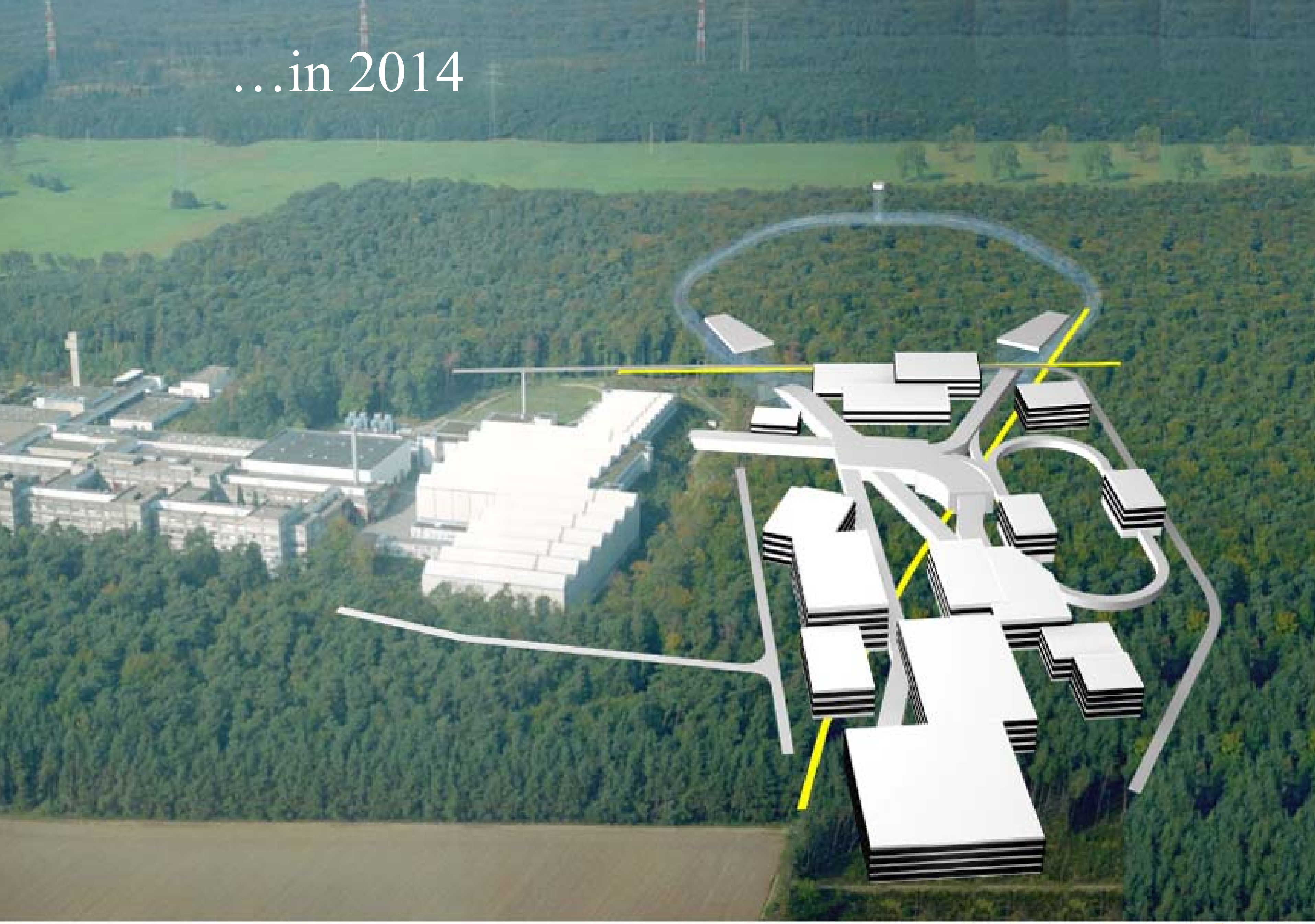
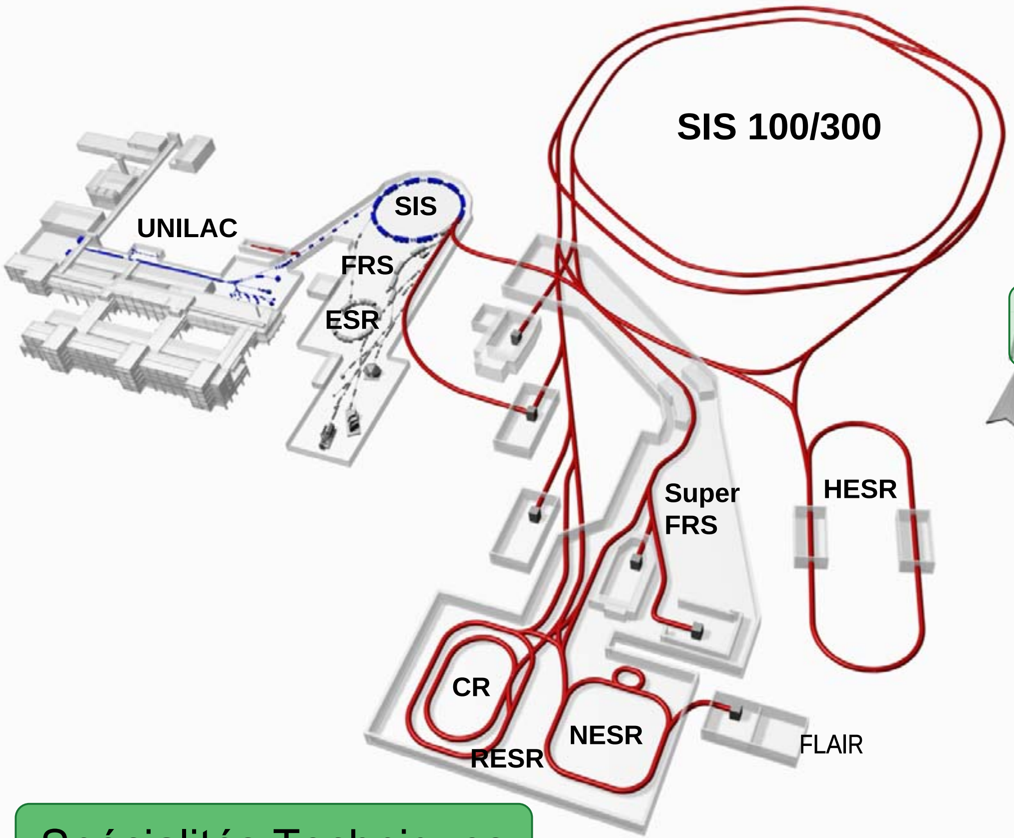
…in 2014



Le Projet International FAIR : Les Characteristiques



Faisceaux Primaires

- 10^{12}/s; 1.5-2 GeV/u; $^{238}U^{28+}$
- **100-1000** plus d'intensité
- $2(4)\times10^{13}$/s 30 GeV protons
- 10^{10}/s $^{238}U^{92+}$ up to 35 GeV/u
- protons de l'énergie jusqu'à 90 GeV

Faisceaux secondaires

•Faisceaux radioactives de 1.5 à 2 AGeV
10 000 x l'intensité d'aujourd'hui
- Antiprotons 0 - 30 GeV

Anneaux de stockage et de refroidissement

•Faisceaux radioactives
e^- – A (or Antiproton-A) collissionneur
•10^{11} antiprotons stockés et refroidis
de 0.8 - 14.5GeV
• Antiprotons polarisés(?)

Spécialités Techniques

•Faisceaux refroidis
•Aimants suprac. pulsés rapidément

Cinque Pilliers Scientifiques +1

- Physique de la structure des Noyaux et Astrophysique nucléaire avec des **faisceaux radioactives**

- Physique Hadronique avec des **Anti-Protons**

- Physique de la matière nucléaire par les collisions des **Ions Lourds Relativistiques**

- Physique du Plasma par les **faisceaux comprimés**

- Physique Atomique and Science Appliqué par des **ions fortement ionisés** et par les **Anti-Protons de très basse énergies**

- ***+ Physique des Accélérateurs***

Letters of Intent (LoI)

Submitted in Spring, 2004

PAC on Nuclear Structure and Nuclear Astrophysics (NUSTAR-PAC): *450 users*

(619)

1.) Low Energy Branch (LEB)	.Scheidenberger	GSI
High-resolution In-Flight Spectroscopy (HISPEC)	J. Gerl	GSI
Decay Spectroscopy with Implanted Ion Beams (DESPEC)	J. Woods	Edinburgh
Precision Measurements of very short-lived Nuclei using an Advanced Trapping System for highly-charged Ions (MATS)	K.Blaum	Mainz
LASER Spectroscopy for the Study of Nuclear Properties (LASPEC)	W.Nörtershäuser	GSI
Neutron Capture Measurements (NCAP)	M.Heil	FZK
Antiprotonic Radioactive Nuclides (Exo+pbar)	M. Wada	Riken
2.) High Energy Branch (R3B)		
A Universal Setup for Kinematical Complete Measurements of Reactions with Relativistic Radioactive Beams (R3B)	T. Aumann	GSI
3.) Ring Branch (STORIB)		
Study of Isomeric Beams, Lifetimes and Masses (ILIMA)	Y .Novikov	SPNPI
Exotic Nuclei Studied in Light-Ion Induced Reactions at the NESR Storage Ring (EXL)	H. Emling	GSI
Electron-Ion Scattering in a Storage Ring (e-A Collider) (ELISe)	H. Simon	GSI
Antiproton-Ion Collider: A Tool for the Measurement of Neutron and Proton rms radii of Stable and Radioactive Nuclei (pbarA)	P. Kienle	TUM
Spectroscopy of Pionic Atoms with Unstable Nuclei (PIONIC)	K. Itahashi	Riken

Letters of Intent (LoI)

Submitted in Spring, 2004

PAC on QCD:

834 users

ASSIA Study of Spin-dependent Interactions with Antiprotons	R.Bertini	Torino
CBM Compressed Baryonic Matter Experiment	P.Senger	GSI
DIRAC Tests of Low Energy QCD	L.Nemenov	JINR Dubna
PANDA Strong Interaction Studies with Antiprotons	U.Wiedner	TSL Uppsala
PAX Antiproton-Proton Scattering Experiments with Polarization	F.Rathmann	FZJ

505 users

PAC on Atomic Physics, Plasma Physics and Applications (APPA-PAC):

Laser Cooling of Highly Charged Ions at SIS 100/300	U. Schramm	LMU
FLAIR - A Facility for Low-energy Antiproton and Ion Research	E. Wiedman	Tokyo
Anti-deuteron Breeding in a Double Ring Collider	W. Oehlert	FZ-Jülich
SPARC Stored Particles in Atomic physics Research	R. Schuch	Stockholm
HEDGEHOB: High Energy Density matter GEenerated by Heavy-iOn Beams	D. Varentsov	Darmstadt
Applications of Relativistic Ions in Radiobiology and Space Research	M. Durante	Napoli
Materials Research with Relativistic Heavy Ion Beams	S. Klaumünzer	HMI
Radiative Properties of Warm Dense Matter	F. B. Rosmej	Marseille

‘Nuclear Structure Physics and Nuclear Astrophysics’ (NUSTAR) par des

Faisceaux des Ions Radioactives

Pour étudier

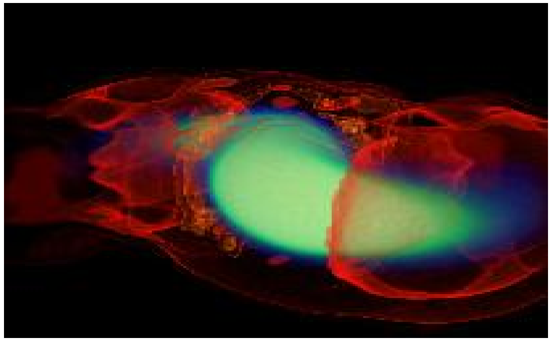
- **La Structure des noyaux éxotiques loin du vallée de la stabilité;**
- **Synthèse des noyaux dans les étoiles et l’explosions des étoiles**
- **Interactions and symmetries fondamentales**

Comment sont ils formés les éléments?

Motivation for RIBs

Zur Anzeige wird der QuickTime™ Dekompressor „Cinepak“ benötigt.

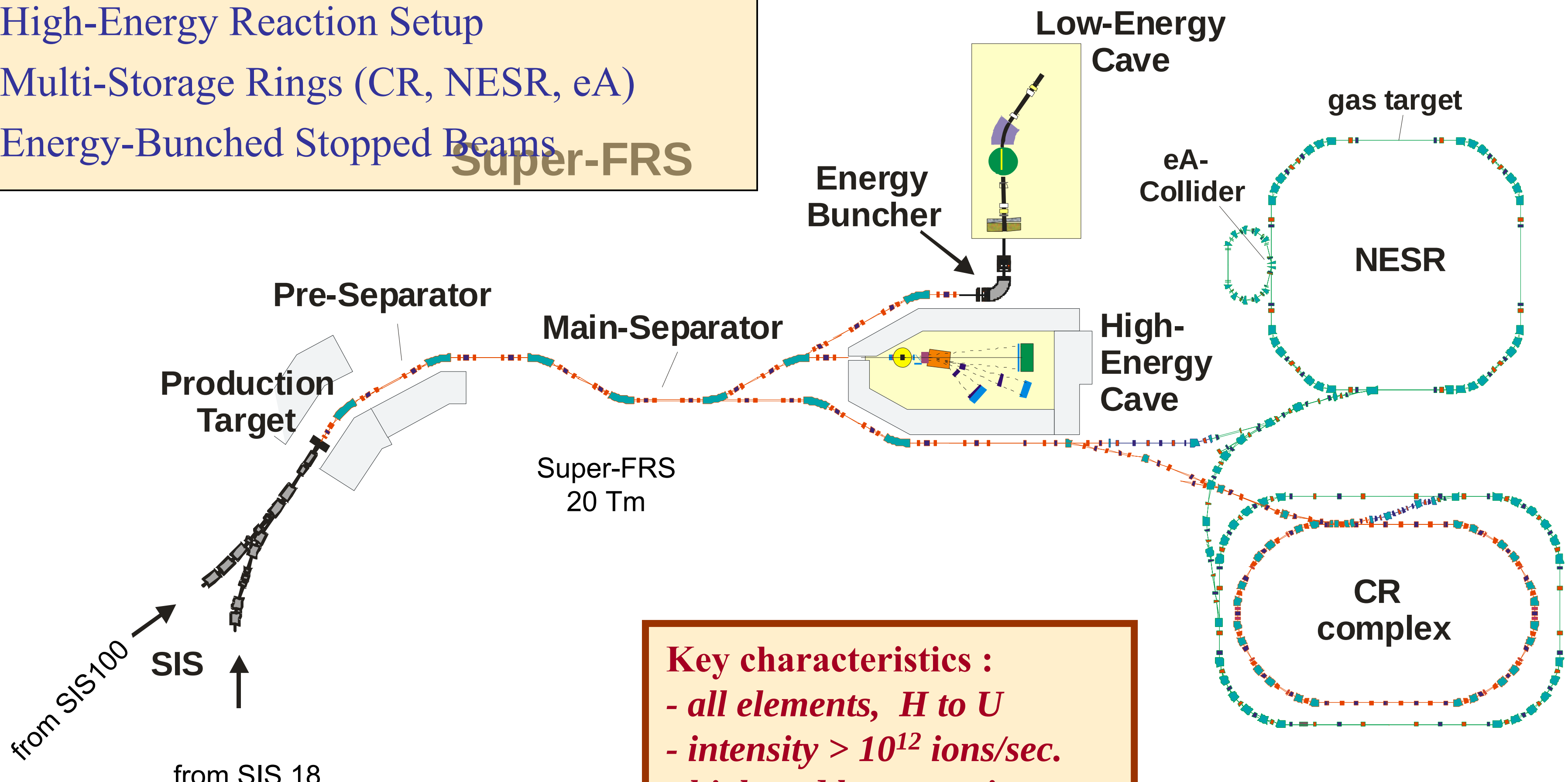
e.g. R-Process
in Neutron Star Mergers ?



Ni^{70} imbedded in large neutron flux

The In-Flight Rare-Isotope Beam Facility 0 - 1500 AMeV

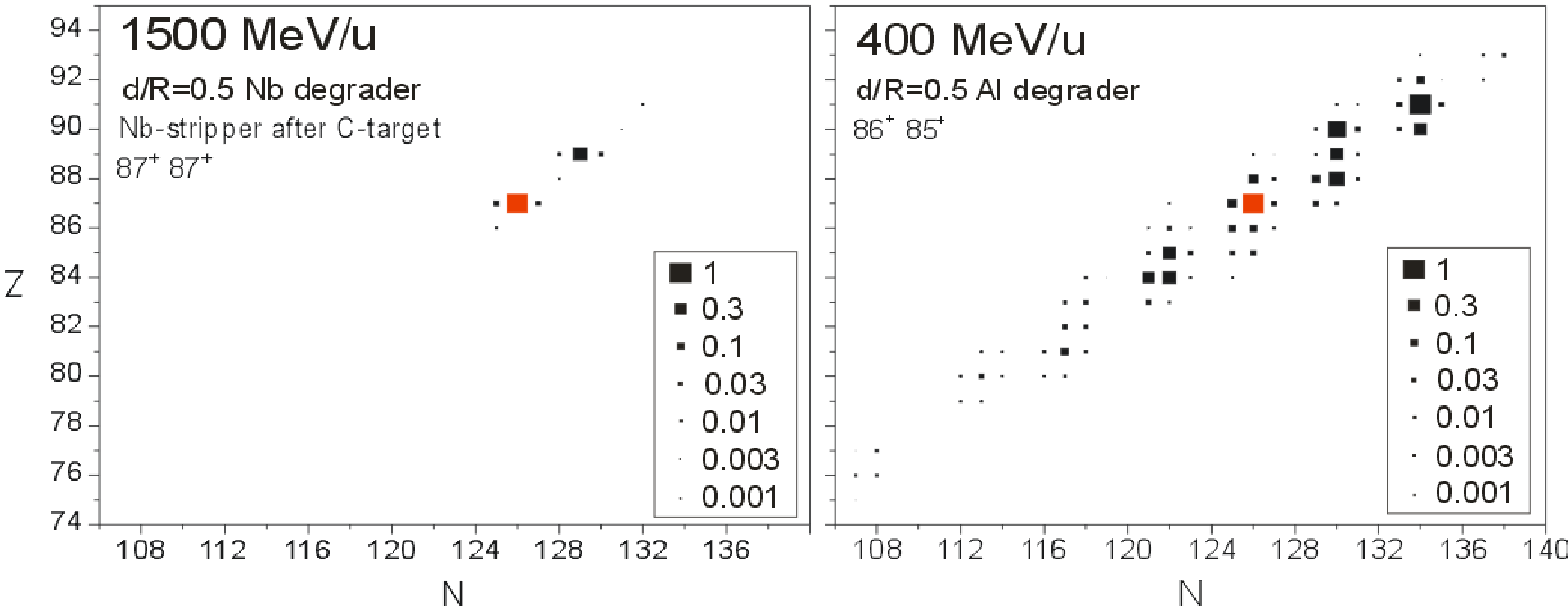
- Superconducting FRagment Separator
- High-Energy Reaction Setup
- Multi-Storage Rings (CR, NESR, eA)
- Energy-Bunched Stopped Beams



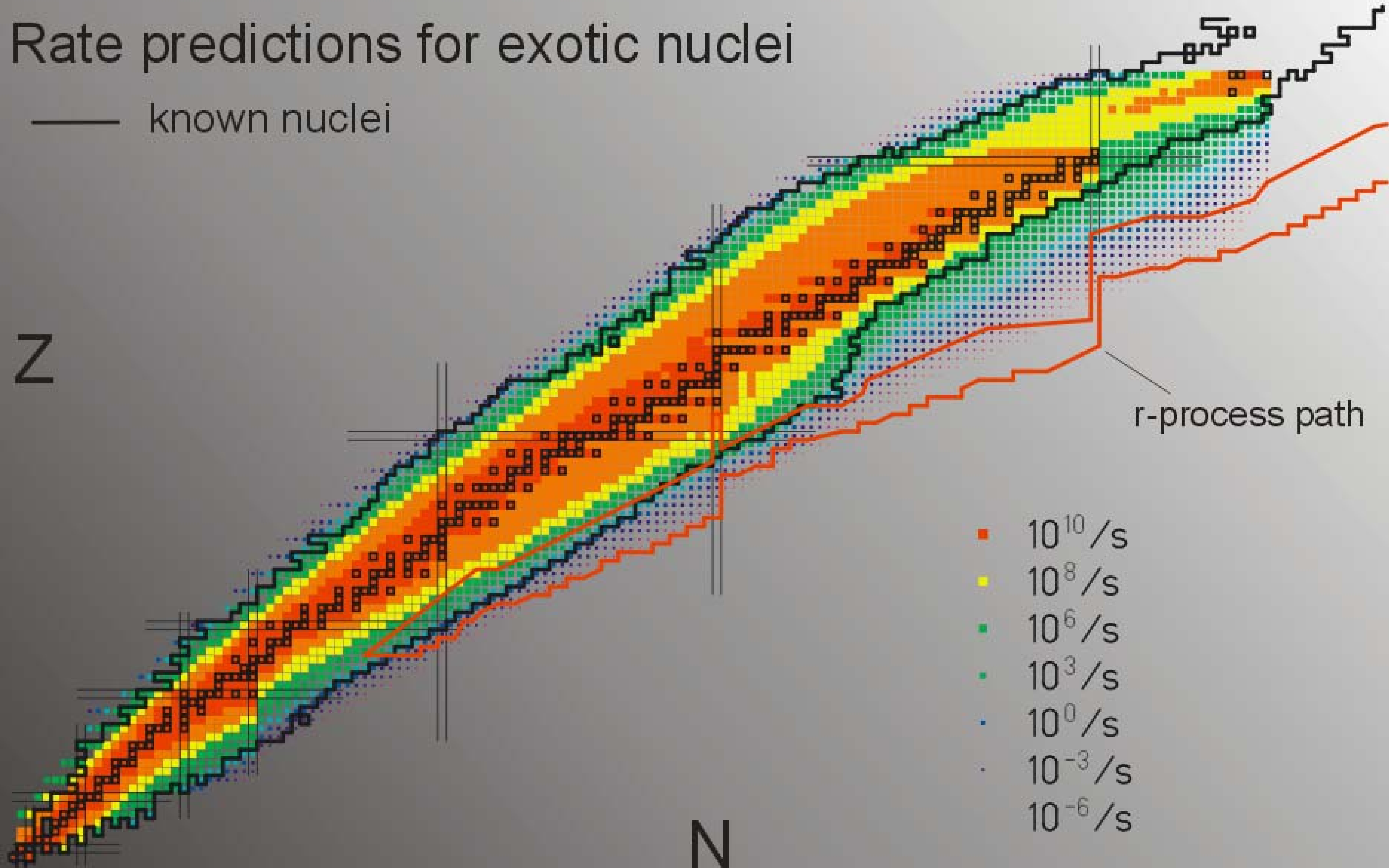
Key characteristics :
- ***all elements, H to U***
- ***intensity > 10^{12} ions/sec.***
- ***high and low energies***
- ***pulsed and CW beams***

