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JÜLICH FORSCHUNGSZENTRUM

Status and Activities

at COSY/Jülich and its Injector Cyclotron

May, 12 2012 | Ralf Gebel

Institute for Nuclear Physics (IKP-4)
Jülich Centre for Hadron Physics (JCHP)

ECPM XXXVIII, May 9-12, 2012

Outline

- Introduction
- New cyclotrons at the research center
- Status, main activities and new projects
  - HESR for FAIR
  - COSY and Cyclotron operation
  - HGF ARD program
  - Future projects: JEDI and Ju-SPARC

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JÜLICH FORSCHUNGSZENTRUM · DLR · DZNE Deutsches Zentrum für Neurodegenerative Erkrankungen e.V. in der Helmholtz-Gemeinschaft

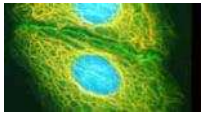
dkfz. · GFZ Helmholtz-Zentrum Potsdam · Helmholtz Zentrum Berlin für Materialien und Energie · DESY

IPP · Helmholtz Zentrum für Infektionsforschung · GKSS Forschungszentrum in der Helmholtz-Gemeinschaft · AWI

Helmholtz Zentrum für Umweltforschung UFZ · GSI · MDC Berlin-Buch · HelmholtzZentrum münchen

Energy

Earth and Environment



Health

Key technologies

Structure of matter

Transport & Space

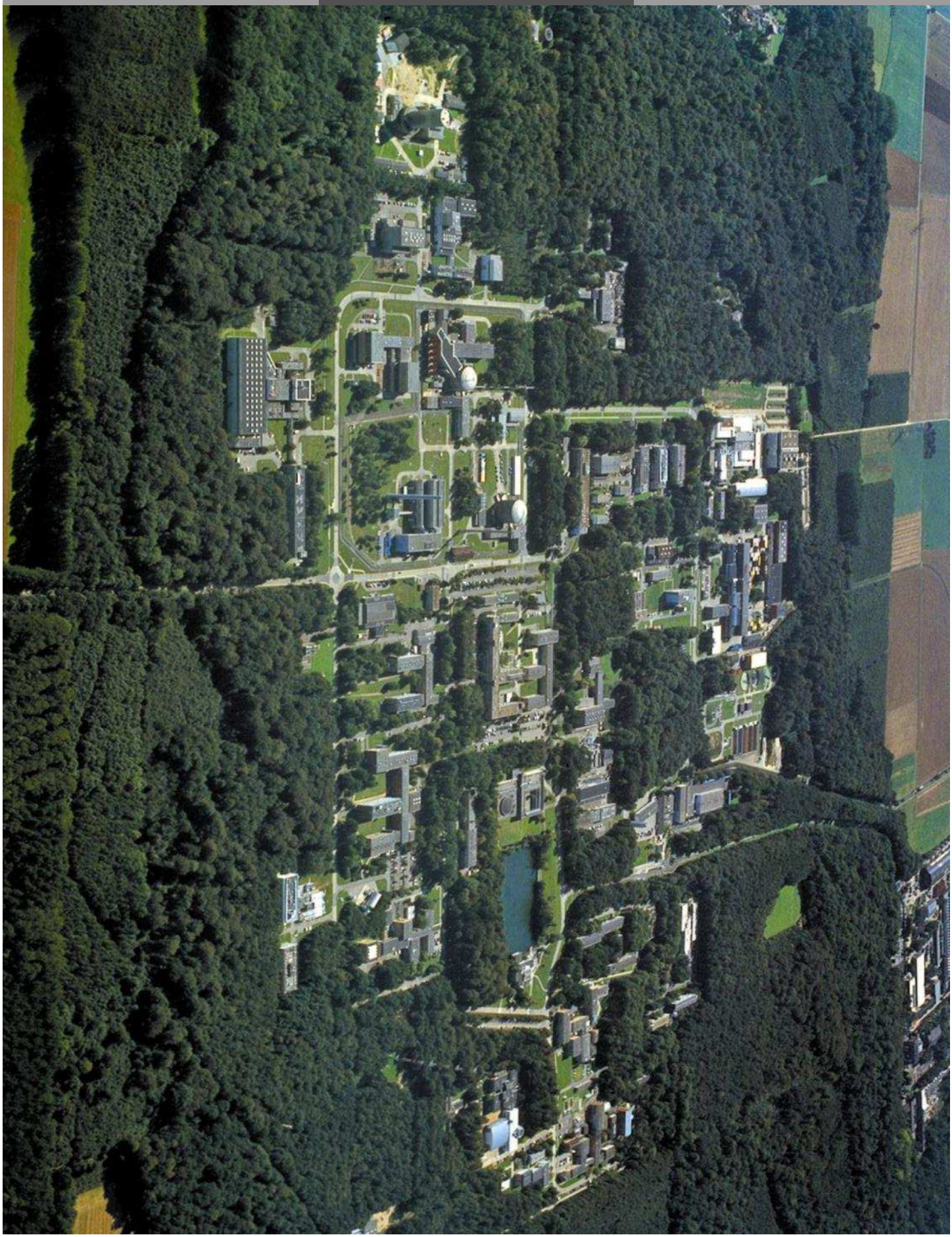
32.698 employees in 18 research centres

10.458 scientists and engineers

5.320 doctoral students

Budget: 3,4 Billion Euro

Mitglied der Helmholtz-Gemeinschaft



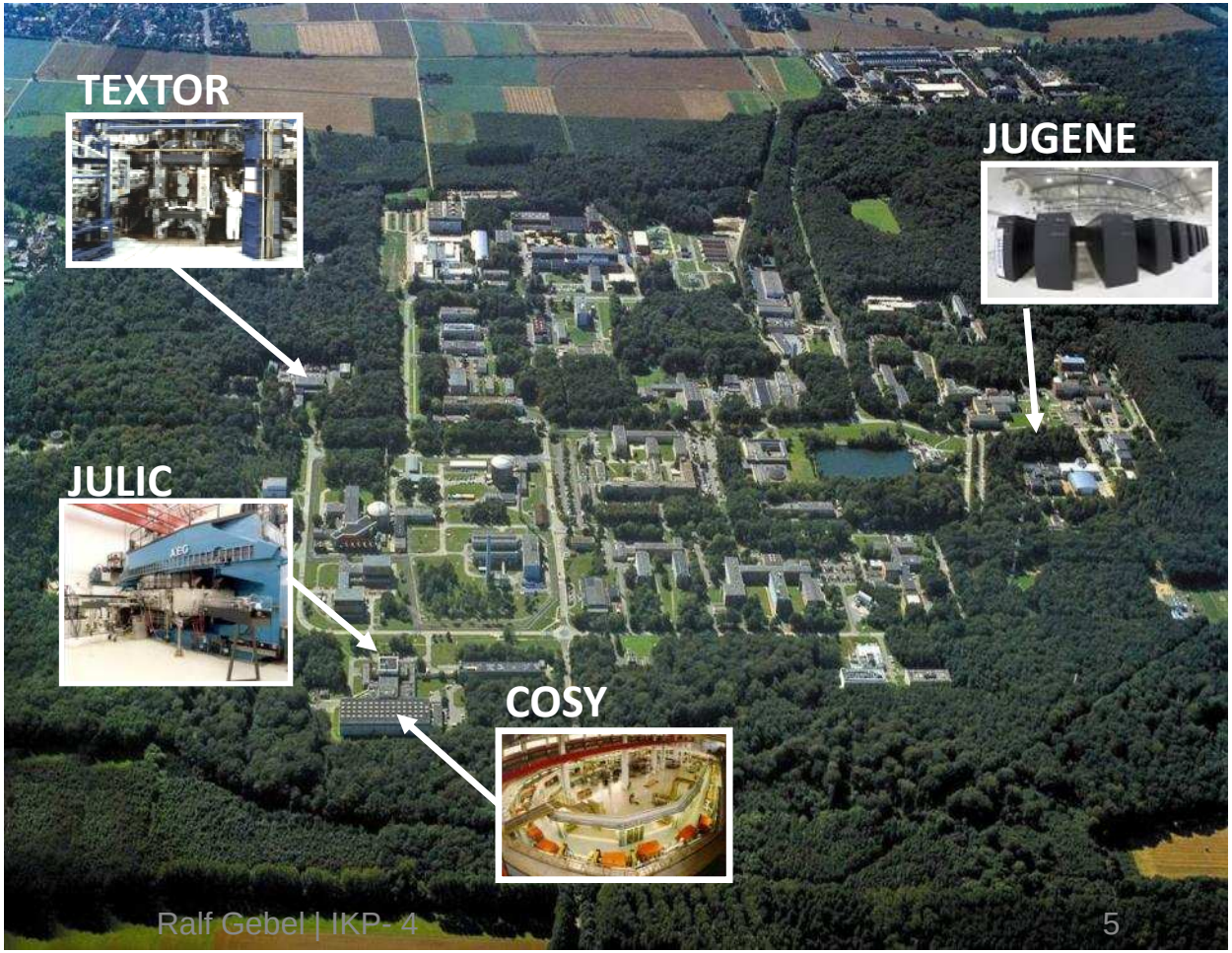
About Jülich

Budget: 380 Mio. €
Third party funding: 95 Mio. € (16 Mio.€ industry)
License fees: 3 Mio. €

staff: 4.767
scientists: 1.625
+ 900 guest scientists
from more than 70 countries

