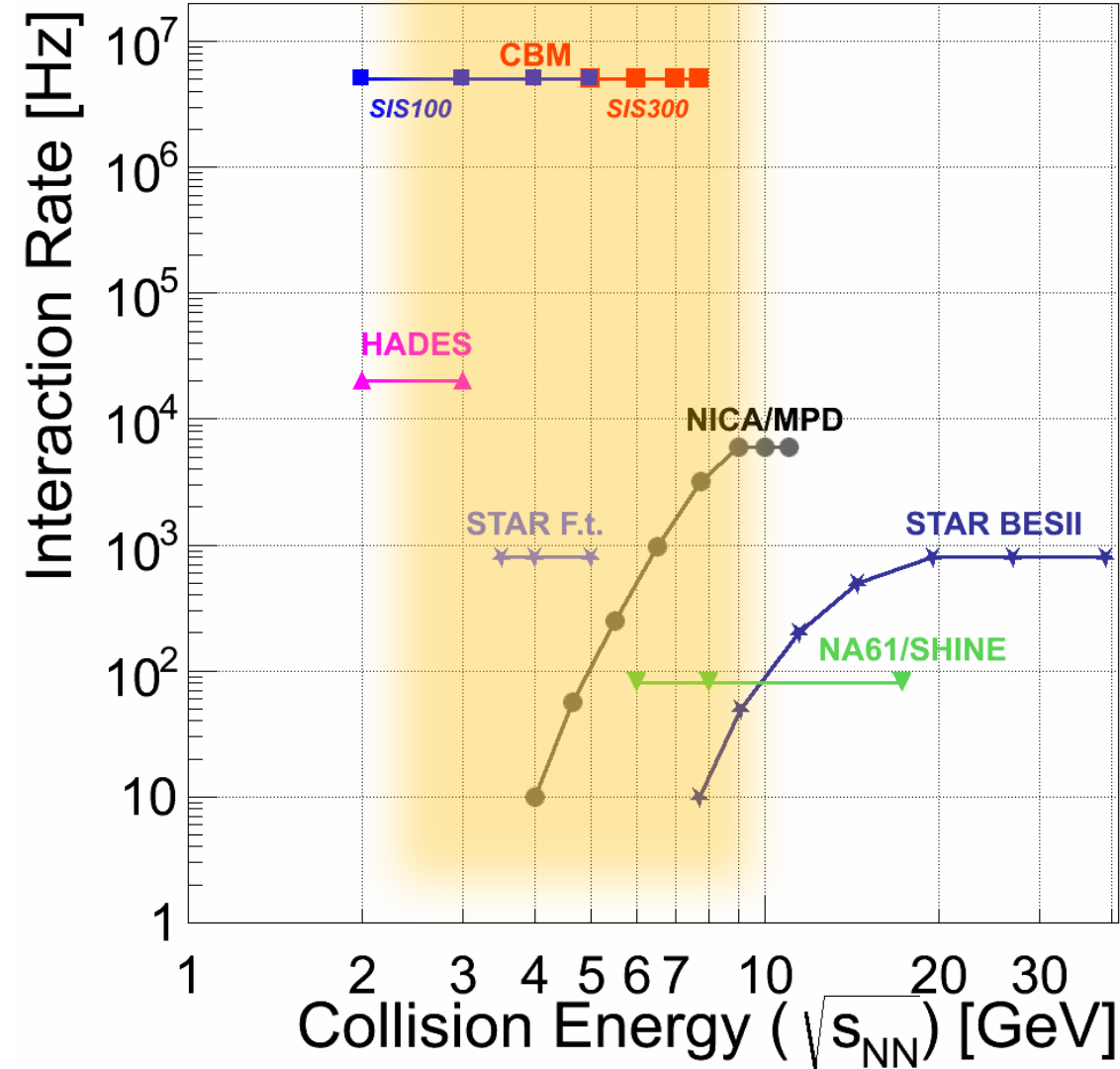
Physics case: Exploring the QCD phase diagram



1. **The equation-of-state at high ρ_B**
collective flow of hadrons
particle production at threshold energies:
multi-strange hyperons, hypernuclei and open charm
2. **Deconfinement phase transition at high ρ_B**
excitation function and flow of **strangeness**
(**K**, **Λ** , **Σ** , **Ξ** , **Ω**) and
charm (J/ψ , ψ' , D^0 , D_s , $D^\pm$, Λ_c)
charmonium suppression, for J/ψ and ψ
3. **QCD critical endpoint**
excitation function of event-by-event
fluctuations (**K/ π** , **Ξ/π** , **Ω/π** ...)
4. **Onset of chiral symmetry restoration at high ρ_B**
in-medium modifications of hadrons ($\rho, \omega, \phi \rightarrow e^+e^-(\mu^+\mu^-)$)
multi-strange anti-baryons production
mechanism

Experiments exploring dense QCD matter

high
net-baryon
densities

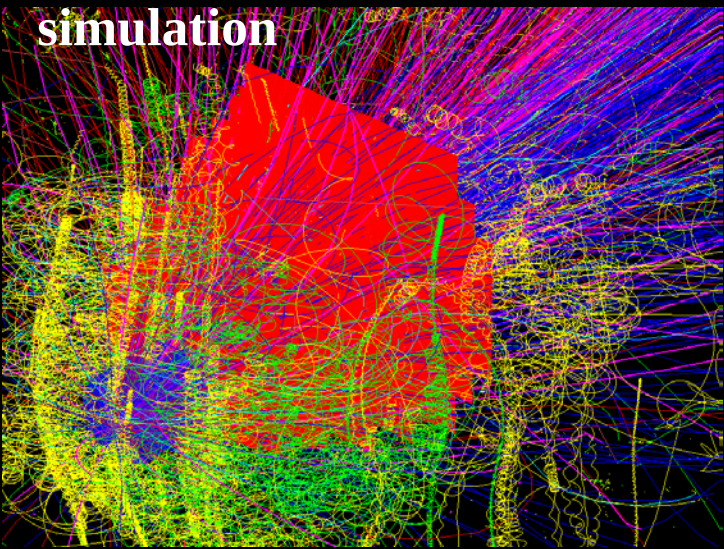
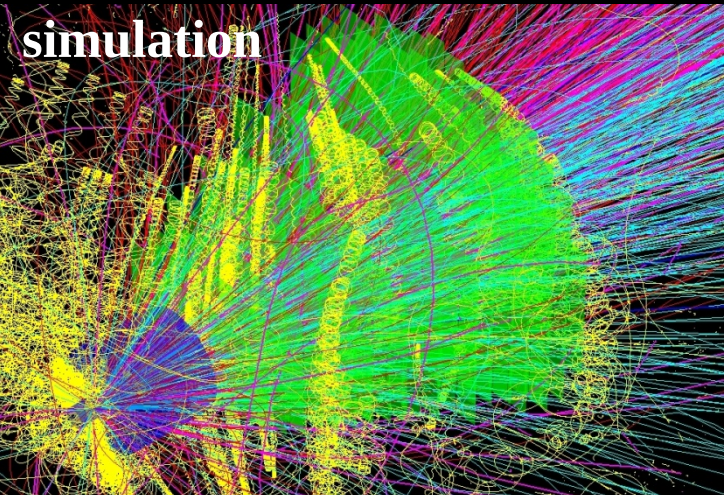
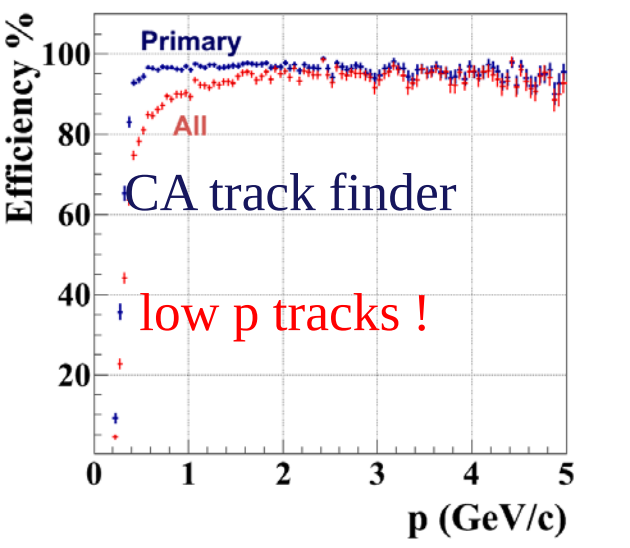
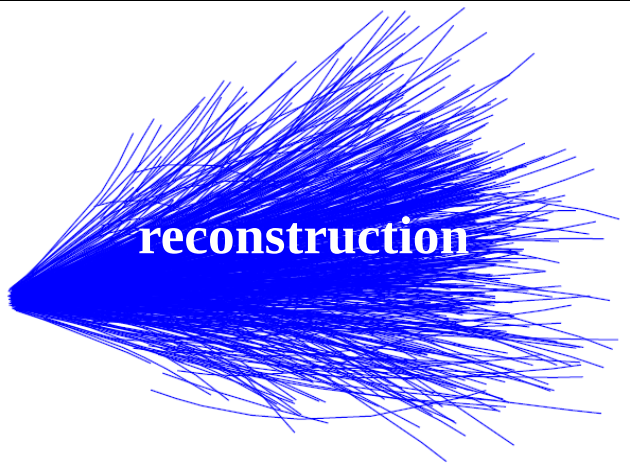