Meilleures Séparation des isotopes aux énergies élevées

Fr^{213} par fragmentation de U^{238}, séparateur principal du Super-FRS



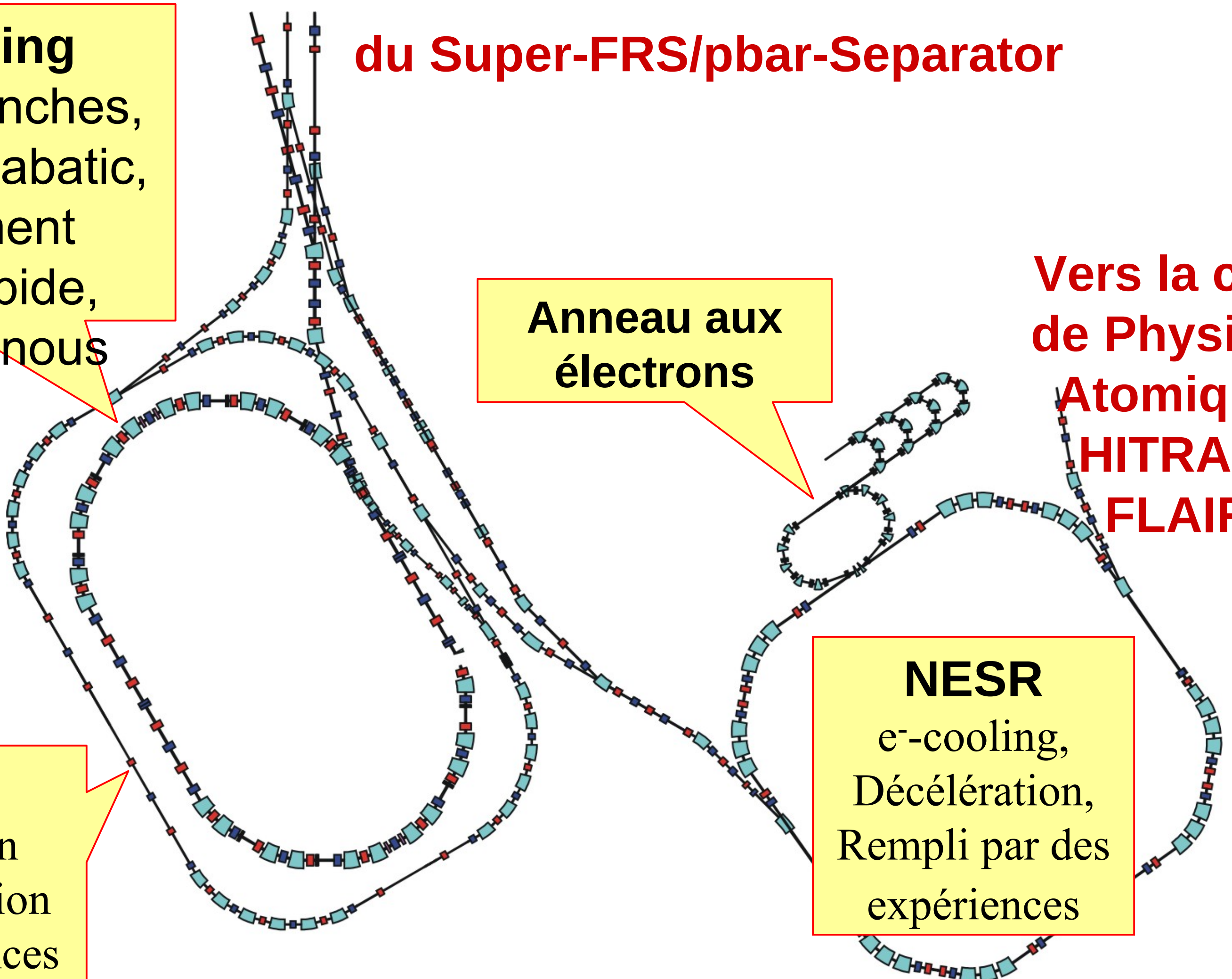
Rate predictions for exotic nuclei



K.H. Schmidt et al.

Les Anneaux de Stockage

Collector Ring
rotation des bunches,
debunching adiabatic,
refroidissement
stochastic rapide,
mode isochronous



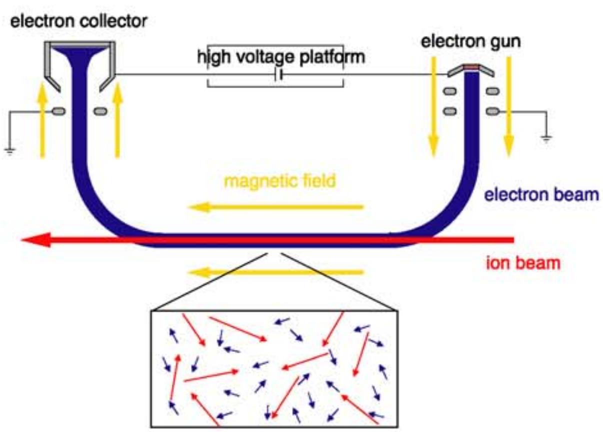
Anneau aux électrons

NESR
e^--cooling,
Décélération,
Rempli par des expériences

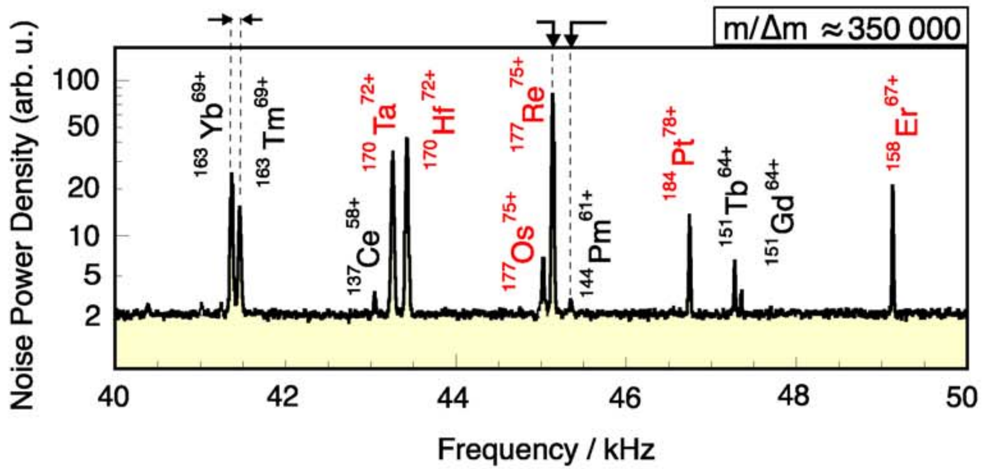
RESR
pbar accumulation
RIB/pbar décélération
quelleques expériences

Refroidissement des Isotopes Radioactive par Électrons

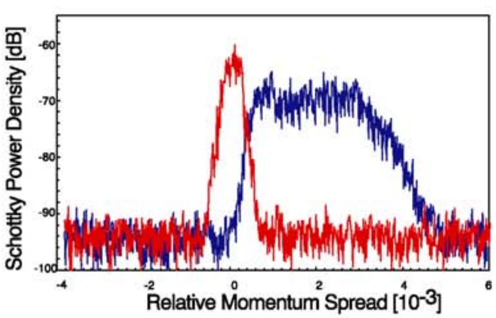
Principle of Electron Cooling



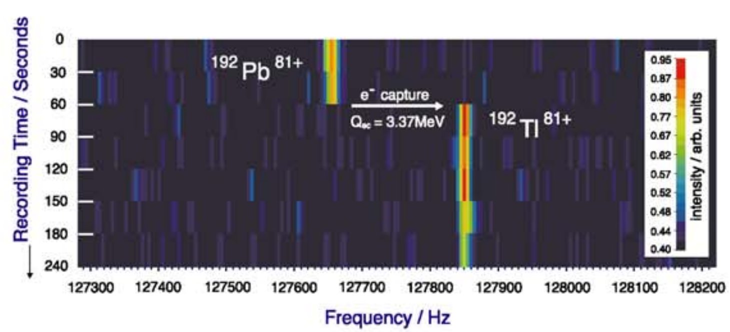
Schottky Mass Spectroscopy



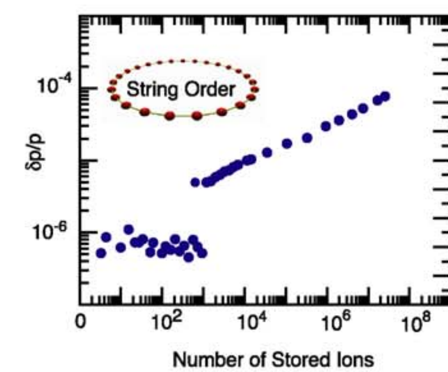
Cooling of Fragment Beams



Decay Spectroscopy of Single Ions



Beam Ordering



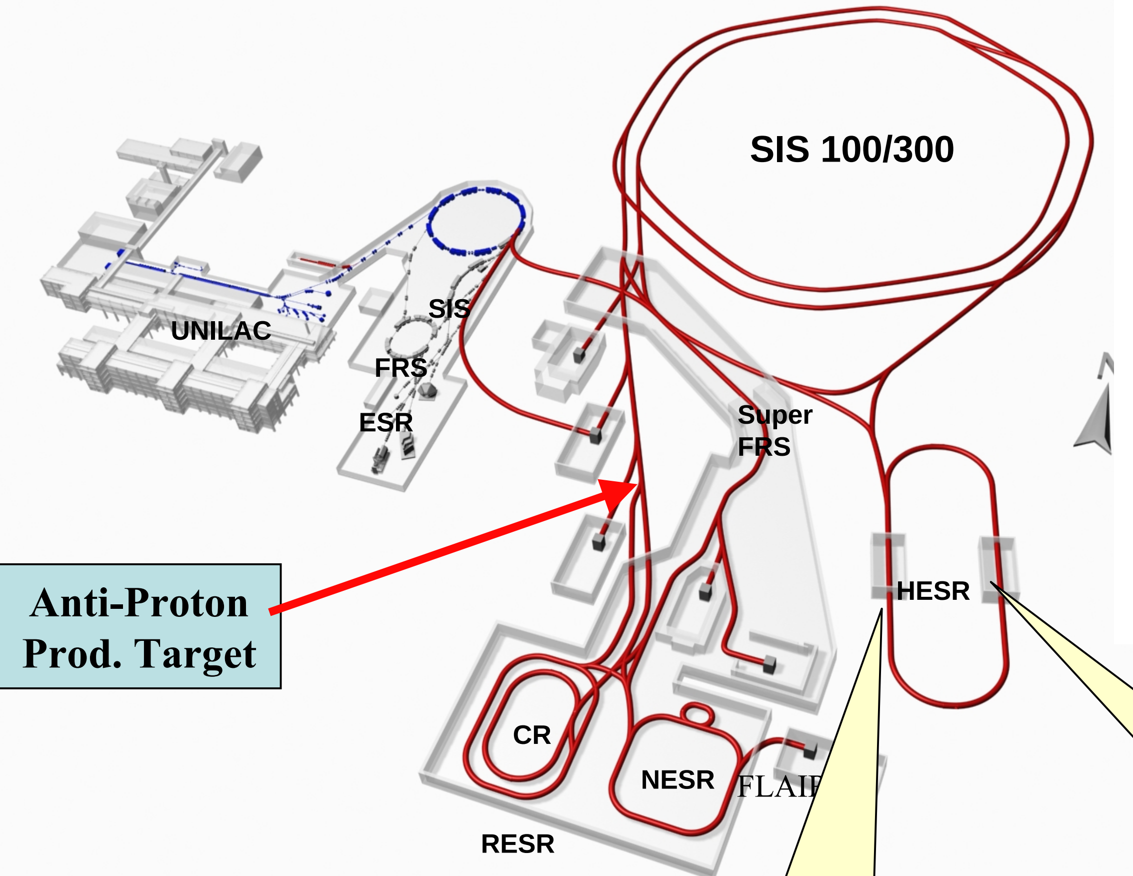
Physique Hadronique via **Antiprotons**

pour étudier

- **la structure Quarkonique et Gluonique et la dynamique des particules avec une interaction forte;**
- **l'Origine du confinement et de la masse des hadrons**
- **la Transversité via antiprotons polarizés et protons polarizés**

Qui donne la Masse aux Hadrons?

Anti-Protons à FAIR de 0 à 30 GeV/c



HESR (High Energy Storage Ring) with electron and stochastic Cooling

Length 442 m Br = 50 Tm

$N_{stored\ p\_bar}$ = 5 x 10^{10} anti-protons

<u>High luminosity mode</u>

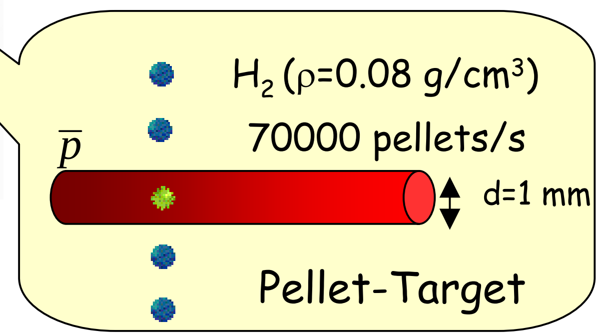
Luminosity = 2 x 10^{32} $cm^{-2}s^{-1}$

$\partial p/p \sim 10^{-4}$ (stochastic- cooling)

<u>High resolution mode</u>

$\partial p/p \sim 10^{-5}$ (electron cooling < 8 GeV/*c*)

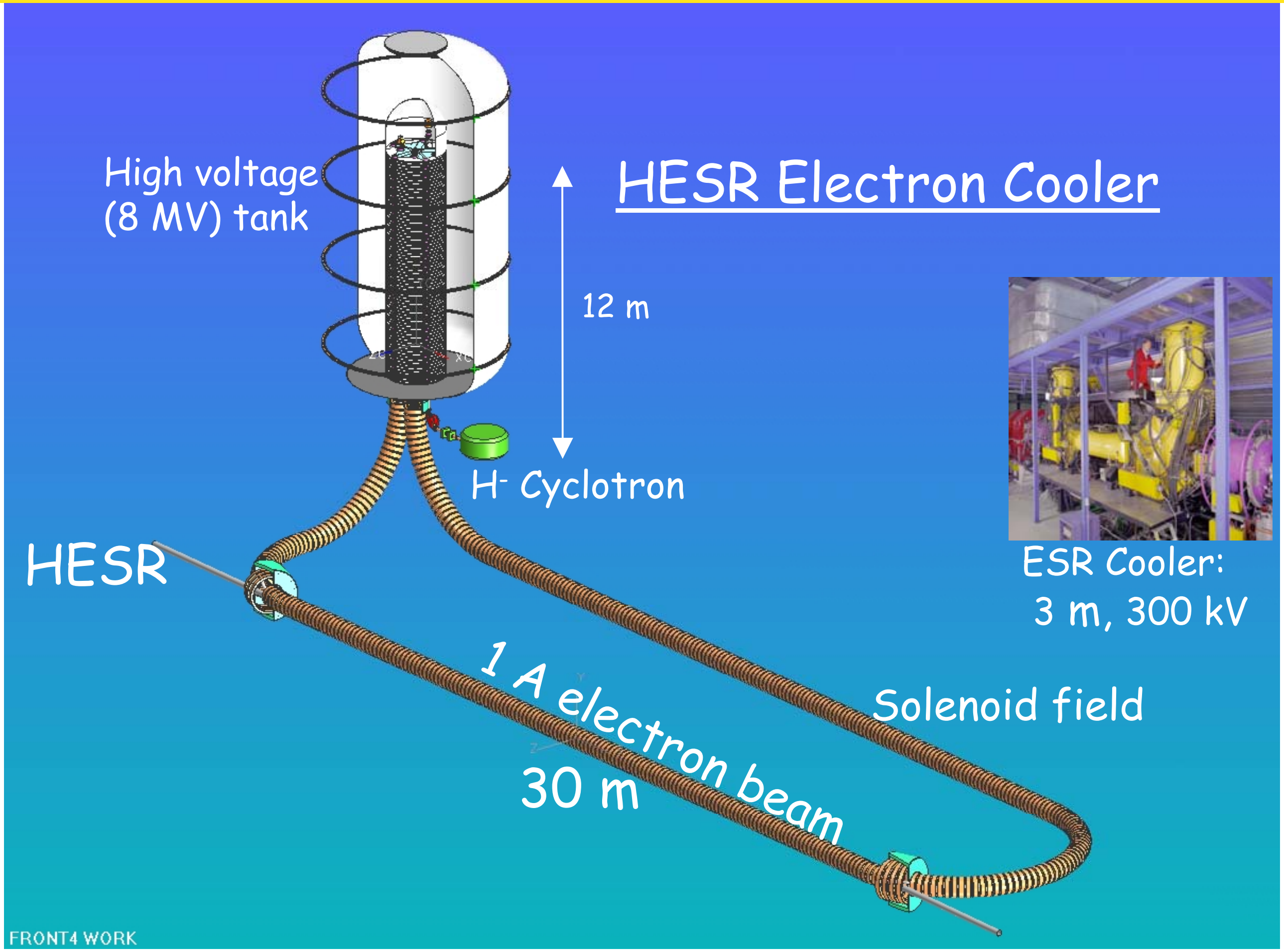
Luminosity = 10^{31} $cm^{-2}s^{-1}$



1 A, 8 MeV e-beam
30 m cooling section
0.5 T magnetic Field

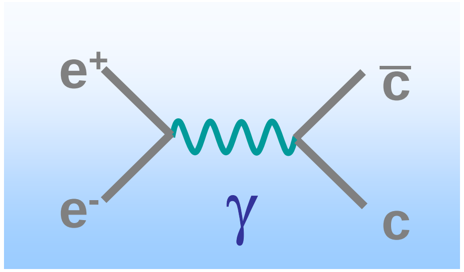
- Antiproton production similar to CERN,
- Production rate 10^7/sec at 30 GeV
- Anti-Proton$_{beam}$ = 0 - 15 GeV/*c*

Étude de Faisabilité pour un refroidissement rapide des antiprotons de hautes énergies (en quelques secondes) par des électrons pour le HESR, par l'institut Budker de Novosibirsk, RUS

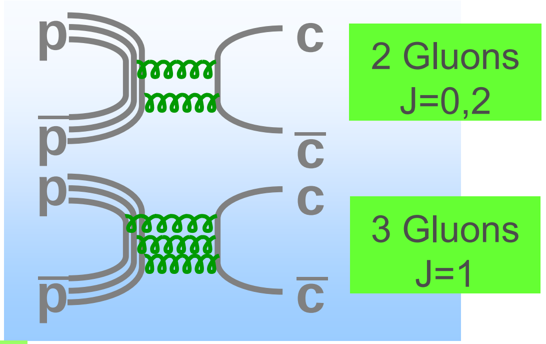


Pourquoi $\bar{p}p$ en Physique Hadronique?

- $e^+e^- \rightarrow c\,\bar{c}$ permet seulement la **production direct** des états avec Quantum numbers du **Photon $J^{PC}=1^{--}$**

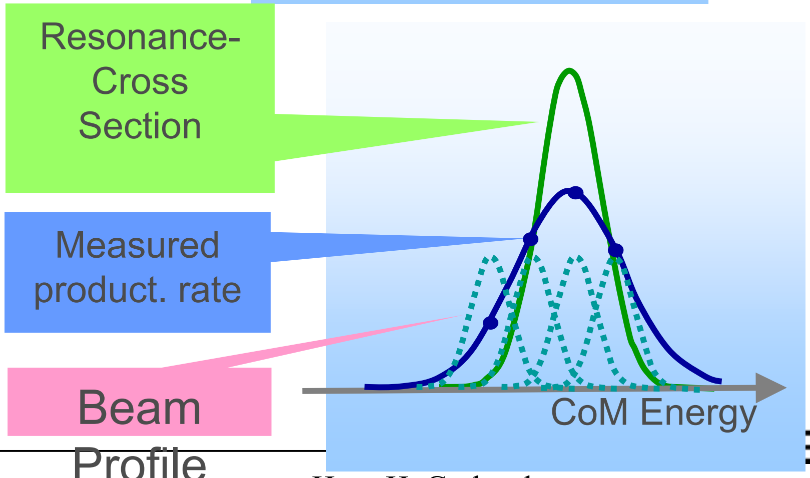


- Tous les autres états seulement via γ-decay

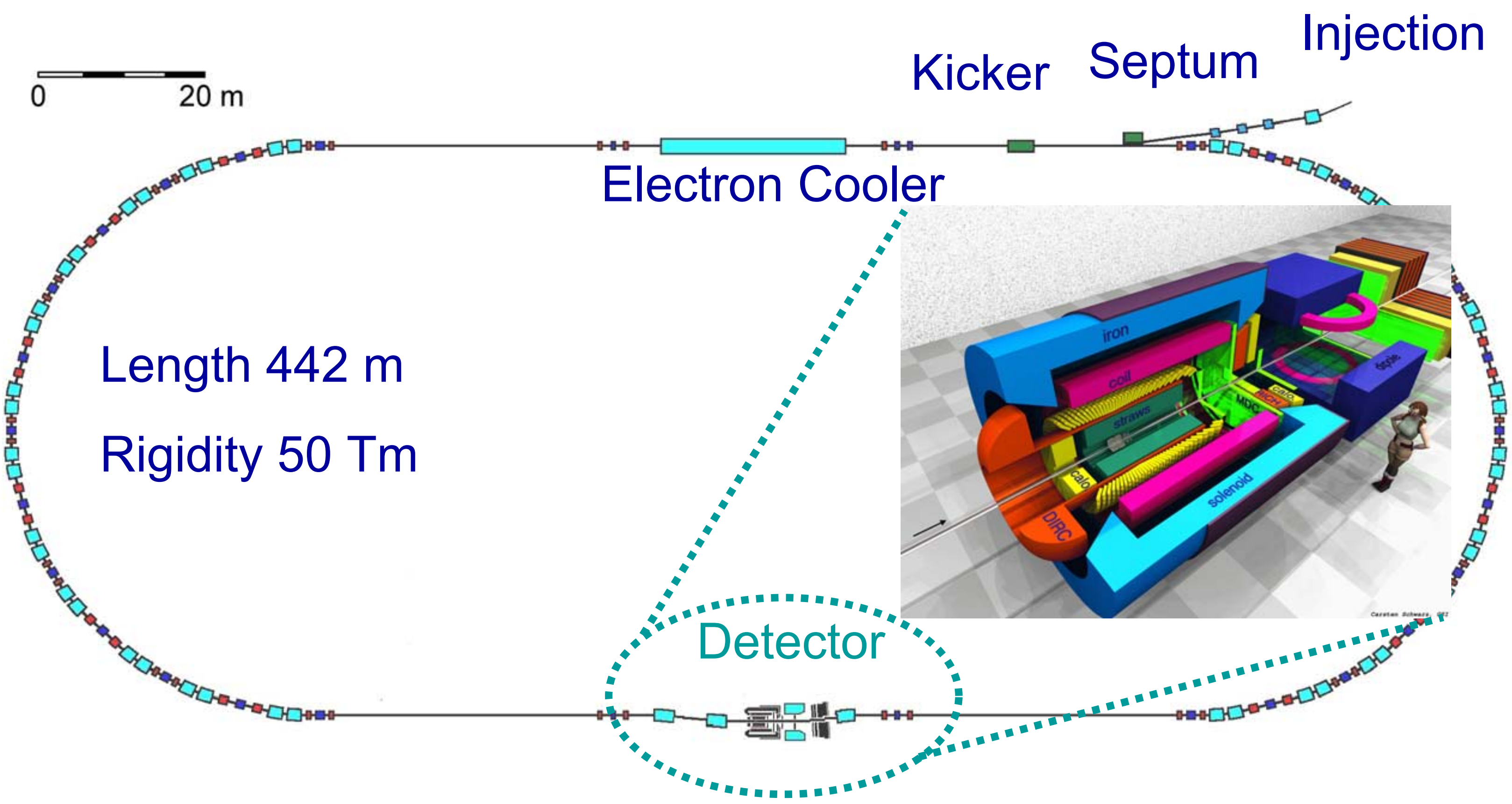


- $\bar{p}p \rightarrow \bar{c}c$ permet la formation direct de **tous les états**

