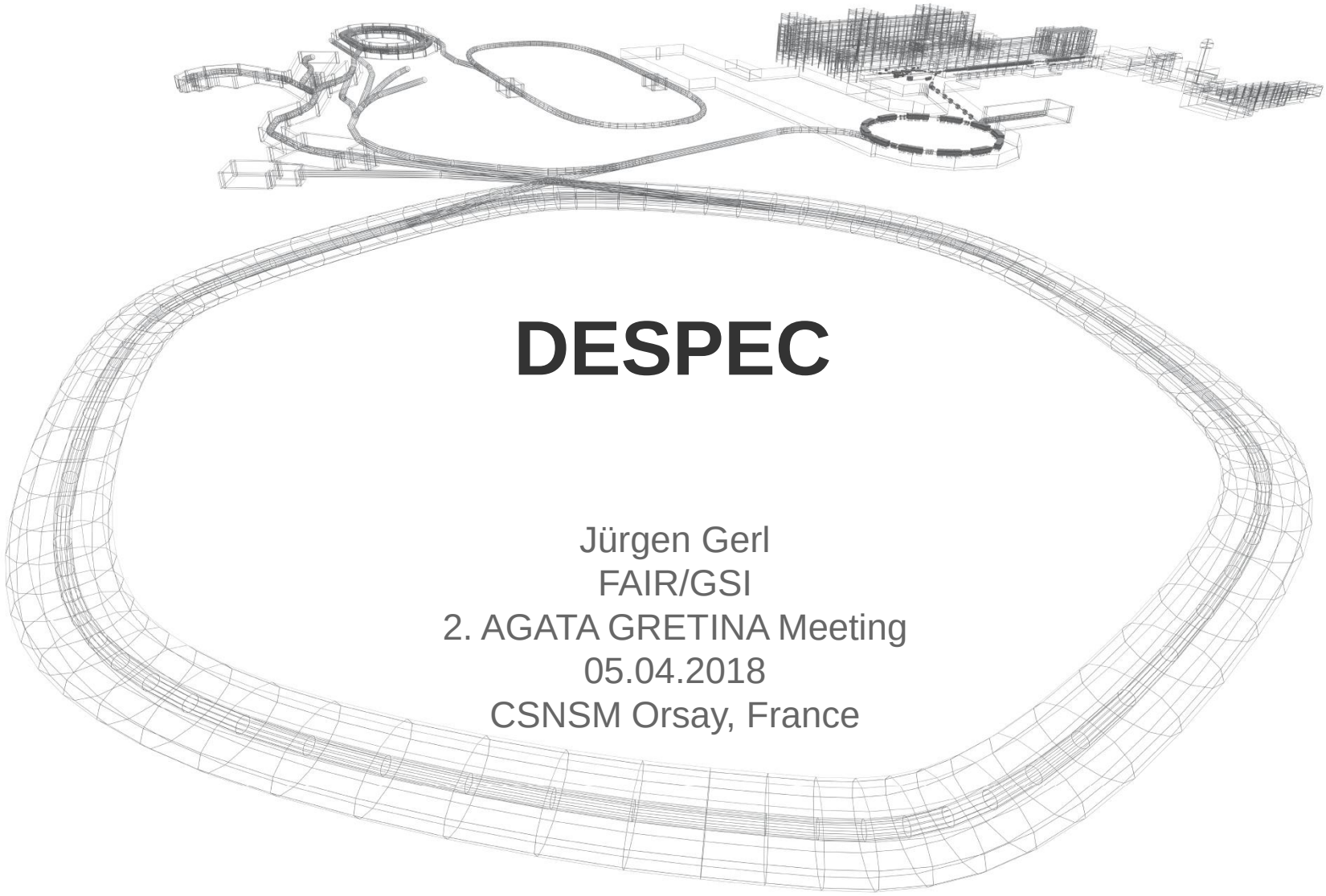


DESPEC

Jürgen Gerl
FAIR/GSI
2. AGATA GRETINA Meeting
05.04.2018
CSNSM Orsay, France

NUclear STructure Astrophysics and Reactions

What are the limits for existence of nuclei?

Where are the proton and neutron drip lines situated?

Where does the nuclear chart end?

How does the nuclear force depend on varying proton-to-neutron ratios?

What is the isospin dependence of the spin-orbit force?

How does shell structure change far away from stability?

How to explain collective phenomena from individual motion?

What are the phases, relevant degrees of freedom, and symmetries of the nuclear many-body system?

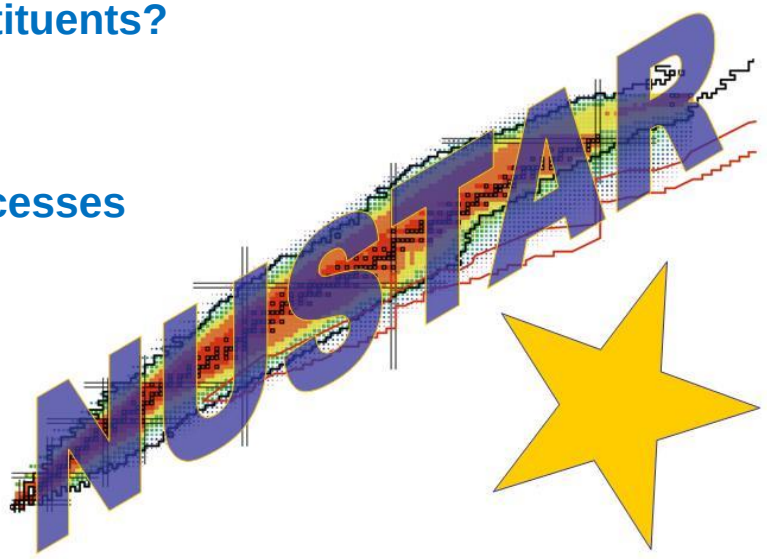
How are complex nuclei built from their basic constituents?

