JÜLICH
FORSCHUNGSZENTRUM

High-Energy Storage Ring HESR

2011 Particle Accelerator Conference (PAC'11)

March 31, 2011 | Rudolf Maier

Outline

Introduction

FAIR: **F**acility for **A**ntiproton and **I**on **R**esearch

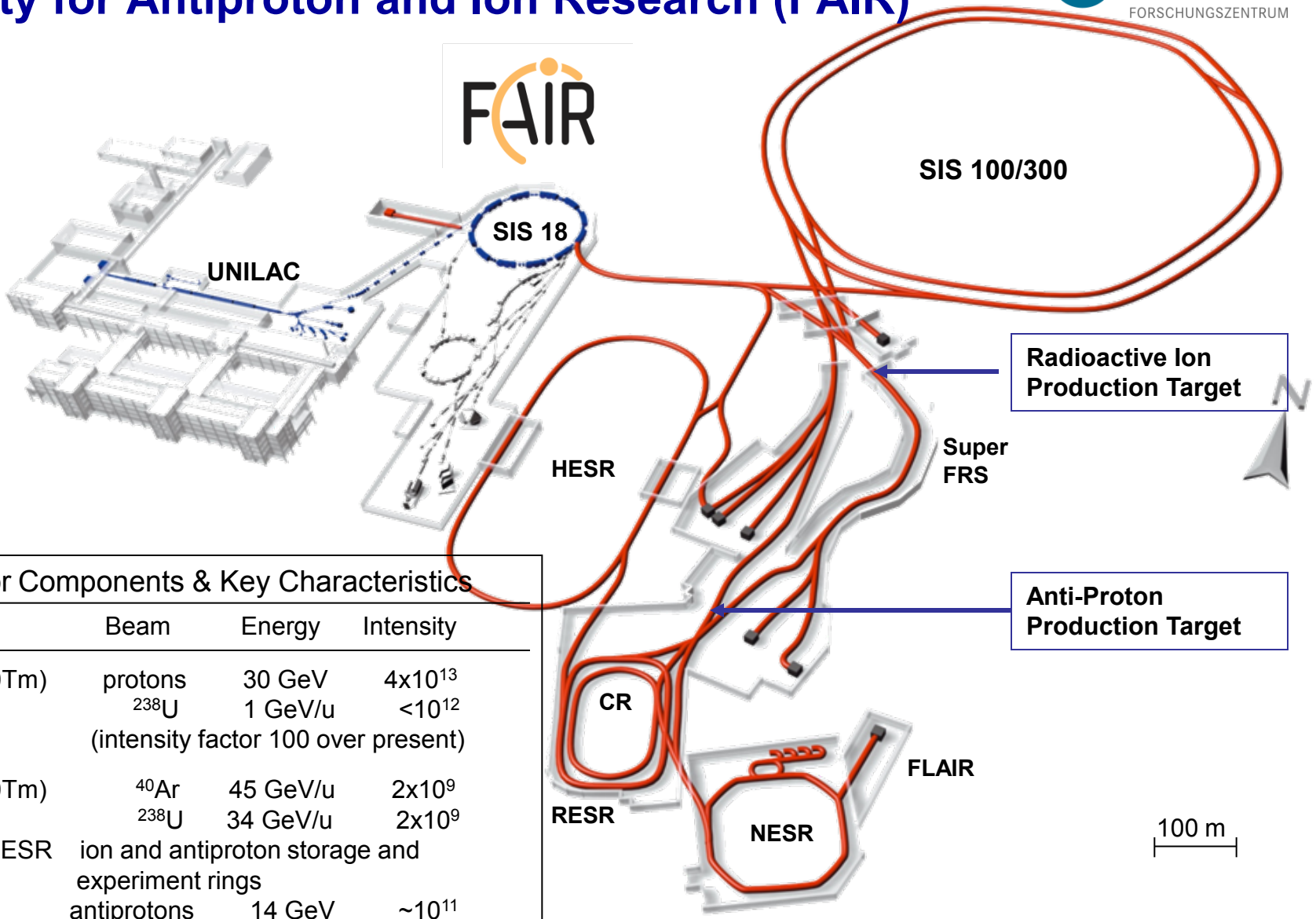
HESR: **H**igh-**E**nergy **S**torage **R**ing

Prototyping of HESR components

Beam Experiments at the Cooler Synchrotron COSY

Summary

Facility for Antiproton and Ion Research (FAIR)