CBM:
world record
rate capability

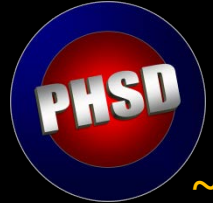
- identification of leptons and hadrons
- high speed data acquisition and online event selection
- fast and radiation hard detectors
- self-triggered readout electronics
- determination of (displaced) vertices with high resolution ($\approx 50 \mu\text{m}$)
- powerful computing farm 4-d tracking*
- software triggers

SIS-300: central Au + Au (UrQMD or PHSD) events

Simulation and reconstruction



~700 π
 160 p
 53 K
 32 Λ
 27 K_S^0
 0.44 E^-
 0.018 Ω^-



~700 π
 174 p
 42 K
 30 Λ
 24 K_S^0
 2.4 E^-
 0.005 Ω^-

central: 82 (TF) + 16 (PF) ms/core
 mbias : 10 (TF) + 2 (PF) ms/core
 up to 80 cores/CPU

648 reconstructed tracks
 Ref. prim. eff = 96%
 All set eff = 87%
 dp/p = [1.3 – 1.5]%

CBM First Level Event Selection (FLES)

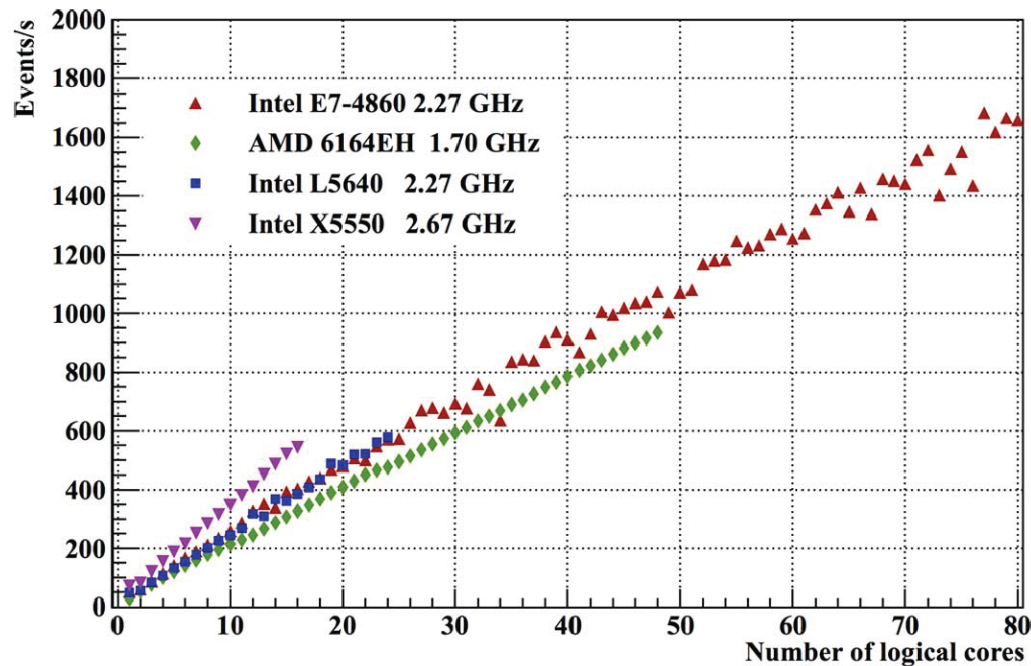
The FLES package is

vectorized, parallelized, portable and **scalable** up to 3 200 cores

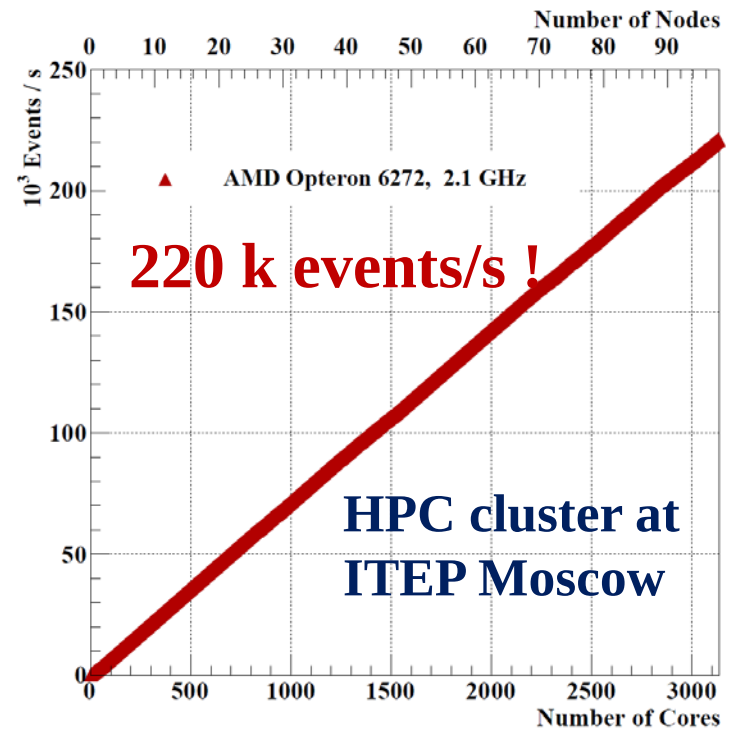
Example:

Full track reconstruction including KF particle analysis of multi-strange (anti) hyperons for min. bias Au+Au collisions at 25 A GeV.

