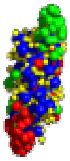


Compressed Baryonic Matter

A heavy-ion experiment at the future facility at GSI

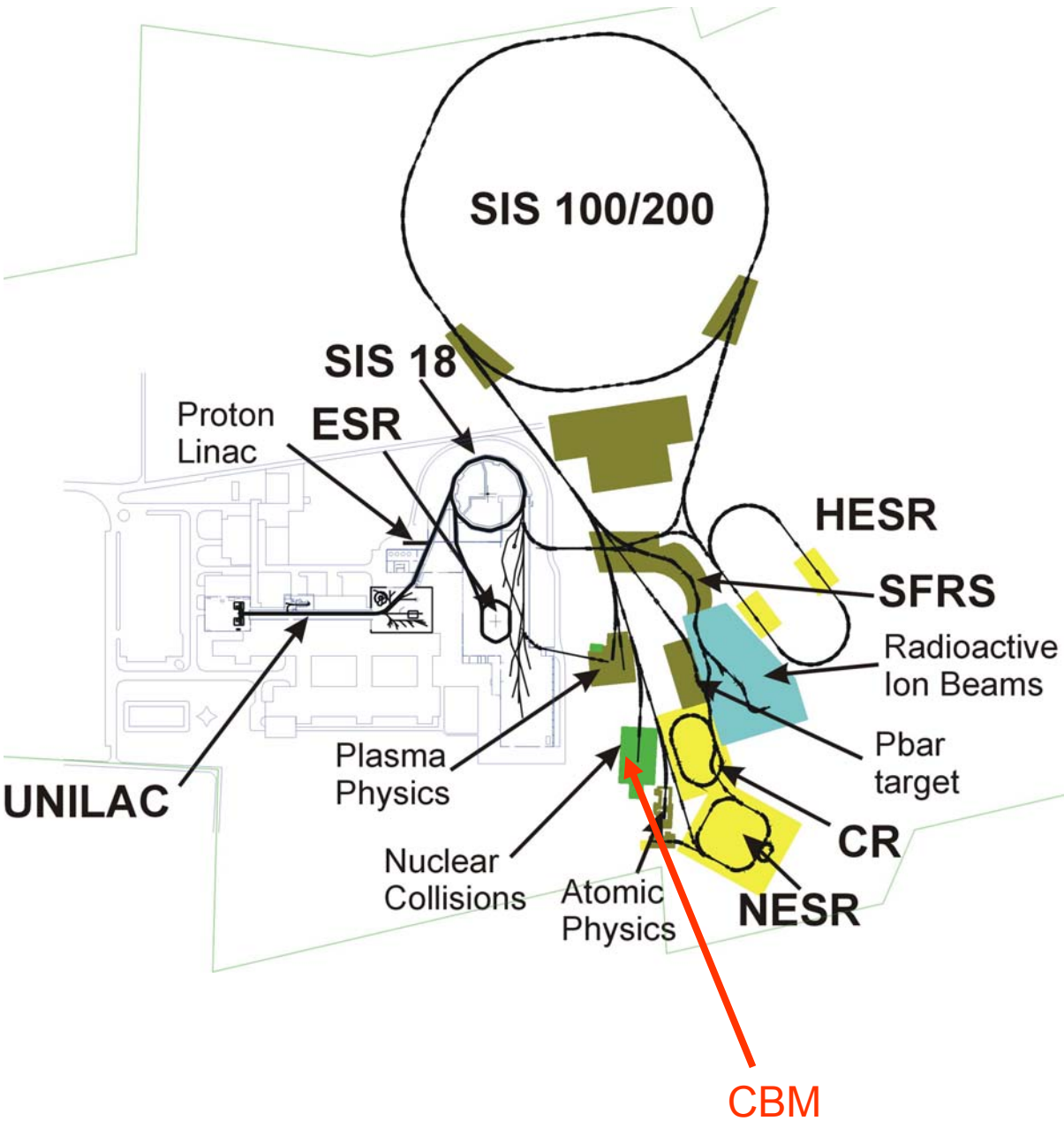
Volker Friese

GSI Darmstadt : A. Andronic, P. Braun-Munzinger, C. Finck, B. Friman, C. Finck, R. Holzmann, W. Koenig, M. Lutz, P. Senger, Y. Shin, R. Simon, J. Stroth