Accelerator Components & Key Characteristics

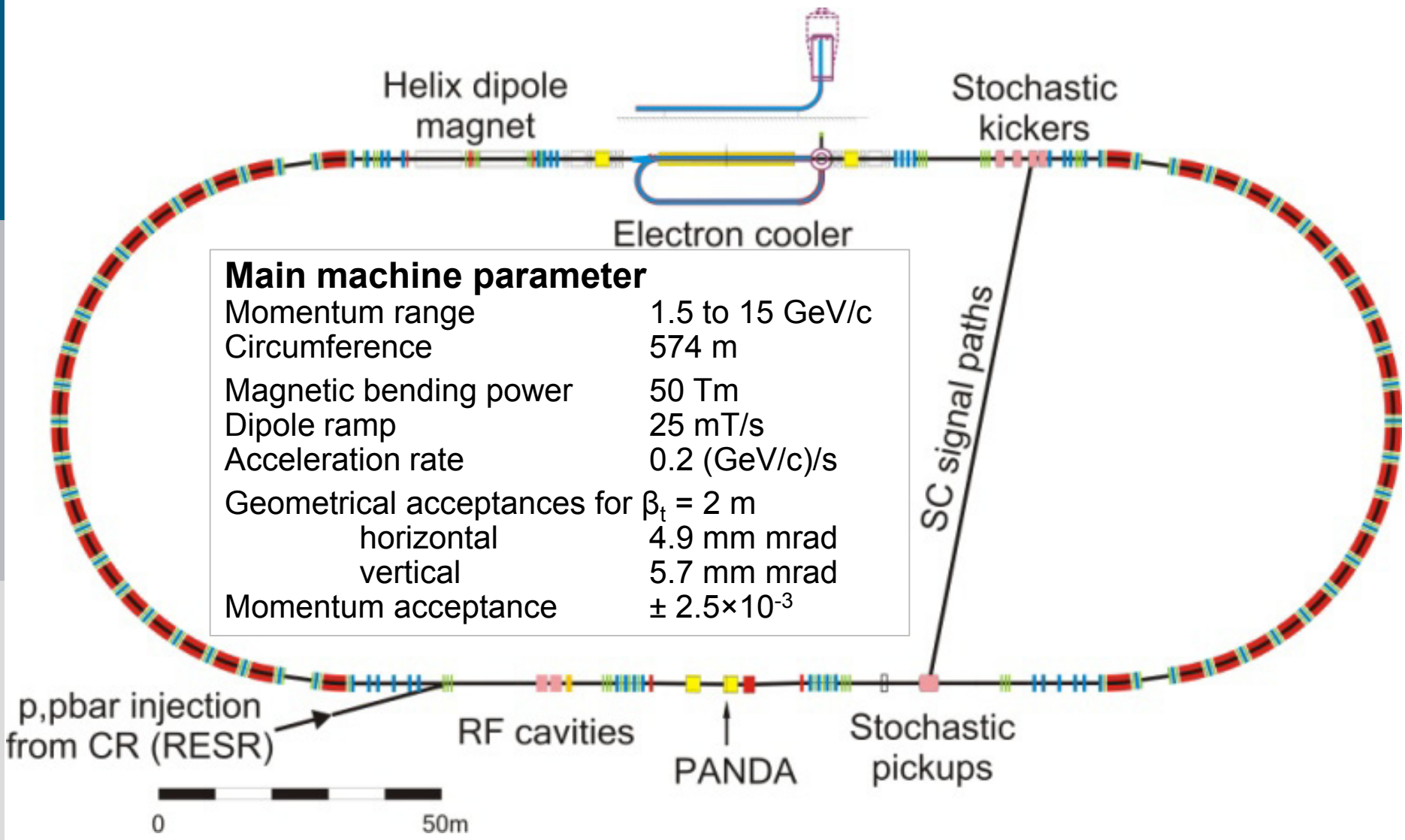
Ring/Device	Beam	Energy	Intensity
SIS100 (100Tm)	protons	30 GeV	4×10^{13}
	^{238}U	1 GeV/u	$<10^{12}$
	(intensity factor 100 over present)		
SIS300 (300Tm)	^{40}Ar	45 GeV/u	2×10^{9}
	^{238}U	34 GeV/u	2×10^{9}
CR/RESR/NESR	ion and antiproton storage and experiment rings		
HESR	antiprotons	14 GeV	$\sim10^{11}$
SuperFRS	rare-isotope beams	1 GeV/u	$<10^{9}$

Criteria for the Layout of the HESR

HESR design driven by the requirements of PANDA:

- Antiprotons with $1.5\ \mathrm{GeV/c} \leq p \leq 15\ \mathrm{GeV/c}$
- High luminosity: $2 \cdot 10^{32}\ \mathrm{cm^{-2}s^{-1}}$
  - Thick targets: $4 \cdot 10^{15}\ \mathrm{cm^{-2}}$
- High momentum resolution: $\Delta p/p \leq 4 \cdot 10^{-5}$
  - Phase space cooling
- Long beam life time: >30 min

