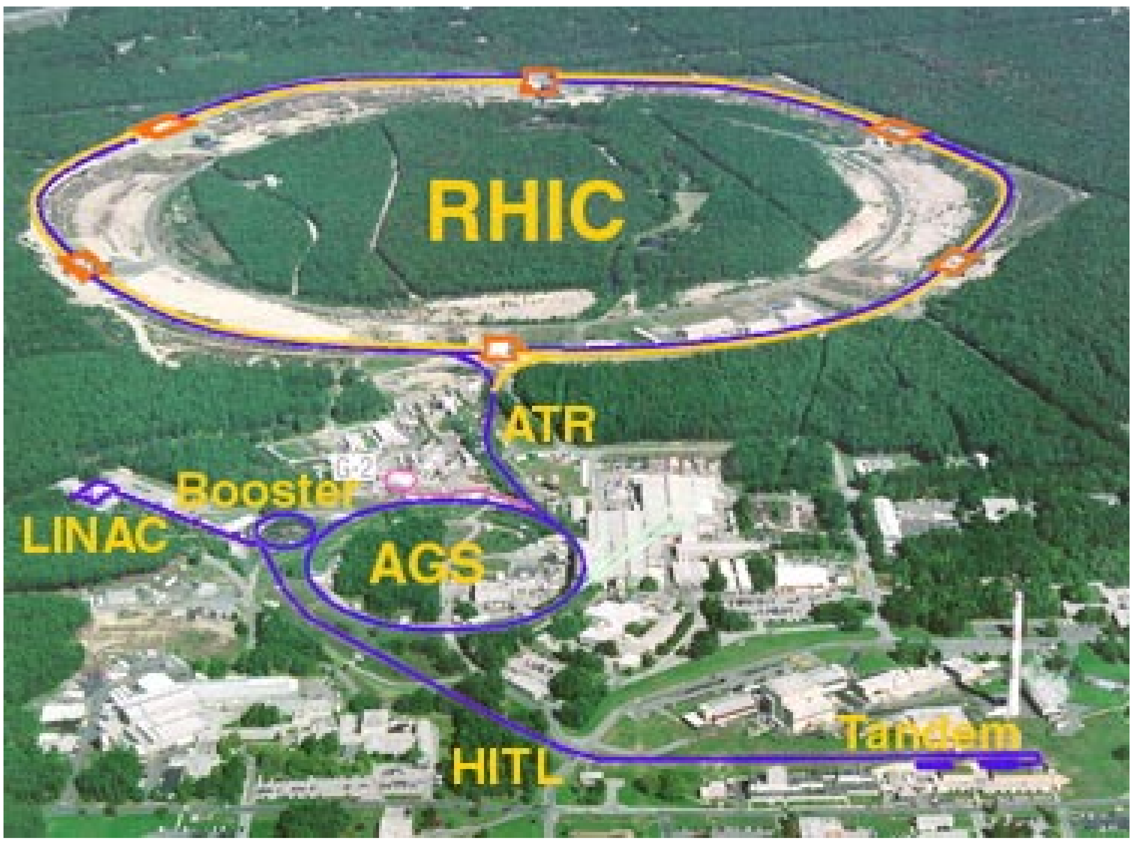
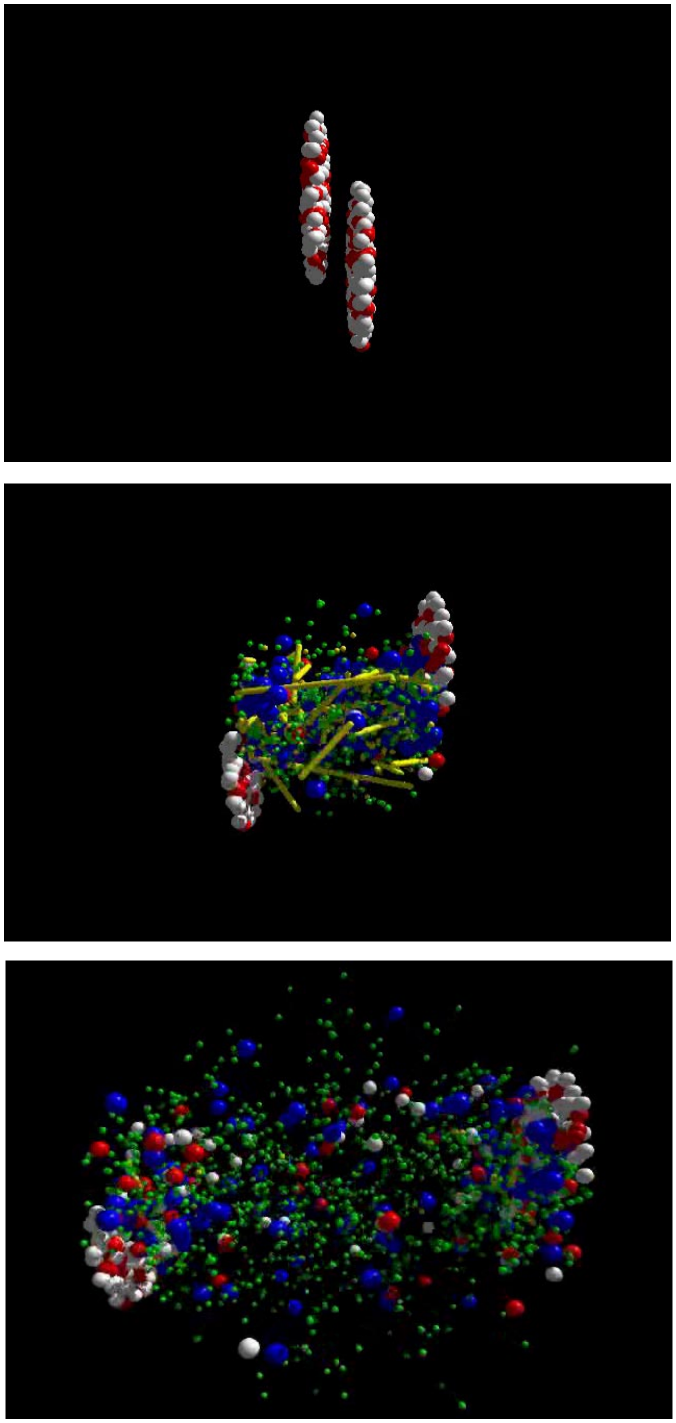
bonner, demello, eppley, geurts, kainz, llope, mutchler, platner, roberts, yepes