What is the effective nucleon-nucleon interaction?

How does QCD constrain its parameters?

Which are the nuclei relevant for astrophysical processes and what are their properties?

What is the origin of the heavy elements?



NUSTAR - The Project

DESPEC	γ-, β-, α-, p-, n-decay spectroscopy
ELISE	elastic, inelastic, and quasi-free e^--A scattering
EXL	light-ion scattering reactions in invere kinematics
HISPEC	in-beam γ spectroscopy at low and intermediate energy
ILIMA	masses and lifetimes of nuclei in ground and isomeric states
LASPEC	Laser spectroscopy
MATS	in-trap mass measurements and decay studies
R3B	kinematically complete reactions at high beam energy
Super FRS	RIB production, identification and spectroscopy
SHE	Nuclear physics and chemistry of super-heavy elements

The Approach

Complementary measurements leading to consistent answers

The Collaboration

> 850 scientists

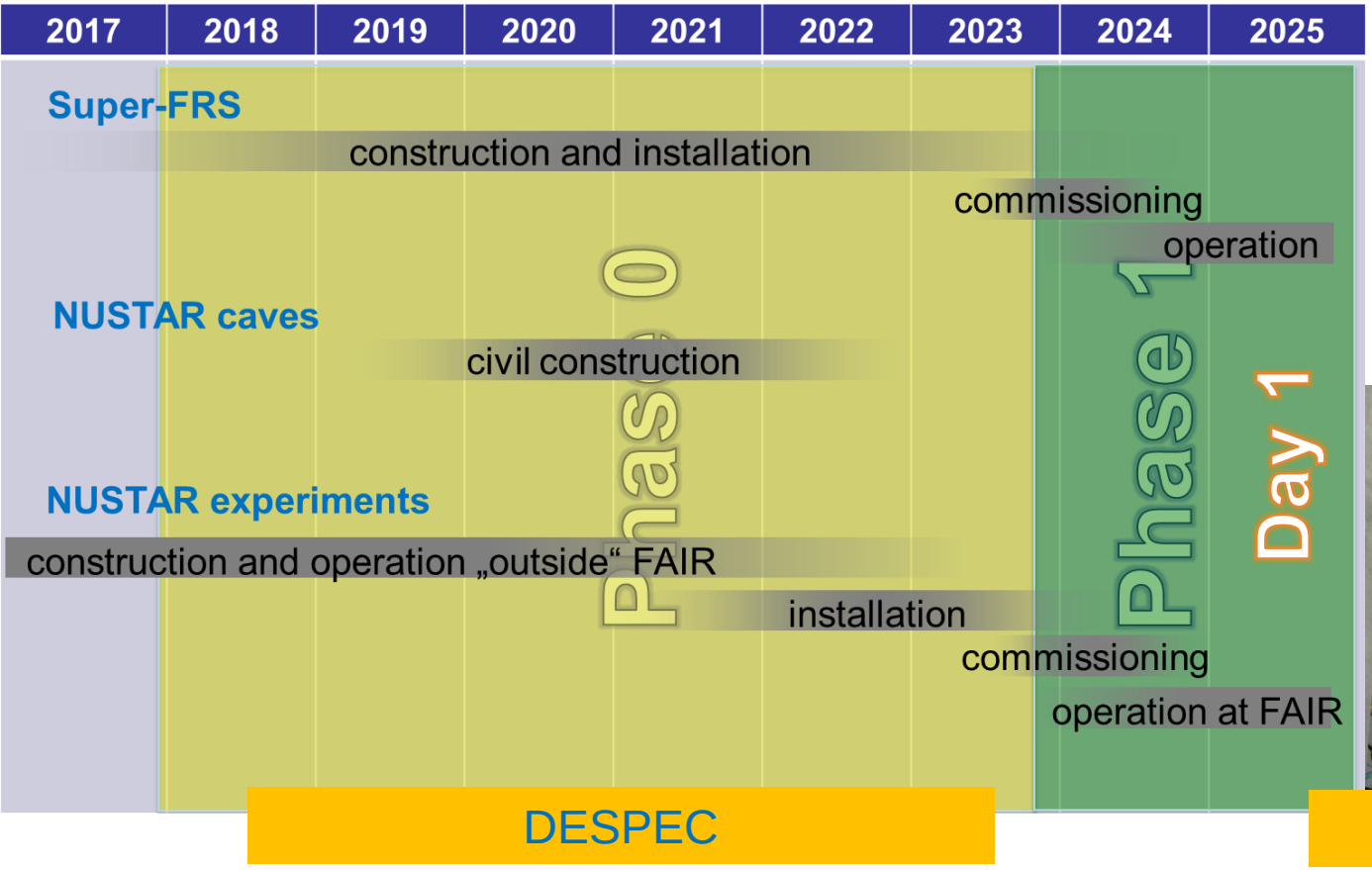
184 institutes

39 countries

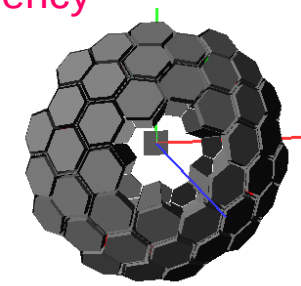
Experimental opportunities for high-resolution spectroscopy at FAIR/NUSTAR

