

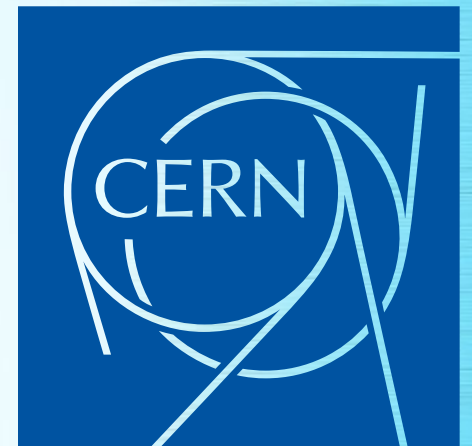
NA61/SHINE: PHYSICS AND FACILITY BEYOND 2020

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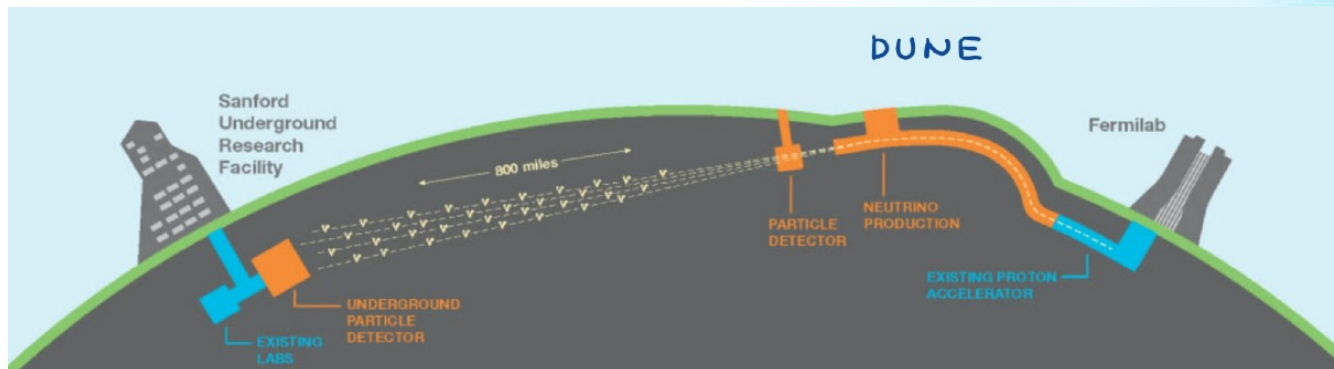
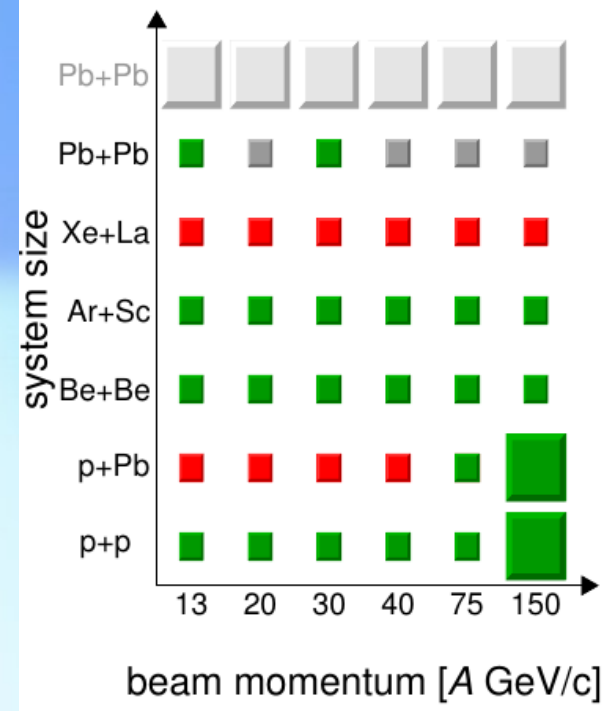


NA61/SHINE: Physics

- NA61/SHINE – unique multipurpose facility for measurements of hadron production in $h+p$, $h+A$ and $A+A$ interactions at $13A-150A$ GeV/c
- Approved physics program covers measurements for:
 - Strong Interactions
 - Neutrinos
 - Cosmic-Rays