Single node with up to 80 cores



100 nodes with 32 cores each



Particle identification with CBM

Ni+Ni 15 AGeV

123 π

53 p

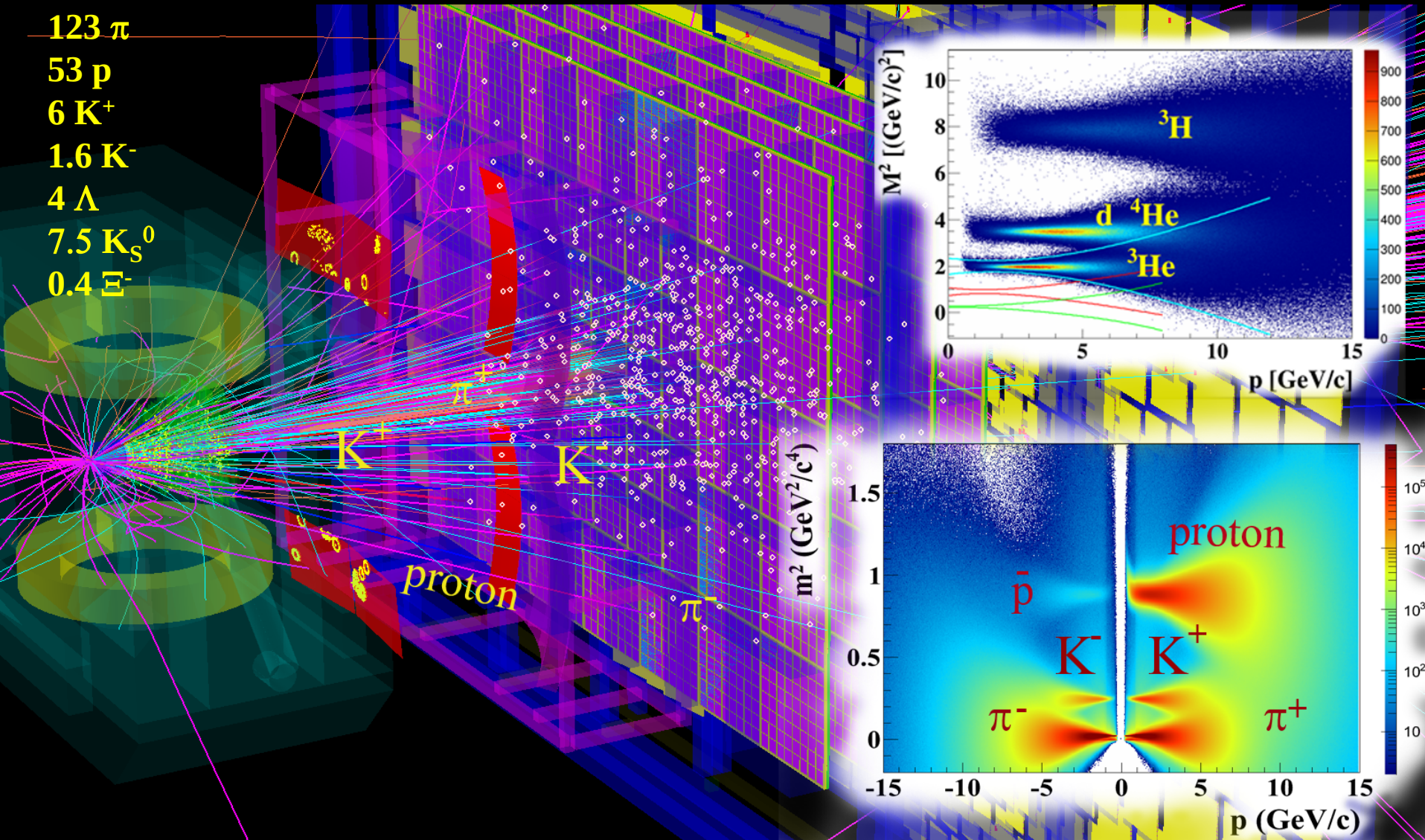
6 K^+

1.6 K^-

4 Λ

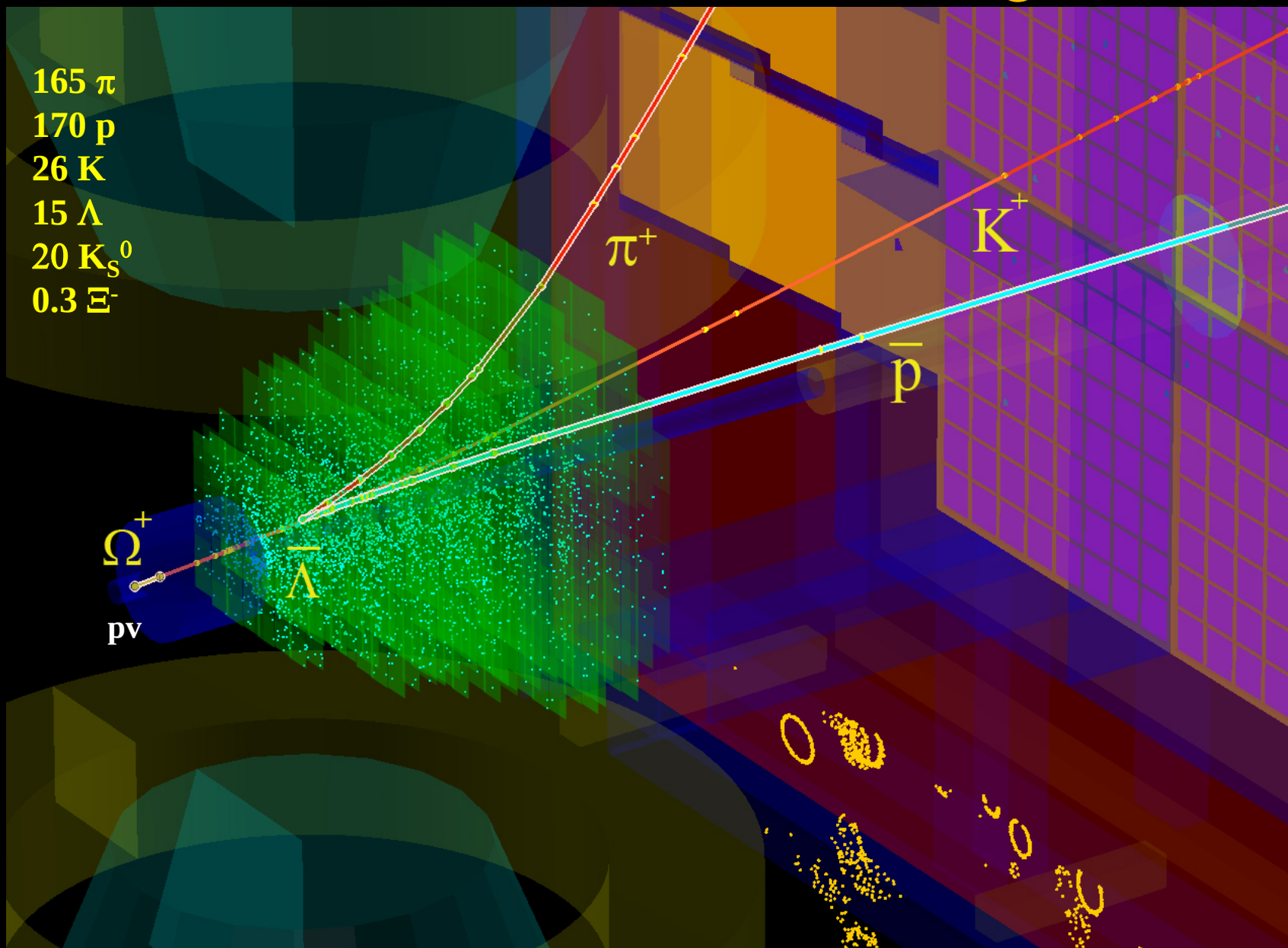
7.5 K_S^0

0.4 Ξ^-



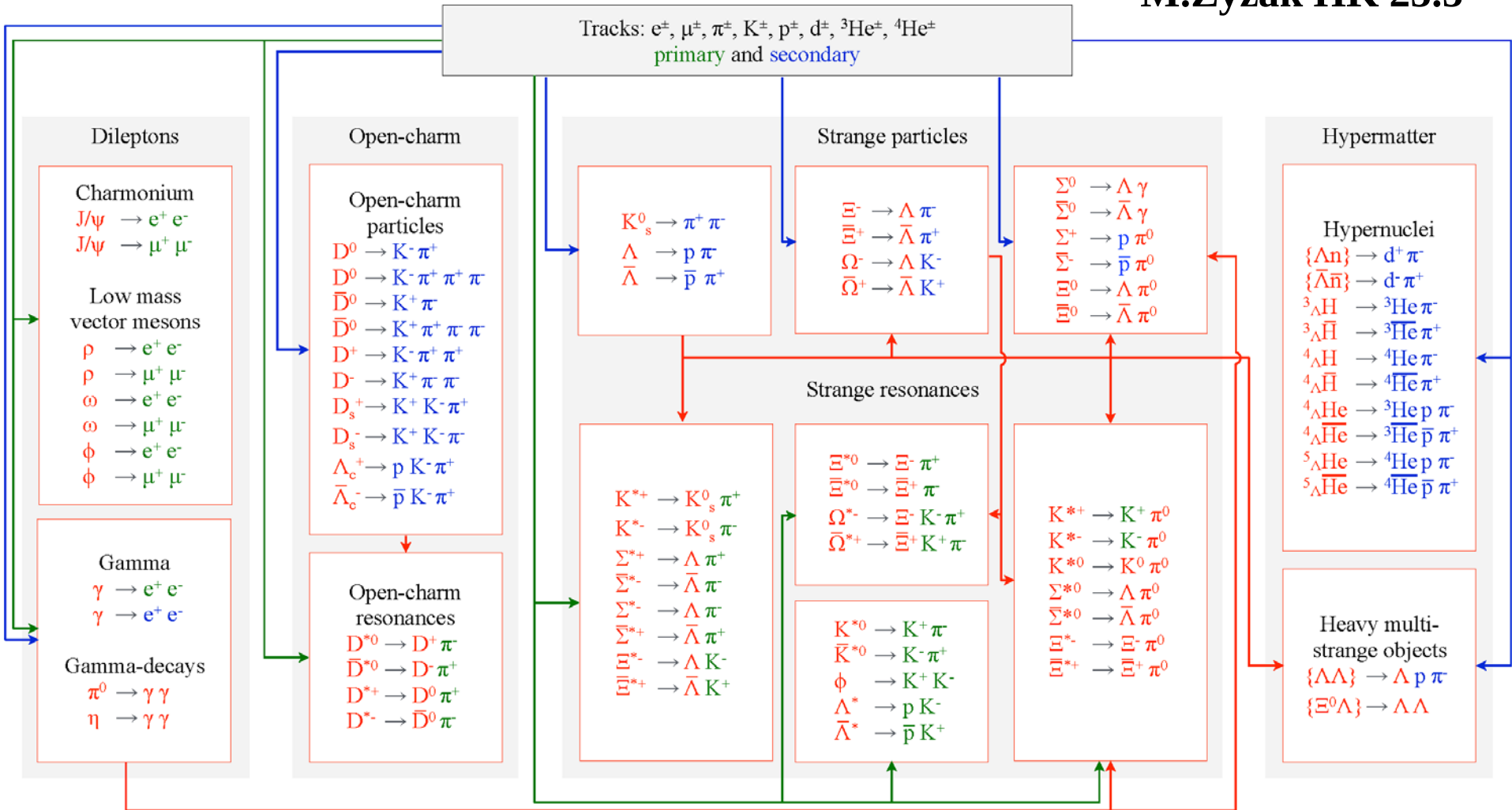
Central event: 40 (TF) + 7 (PF) ms/core with MVD!
 (~ 2 faster w/o MVD)