	Experimental method (beam-energy range)	Physics goals and observables	Beam int. (particle/s)
HISPEC	Intermediate energy Coulomb excitation, In-beam spectroscopy of fragmentation products (E/A ~ 100 MeV)	Medium spin structure, Evolution of shell structure and nuclear shapes, transition probabilities, moments,	10^{1}...10^{5}
HISPEC	Multiple Coulomb excitation, direct and deep-inelastic, fusion evaporation reactions (E/A ~ 5 MeV; Coulomb barrier)	high spin structure, single particle structure, dynamical properties, transition probabilities, moments,	10^{4}...10^{7}
DESPEC	Decay spectroscopy (E/A = 0 MeV)	half-lives, spins, nuclear moments, GT strength, isomer decay, beta-decay, beta-delayed neutron emission, exotic decays such as two proton, two neutron.	10^{-5}...10^{3}

NUSTAR overall plan



≥ 60 AGATA Ge crystals
> 20% Efficiency



HISPEC

DESPEC: Decay Spectroscopy

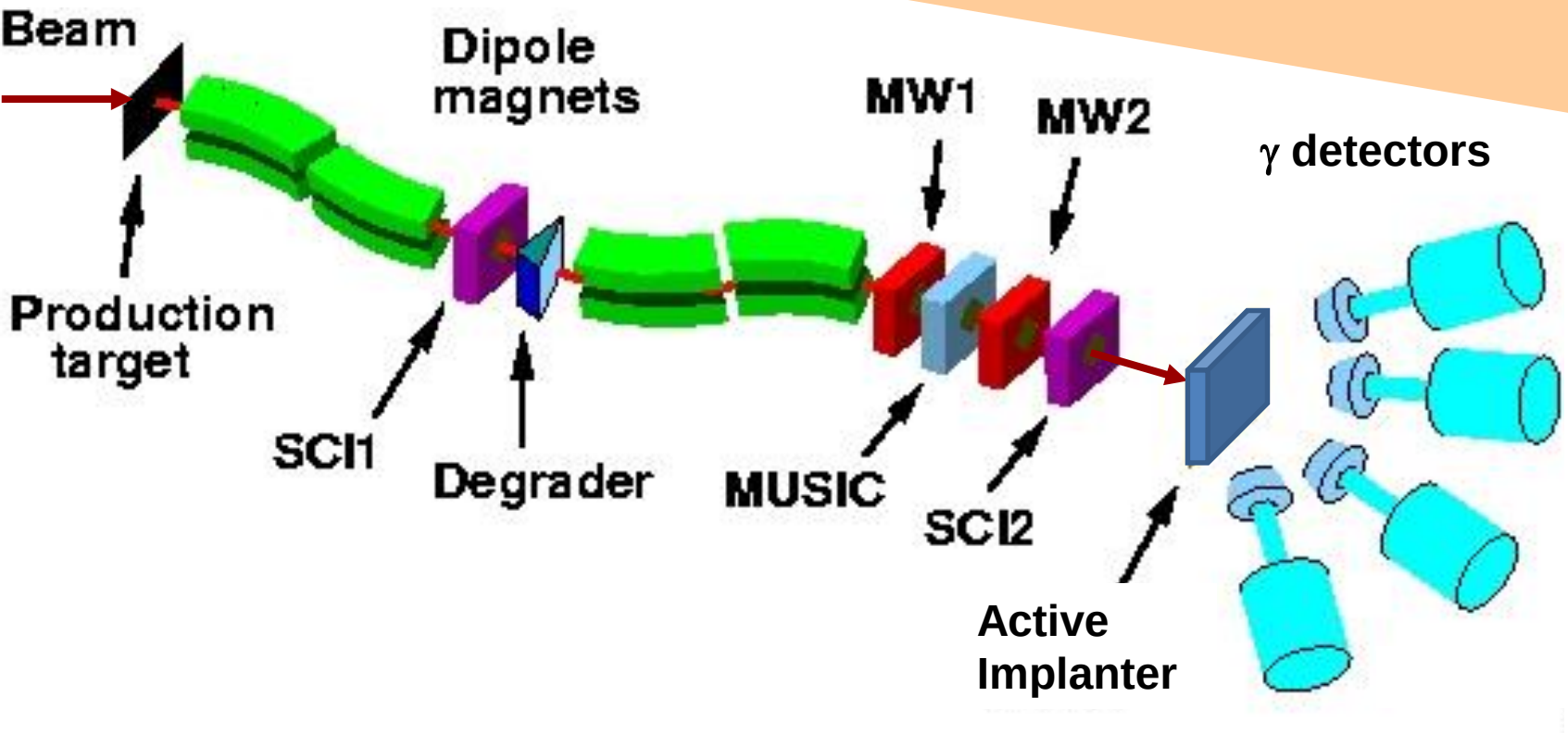
production

selection

identification

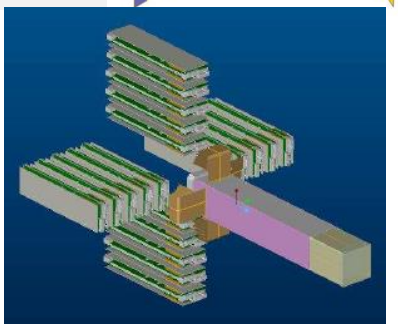
implantation

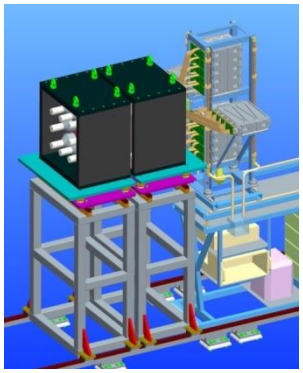
spectroscopy



Ingredients for a successful DESPEC Phase-0 programme at GSI

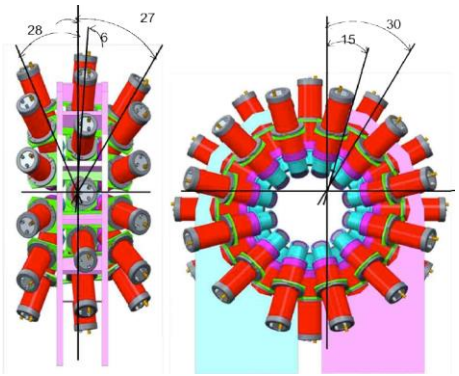
take AIDA as common active implanter

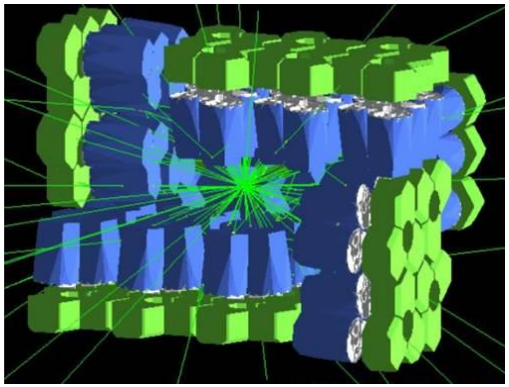




use DTAS to measure β-strength distributions

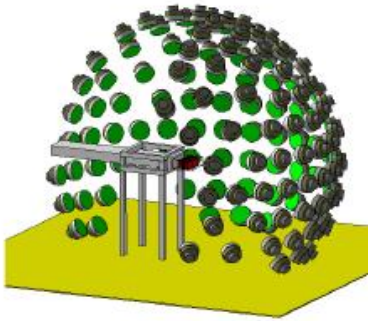
use FATIMA to measure lifetimes





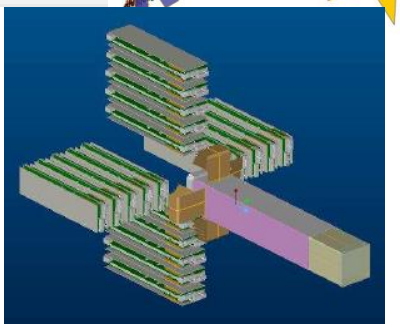
use DEGAS for high-resolution spectroscopy

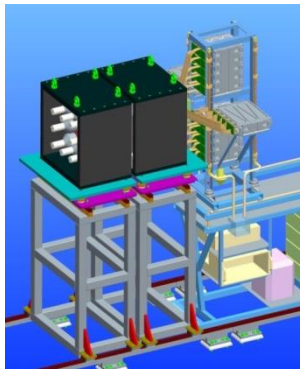
use MONSTER to perform neutron spectroscopy



Exploitation plan

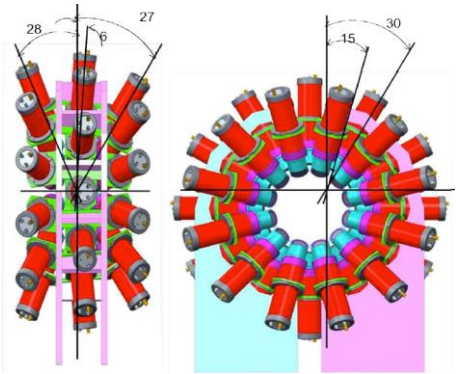
AIDA (narrow config.) used at RIKEN, will serve as initial implanter in 2018. AIDA (wide config.) to be built and commissioned for 2019 and later.

