The COSY Synchrotron in Jülich

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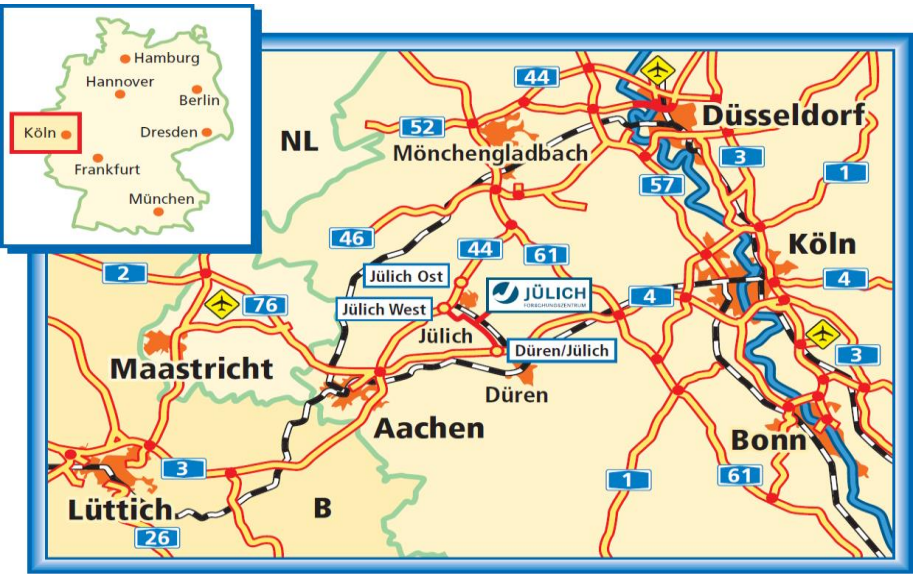
Forschungszentrum Jülich



At a Glance

Forschungszentrum Jülich focuses on use-inspired basic research. It faces up to the challenges of the present and pursues research for a future worth living.

As a member of the Helmholtz Association, Forschungszentrum Jülich is among the major interdisciplinary research centres in Europe.

5,868 employees

1.46 funding turnover at Project Management Jülich in billions of euros

82 new patent applications

40 of these applications European or international

4 new JARA Institutes

18 partnerships with graduate schools/research training groups for doctoral researchers' qualifications

354 collaborations with industry

Institute for Nuclear Physics

The **Institut für Kernphysik** (IKP) is conducting basic research in the fields of nuclear and elementary particle physics. The physics program addresses two big questions of modern physics, namely the matter-anti-matter asymmetry of our universe and a basic understanding of the building blocks matter is comprised of.

The major part of the experimental program is conducted at the cooler synchrotron and storage ring COSY, with its capability to provide phase-space cooled proton and deuteron beams with momenta up to 3.7 GeV/c to internal as well as external target stations, is a unique facility on a world-wide scale.

Divisions

- Experimental Hadron Structure (IKP-1)
- Experimental Hadron Dynamics (IKP-2)
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- Theory of the strong interactions (IKP-3/IAS-4)
- Large Scale Nuclear Physics Equipment (IKP-4)

IKP has roughly 120 coworkers

COSY Injector

AEG design

Request for quote: 1961

First internal beam: 1968

Upgrade for COSY: 1990

Pole diameter 3.3 m / 700 t iron

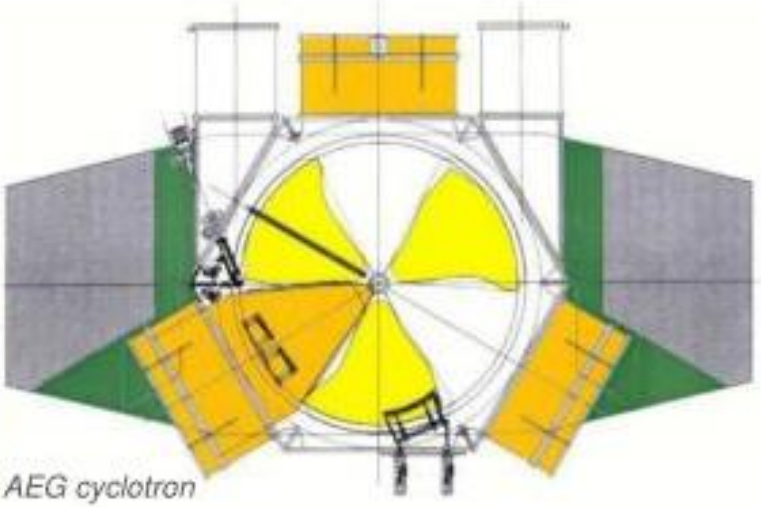
$\langle B \rangle_{max}$ =1.35 T B_{hill} = 1.97 T