- Détermination de la **Masse** et de la largeur (**Width)** avec une haute précision („Resonance-Scan“)



HESR and PANDA



PANDA Collaboration

At present a group of **320 physicists** from 44 institutions of 11 countries

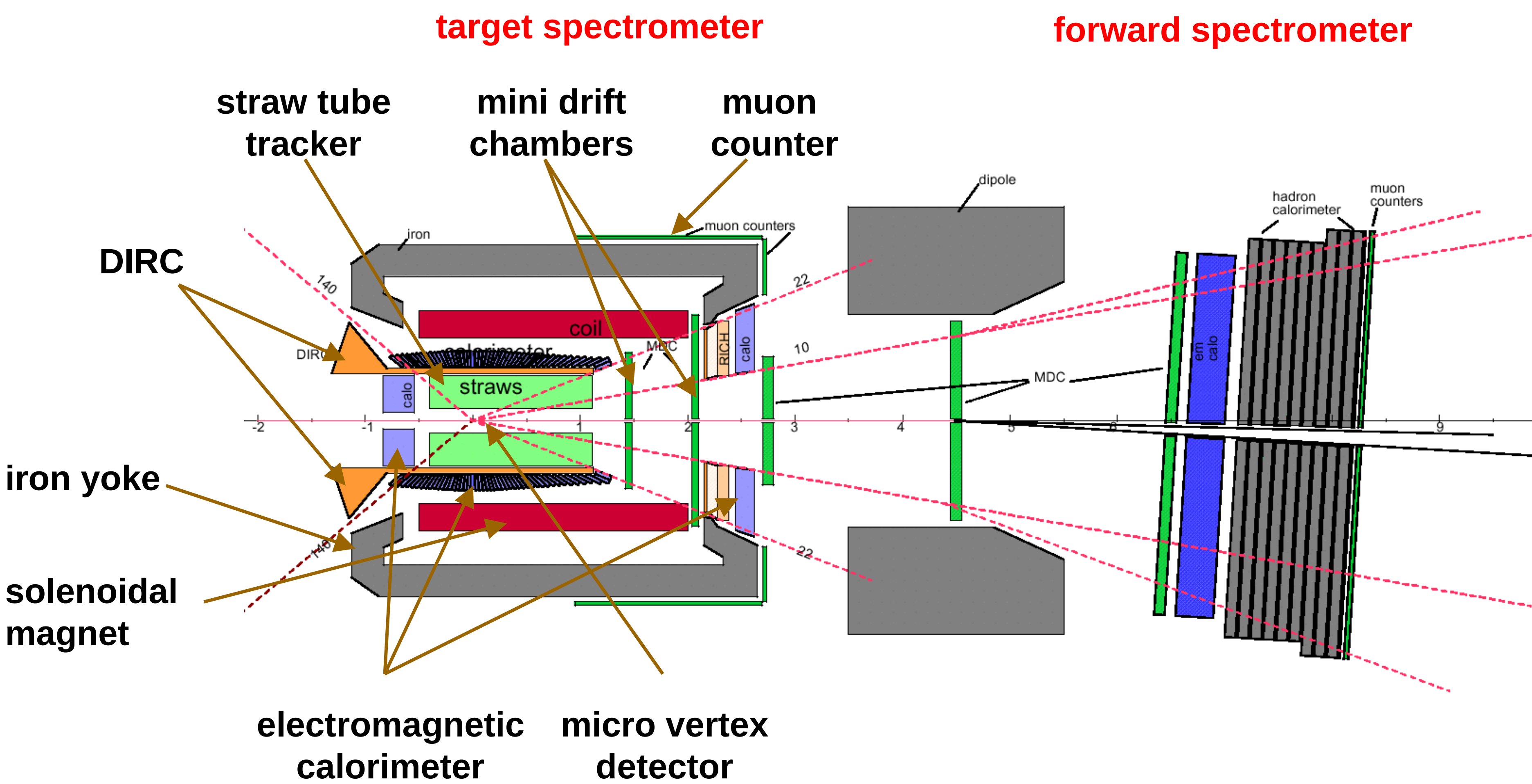
Austria – China - Germany – Italy – Netherlands – Poland – Russia – Sweden – Switzerland - U.K. – USA

Basel, Beijing, Bochum, Bonn, Catania, Cracow, Dresden, Edinburg, Erlangen, Ferrara, Frankfurt, Genova, Giessen, Glasgow, KVI Groningen, GSI, FZ Jülich, JINR, Katowice, Lanzhou, LNF, Mainz, Milano, Minsk, TU München, Münster, Northwestern, BINP Novosibirsk, Pavia, Piemonte Orientale, IHEP Protvino, PNPI St. Petersburg, Stockholm, Torino I + II, Torino Politecnico,Trieste, TSL Uppsala, Tübingen, Uppsala, SINS Warsaw, TU Warsaw, AAS Wien

Spokesperson: Ulrich Wiedner - Uppsala; Deputy: Paola Gianotti - Frascati INFN

http://www.gsi.de/zukunftsprojekt/experimente/hesr-panda/

panda Detector

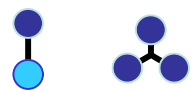


Interaction rate of 10^7/s

Les Objets du Désire

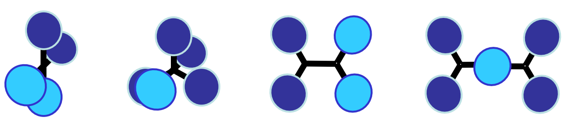
$SU(3)_C$ Symmetry tells us that $q^{3i+n}q^{3j+n}g^{k}$ is color neutral

- Mesons/Baryons



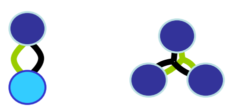
i=1 j,n,k=0 baryon (B=i-j)
i,j,k=0 n=1 meson

- Molecules/Multiquarks



i,n=1 j,k=0 penta quark
i,j,k=0 n=2 four quark
i,j,k=0 n=3 / i,j=3 k,n=0 baryonium (hexa quark)

- Hybrids



i,j=0 n=1 k>0 meson hybrid
i=1 j,n=0 k>0 baryon hybrid

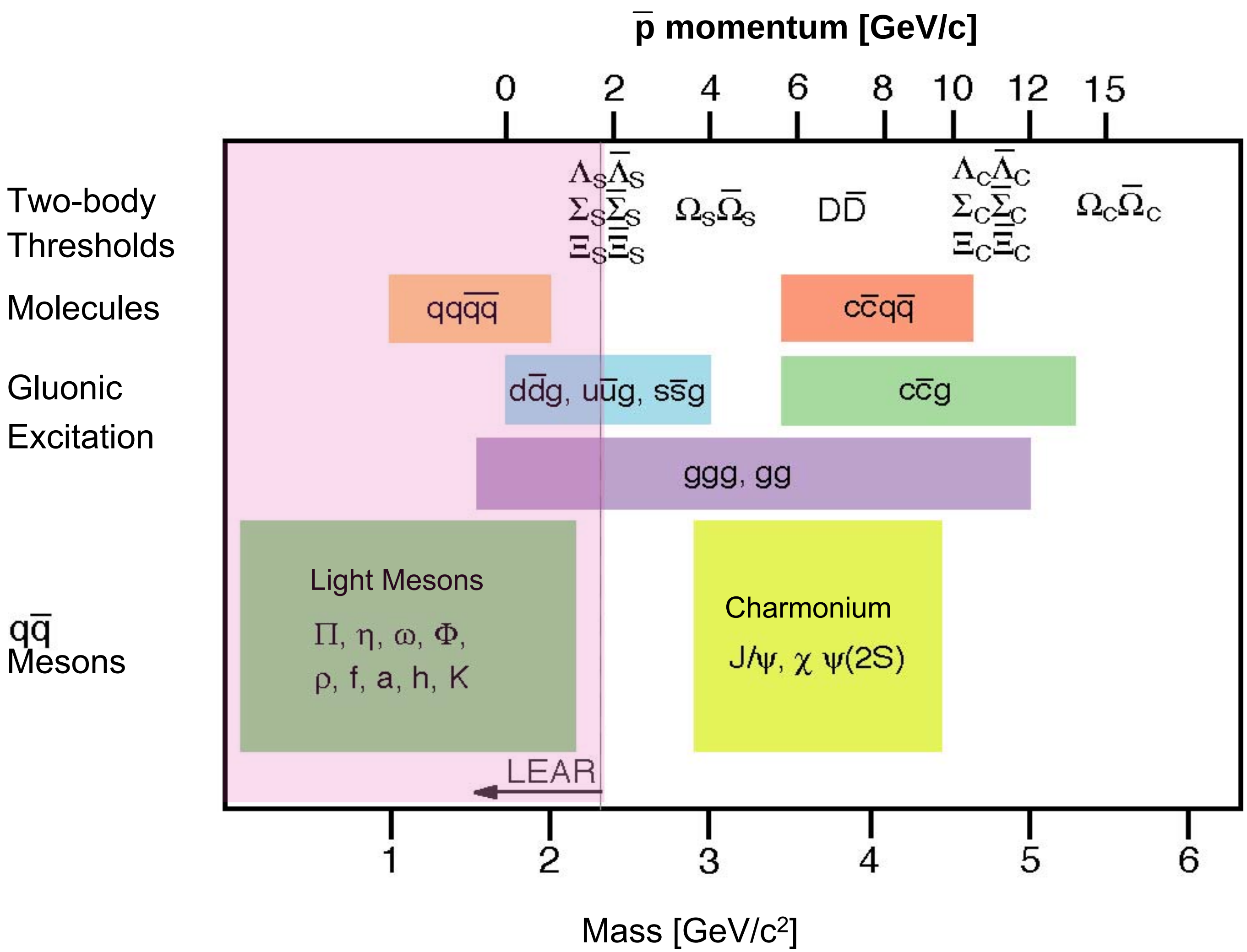
- Glueballs

- + other Effects

Quark AntiQuark

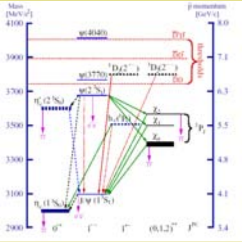
Le Potential en Physique de l'Usine à Antiproton

- structure Quarkonique et gluonique et le dynamisme dans les "strong" interacting particules;
- L'Origine du confinement et de la mass des hadrons

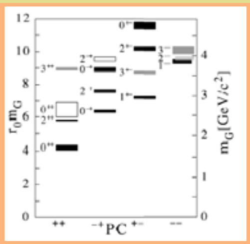


Antiproton Physics Program

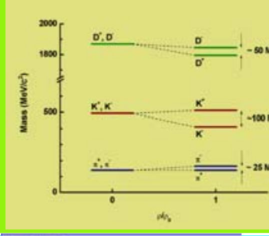
Charmonium ($\bar{c}c$) spectroscopy: precision measurements of mass, width, decay branches of all charmonium states, especially for extracting information on the quark confinement.



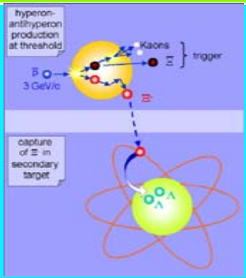
Search for gluonic excitations (charmed hybrids, glueballs) in the charmonium mass range (3 – 5 GeV/c^2).



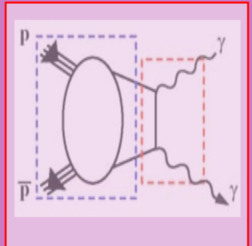
Search for modifications of meson properties in the nuclear medium, and their possible relationship to the partial restoration of chiral symmetry for light quarks. (*see relativistic nuclear collision program*)



Precision γ-ray spectroscopy of single and double hypernuclei for extracting information on their structure and on the hyperon-nucleon and hyperon-hyperon interaction.



Proton Form-Factors at large Q^2 up to 25 GeV^2/c^4
$D_{(S)}$-Physics BR and decay Dalitz plots
CP-Violation in the D/Λ sector



Physique de la Matière Nucléaire étudiée par les

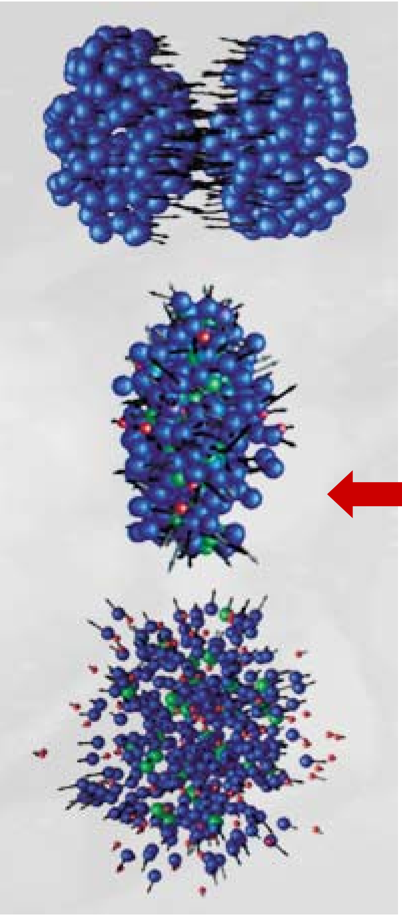
Collisions Nucléaires Relativistes

- **Études de la matière hadronique de haute densité;**
- **Transitions de Phase en quark matière de quark et de gluons;**
- **Characteristiques des étoiles neutrons**
- **Modification de la Masse dans le milieu dense**

La Masse dans le milieu, elle change?

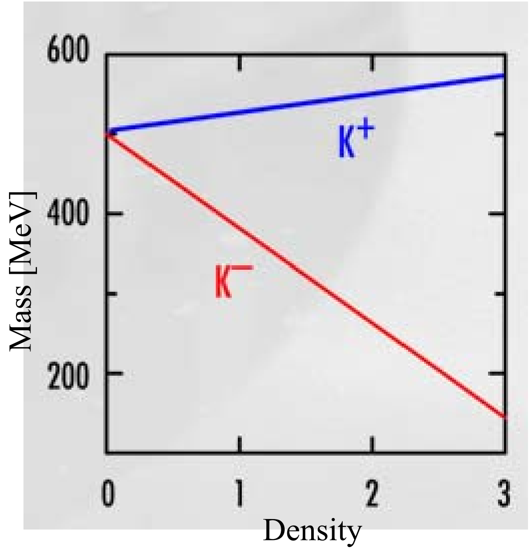
Motivation for NN collisions at 2-40 AGeV

Hadrons in the Nuclear Medium

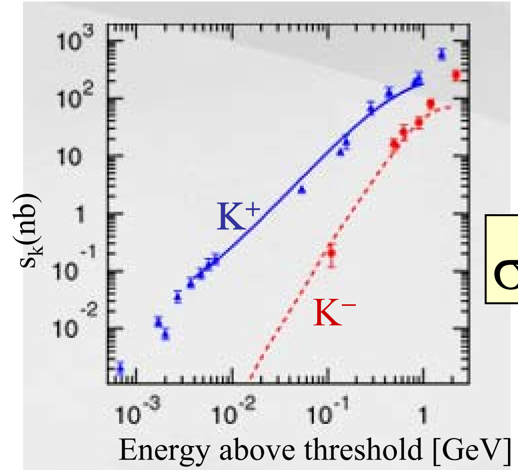


Theoretical Prediction:

Masses of particles are modified in dense nuclear matter

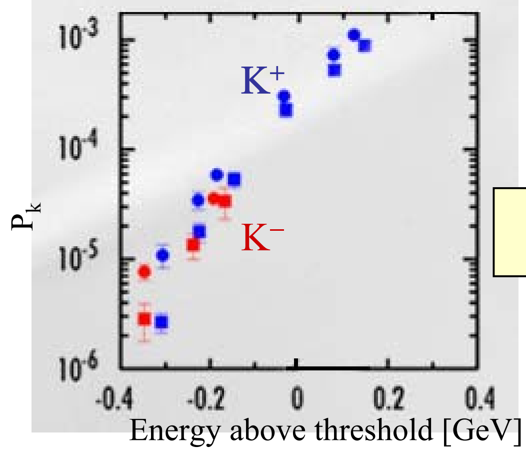


Proton-Proton Collisions



$$\sigma_{K^-} \lesssim \frac{1}{10}\,\sigma_{K^+}$$

Nucleus-Nucleus Collisons



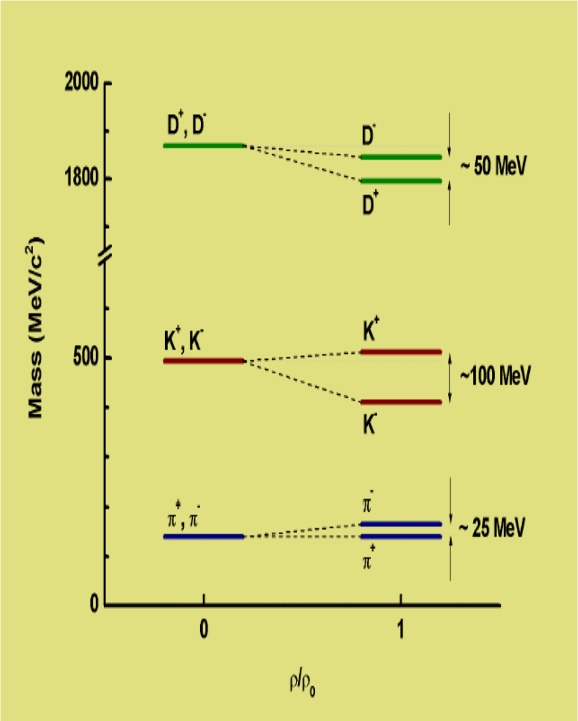
$$\sigma_{K^-} \approx \sigma_{K^+}$$

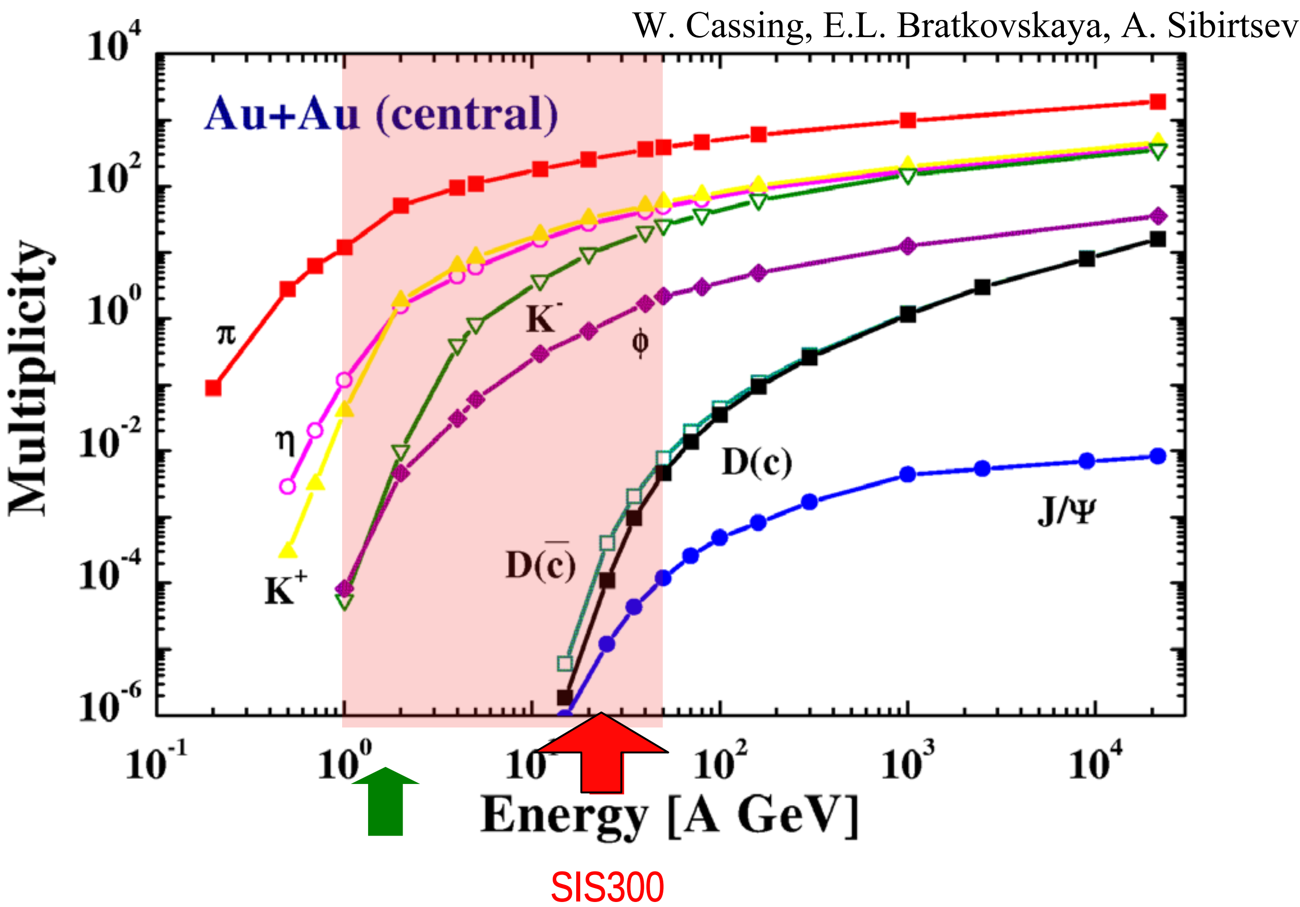
- Enhanced K^--yield in nucleus-nucleus collisions
- Evidence for K-mass modification in dense matter