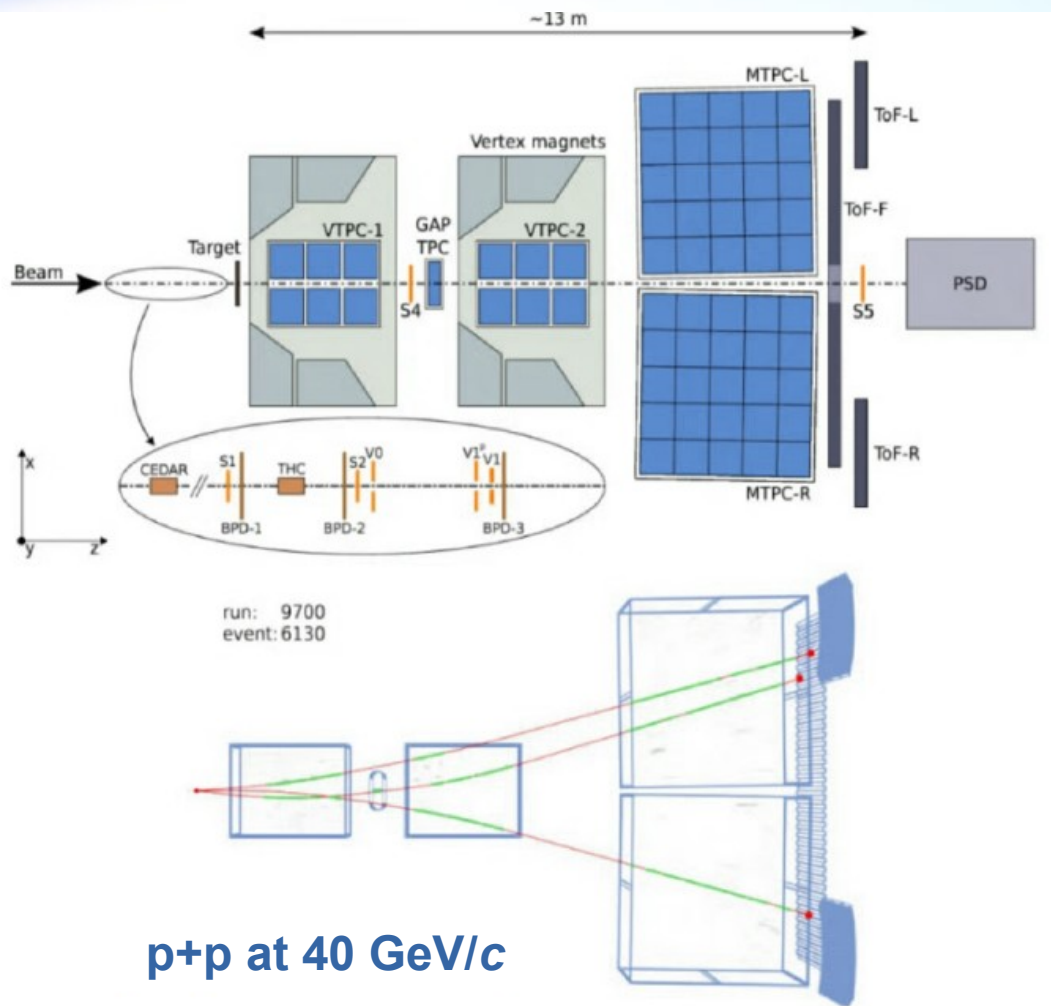
NA61/SHINE: Physics

- Strong interactions:
 - Study of the onset of deconfinement
 - Search for critical point
- Neutrinos:
 - Hadron production measurements for T2K
 - Hadron production measurements for FERMILAB neutrino beams



- Cosmic-rays:
 - Hadron and resonances production in $\pi^- + C$ interactions for extensive air shower modeling