Universität Frankfurt : H. Ströbele

Universität Heidelberg : N. Hermann

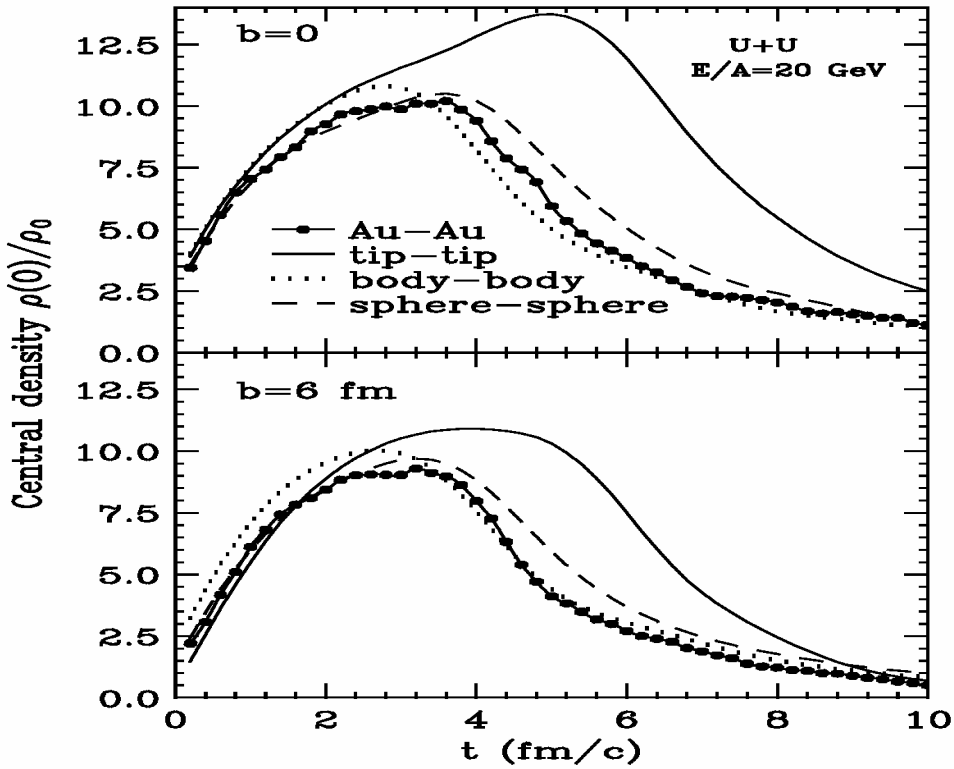
The future facility at GSI

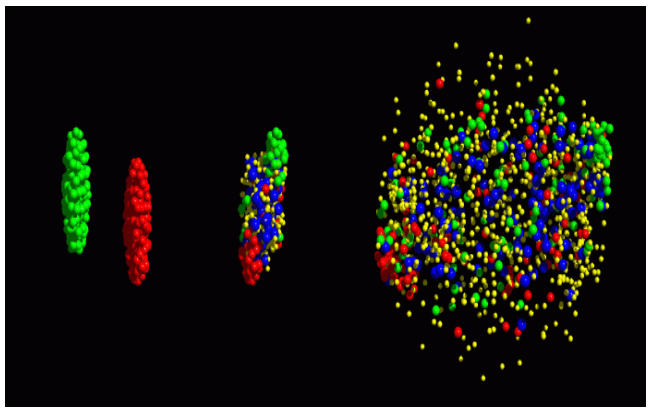


Baryon density in heavy-ion collisions at SIS200

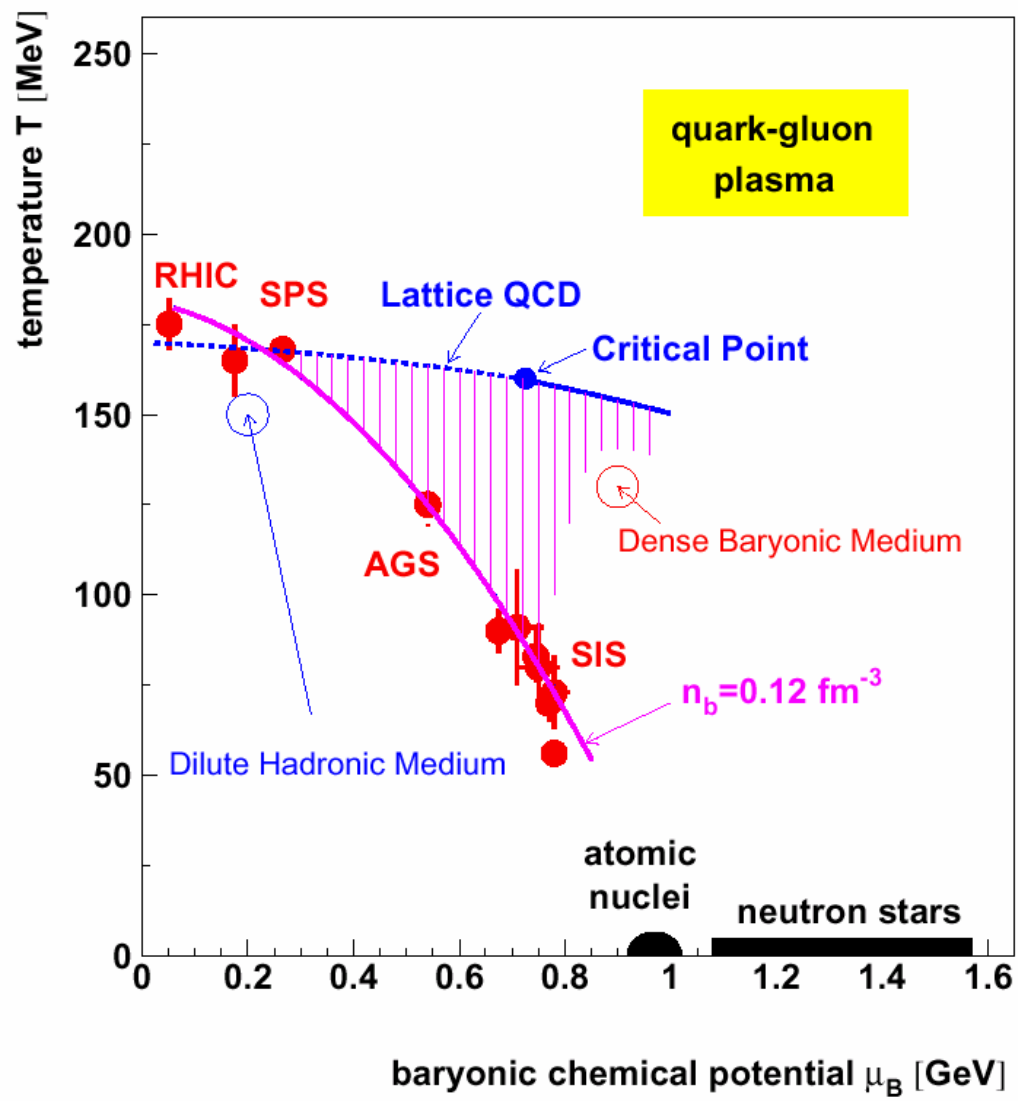
Au+Au @ 20 AGeV :

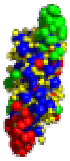
$\rho = 7\ \rho_o$





The phase diagram of strongly interacting matter





What can we expect?