Motivation for NN collisions at 2-40 AGeV

Meson production in central Au+Au collisions

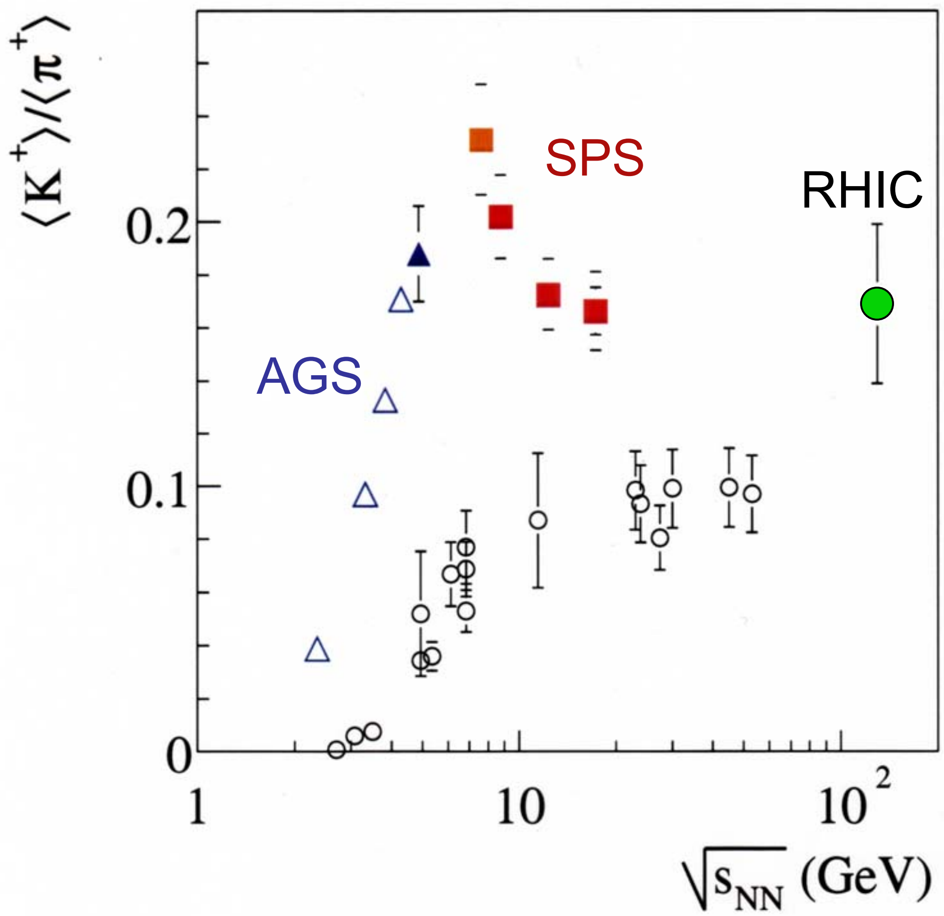
Theory

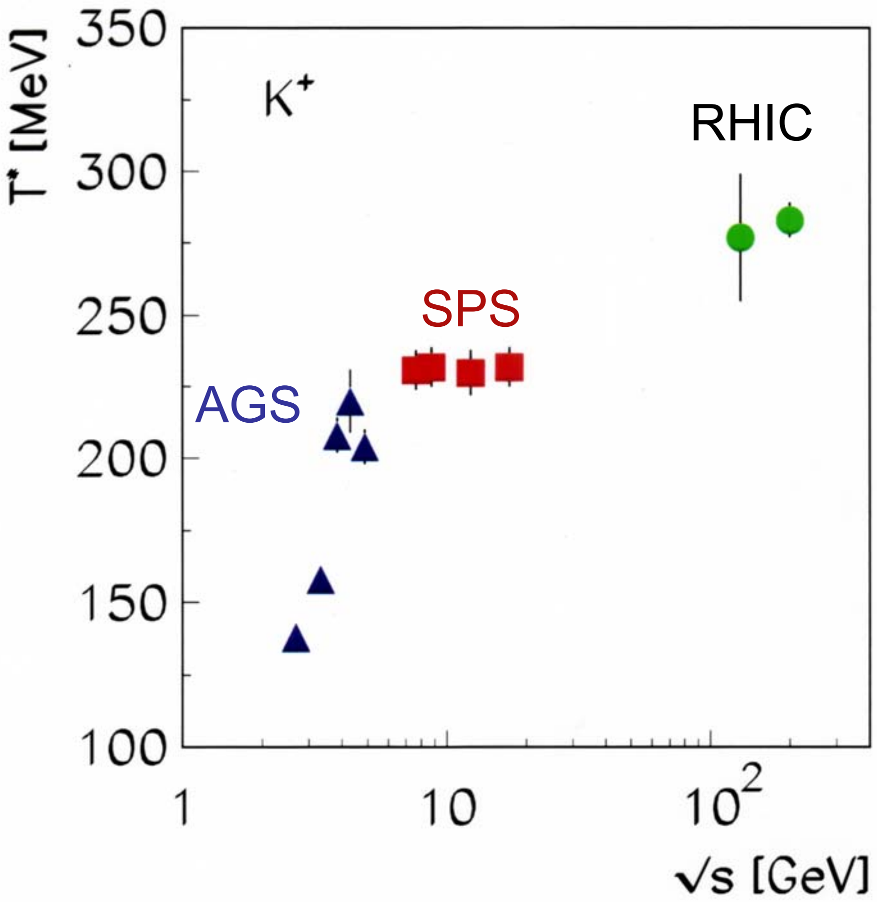




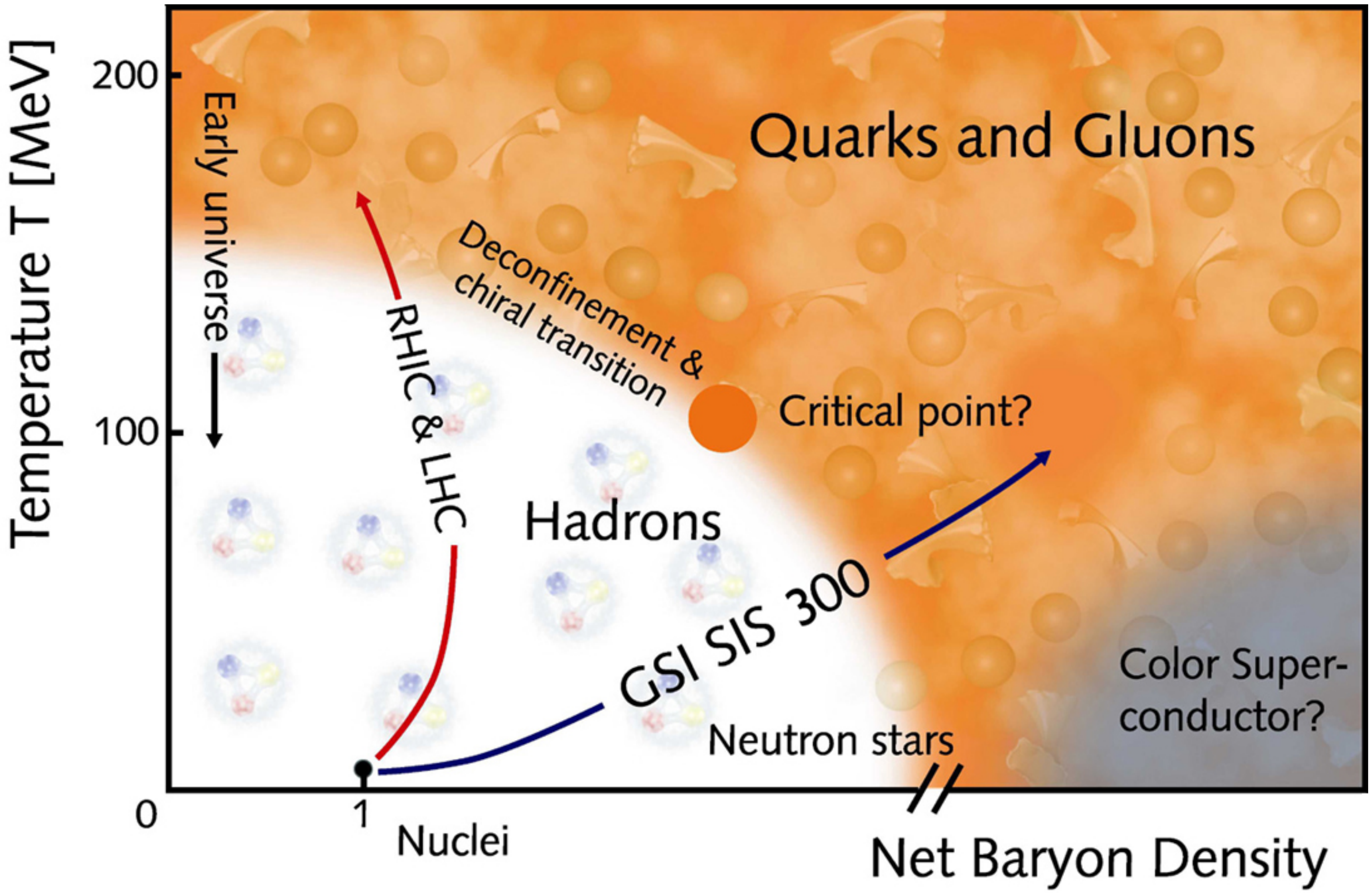
Charm production at threshold
>> probing in-medium properties at $\rho = 5 - 10\ \rho_0$

Matter at High Baryon Densities: *Strange Phenomena*





Exploring the Phase Diagram of Strongly Interacting Matter via Di-Leptons



RHIC, LHC: high temperature, low baryon density

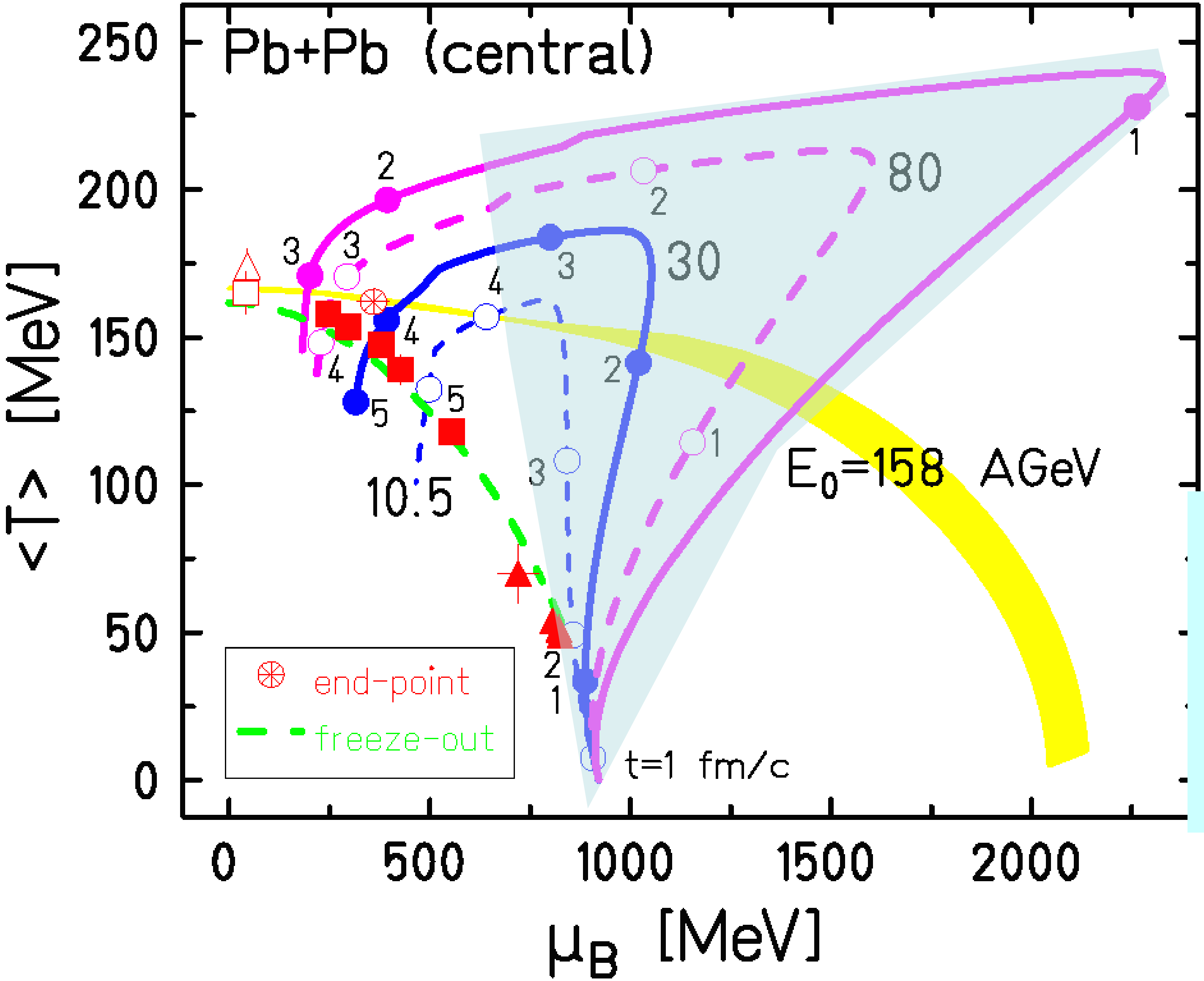
FAIR SIS300: moderate temperature, high baryon density

Motivation for NN collisions at 2-40 AGeV

CBM

"Trajectories" (3 fluid hydro)

Ivanov & Toneev



WA98: Direct Photons

Hadron gas EOS

Calculations reproduce freeze-out conditions

30 AGeV trajectory close to the critical endpoint

GSI

CBM Collaboration : 39 institutions, 14 countries, 240 scientists

"Di-Leptons"

(p-p, p-A, A-A collisions 7-45 AGeV)

Croatia:
RBI, Zagreb

Cyprus:
Nikosia Univ.

Czech Republic:
Czech Acad. Science, Rez
Techn. Univ. Prague

France:
IReS Strasbourg

Germany:
Univ. Heidelberg, Phys. Inst.
Univ. HD, Kirchhoff Inst.
Univ. Frankfurt
Univ. Mannheim
Univ. Marburg
Univ. Münster
FZ Rossendorf
GSI Darmstadt

Hungaria:
KFKI Budapest
Eötvös Univ. Budapest

Korea:
Korea Univ. Seoul
Pusan Univ.

Norway:
Univ. Bergen

Poland:
Krakow Univ.
Warsaw Univ.
Silesia Univ. Katowice

Portugal:
LIP Coimbra

Romania:
NIPNE Bucharest

Russia:
CKBM, St. Petersburg
IHEP Protvino
INR Troitzk
ITEP Moscow
KRI, St. Petersburg
Kurchatov Inst., Moscow
LHE, JINR Dubna
LPP, JINR Dubna
LIT, JINR Dubna
Obninsk State Univ.
PNPI Gatchina
SINP, Moscow State Univ.
St. Petersburg Polytec. U.

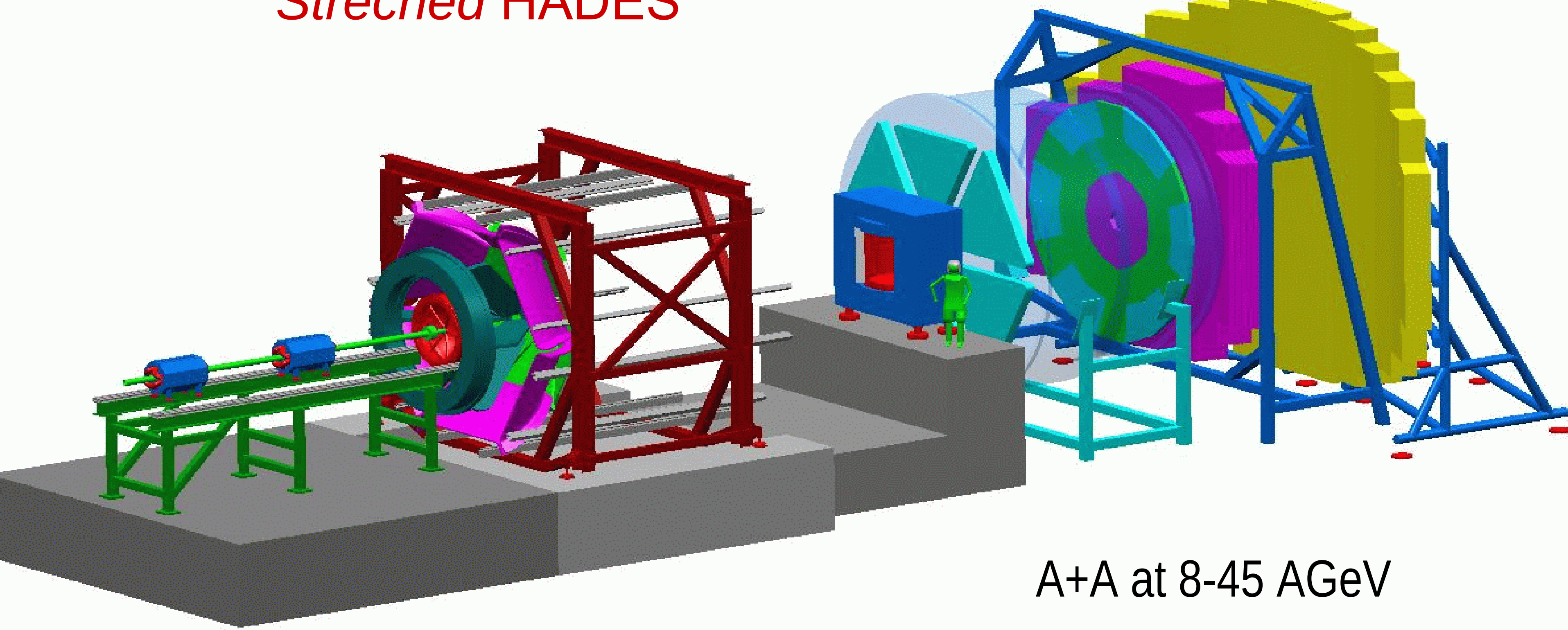
Spain:
Santiago de Compostela Univ.

Ukraine:
Shevshenko Univ. , Kiev
Univ. of Kharkov

The nuclear reaction experiments at FAIR

Streched HADES

CBM



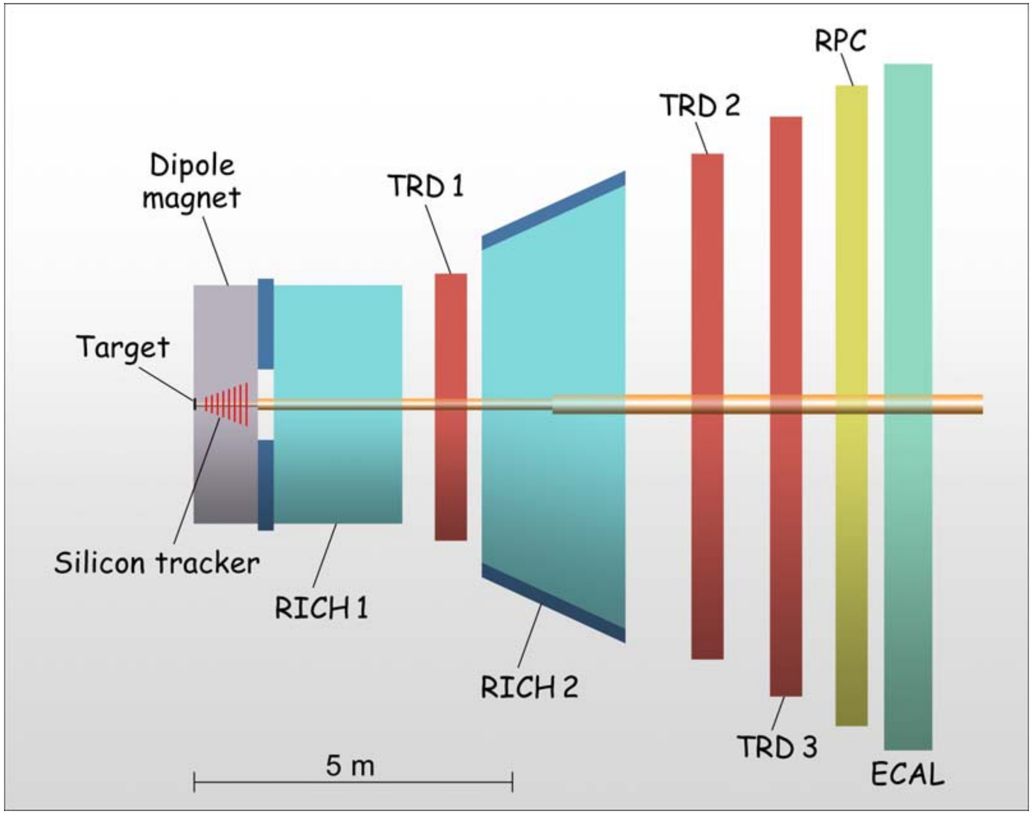
A+A at 8-45 AGeV

A+A at 2-8 AGeV

At 10^7 interactions per second!!

The CBM Experiment

At 10^7 interactions per second!



Measuring Hard Probes!