AGS: up to ~11.5 GeV/c/N Au, fixed target
E896
RHIC: up to 100 GeV/c/N Au + 100 GeV/c/N Au
polarized proton collisions, up to 250 GeV/c/beam, and p+A
STAR
LHC: up to 7 TeV p + 7 TeV p collisions
up to 3 TeV/nucleon Pb + 3 TeV/nucleon Pb collisions
p + e collisions at $\sqrt{s}$ = 1.5 TeV
CMS

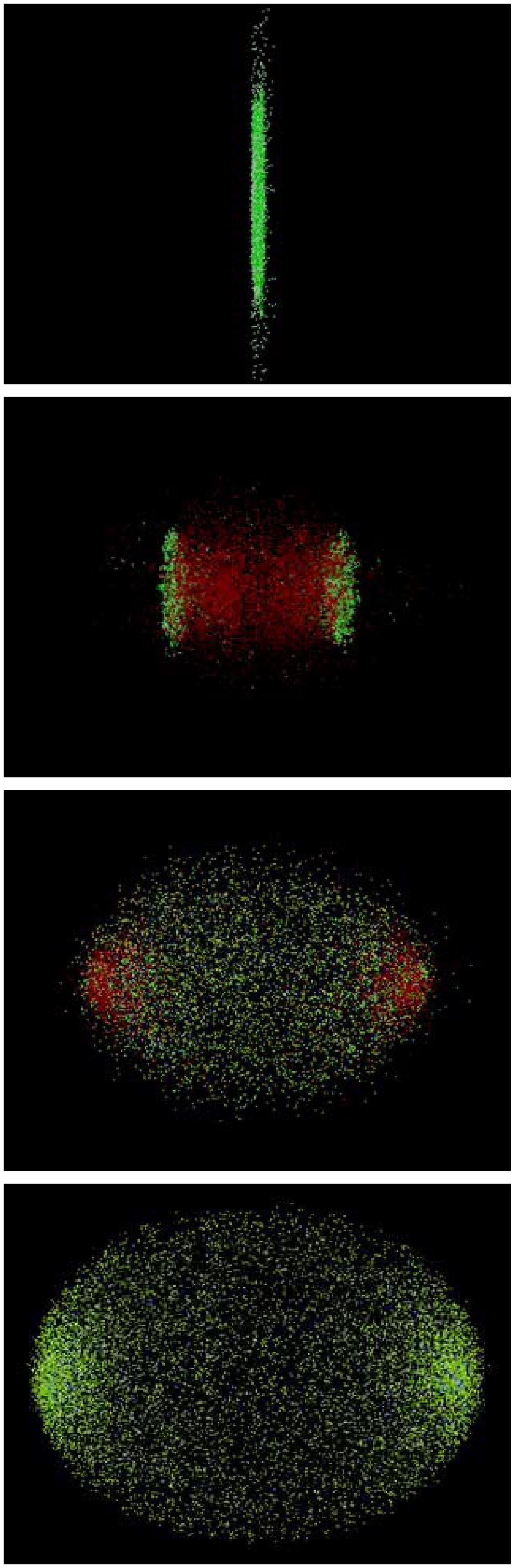
Experimental Relativistic Heavy-Ion Physics



UrQMD
Au+Au
100 GeV/c/N
b = 5fm

collide big nuclei at the highest possible speeds
form large systems of very hot, very dense nuclear matter
try to measure final state as completely as possible
(build detectors, put them in beam, and write tape!)

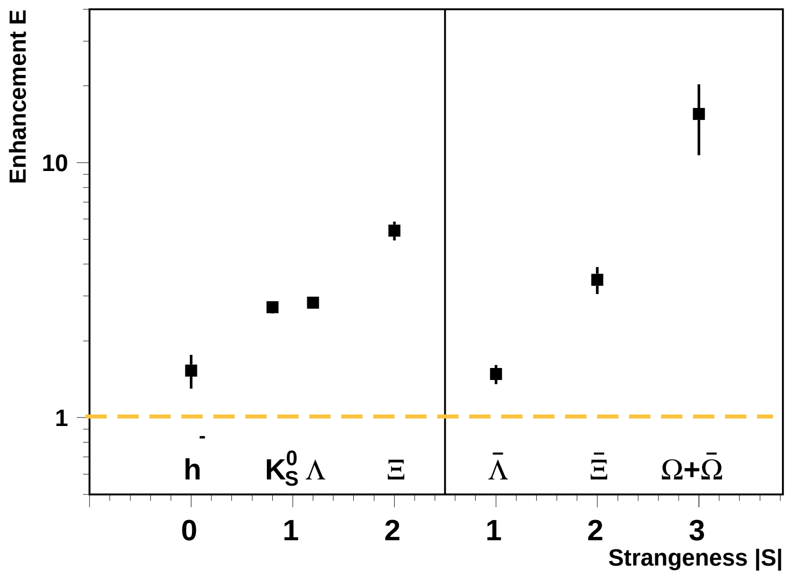
→ work back to infer conditions during the collision and
the physical processes leading to observed final states.....