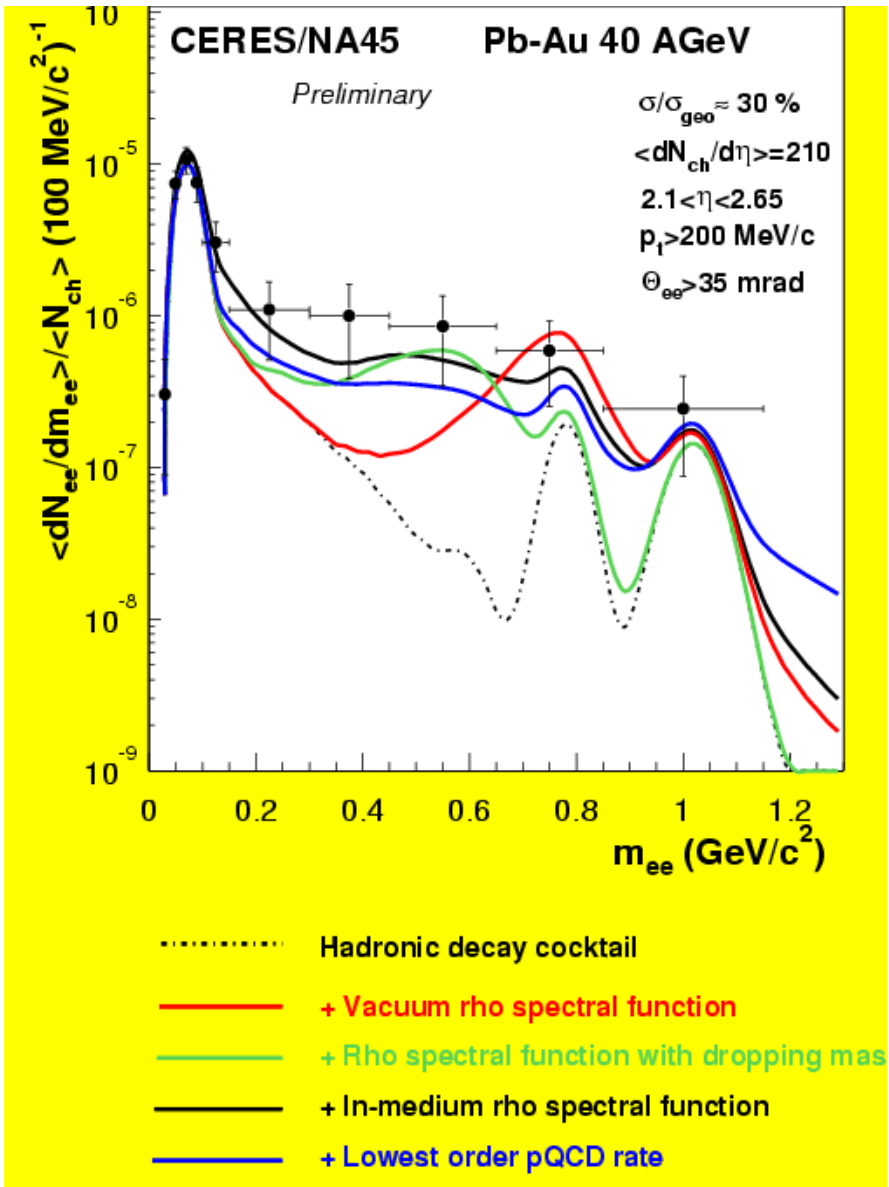
- The future facility at GSI will deliver heavy-ion beams from 2 to 30 AGeV (maybe more)

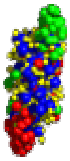
- In heavy-ion collisions at such beam energies, extreme baryon densities are expected

- This gives the opportunity to study the region of dense baryonic medium in the QCD phase diagram, maybe even in the vicinity of the critical point

- Clearly, penetrating probes such as dipletons are needed

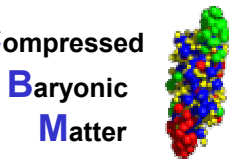
What do we know :
In-medium modification of vector mesons





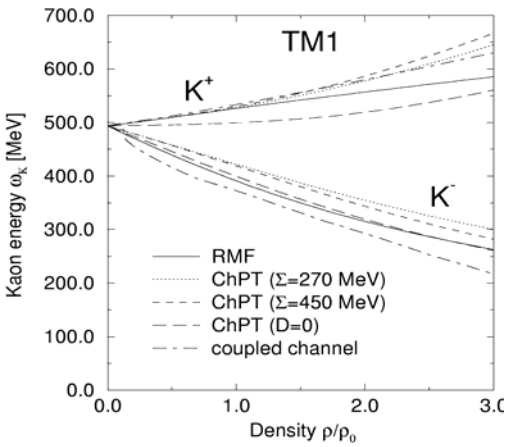
What do we know :
In-medium modification of vector mesons

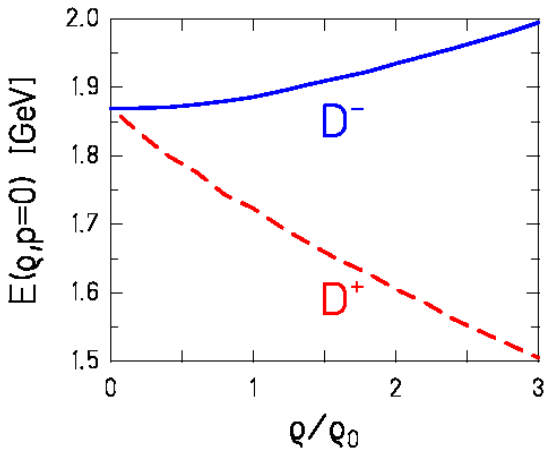
- At SPS, an excess of low-mass dipletons is observed
- The effect is stronger at 40 AGeV than at top SPS energy
- It is already seen at BEVALAC (1 AGeV)
- The interpretation seems to require a modified rho-meson
- The present data do not allow to distinguish between various in-medium scenarios
- There is need for a high-precision dilepton measurement

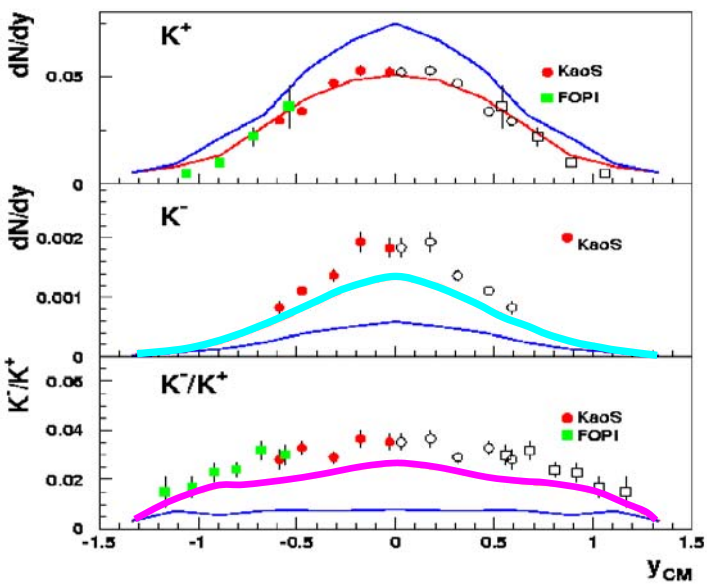


What do we know :