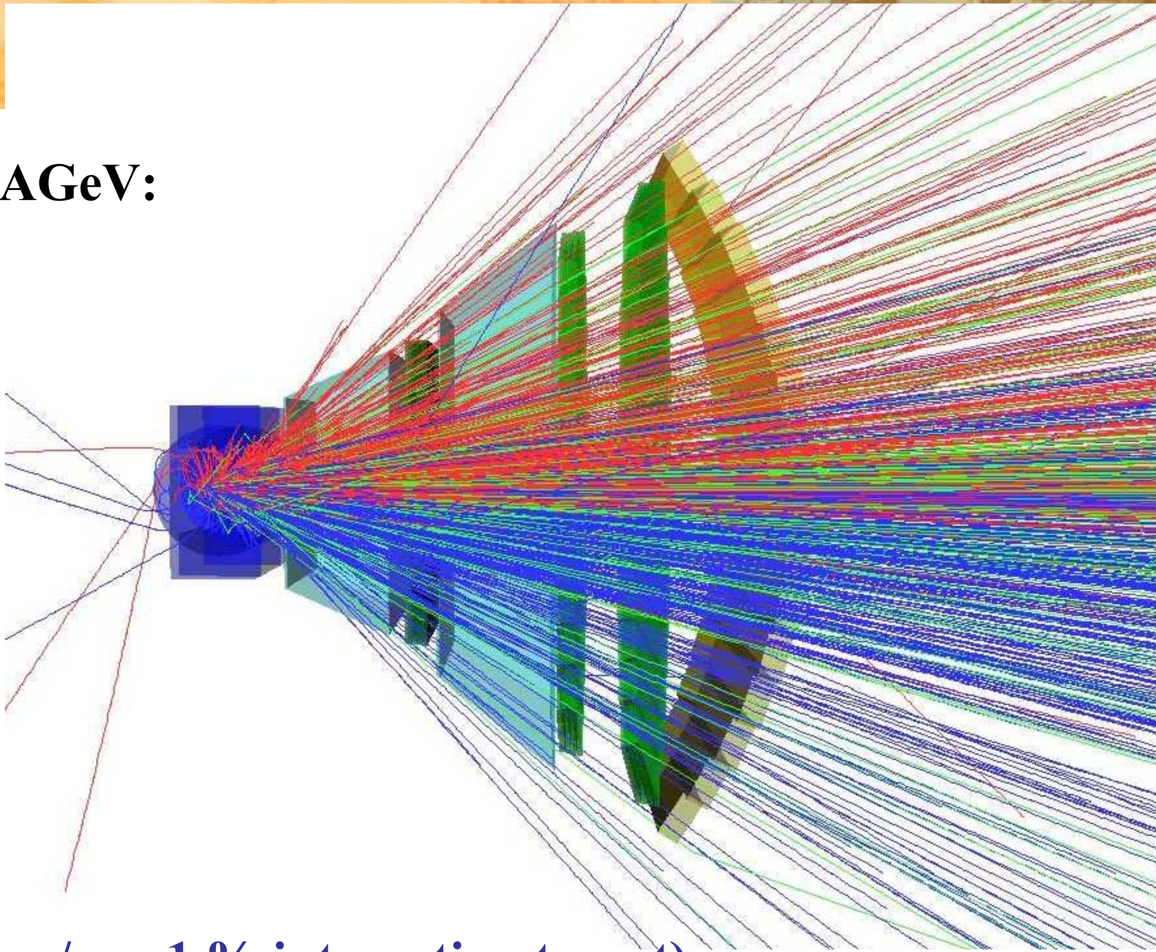
- Radiation hard Silicon pixel/strip detectors in a magnetic dipole field
- Electron detectors: RICH1 & TRD & ECAL: pion suppression up **to 10^5**
- Hadron identification: RPC, RICH2
- Measurement of photons, π^0, and muons: electromagn. calorimeter (ECAL)
- High speed data acquisition and trigger system

Experimental Challenges

Central Au+Au collision at 25 AGeV:
URQMD + GEANT4

Multiplicities:

160 p
400 π^-
400 π^+
44 K^+
13 K^-
800 γ



- **10^7 Au+Au reactions/sec (beam intensities up to 10^9 ions/sec, 1 % interaction target)**
- **determination of (displaced) vertices with high resolution ($\sigma \sim 30\mu m$)**
- **identification of electrons and hadrons**

CBM Physics Topics and Observables

1. In-medium modifications of hadrons (p-A, A-A)

↳ **onset of chiral symmetry restoration at high ρ_B**

measure: ρ, ω, ϕ $\rightarrow$ e^+e^- , J/ψ , open charm (D mesons)

2. Indications for deconfinement at high ρ_B (A-A heavy)

↳ **anomalous charmonium suppression ?**

measure: J/ψ, D excitation function *(see also PANDA)*

↳ **softening of EOS**

measure flow excitation function

3. Strangeness in matter (strange matter?)

↳ **enhanced strangeness production ?**

multi quark states?

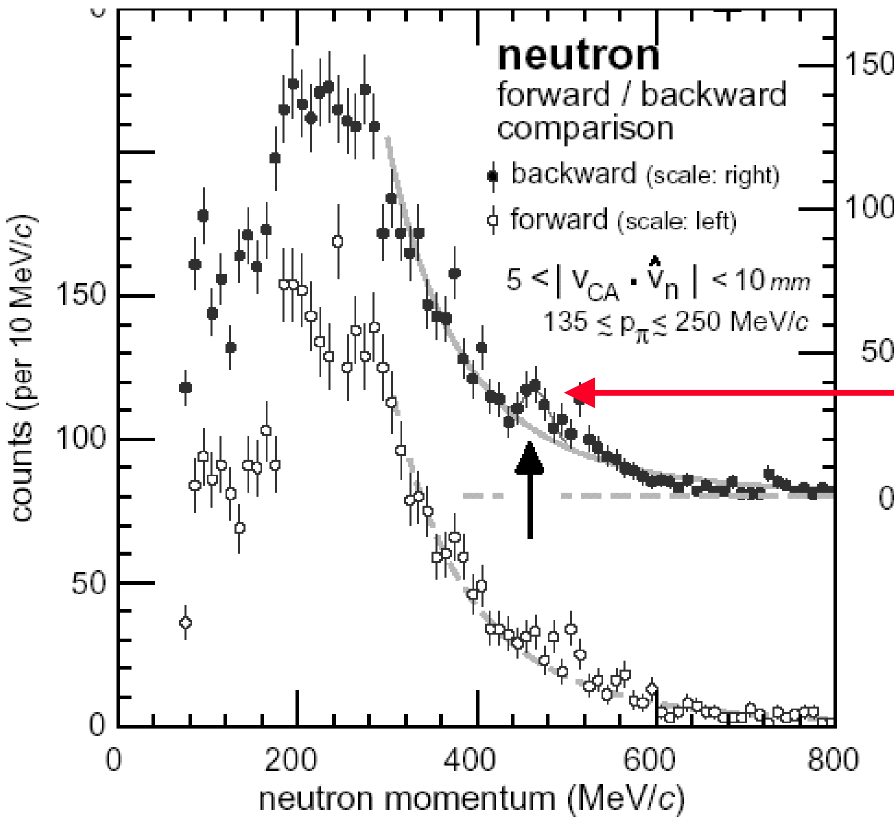
measure: K, Λ, Σ, Ξ, Ω etc. , 'pentaquarks' at low entropy

4. Critical point

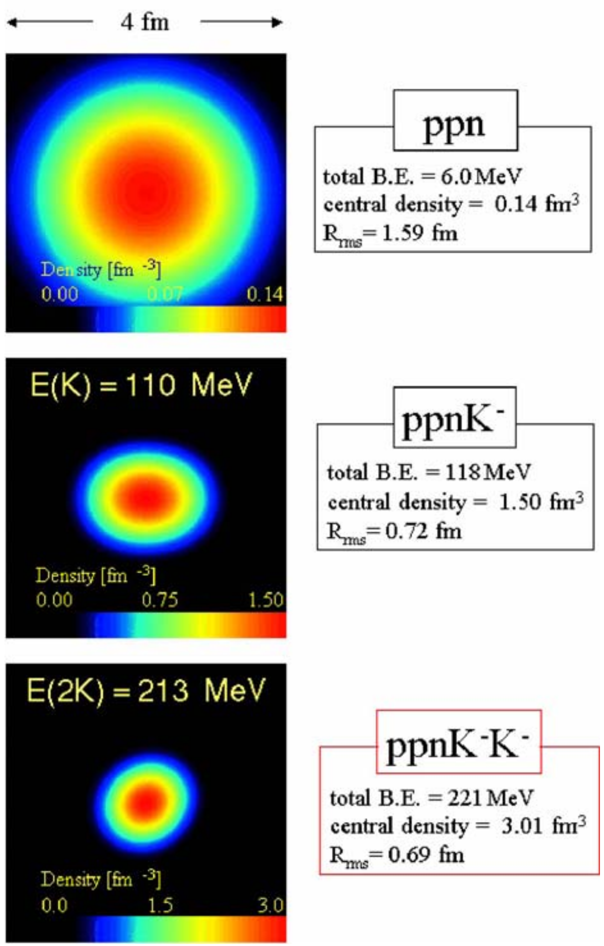
↳ **event-by-event fluctuations**

Strange Meson Implantation

$K^- + {}^3He \rightarrow$ "K^-ppn" + n



Experiment by M. Iwasaki, et al.

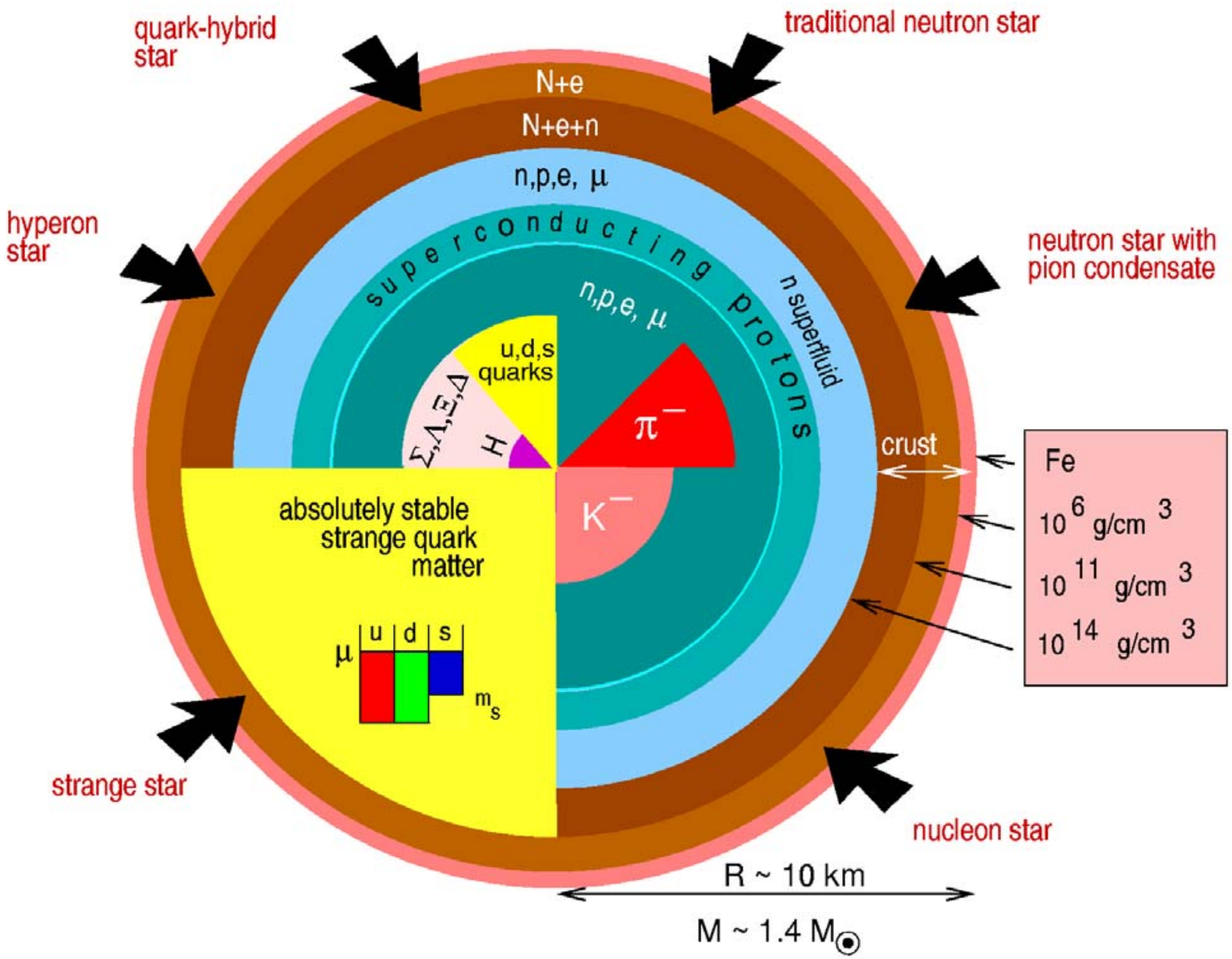


Theory by Y. Akaishi, et al.

Nuclear shrinkage is also observed in Λ implantation inside the nucleus ← K. Tanida, et al.

Motivation for NN collisions at 2-40 AGeV

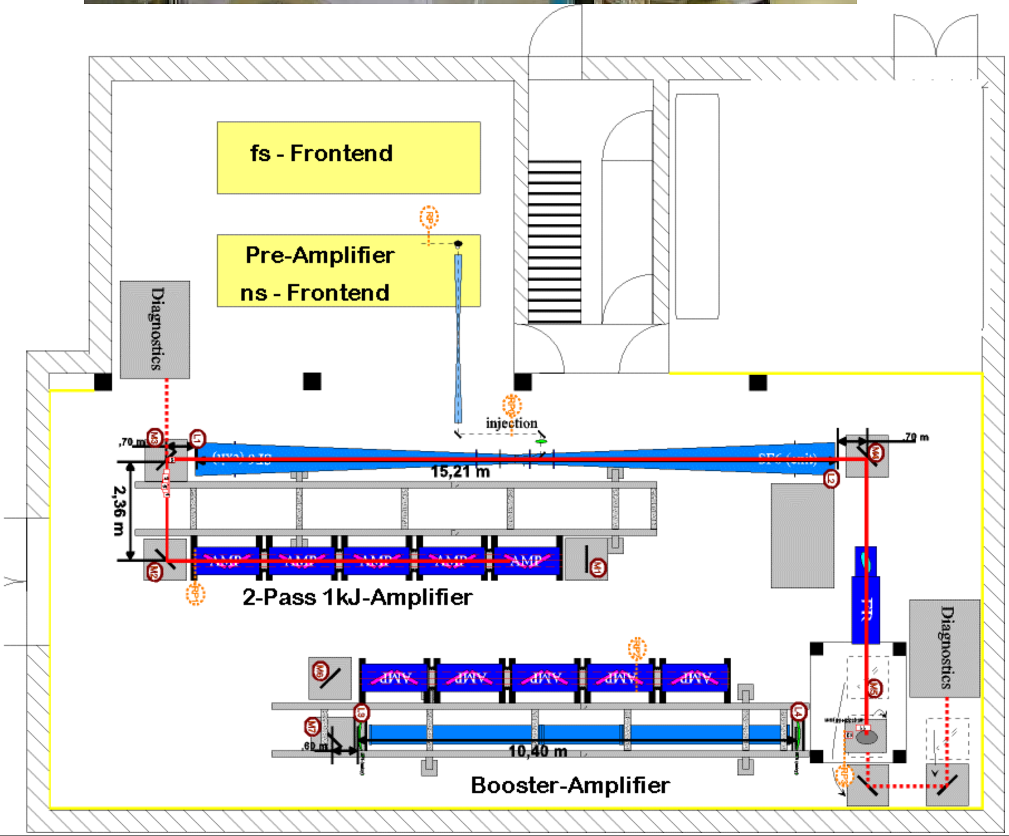
Properties of neutron stars



Combining Ultra-High Intensity Laser and Ion Beams

PHELIX:
laser pulses of up to
5 kJ @ 10 ns
1 PW, 500J @ 500 fs
10^{21} Watt/cm^2

Heavy-Ion Synchrotron
SIS-18: pulses of
1 kJ @ 100ns
SIS100: pulses of
80 kJ@ 50 ns
P_s = 12 TW/g



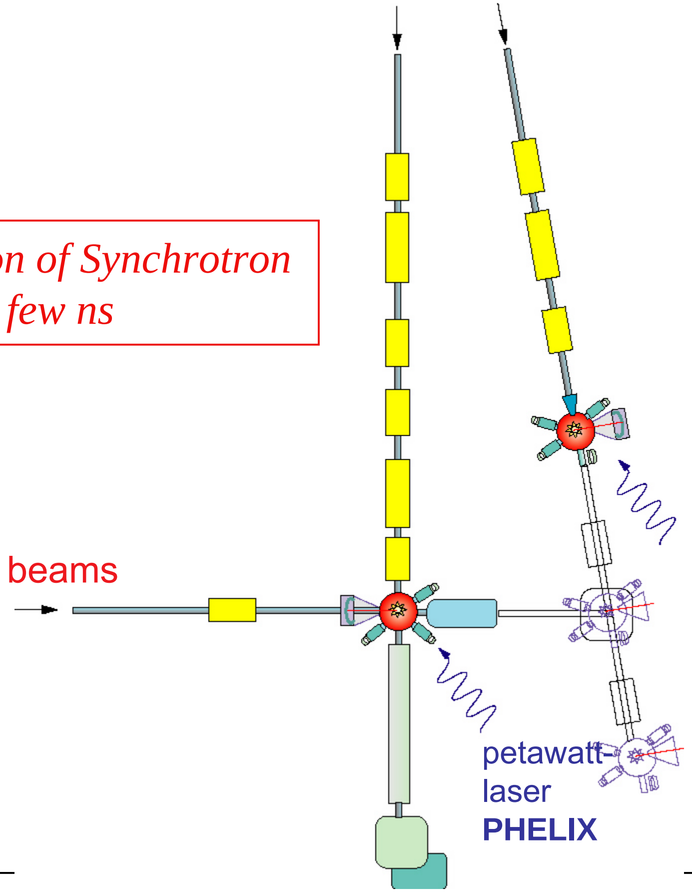
- Plasma Physics
- Astrophysics
- NuclearPhysics
- Atomic Physics
- Accelerator Physics
- Technical Applications

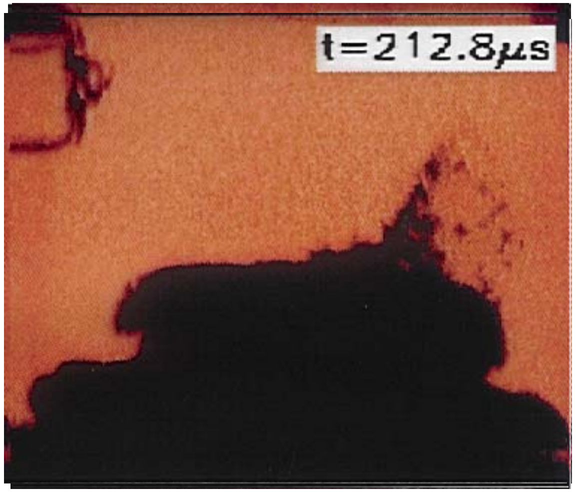
Plasma Physics with highly Bunched Beams

Bulk matter at very high Pressures, Densities, and Temperatures

ΔE Energy loss of heavy ions in hot plasma is larger than in cold matter

Synchronization of Synchrotron and Laser to a few ns





Expected Beam Parameters

SIS 100 (GSI)