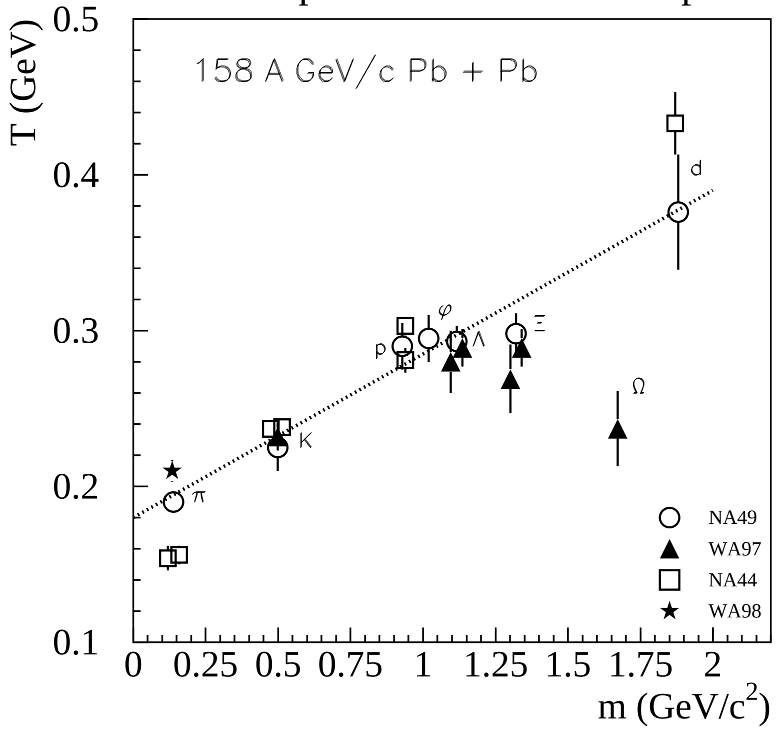
VNI
Au+Au
100 GeV/c/N
b = 0 fm

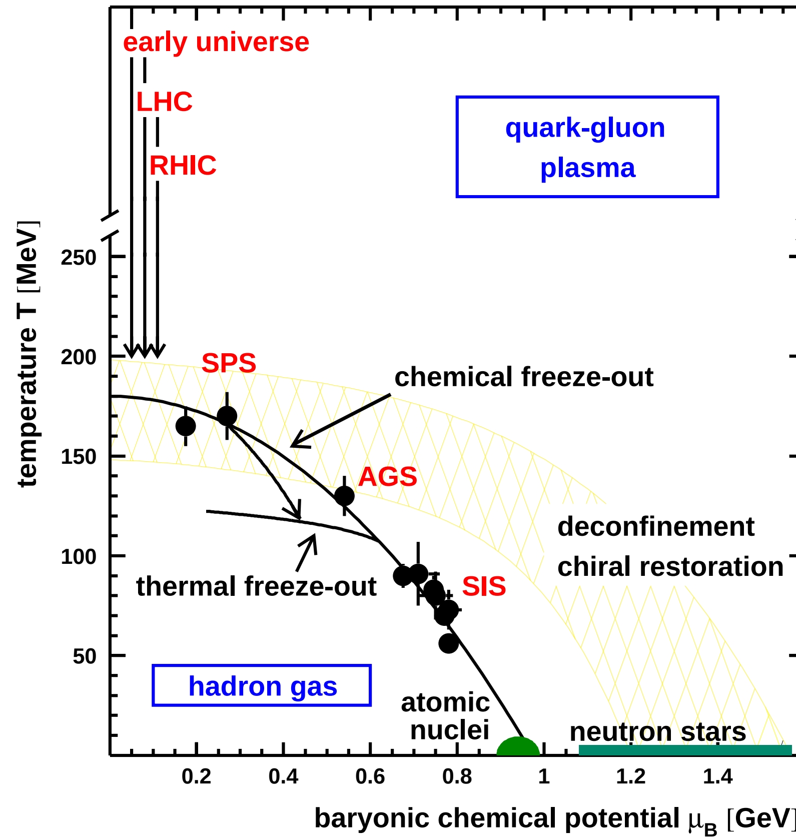
RHIC: order of magnitude jump from previously accessible √s...
no two models agree on anything....
brand new field

Something funny is going on with the observed “strangeness”...



mass dependence of inverse slopes



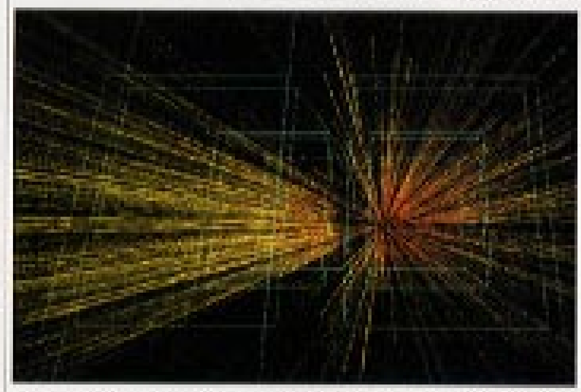


are we approaching a new state of matter in the lab?!?
called the QUARK-GLUON PLASMA

