

PARIS at HISPEC/DESPEC

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Overall strategy





- Research program with 3-4 months beamtime per years at GSI facility until FAIR is ready
 - Upgrade of GSI machines went well and continuous as planned
- Campus development towards FAIR host lab started
- FAIR construction continuous full speed

Construction site in November 2019









FAIR GmbH | GSI GmbH

HISPEC – ready for operation



-LYCCA heavy ion calorimeter with ToF capability in operationDay-1-AGATA gamma spectrometer in operationDay-1-NEDA Neutron detector array under constructionPhase-1-Hyde light particle array prototypePhase-1

HISPEC-0 was used at GSI in 2012-2014, next utilization on Day-1 TDRs done



DESPEC at FRS/S4





DESPEC setup at S4 of the FRS - First successful test in April

- active implanter AIDA
- fast beta detector **b-plast**
- fast gamma detector array FATIMA
- high-resolution gamma monitor DEGAS/GALILEO
- ion timing detector **FINGER**

EDAQ sub-systems coupled with white rabbit

Purpose of the tests

- Check basic functionality of subsystems
- Check white rabbit correlation
- Investigate response of detectors to ions and radiation background



Latest news: Time resolution of FATIMA improved from 340 ps to 220 ps by using TAMEX!



Modular detectors enable step-wise upgrade of set-ups for early physics exploitation

DESPEC Time Line



DESPEC Experiments					
Commission AIDA + FATIMA at FRS					
Commissioning and experiment runs Sxxx, S452, S460					
Commission AIDA + DEGAS and run S450 and further experiments to be proposed					
Continue commissioning new detectors and performing respective					
experiments	2023	U U U U			
	Install compact set-up (AIDA+DEGAS) at Super-FRS FHF1	2024	ctors a		
Continue experiments at moderate scale at FRS	Commissioning and first experiments at Super-FRS FHF1	2025	S deteo		
	Install full initial DESPEC set-up at LEB and run first experiments	2026	PARIS		

Next call for proposals in January for the time period 2021-2022...

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Total Absorbtion Spectroscopy



Spectroscopy of very exotic nuclei Complete β-decay level schemes, γγ-coincidences K-Isomer spectroscopy

PARIS

- Increased efficiency
- Better energy resolution
- Fast timing
- Complementing or replacing DTAS



β decay lifetimes and strength distributions to refine the accuracy of rprocess path calculations describing the mass abundance of heavy elements,

Structure of very n-rich Hf isotopes

- level energies of excited states in hafnium isotopes to allow testing the predicted shape evolution from prolate to oblate with the critical point at N=116,
- K-isomer lifetimes to shed further light on the structure of the heaviest hafnium isotopes accessible





¹⁸⁸Lu, 0.26 nb

DESPEC – DTAS set-up

Setting optimized for most n-rich Hf isotopes from both

- Lu β decay into excited Hf states,
- Hf isomer decay (≈10% est. isomeric ratio)

γ yield / shift									
Α	184	185	186	187	188	189	190		
Hf		21	98	345	252	166	73		
Lu	70	659	437	196	69				







K-isomer background considerations

Isomeric decays produce no trigger like a β in AIDA. Therefore ambient background radiation becomes critical for rare and/or long lived isomers.

Novel approach: The multiplicity information provided by DTAS provides a selective trigger!



Worst case scenario, corresponding to expected isomer yield of ¹⁹⁰Hf!



2s isomers will be visible with <10 observed decays per hour!!!

GEANT simulations confirm efficient background suppression. To avoid multiplicity "pile-up" by chance coincidences, a narrow time window is needed.

DEGAS Decay Spectroscopy



High-resolution decay spectroscopy of exotic nuclei Detailed level schemes, *yy*-coincidences **PARIS** PDR with β -decay Increased efficiency Lifetimes High efficiency at high energy Sufficient energy resolution Fast timing **Complementing Ge**

gSPEC Nuclear Moments



DESPEC Nuclear Moments g-factors of exotic nuclei

PARIS

- Increased efficiency
- Sufficient energy resolution
- Complementing Ge



Dipole response of exotic nuclei



HISPEC In-Flight Spectroscopy at relativistic energies PDR and GDR of exotic nuclei, fine structure



PARIS

- Increased efficiency
- Better energy resolution
- Better Doppler correction





FAIR is on schedule

SIS18 + SUPER-FRS + NUSTAR planned to be first commissioned

GSI is back with the FAIR Phase-0 programme

Many Physics Opportunities at HISPEC/DESPEC with PARIS

- Total Absorbtion Spectroscopy
- Spectroscopy of very exotic (=rare) nuclei
- β-decay to PDR states
- g-factor measurements
- Dipole response of exotic nuclei