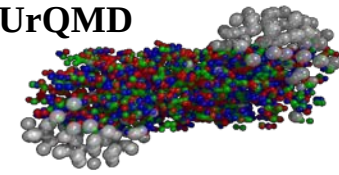
KF Particle Finder with ToF track ID: Au+Au @ 10AGeV



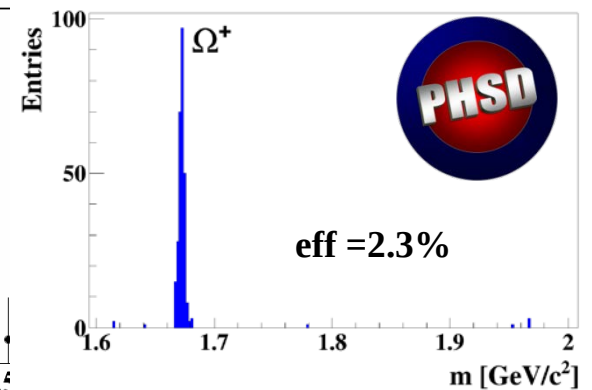
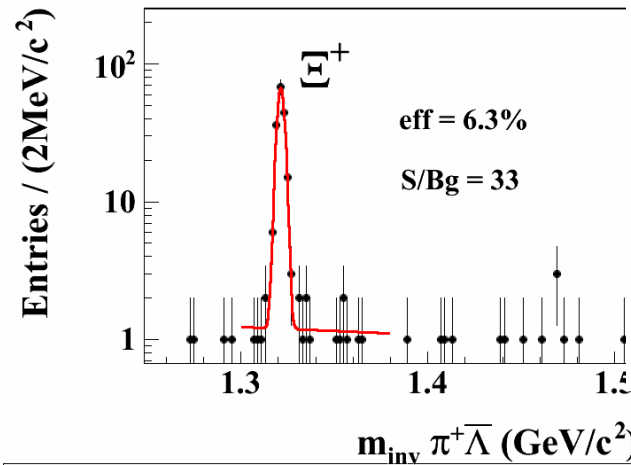
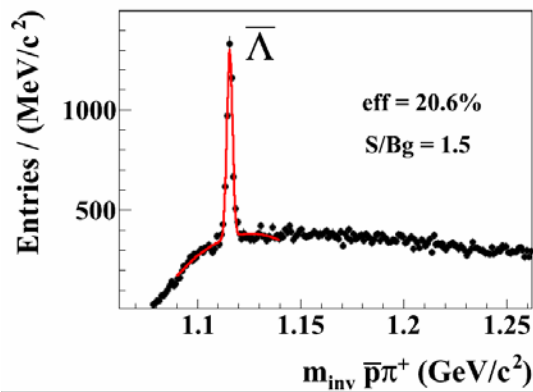
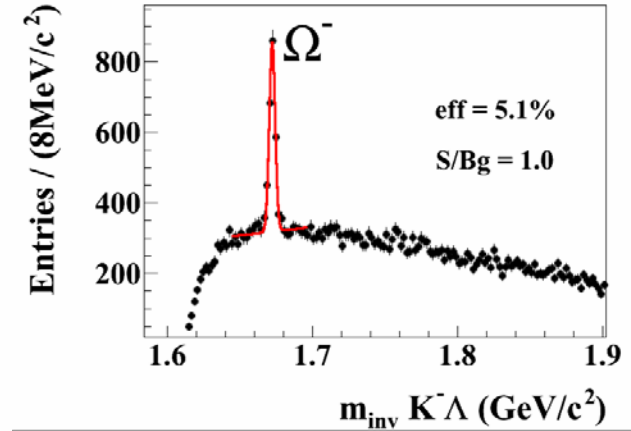
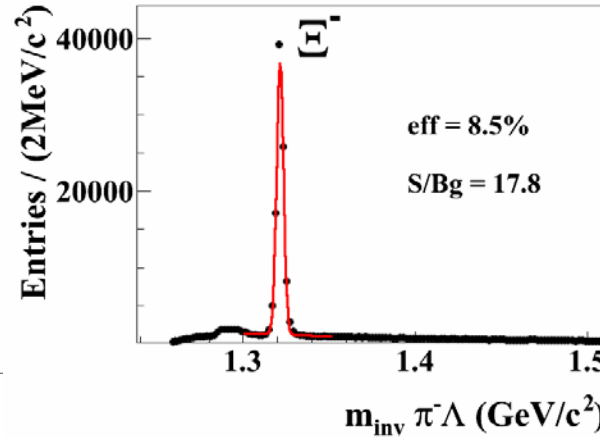
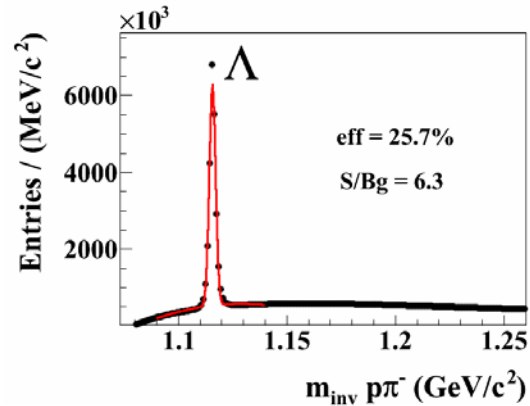
KF Particle Finder for the CBM Experiment