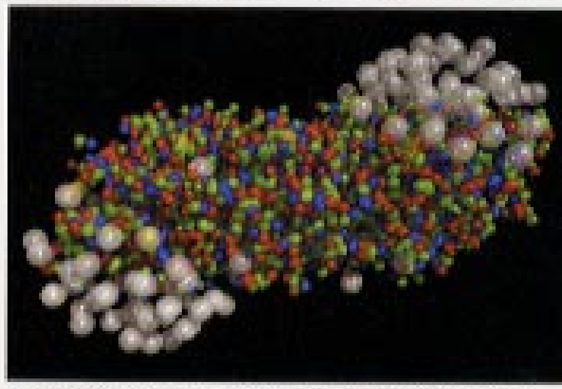
...so, RHIC has the QGP in *every* central event?!?!
→ RHIC = QGP observation & spectroscopy...

Heavy implications for the first second

After a decade of running, the results from CERN's research programme with high-energy nuclear beams provide tantalizing glimpses of mechanisms that shaped our universe.



Recreating the Big Bang – a "Little Bang" as seen by the NA49 experiment at CERN. The image shows a display of the tracks emanating from the Little Bang created in a central collision of lead projectile with a lead nucleus.



Fusion of two high-energy nuclei to form a core of plasma of quarks and gluons – the kind of matter produced a few microseconds after the Big Bang to set the stage for the production of nuclear particles.

About a microsecond after the Big Bang, the universe was a seething soup of quarks and gluons. As this soup cooled, it "froze" into protons and neutrons, supplying the raw material for the nuclei that appeared on the scene a few minutes later.

To check if this imagined scenario is correct, since 1985 experiments at CERN have been accelerating beams of nuclear particles to the highest possible energies and piling them into dense nuclear targets. Recreating what happened in the first microsecond of creation has so far taken many years of careful and painstaking work.

The goal has been to use the energy supplied by the nuclear beams to recreate tiny pockets of primordial quark-gluon plasma about the size of a big nucleus and watch them behave as "Little Bangs". Theorists using simulation tools predict that this soup/plasma should be formed at a temperature of about 170 MeV (about 10^{12} degrees, or 100 000 times the temperature at the centre of the Sun) with an energy concentration of about 1 GeV per cubic femtometre – seven times that of ordinary nuclear matter.

The milestones of the early universe, separated by only fractions of a second, nevertheless stretched over immense energy gaps as the Big Bang temperature plummeted. The Little Bang experiments too have to contend with vast swings of temperature/energy.

The experiments take snapshots of the particle patterns emerging from these Little Bangs, but these patterns, although embedded in the particle behaviour, are quickly masked by the surrounding nuclear debris. The challenge is to peer through this debris to glimpse the signature of the Little Bangs.

Ion beam experiments

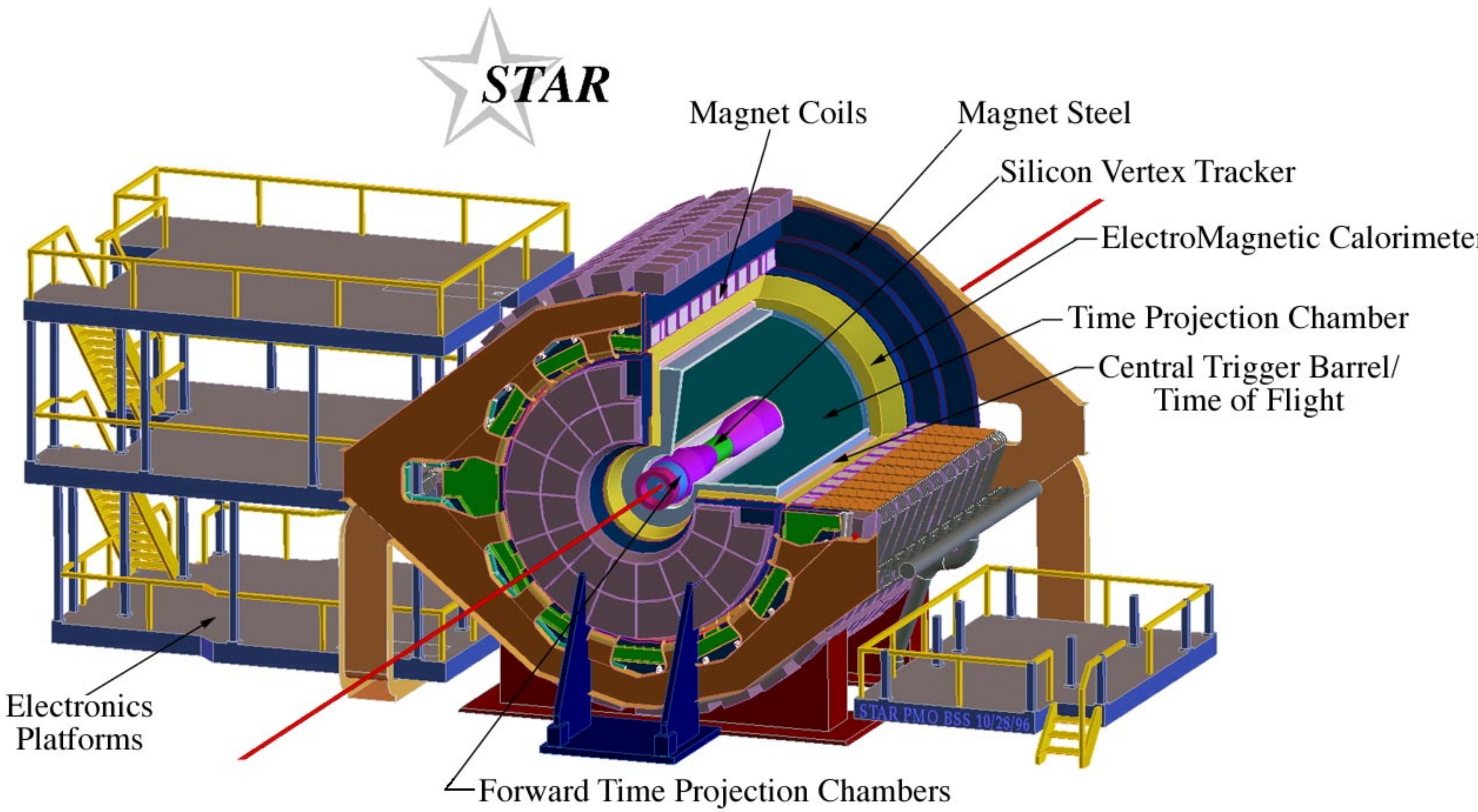
The ion beams at CERN serve several large experiments, codenamed NA44, NA45, NA49, NA50, NA52, WA97/NA57 and WA98. Some of these studies use existing multipurpose detectors to investigate the fruit of the heavy-ion collisions. Others are special dedicated experiments to detect rare signatures.