Threshold production of strangeness / charm







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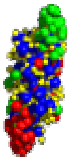
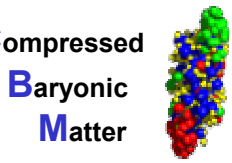


What do we know :
Threshold production of strangeness / charm

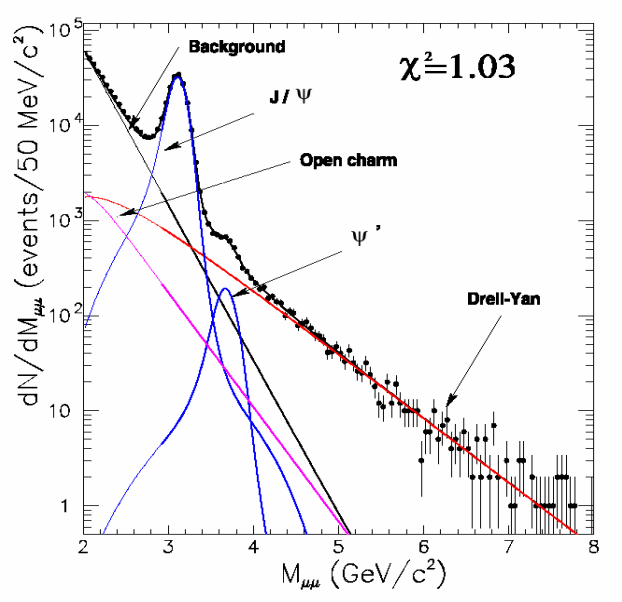
- The threshold production of kaons is sensitive to the in-medium modifications of the kaon masses
- This has been shown at SIS18 (KaoS and FOPI)
- A similar effect is expected for open charm
- D mesons have not been measured in heavy-ion collisions so far

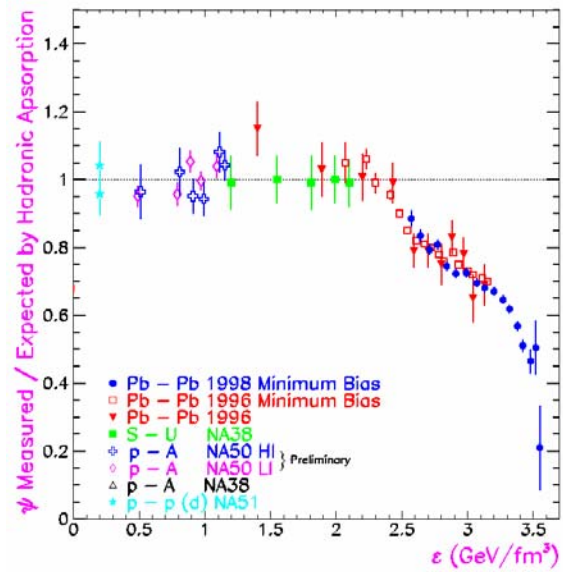


What do we know :

J/Ψ suppression

SPS (NA50)

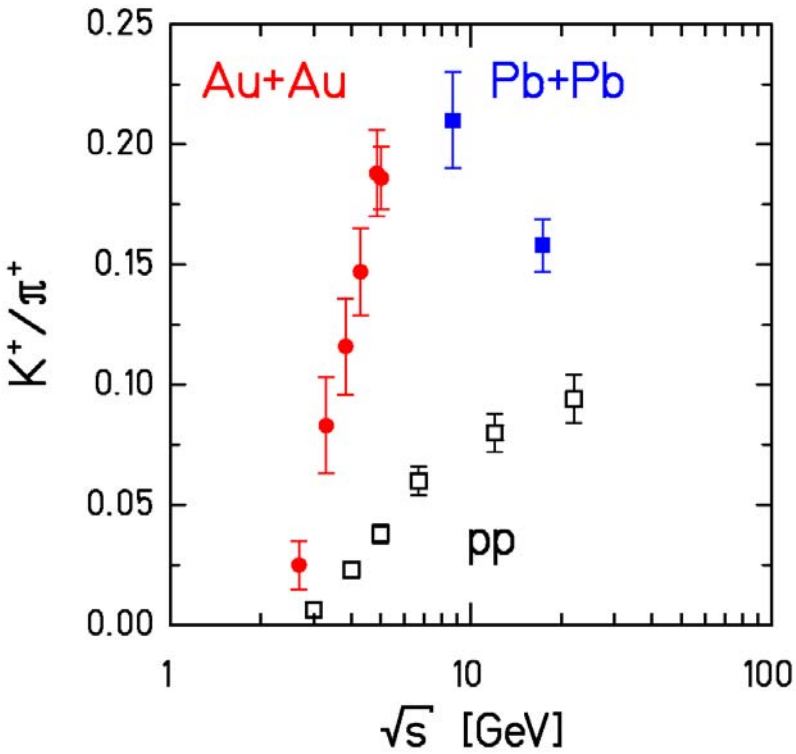




- At top SPS energy, an anomalous suppression of J/Ψ is observed
- Such a suppression is expected for a deconfined phase due to colour screening
- This is one of the evidences that the phase transition is reached at SPS
- Is there an onset of this effect with collision energy?
- No measurement below SPS energies up tp now

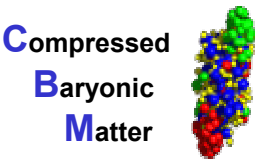
What do we know :

Strangeness enhancement



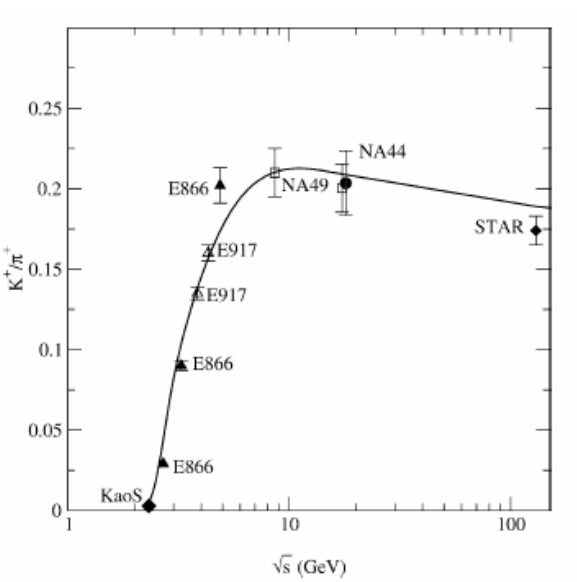
Maximum in relative strangeness production observed for kaons around 30 AGeV

