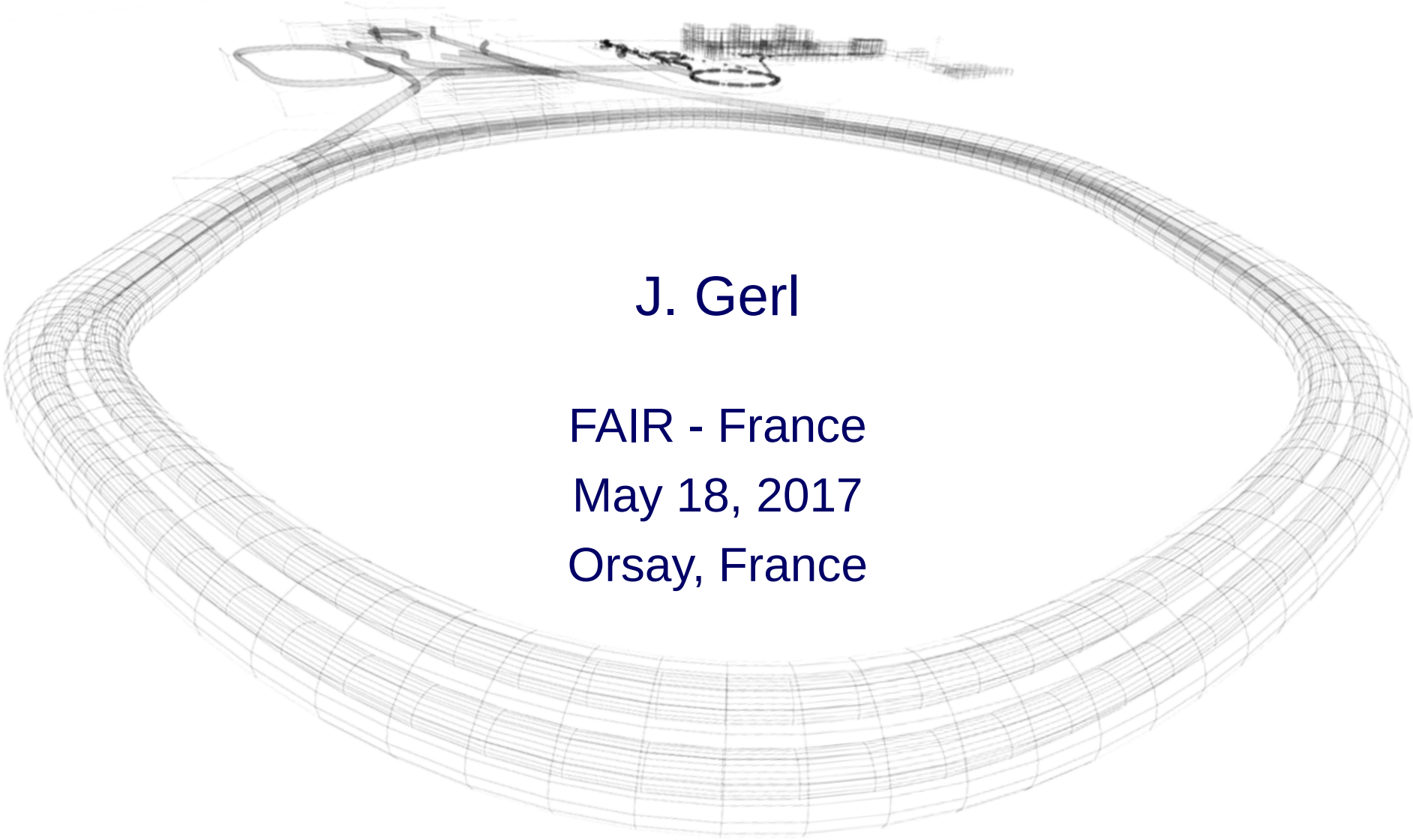
NUSTAR instrumentation



J. Gerl

FAIR - France

May 18, 2017

Orsay, France

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

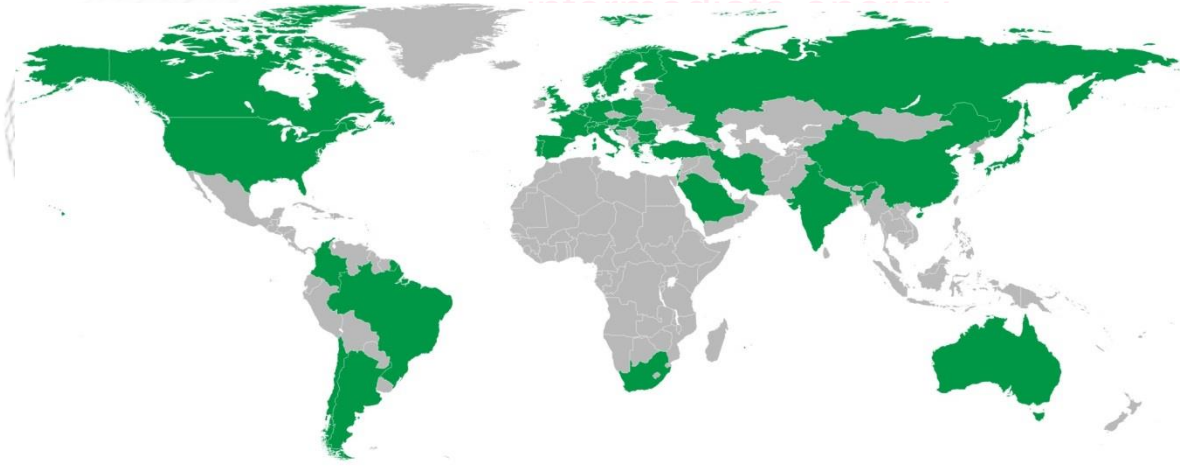
184 institutes

39 countries

NUSTAR - The Project

Evolutionary approach:

Advancing instrumentation by continuous development and gaining experience by physics exploitation



The Approach

Complementary measurements leading to consistent answers

The Collaboration

> 850 scientists

184 institutes