8.500 patents, 192 licenses
100 new patents per year
2-3 spin offs per year
> 1.700 papers per year
> 1.200 ISI-listed

cooperation contracts with
>120 international companies
50 internal technology transfer projects/ spin off-funding



New cyclotrons at the research centre

Routine production and research tools for medicine and biology

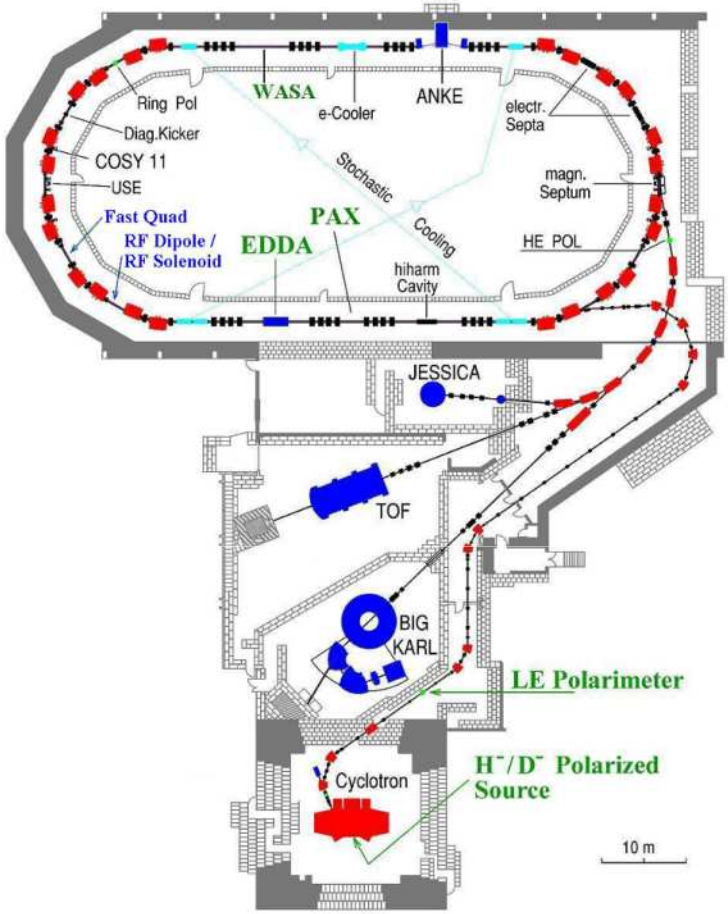
- Radionuclides for Medical Imaging
- Standard PET- tracers for INM and external partners
- Non-Standard radionuclides and PET- tracers for special investigations

IBA 30XP at INM-5 (4/2012)
Nuclear Chemistry
Institute for Neurology and Medicine
Replacement for two cyclotrons (CV28, BC1710)

IBA 18/9 CYPRES cyclotron for MRI-PET at IPG (12/2009)
CYclotron for Plant RESearch

Status - IKP-4 main tasks

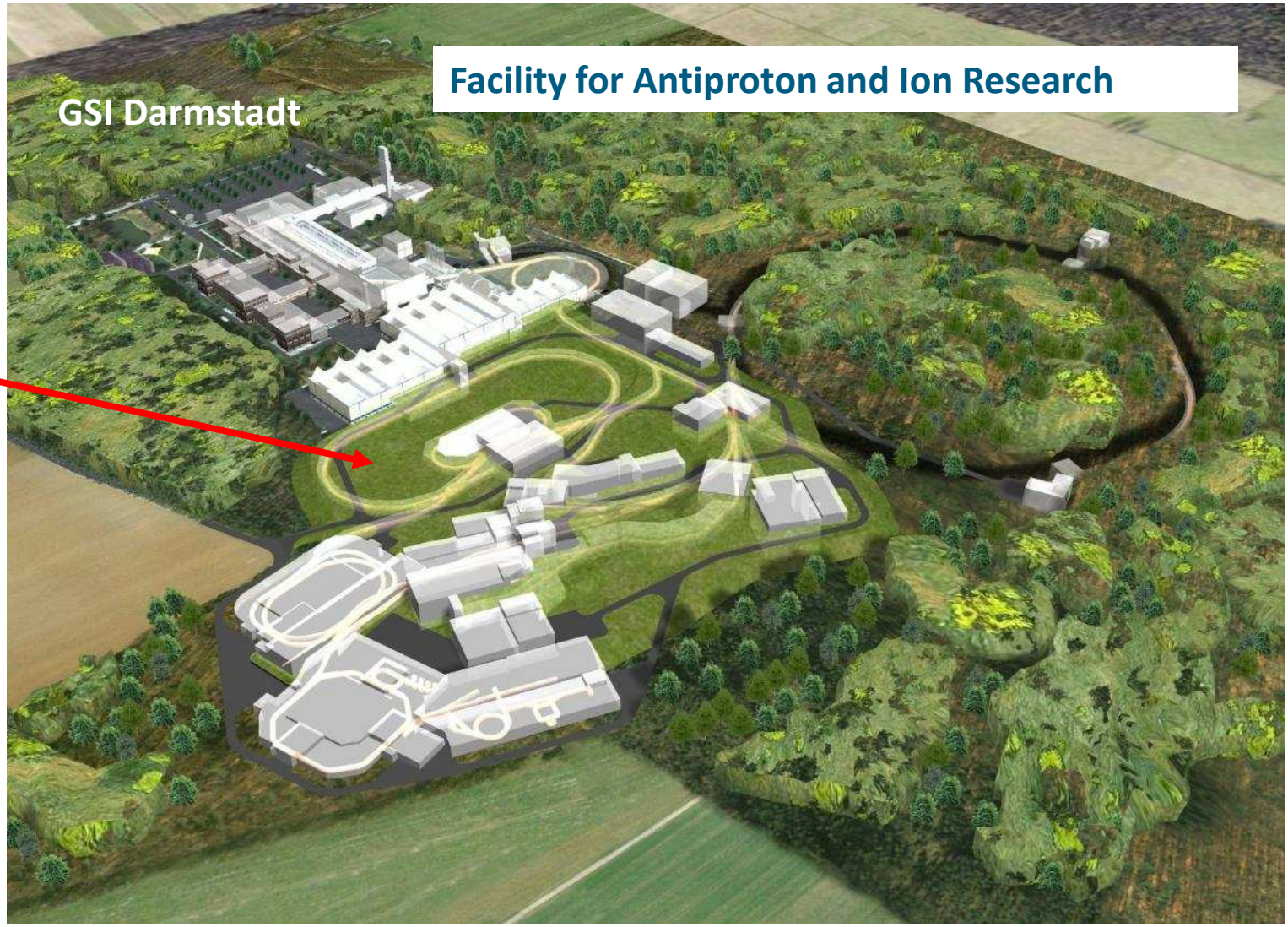
- **Design and construction of HESR for FAIR**
- **Operating of COSY 24/7**
- Preparation of new installations at COSY in 2012:
  - 2 MeV electron cooler (Commissiong in Novosibirsk at BINP)
  - superconducting solenoid (full sibirian snake) (5 T, 1 m length, full ramp in 30 s)
- Developments for Experiments:
  - EDM at COSY
  - Jülich EDm Investigation (JEDI)