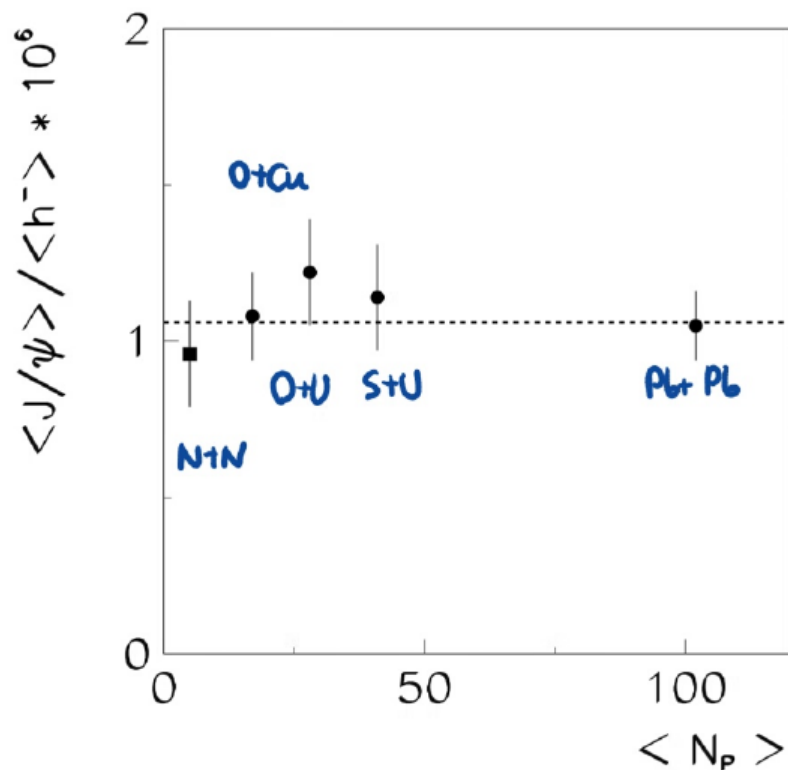
NA61/SHINE: Facility



- A large acceptance hadron spectrometer
- Charged particles measured in 5 TPCs
- PID via dE/dx and tof
- Centrality measured by Projectile Spectator Detector
- Precise vertexing via Small Acceptance Vertex Detector

NA61/SHINE measurements beyond 2020

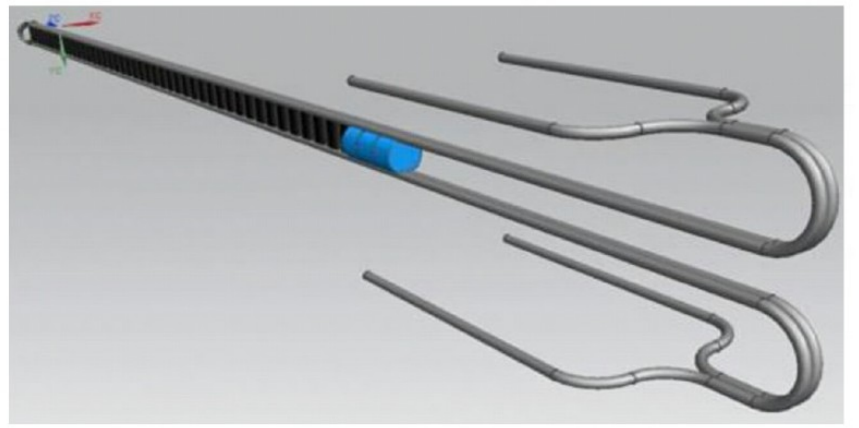
- Strong interactions:
 - Open charm and multi-strange hadron production - statistical vs dynamical models
 - Pb beams at 13A–150A GeV/c



- Data agree with statistical J/ψ production (PRL 83(1999)4009)
- To test predictions of pQCD-based models measurement of open charm yield is needed (Acta Phys.Pol. 7(2014)49)

Ideas for measurements beyond 2020

- NA61/SHINE measurements with thin and replica T2K targets demonstrated need for precise data on hadron production from the surface of the replica target
- Measurements for DUNE and HyperK experiments with protons beam at 20–120 GeV/c
- A prototype DUNE target will not be ready before LS2



A NUMI-like DUNE target design
47 graphite segments
each 2 cm long, spaced 0.2 mm apart
target core length 95 cm