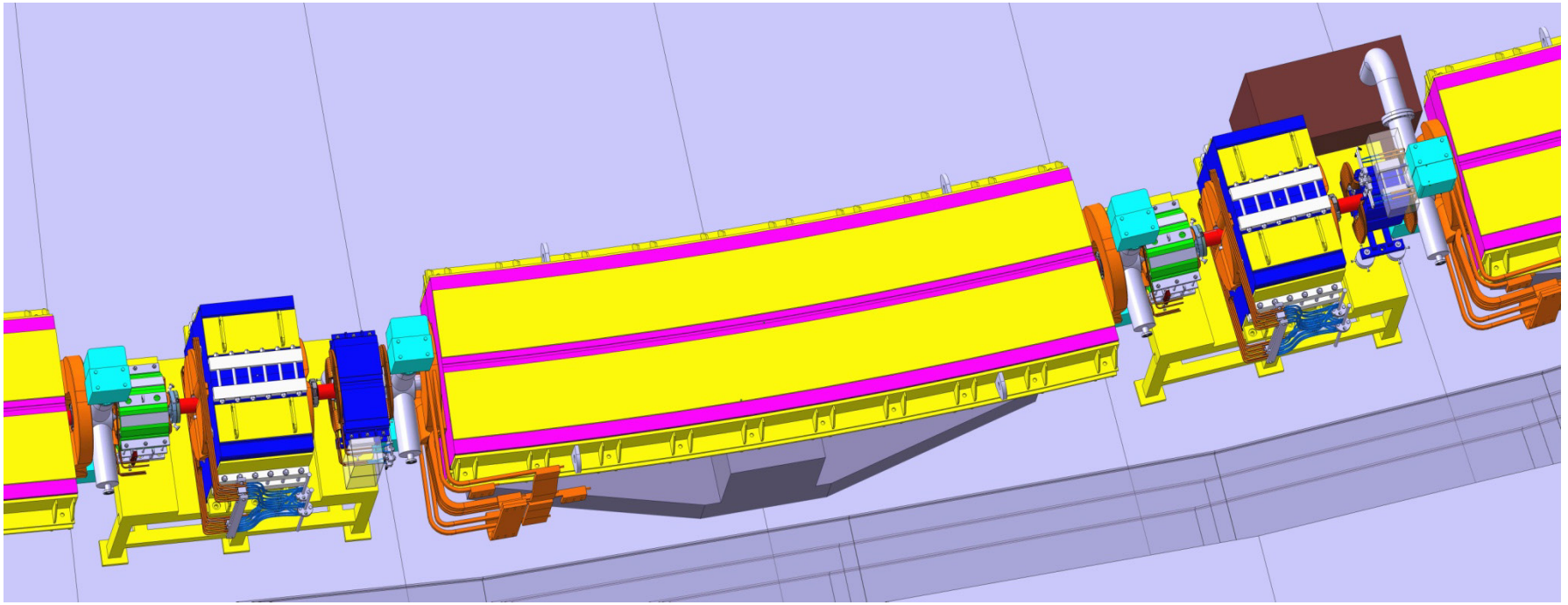
HESR Layout



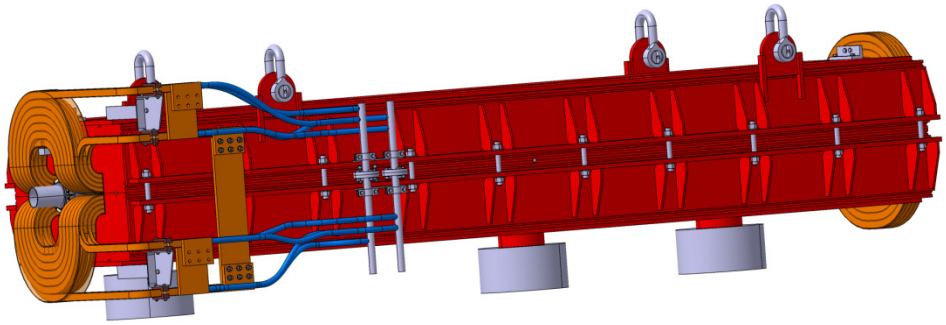
Main machine parameter

Momentum range	1.5 to 15 GeV/c
Circumference	574 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	$\pm 2.5 \times 10^{-3}$

Half FODO Cell

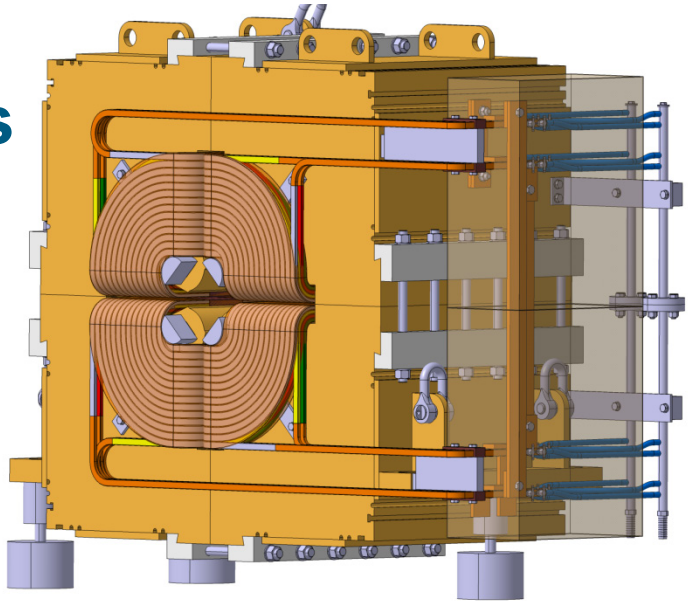


Dipoles



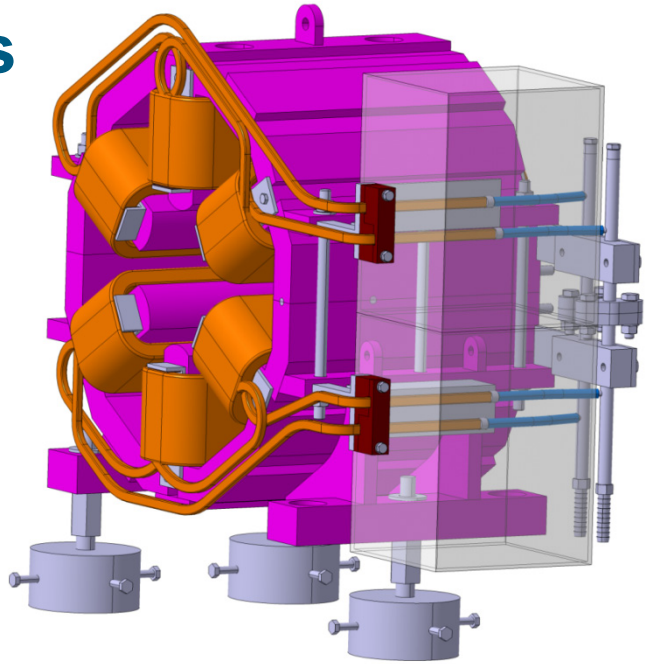
Number	44
Magnetic length	4.2 m
Deflection angle	8.182°
Max B-field	1.7 T
Min B-field	0.17 T
Aperture	100 mm

Quadrupoles



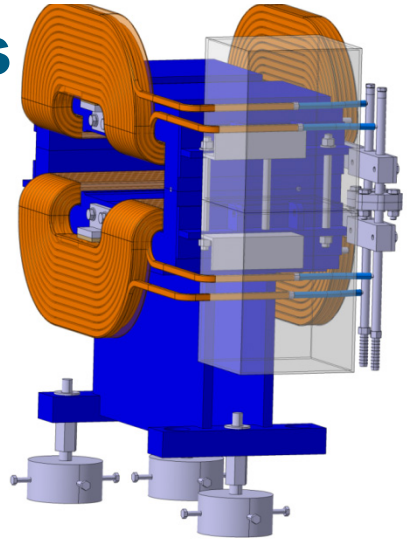
Number	84
Magnetic length	0.6 m
Iron length (arc)	0.58 m
Max gradient	20 T/m
Aperture	100 mm

Sextupoles



Number 52 in arcs
Magnetic length 0.3 m
Max d^2B/dx^2 42.5 T/m^2
Aperture 135 mm
allow insertion of BMPs