39 countries

>50 instrumentation sub-projects (MSV)

several 1000 major components

HISPEC/DESPEC planned instrumentation

HISPEC

-LYCCA *heavy ion calorimeter with ToF capability* *in operation*

-AGATA *gamma spectrometer* *in operation*

-Hyde *light particle array* *prototype*

-NEDA *Neutron detector array* *prototype*

DESPEC

-AIDA *active implantation device* *in operation*

-MONSTER *neutron ToF array* *under construction*

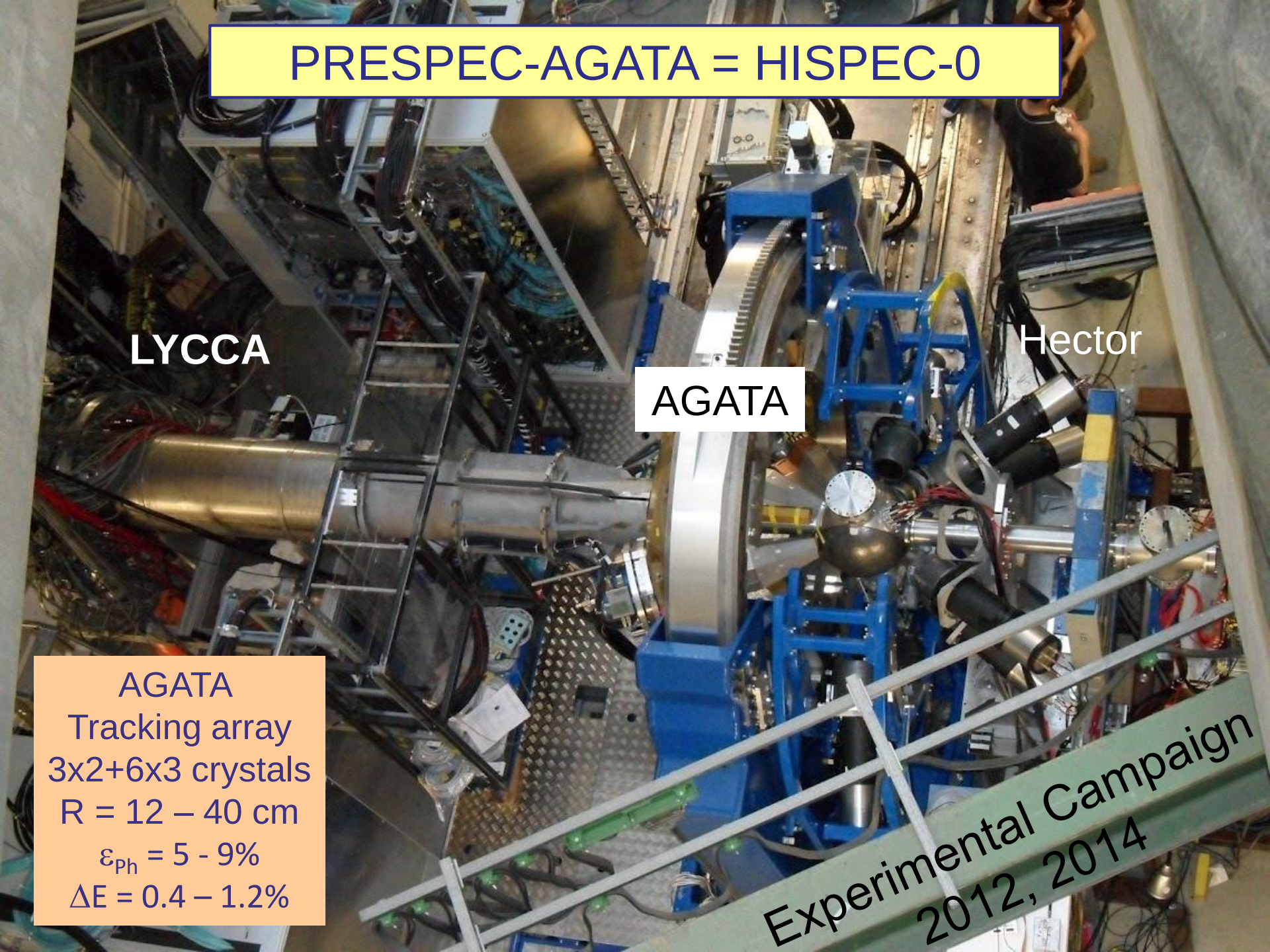
-BELEN *neutron detecion array* *in operation*