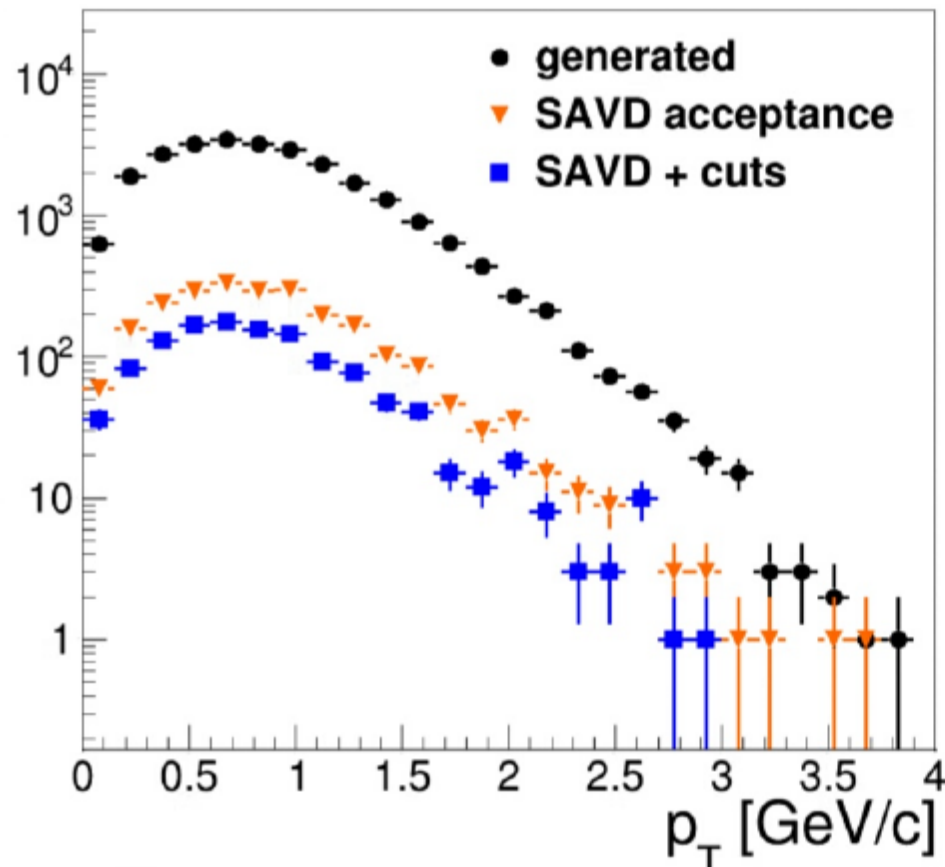
Required facility upgrades

- Increase event rate from 100 Hz to 1kHz
- Increase acceptance of vertex detector from total surface of 32 cm² to at least 240 cm²
- Precise tracking along DUNE, HyperK targets