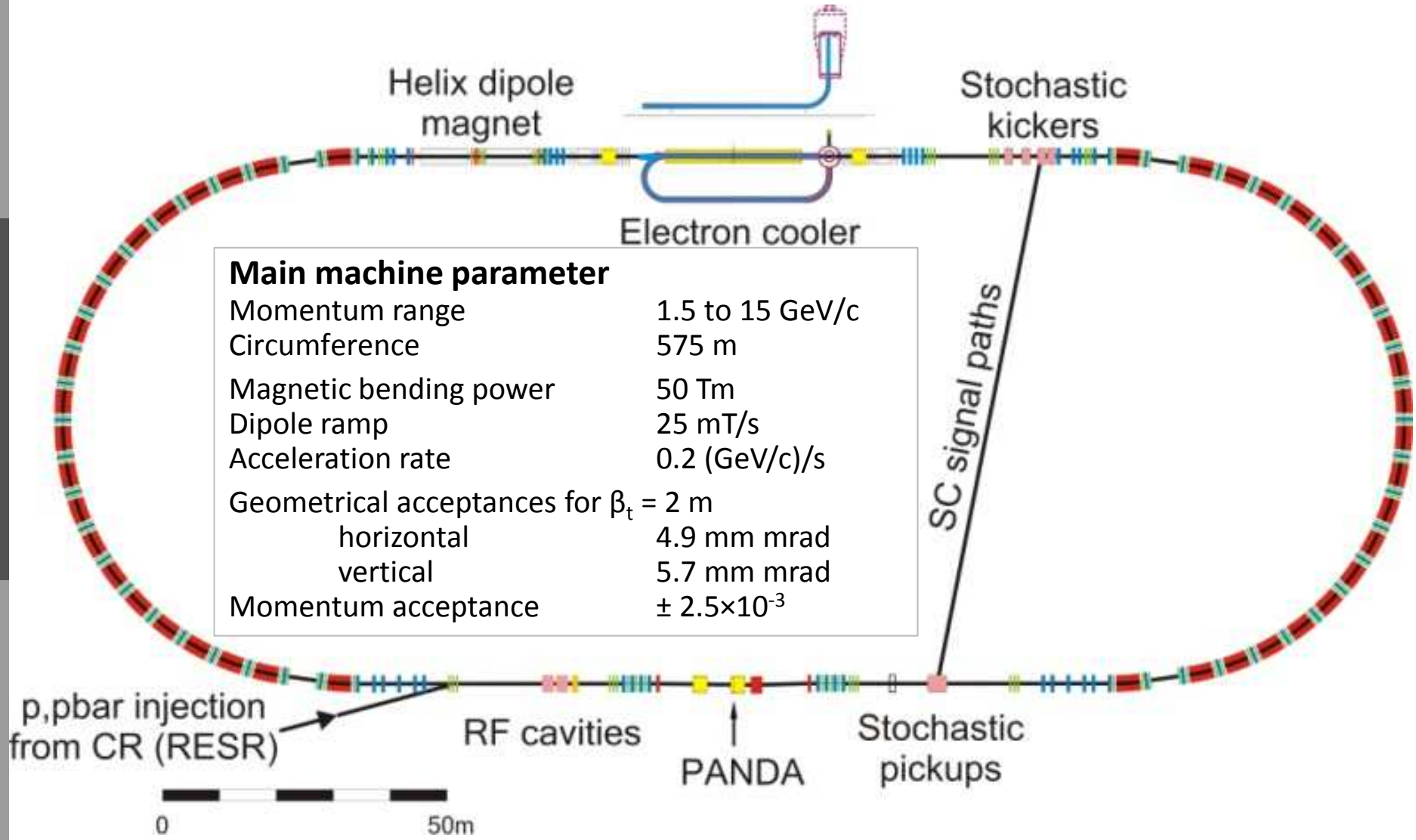
- HGF ARD: polarized hadron sources, high energy electron cooler, EM-deflector
- JuSPARC: Jülich Short-pulse PArticle and Radiation Centre

Construction of HESR

High Energy Storage Ring HESR



Construction of HESR for FAIR



Main machine parameter

Momentum range	1.5 to 15 GeV/c
Circumference	575 m
Magnetic bending power	50 Tm
Dipole ramp	25 mT/s
Acceleration rate	0.2 (GeV/c)/s
Geometrical acceptances for β_t = 2 m	
horizontal	4.9 mm mrad
vertical	5.7 mm mrad
Momentum acceptance	$\pm 2.5\times10^{-3}$

Progress with Construction of HESR for FAIR

Collaboration Contract FAIR – FZJ about In-kind contribution of the HESR has been signed: 17.10.2011 in Juelich

Trees have been cut at GSI end of 2011.

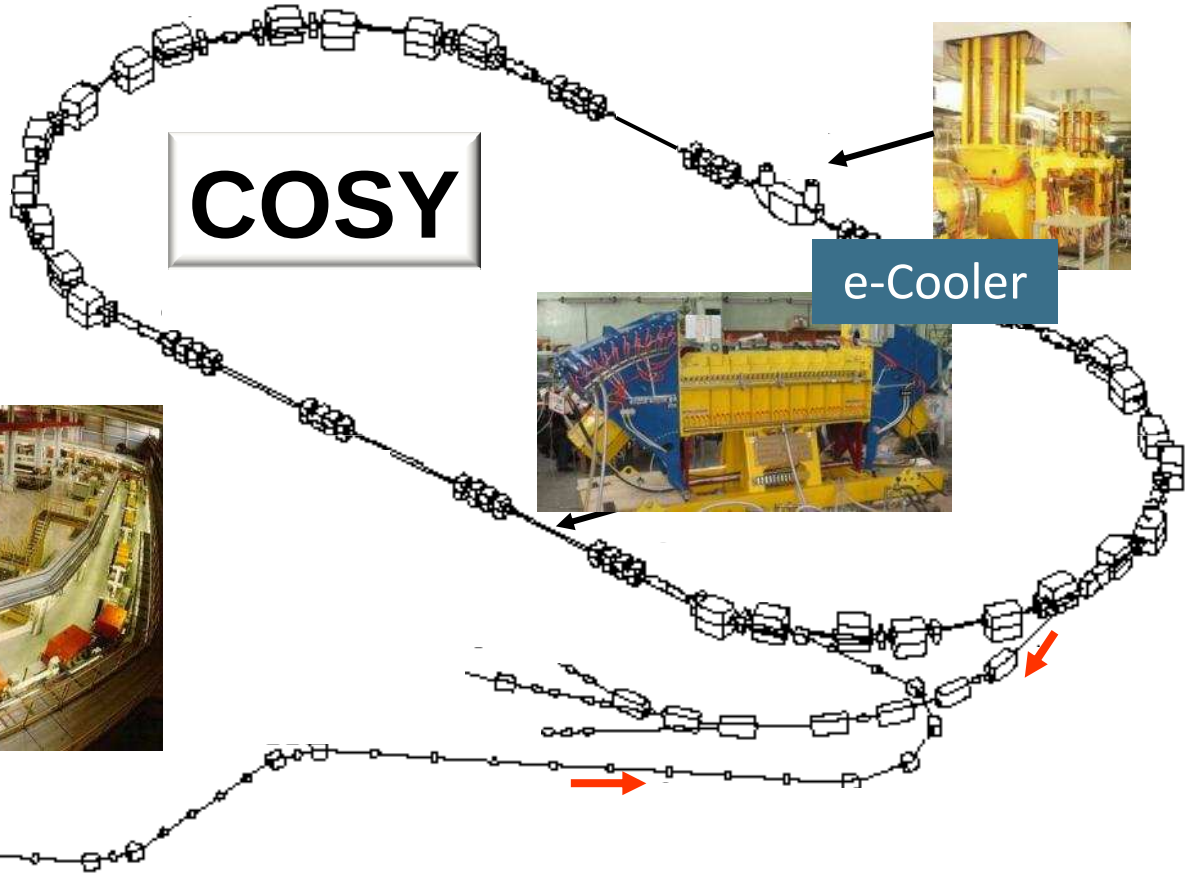
Bats and frogs have been resettled, before…