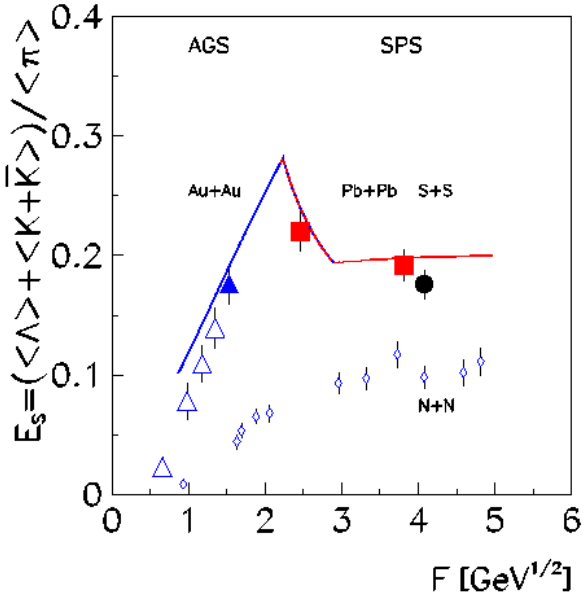
Interpretation is still under debate



What do we know :

Strangeness enhancement



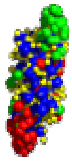


- Interpretations:

Maximum is due to change in baryochemical potential (hadron gas model) or due to phase transition (statistical model of the early stage)

- The region around 30 AGeV is of special interest

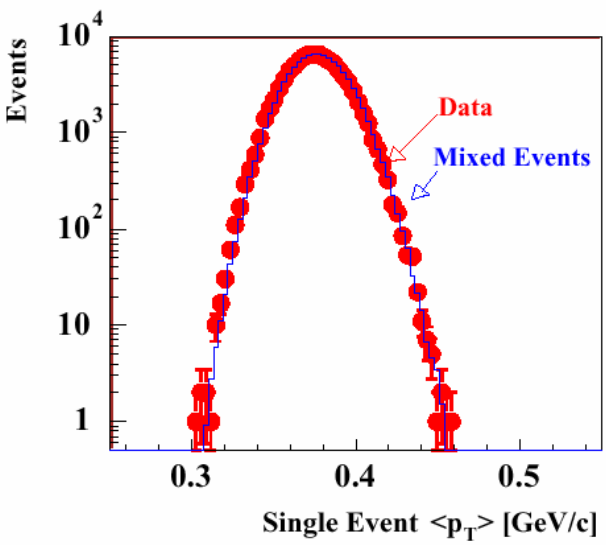
- The measurement of multi-strange hyperons would be informative

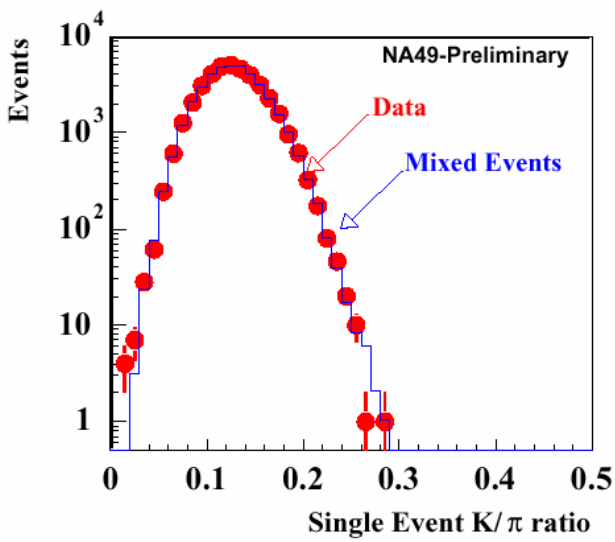


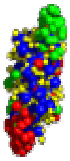
What do we know :

Event-by-event fluctuations

- In the vicinity of the critical point, large fluctuations, e.g. in mean pt or chemical composition are expected
- Such fluctuations would be a direct proof of a phase transition
- At SPS, no non-statistial fluctuations are observed
- Looking for the critical point in the range 10 – 30 AGeV







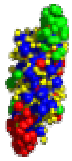
What would we like to measure ?

- $\rho \rightarrow$ e+ e- with high precision
- J/$\Psi \rightarrow$ e+ e-
- D $\rightarrow \pi$K
- π, K, p direct
- Λ, Ξ, Ω via topology
- event-by-event variables

What do we need ?

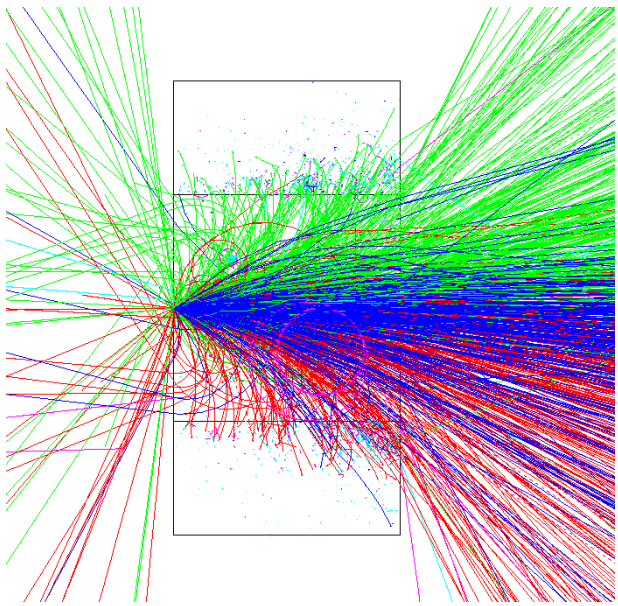
- high beam intensities (10^9 / s) and reaction rates (up to 10 MHz)
- large acceptance (>2 π)
- trigger for rare probes