On both the machine and the physics sides, the programme is an excellent example of collaboration in physics research. Scientists from institutes in more than 20 countries, including Italy, Japan, Germany, France, Portugal, Russia, Finland, India, Poland, Greece, Switzerland, the UK and the US, have participated in the ▷

The Solenoidal Tracker at RHIC (STAR)

hadrons over wide, azimuthally symmetric, acceptance...
(little concensus on the unambiguous QGP signature)

for the first time, event-by-event physics!
(other RHIC experiments less or not capable here → STAR leads the way in QGP spectroscopy)



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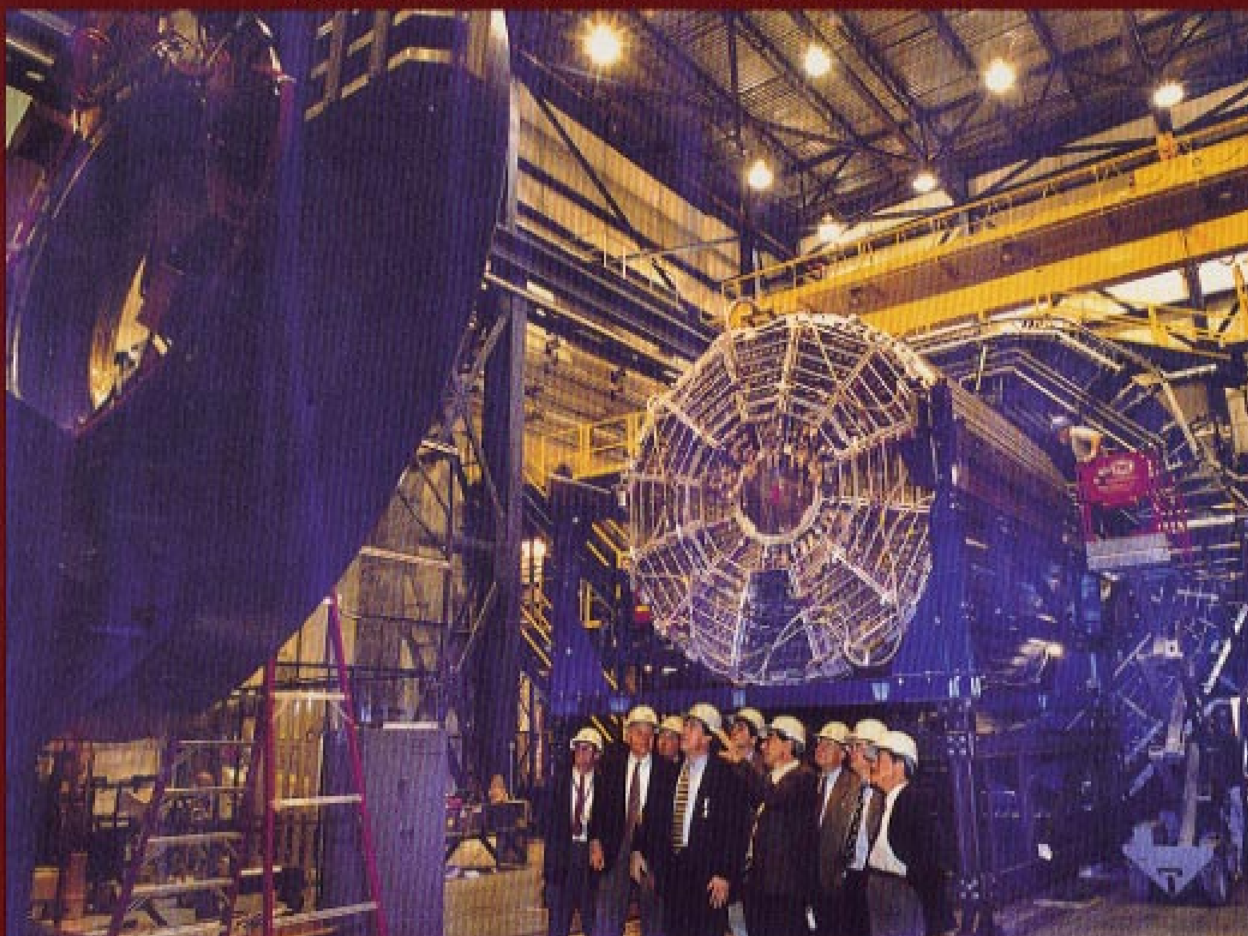


