News from NA49 and NA61 Status and Plans

- News from NA49
- NA61 status and plans

M. Gazdzicki, Frankfurt, Kielce
for the NA61 and NA49 Collaborations

News from NA49

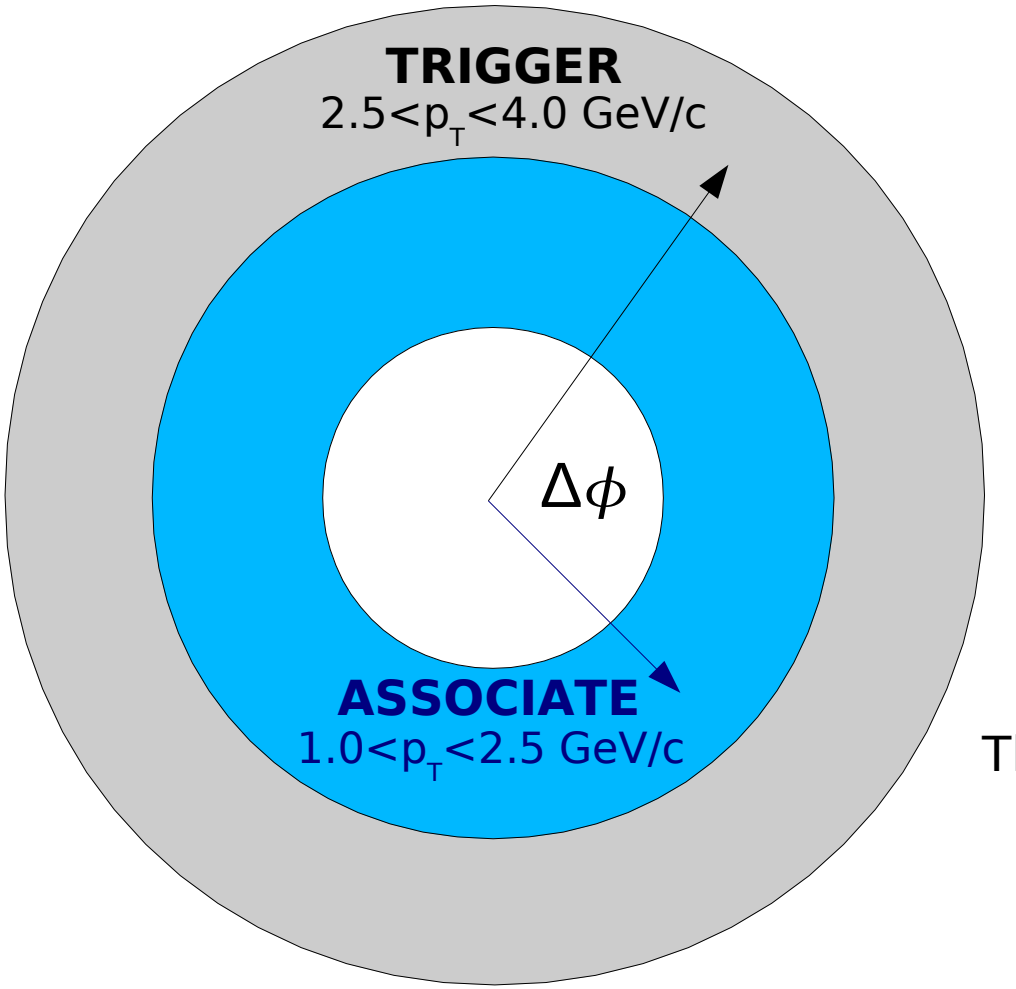
Important examples:

Energy dependence of azimuthal correlations:
The HOLE-JET transition

Resonances in central Pb+Pb collisions:
The long lasting hadronic phase

Centrality dependence of baryon spectra:
The limited rescattering at the interpenetration stage

Energy dependence of azimuthal correlations:
The HOLE-JET transition

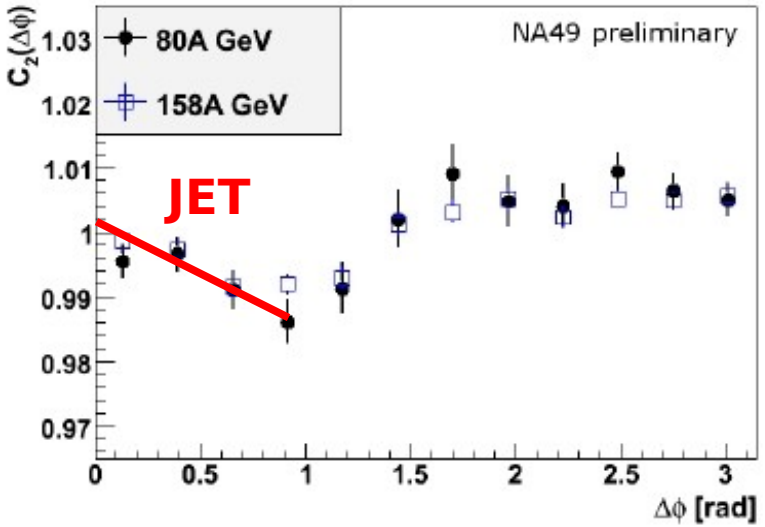


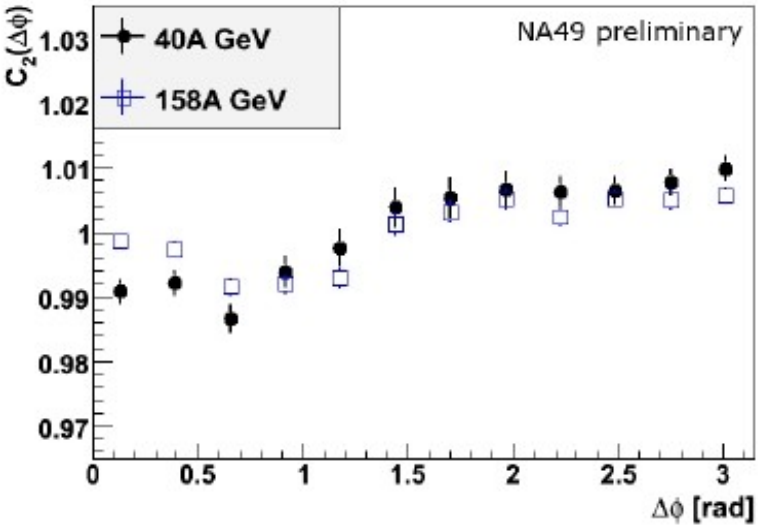
Plane transverse to the collision axis

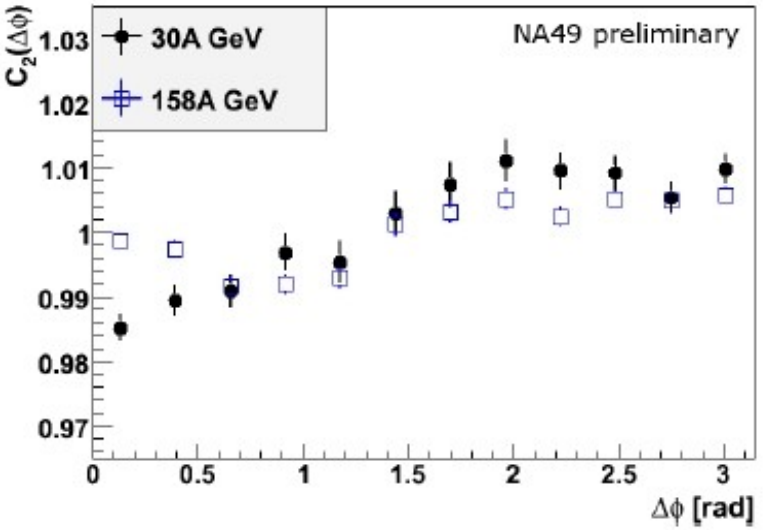
The azimuthal correlation function:

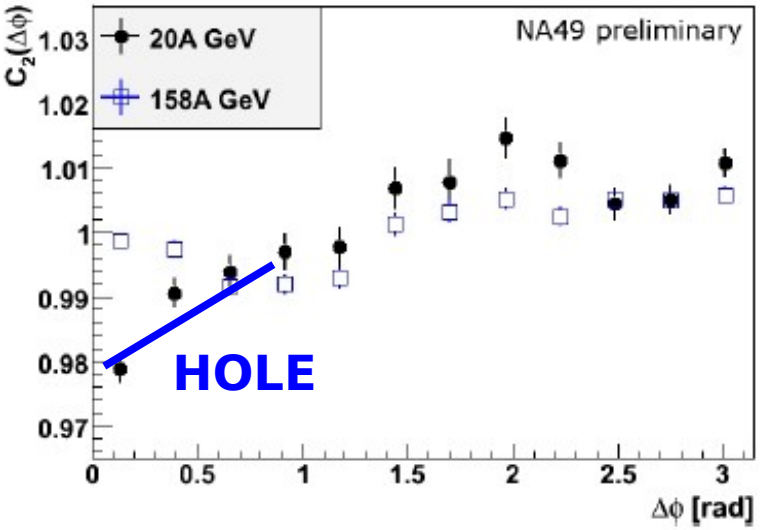
$$C_2(\Delta\phi)=\frac{N_{corr}(\Delta\phi)}{N_{mix}(\Delta\phi)}\frac{\int N_{mix}(\Delta\phi')d(\Delta\phi')}{\int N_{corr}(\Delta\phi')d(\Delta\phi')}$$

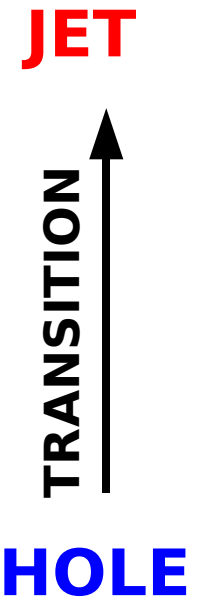
Central Pb+Pb collisions at the SPS energies



