

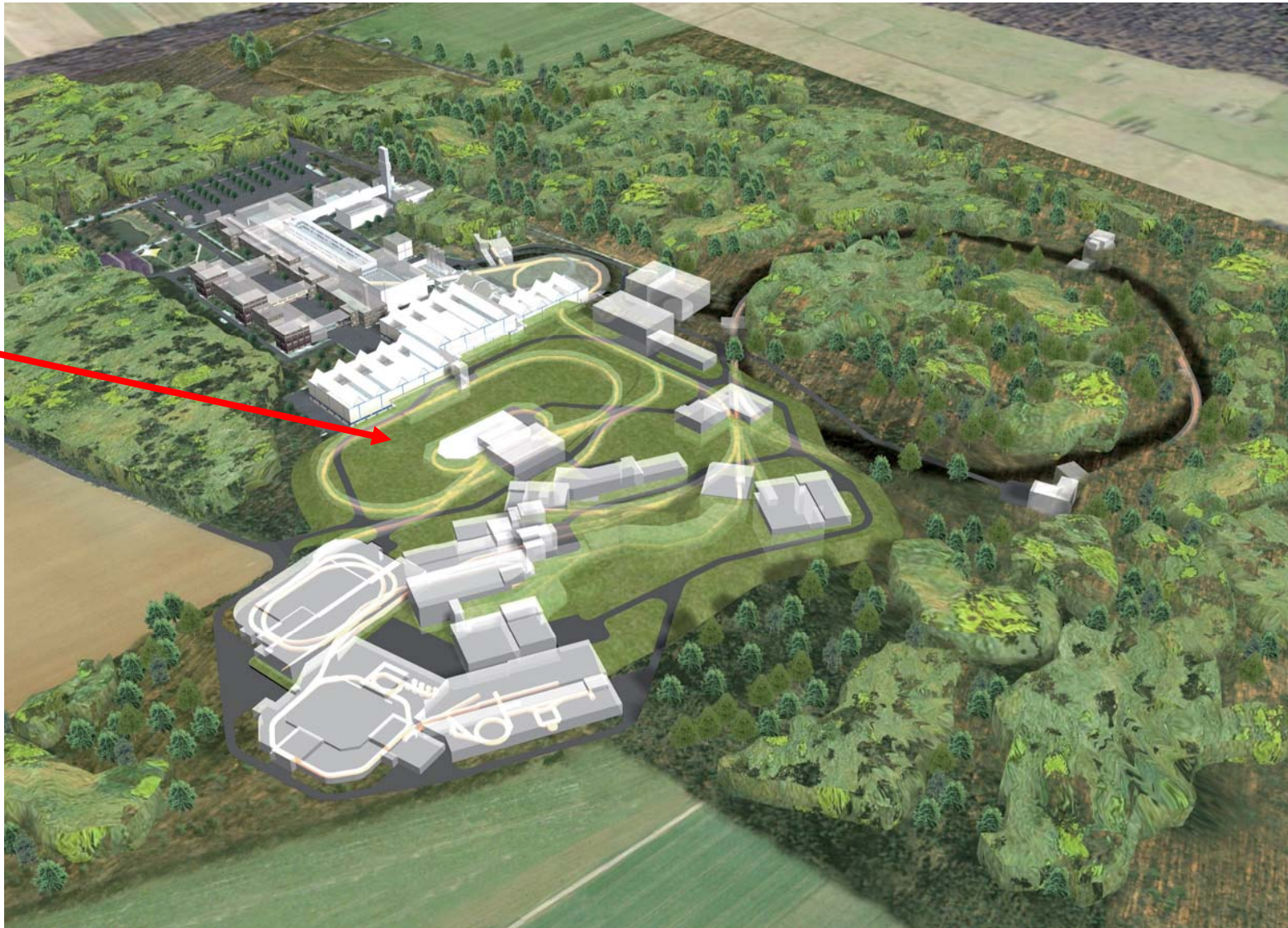
High Energy Storage Ring HESR at FAIR

High Energy Antiproton Physics

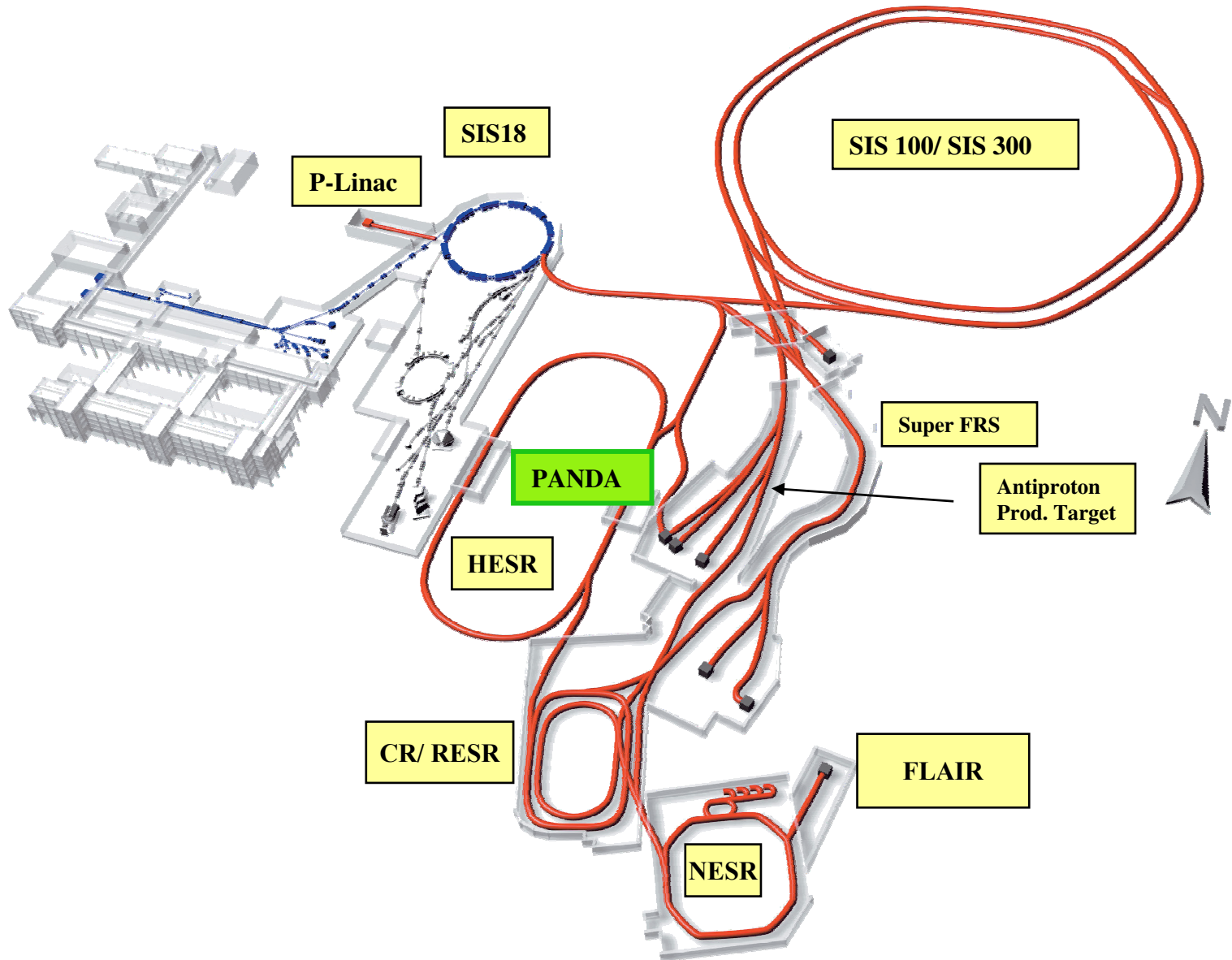
9. December 2008 | Rudolf Maier

Artist's view FAIR and GSI

High
Energy
Storage
Ring



FAIR Baseline Layout

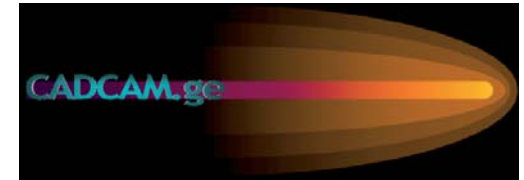


Consortium Members



New Consortium members

CAD/CAM Georgian Centre (Alexander Sharmazanashvili)