Status - COSY

Cooler and storage ring for (polarized) protons and deuterons

p = 0.3 – 3.7 GeV/c

Phase space cooled internal & extracted beams

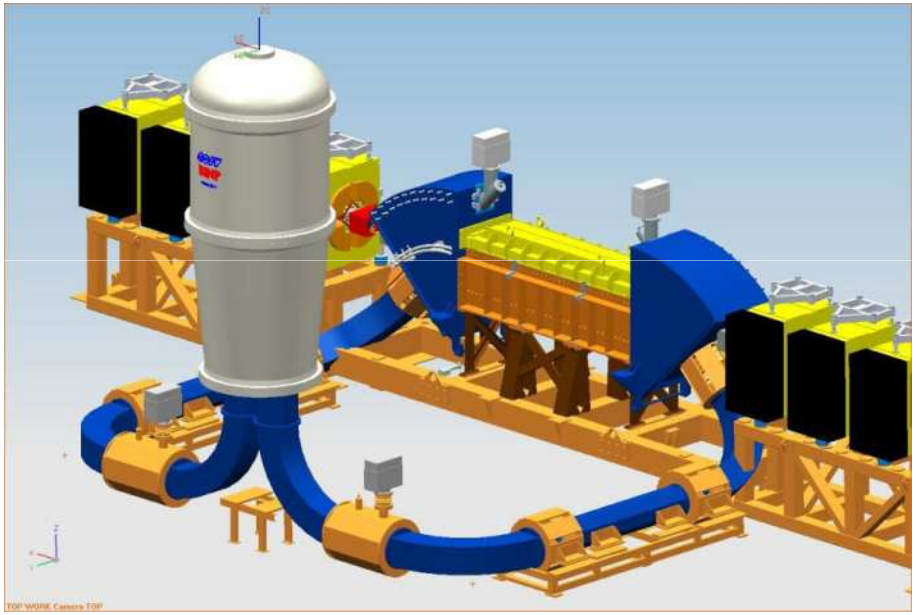


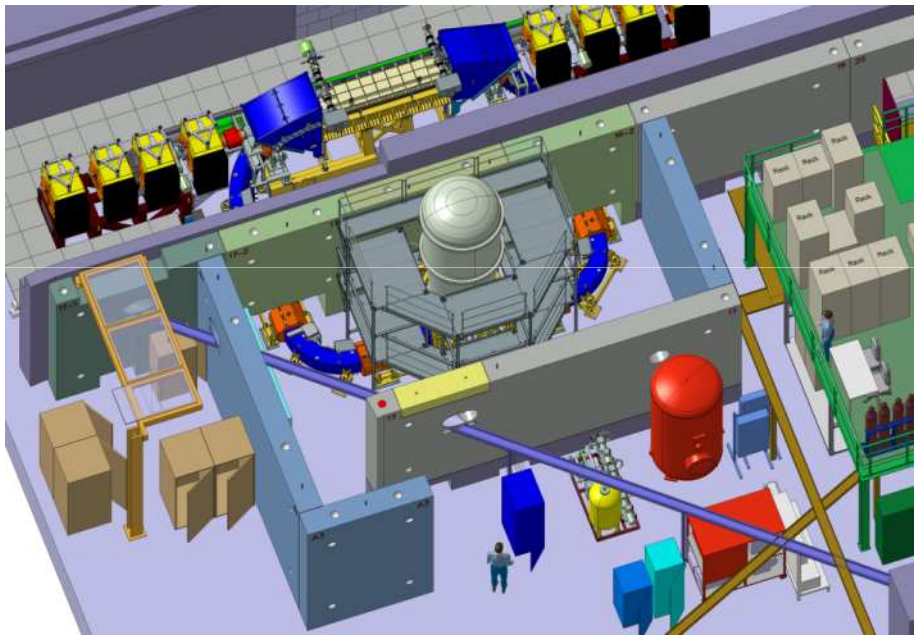
Injector cyclotron

… *the* machine for spin physics with hadron beams

New installation in 2012

2 MeV Electron Cooler, together with BINP/Novosibirsk





- Energy Range: 0.025 ... 2 MeV
- High Voltage Stability: $< 10^{-4}$
- Electron Current: 0.1 ... 3 A
- Electron Beam Diameter: 10 ... 30 mm
- Cooling section length: 2.694 m
- Magnetic field (cooling section): 0.5 ... 2 kG

Status - Experiments

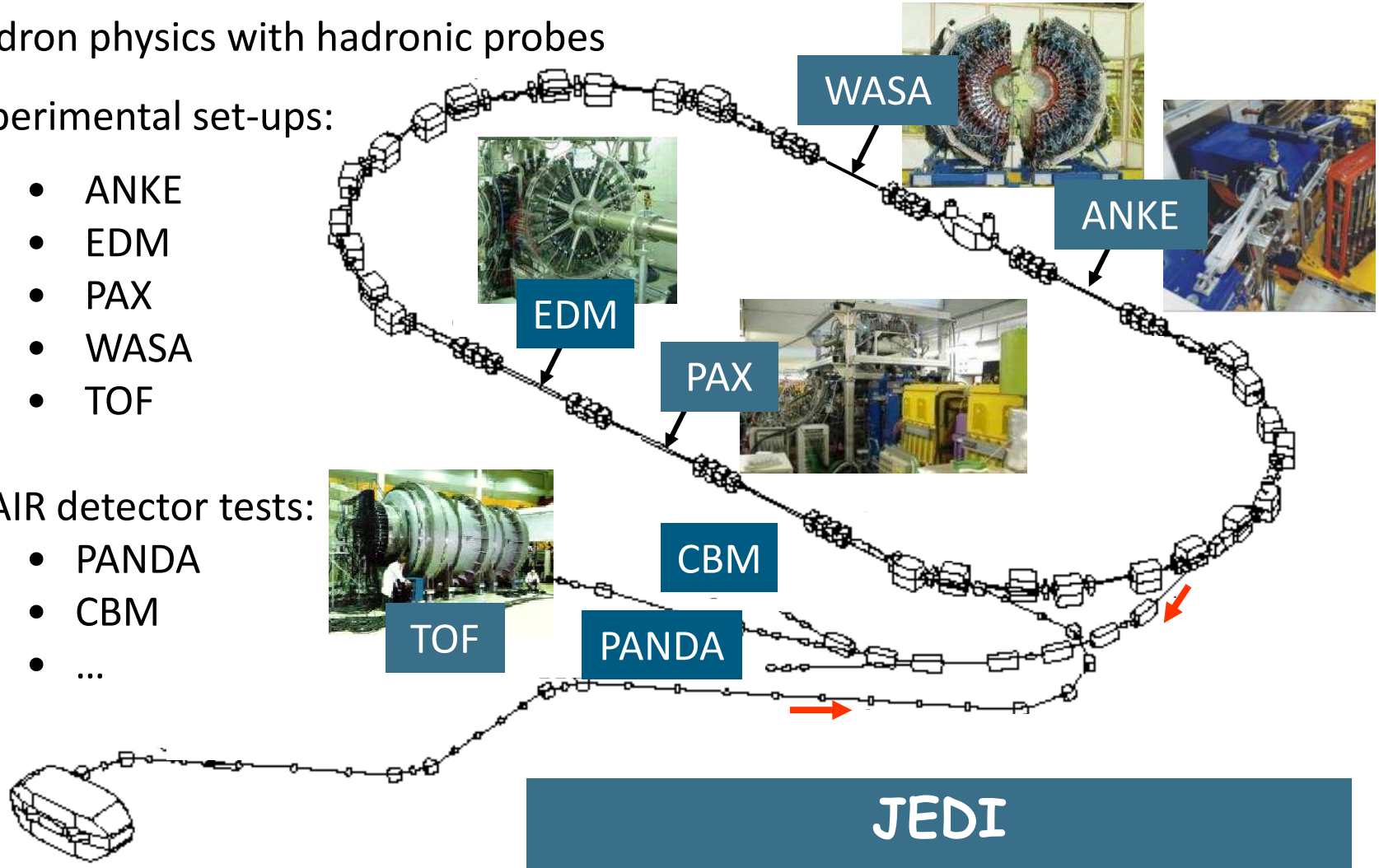
Hadron physics with hadronic probes

Experimental set-ups:

- ANKE
- EDM
- PAX
- WASA
- TOF

•FAIR detector tests:

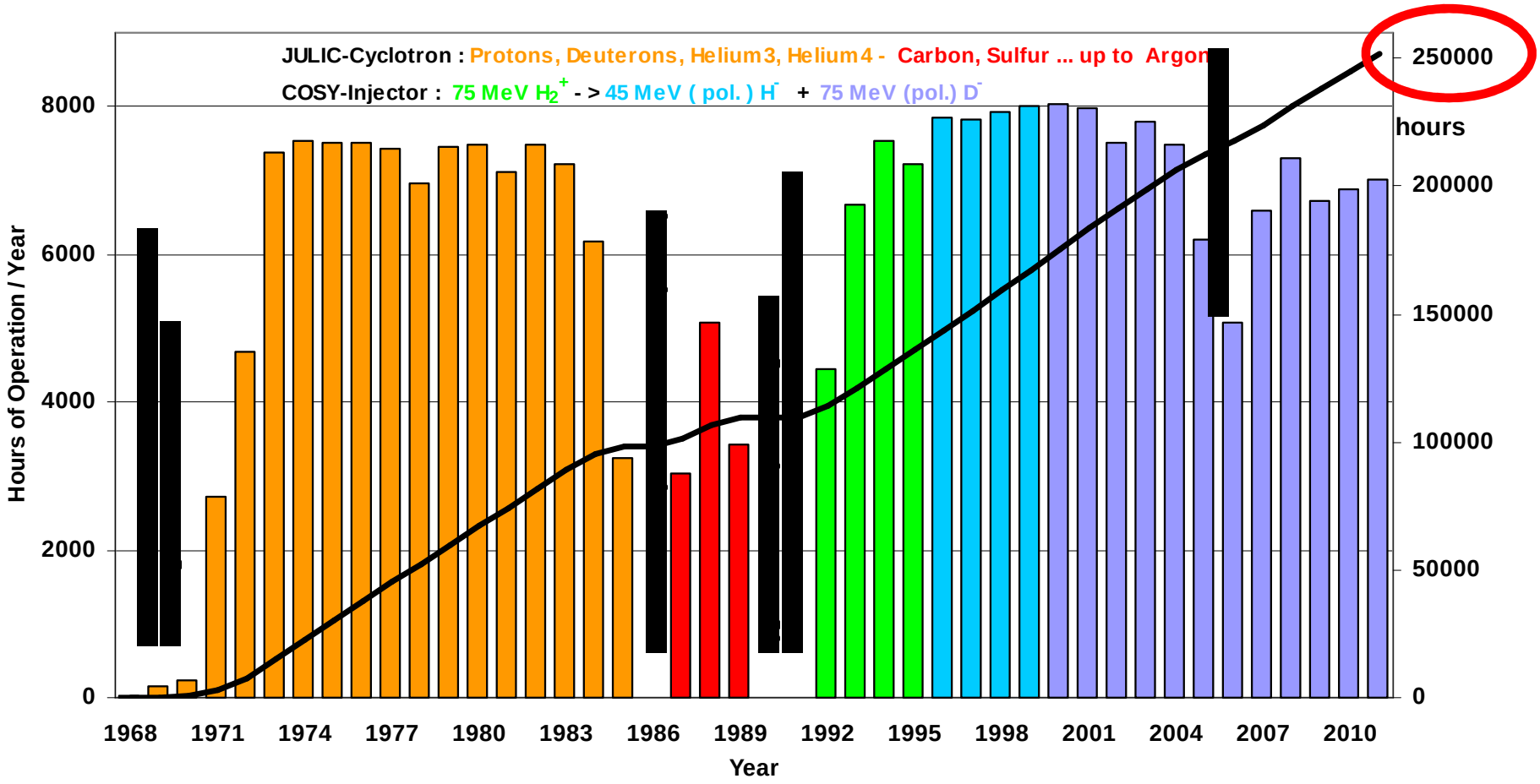
- PANDA
- CBM
- …



JEDI

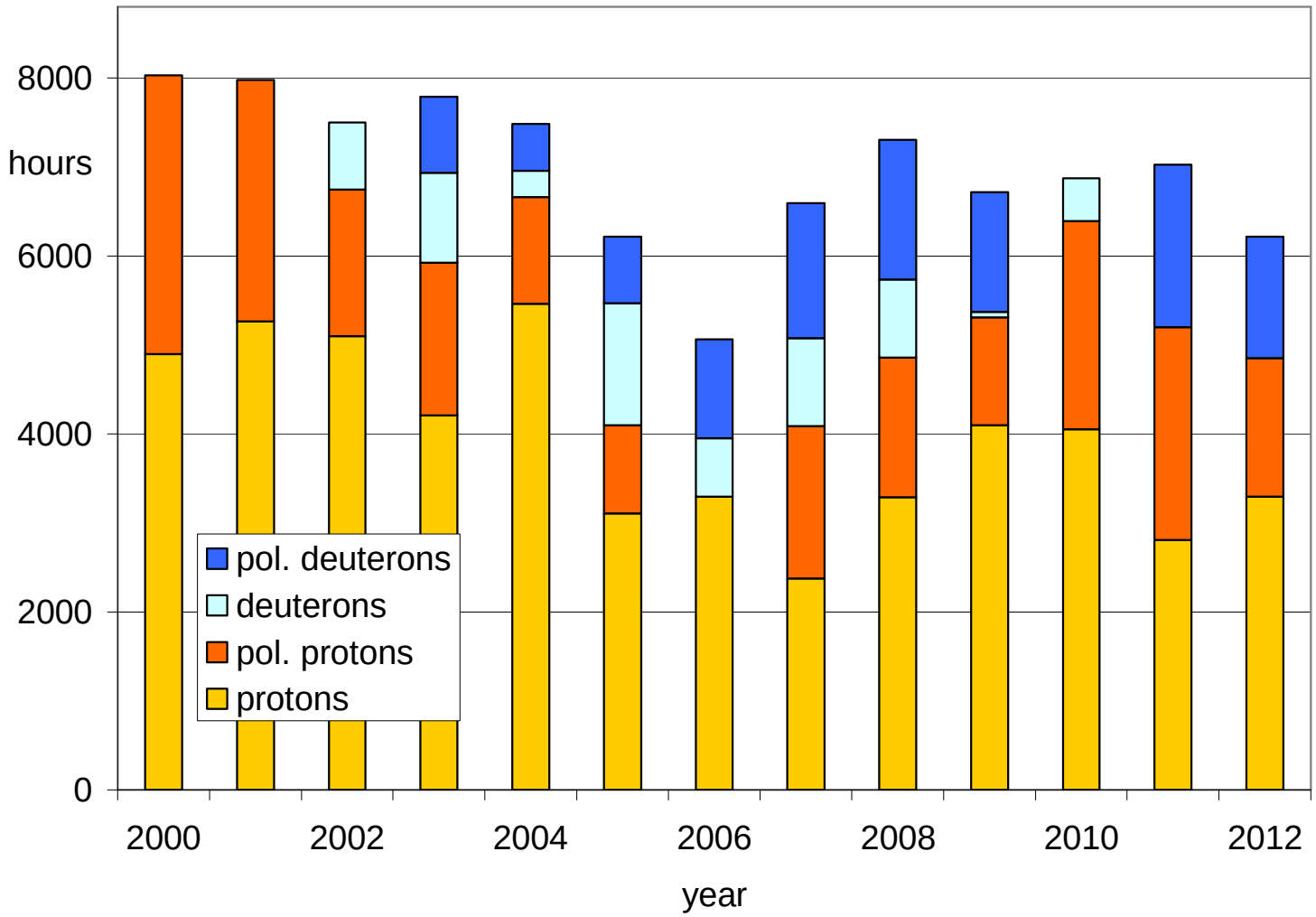
(Jülich Electric Dipole Moment Investigations)

COSY and Cyclotron operation 24/7



Availability (Up time) of the injector cyclotron

Operational statistics 2000 -2012



Delivered beam species

The cyclotron

AEG cyclotron

AEG design

Request for quote: 1961

First internal beam: 1968

Pole diameter 3.3 m / 700 t iron

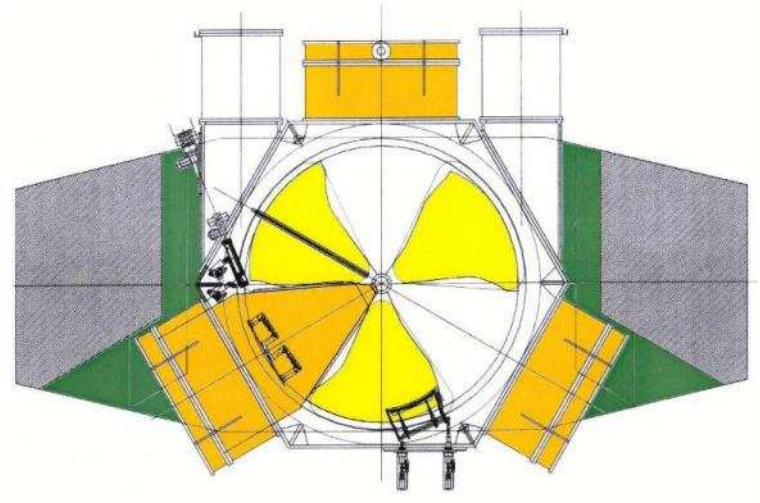
$\langle B \rangle_{max}$ =1.35 T B_{hill} = 1.97 T

20 – 30 MHz (h=3)

22.5-45 MeV/A

2-4.5 keV/A injection

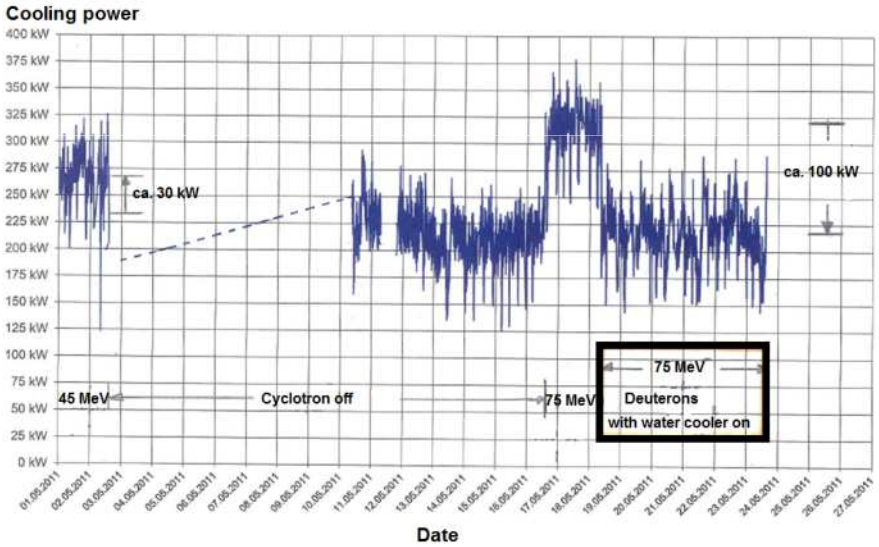
3 ion sources (2 multicusp +pol. CBS)