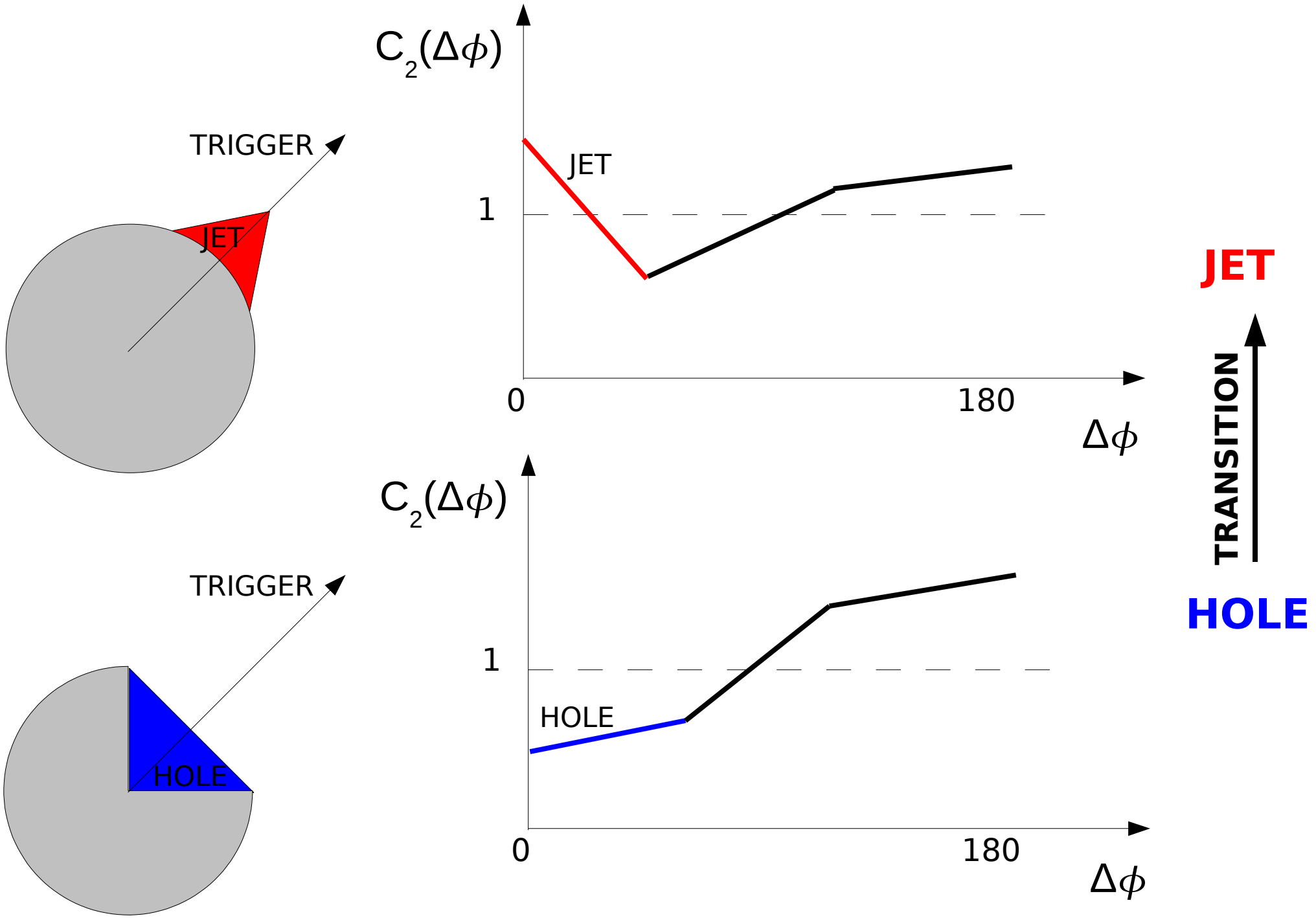






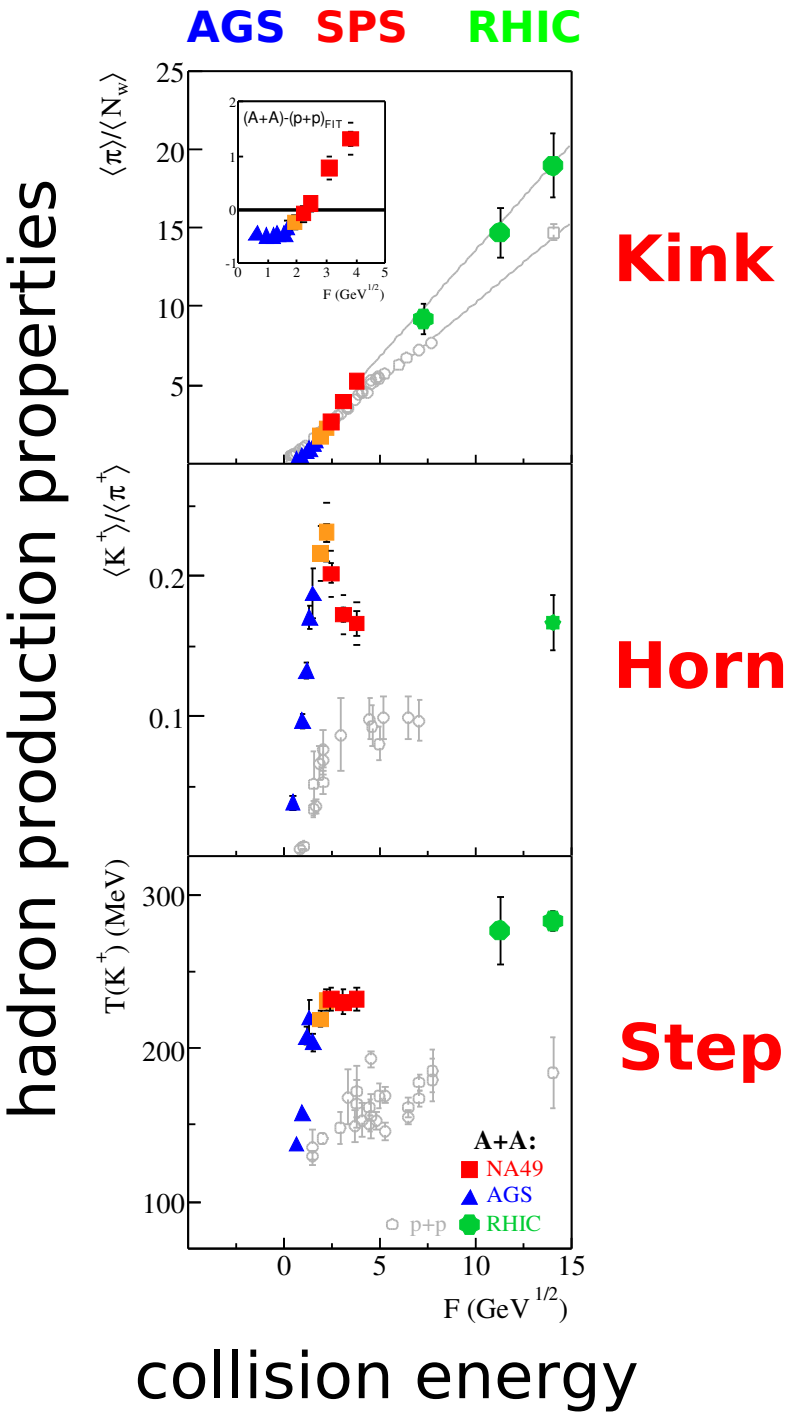


NA49: M. Szuba et al., 0809.5210
More at QM2009


TRIGGER
JET
$C_2(\Delta\phi)$
JET
1
0
180
$\Delta\phi$
JET
TRANSITION
HOLE
TRIGGER
HOLE
$C_2(\Delta\phi)$
1
HOLE
0
180
$\Delta\phi$

The HOLE-JET transition is located at the low SPS energies, where the signals of the onset of deconfinement have been previously observed by NA49

Is this by chance?

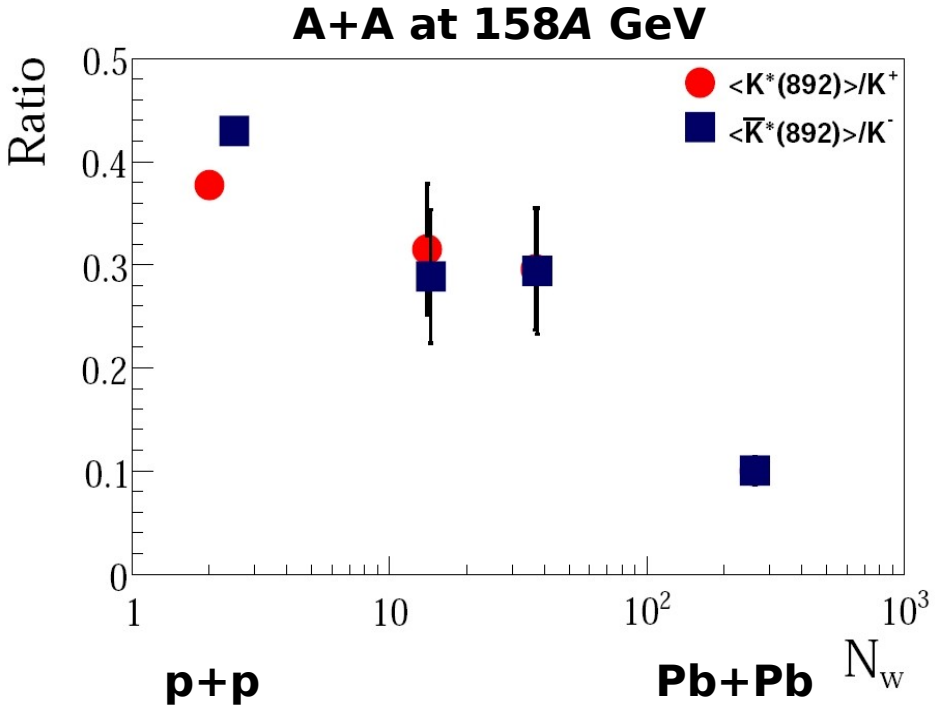


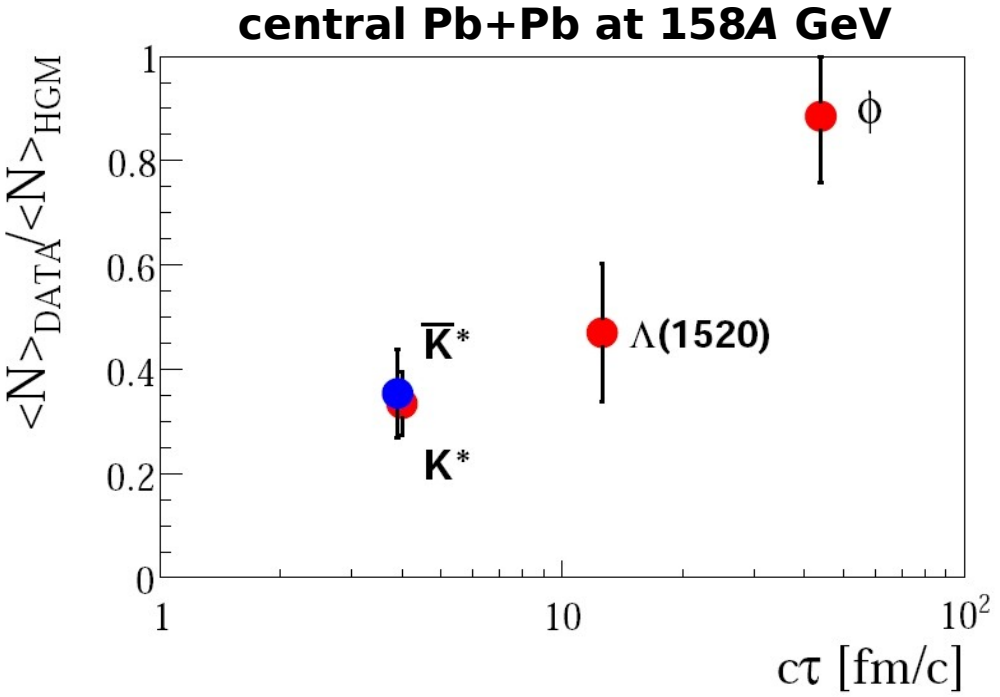
Final NA49 data:
Phys.Rev.C77:024903,2008

Predictions:
M.G., Gorenstein,
Acta Phys.Polon.B30:2705,1999

Resonances in central Pb+Pb collisions:

The long lasting hadronic phase





strong suppression of the resonance yield in central Pb+Pb collisions

The suppression increases with decreasing resonance life-time

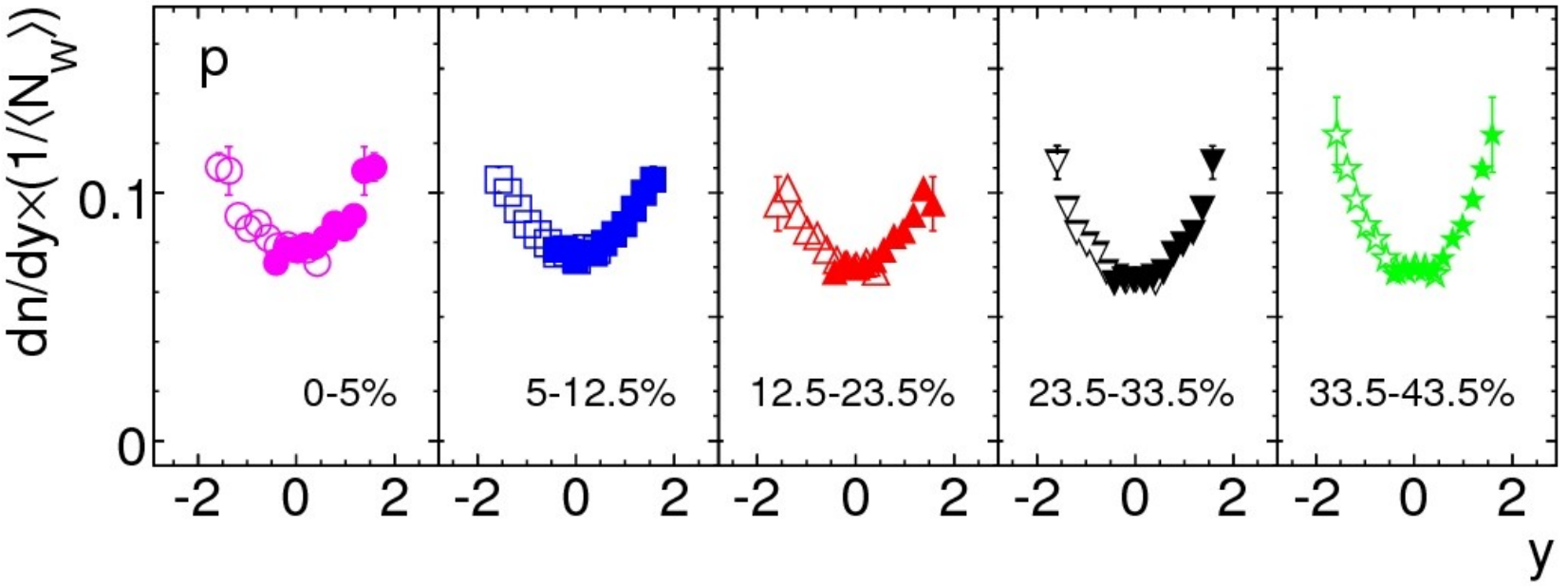
Rescattering of decay products in the long lasting hadronic phase

The freeze-out temperature decreases with an increasing system size

NA49: M. Slodkowski

Centrality dependence of baryon spectra:
The limited rescattering at the interpenetration stage

Pb+Pb collisions at 158*A* GeV



The proton rapidity spectra are almost independent of centrality

Early stage conditions are centrality/system size independent

Baryo-chemical potential is centrality/system size independent

NA49: M. Utvic

Physics goals (I):

Physics of strongly interacting matter

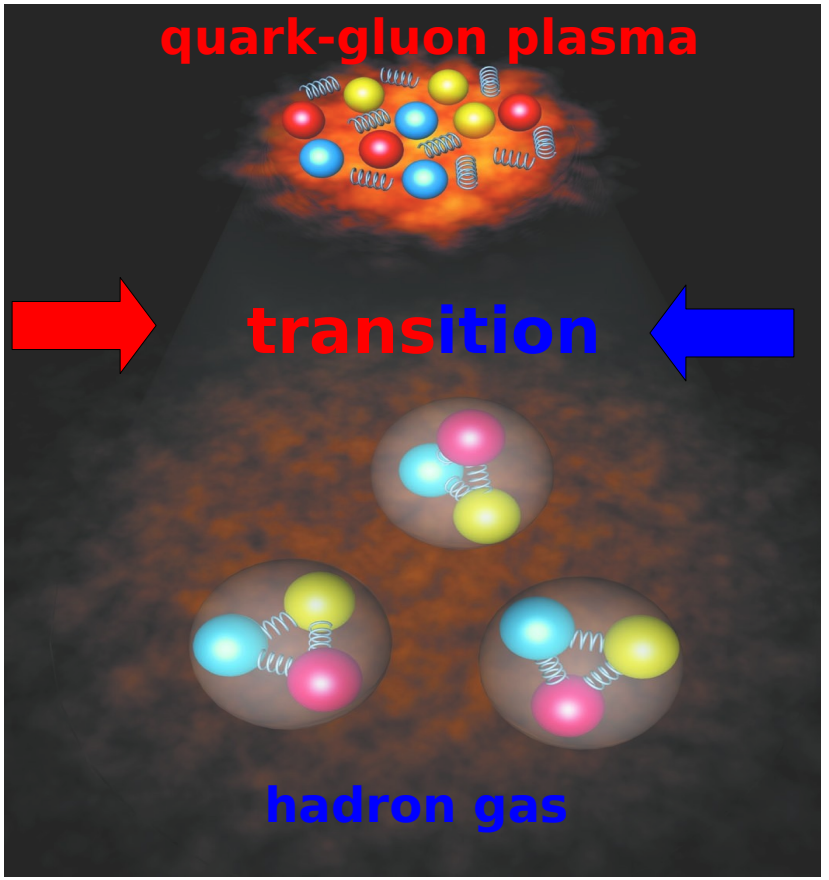
Discovery potential:

Search for the critical point of strongly interacting matter

Precision measurements:

Study the properties of the onset of deconfinement in nucleus-nucleus collisions

Measure hadron production at high transverse momenta in p+p and p+Pb collisions as reference for Pb+Pb results



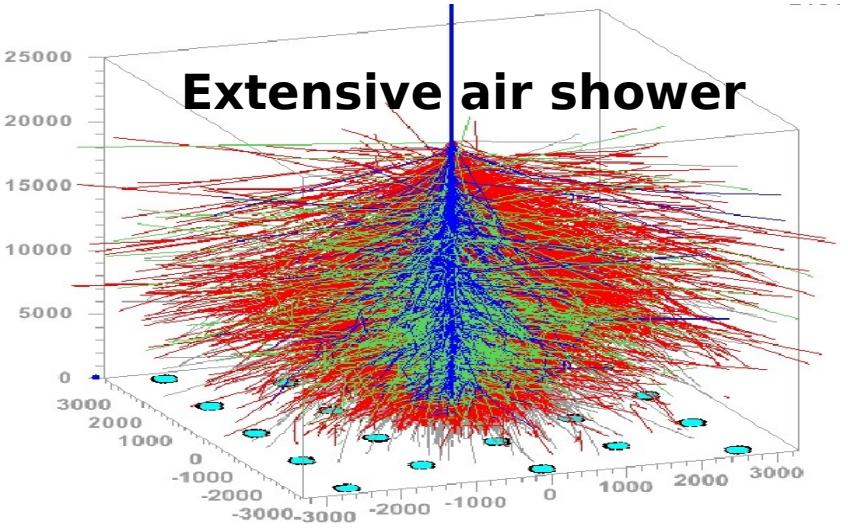
Physics goals (II):

Data for neutrino and cosmic ray experiments

Precision measurements:

Measure hadron production in the T2K target needed for the T2K (neutrino) physics

Measure hadron production in p+C interactions needed for T2K and cosmic-ray, Pierre Auger Observatory and KASCADE, experiments



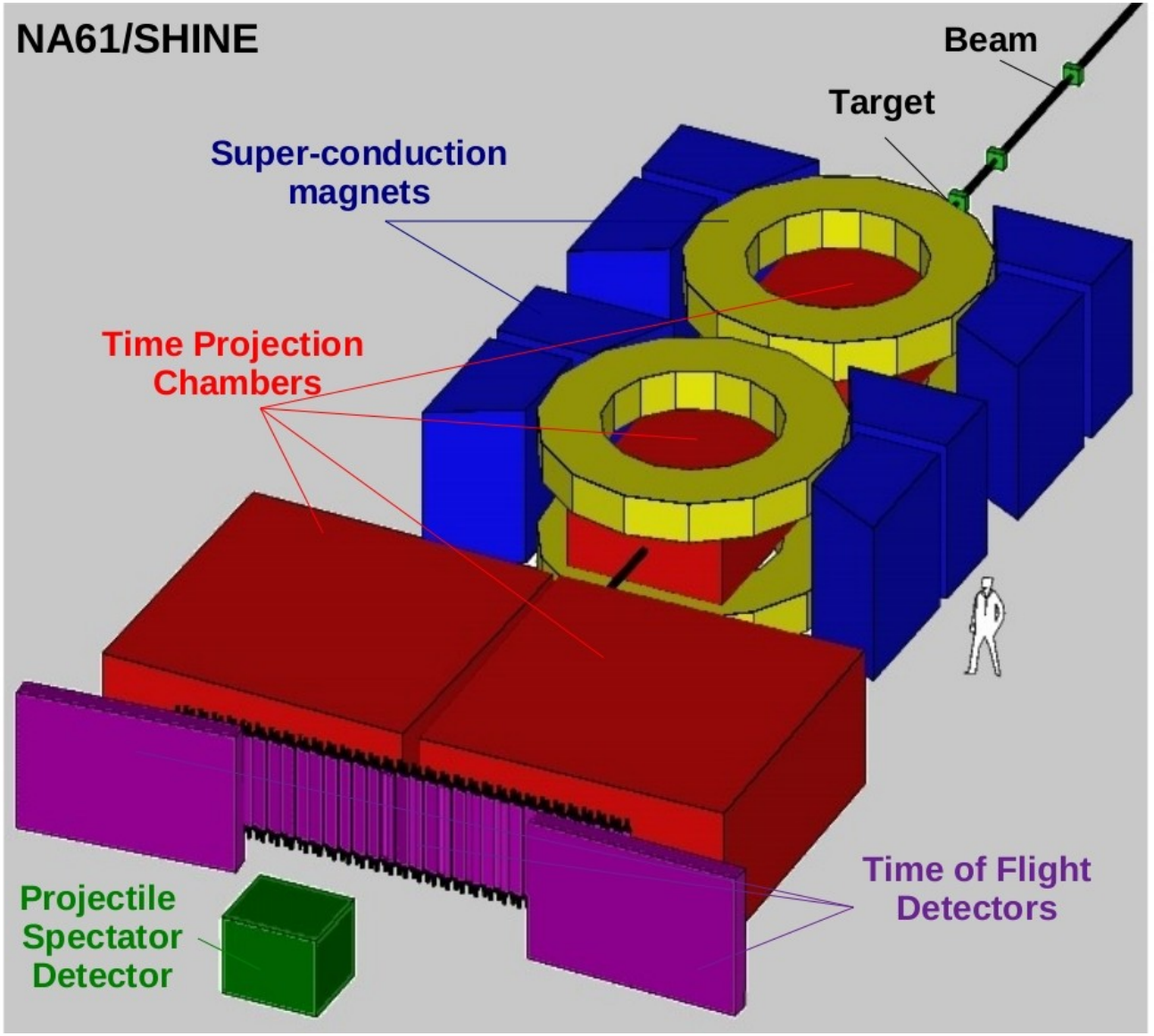
The NA61/SHINE Collaboration:

123 physicists from 24 institutes and 13 countries:

University of Athens, Athens, Greece
University of Bergen, Bergen, Norway
University of Bern, Bern, Switzerland
KFKI IPNP, Budapest, Hungary
Cape Town University, Cape Town, South Africa
Jagiellonian University, Cracow, Poland
Joint Institute for Nuclear Research, Dubna, Russia
Fachhochschule Frankfurt, Frankfurt, Germany
University of Frankfurt, Frankfurt, Germany
University of Geneva, Geneva, Switzerland
Forschungszentrum Karlsruhe, Karlsruhe, Germany
Institute of Physics, University of Silesia, Katowice, Poland
Jan Kochanowski Univeristy, Kielce, Poland
Institute for Nuclear Research, Moscow, Russia
LPNHE, Universites de Paris VI et VII, Paris, France
Faculty of Physics, University of Sofia, Sofia, Bulgaria
St. Petersburg State University, St. Petersburg, Russia
State University of New York, Stony Brook, USA
KEK, Tsukuba, Japan
Soltan Institute for Nuclear Studies, Warsaw, Poland
Warsaw University of Technology, Warsaw, Poland
University of Warsaw, Warsaw, Poland
Rudjer Boskovic Institute, Zagreb, Croatia
ETH Zurich, Zurich, Switzerland

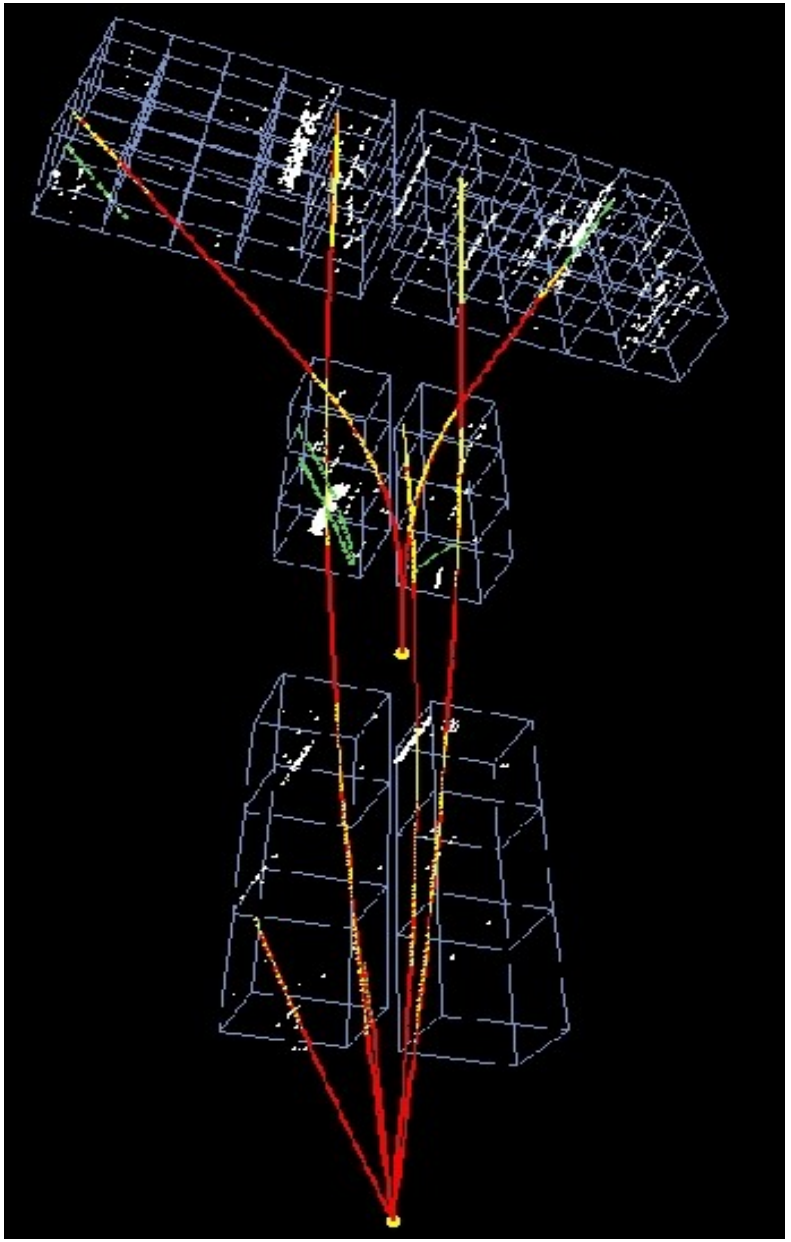
Location:

Detector



NA49: Nucl. Instrum. Meth. A430, 210 (1999)
NA61 upgrades: CERN-SPSC-2006-034, SPSC-P-330

Performance of the NA61 detector:



Results of the 2007 run:

- Large acceptance: ≈50%
- High momentum resolution:
  $\sigma(p)/p^2 \approx 10^{-4} \quad ((GeV/c)^{-1})$
  at full magnetic field
- Good particle identification:
  $\sigma(TOF) \approx 100\,ps,$
  $\sigma(dE/dx)/\langle dE/dx \rangle \approx 0.04,$
  $\sigma(m_{inv}) \approx 5\,MeV$
- High detector efficiency:
  > 95%
- Event rate:
  70 events/sec

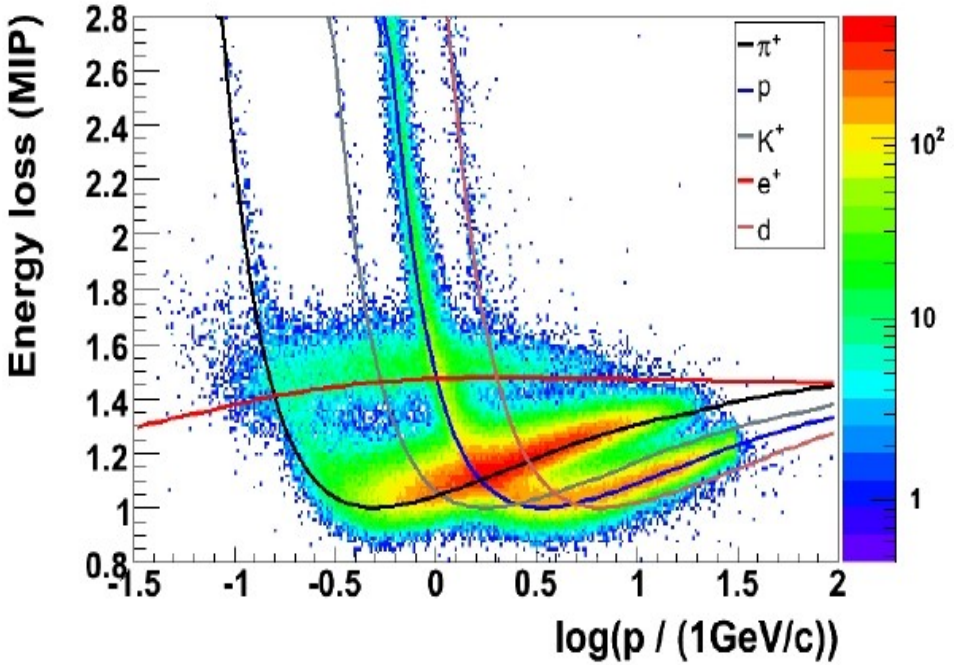
Details in: CERN-SPSC-2008-018 ; SPSC-SR-033

Performance of the NA61 detector:

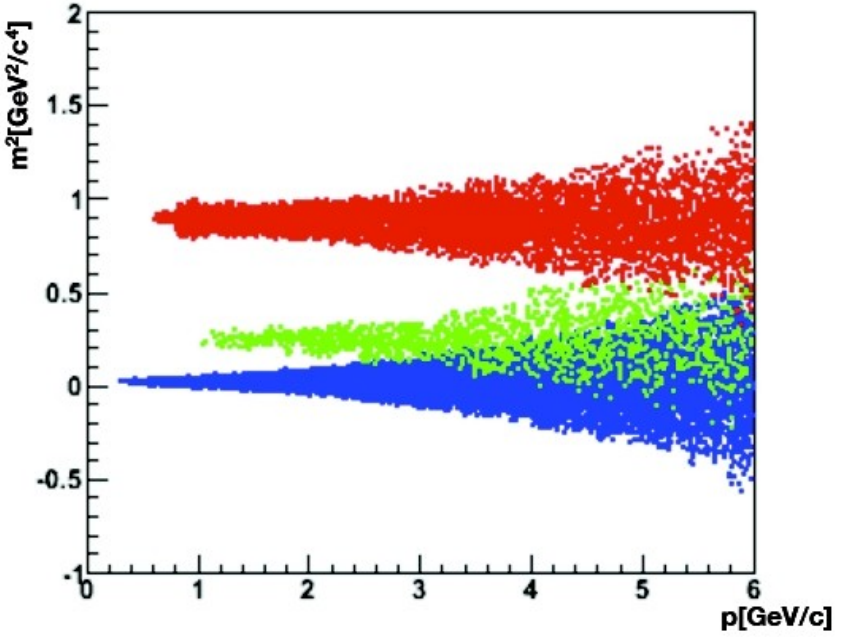
Significantly improvements in comparison to NA49

-10 times higher event rate,
-ToF acceptance extended to low momenta (≈1 GeV/c),
-projectile spectator measurements with a precision of a single nucleon
-high flexibility in selection of the wanted ion beam
-low δ-electron background

TPC dE/dx



ToF-dE/dx PID



Status and plans:

-NA61 was approved at CERN in June 2007,

-the pilot run was performed during October 2007,

-the commissioning of the TPC read-out upgrade and DAQ was performed during September 2008

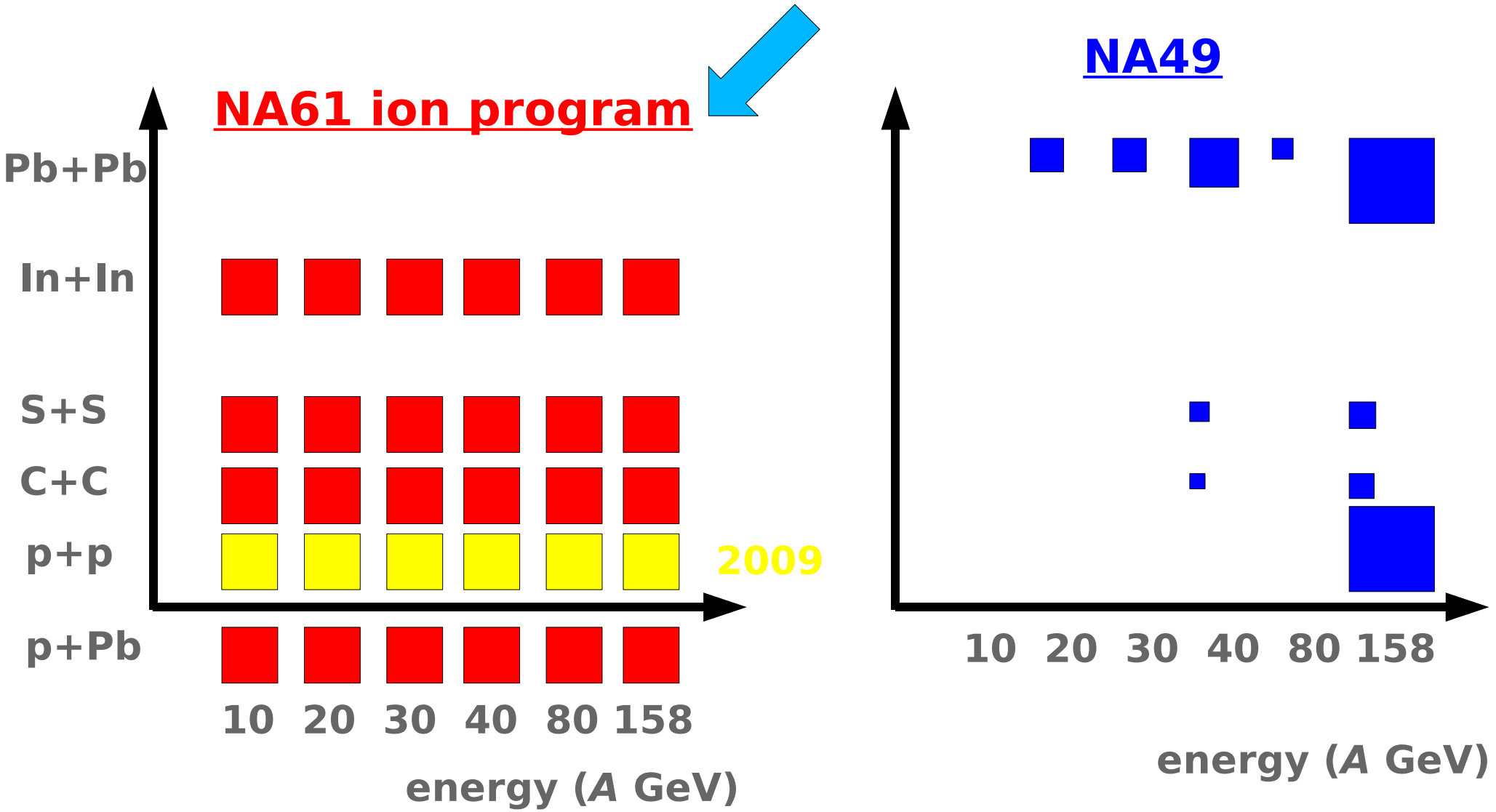
-the 2008 run has been cut due to the LHC incident

-2009-2010: runs with proton beam,

-2011-2013: runs with secondary ion beams produced from the primary Pb beam (compatibility with I-LHC is requested)

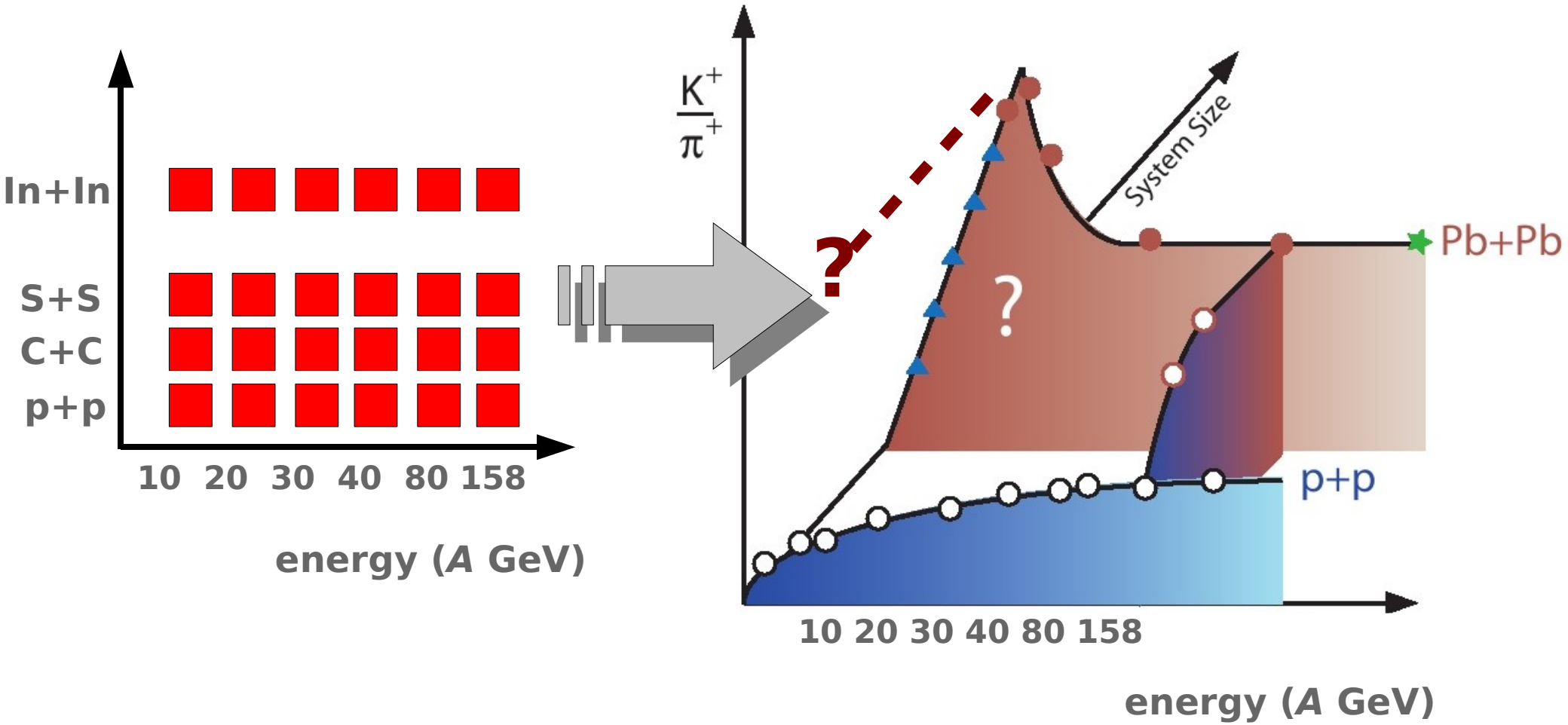
This year 4 months of the beam time,
Start of the energy-system size scan,
p+p interactions at 10, 20, 30, 40, 80 and 158 GeV