All detector components have to deal with high reaction rates (fast readout, radiation hardness, high granularity)



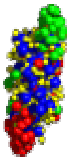
Experimental conditions

URQMD Au+Au @ 25 AGeV
GEANT simulation: B = 1 T



π^+	328
π^-	357
p	161
K^+	41
K^-	13
Σ^-	9
Σ^+	8

700 – 1000 charged particles per event



Experimental task:

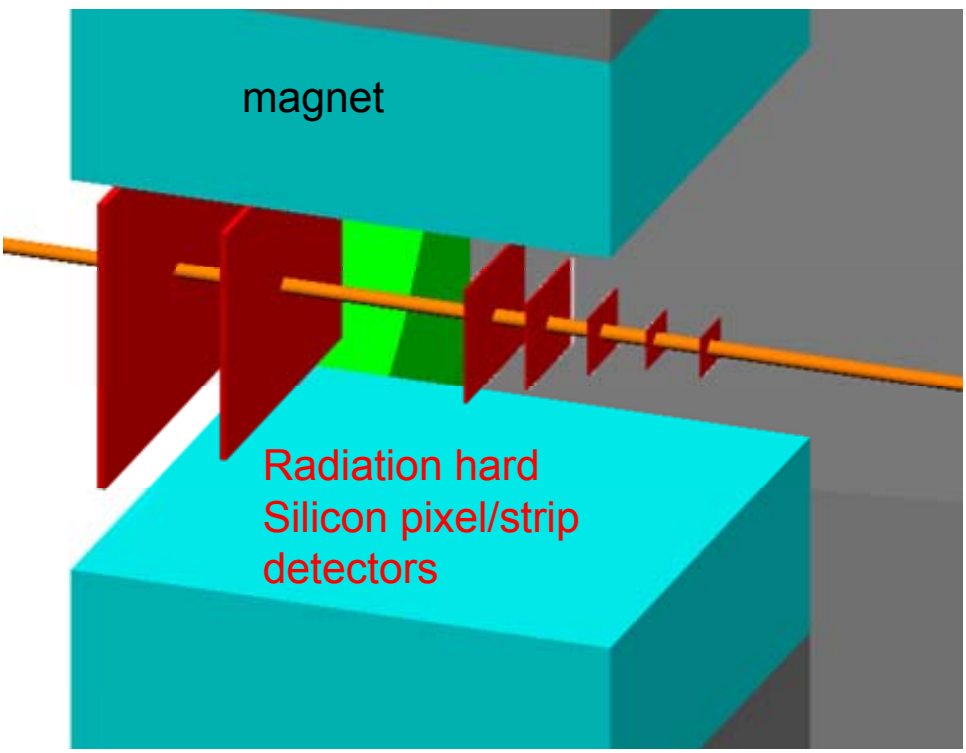
Tracking

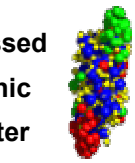
- determination of momentum
- measurement of displaced vertex (D meson)

Requirements:

- o operation in magnetic field
- o close to target
- o radiation hardness
- o high granularity
- o minimal thickness

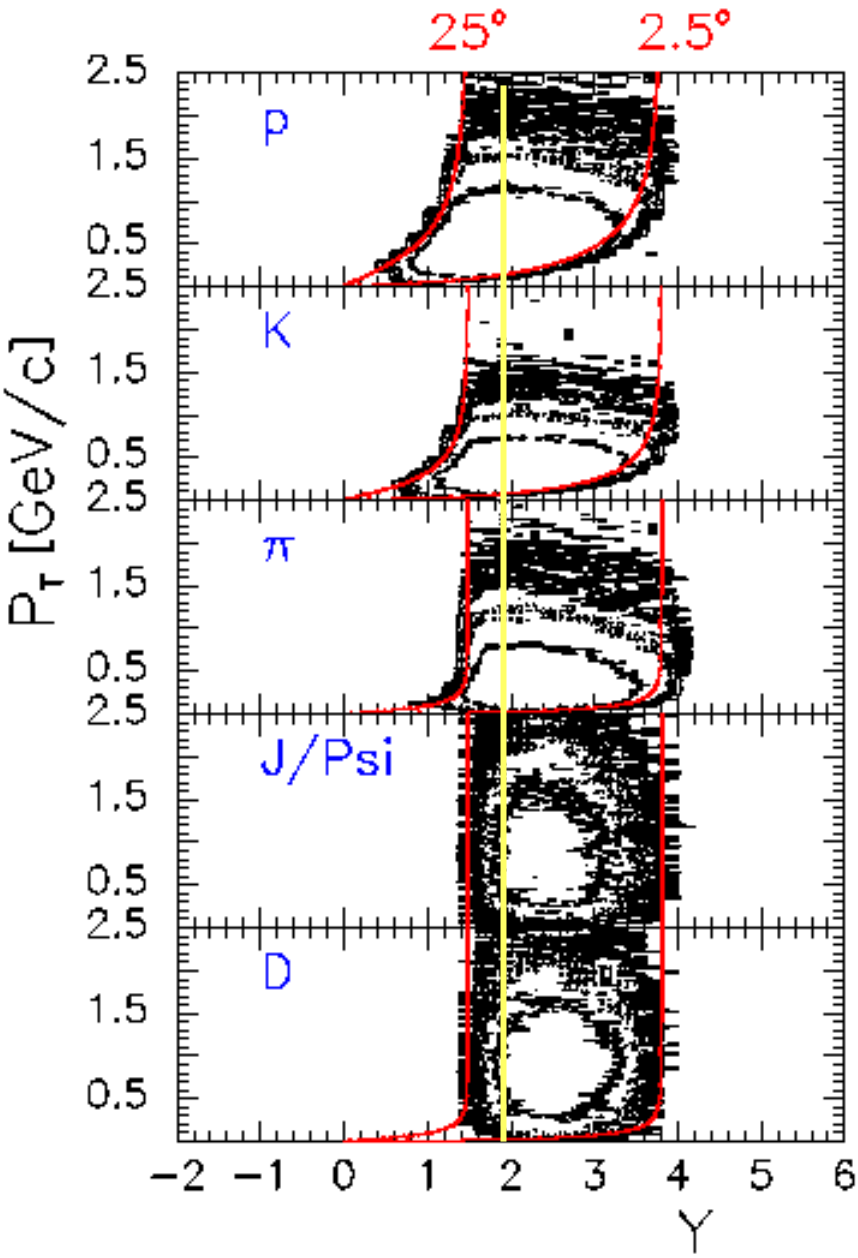
A possible solution: Silicon pixel / strip detectors





Acceptance for the tracking system

UrQMD Au+Au @ 25 AGeV + GEANT



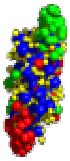
80%

60%
incl. decay

67%
incl. decay

20%

30%



Experimental task:

Hadron PID

- separation of π, K, p
- method : time of flight

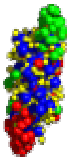
Requirements:

- distance from target 10 – 15 m
- large area to cover
- resolution < 100 ps
- high rate capability

Possible solutions:

Resistive plate counters ?