New installations

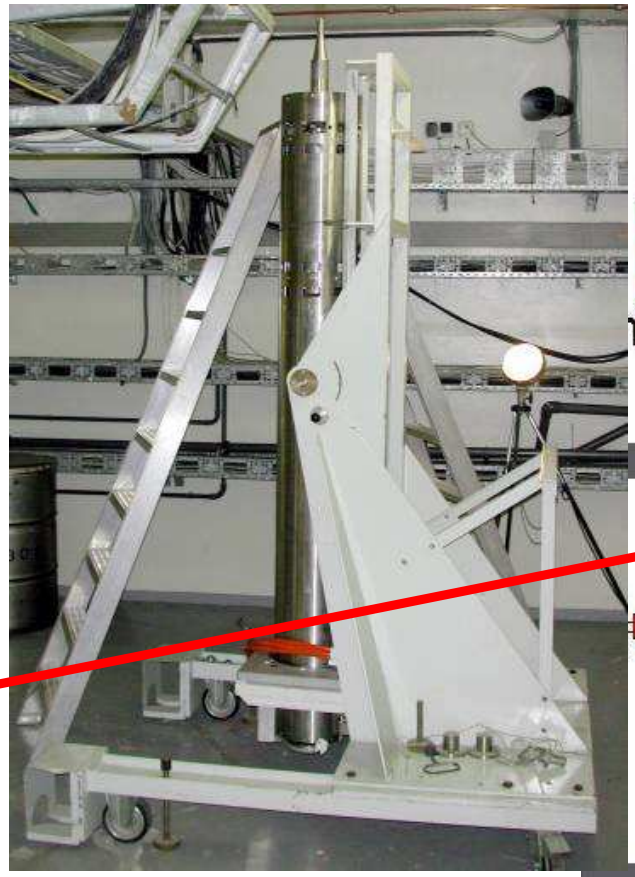
Infrastructure and sub systems have been improved

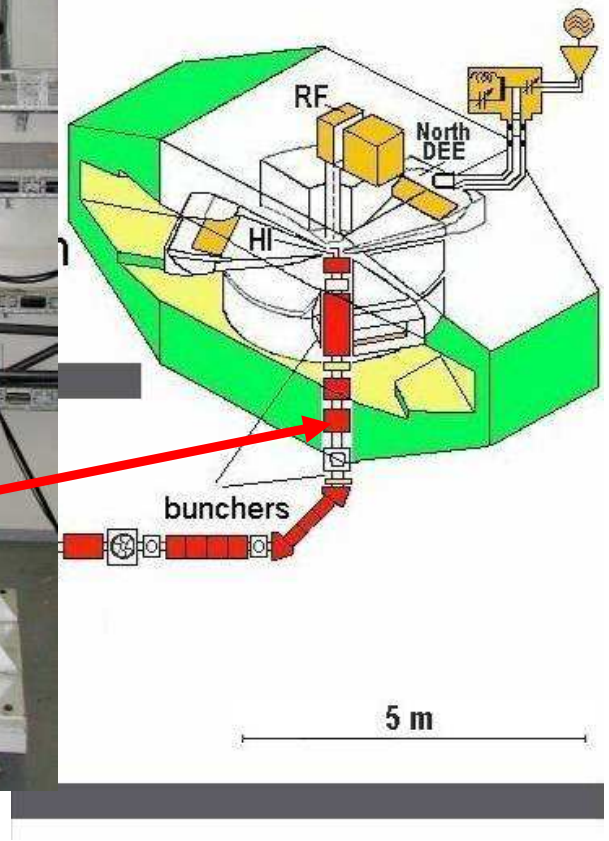
By-pass and an additional cold water aggregate



Cold water consumption, from central supply

After 6 years: again a water leak at solenoid LV1

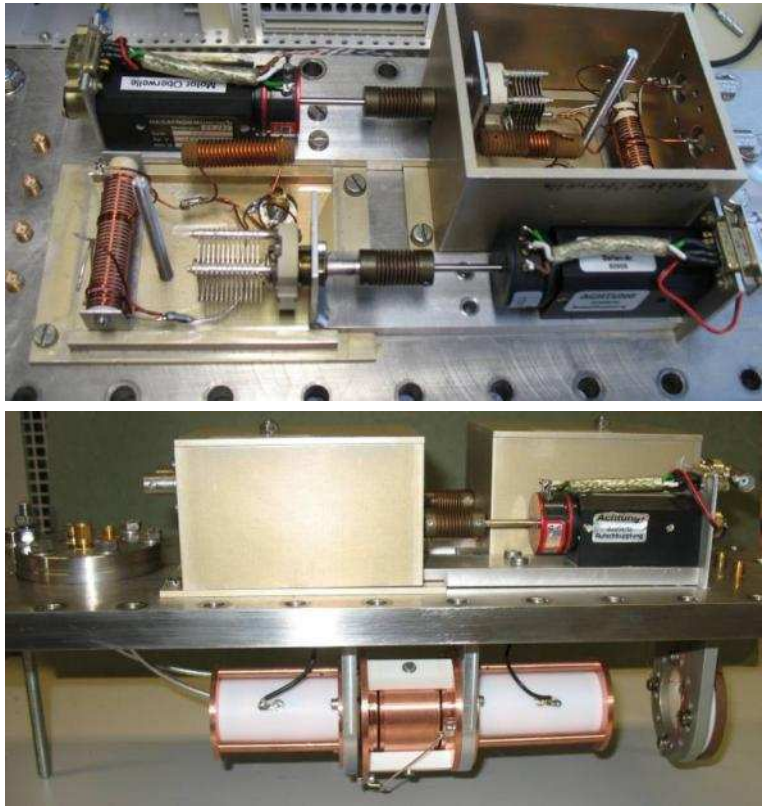




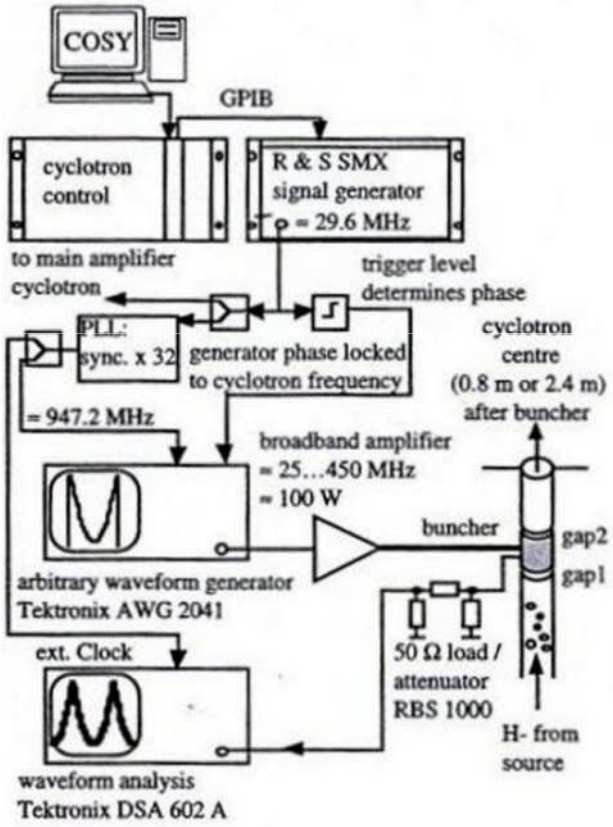
After 6 years: inflector inspection possible

An opportunity: Buncher replacement

New options: resonant on 2nd harmonic and arbitrary



Buncher set-up (3 double gap buncher)



Buncher signal generation

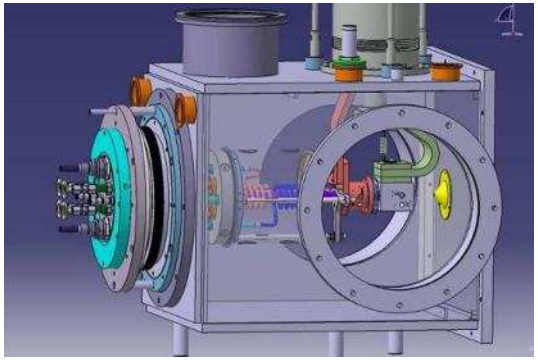
Accelerator Research and Development (ARD)