NA61/SHINE energy-system size scan



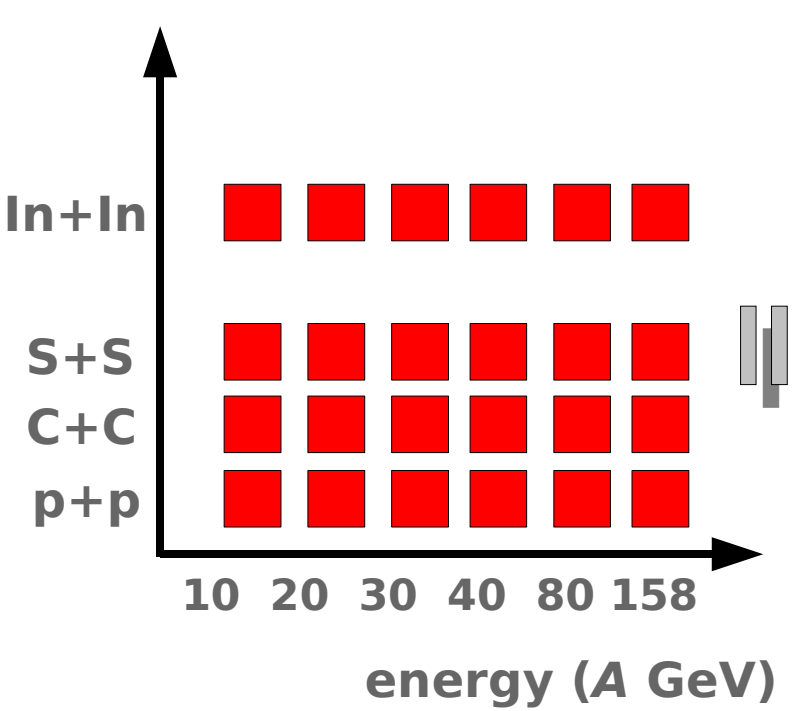
= $2 \cdot 10^6$ registered collisions

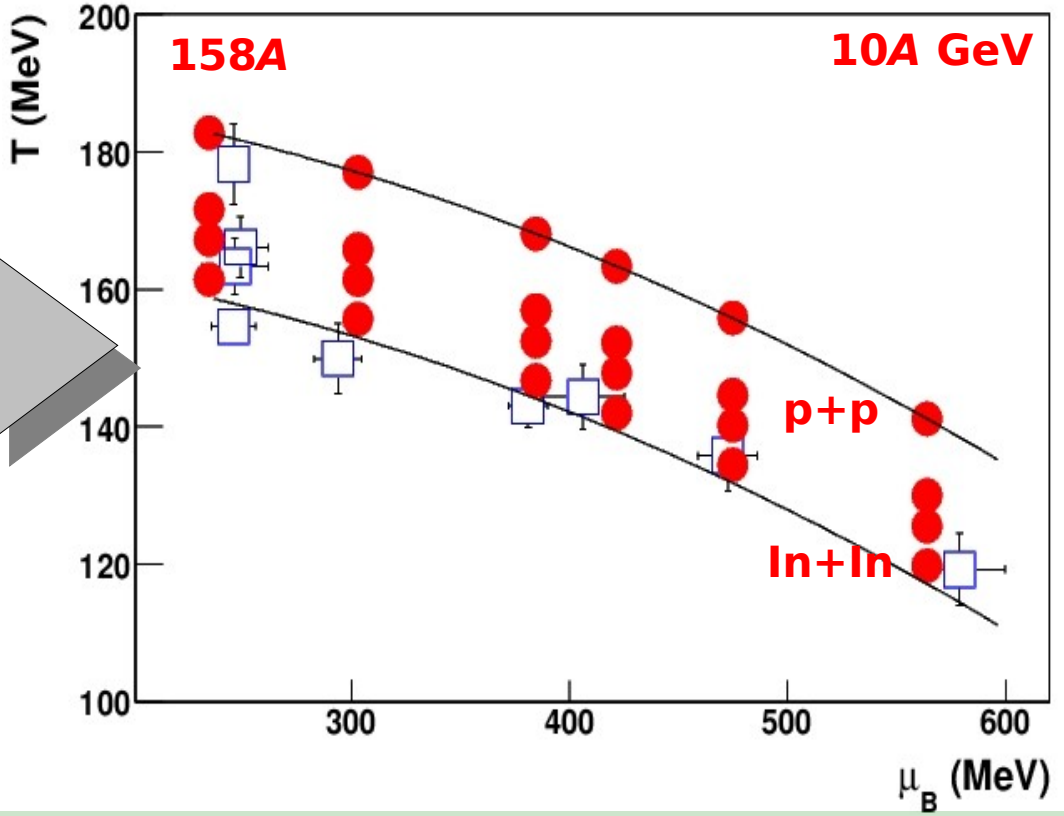
Study the onset of deconfinement

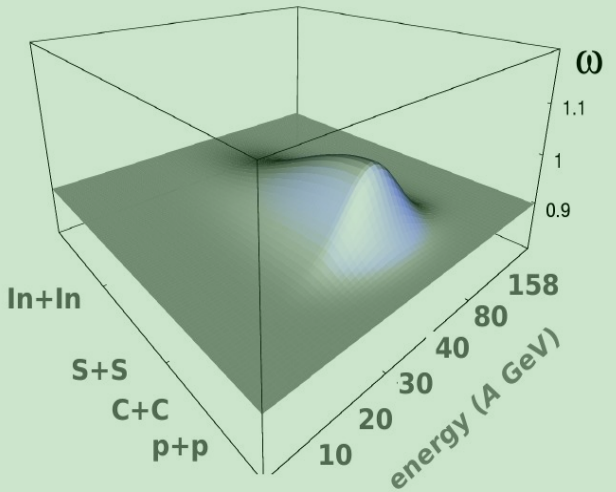


Search for the onset of the horn in collisions of light nuclei

Search for the critical point





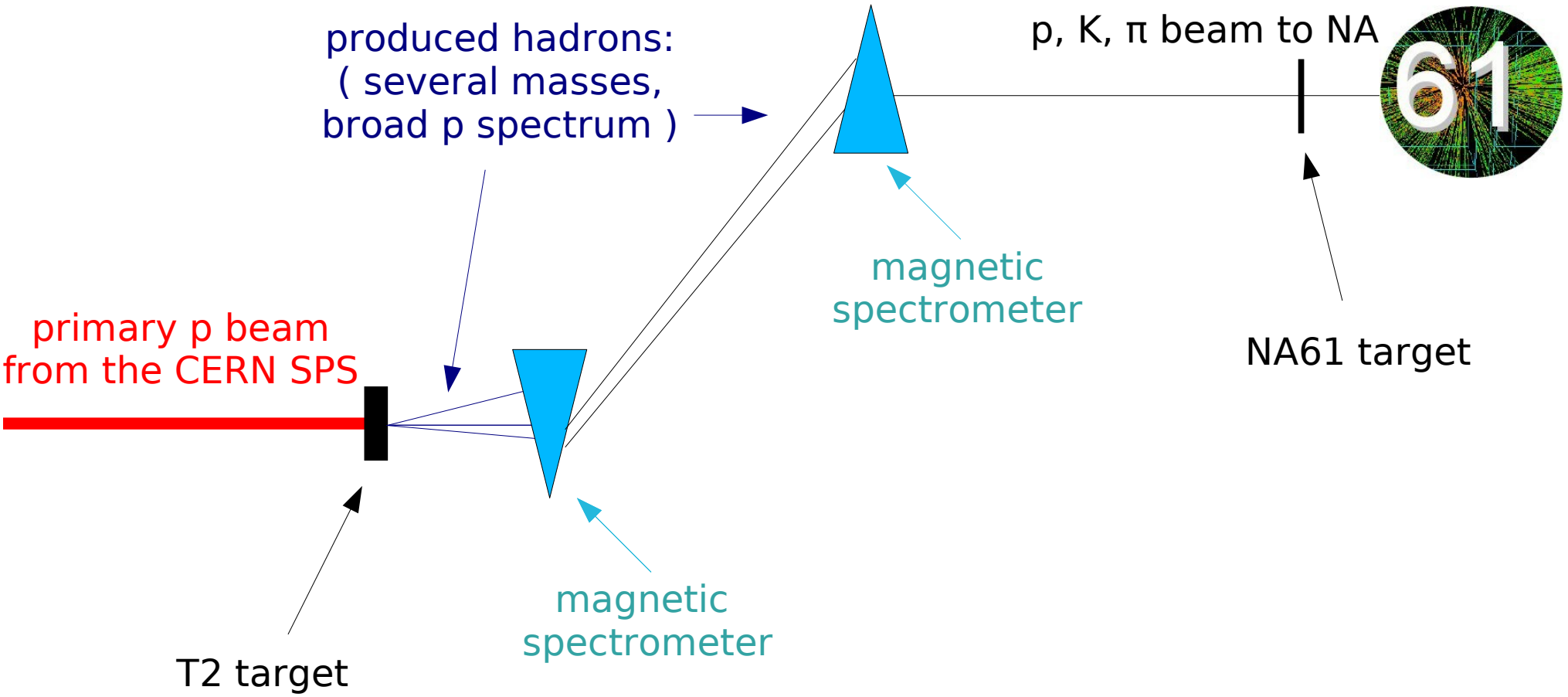


Search for the hill of fluctuations

NA61/SHINE updated beam request

Beam Primary	Beam Secondary	Target	Energy (A GeV)	Year	Days	Physics	Status
p			400				
	p	C(T2K)	31	2009	21	T2K, C-R	*recommended*
p			400				
	π^-	C	158,350	2009	2x7	C-R	*recommended*
p			400				
	p	p	10,20,30,40,80,158	2009	6x7	CP&OD	*recommended*
p			400				
	p	p	158	2010	77	High p_T	*recommended*
Pb			10,20,30,40,80,158				
	$A \approx 30$	$A \approx 30$	10,20,30,40,80,158	2011	6x7	CP&OD	*recommended*
p			400				
	p	Pb	158	2011	6x7	High p_T	*recommended*
Pb			10,20,30,40,80,158				
	$A \approx 10$	$A \approx 10$	10,20,30,40,80,158	2012	6x7	CP&OD	*to be discussed*
p			400				
	p	Pb	10,20,30,40,80,158	2012	6x7	CP&OD	*recommended*
Pb			10,20,30,40,80,158				
	$A \approx 100$	$A \approx 100$	10,20,30,40,80,158	2013	6x7	CP&OD	*to be discussed*

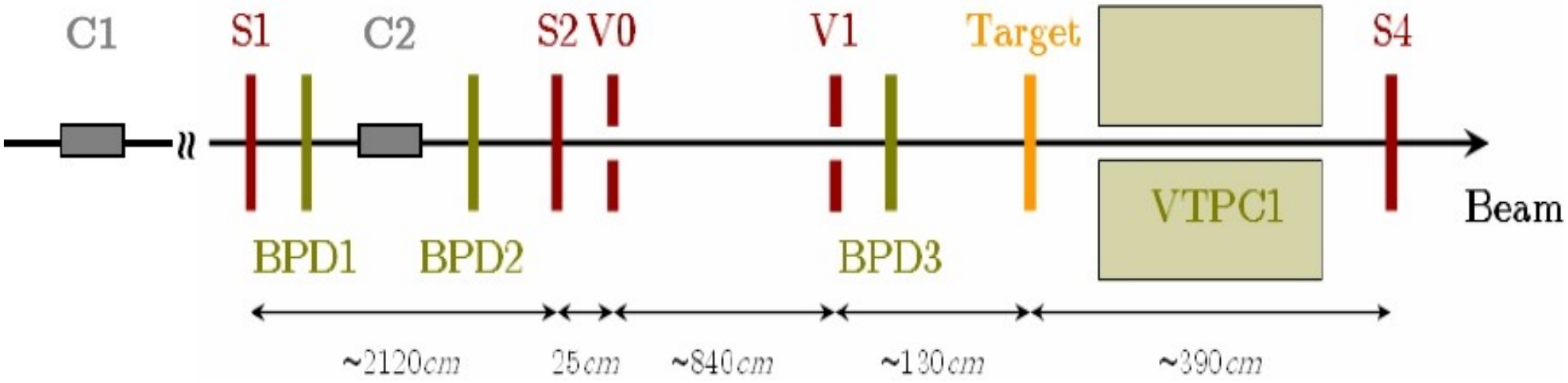
Secondary Hadron Beam Line for NA61:

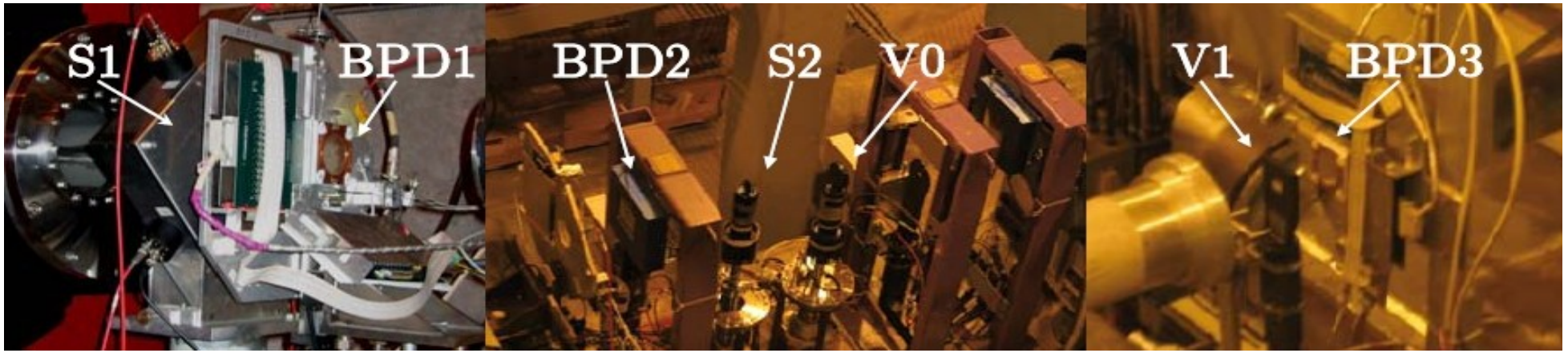


-selects beam of hadrons with a fixed p momentum
-further hadron identification possible by mass measurements

Secondary hadron beam in NA61:

Beam and trigger counters

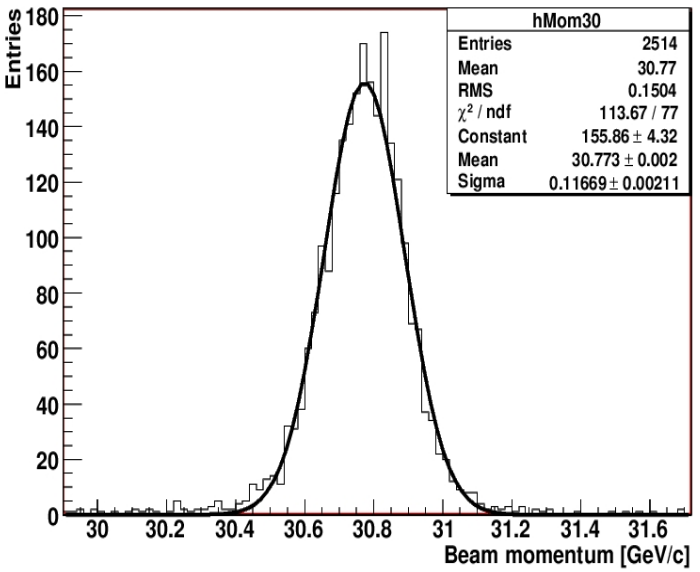




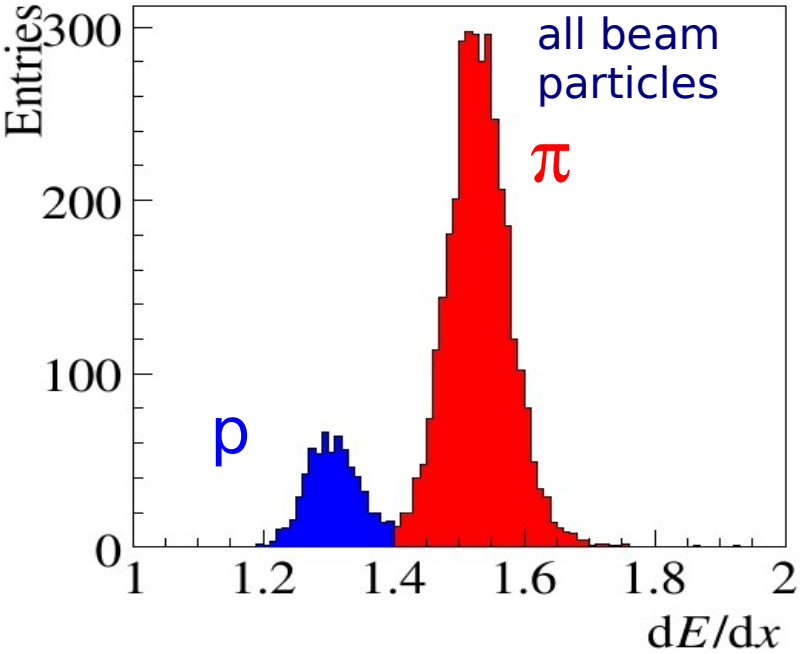
C1 and C2 - proton identification,
S1, S2, V0, V1, BPD1/2/3 – determination of proton trajectory,
S4 – selection of p+target interactions