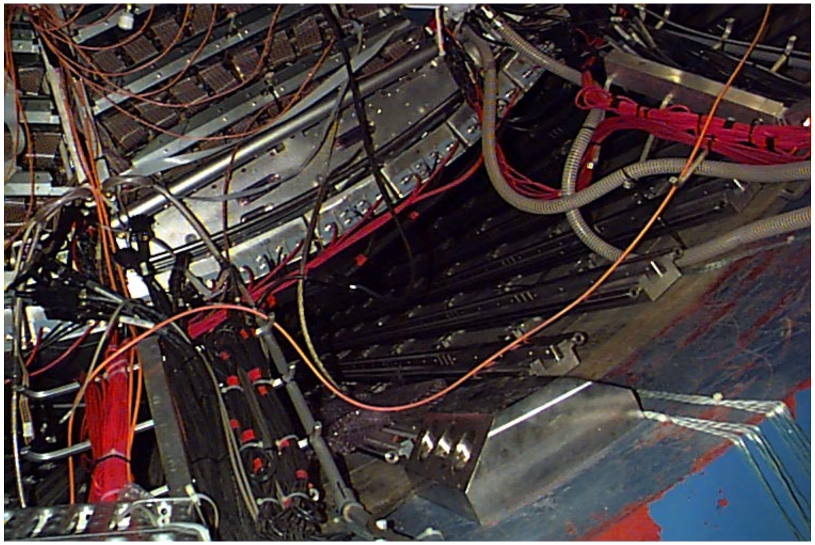
A STAR in the making

LHC COLD START
Procurement and construction work for CERN's LHC project begin in earnest

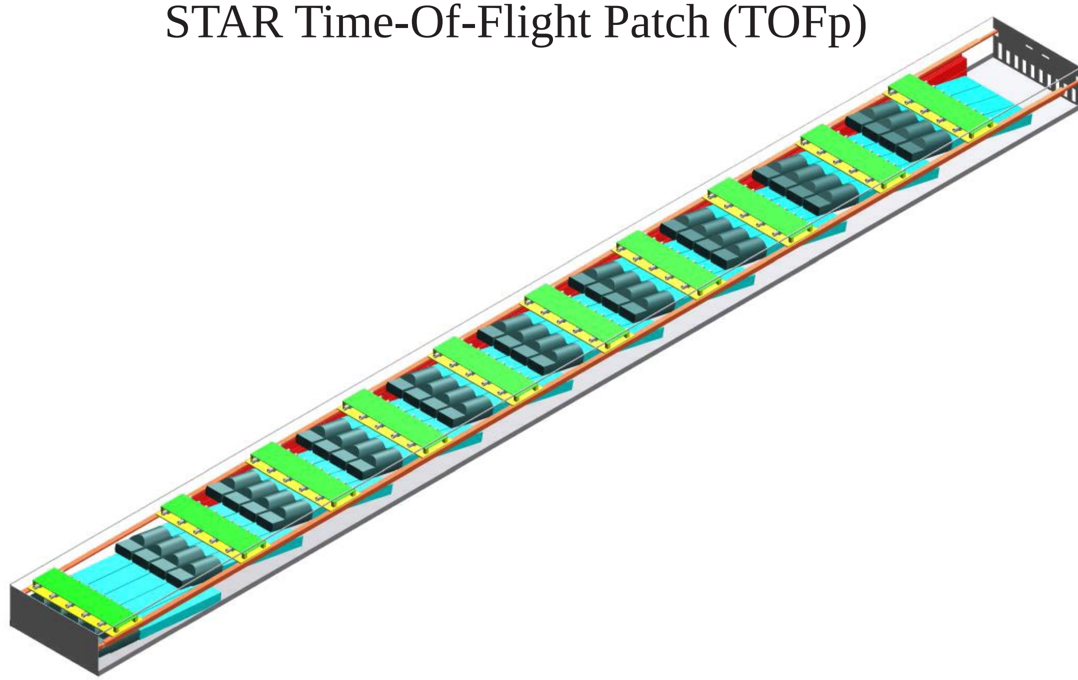
EPIC DEVELOPMENTS
Physics helps and is helped by a new generation of microprocessors being tested at CERN

MYSTERIES OF COSMIC RAYS
Unexplained phenomena in the ultra-high-energy area point to gaps in our understanding

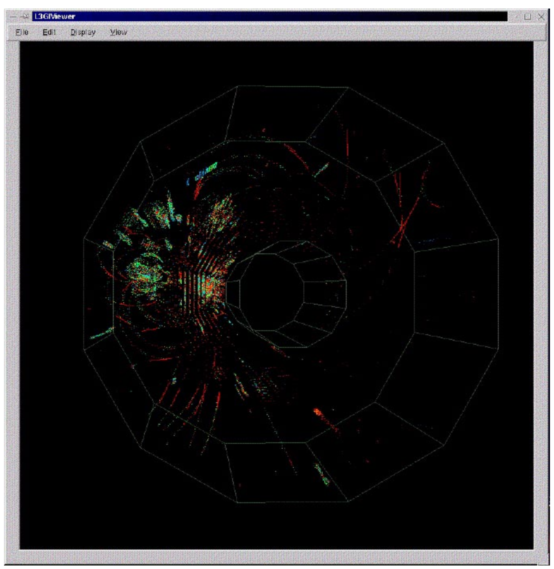
STAR Central Trigger Barrel (CTB)