**Soltan Institute for Nuclear Studies, Poland
(Slawomir Wronka and Jan Kopec)**



INSTYTUT PROBLEMÓW JĄDROWYCH im. Andrzeja Soltana
THE ANDRZEJ SOLTAN INSTITUTE FOR NUCLEAR STUDIES

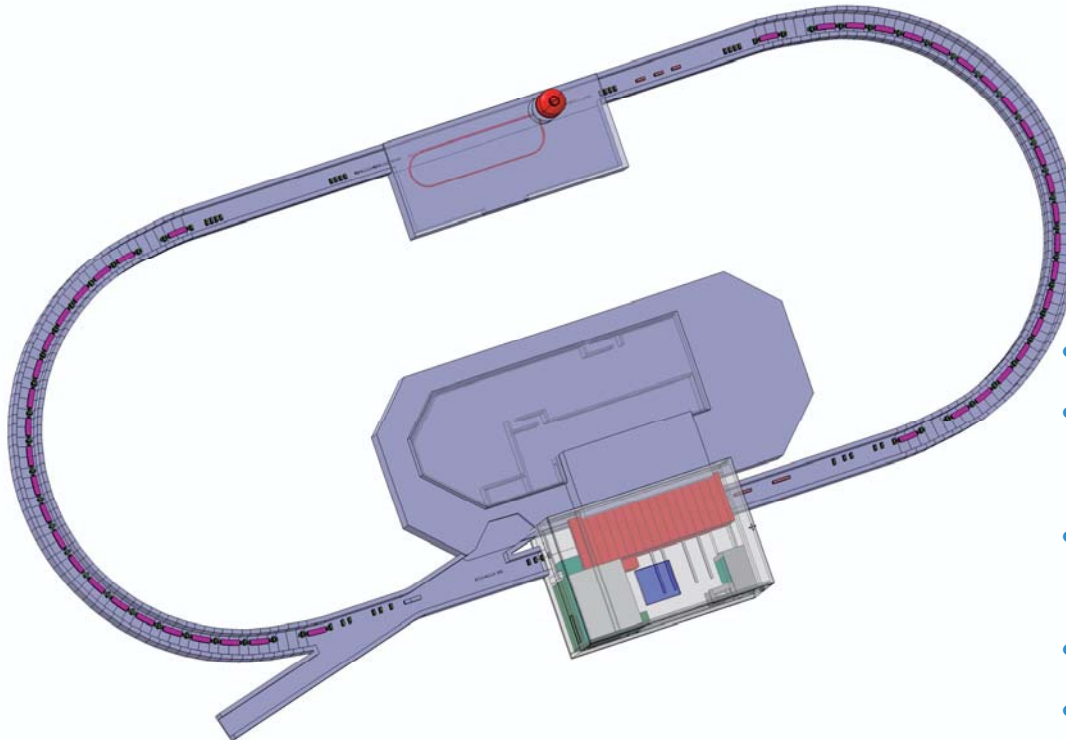


**National Institut for Research and Development in
Electrical Engineering ICPE-CA, Bukarest
(Wilhelm Kappel)**



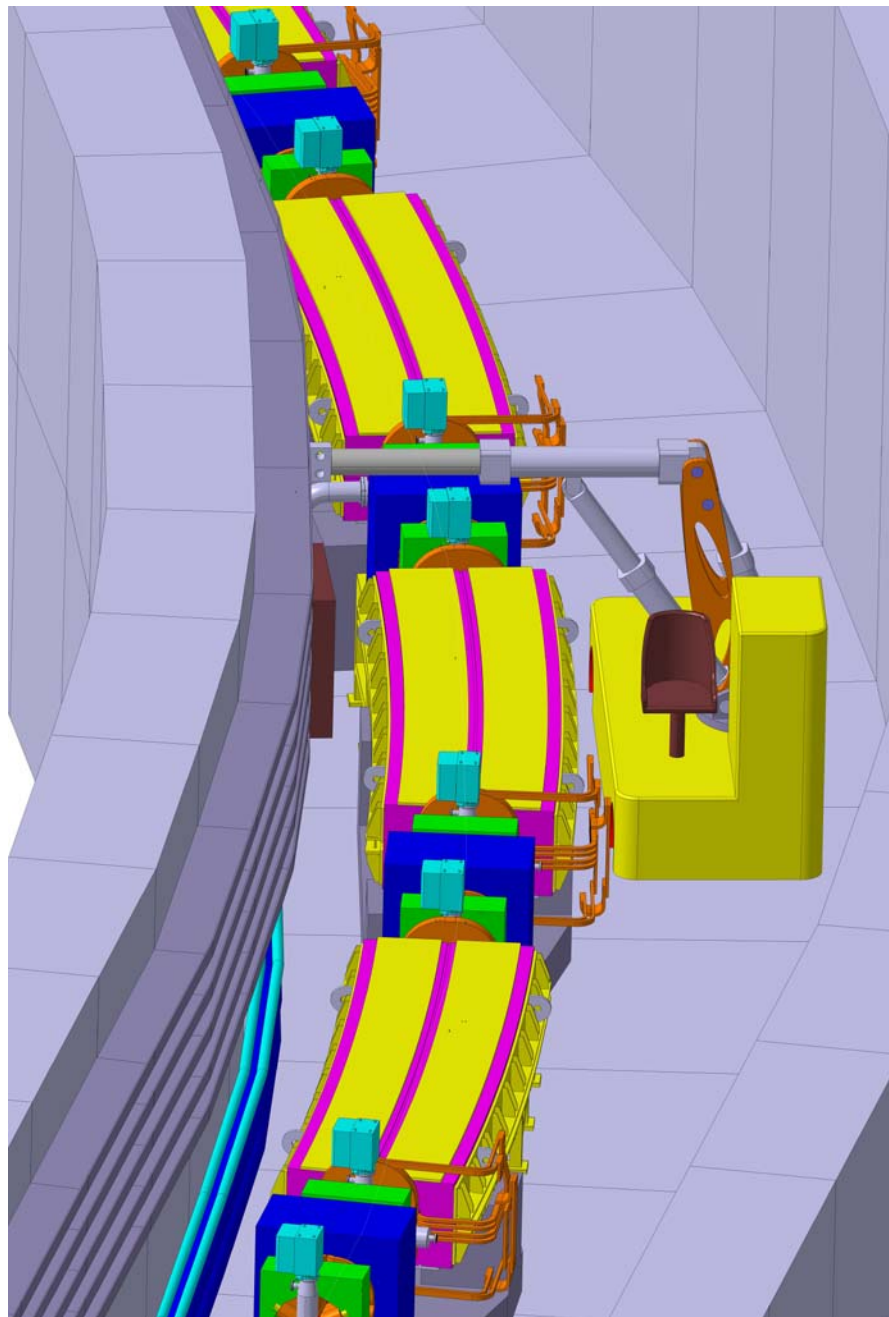
**Institute of Applied Physics, National Academy of
Sciences of Ukraine, Sumy, Ukraine (V. I.