20 – 30 MHz (h=3)

22.5-45 MeV/A

2-4.5 keV/A injection

3 ion sources (2 multicusp +pol. CBS)

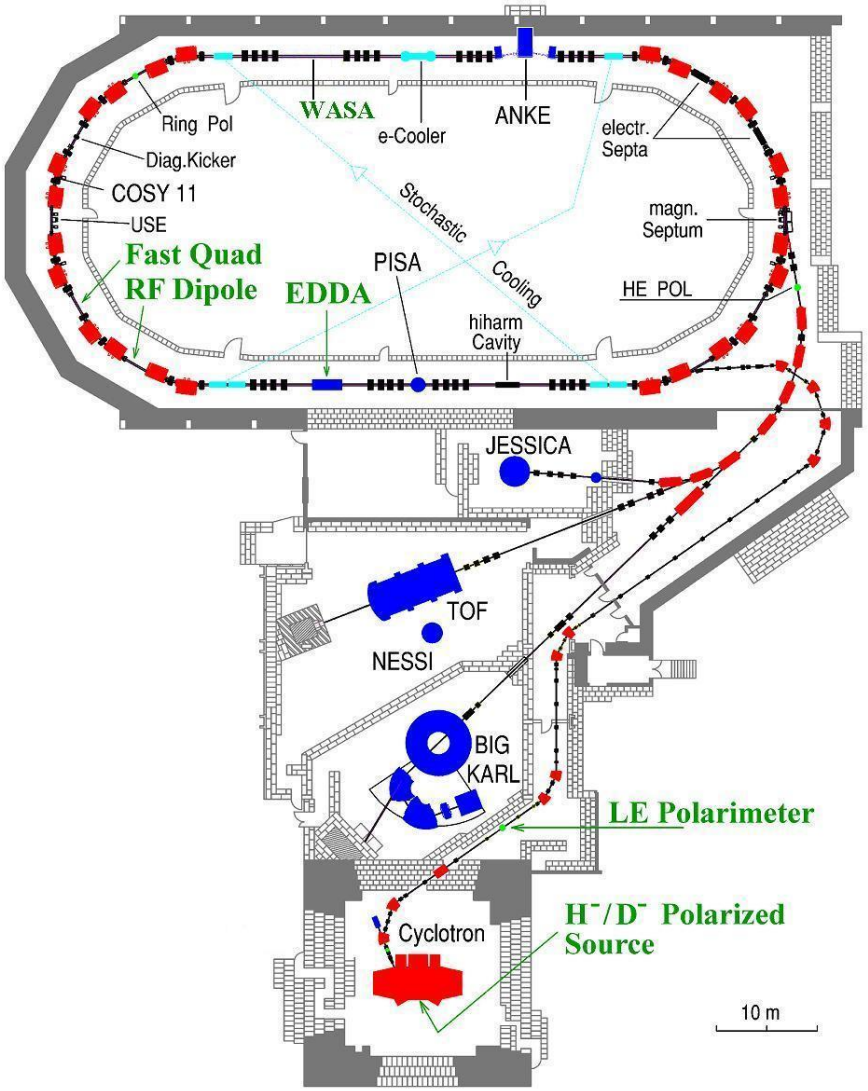


AEG cyclotron

routinely 45 MeV H^- and 75 MeV D^- for COSY with 20 ms stripping injection/cycle