-DTAS *Decay Total Absorption Spectrometer* *in operation*

-DEGAS Ge Array *gamma spectrometer* *in development*

-FATIMA *Fast timing array* *in operation*

-MOMENTS *In discussion*


PRESPEC-AGATA = HISPEC-0
LYCCA
AGATA
Hector
AGATA
Tracking array
3x2+6x3 crystals
R = 12 – 40 cm
ε_{Ph} = 5 - 9%
ΔE = 0.4 – 1.2%
Experimental Campaign
2012, 2014

DESPEC: Decay Spectroscopy

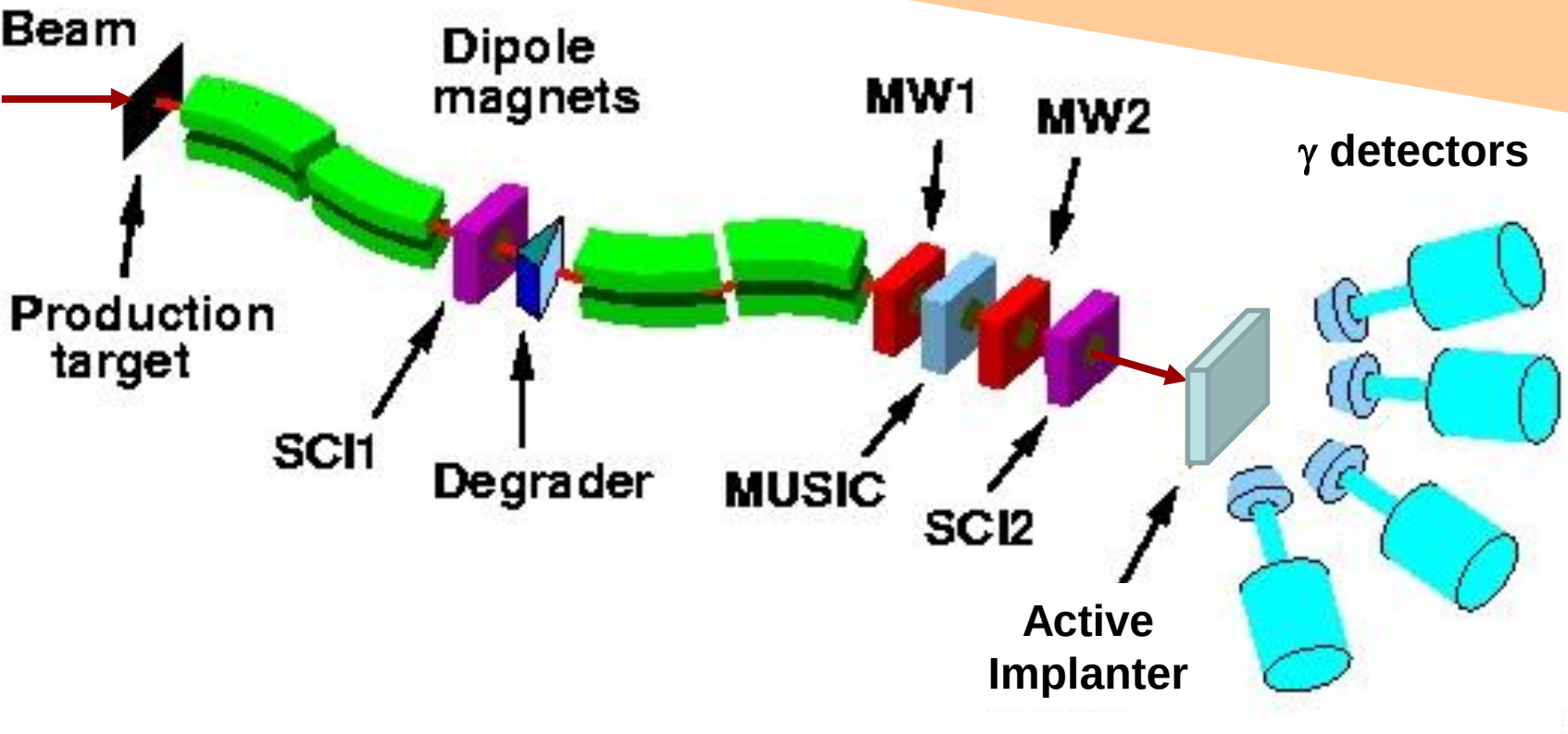
