STONY BROOK
STATE UNIVERSITY OF NEW YORK

E.V.Shuryak,Center for Nuclear Theory,
Physics & Astronomy, SUNY at Stony Brook, NY11794
e-mail: shuryak@tonic.physics.sunysb.edu Tel: 631-632-8127 Fax: 631-632-9718

John Dainton, Chairman SPSC,
Jos Engelen, Chief Scientific Officer,
Members of CERN/SPS Committee

Re:Future heavy ion experiments at SPS

Dear Colleagues,
This short letter is written in support of the proposals to continue SPS heavy ion program, with at least NA49 and and NA60 detectors (and maybe others). My main point is that (in spite of many years of work at the SPS) there are large unexplored domains left and thus there remains high potential for answering the central questions, and even making significant discoveries.

The SPS energy region is of special interest for heavy ion /search for QGP program because rapid change of trends are expected to occur there. This is best explained by thinking about evolution of the matter trajectory on the QCD phase diagram: as the collision energy increases one expects the following phenomena to happen:

(i) The "initial" point (at which one can think of equilibrated matter) first *touches* the phase transition line, so from that energy on the matter is produced in the "mixed phase"
(ii) The "initial" point *leaves* the mixed phase and first enter the QGP
(iii) The "chemical freezeout" *nearly touches* the phase transition line, and moves along it all the way toward RHIC/LHC energies
(iv) The "chemical freezeout" point approach the *QCD critical point*, at which the transition is second order and σ meson mass vanishes.

Experiments done so far see some changes of behavior, indicative of (i-iii), at low SPS region, although there is so far no clear distinction between them. Various observables should be studied in order to clearly explain what is going on in this region. Most importantly, systems of different sizes should be explored, locating where precisely a transition from pp-like to bang-like collisions happens.

Phenomena (iv) related with the *QCD critical point* are studied much less. Theoretically, we do not know exactly where this point is, and only quite recently lattice works indicated it is probably inside the SPS domain. Phenomenologically, the only suggestion so far was to look for unusual fluctuations, the "QCD critical opalescence", which are not yet found. However massless sigma means such a dramatic change in interaction between secondaries, especially nucleons, that many other signs of this should exist. (I am working on a paper with

several proposals along these lines.) It is clearly an exploratory science, with success far from guaranteed, but of a type which potentially may be a major discovery if the critical point be found.

New NA60 experiment promises to significantly surpass both statistics and especially mass resolution of all precious dilepton experiments. The issues at stake are: (i) whether intermediate mass dileptons discovered before are from charm production or QGP radiation; and (ii) how exactly masses of ϕ, ω mesons are modified in matter. Extra efforts to get final clear answers to these central questions of the SPS heavy ion program are certainly worth it.

Finally, an argument based not on science but on scientific policy. Bright future of the field in Europe notwithstanding, with Alice/LHC and GSI facility to come, it is dangerous to concentrate 100 percent of efforts on facility/detector building for extended time. Students and postdocs need Ph.Ds and live experiments, with physics results appearing continuously: otherwise the education pipeline may dry out. After all, we need talented physicists to be the program's future leaders, not managers.

/ Edward Shuryak
Director, Center for Nuclear Theory/

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