M.Zyzak HK 25.5





Au+Au 10 AGeV 5M central events



QGP signatures at FAIR energies: Multi-strange **antibaryons**

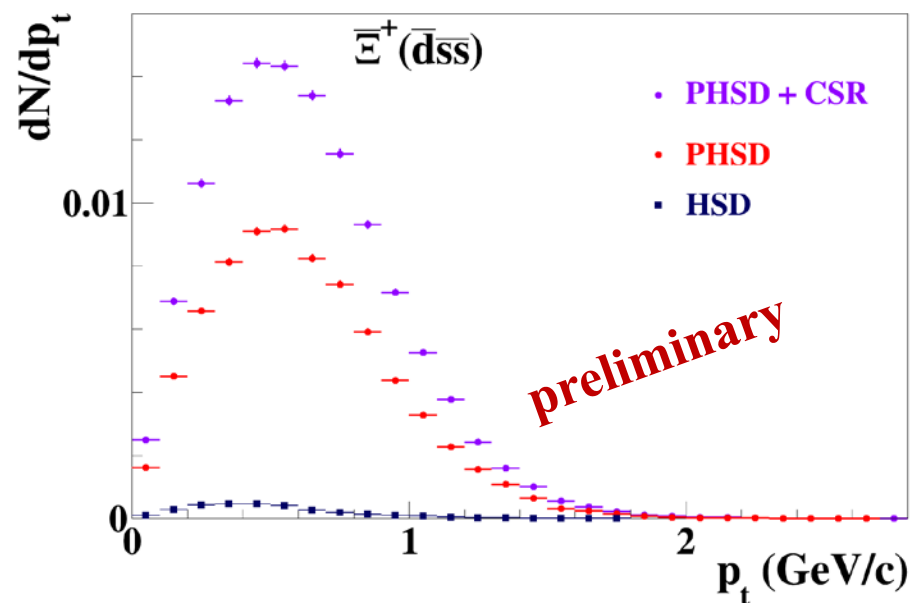
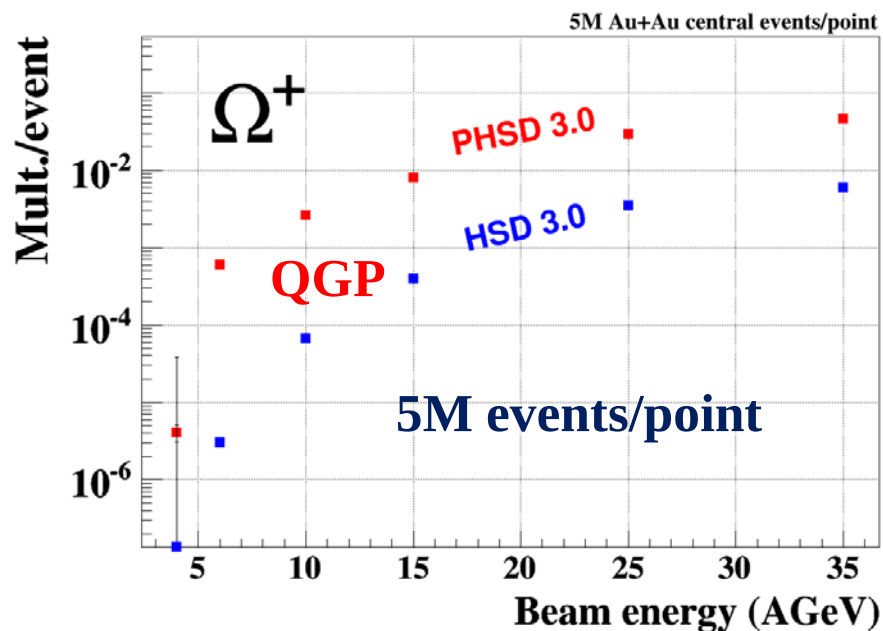


E.Bratkovskaya

fias.uni-frankfurt.de/~brat/PHSD/index1.html

V.Vovchenko

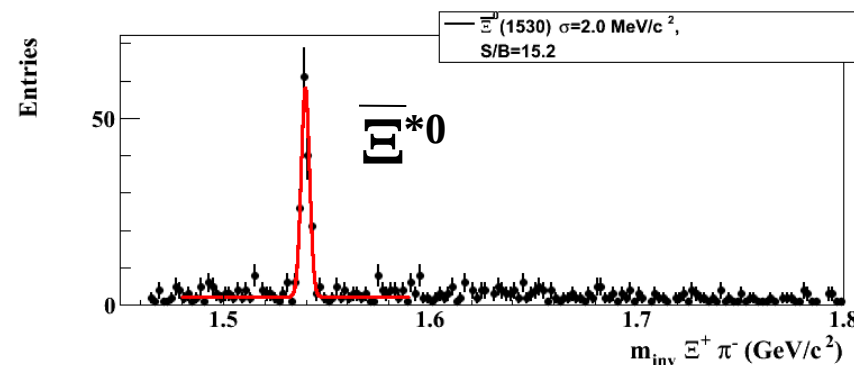
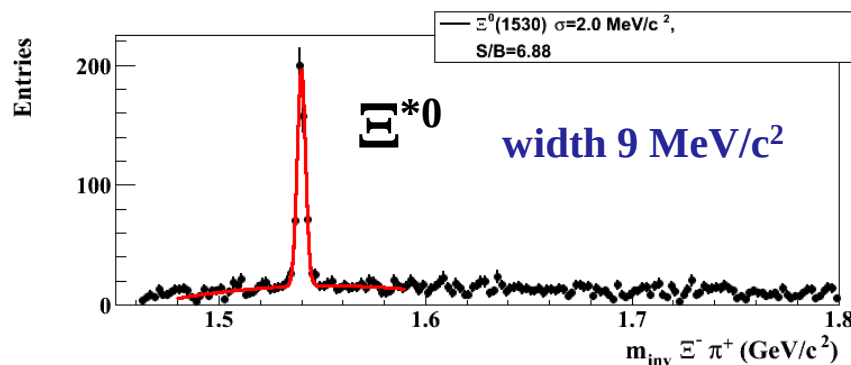
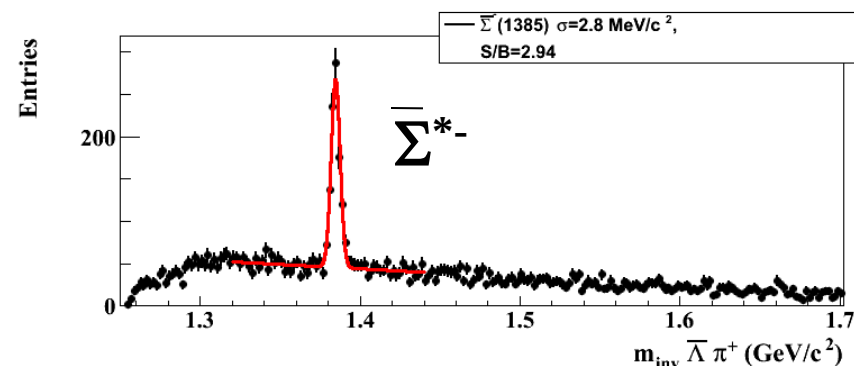
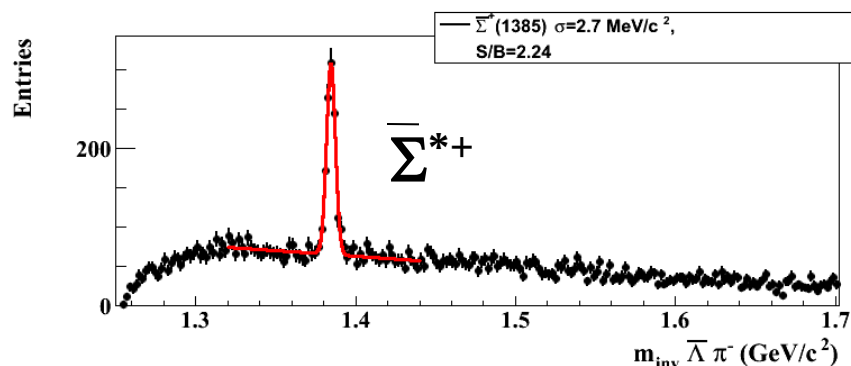
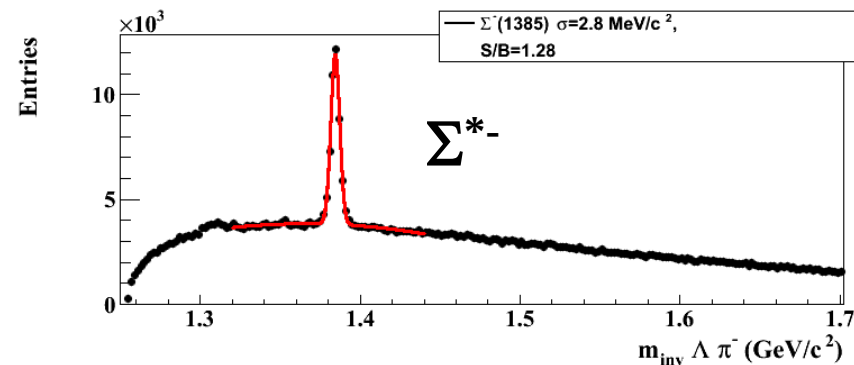
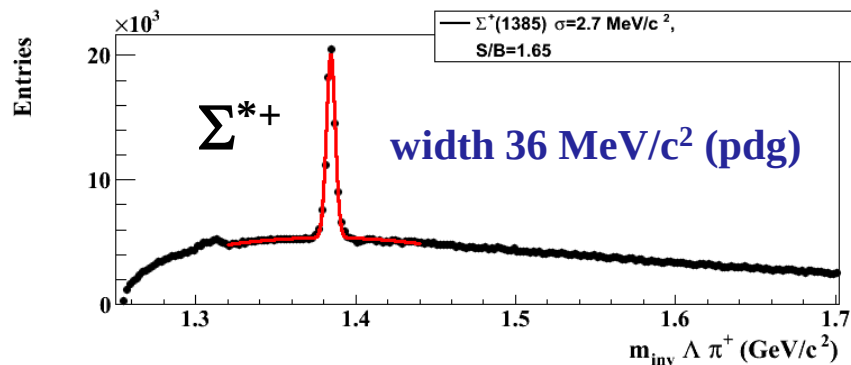
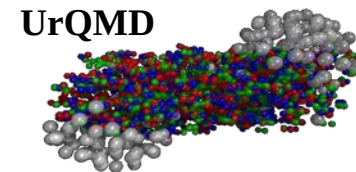
PHSD 3.3 Au + Au @ 10 AGeV