N = 2 x 10^{12} Uran

E_0 = 1 GeV/u

E_{tot} = 80 kJ

τ = 50 ns

Range in solid Pb ≈1.55 cm

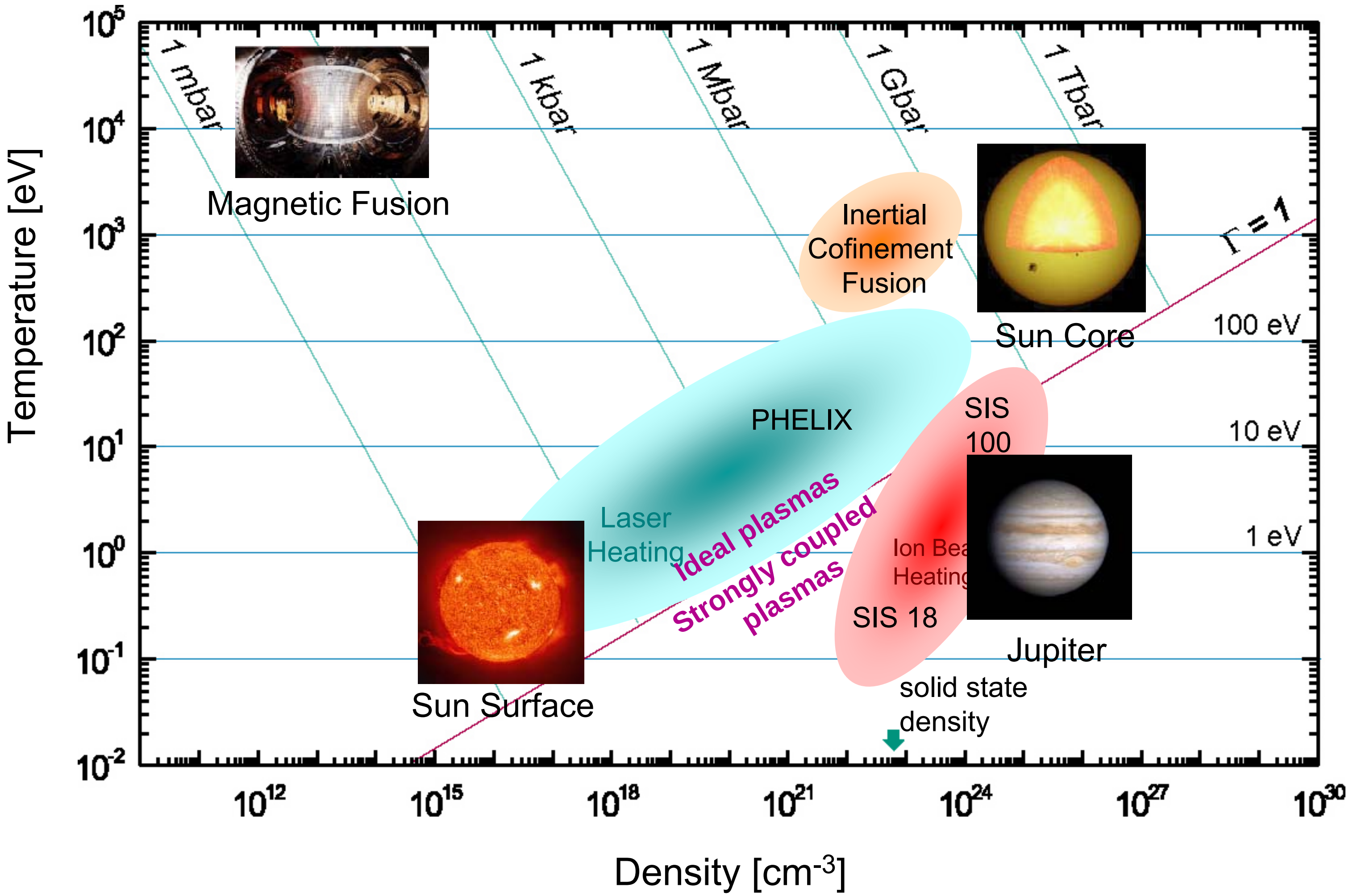
beam radius ≈ 0.05 cm

E_s = 600 kJ/g

P_s = 12 TW/g

Plasma Physics with highly Bunched Beams

Bulk matter at very high pressures, densities, and temperatures



Atomic Physics and Applied Science

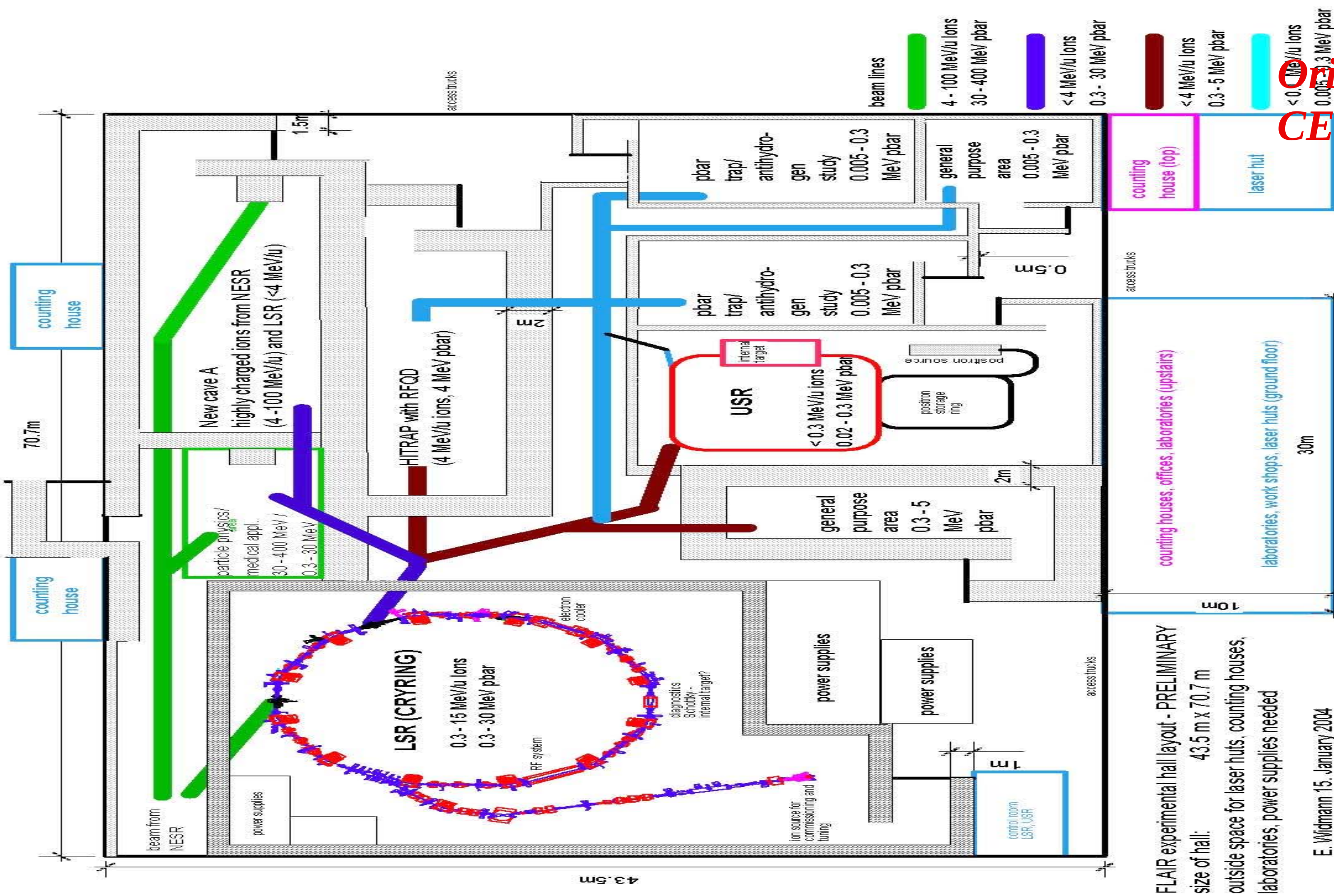
via

- Highly charged atoms
- Very low energy anti-protons
- Laser cooling

High Field QED, Anti-Matter, etc.

FLAIR@FAIR:
Facility for Low energy Antiprotons and Ion Research

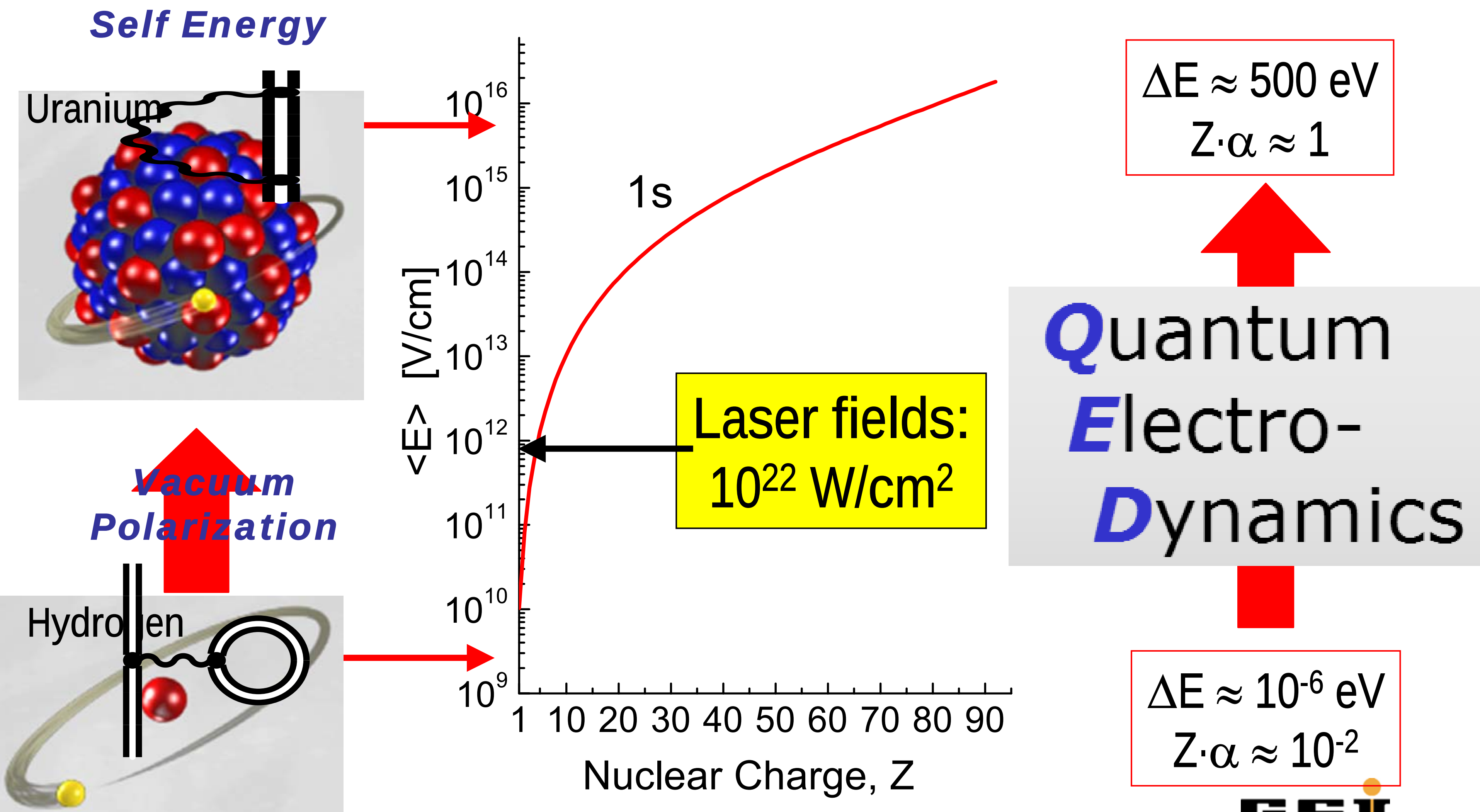
100x more intensity than at AD



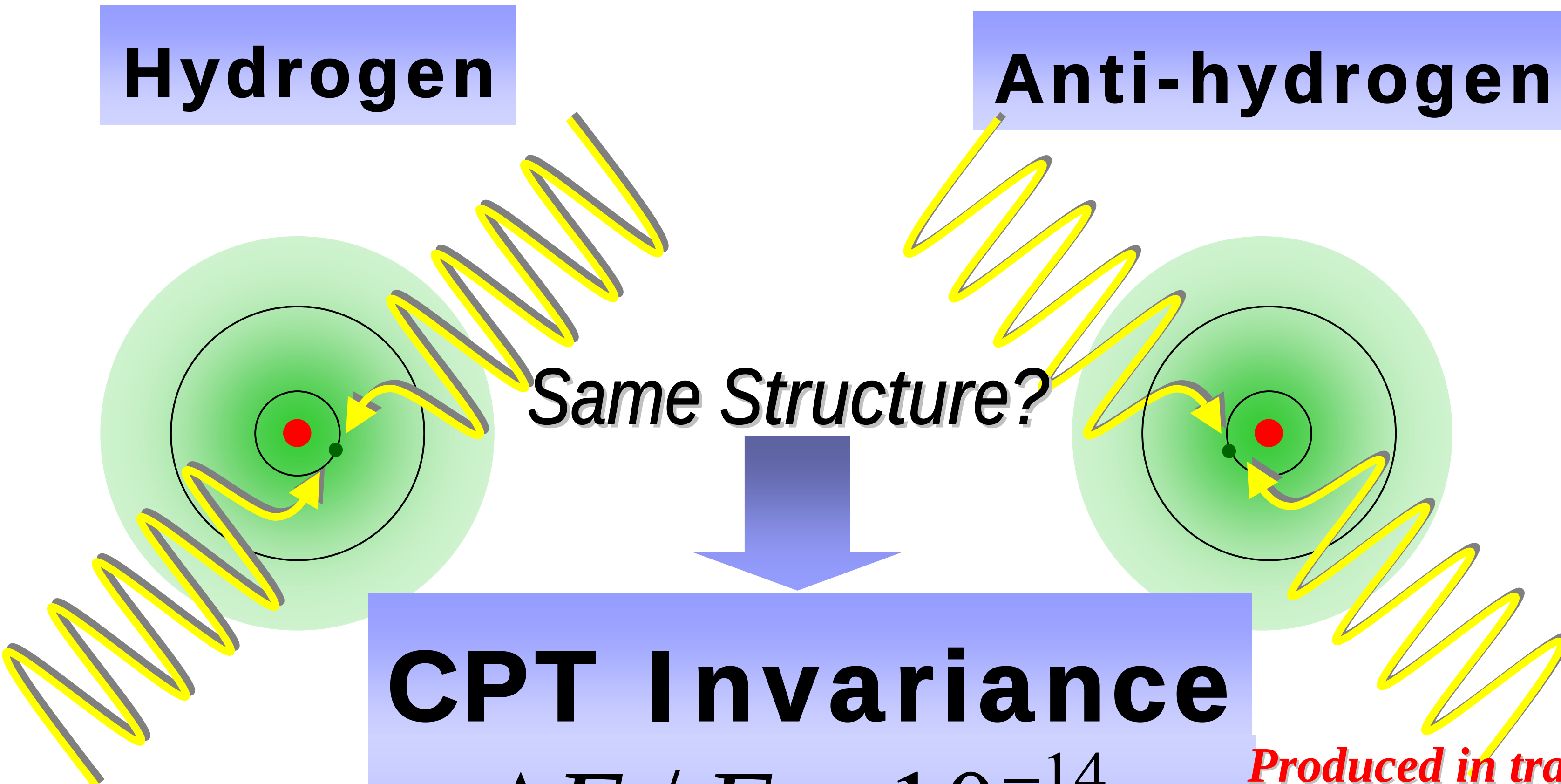
Originates from CERN-AD program

Figure 15: Preliminary layout of the low-energy antiproton and heavy ion facility.

Extreme Static Electromagnetic Fields



Ultra-Slow and Trapped Antiprotons

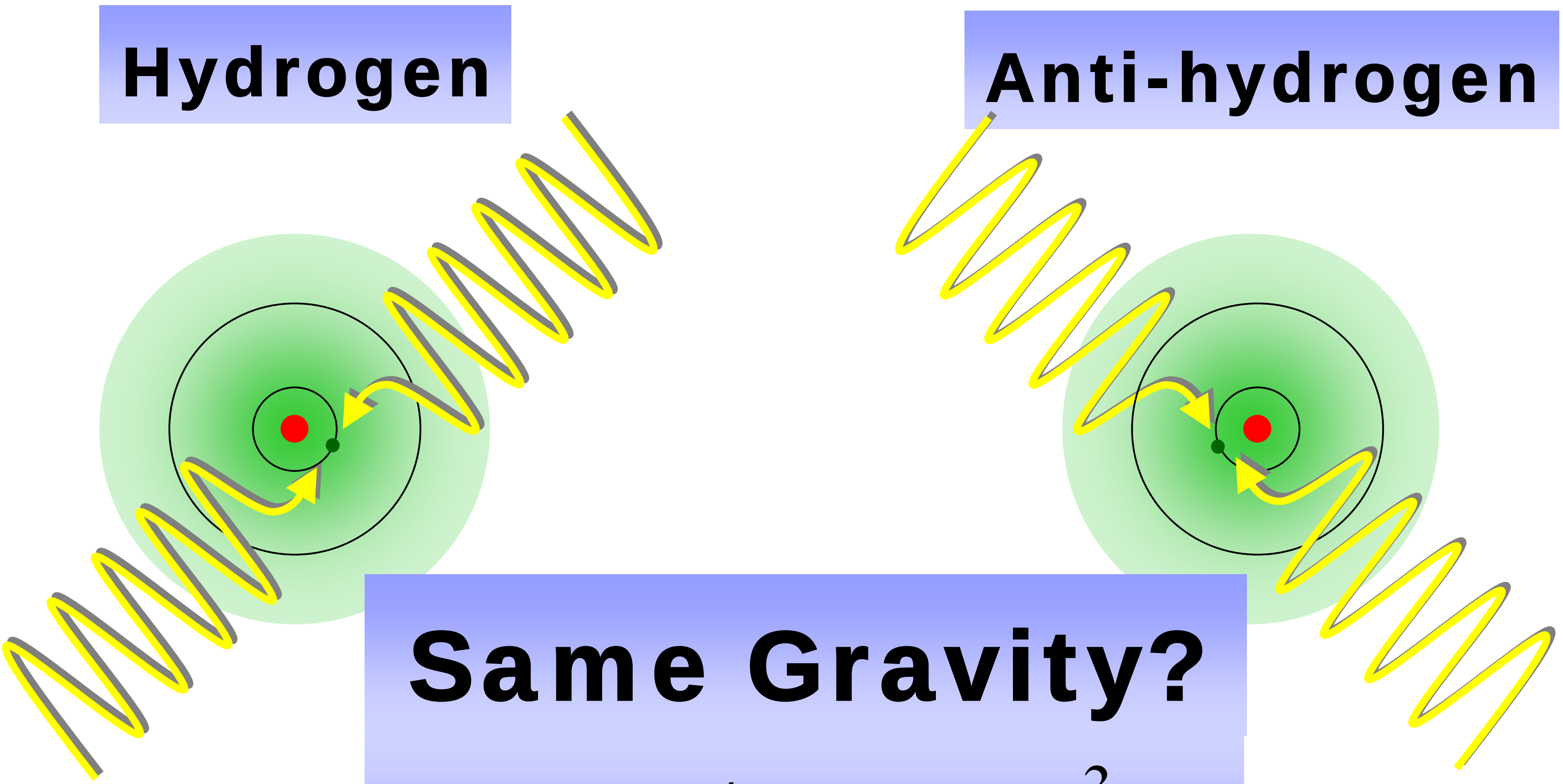


CPT Invariance

$$\Delta E / E \approx 10^{-14}$$

Produced in traps at AD CERN in 2002

Ultra-Slow and Trapped Antiprotons



Same Gravity?

$$\Delta g / g \approx 10^{-3}$$

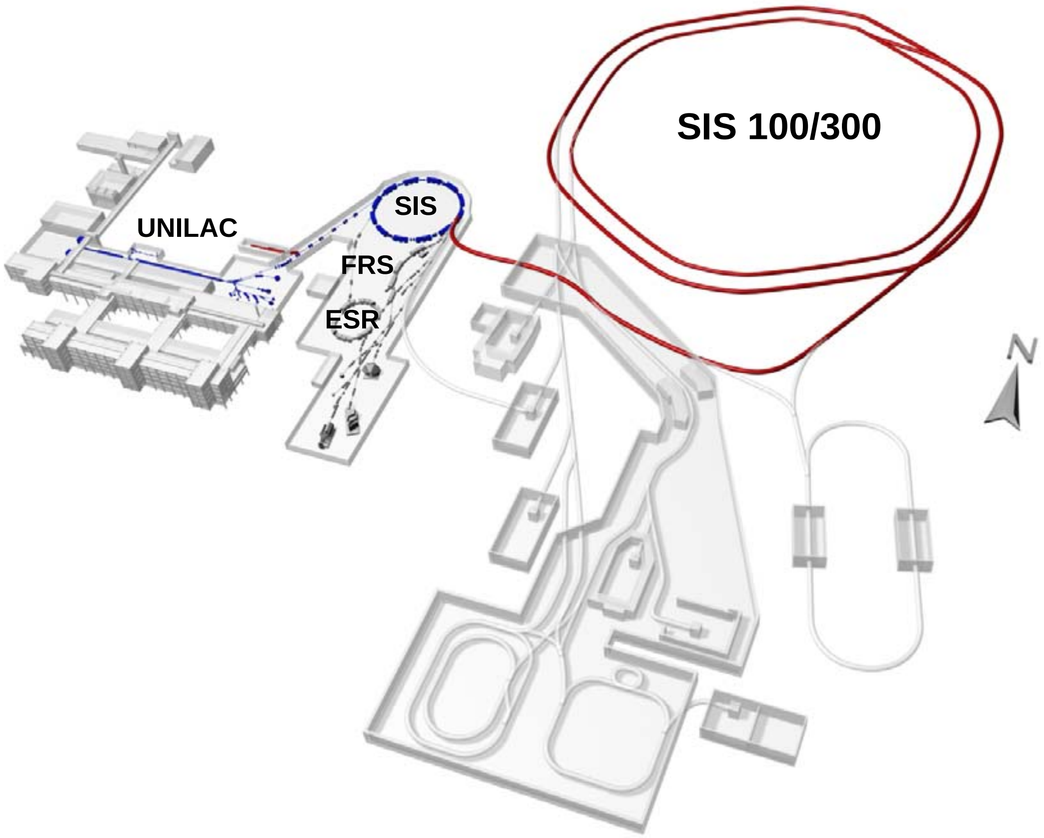
FAQs:

Why can all this not be done at CERN?

It is the Intensity……..

→ **Accelerator Issues @ FAIR**

International FAIR Project: Characteristics



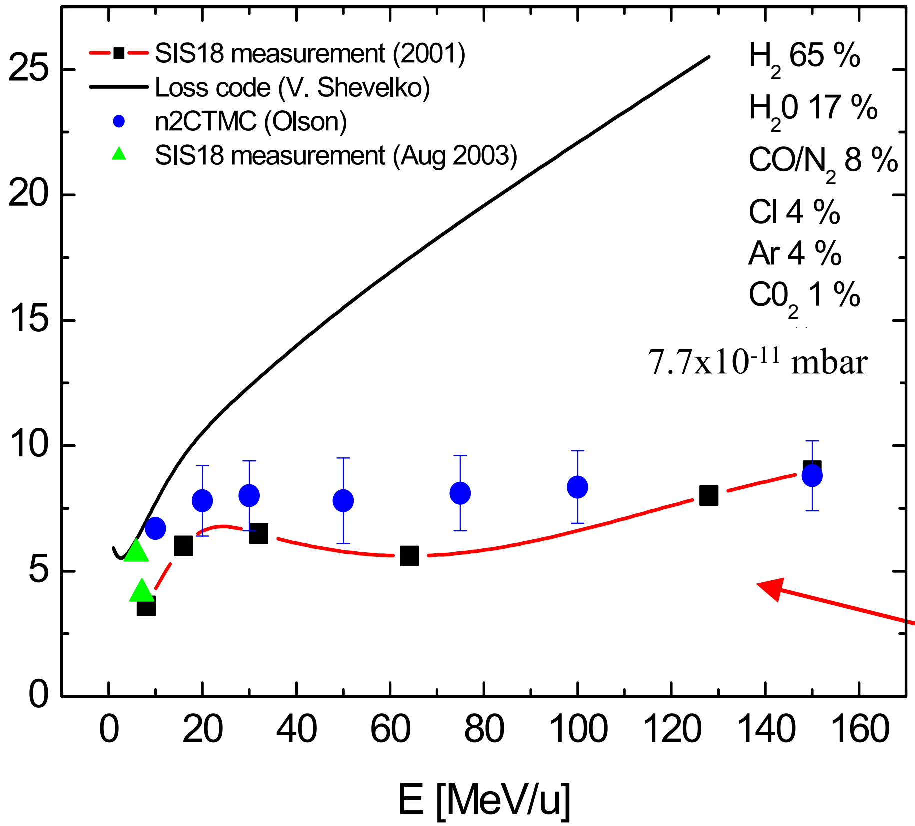
Primary Beams

- **10^{12}/s; 1.5-2 GeV/u; $^{238}U^{28+}$**
- Factor 100-1000 over present in intensity
- 2(4)x10^{13}/s 30/90 GeV protons
- **10^{10}/s ^{238}U up to 35 GeV/u**

U^{28+} Lifetime and Ultra High Vacuum

Projectile-"Stripping" at Residual Gas: $U^{28+} + X \rightarrow U^{(28+j)+} + X^{m+} + (m+j)e$

Lifetime: $\tau(E) = [\beta c n_X \sigma(E)]^{-1}$



U^{28+} operation with 1 % beam loss means:

10 s lifetime in SIS18 (4 Hz)
or $P=5 \times 10^{-11}$ mbar

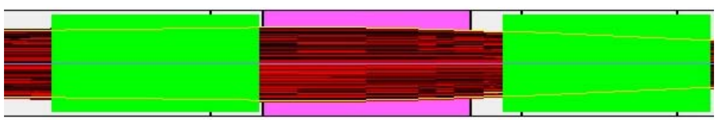
100 s lifetime in SIS 100/300 (T= 1 s)
or $P=5 \times 10^{-12}$ mbar

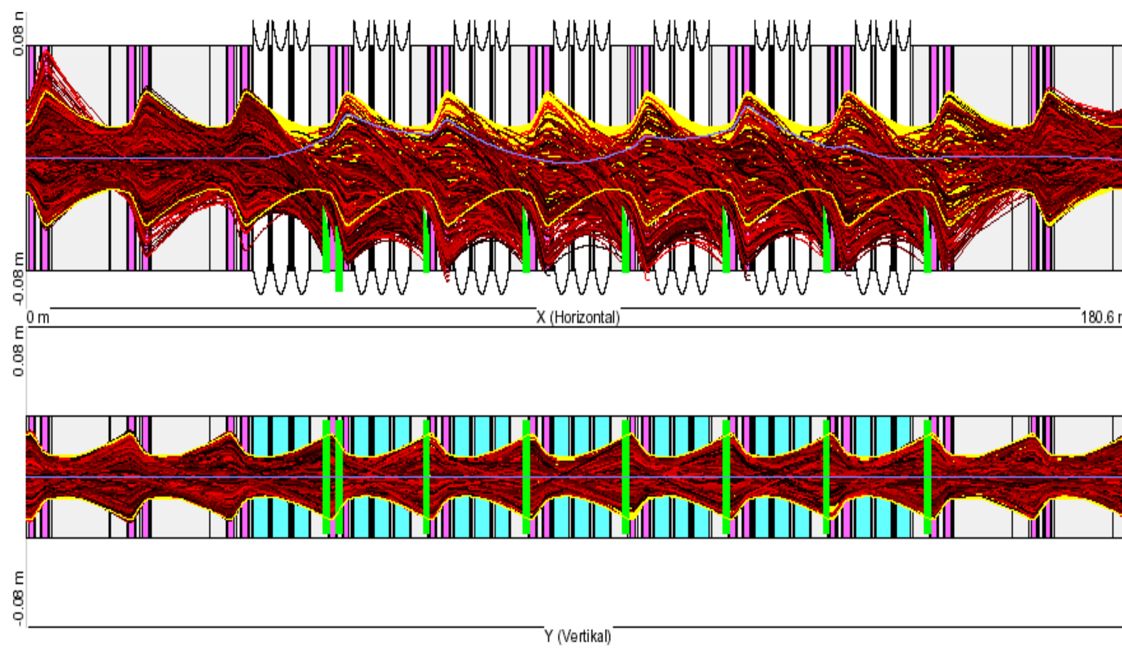
Lifetime is independant of the energy: $\sigma \propto 1/\beta$

Collimation Concept

wedge collimator at 80 K

cold, pumping sec. chamber at 4.5 K





charge changed ions must hit collimators, never the beampipe!