R&D for Hadron Storage Rings

Topics (with FZJ as leading lab)

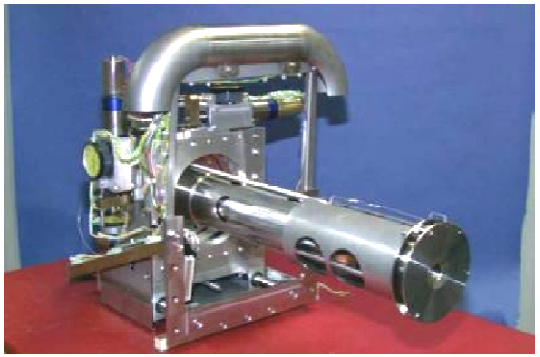
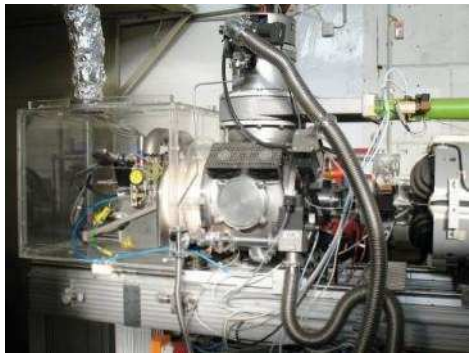
- (polarized) Ion sources for hadron storage rings
  - Assure high intensity beams for COSY
  - Possible later experiments at FAIR with polarized beams
- Combined electrostatic and magnetic deflectors
  - Search for an electric dipole moment in p, d and He3
- High energy beam cooling and broad band stochastic cooling
  - Electron cooling up to COSY's maximum momentum
  - Electron cooling for HESR
  - Fast stochastic cooling at different energies

ARD topic: New (pol.) Ion sources



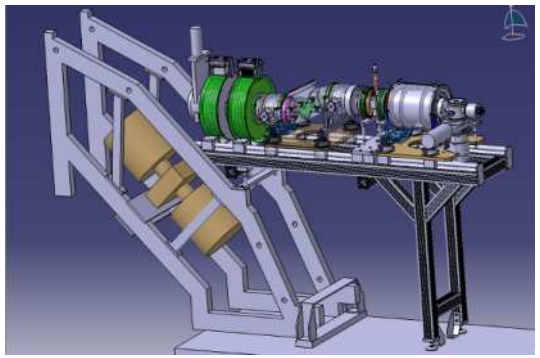
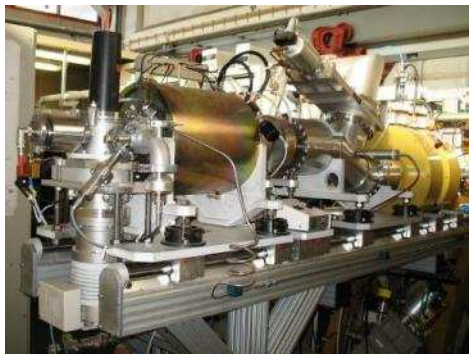

Atomic beam studies

- Intensity
- Density, profiles
- Velocity distribution

Cs beam studies

- Intensity
- Profile/ Brightness

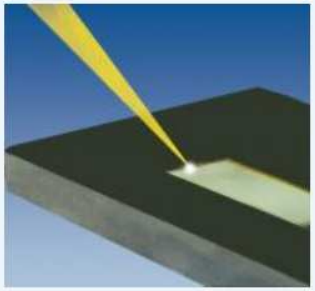
Beam diagnostics

- Polarization

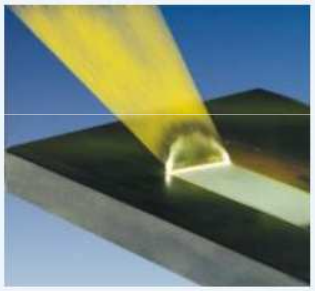
cleanLASER
Clean-Lasersysteme GmbH

JÜLICH
FORSCHUNGSZENTRUM

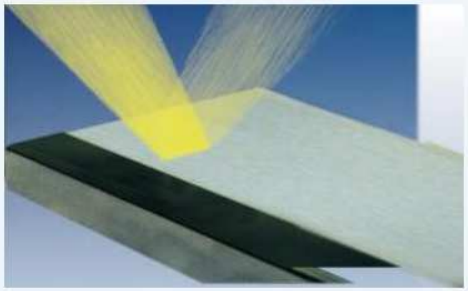
Laser cleaning: an essential new tool



Rapid pulsed laser beam scans across treated surface

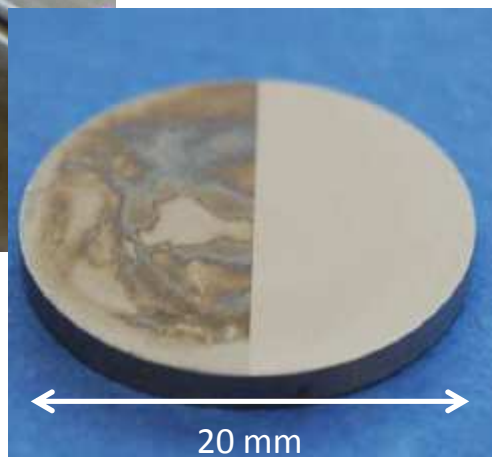


Target coating/contaminant is vaporized & residue is captured



Cleaning process stops when target material is removed

Application samples:
Tungsten, Mo, Ti, Steel …
Speed: up to several cm²/s



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Applikation
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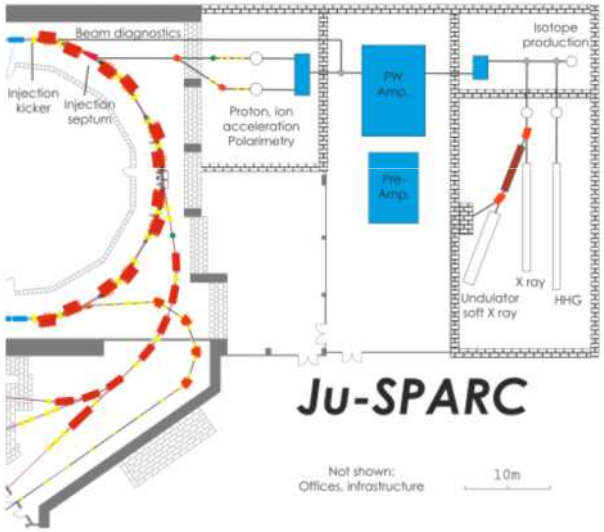
E applikation@cleanlaser.com

