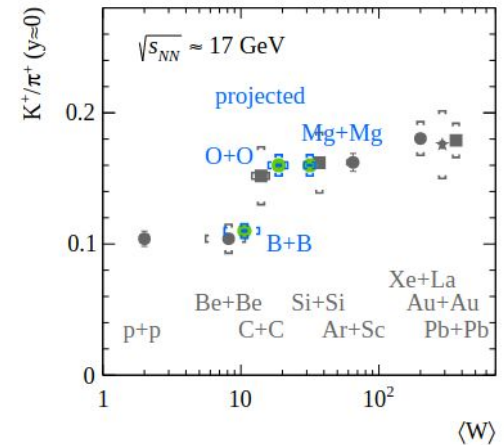
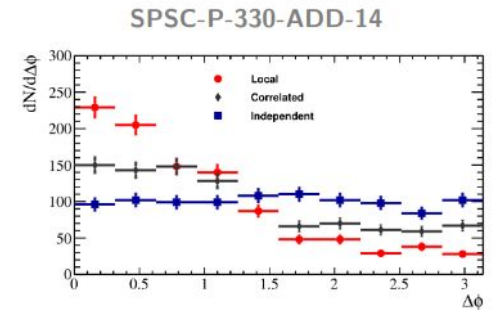


# NA61/SHINE future plans

- precision studies of **the onset of fireball** of strongly interacting matter with O, Mg, and B beams
- verification of the hypothesis of **large isospin violation** with **N=Z** nuclei (the simplest case) - O and Mg
- **charm and anti-charm correlations** in central Pb+Pb collisions at 150A GeV/c with LAST (data rate ↗ 10 kHz)



	SIS18 / SIS100		SPS		RHIC STAR	LHC ALICE / ALICE3
	HADES	CBM	NA61/SHINE	NA60+		
Domains of heavy-ion physics	Properties of dense hadronic matter		Onsets of deconfinement and fireball Critical point		Properties of dense quark-gluon plasma	
$\sqrt{s_{NN}}$ (GeV)	1.9 – 4.9	2.7 – 4.9	5.1 – 17.3	6.3 – 17.3	3 – 200	2760 – 5440
Start date	running	2028	running	>2029	running	running / 2035
			light ions	Pb+Pb		
Bulk properties	+	+	+	+	+	+
E-by-E fluctuations	+	+	+	+	+	+
Resonances	+	+	+	+	+	+
Open charm			+	+	+	+
$c - \bar{c}$ correlations				+	only top energy	+
Quarkonium	+	+		+	+	+
Dileptons	+	+		+	+	+



M. Gazdzicki et al., arXiv:2305.00212  
[hep-ph]

# For discussion - NA60+

Physics questions → the 4 (main) pillars

## Caloric curve of QGP

→ Measurement of temperature of thermal dimuons vs  $\sqrt{s_{NN}}$

## Chiral symmetry restoration

→  $\rho$ - $a_1$  mixing in the dimuon channel

## QGP transport coeff. and charm hadronization

→ Hadronic decays of open HF mesons/baryons

## Charmonium melting in the QGP

→ Charmonium suppression vs  $\sqrt{s_{NN}}$   
(dimuon decay channel)

Almost unexplored observables  
below top SPS energy  
Characterization of high- $\mu_B$  QGP  
Nature of the QGP phase transition

Experimental aspects

**Coupling state of the art and well-tested detector techniques** → strategic collaboration with ALICE ITS3 project for vertex spectrometer, use of (large) facilities for construction of muon detectors

**Measurement of rare probes** → need high luminosity and focused Pb and proton beam from low to top SPS energy  $\sim 10^7$  Pb/spill,  $> 5 \cdot 10^8$  p/spill

**Completely new experiment** → address significant integration issues to adapt the experimental hall, transport/install large equipments (magnets)

Good progress on all these aspects also thanks to significant CERN support in the frame of PBC, several aspects still being assessed

# Summary

- CBM will explore the high  $\mu_B$  region of the QCD phase diagram starting 2028
- Excitation function for dileptons, e-b-e fluctuations, strangeness
- Importance of transport theory for evolution of fireball at moderate beam energies
- Complementary program using proton beam with focus on strangeness baryons and charm (meson-baryon coupling) - see White Paper "QCD at FAIR" (coming soon)
- Long term view is installation of second (stretcher) ring for higher energies and efficient parallel operation with storage ring experiments. Opens charm physics, more reach in CEP search
- Perspective for a multi-purpose experiment using relativistic radioactive beams
- Strong interest in developments of silicon pixel sensors (high timing precision and radiation hardness)