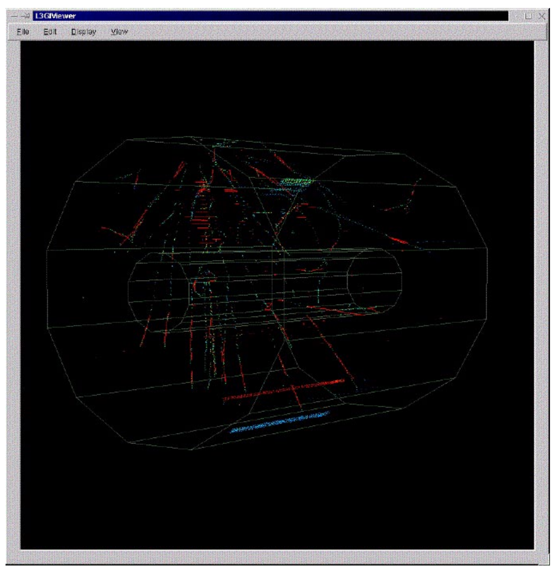


STAR Time-Of-Flight Patch (TOFp)



STAR Level-3 Trigger

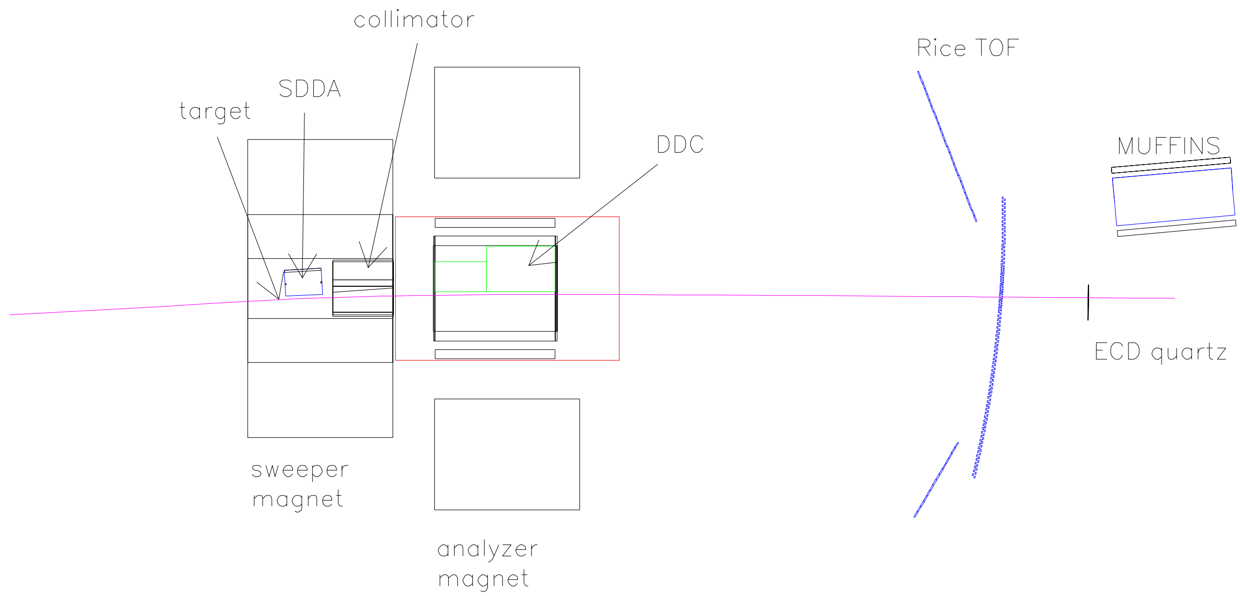


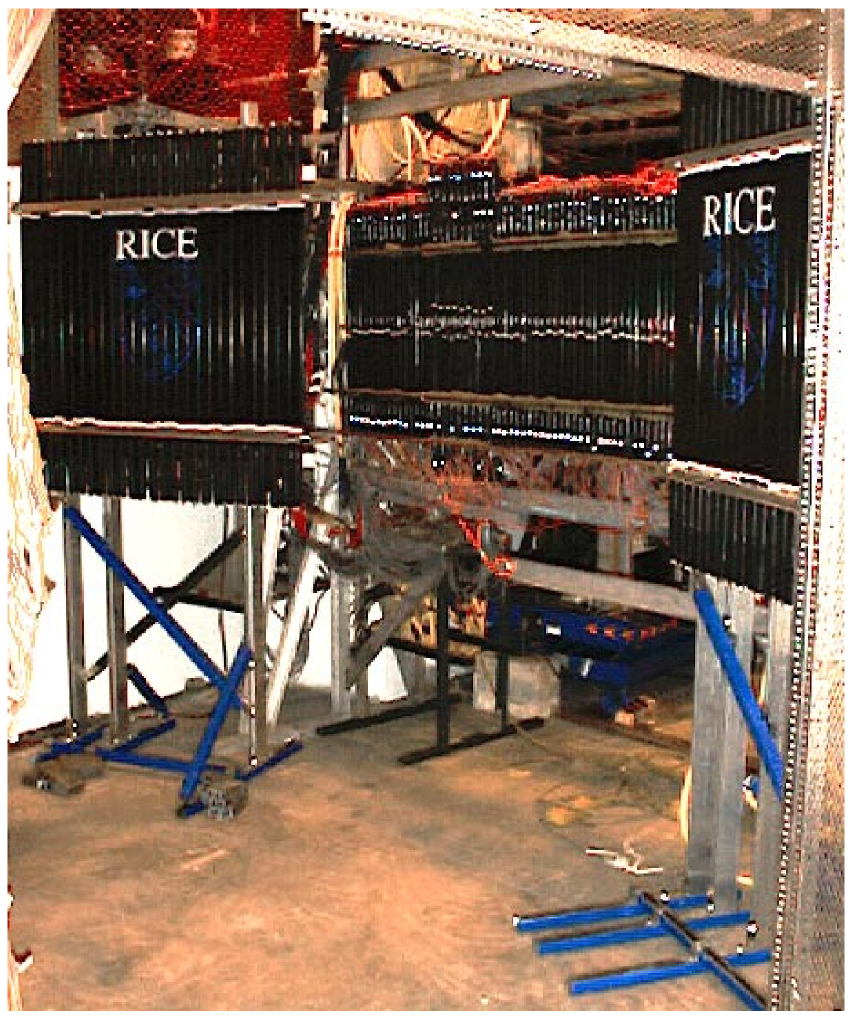


other involvement
- STAR-EMC
- PWGs

planned det. upgrades
- TOFq...
- TOFr...

BNL-AGS Experiment 896



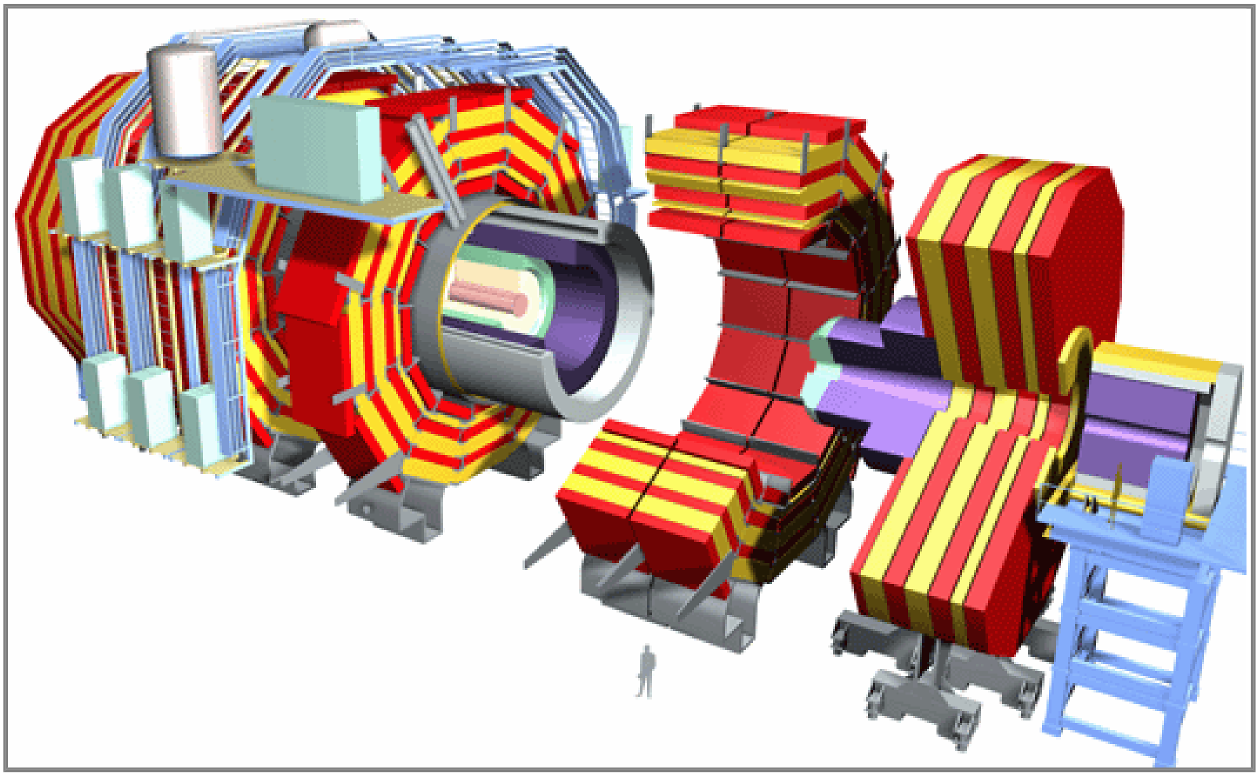


...analyzing large set of 1998 Au+Au data towards Λ and Ks reconstruction including direct PID...

CMS at CERN

another factor of ~30 in Pb+Pb total energy above RHIC Au+Au
electrons, photons, and muons (CMS "~" Phenix, and ALICE "~" STAR)
mid-late this decade

CMS
Compact Muon Solenoid



Collaboration
Institutes in CMS
US CMS server
RDMS CMS server

Documents
Introduction to CMS
Letter of Intent
Technical Proposal
CMS Outreach

General
CERN homepage, LHC experiments, Committee (LHCC), SLAC Spires Particle Data Group

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