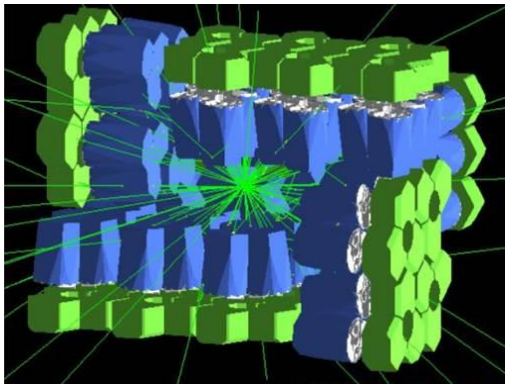




DTAS used at JYFL and RIKEN, was planned for the 1. set-up but got no beamtime

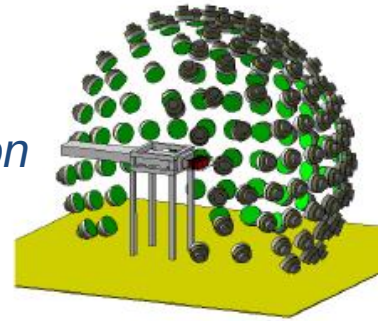
FATIMA used at IFIN-HH, RIKEN and GANIL, is planned for the 1. set-up in 2018



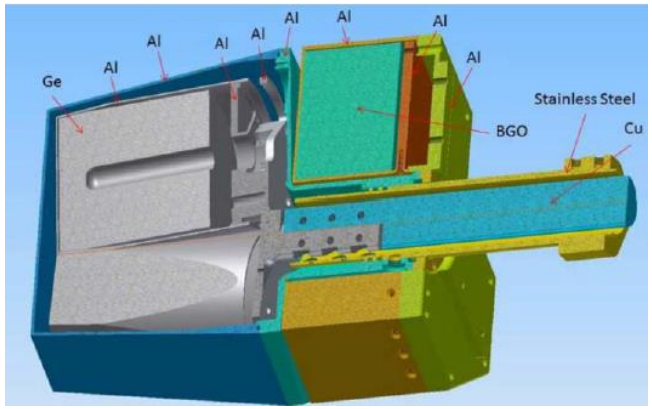


DEGAS is under construction and is planned to be used for the 2. setup in 2019. Up to 7 modules will be employed already for FATIMA in 2018.

MONSTER is under construction and shall be tested in 2018 parasitically, prior to proposing experiments