Miroshnichenko)**

HESR with Injection, PANDA Hall and EC

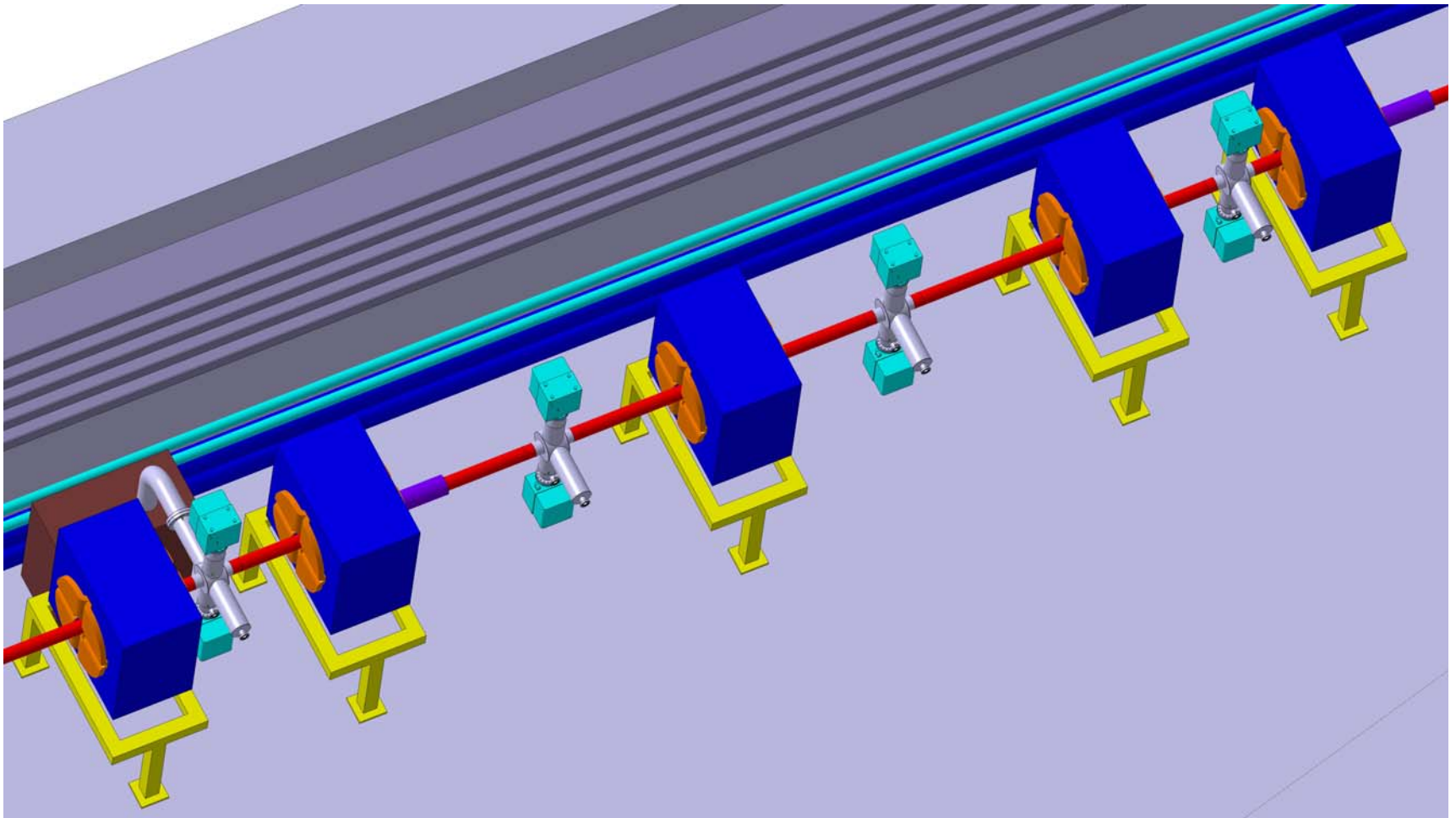


- Circumference 574 m
- Momentum (energy) range
1.5 to 15 GeV/c (0.8-14.1 GeV)
- Injection of (anti-)protons from
RESR at 3.8 GeV/c
- Acceleration rate 0.1 (GeV/c)/s
- Electron cooling up to 8.9 GeV/c
(4.5 MeV electron cooler)
- Stochastic cooling above
3.8 GeV/c

HESR Arc



HESR Straight Section



PANDA (Strong Interaction Studies with Antiprotons):