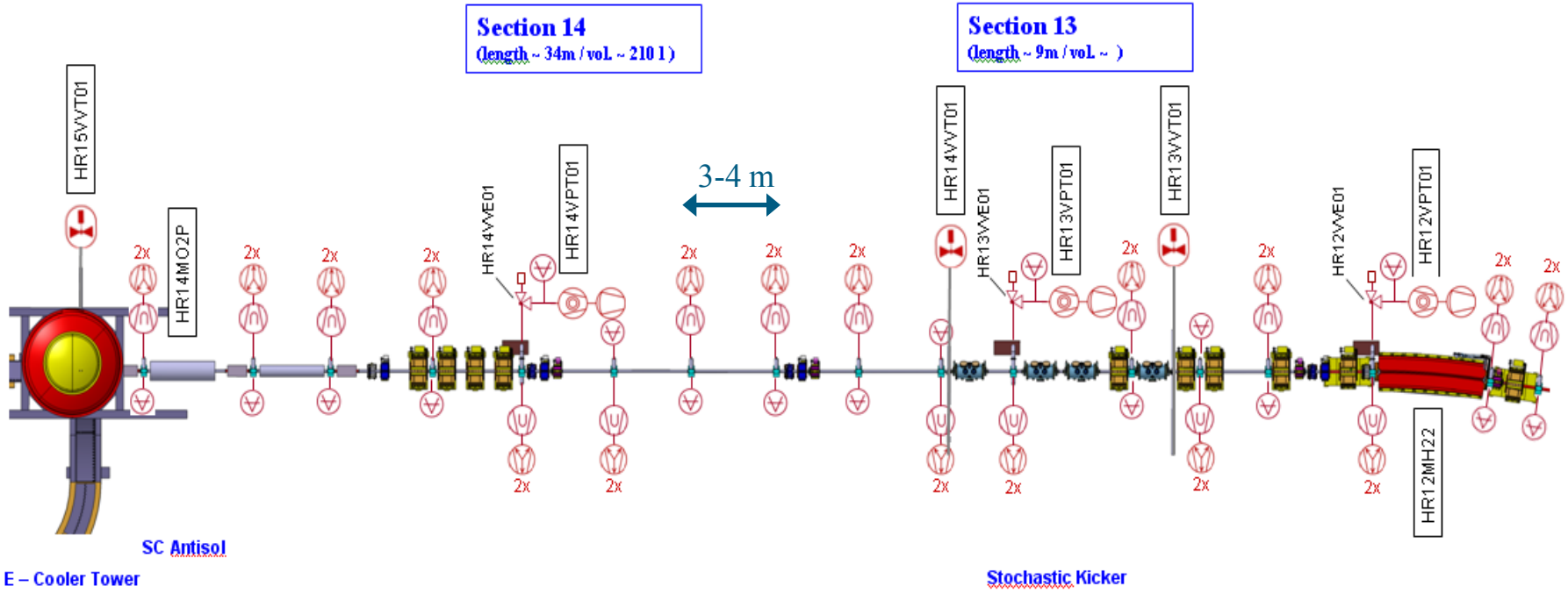
Dipole Correctors



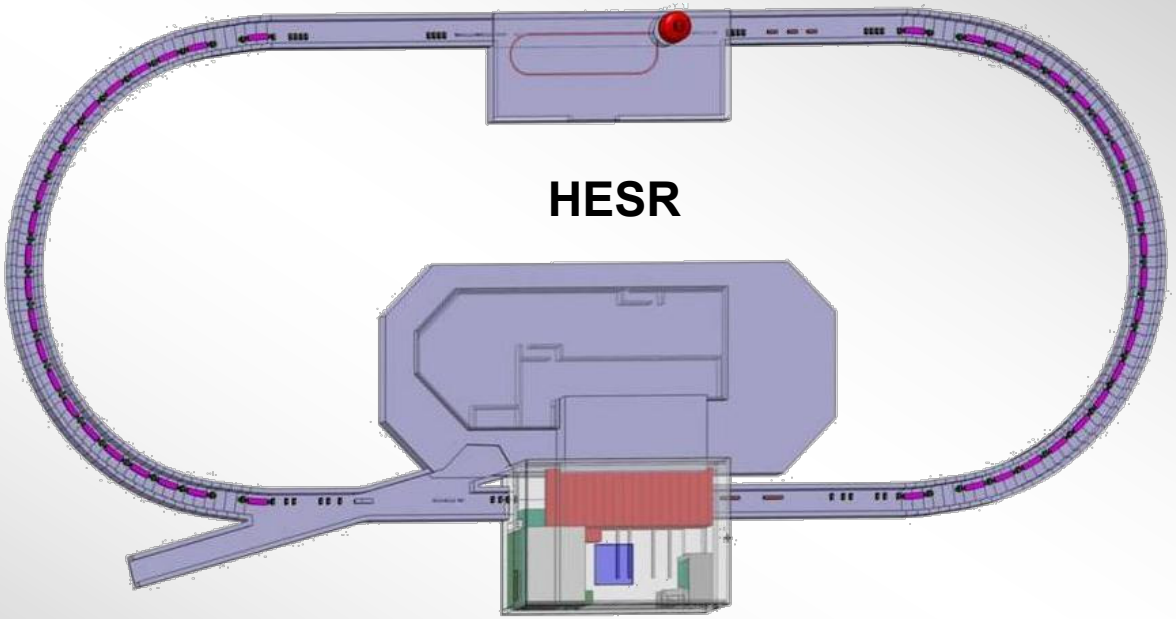
Number 4 in arcs
12 in straights
Magnetic length 0.3 m
Max deflection angle:
1 mrad for orbit correction
2 mrad for orbit correction and local bumps
Aperture 100 mm