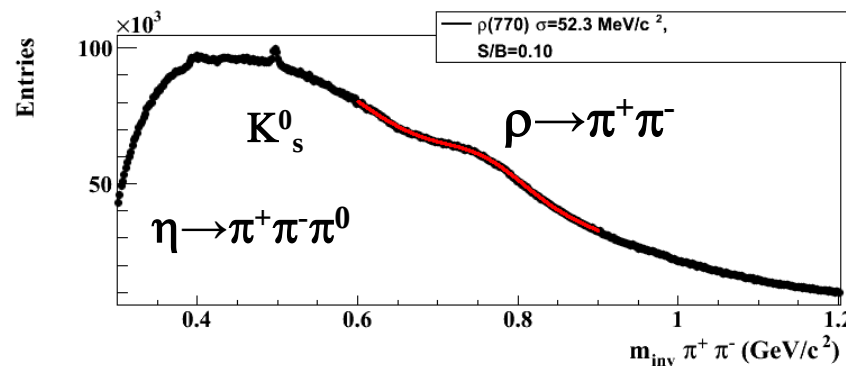
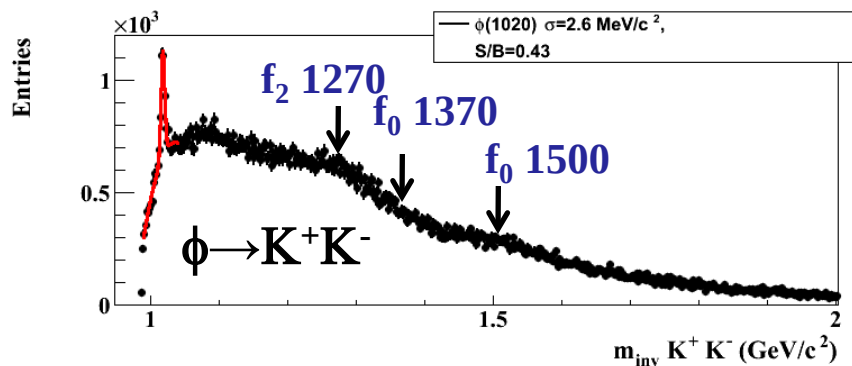
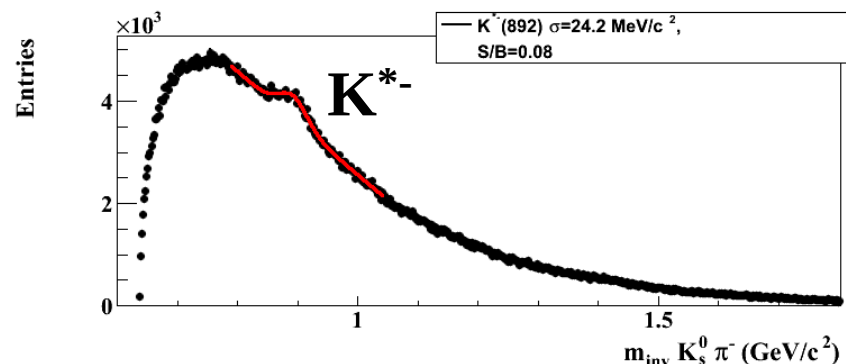
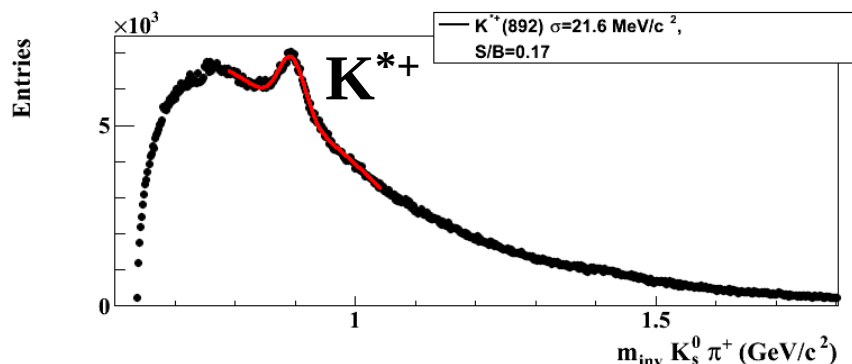
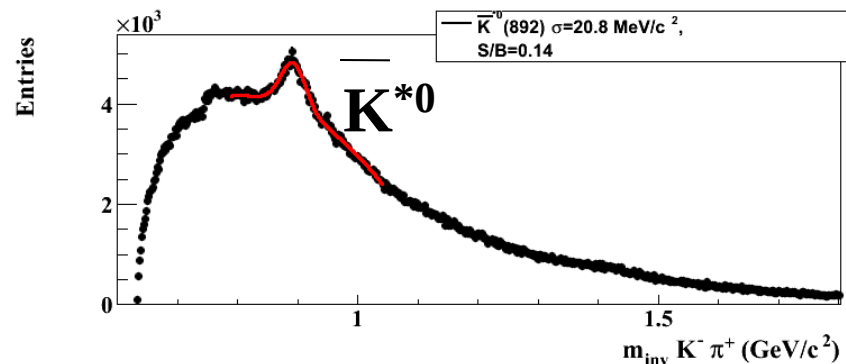
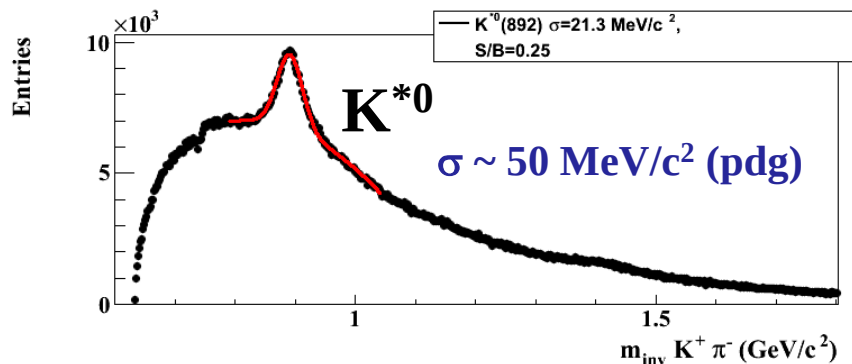
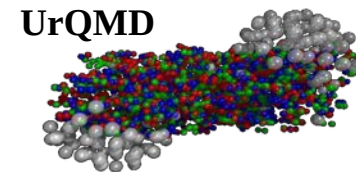
Most of the Ω^+ produced by QGP @ FAIR energy!?