Momentum range: 1.5 to 15 GeV/c (Protons and Antiprotons)

Effective target thickness (pellets): $4 \cdot 10^{15} \text{ cm}^{-2}$		
Beam radius at target (rms): 0.3 mm		
	“High Resolution Mode”	“High Luminosity Mode”
Momentum range	1.5 - 8.9 GeV/c	1.5 – 15 GeV/c
Number of antiprotons	10^{10}	10^{11}
Peak luminosity	$2 \cdot 10^{31} \text{ cm}^{-2} \text{ s}^{-1}$	$2 \cdot 10^{32} \text{ cm}^{-2} \text{ s}^{-1}$
Momentum resolution (rms)	$\Delta p/p \leq 4 \cdot 10^{-5}$	$\Delta p/p = 1 \cdot 10^{-4}$
Beam cooler	Electron ($\leq 8.9 \text{ GeV/c}$)	Stochastic ($\geq 3.8 \text{ GeV/c}$)

Requirements for the layout of the HESR

HESR is designed to fulfill the requirements of PANDA:

- antiprotons in the momentum range
 $1.5 \text{ GeV}/c \leq p \leq 15 \text{ GeV}/c$ ($800 \text{ MeV} \leq T \leq 14.1 \text{ GeV}$)
- High luminosity
- High momentum resolution
- Long beam life time

The beam life time is determined by

- ☺ The hadronic interaction
- ☹ Multiple scattering
- ☹ Mean energy loss
- ☹ Single Coulomb scattering
- ☹ Large energy loss probability

WHY ELECTRON COOLING AT HESR?

- ✓ Users want resolution near what corresponds to $\Delta p/p = 10^{-5}$. This can not be achieved with stochastic cooling alone.
- ✓ Easy cooling of bunched beam
- ✓ Cooling rate is independent of antiproton intensity, no degradation of cooling at higher intensity
- ✓ Possibility for absolute calibration of antiproton energy (by means of H⁻-beam and ${}^7\text{Li}(p,n)$ -reaction:
 $E_{\text{threshold}} = 1880.3558 \pm 0.0812 \text{ kV}$)
- ✓ Possibility for cooling below 3 GeV, which is difficult with stochastic cooling in HESR due to band overlap.

Parameters for the HESR electron cooler:

Momentum range (antiprotons): 1.5 – 8.9 GeV/c

Electron energy: 0.45 – 4.5 MeV

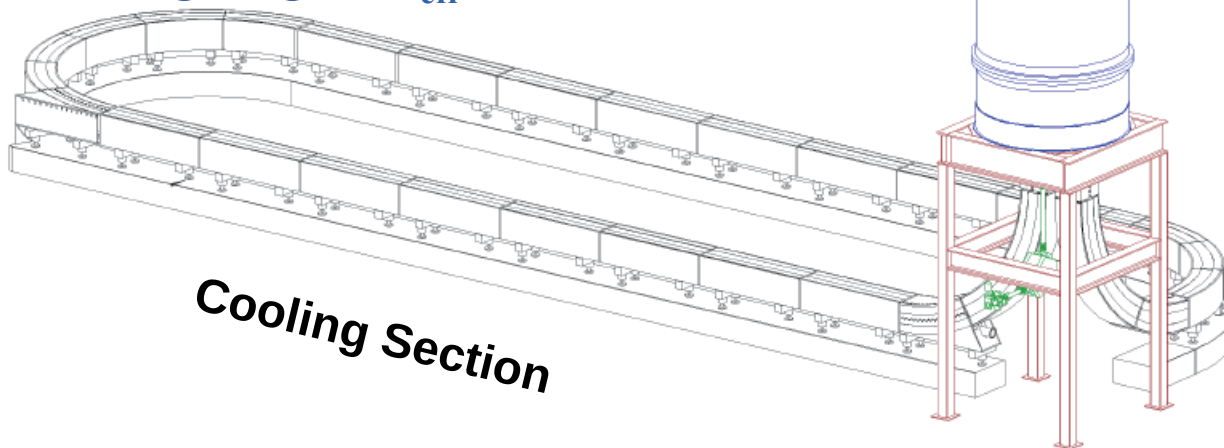
Electron current: 0 - 1 A

Electron beam radius: 5 mm

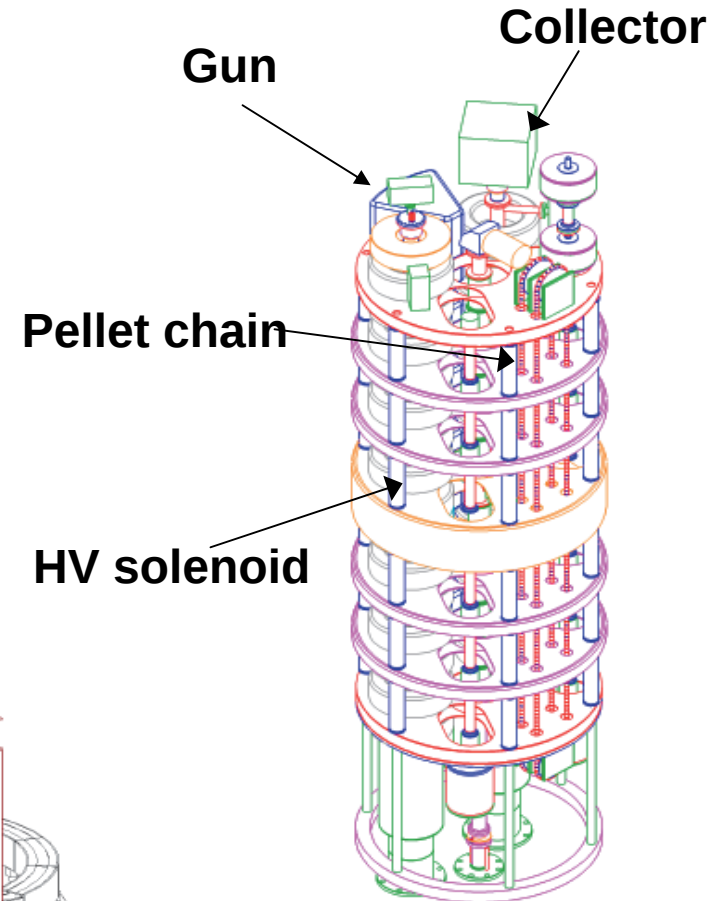
Magnetic Field (cooling section): 0.2 T

Magnetic field straightness (rms): $B_r/B < 10^{-5}$ rad

Cooling length: $L_{\text{eff}} = 20$ m



High-Voltage Column



The Svedberg Laboratory
Uppsala University

Parameters for the HESR stochastic cooler:

Momentum range (antiprotons): 3.8 - 15 GeV/c

Band width: 2 - 4 GHz, high sensitivity

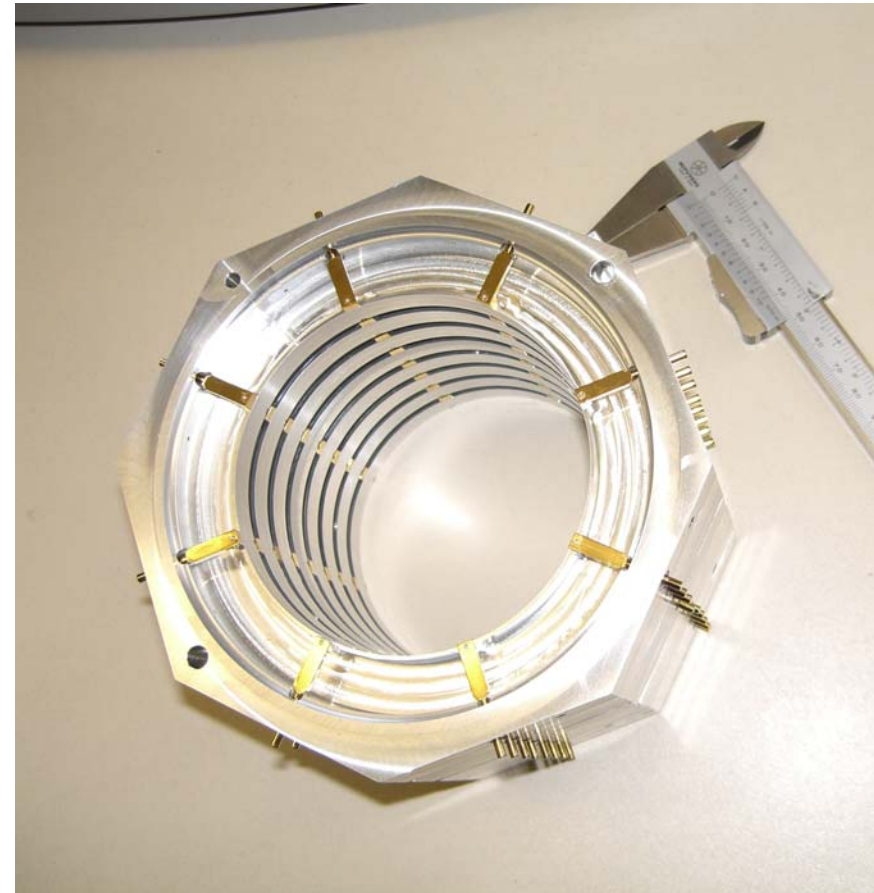
Longitudinal cooling: Notch-Filter

Aperture of couplers: 89 mm

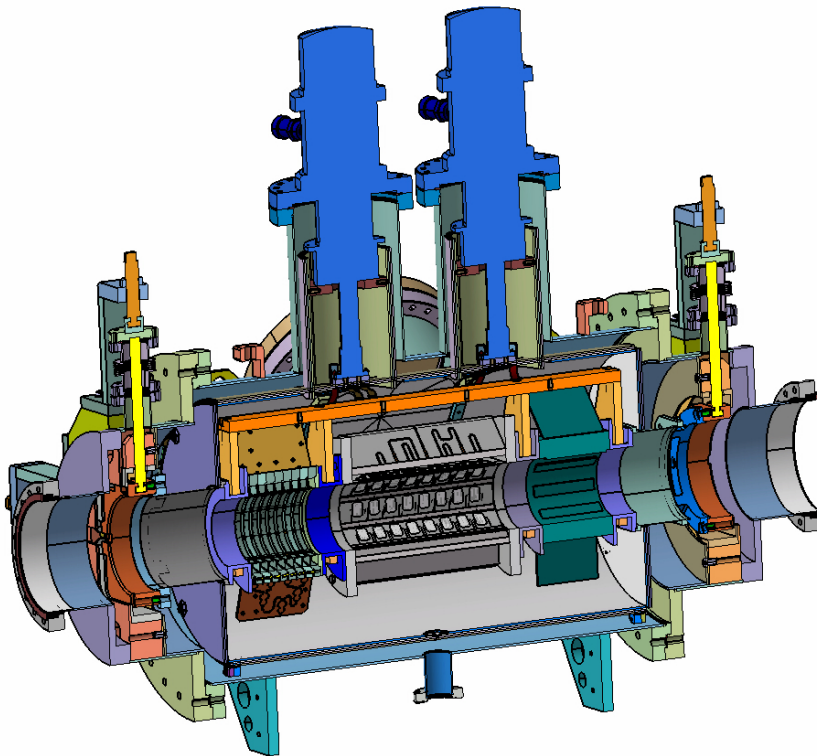