Scintillators ?



Experimental task:

Lepton PID

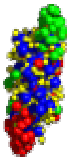
- Dilepton measurement requires separation of e from π

Requirements:

- suppression factor < 10^{-4}
- high electron efficiency

Possible solution:

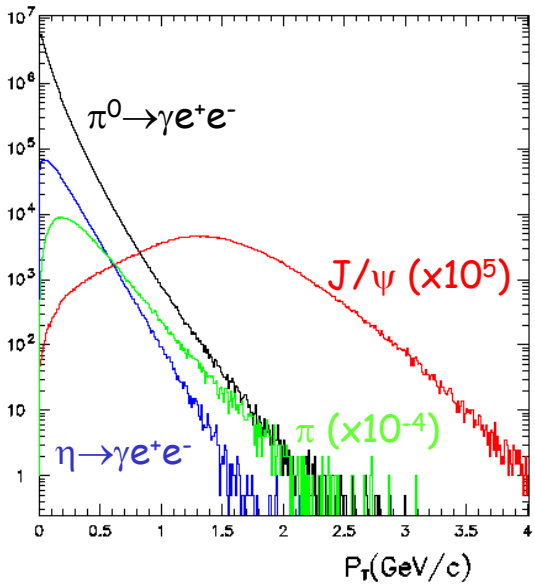
1. stage RICH
2. stage TRD (ALICE type)