production

selection

identification

implantation

spectroscopy



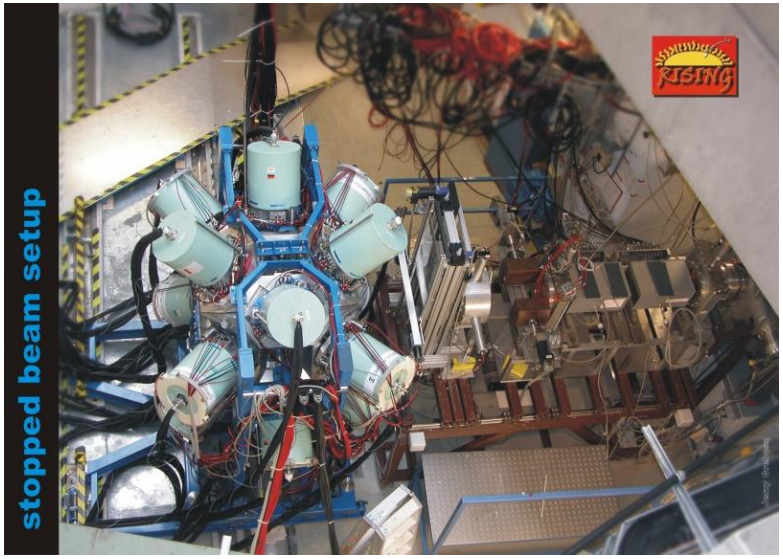
Previous RISING Set-up

Active Implanter
Si-DSSSD array
Active area: 15x5 cm^2
Pixels: 3x16x16 = 768
Layers: fixed
E-range: 10 GeV log
Processing time: 200µs

Rate limitations due to too few pixels

RISING
7-fold Cluster Ge array
No. Ge Det.: 7x15 = 105
Efficiency: 15%
E-range: 50 keV ... 5 MeV