Vacuum System for the HESR @ FAIR

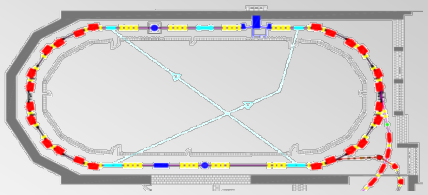
Schematic layout of the vacuum system



HESR with PANDA and Electron Cooler



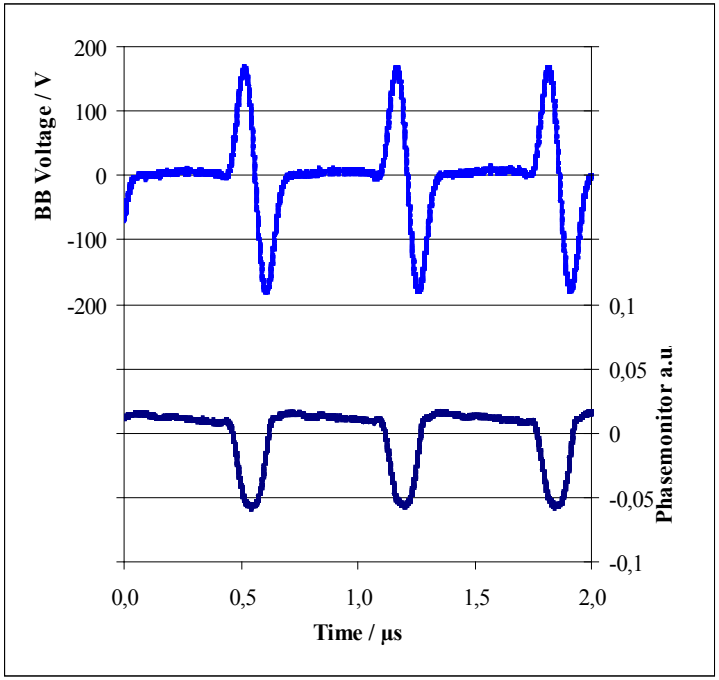
COSY

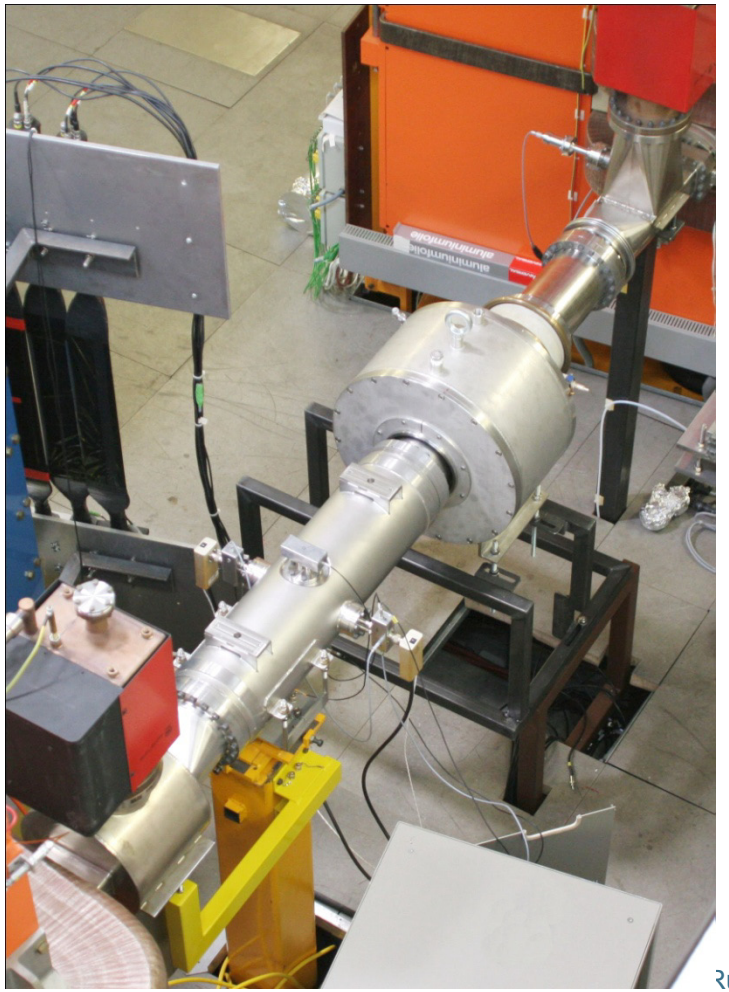


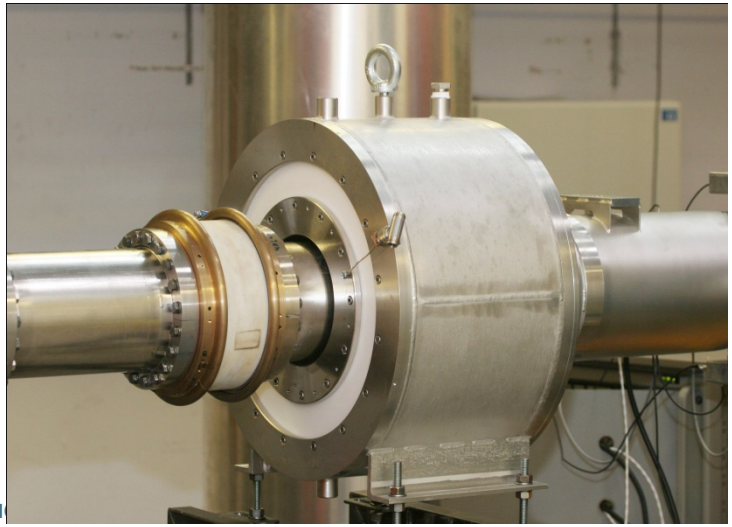
HESR		COSY
575 m	Circumference	184 m
1.5 – 15 GeV/c	Momentum	0.3 – 3.7 GeV/c
up to 9 GeV/c	Electron Cooling	up to 0.5 GeV/c
Full range	Stochastic Cooling	1.5 – 3.7 GeV/c