CSR increase yield of MS Antibaryons !?

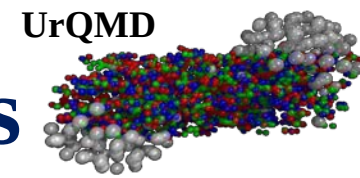
p+C 25 GeV 50M central events



p+C 25 GeV 50M central events

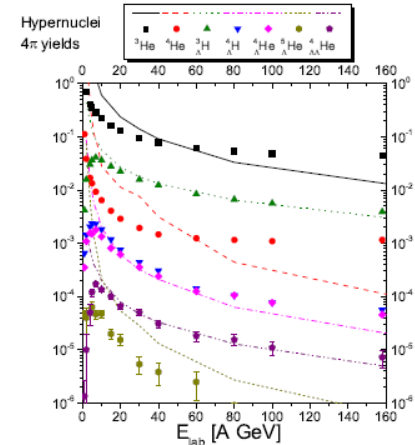
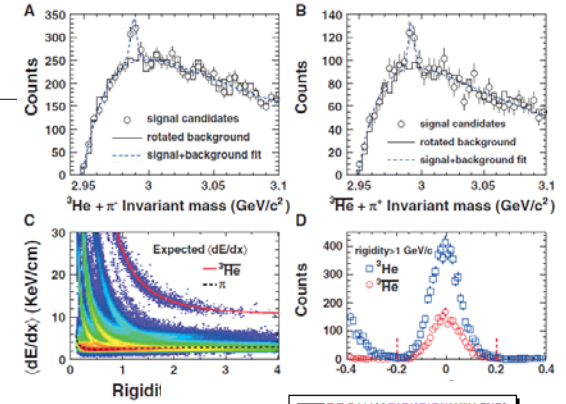
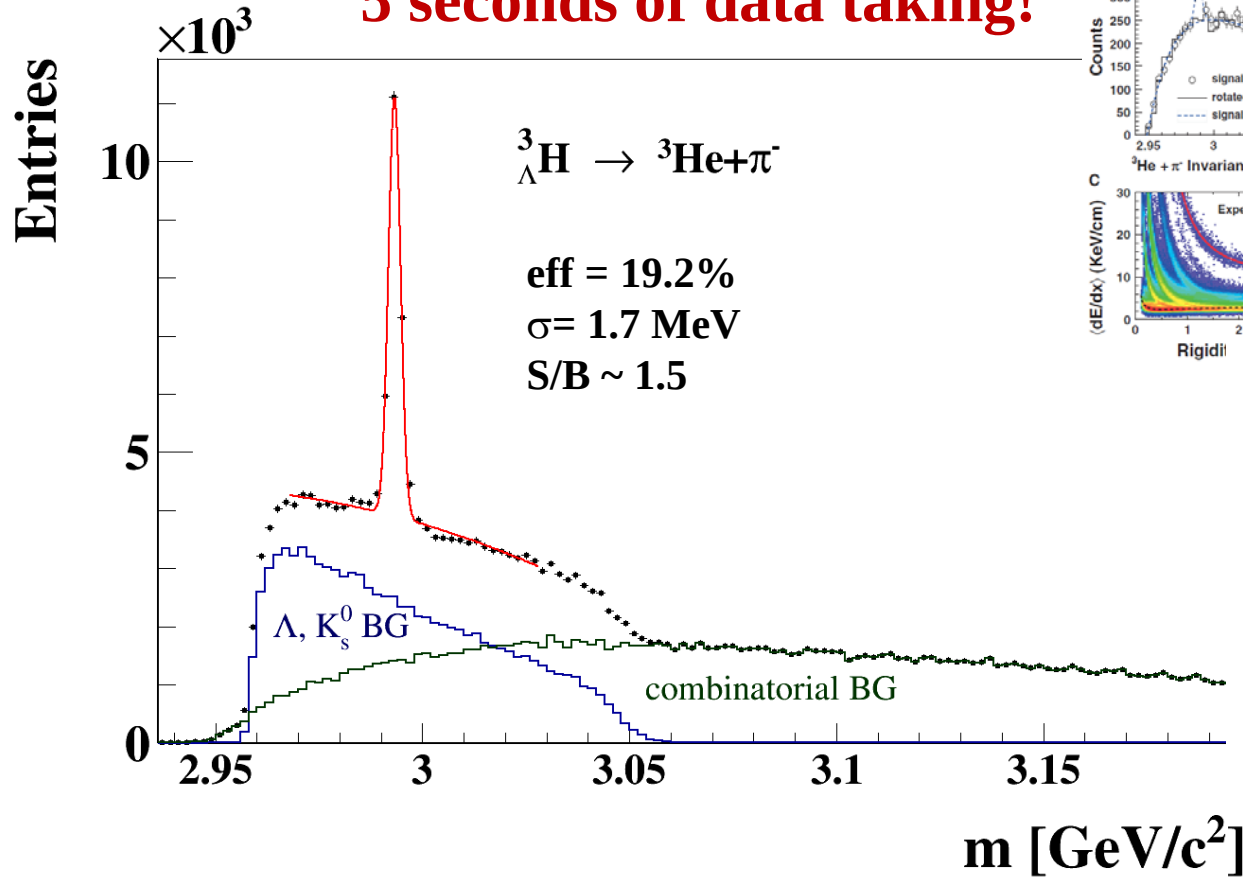


Au+Au 10 AGeV 5M central events



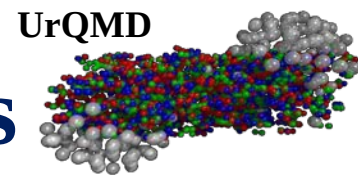
STAR 2010

Extended KFParticle Finder ${}^3_{\Lambda}\text{H}$
5 seconds of data taking!