2007-2009



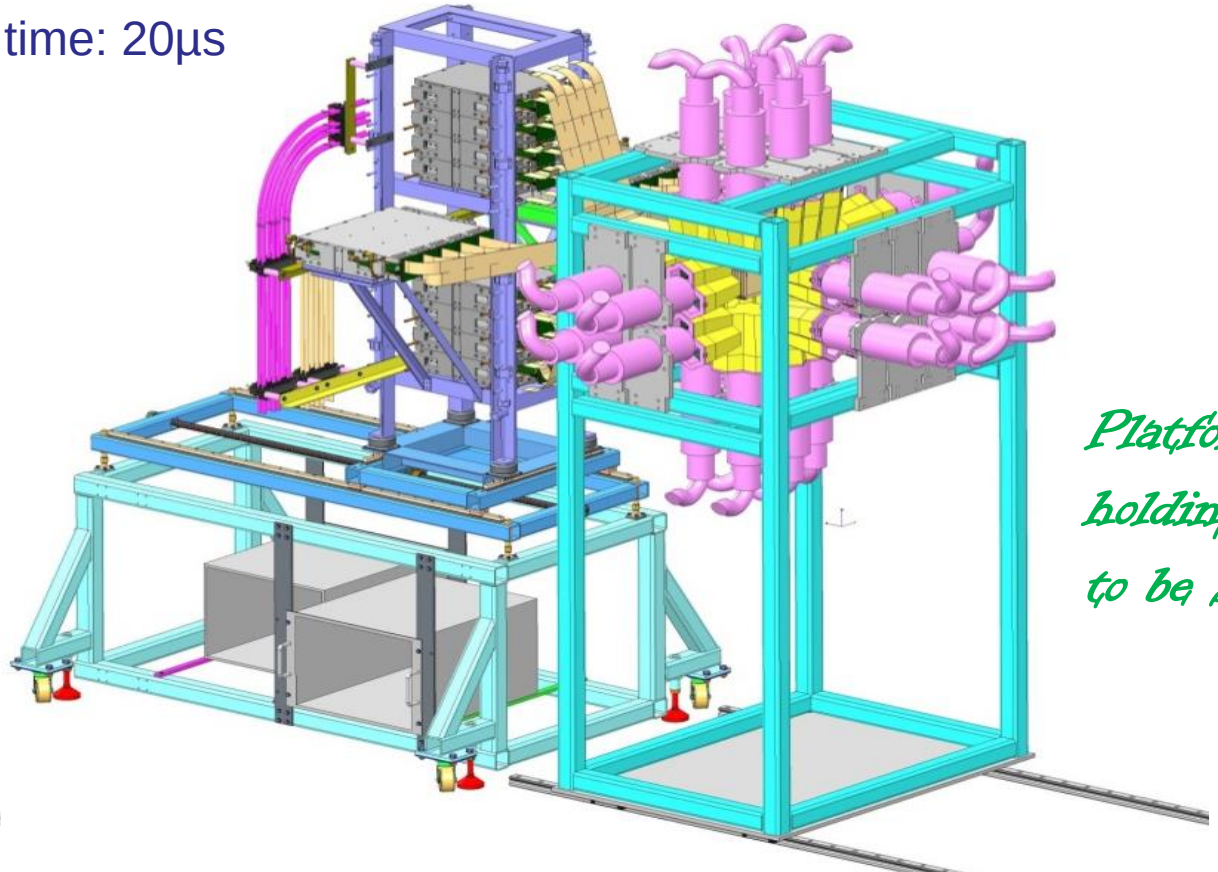
K-isomer lifetime limitations due to missing environmental shielding

...evolution to the next generation

AIDA – DEGAS Set-up

AIDA
Trigger-less Si-DSSSD array
Active area: 24x8 cm^2, 8x8 cm^2
Pixels: 3x128x128 = 49152
Layers: variable
E-range: 20 MeV + 20 GeV
Processing time: 20µs

DEGAS
Shielded Triple Cluster Ge array
No. Ge Det.: 3x28 = 84
Efficiency: 23%
E-range: 50 keV ... 5 MeV

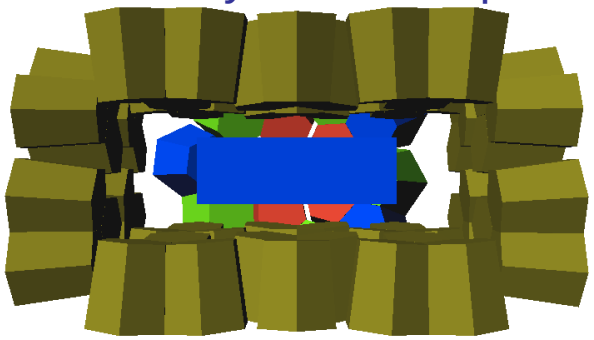


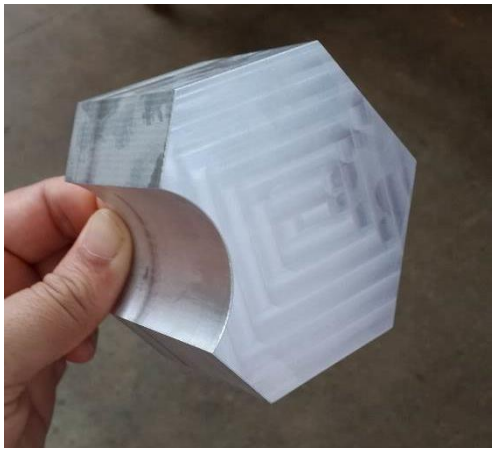
Platform and holding structures to be supplied