Octagonal Printed-Loop Coupler



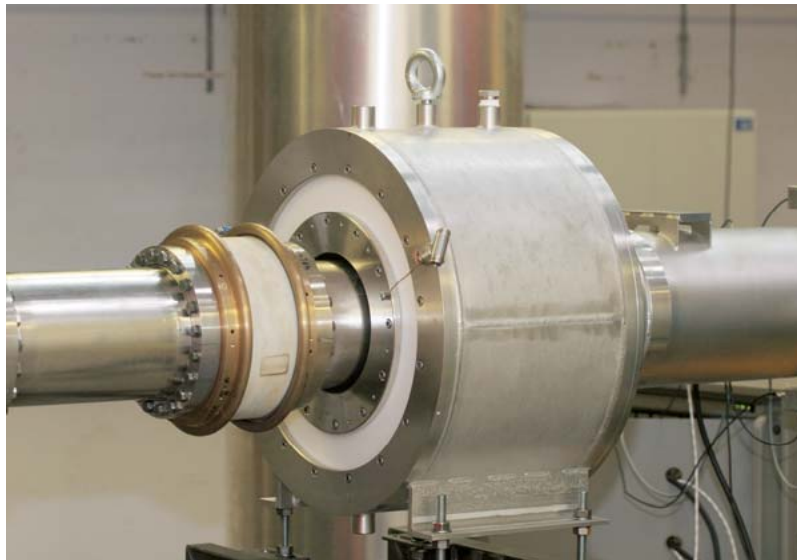
Octagonal Slot-Coupler



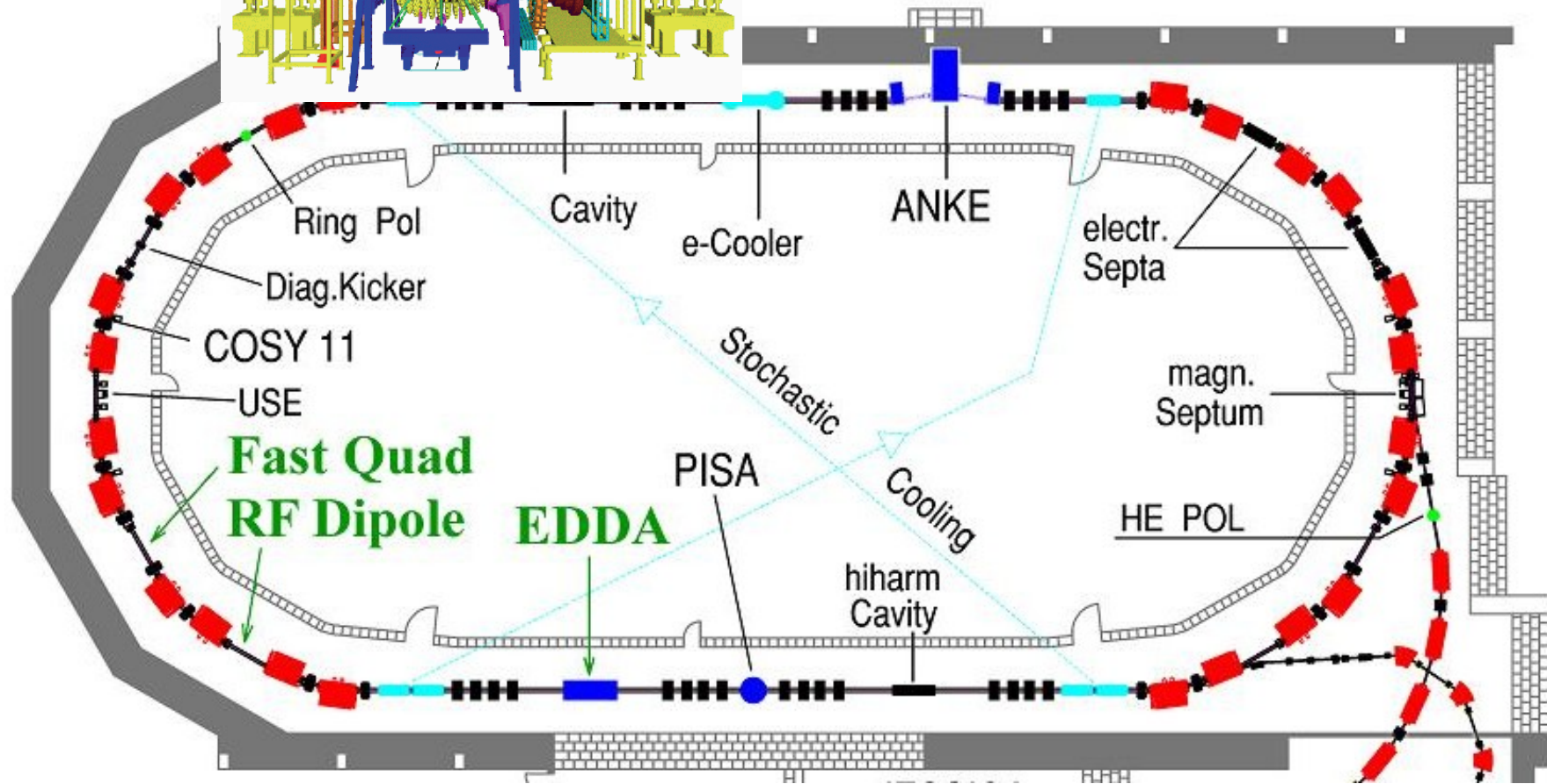
Stochastic cooling pickup (prototype) installed in COSY