HESR Consortium: Germany (Jülich, GSI, Mainz), Georgia and Romania

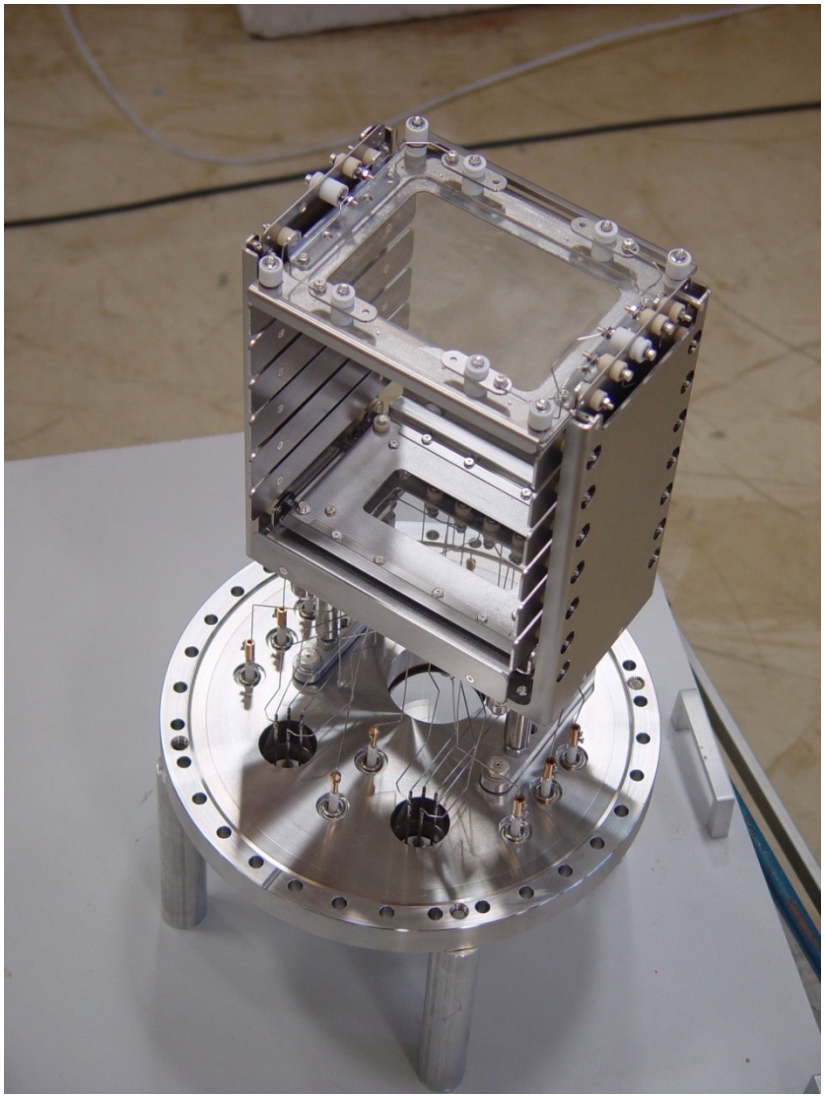
Barrier Bucket cavity, in COSY installed

