

The Search for the Quark-Gluon Plasma - I

Jean Cleymans
University of Cape Town, South Africa

International Workshop on Hot and Dense Nuclear and
Astrophysical Matter,
Stellenbosch, South Africa
26 November - 2 December 2017



Outline

Use of Thermal Concepts in Heavy-Ion Collisions

The ALICE Detector at CERN

The Start of the SA-CERN Programme



Quark-Gluon Plasma

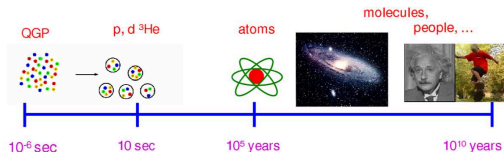
- "Normal" Plasma: Gas under such conditions that electrons break free from atoms (or molecules).
- Analogously the Quark-Gluon Plasma (QGP): State of strongly interacting matter where quarks and gluons are not confined to to a single hadron, proton or pion.
- Asymptotic freedom I: At high temperatures strong interactions become weak.
- Asymptotic freedom II: At high densities strong interactions become weak.





What's the point of all this?

- Part of the standard model predictions
- Early universe conditions: High density, high temperature
- QGP existed at the early universe before the phase transition to hadronic matter

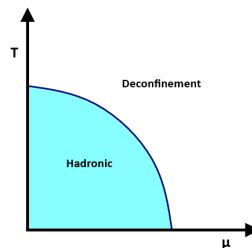




Thermodynamics I

- "Standard" statistical mechanics approach
- T = temperature
- μ = Baryon chemical potential = baryon density

Quark Gluon Phase Diagram



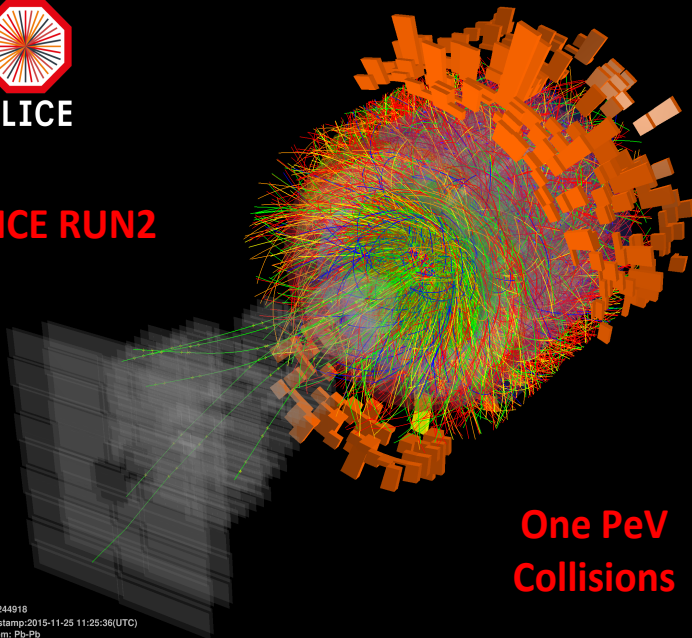
- Aside: High pressure, low temperature: Color superconductor





ALICE

ALICE RUN2



One PeV
Collisions

Run:244918
Timestamp:2015-11-25 11:25:36(UTC)
System: Pb-Pb

Particle Multiplicity in Heavy Ion Collisions

About 24 000 particles are produced in a heavy ion collision at the LHC.

Hence: Use Concepts from Statistical Mechanics to analyze the final state

e.g. use Energy Density, Particle Density, Pressure, Temperature, Chemical Composition, ...

These concepts turn out to be useful at all energies, RHIC, SPS, GSI ...





ALICE

The LS2 ALICE upgrades

New Inner Tracking System (ITS)

- improved pointing precision
- less material -> thinnest tracker at the LHC

Muon Forward Tracker (MFT)

- new Si tracker
- Improved MUON pointing precision

Time Projection Chamber (TPC)

- new GEM technology for readout chambers
- continuous readout
- faster readout electronics

MUON ARM

- continuous readout electronics

New Central Trigger Processor

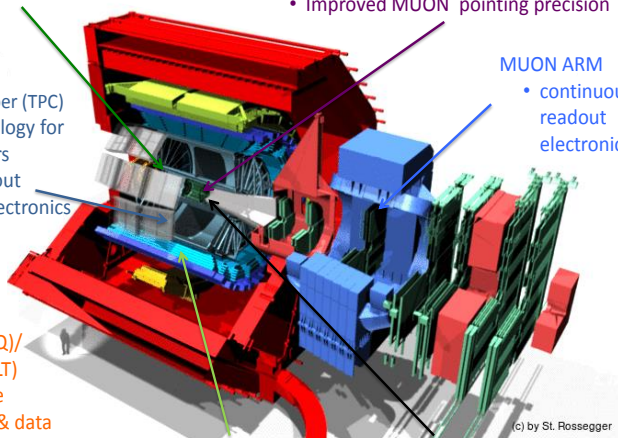
Data Acquisition (DAQ)/ High Level Trigger (HLT)

- new architecture
- on line tracking & data compression
- 50kHz PbP event rate

TOF, TRD, ZDC

- Faster readout

New Trigger Detectors (FIT)



- Primary design focus: heavy ion collisions
- Need to cope with high particle densities
- Relatively low magnetic field of 0.5 T (for comparison ATLAS has 2 T, CMS has 3.8T). This allows tracking of low p_T particles
- pp programme is also possible
- central energy for Pb-Pb $\sqrt{s_{NN}} = 2.76, 5.02$ TeV



CERN



CERN

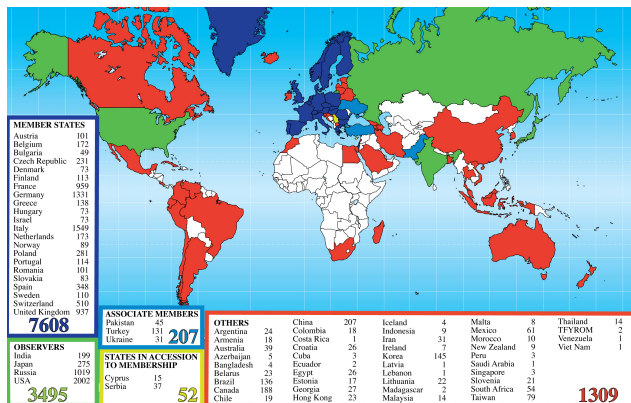


Figure 2. Countries of origin of CERN's visiting scientists (Users) by location of their home institute (September 2016). India, which is listed here as an Observer, joined as an Associate Member in January 2017.



CERN

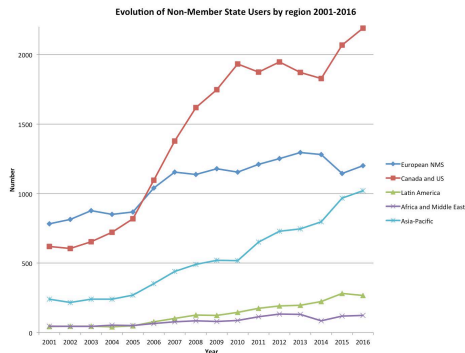


Figure 3. Evolution of the number of CERN Users from Non-Member States (NMS) grouped by region. The apparent decrease for Africa and Middle East reflects the fact that Users from Israel are not included any longer for 2014, when Israel became a Member State.





LAUNCH December 15 2008



Launch of the National SA-CERN Programme
December 15 2008.

Minister of DST



Minister of DST



Minister of DST



UNO Kofi Annan