FAQs: Pourquoi des Aimants Supras?

Advantages
- Zero Consommation pour operation en continue
- High Current Density
- Matériaux d'isolation refroidis robustes contre radiation

– Coût de l'operation bas
– Haut Champs magnétique possible > 2 T
– Dessin compact de l'aimant
– Design

⇒ moins de l'acier (voir prix)

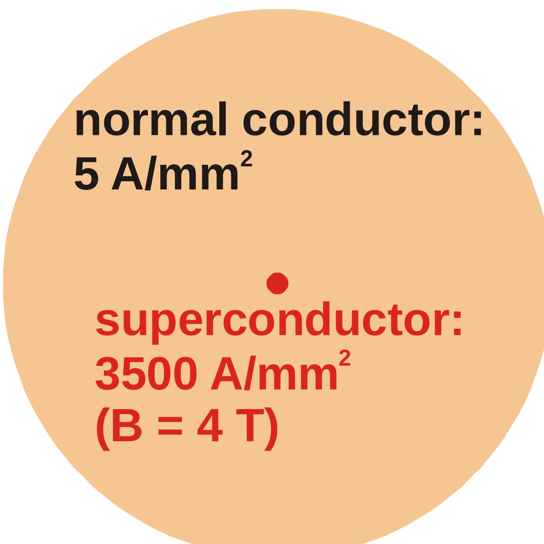
⇒ énergie stocké réduite

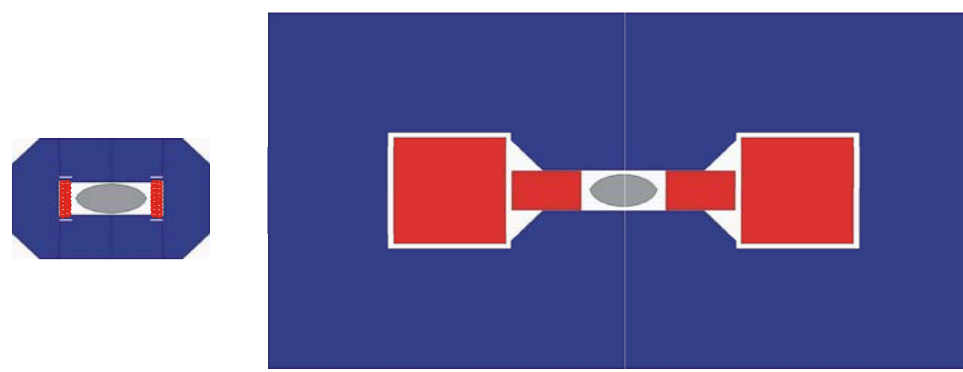
Investissements reduites

⇒ 4-10 €/kA/m –Conducteur Supra

⇒ 12 €/kA/m – Conducteur chaud

(en 2002)

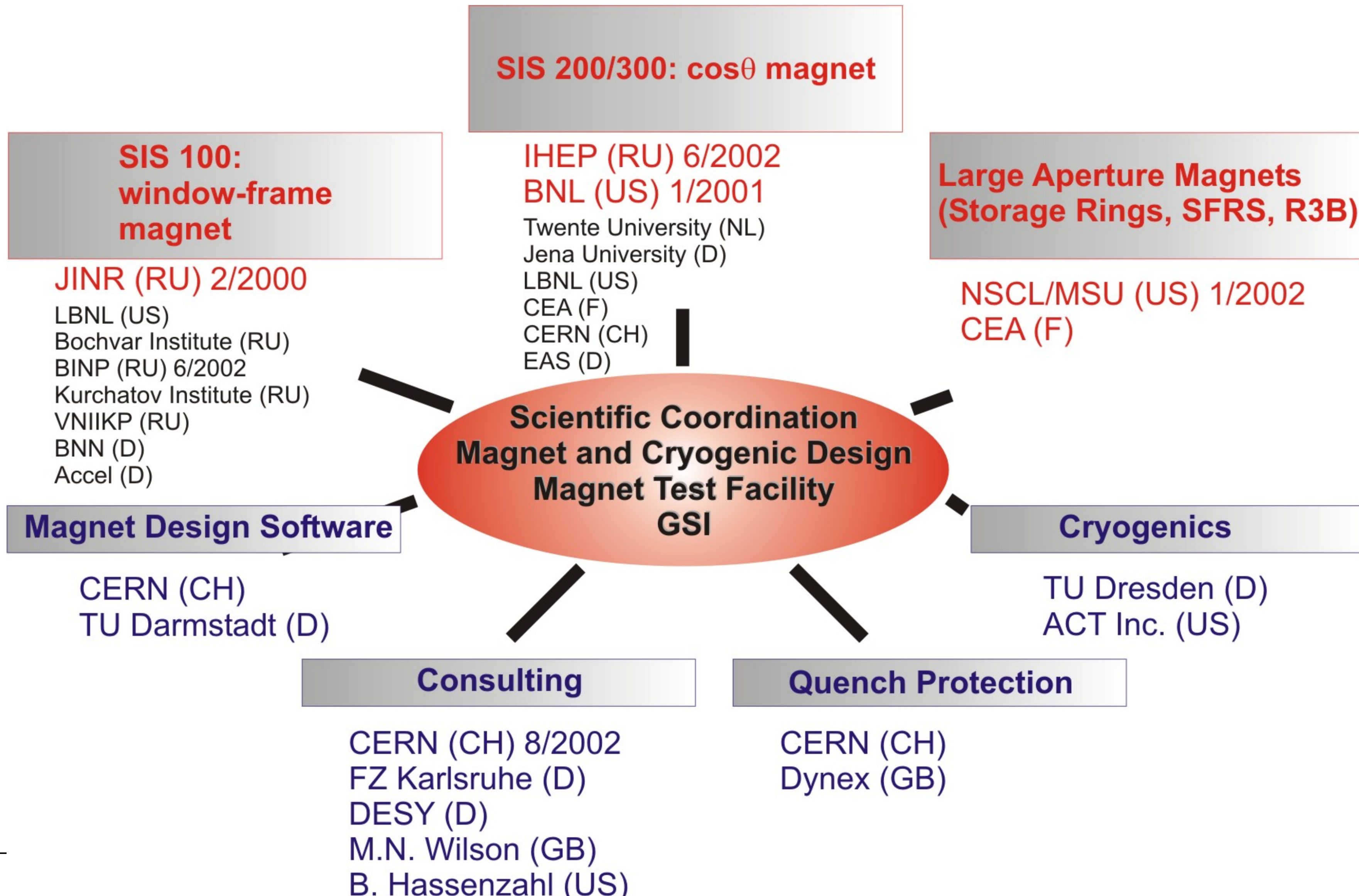




Conductor Cross Section:

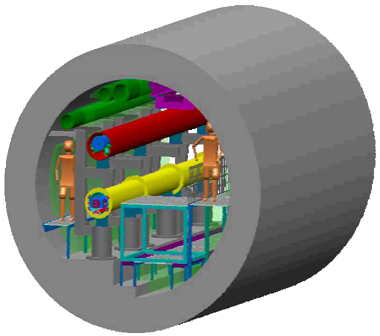
Plus petit, plus léger, moins cher

SC Magnet Collaborations 2004



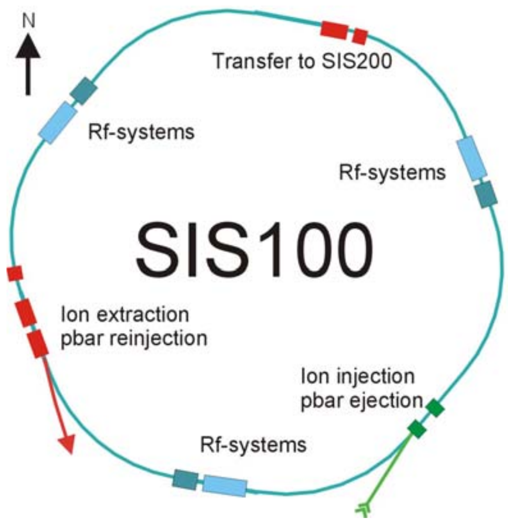
New SIS 100/300 Synchrotrons

Two synchrotrons in one tunnel
(ca.1100 m circumference)

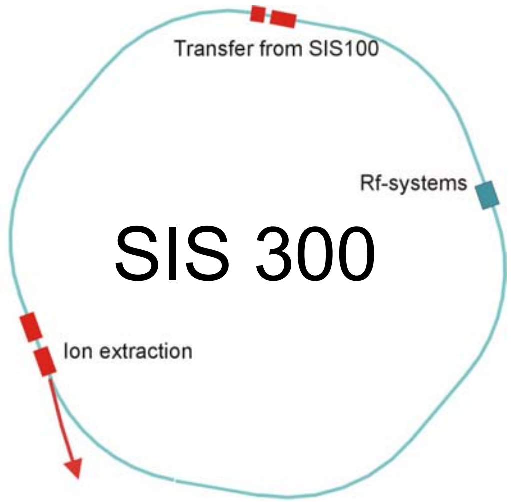


R&D Programm in:
- rapidly cycling
- superconducting magnets

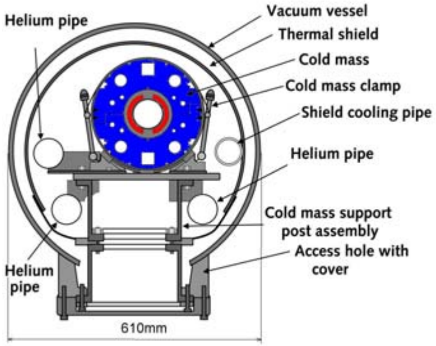
‚Booster' and compressor



‚Stretcher' and high energy ring

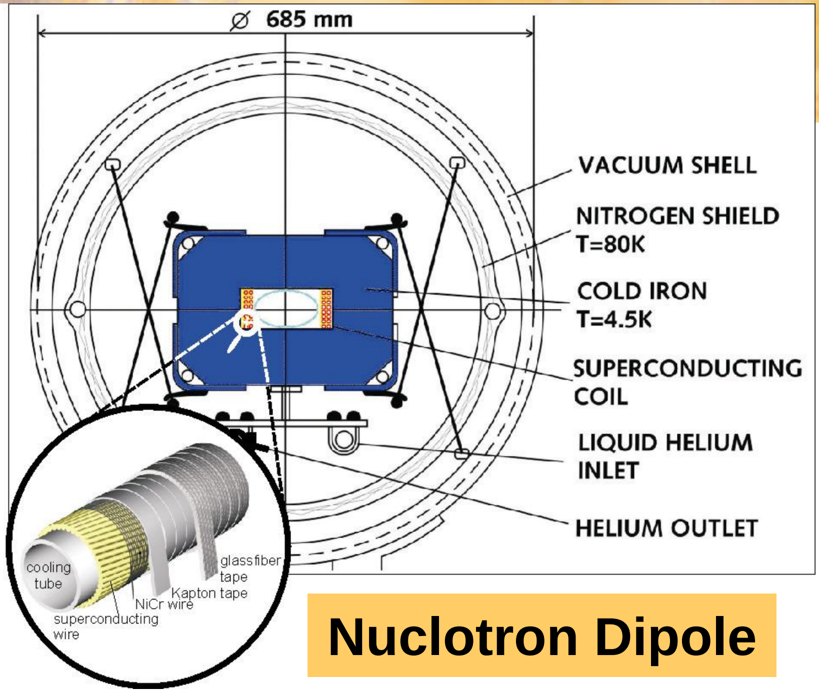


Nuclotron dipole magnet:
B=2T, dB/dt=4T/s



RHIC typ dipole magnet:
B=4T (6T), dB/dt=1T/s

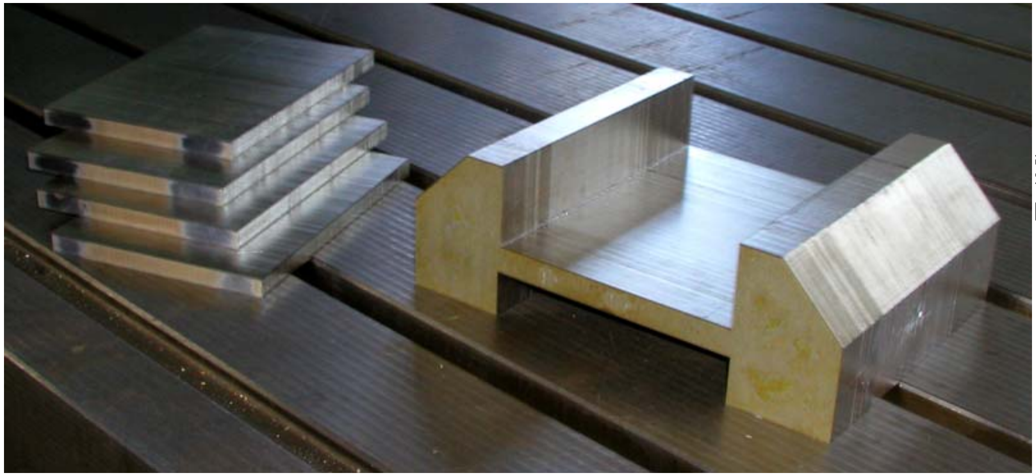
SIS 100 Dipole – heat load reduction



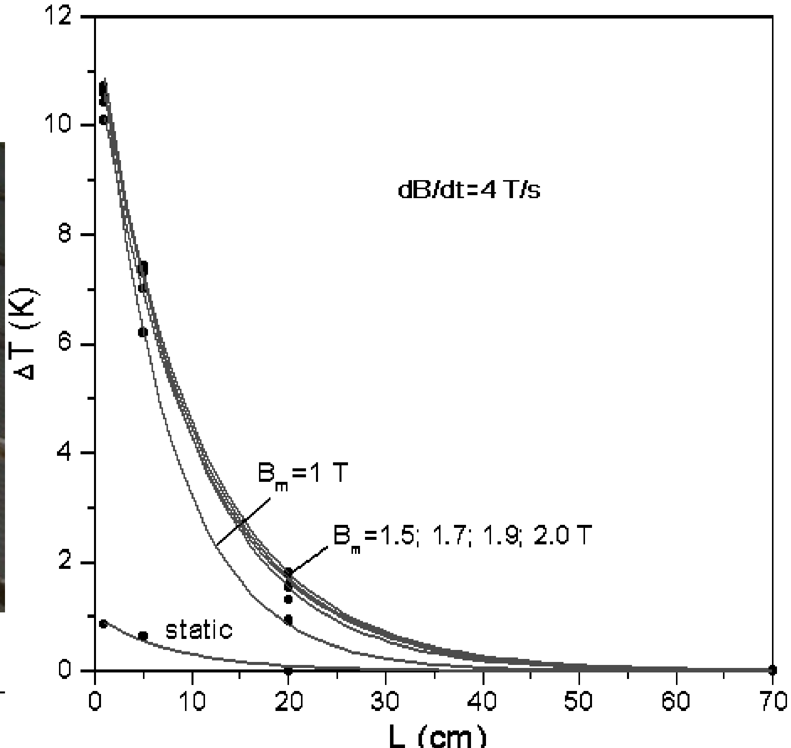
Nuclotron Dipole

AC heat load to Helium (4K) triangular cycle: 0-2T, 4 T/s, 1 Hz	Nuclotron-Dipole (1.4 m)	planned prototype (2.6 m)
Yoke (W/m)	29	9
Coil (W/m)	9	6

heating of the end parts by eddy currents



laminated end blocks



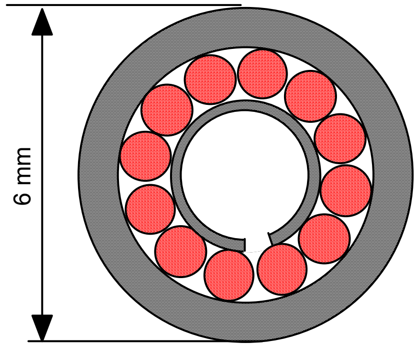
Cable R&D

Rutherford cored cable R&D

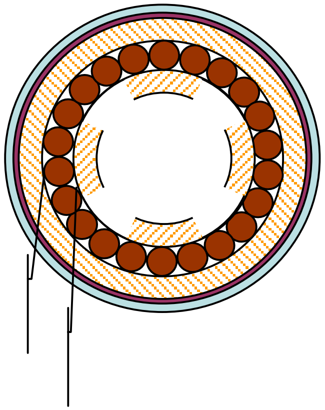
- **different cores (stainless steel, titanium, Cu-Ni, brass, Kapton)**
- **different mandrels (hollow, slotted)**
- **measurement of j_c, R_a, R_c, AC-losses**

➡ **details in A. Ghosh, WAMS-workshop, Archamps, 2004**

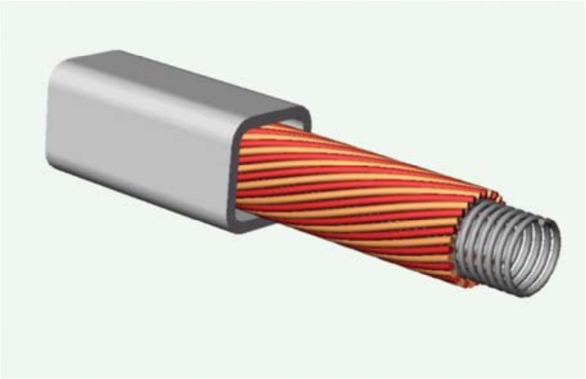
EU INTAS 03-54-4964 : improved N- CICC



by L. Bottura, M.N. Wilson



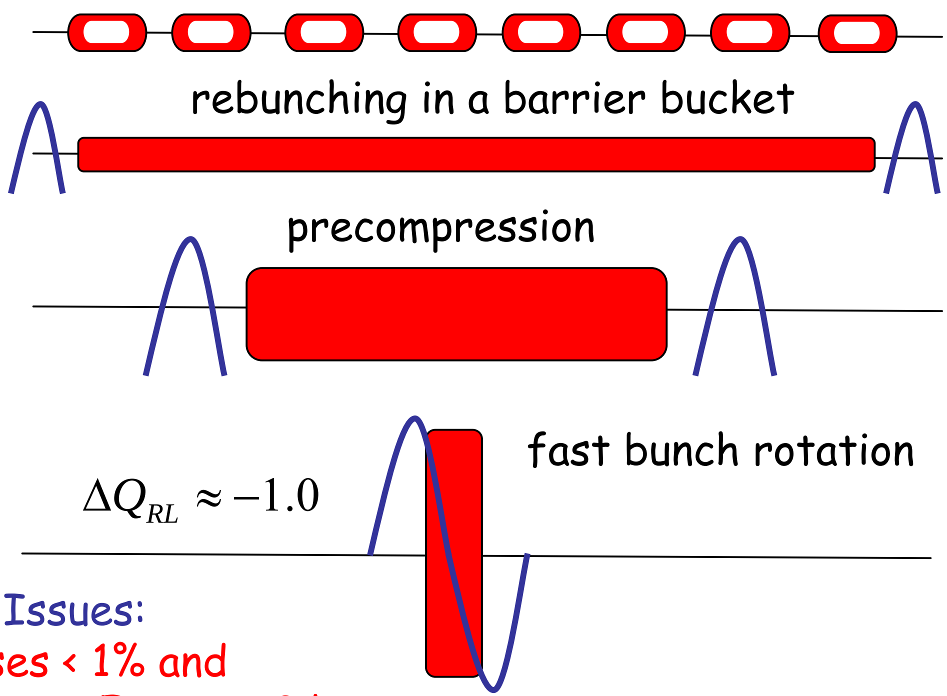
by P. Bruzzone



by V. Keylin

RF Bunch Manipulations in SIS 100

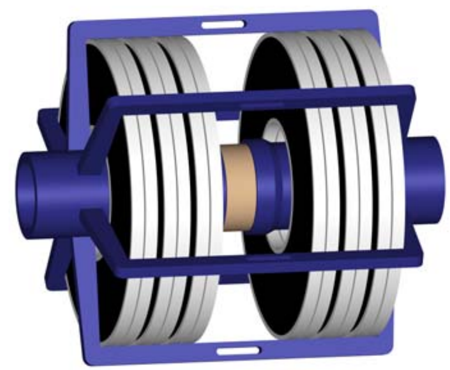
Injection/acceleration of flat-topped bunches



Key Issues:
Losses < 1% and
Dilution Factor < 2 !

10^{12} U^{28+} 1 GeV/u 50 ns ⇨ $P_{max} \approx$ 1 TW ⇨ Beam loss budget:
- Projectil range in steel ≈ 1 cm

26 compressor cavities (20 m) filled with high-μ cores:



40 kV/m
500 kHz

+ about 20 'normal' acceleration cavities

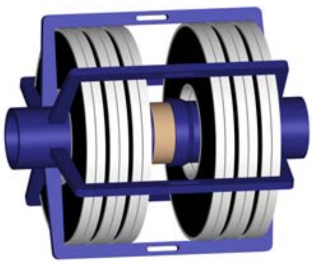
= 1 MV total !