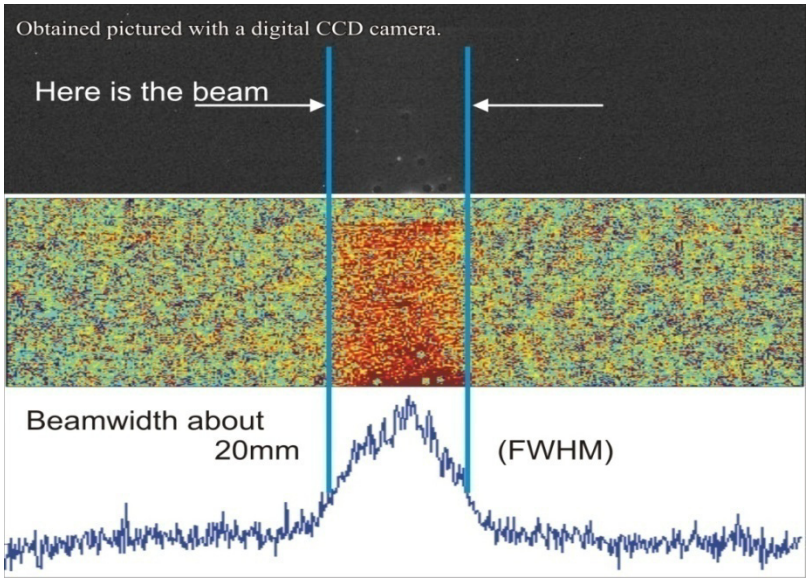






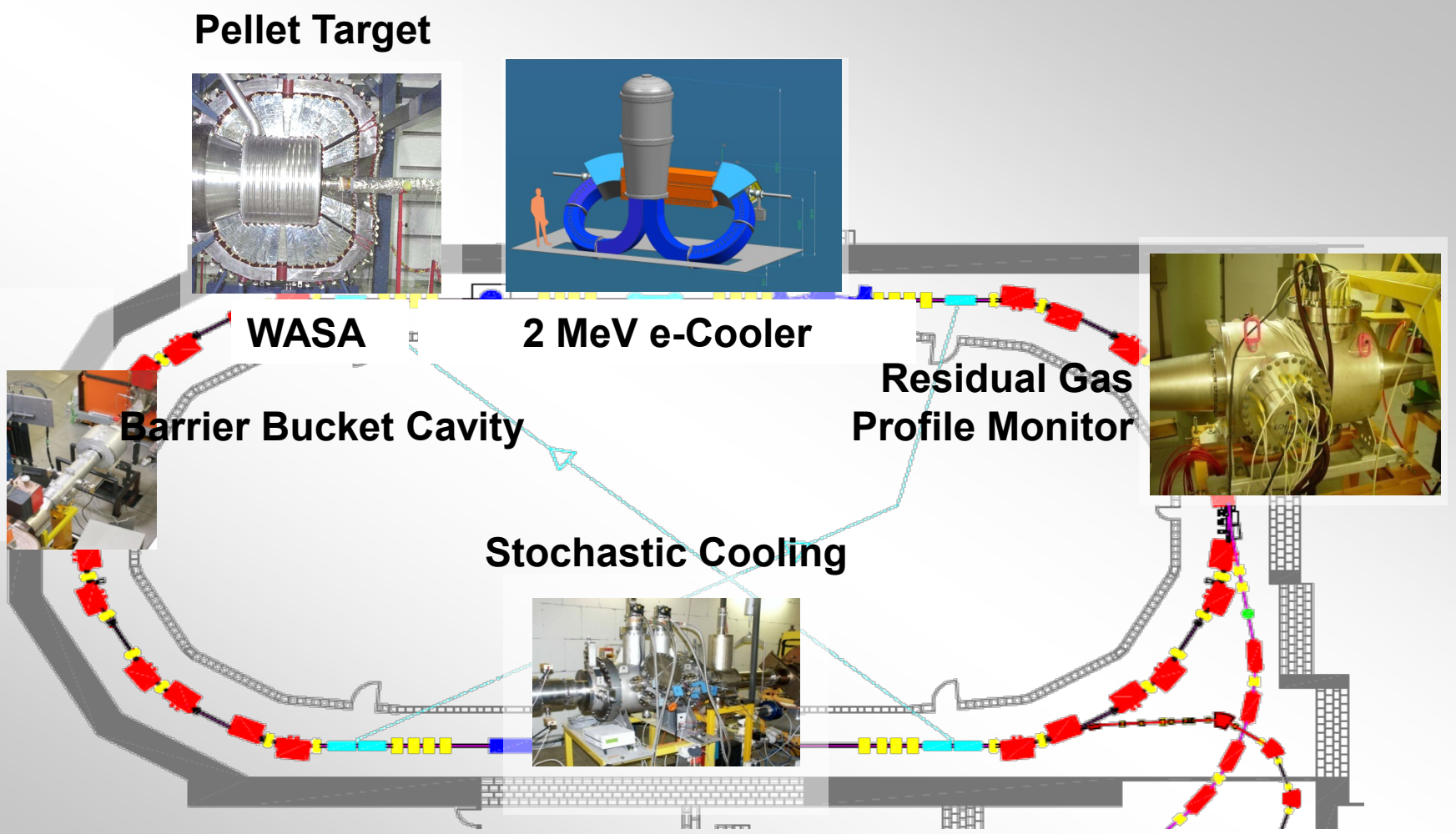
Gas Profile Monitor Test in COSY



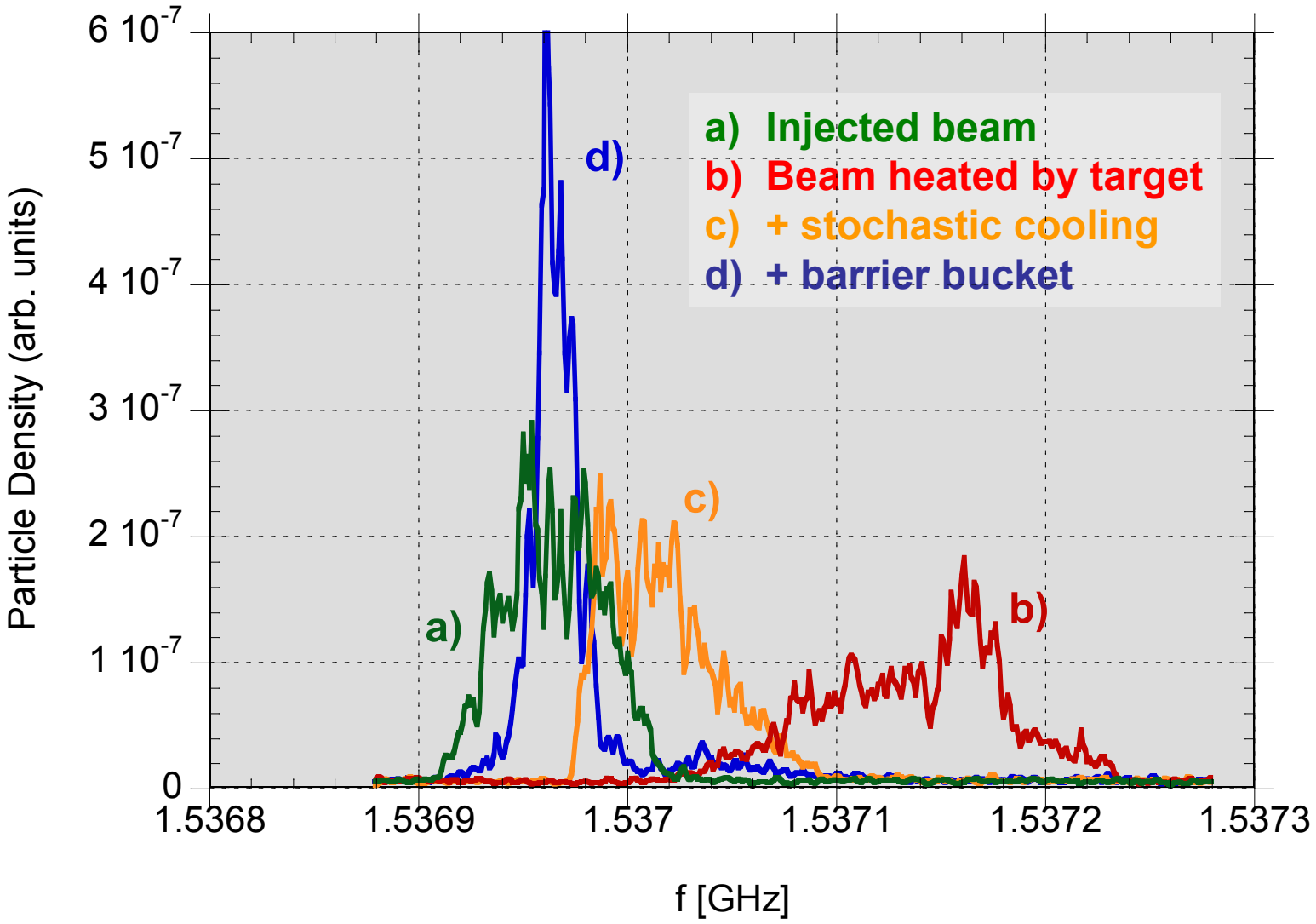


GSI Darmstadt
FZ Jülich
University Dortmund
ITEP (Moscow)