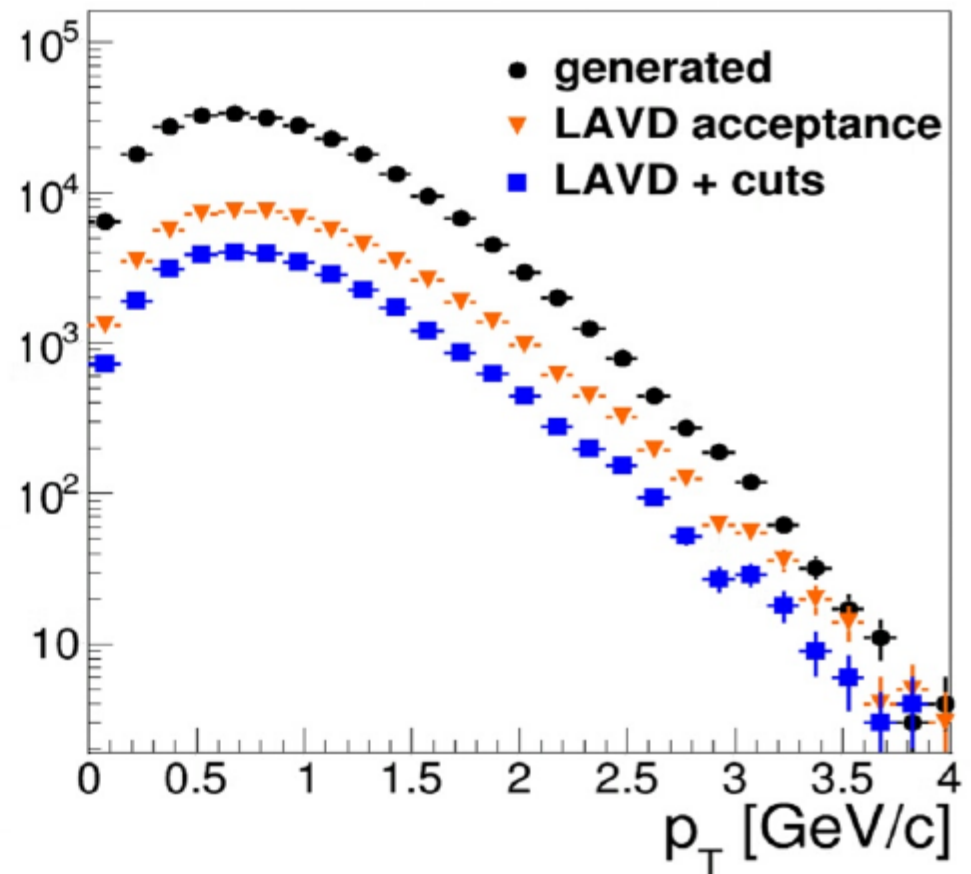
Example: $D^0 + \bar{D}^0$ in central Pb+Pb at 150A GeV/c

10 days in 2018

10 days in 2020+



$\approx 4000 D^0$ in 4M events

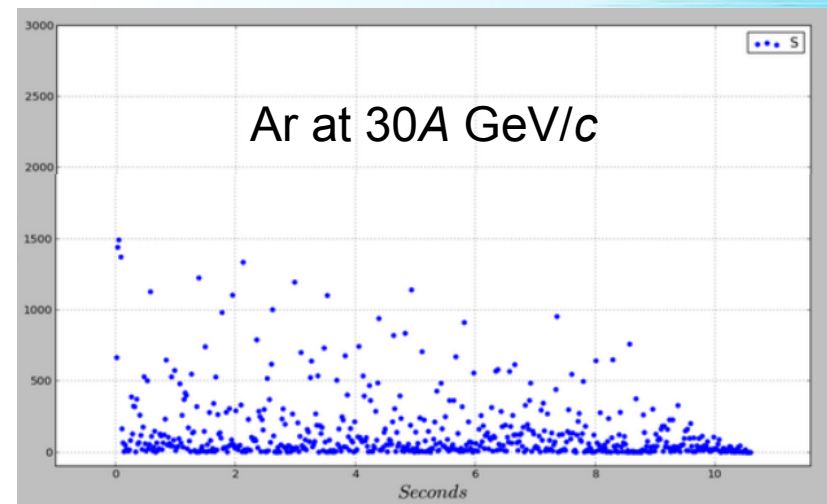
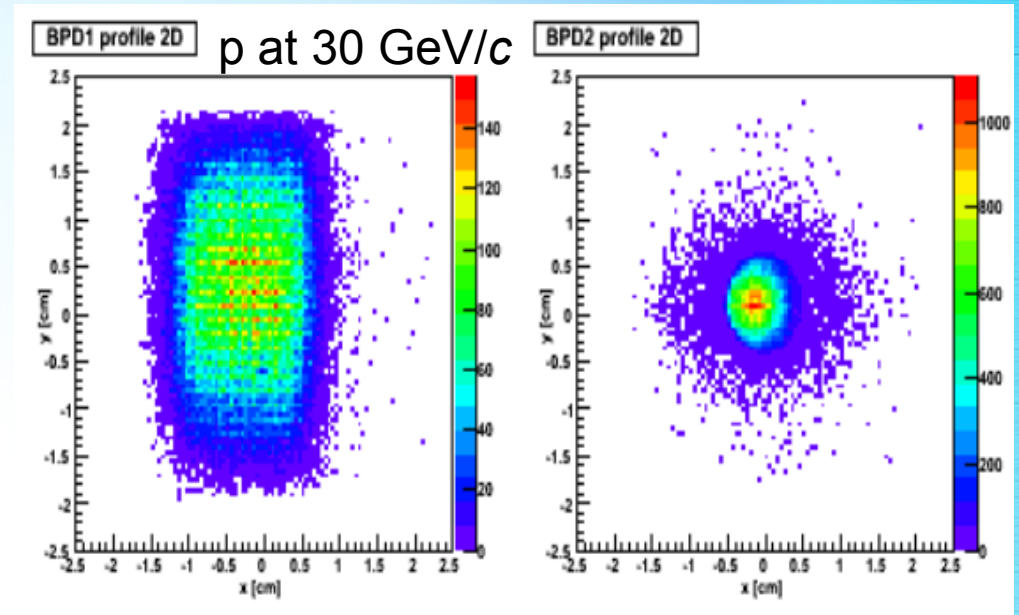