Accelerator Physics and Technology for FAIR

Challenges

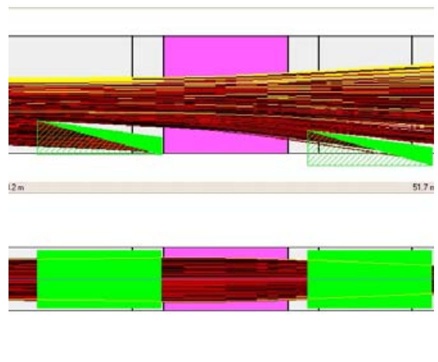
High gradient,
low frequency
RF cavities

SIS 100 compressor cavity



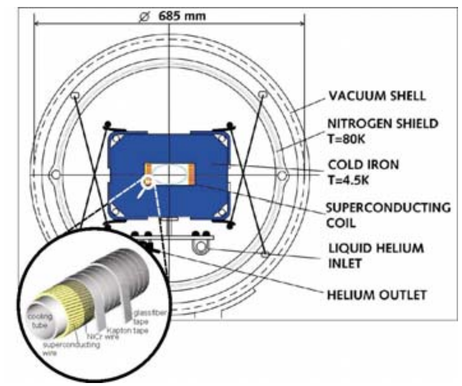
Novel lattice/collimation
design: Beam optics studies

control of stripping losses

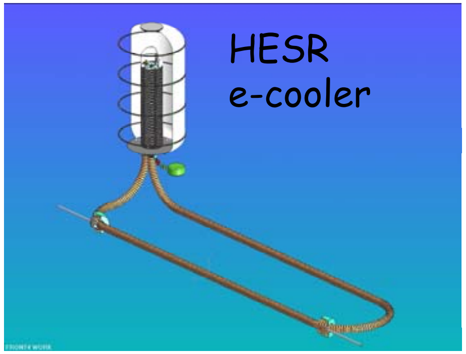


Superconducting, fast ramping
synchrotron magnets

SIS 100 dipole magnet



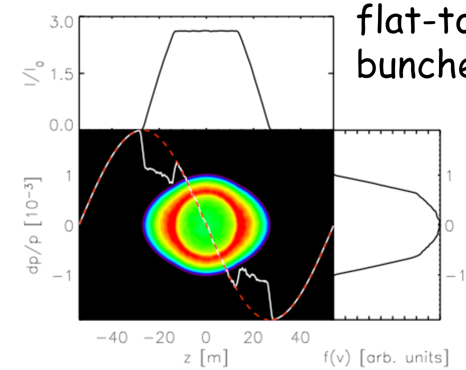
Fast stochastic and
electron cooling



Ultra high vacuum
for intense beams

NEG coated beam pipe (CERN)

Control of collective effects:
Large scale simulation studies



flat-topped
bunches

Polarization at FAIR!

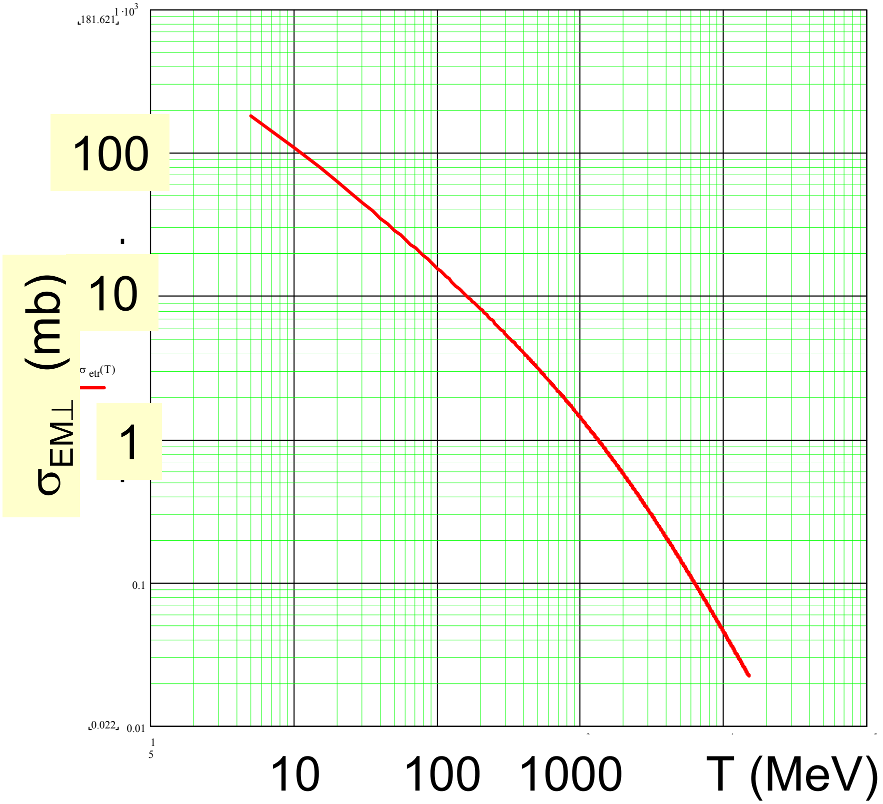
The QCD PAC considers the spin physics of extreme interest and the building of an antiproton polarized beam as a unique possibility for the FAIR project.

The QCD PAC strongly encourages the PAX and ASSIA proponents and the laboratory to explore how antiproton polarization capabilities can be incorporated, and given the time constraint, urge the proponents of these proposals to present detailed case!

Note: Anti Proton Self Polarization best done at 50-100MeV, so why not COSY@FAIR???

Spin Transfer Cross Section

$$p + \vec{e} \rightarrow \vec{p} + e$$

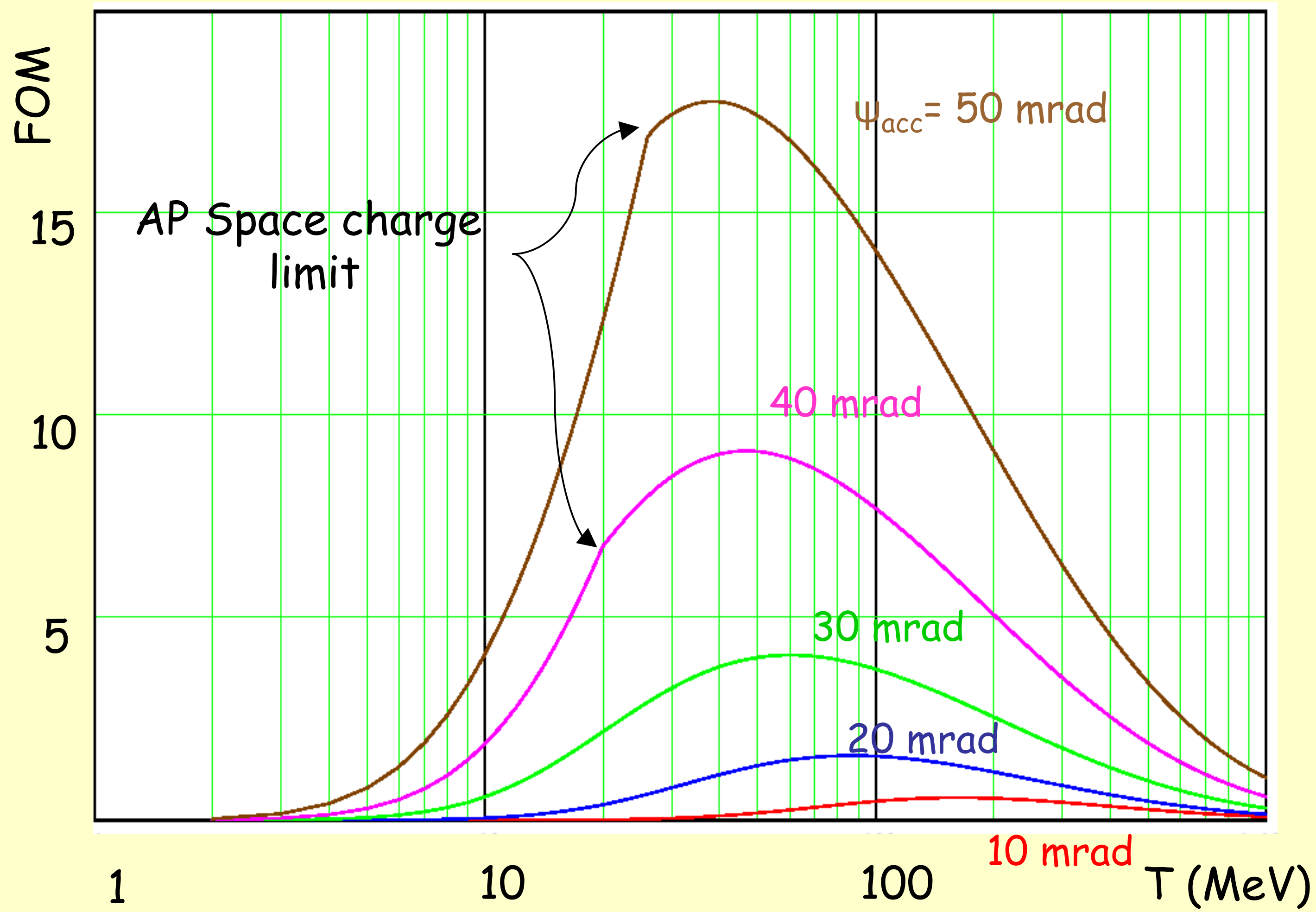


The Spin Filter principle:
Absorption of antiprotons in a **polarized proton target** is different when the two spins are parallel or anti-parallel.
If the spin-dependent cross-sections σ_L or σ_T are not negligible, the transmitted beam can be (slightly) polarized.

The effect is multiplied in the case where a polarized hydrogen target, based on the storage cell technique, is installed in a storage ring.

Problems to be solved:
Small angle scattering in polarized targets requires large acceptance in the ring and a cooling system

Optimum beam energies for build-up in AP



The Antiproton Polarizer

Synchrotron Ring

Acceleration from 240 MeV/c to 1.5 GeV/c (30 MeV to 830 MeV)

Electron Cooler
Full snake at low energy
Polarisation conservation (Fast Quads, RF Dipole)
Polarimeter
2 Injections
2 Extractions
Targetstation

Polarized H^- source

30 MeV injector

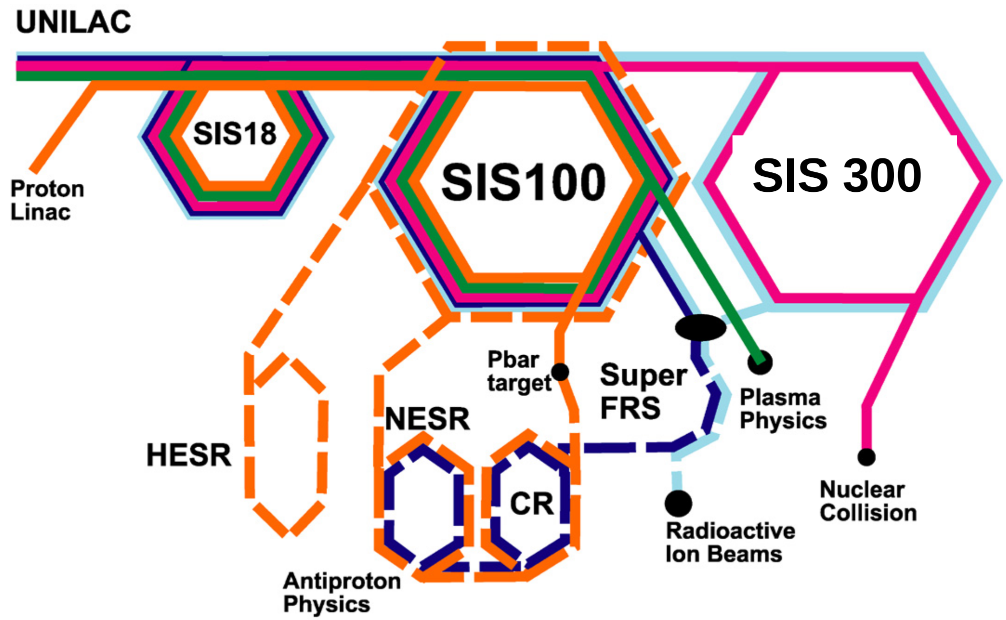
Estimated Costs and Manpower: 30 M€ & 150 MY (without infrastructure costs) ***But could well be COSY from FZJ, since it has it all!***

1.5-22.5GeV/c

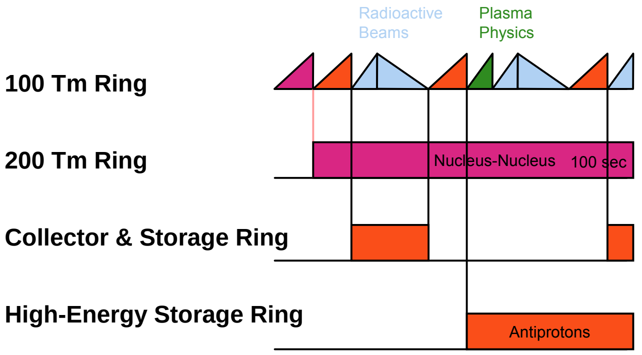
Zur Anzeige wird der QuickTime™
Dekompressor „TIFF (LZW)“
benötigt.

Could be operated also in a collider mode of polarized protons against polarized antiprotons

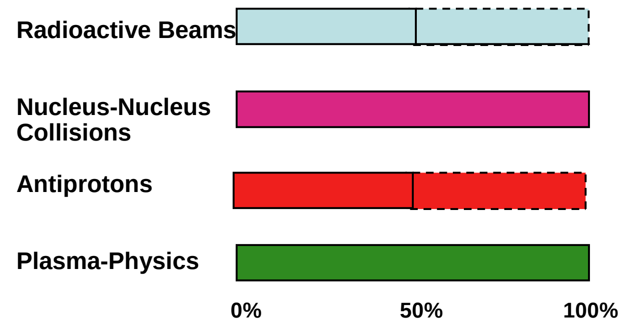
Parallel Operation



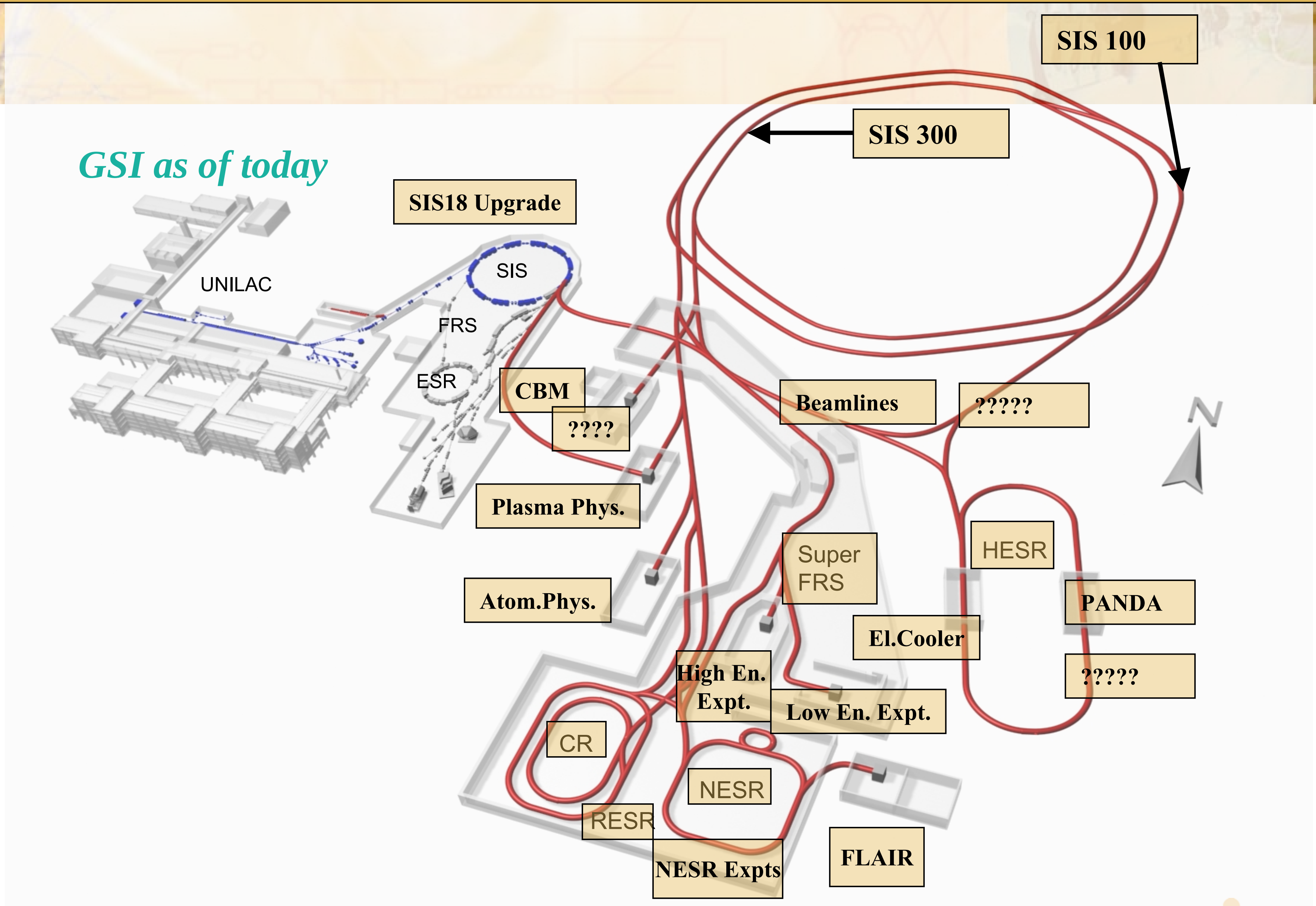
Duty-Cycles of the Accelerator Rings



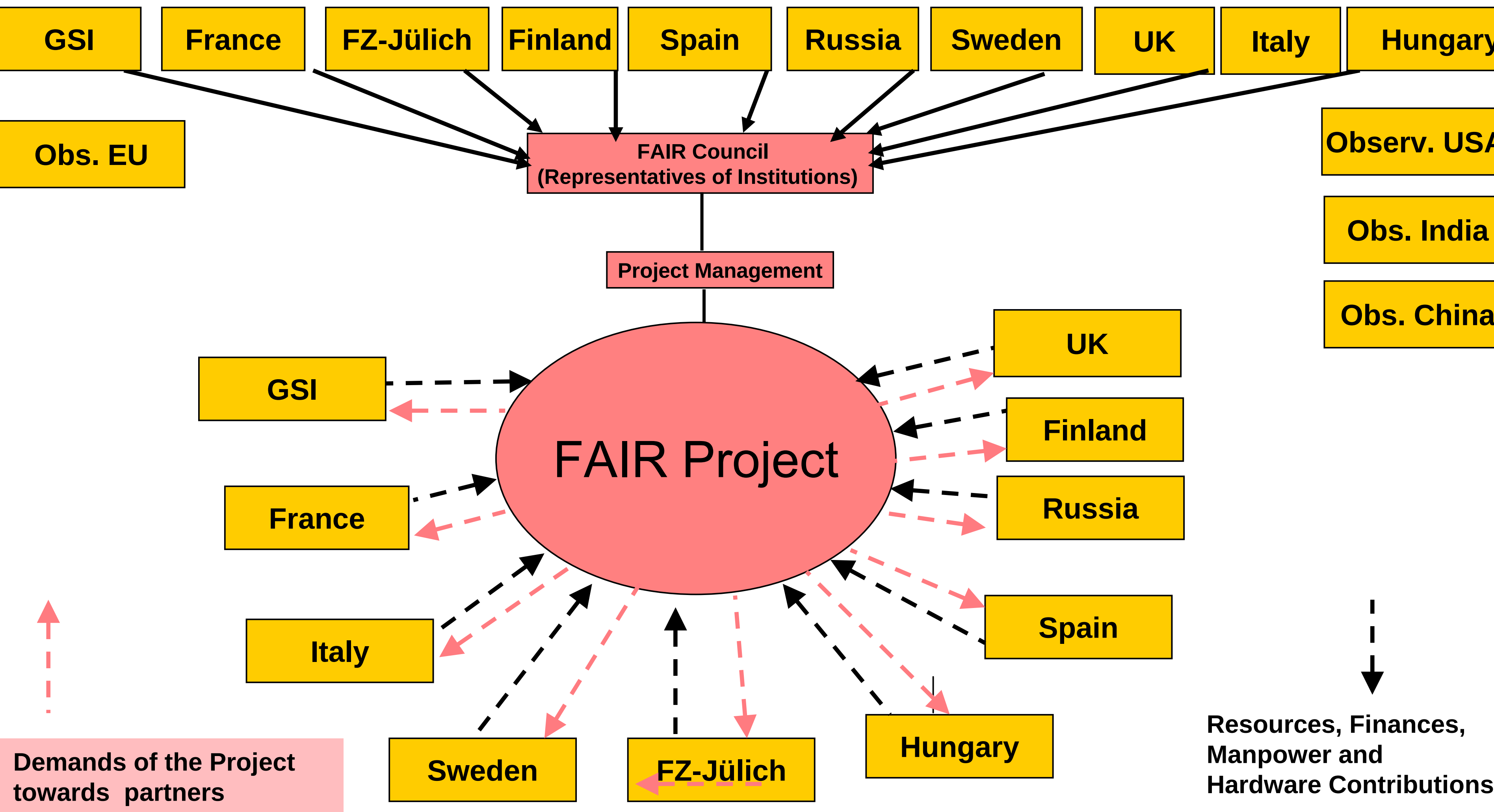
Duty-Cycles of the Physics Programs



FAIR most complex accelerator project: *not 27km, not 34 km, but…*



International FAIR and its Members (as of June 2004)



Next Steps

- **September 23, 2004**, signature of MoU and **Formation of International FAIR Project Team hosted by GSI**
- **January 15th, 2005, Submission of TRs (Technical Reports -Accel.) and TPs (Technical Proposals) with options and milestones.**
- **March 11 - 17, 2005,** Evaluation of TPs and TRs
- **May of 2005**, **the International Steering Committee defines the Scope of the Project based on the scientific merits (STI) and the resources (AFI) available.**
- The approved projects will present their string of **Technical Design Reports (TDR)** for their sub systems according to the milestones given in the TPs. This allows a staged construction of sub projects.
- **Summer of 2005:** Legal Structure of FAIR ready for signature
- **Summer of 2006:** FAIR Inc. signed Member States, start of construction of FAIR Fall 2006/January 2007

- ***2011 - 2014: Staged Commissioning of FAIR***

FAIR MoU Signature Ceremony, 23d September 2004 at Berlin

Germany Finland

Sweden

+ France, Italy, Spain, Russia, UK, Poland, Hungary, China, India