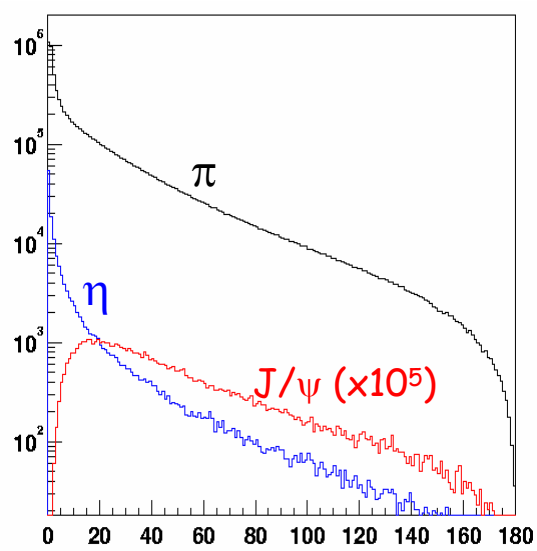
J/Ψ Detection

PLUTO + GEANT simulation, 10 M events

e^+, e^- transverse momentum

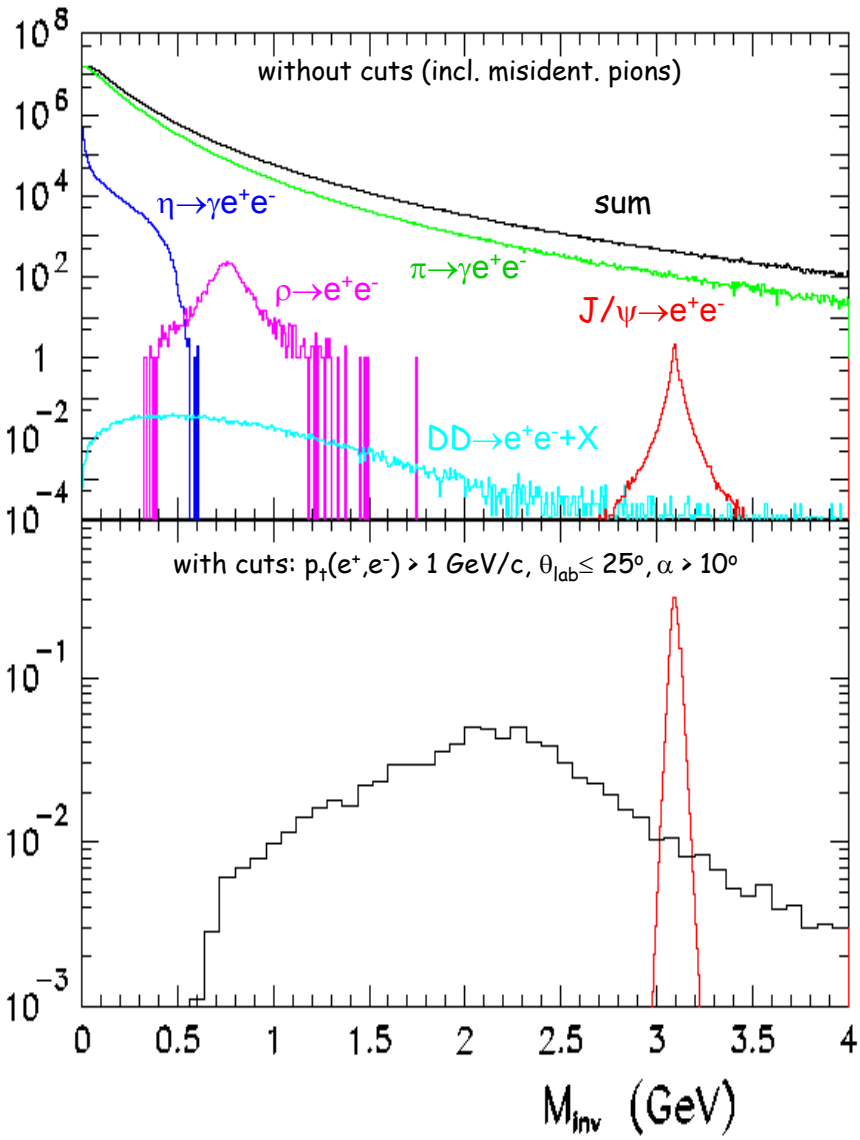


e^+, e^- opening angle



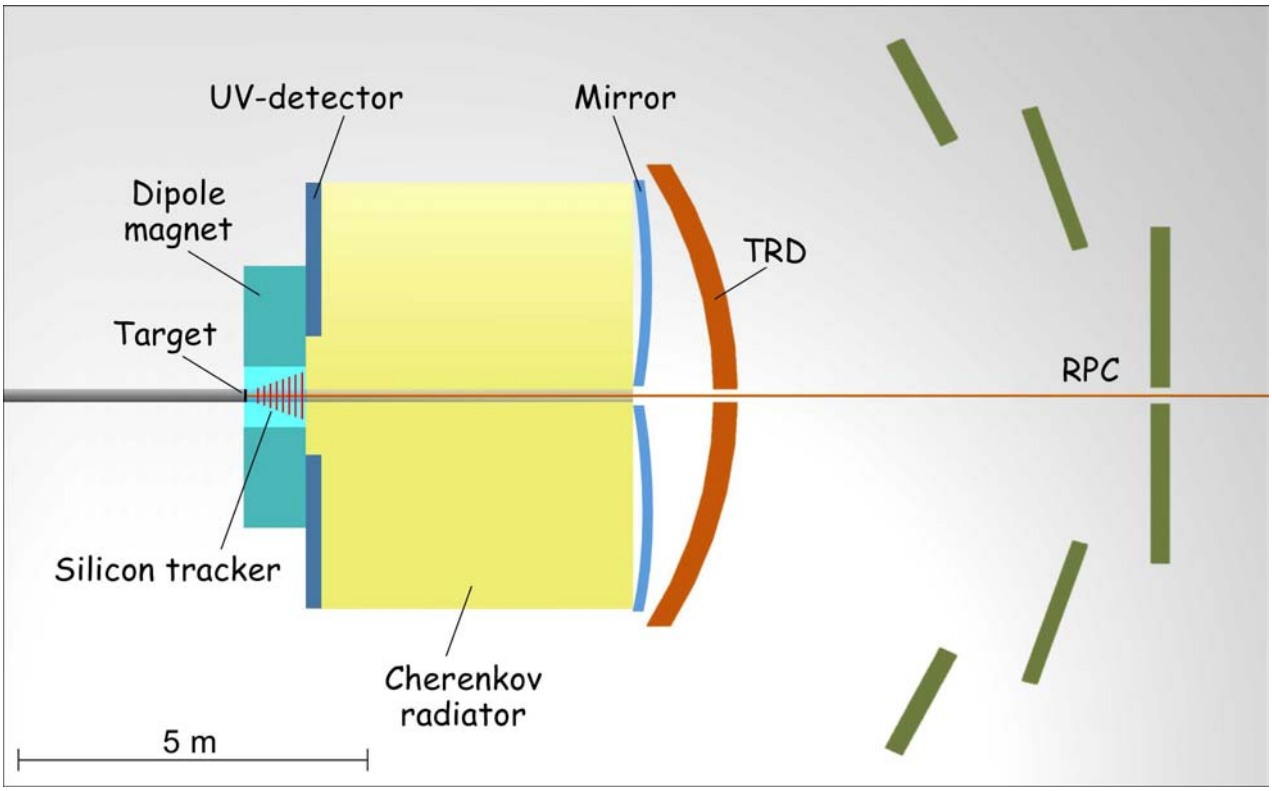
J/Ψ Detection

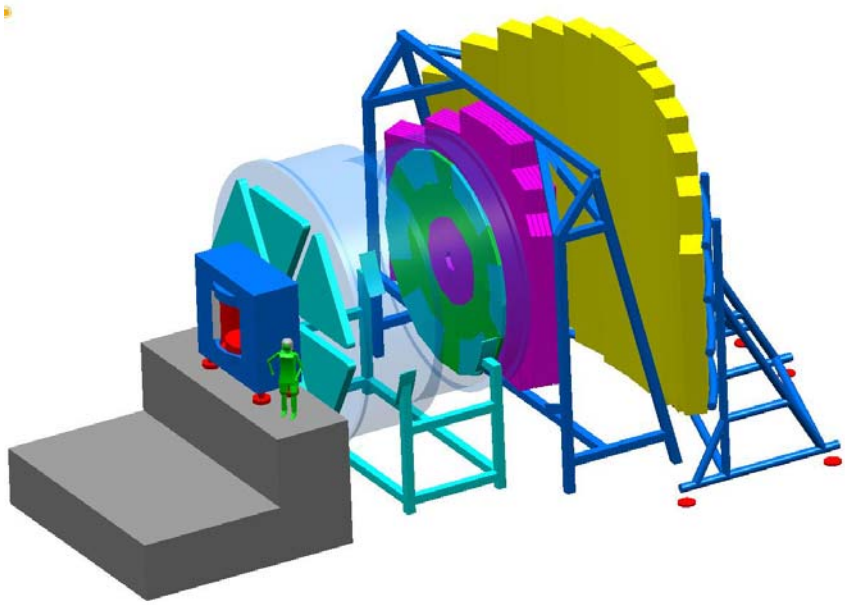
PLUTO + GEANT simulation, 10 M events

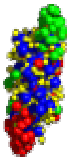


signal / background ≈ 10
estimated detection rate : 80,000 / week

A possible detector concept







Summary

- The future facility at GSI will provide heavy-ion beams from 10-30 AGeV.
- A dedicated heavy-ion experiment will allow to study the (largely unknown) high μ_B region of the QCD phase diagram.
- The physics questions that can be adressed are chiral symmetry restauration (vector meson properties), phase transition (J/Ψ, strangeness) and the critical point (fluctuations).
- The experiment should measure dileptonic decays of ρ, ω, J/Ψ with high precision, weak decays of multistrange hyperons, displaced vertices of D mesons as well as p, π, K.
- These observables should be studied as a function of beam momentum and impact parameter.
- A first, schematic detector concept includes a silicon tracking system, a RICH, a TRD and a TOF-Wall.
- The experimental challenge will be to deal with unprecedented high beam intensities / reaction rates that are needed for rare probes.