$\approx 40000 D^0$ in 40M events

... and about $1000 D^0 + \bar{D}^0$ in Pb+Pb at 40A GeV/c

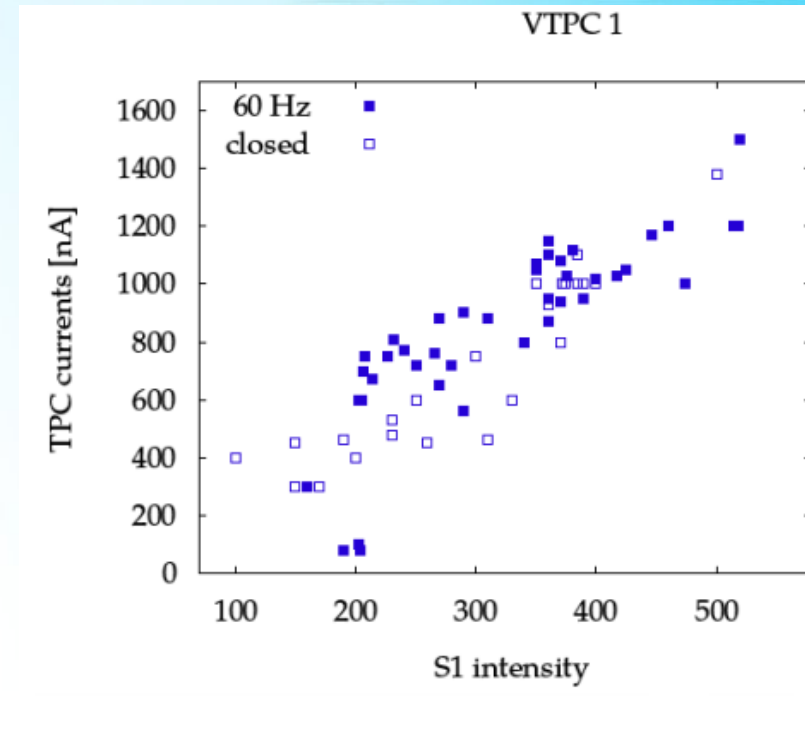
Requested beam properties

- **Beams:**
 - Protons at 20–120 GeV/c
 - Pb ions at 13A–158A GeV/c
- **Improved beam quality** mostly at low energies secondary beams
 - Beam transverse size $\varnothing < 8$ mm
 - Beam slope < 200 μ rad
- **Beam intensity $\approx 10^6$ Pb ions/spill (10 s)**
 - Upgrade of the H2/NA61 radiation protection
- **Reduced beam intensity oscillation on NA61 target during the spill**
 - $\Delta I/I < 10\%$



Possible tests

- Test of the TPCs with 10^6 Xe ions per spill (10s) **in 2017**
- Test of the TPCs with 10^6 Pb ions per spill (10s)
on NA61/SHINE target.
- We performed a pilot test in 2016 but radiation alarms did not allow to reach intensity higher than 500k/per spill (only single spill with such intensity).



Summary

- NA61/SHINE plans new measurements of hadron production with beams of hadrons and nuclei in the SPS/H2 beam momentum range
- The measurements require major beams and detector upgrades
 - We hope to profit from developments from other experiments (ALICE, MPD, CBM, ...) and support from CERN