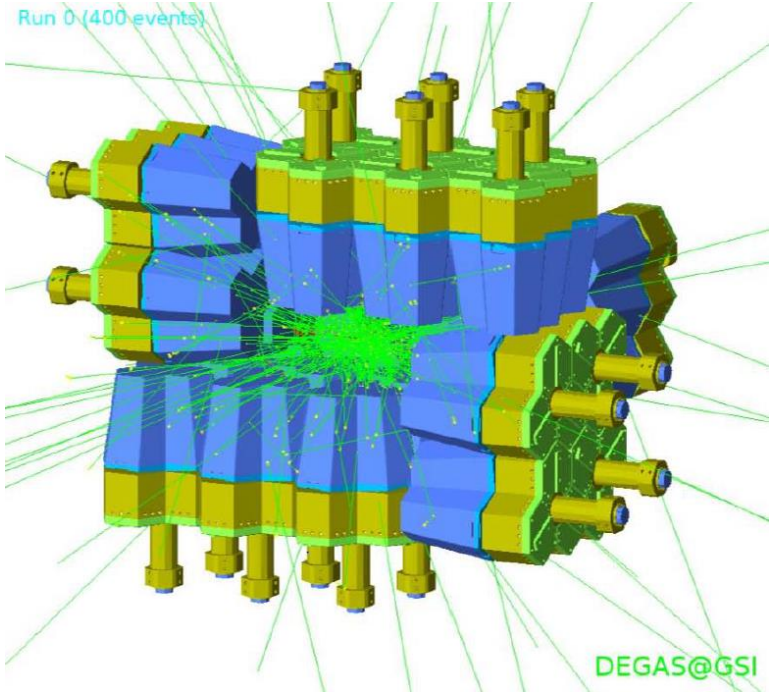
DEGAS Array

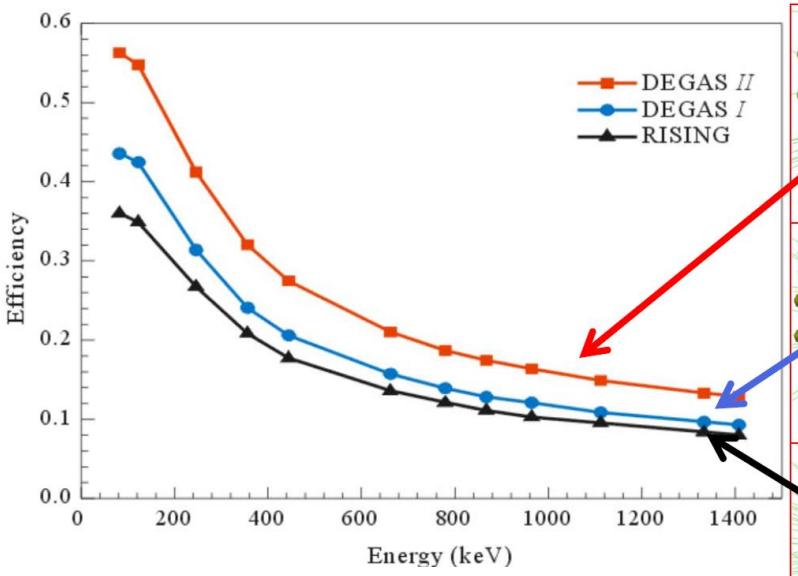


28 triple Clusters of Euroball Ge capsules

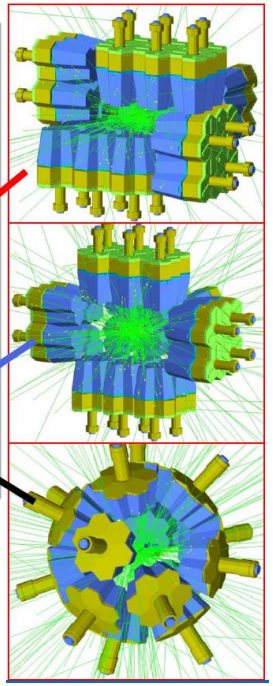
with BGO back-catchers and side-shields

Box configuration around a 24x8 cm^2 implanter

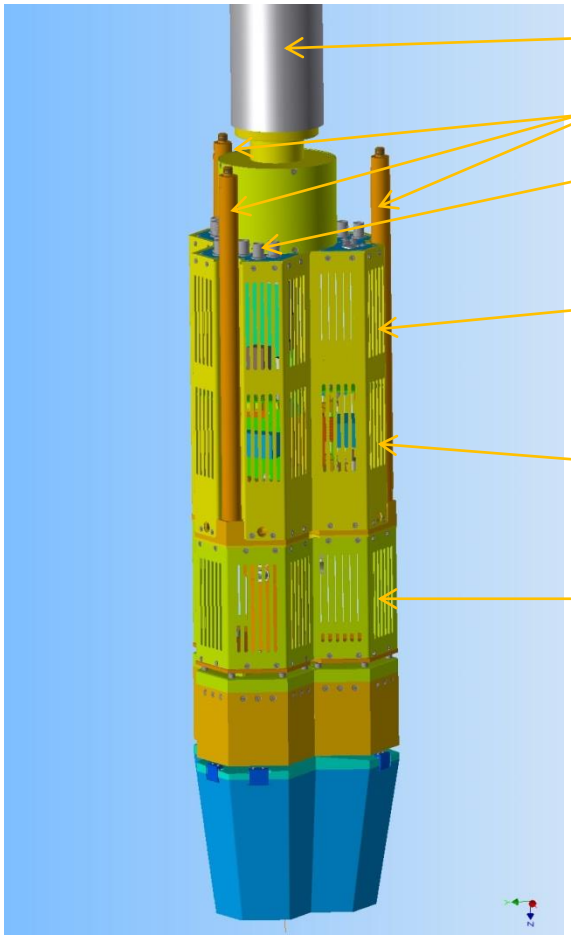




without inter-cluster add-back



DEGAS Structure



XC-2 Engine

Holding bars

Connectors

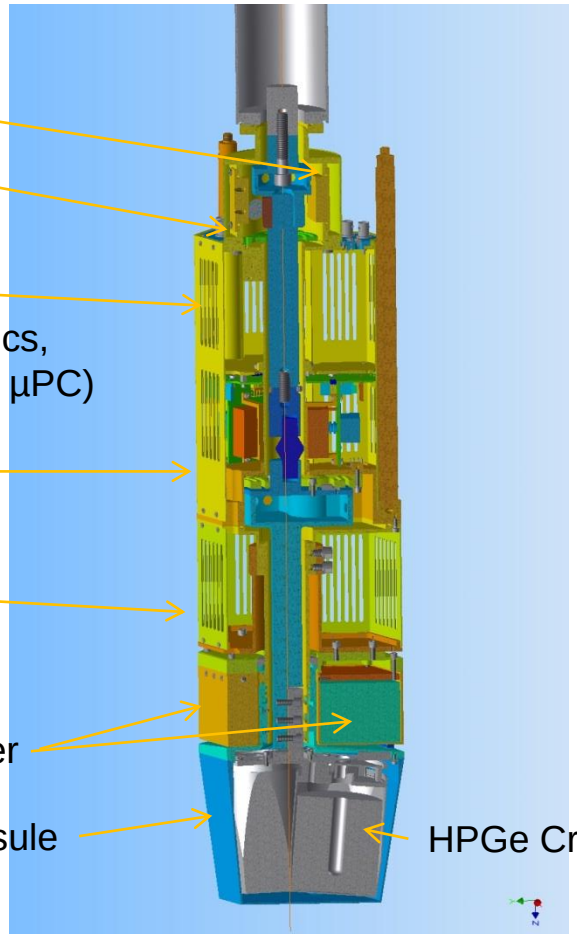
Top Deck
(Support electronics,
power supply and µPC)

Middle deck
(Ge-PA + HV)

Bottom Deck
(BC electronics,
later Ge-DAQ)