http://www.cleanlaser.de

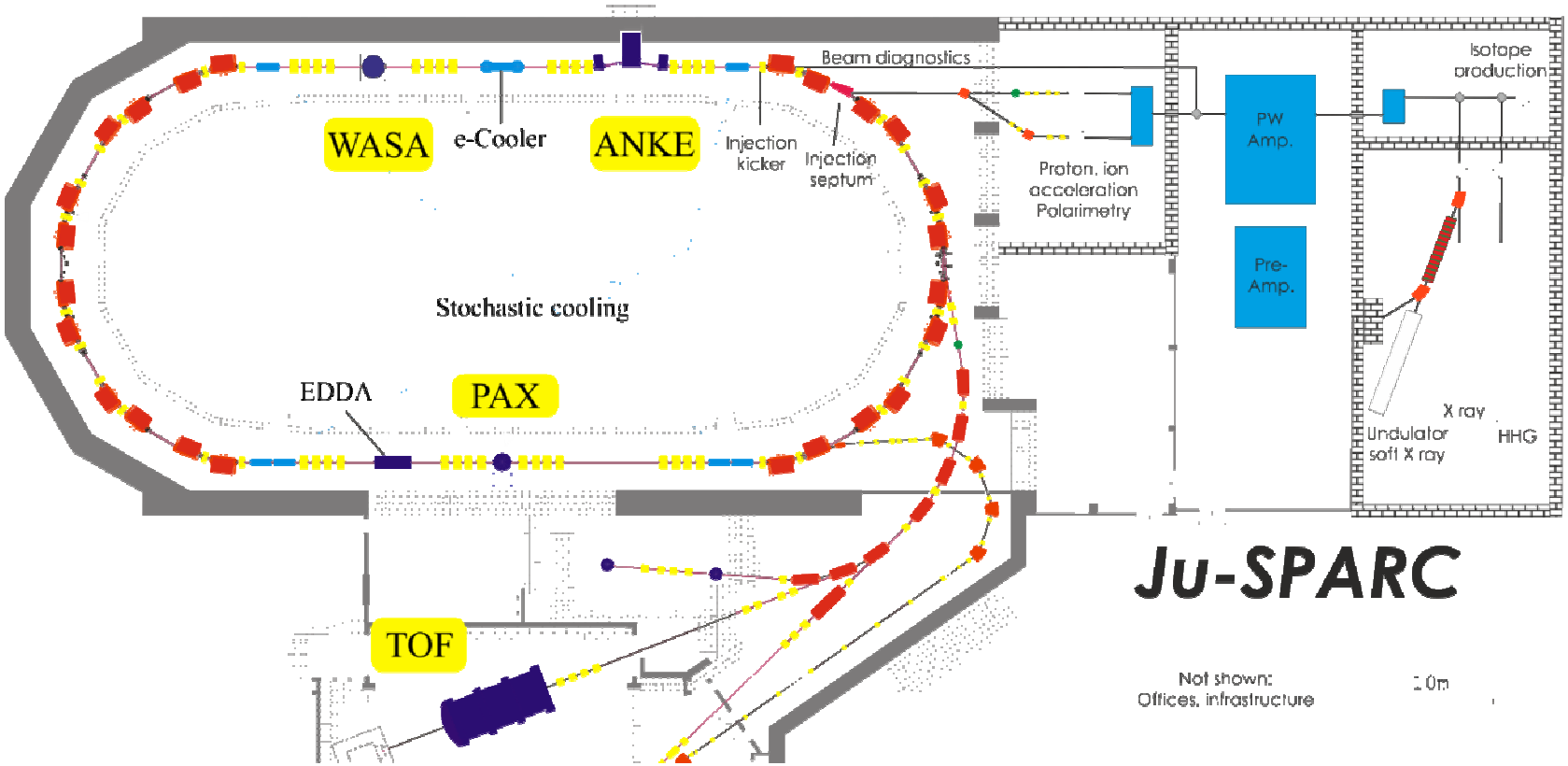
Outlook

Future projects at IKP: JEDI and Ju-SPARC

JEDI



JuSPARC = Jülich Short-pulse PArticle and Radiation Centre



JuSPARC physics program

EUV X-rays:

- time-resolved X-ray microscopy
- high-harmonic generation
- tunable X-rays from undulator

Hadrons:

- production of polarized beams
- nuclear spallation
- isotope production

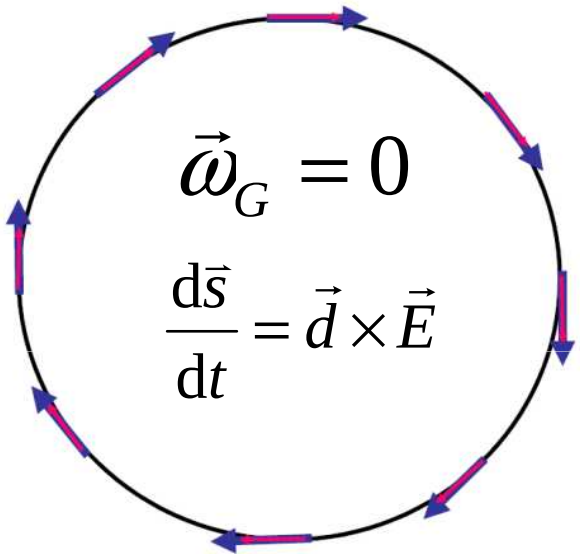
Accelerator:

- post-acceleration with COSY
- non-destructive beam diagnostics

Laser parameters	
Wave length	800 nm
Focus diameter	20 µm
Peak power	1.5 PW
Pulse energy	40 J
Pulse length	25 – 40 fs
Repetition rate	5 Hz

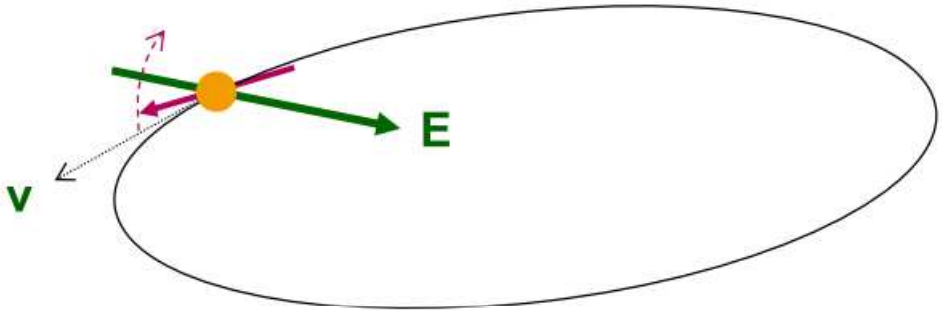
Search for Electric Dipole Moments

NEW approach: EDM search in time development of spin in a storage ring:



$$\vec{\omega}_G = 0$$

$$\frac{\mathrm{d}\vec{s}}{\mathrm{d}t} = \vec{d} \times \vec{E}$$



"Freeze" horizontal spin precession; watch for development of a vertical component !

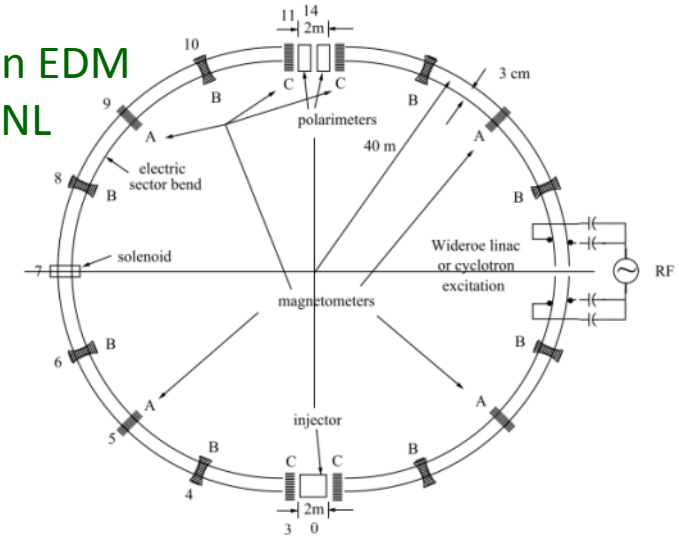
A *magic* storage ring for protons (electrostatic), deuterons, …

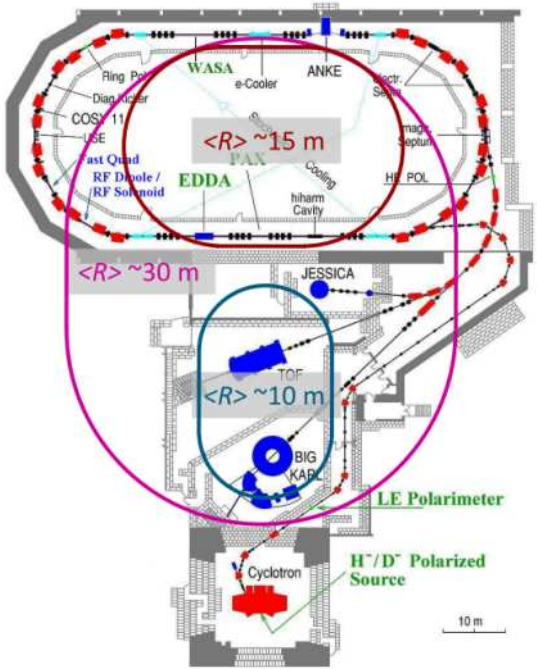
particle	p (GeV/c)	E (MV/m)	B (T)
proton	0.701	16.789	0.000
deuteron	1.000	-3.983	0.160
^{3}He	1.285	17.158	-0.051

One machine with r ~ 30 m

EDM Projects

Proton EDM
BNL





Light-Ion EDM
Jülich

R&D Activity	Goal	Test
Internal Polarimeter	spin as a function of time Systematic errors < 1 ppm	EDM at COSY
	Full-scale polarimeter	EDM at COSY
Spin Coherence Time	$>10^3$ s	EDM at COSY
Beam Position Monitor	resolution 10 nm,1 Hz BW 64 BPMs, 10^7 s measurement time 1 ppm (stat.) relative position (CW-CCW)	BNL RHIC IP
EB-field Deflector	17 MV/m 2 cm plate separation, 0.15-0.5T	Jülich

Thank you for your attention!

For contributions: Thanks to R.Brings, A.Lehrach, R.Maier, F.Rathmann ...

EDM workshop at ECT* Trento, Italy
October 1 - 5, 2012
„EDM Searches at Storage Rings“
http://www.ectstar.eu/