Example: beam of positively charged hadrons at 31 GeV/c

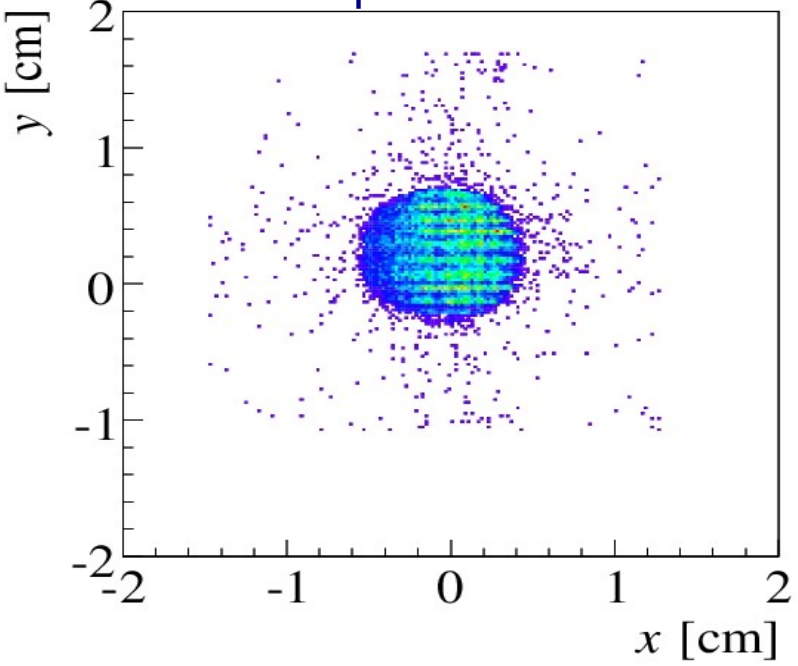
momentum from TPC

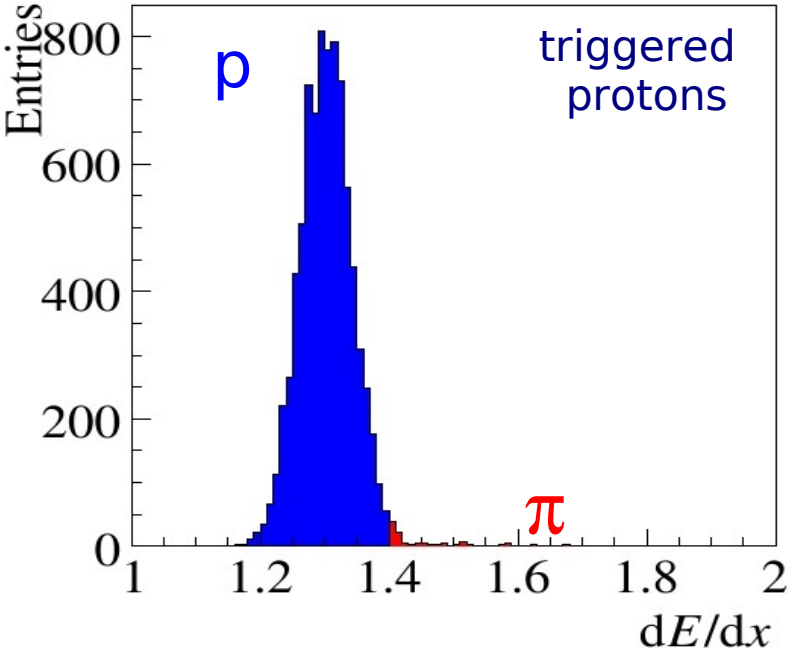


dE/dx from TPC



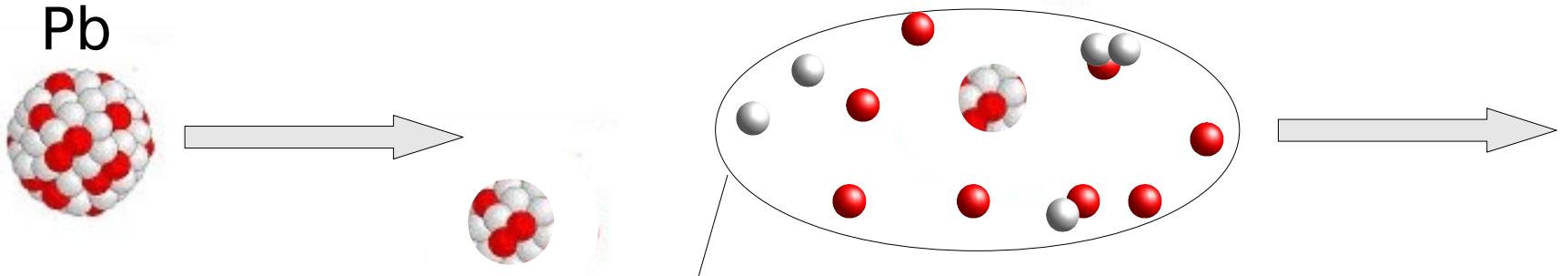
beam spot from BPD-3





Secondary Ion Beam Line for NA61:

The basic idea

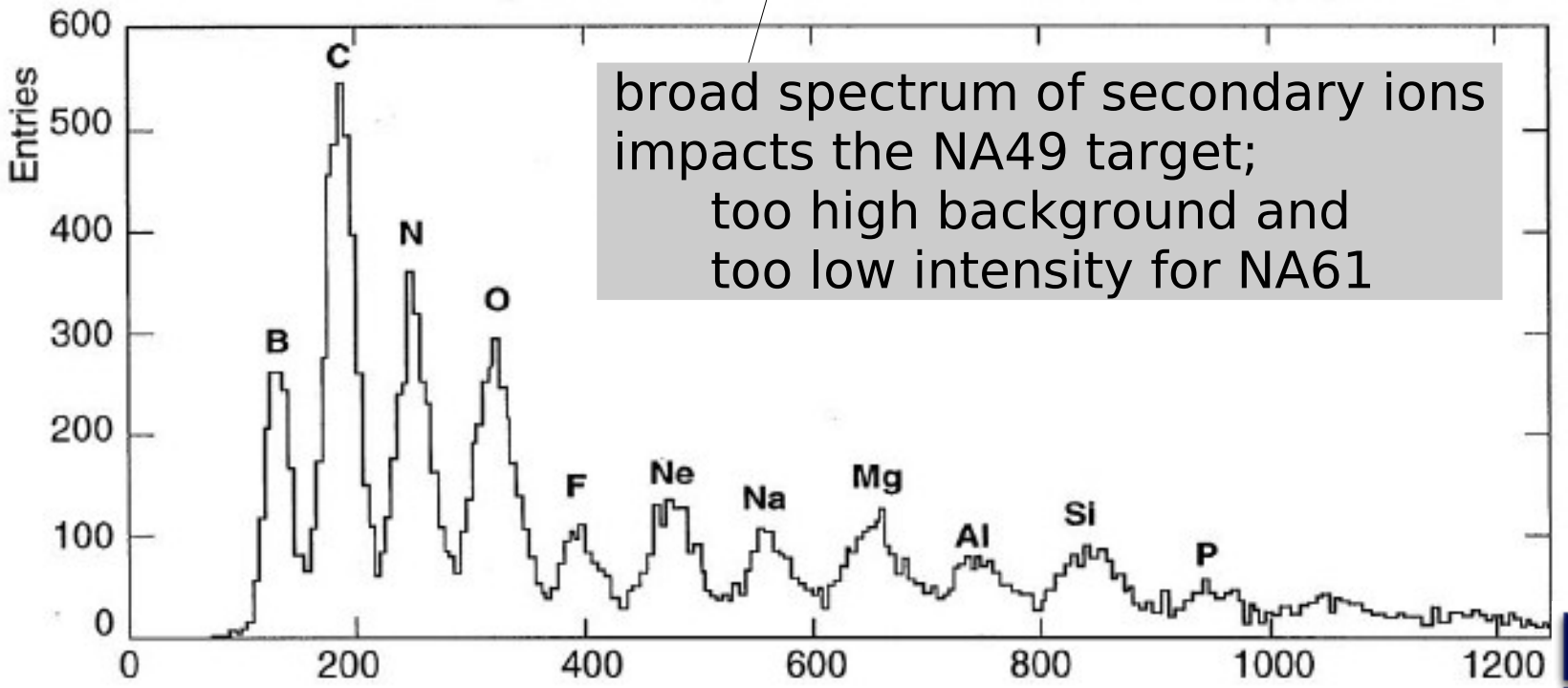


primary Pb beam from the SPS

fragmentation target

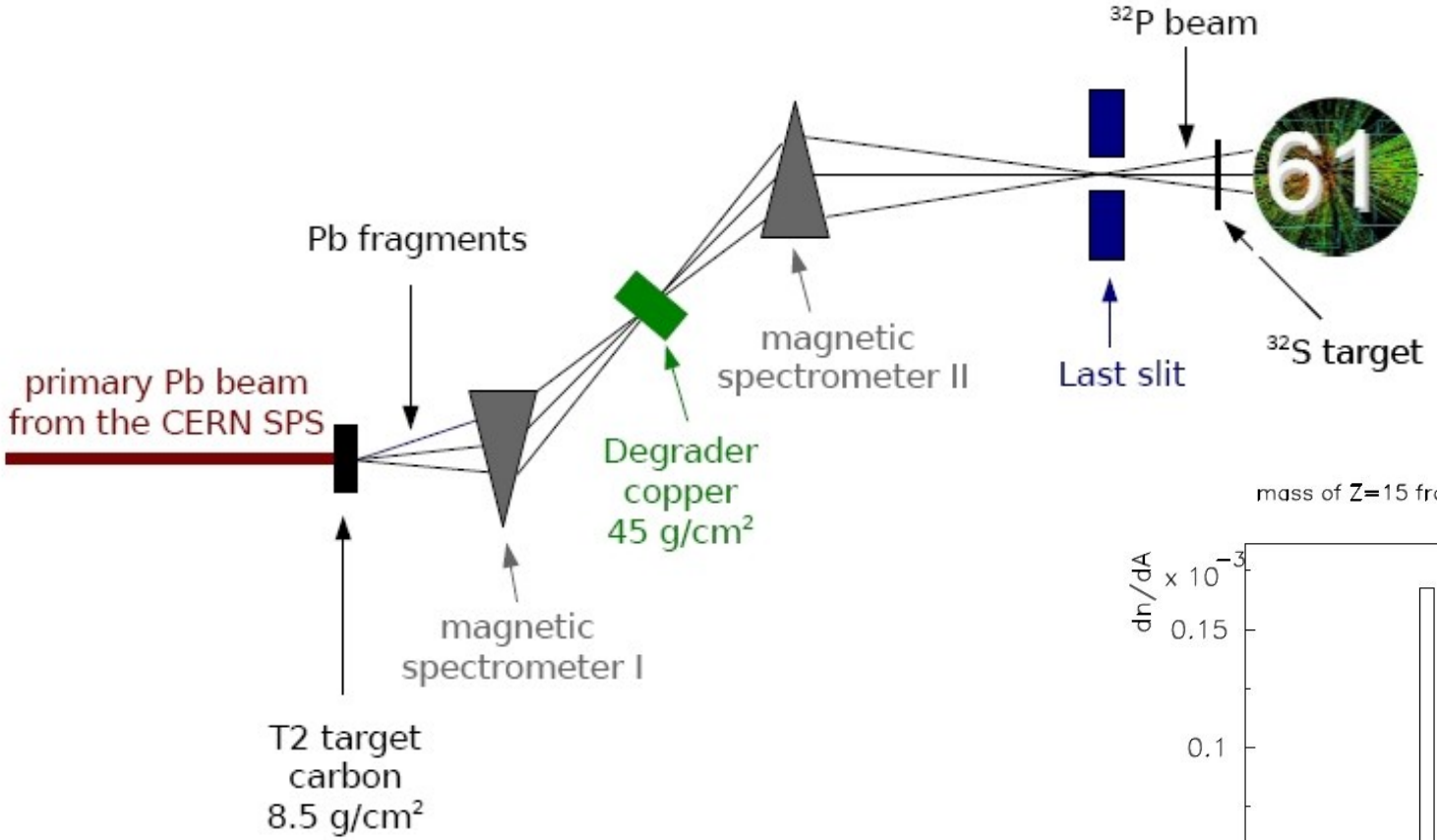
secondary light ion beam to NA49

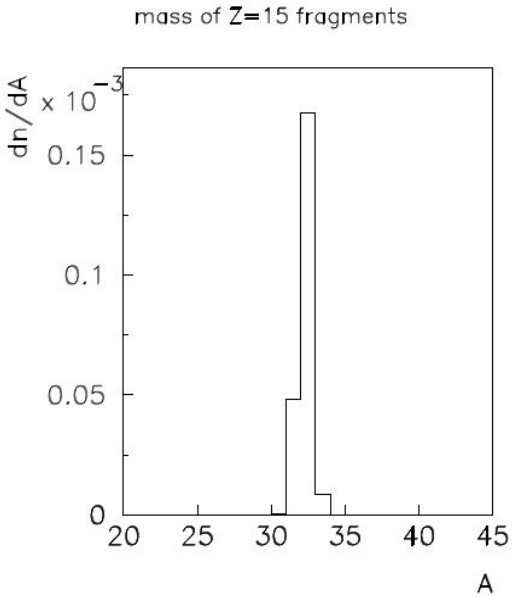
The pilot NA49 studies



broad spectrum of secondary ions impacts the NA49 target;
too high background and
too low intensity for NA61