COSY Facility

COSY Accelerator Facility



Ions: (unpol. and pol.) p and d

Momentum: 0.30 to 3.7 GeV/c for p
0.54 to 3.7 GeV/c for d

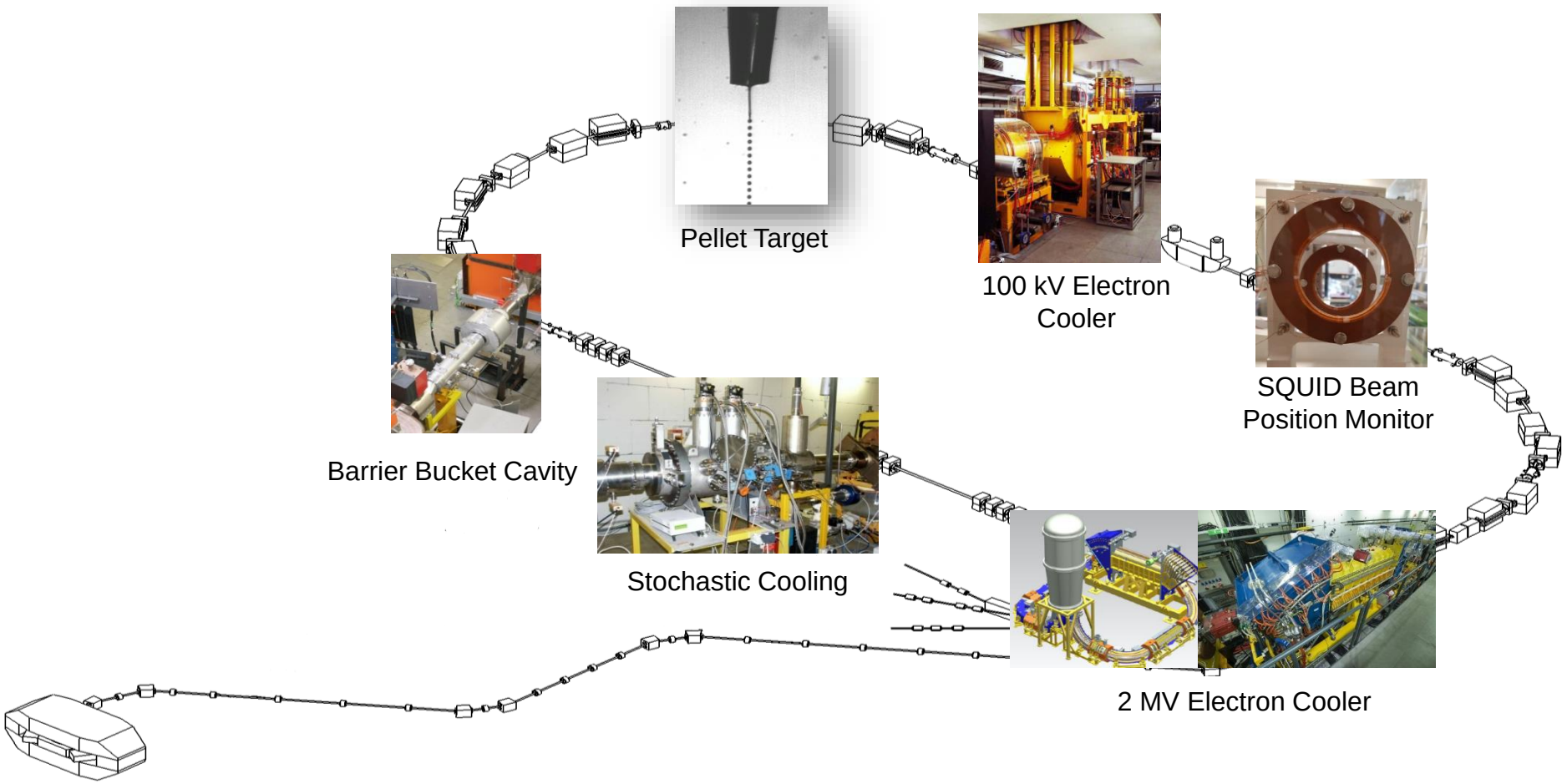
Circumference: 184 m

Experimental areas: 4 internal
3 external

Beam cooling:

- Electron cooling at injection
  beam accumulation
  high-brightness beams
- Stochastic cooling above 1.5 GeV/c luminosity preservation