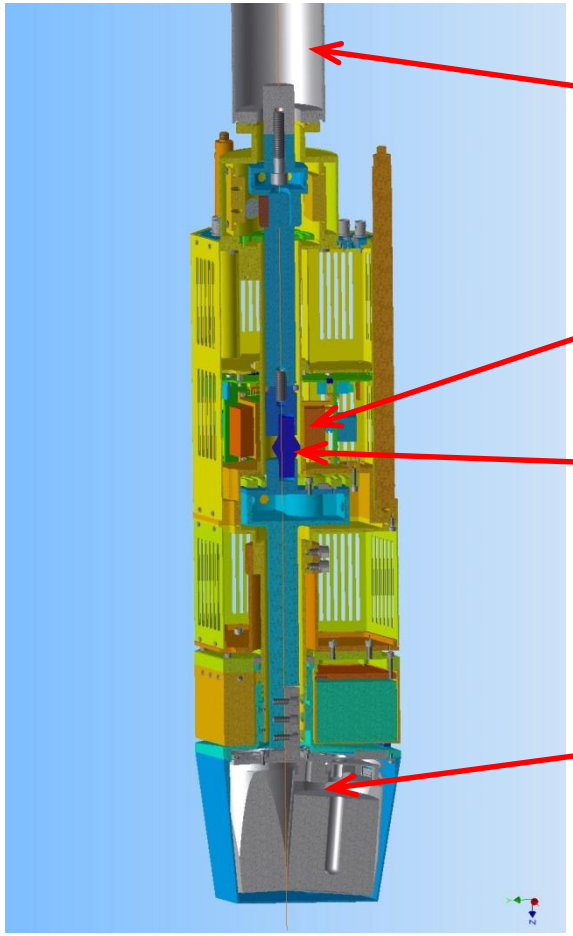
Backcatcher

Crystal capsule



HPGe Crystal

DEGAS Critical components



Cooling Engine – XC2 or SunPower CT

Preamplifier-HV block – suitable preamplifier and HV control board

Cold Flex – more than 2000 W/sqm thermal contact

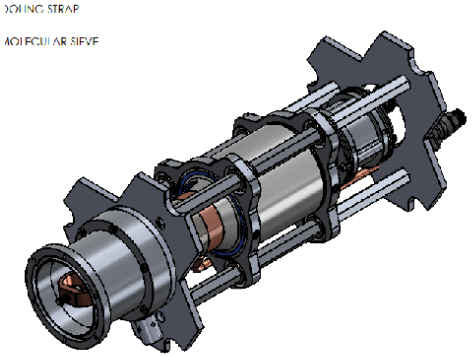
HEAD – the proper positioning of the capsules and the Lid to the cryostat

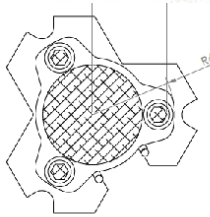
DEGAS electrical cooler

production stopped

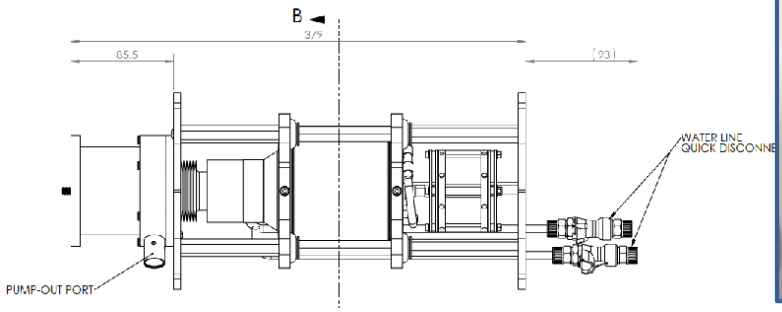
MMR/ORTEC X-Cooler II or III

vibration decoupling under development with ORTEC





SECTION B-B

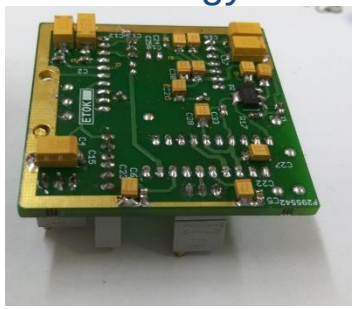


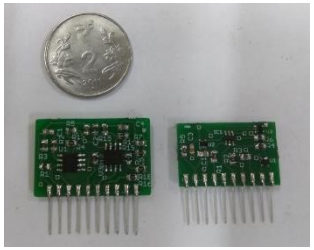
SunPower/ORTEC Type CT or GT

DEGAS Preamplifier - HV block

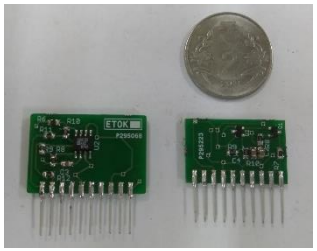
PA partially developed at TIFR, successfully tested at GSI
HV control board developed at GSI and successfully tested