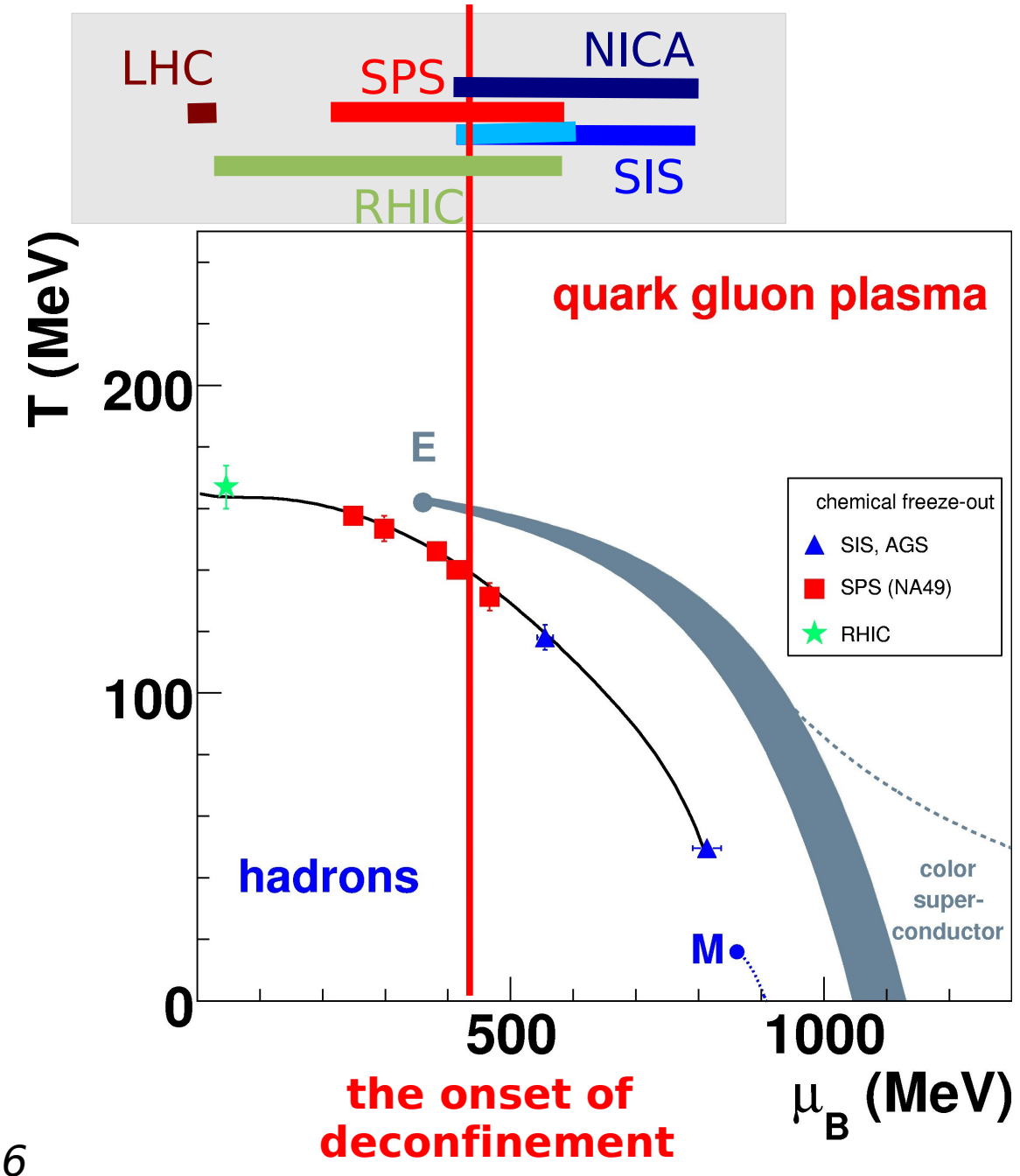
Secondary Ion Beam Line for NA61:





-selects beam of nuclei with close Z and A,
-further ion identification possible by Z (charge) measurements
-momentum per nucleon cannot be changed

Conclusions:



the onset of deconfinement

New period in the experimental study of A+A collisions at the SPS energy range starts this year with the p+p energy scan of NA61/SHINE at the CERN SPS

We looking forward for start of the corresponding programs at RHIC, NICA and FAIR as well as for exciting first data from the CERN LHC

Additional slides

The HOLE-JET transition:

Next evidence for the onset of deconfinement?

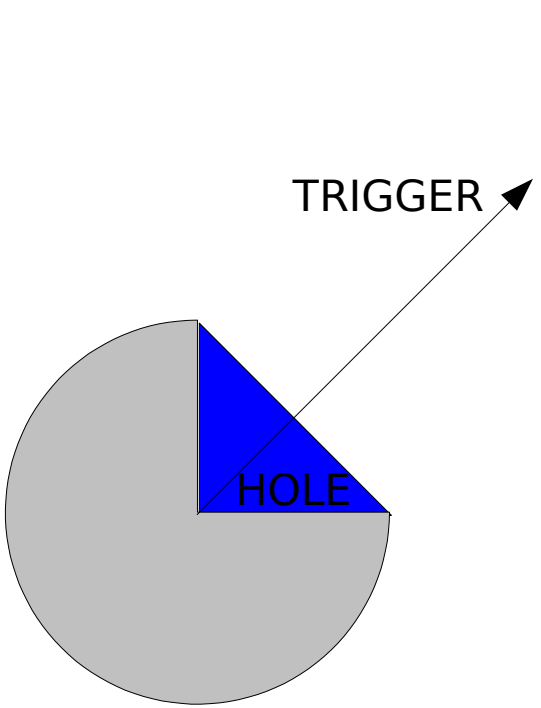
Base on statistical approach to strong interactions

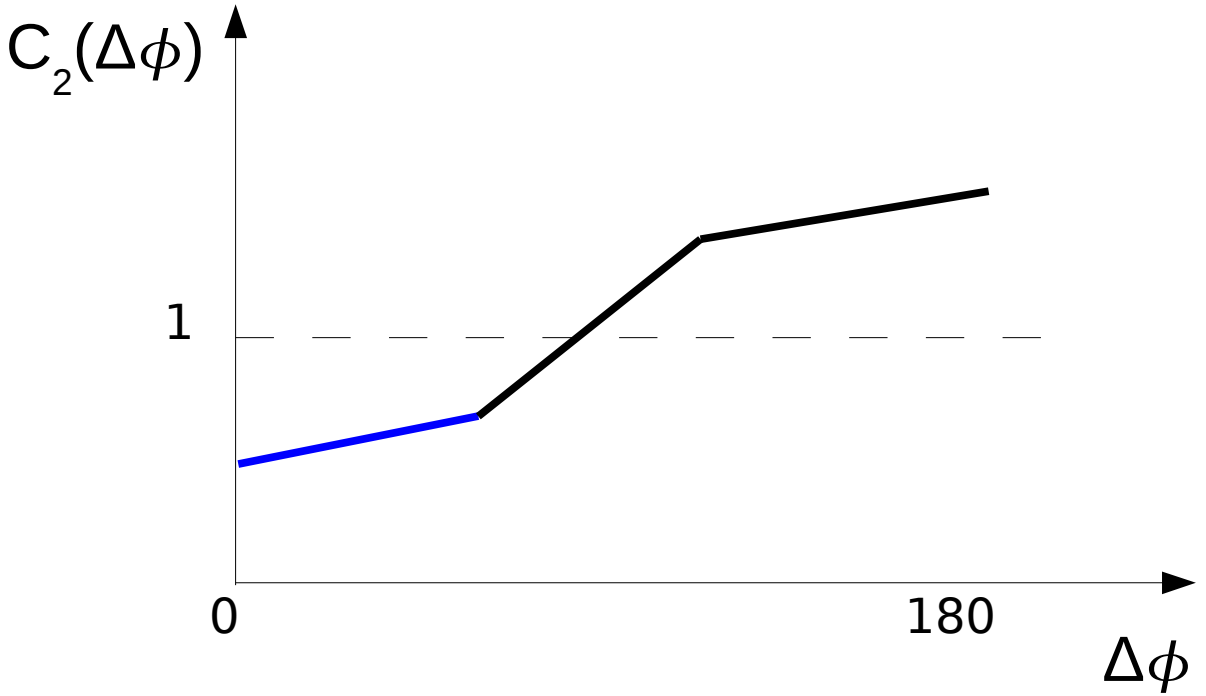
Acta Phys.Polon. B30:2705, 1999.
Phys.Rev. C78:024904, 2008.

HADRON GAS – a system of hadrons close to equilibrium

HOLE – a medium range anti-correlation of hadrons with a high transverse momentum hadron

The HOLE effect appears in the MCE HG model as a consequence of transverse momentum conservation (Borghini, Hauer)

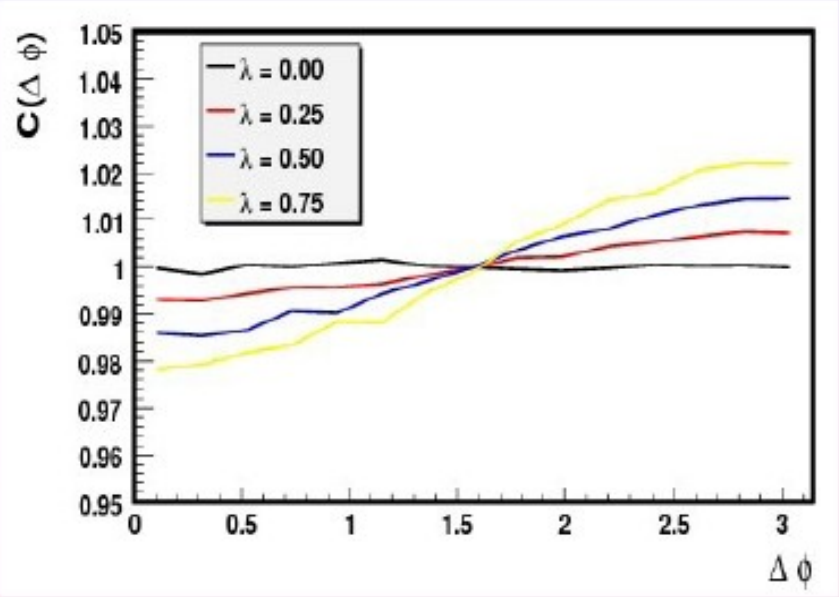




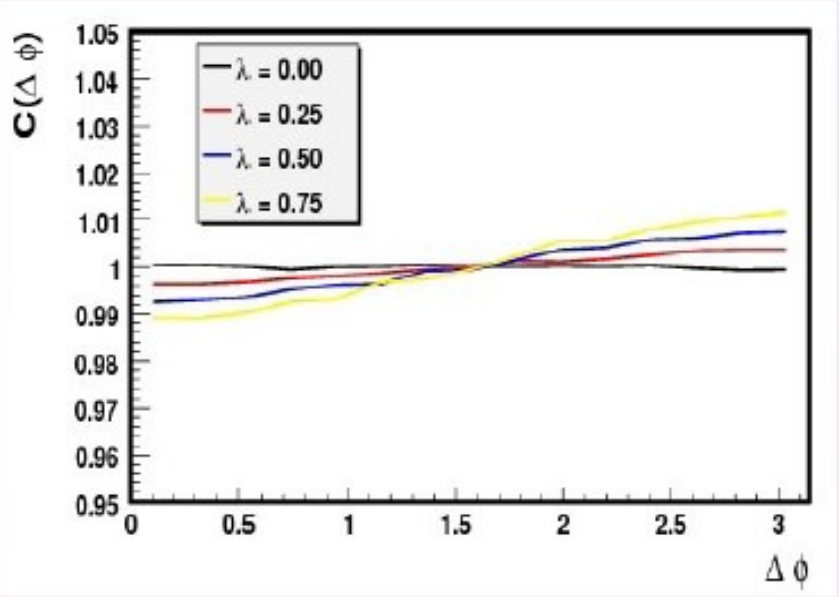
After Michael Hauer

2 Particle Correlation Function

$V = 1000 fm^3$



$V = 2000 fm^3$



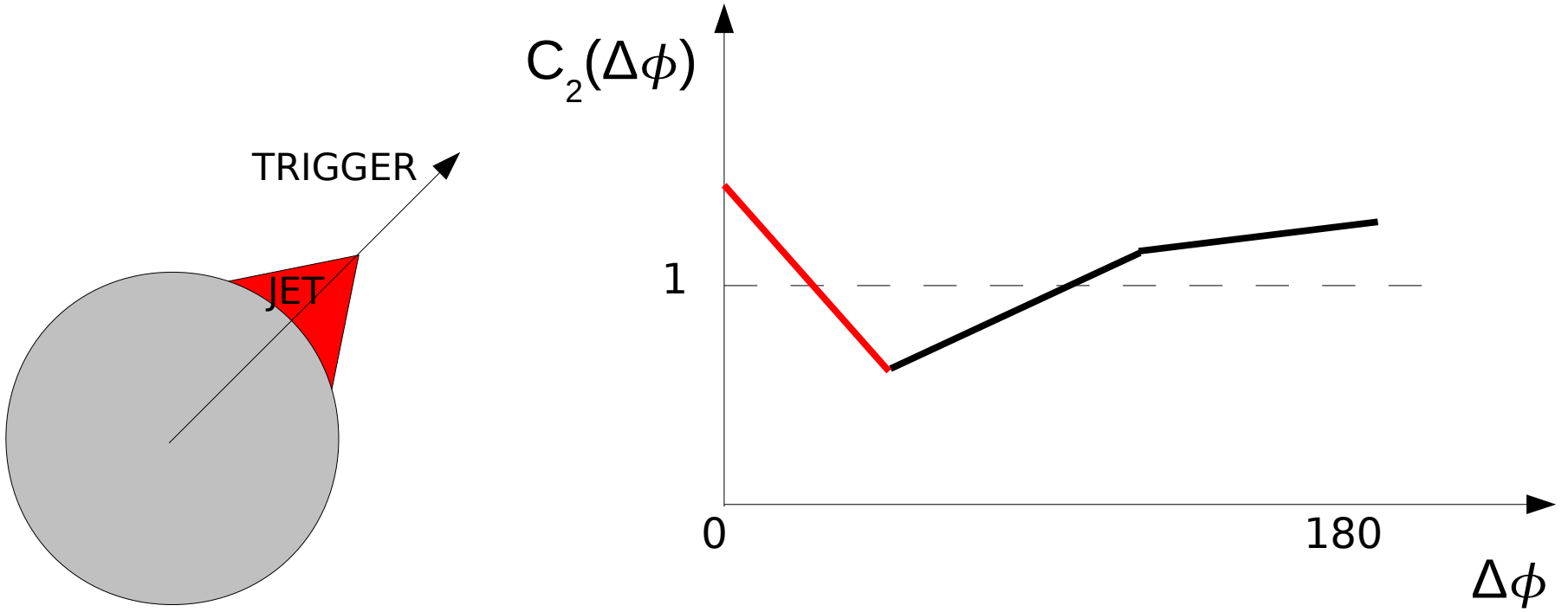
$0.0 GeV < p_T^{asso} < 1.0 GeV$ and $1.0 GeV < p_T^{trigger} < 4.0 GeV$