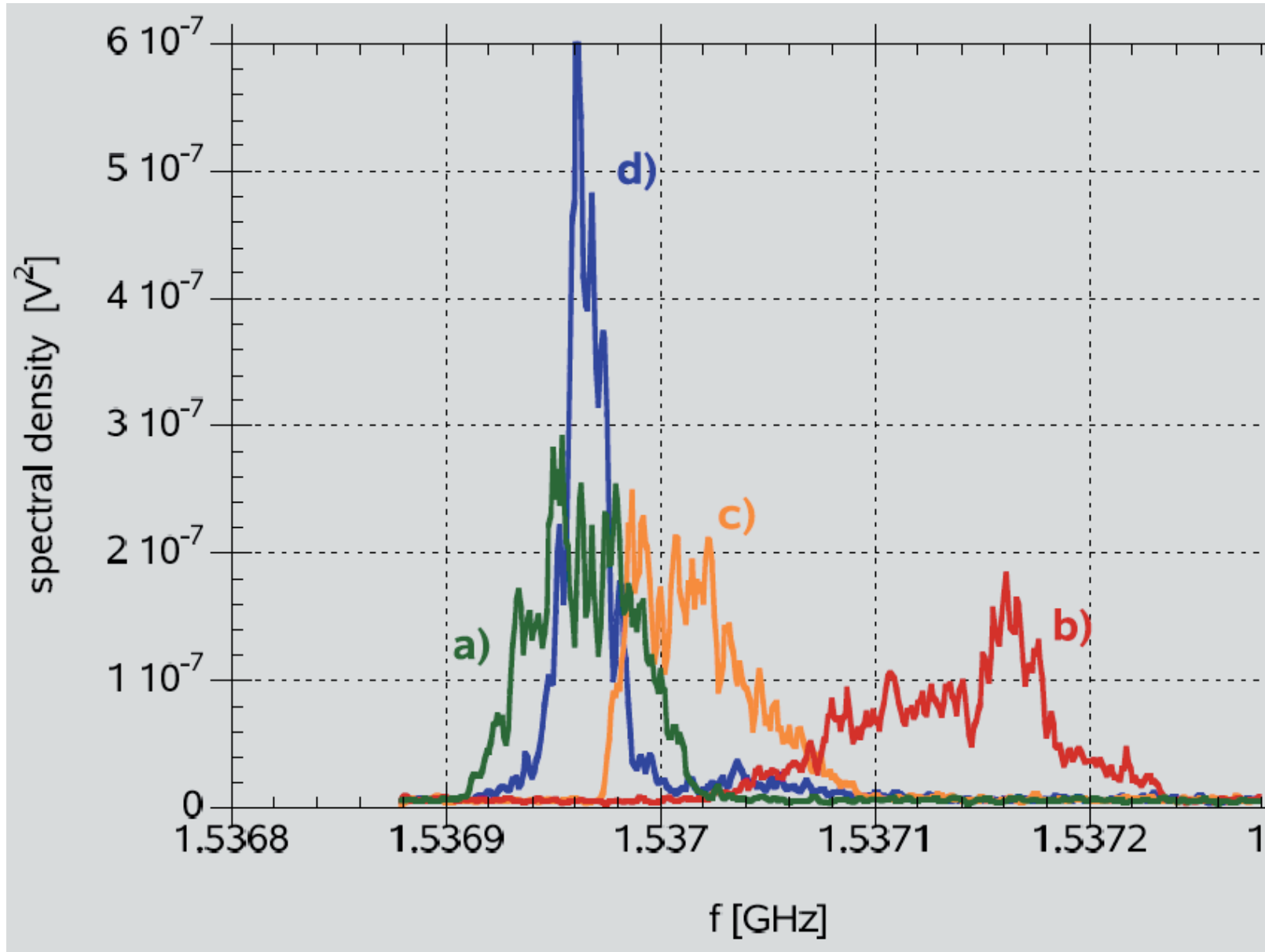


Barrier Bucket cavity, in COSY installed

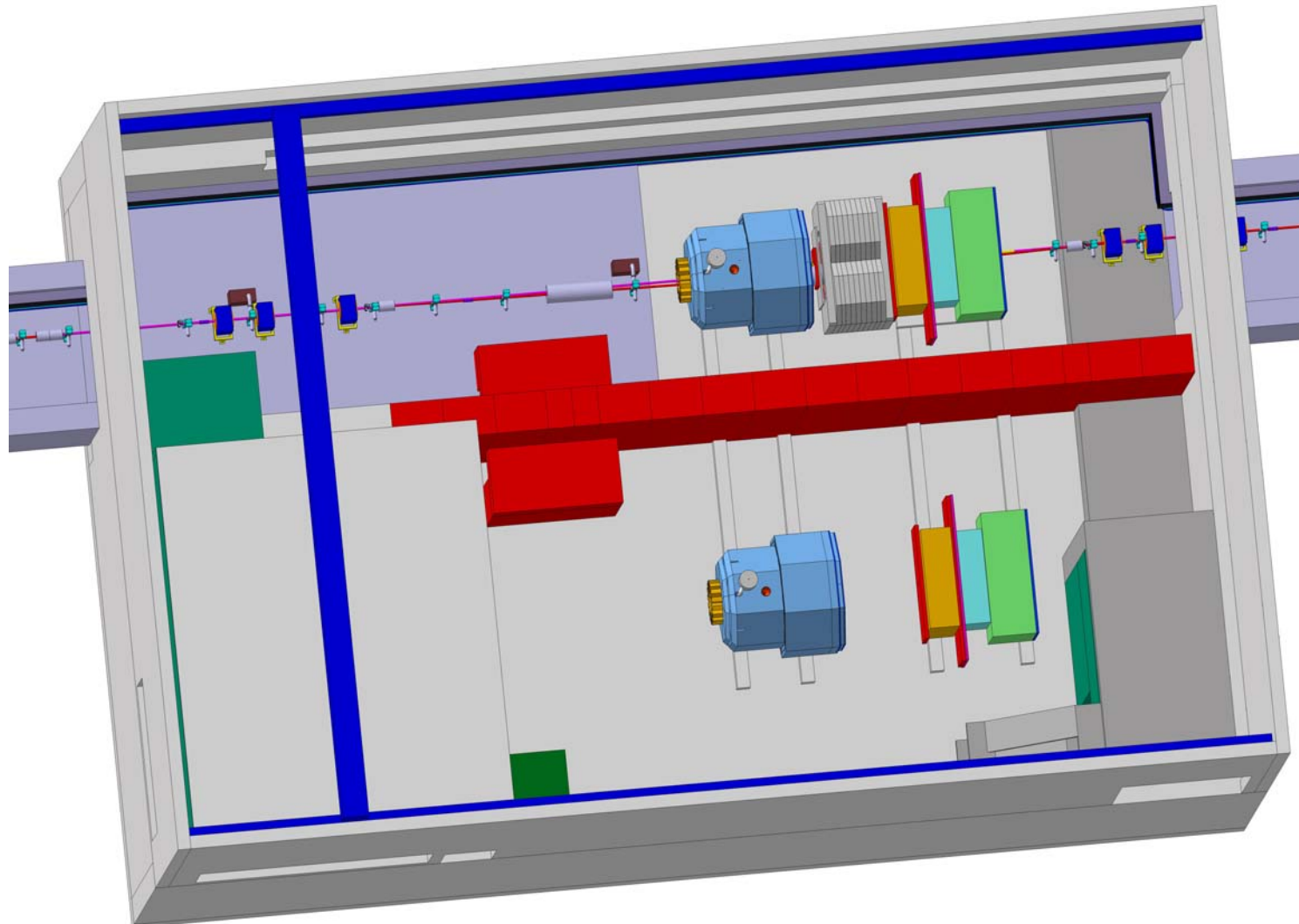


WASA in COSY





PANDA Hall



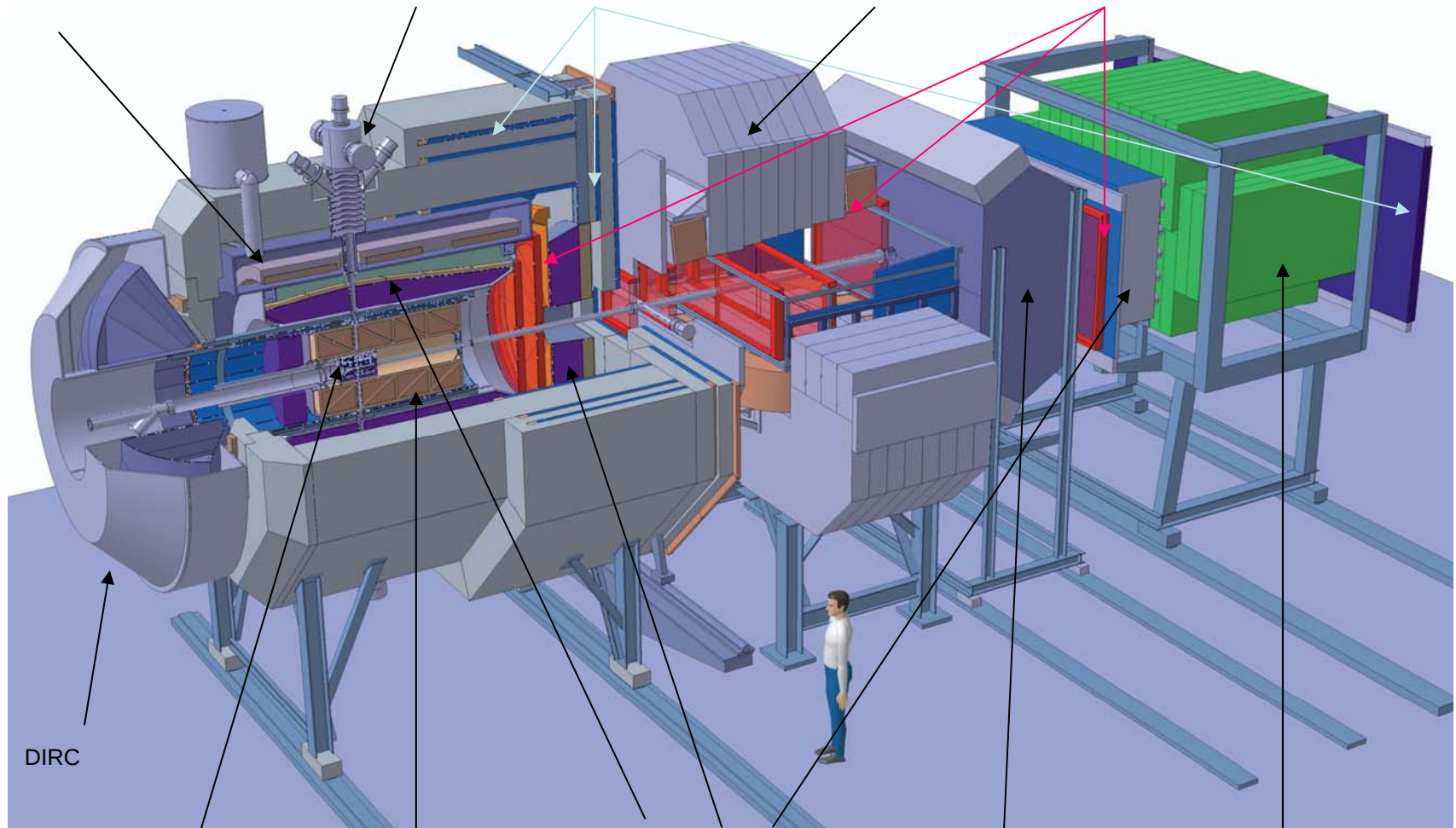
Solenoid

Target

Muon ID

Dipole

Drift Chambers



DIRC

Vertex

Straws/TPC

Elektromag.
Calorimeter

Cherenkov

Hadron
Calorimeter

EoI 2.11 HESR

2.11.2 Magnets , taken partly by ICPE-CA

2.11.3 Power Converters, taken partly by ICPE-CA

2.11.4 RF Systems

2.11.5 Injection, taken partly by ICPE-CA

2.11.6 Beam Diagnostics

2.11.7 Vacuum

2.11.9 Electron Cooling, taken by TSL & others

2.11.10 Stochastic Cooling

To carry on negotiations with BoM FZJ, GSI, (FAIR GmbH), HGF, BMBF

Status Power Converters

Specifications

2.11.3 Power Converters

2.11.3.1 Dipoles

done

2.11.3.2 Quadrupoles

more or less done

2.11.3.3 Sextupoles

done

2.11.4.4 Corrector Magnets

waiting for magnet design