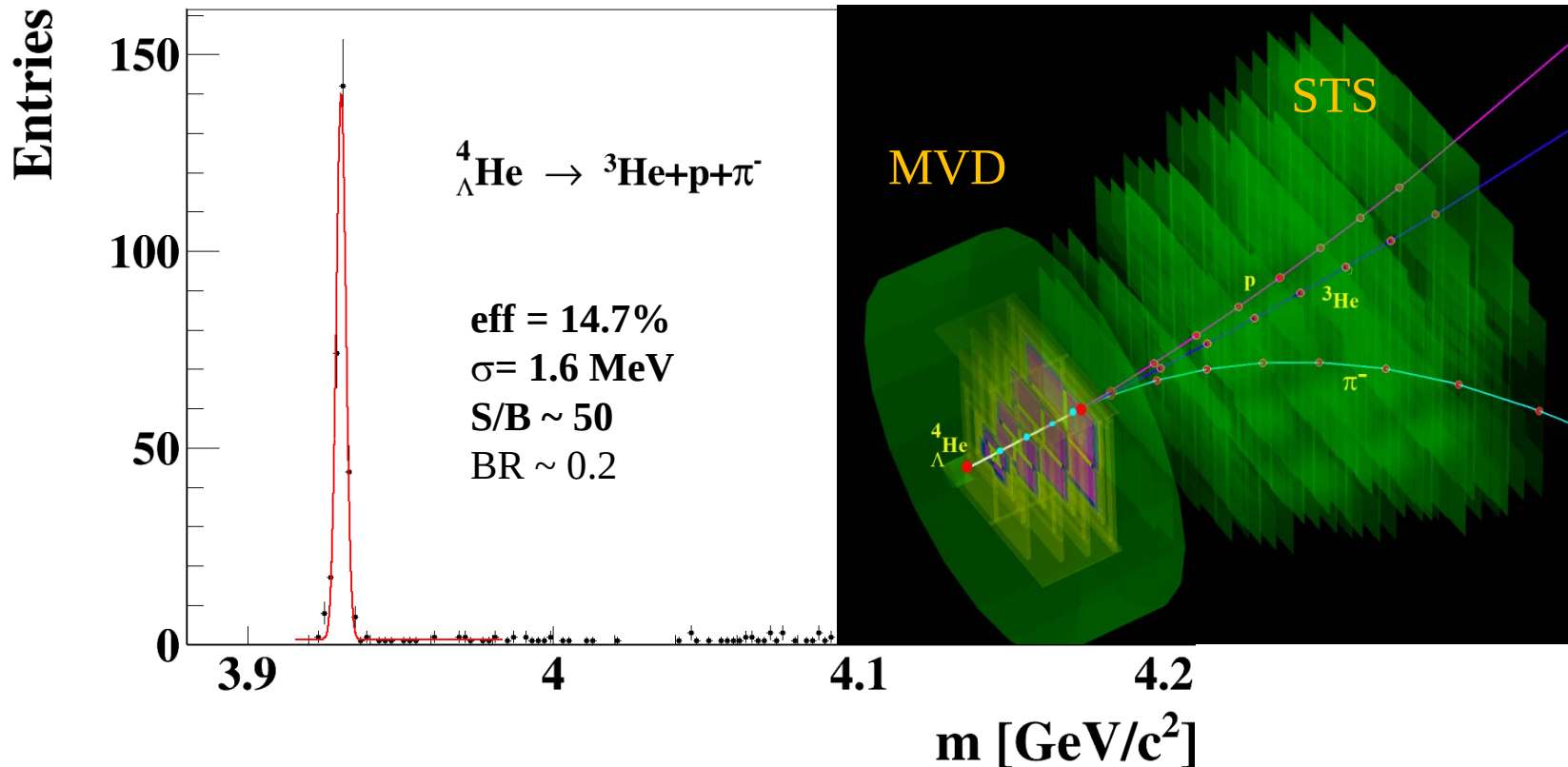


BR by H. Kamada et al., Phys. Rev., Ser. C 57, 1595 (1998)
 M by J. Steinheimer et. al., Phys. Lett. **B714**, 85, (2012)

Au+Au 10 AGeV 5M central events



Extended KFParticle Finder ${}^4_{\Lambda}\text{He}$



3 prong detached vertex is good signature of ${}^4_{\Lambda}\text{He}$ decay
MVD detector allows to reconstruct mother particle track $\rightarrow$
neutron rich hypernuclei sector

Expected particle yields Au + Au (central)

Particle (mass MeV/c ²)	Multi- plicity 6 AGeV	Multi- plicity 10 AGeV	decay mode	BR	ϵ (%)	yield (s ⁻¹) 6AGeV	yield (s ⁻¹) 10AGeV	yield in 10 weeks 6AGeV	yield in 10 weeks 10 AGeV	IR MHz
Λ (1115)	10.4	17.4	$p\pi^-$	0.64	18	$1.2 \cdot 10^6$	$2.0 \cdot 10^6$	$7.2 \cdot 10^{12}$	$1.2 \cdot 10^{13}$	10
$\bar{\Lambda}$ (1115)	$4.6 \cdot 10^{-4}$	0.034	$\bar{p}\pi^+$	0.64	11	1.1	81.3	$6.6 \cdot 10^6$	$2.2 \cdot 10^8$	10
Ξ^- (1321)	0.054	0.222	$\Lambda\pi^-$	1	6	$3.2 \cdot 10^3$	$1.3 \cdot 10^4$	$1.9 \cdot 10^{10}$	$7.8 \cdot 10^{10}$	10
Ξ^+ (1321)	$3.0 \cdot 10^{-5}$	$5.4 \cdot 10^{-4}$	$\Lambda\pi^+$	1	3.3	$9.9 \cdot 10^{-1}$	17.8	$5.9 \cdot 10^6$	$1.1 \cdot 10^8$	10
Ω^- (1672)	$5.8 \cdot 10^{-4}$	$5.6 \cdot 10^{-3}$	ΛK^-	0.68	5	17	164	$1.0 \cdot 10^8$	$9.6 \cdot 10^8$	10
Ω^+ (1672)	-	$7 \cdot 10^{-5}$	ΛK^+	0.68	3	-	0.86	-	$5.2 \cdot 10^6$	10
$^3_\Lambda\text{H}$ (2993)	$4.2 \cdot 10^{-2}$	$3.8 \cdot 10^{-2}$	$^3\text{He}\pi^-$	0.25	19.2	$2 \cdot 10^3$	$1.8 \cdot 10^3$	$1.2 \cdot 10^{10}$	$1.1 \cdot 10^{10}$	10
$^4_\Lambda\text{He}$ (3930)	$2.4 \cdot 10^{-3}$	$1.9 \cdot 10^{-3}$	$^3\text{He}p\pi^-$	0.32	14.7	110	87	$6.6 \cdot 10^8$	$5.2 \cdot 10^8$	10

The CBM Collaboration: 60 institutions, 530 members

Croatia:

Split Univ.

China:

CCNU Wuhan

Tsinghua Univ.

USTC Hefei

CTGU Yichang

Czech Republic:

CAS, Rez

Techn. Univ. Prague

France:

IPHC Strasbourg

Hungary:

KFKI Budapest

Budapest Univ.

Germany:

Darmstadt TU

FAIR

Frankfurt Univ. IKF

Frankfurt Univ. FIAS

Frankfurt Univ. ICS

GSI Darmstadt

Giessen Univ.

Heidelberg Univ. P.I.

Heidelberg Univ. ZITI

HZ Dresden-Rossendorf

KIT Karlsruhe

Münster Univ.

Tübingen Univ.

Wuppertal Univ.

ZIB Berlin

India:

Aligarh Muslim Univ.

Bose Inst. Kolkata

Panjab Univ.

Rajasthan Univ.

Univ. of Jammu

Univ. of Kashmir

Univ. of Calcutta

B.H. Univ. Varanasi

VECC Kolkata

IOP Bhubaneswar

IIT Kharagpur

IIT Indore

Gauhati Univ.

Korea:

Pusan Nat. Univ.

Poland:

AGH Krakow

Jag. Univ. Krakow

Silesia Univ. Katowice

Warsaw Univ.

Warsaw TU

Romania:

NIPNE Bucharest

Univ. Bucharest

Russia:

IHEP Protvino

INR Troitzk

ITEP Moscow

Kurchatov Inst., Moscow

LHEP, JINR Dubna

LIT, JINR Dubna

MEPHI Moscow

PNPI Gatchina

SINP MSU, Moscow

St. Petersburg Polytech. Univ.

Ioffe Phys.-Tech. Inst. St. Pb.

Ukraine:

T. Shevchenko Univ. Kiev

Kiev Inst. Nucl. Research

26th CBM Collaboration meeting in Prague, CZ
14 -18 Sept. 2015



Scientist fraction, CBM