HESR Prototyping and Tests with COSY



Example: Beam Cooling with WASA Pellet Target



Summary

Hadron Physics with Antiprotons

- Sophisticated accelerators
- Forefront beam cooling
- Internal targets
- RF manipulation techniques

COSY is essential to
develop and establish these techniques
for HESR

PANDA Physics Program

Search for Exotics

- Glueballs
- Hybrids
- Multi-quark systems

→ QCD Predictions

Charm Hadrons

- High precision spectroscopy of charmonium and D-mesons
- New narrow X,Y, Z states
- CP-violation (with higher luminosity)
- Charm in matter

→ Quark Confinement

→ Chiral Symmetry

Strange and Charm Baryons

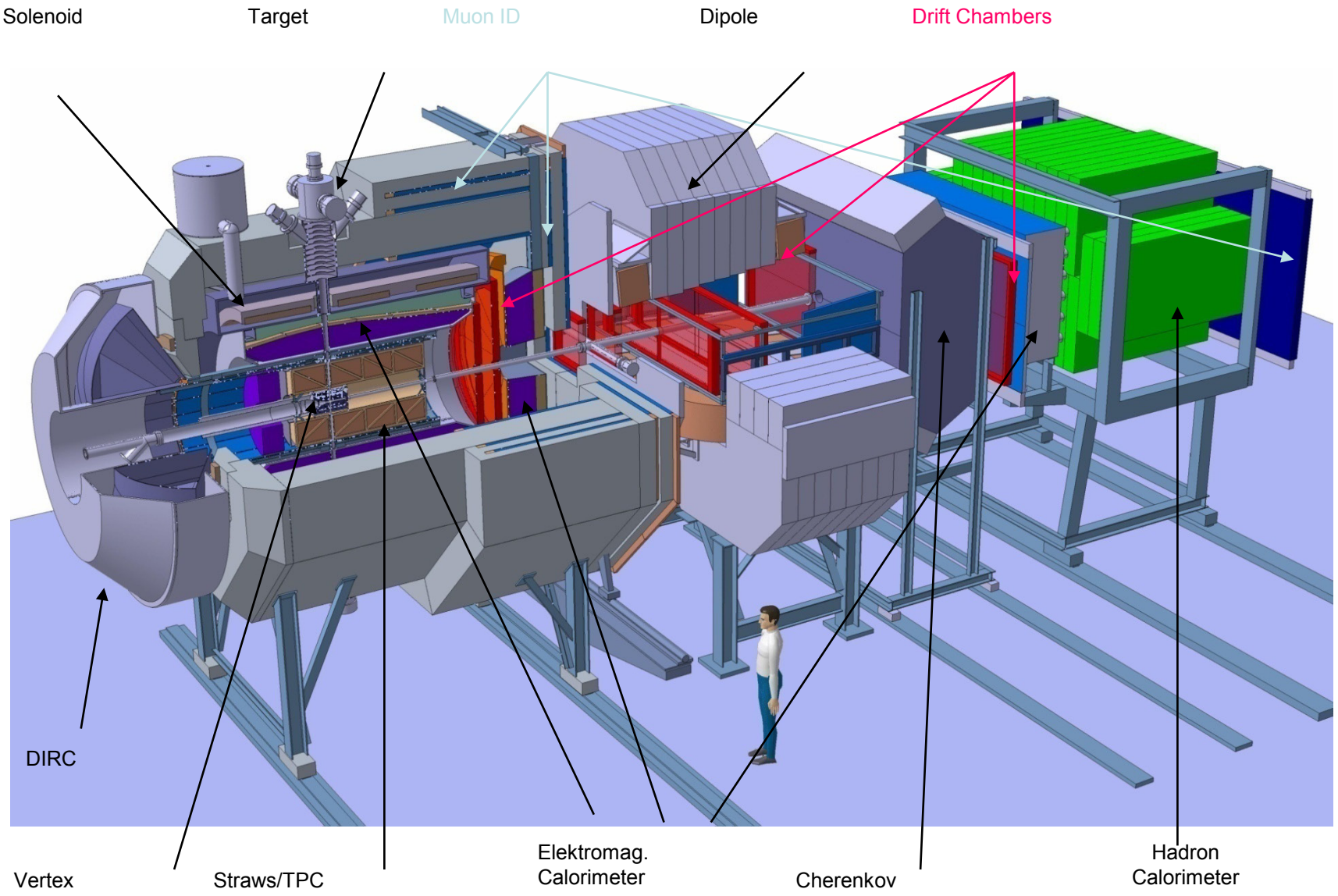
- Baryon excitation spectrum
- (Double) Hypernuclei

→ Y-N & Y-Y Interaction

Electromagnetic final states

- Timelike Form Factors
- Non k_t-integrated Structure Functions (Drell Yan)
- Generalized Distribution amplitudes

→ From Partons to Hadrons


Solenoid
Target
Muon ID
Dipole
Drift Chambers
DIRC
Vertex
Straws/TPC
Elektromag.
Calorimeter
Cherenkov
Hadron
Calorimeter

Facility for Antiproton and Ion Research