Call for bids End of 2009 with elaborated ACU's

	design	prototype	tests	final layout
Stochastic cooling				
2 - 4 GHz				
Pickup-Kicker structures	100%	100%	30%	80%
Cryo-tank	80%	100%	90%	75%
RF system	50%	---	0%	10%
RF amplifier	50%	20%	5%	10%
prog. Delay-lines, atten.	10%	0%	0%	0%
optical notchfilter	5%	0%	0%	0%

RF System	design	prototype	tests	final layout
RF cavity	100%	100%	50%	90%
BB cavity	100%	100%	90%	50%
tube-amplifier	0%	---	0%	0%
2kW amplifier	GSI		---	---
BB signal generation	100%	100%	80%	50%
RF signal generation	GSI			

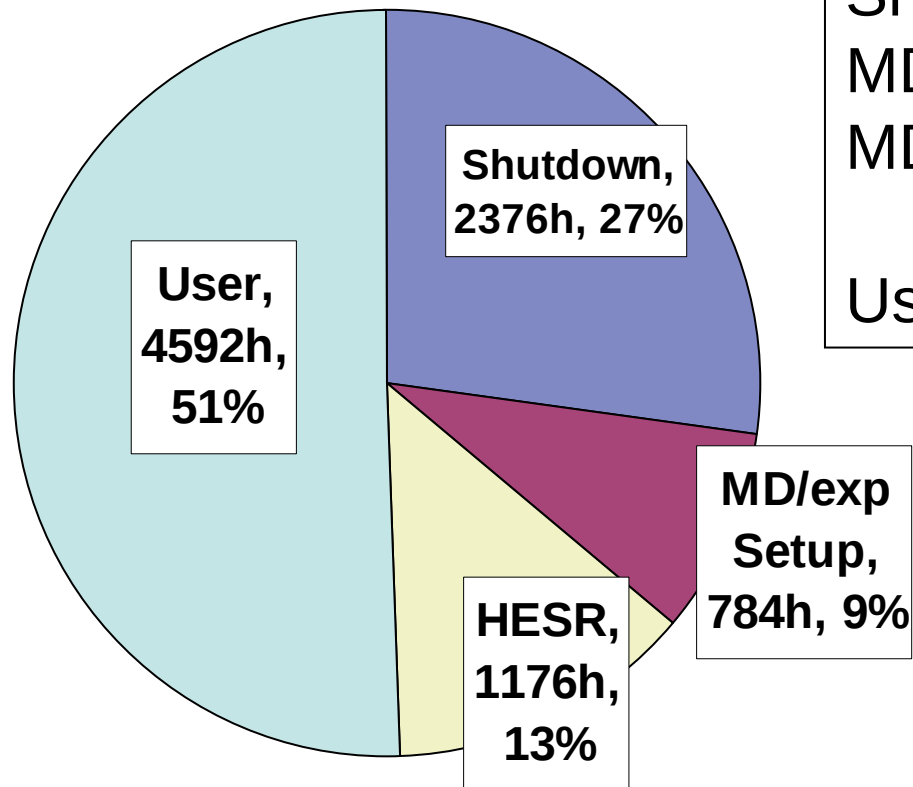
Summary

Antiproton Physics

Sophisticated Accelerators
Forefront cooling techniques
Brilliant RF Manipulation techniques
Excellent Detectors

The proposed schedule for 2009

Proposed Beam Time Distribution in 2009
(In total 6384 hours of operation)



Shutdown	14 weeks
MD/exp. Setup	7 weeks
MD-HESR	7 weeks
User time	24 weeks