The re-weighting was done w.r.t. Q, E, P_x, P_y, (but not P_z)

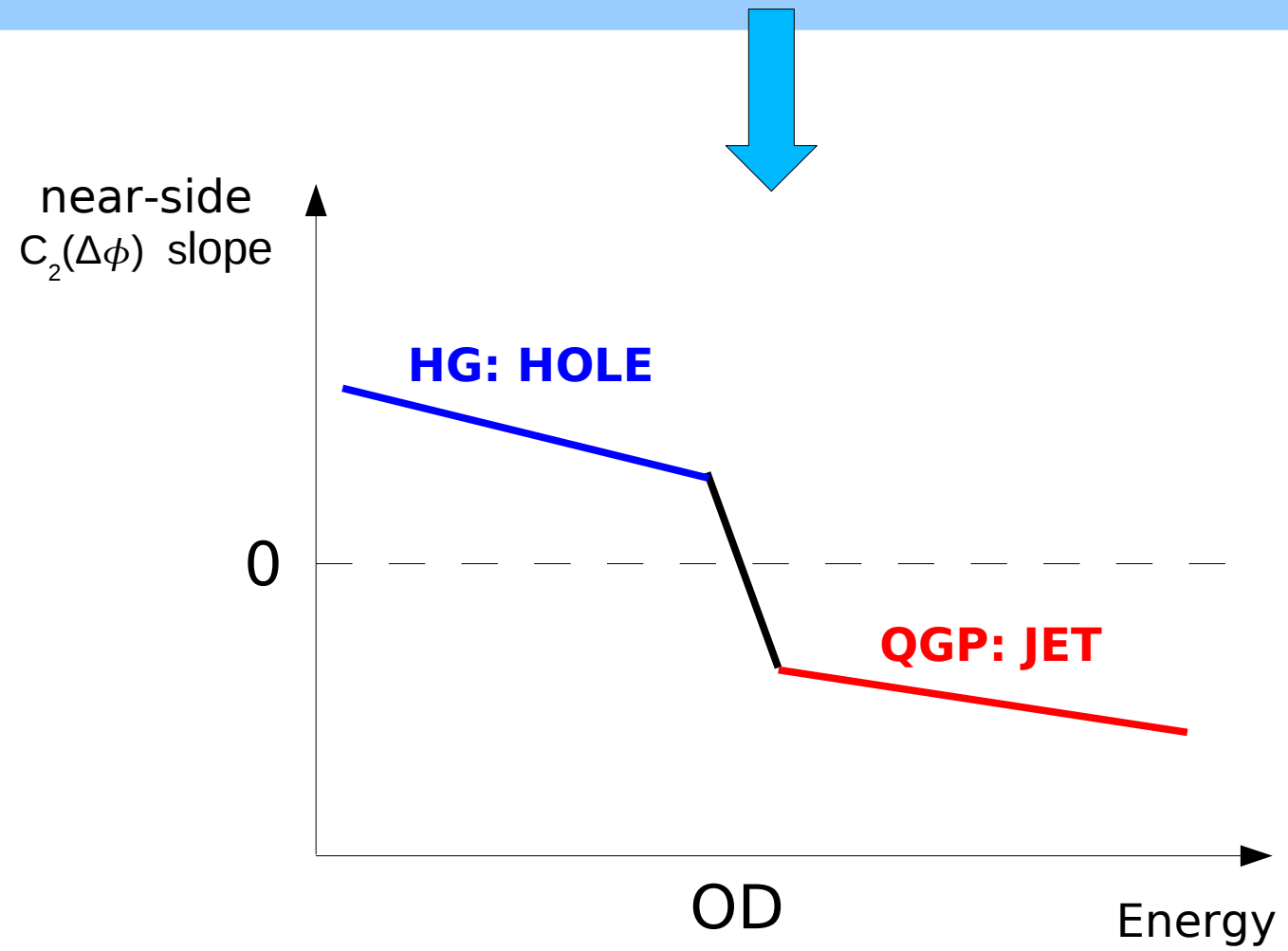
QGP – a system of quarks and gluons close to equilibrium

JET – a medium-range correlation of hadrons with a high transverse momentum hadron

The JET effect appears as a consequence of the evolution and hadronization of the QGP quarks and gluons with high transverse momenta



Onset of Deconfinement – threshold for QGP production in collision energy



Comparison of two approaches

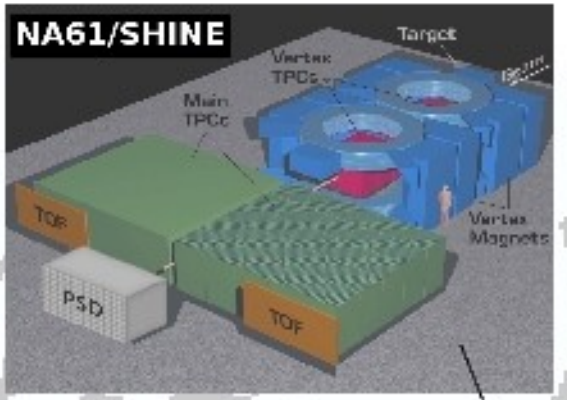
	statistical	dynamical
Jet:	evolution and hadronization of high p_T parton	evolution and hadronization high p_T parton
High p_T parton:	statistical fluctuation	hard parton-parton scattering
Hole-Jet transition:	onset of deconfinement	onset of hard parton-parton scattering
Away-side enhancement:	global momentum conservation	away-side jet quenching
Power law p_T spectra:	scaling volume fluctuations	dynamics of parton-parton scattering

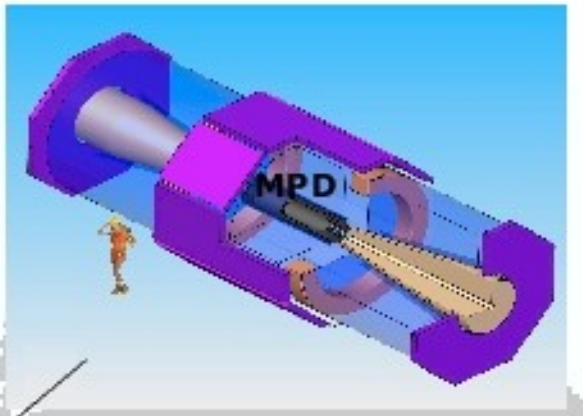
Experimental landscape of complementary programs of nucleus-nucleus collisions around the SPS energies

Facility:	SPS	RHIC	NICA	SIS-100 (SIS-300)
Exp.:	NA61	STAR PHENIX	MPD	CBM
Start:	2011	2011	2014	2014 (2016)
Pb Energy: (GeV/(N+N))	4.9-17.3	4.9-50	≤9	≤5 (<8.5)
Event rate: (at 8 GeV)	100 Hz	1 Hz(?)	≤10 kHz	≤10 MHz
Physics:	CP&OD	CP&OD	OD&HDM	HDM (OD)

CP – critical point
OD – onset of deconfinement, mixed phase, 1st order PT
HDM – hadrons in dense matter

Experimental landscape: the complementary programs





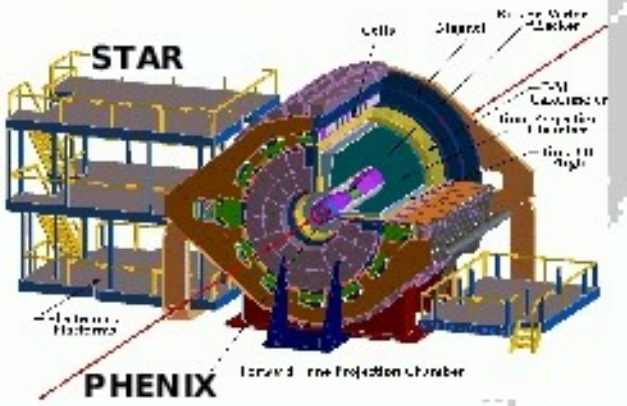
NICA

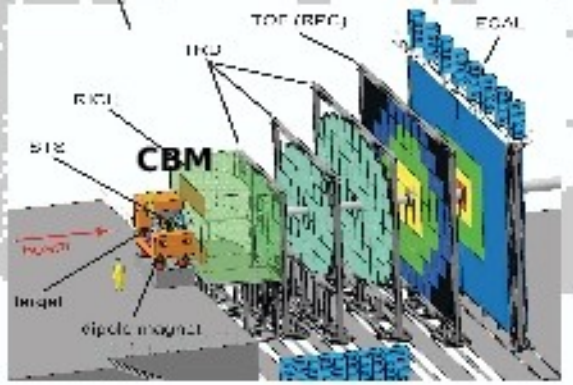
SIS

SPS

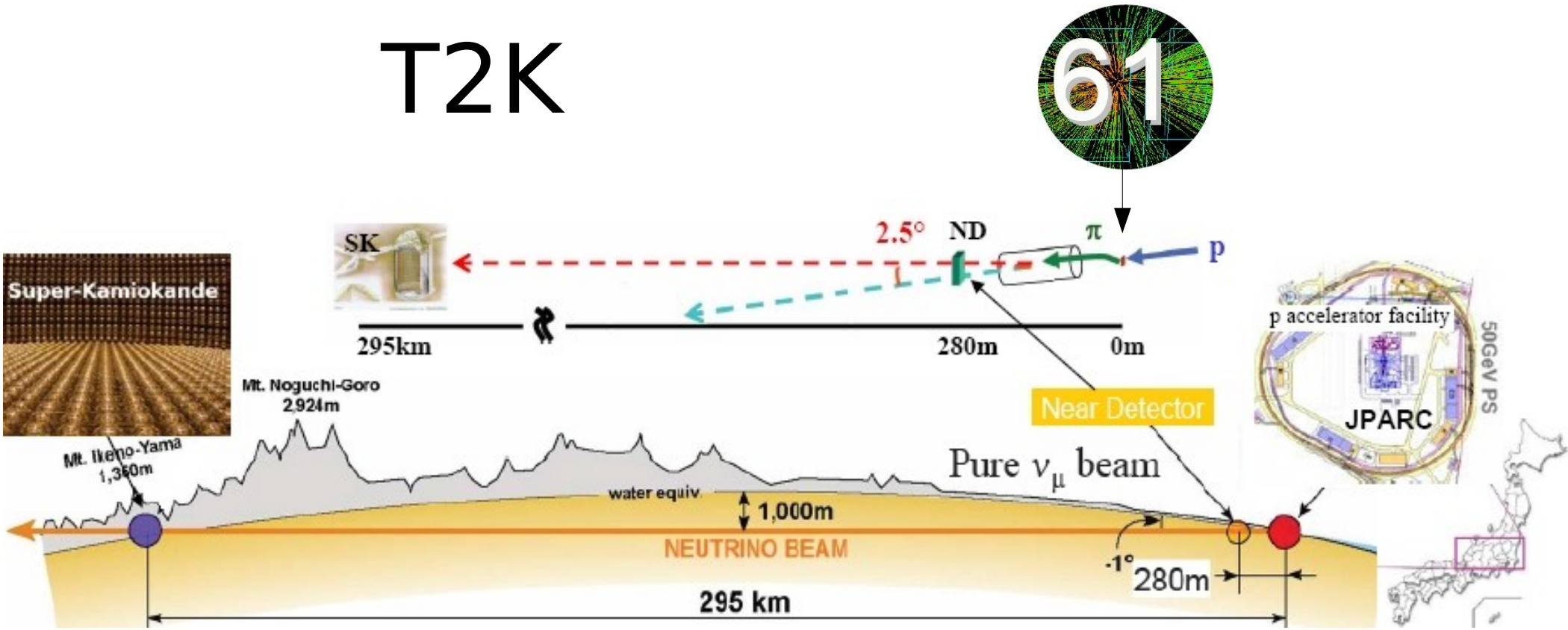
RHIC

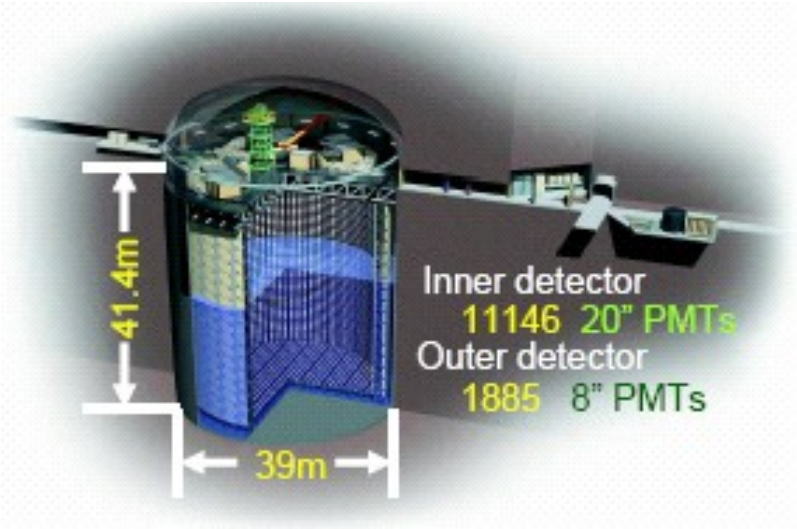
STAR Detector





T2K


Super-Kamiokande
SK
2.5°
ND
π
p
295km
280m
0m
Mt. Noguchi-Goro
2924m
Mt. Ikeno-Yama
1,350m
Near Detector
p accelerator facility
JPARC
50GeV PS
Pure ν_μ beam
water equiv.
1,000m
NEUTRINO BEAM
-1°
280m
295 km


41.4m
39m
Inner detector
11146 20" PMTs
Outer detector
1885 8" PMTs


Hadron Experimental Facility
Materials and Life Science Facility
3 GeV Synchrotron
Neutrino Facility
50 GeV Synchrotron
Linac
Accelerator-Driven
Transmutation Experimental Facility