Beam Physics

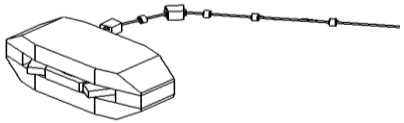


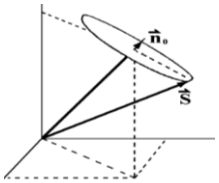
Accelerator component tests and beam experiments at COSY

Spin Physics

Ion Source for ELENA
at CERN

COSY Polarized
Ion Source

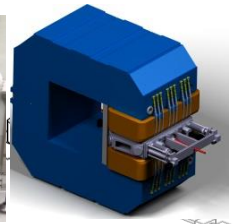




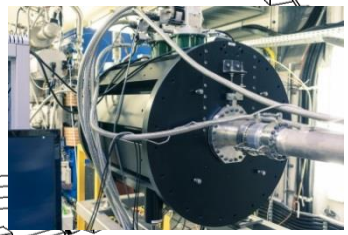
Beam and Spin
Dynamics

Prototype
RF Wien Filter

Waveguide
RF Wien Filter



Deflector Development



Siberian Snake

Accelerator component tests and spin experiments at COSY

COSY Parameter

General parameter	
Circumference	183.5 m
Ions	(Un-)polarized protons and deuterons
Injection	Charge exchange of H^- and D^- ions
Momentum range	300 - 3700 MeV/c
Experimental areas	4 internal, 3 external
Extraction mechanism	Kicker extraction, stochastic extraction
Cycle length	10 s to several hours, depending on experimental requirements
Internal targets	Fiber targets, gas cluster targets, polarised atomic beam targets
External targets	Solid state targets, liquid hydrogen and deuterium targets
Polarization	Up to 75%
Electron cooling	Transverse and longitudinal cooling, used at injection energy
Stochastic cooling	Transverse and longitudinal cooling, used above 1.5 or 3.0GeV/c (p/d)
Beam Current Measurement	Beam Current Transformer (BCT) for DC beam intensity control
Beam Position Measurement	Beam Position Monitor (BPM), 30 horizontal and vertical BPMs used for closed orbit measurement
Tune measurement	Dynamic tune measurement during acceleration with noise excitation; Schottky pickup and stripline for flattop measurements
Beam Profile Measurement	Residual gas profile monitor for transverse beam profile

Ion Optics and Machine Cycles

Ion optical conditions	
Gamma transition	g_{tr} = 2.2 at injection, shifted dynamically during acceleration to about 10
Betatron Tunes	Q_{hor} ~ 3.6, Q_{vert} ~ 3.55
Max. Twiss parameters	b-functions: 30m in both planes; D_{max}= 15 m
Min. Twiss parameters	b-functions: 2m in both planes; D_{min}= 0 m
Transverse emittances	15-30 π mmm mrad (geom., 3σ uncooled at injection), below 3 π mm mrad (geom., 3σ cooled at injection)
Momentum resolution	$\Delta p/p = 10^{-3}$ (uncooled) to 10^{-4} (cooled)
Internal experiments	b_{hor} = 2 to 5 m; b_{vert} = 2 to 5 m; D = 0 m (straight sections)
External experiments	b_{hor} < 1 m; b_{vert} < 1 m

Type of beam preparation	
Beam injection and accumulation	20 ms
Cooling and single injection	10 s
Cooling and stacking injection	1 to 15 min
Acceleration	2 to 3 s
Beam preparation for experiments	up to 3 s
Extraction	20 s to 15 min
Magnet down ramp	2 to 3 sec

Number of Particles (Peak Values)

Operation mode	
Unpolarized protons:	
Single injection	$1.5 \cdot 10^{11}$
Single injection with electron cooling	$1.4 \cdot 10^{10}$ (10s)
Multiple injection with electron cooling and stacking	$5.0 \cdot 10^{10}$ (1-5min)
Polarized protons:	
Single injection	$1.0 \cdot 10^{10}$
Single injection with electron cooling	$5.0 \cdot 10^{9}$ (10s)
Multiple injection with electron cooling and stacking	$1.2 \cdot 10^{10}$ (15min)
Unpolarized deuterons:	
Single injection	$1.3 \cdot 10^{11}$
Single injection with electron cooling	$4.0 \cdot 10^{10}$ (10s)
Polarized deuterons:	
Single injection	$6.0 \cdot 10^{9}$