PA based on hybrid technology



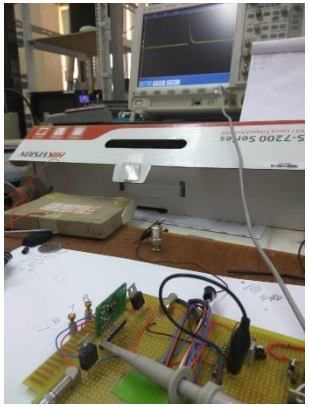


Differential Driver

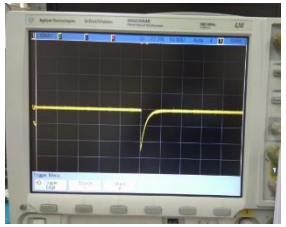


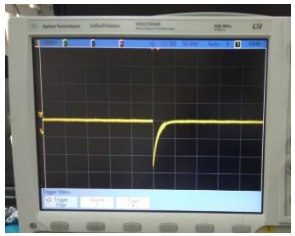
Active reset

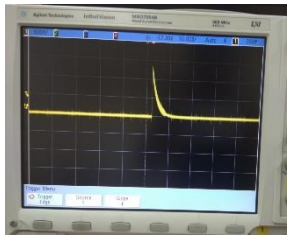
by Rajaneesh Donthi, TIFR



Input signal
RT = 50 ns
FT = 50 us
Gain = 4
Amp = 400 mv





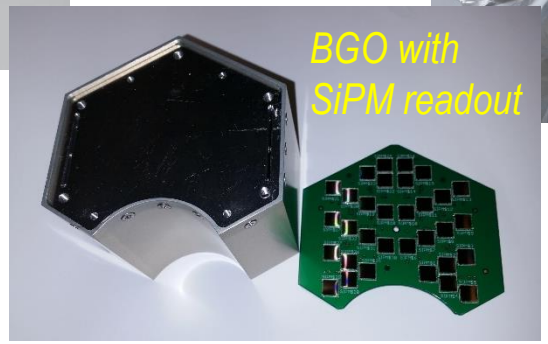


Final version with adapted form factor being designed

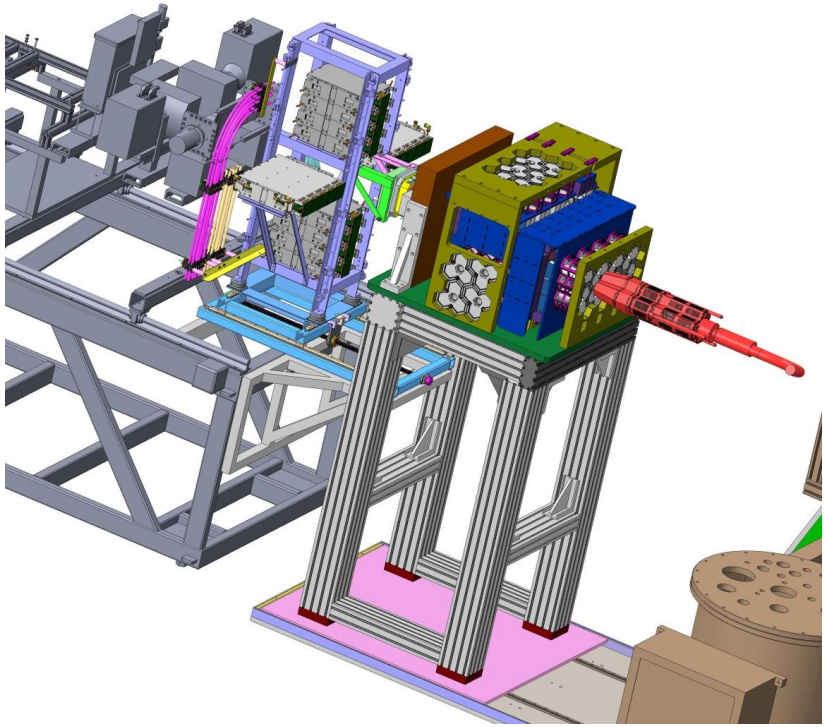
DEGAS First of Series

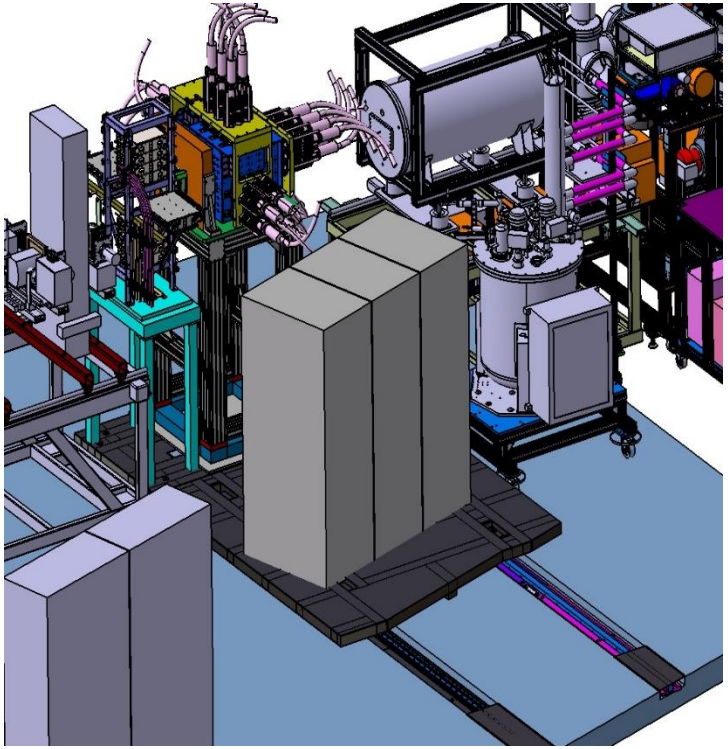
Currently under testing:

- vacuum ok
- cooling losses under investigation



DEGAS Set-up





Full array to be employed for DESPEC-0 experiments at GSI in 2019

Digitizers: FEBEX2 14bit, up to 250 MHz

DAQ: MBS branch

Conclusions

- DEGAS will be a powerful substitution of RISING
- 20% full-energy efficiency at 1 MeV expected
- Complex triple detectors with electrical cooling
- Integrated electronics with fast reset preamp, HV and all controls on-board
- Issues with the cooling need to be solved
- Planned for an experimental campaign at GSI in 2019

…Thank you