DEGAS Detector Realization

TDR approved in 7.2015

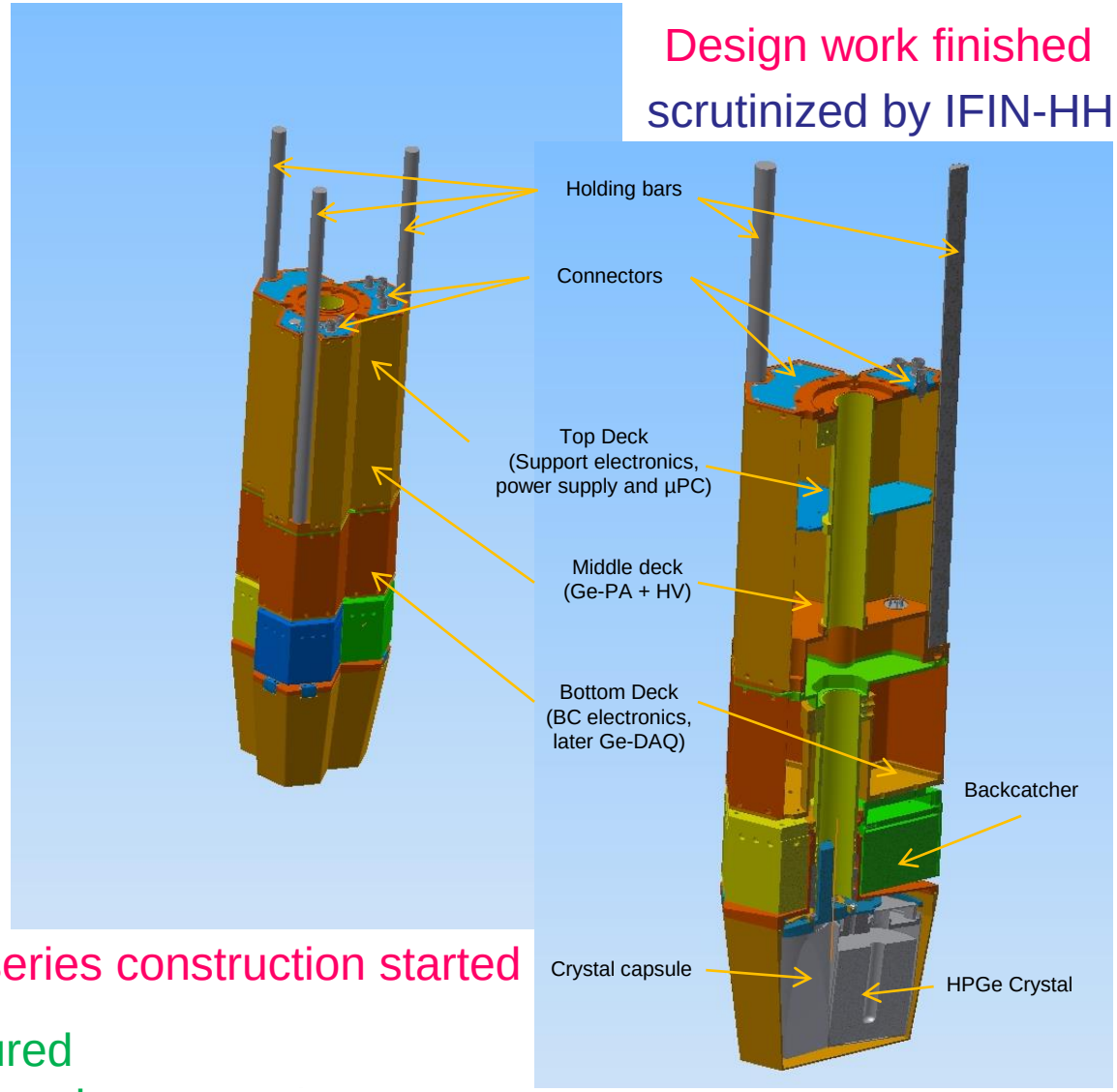
Ge Array with 28 Triples





Design work finished

scrutinized by IFIN-HH

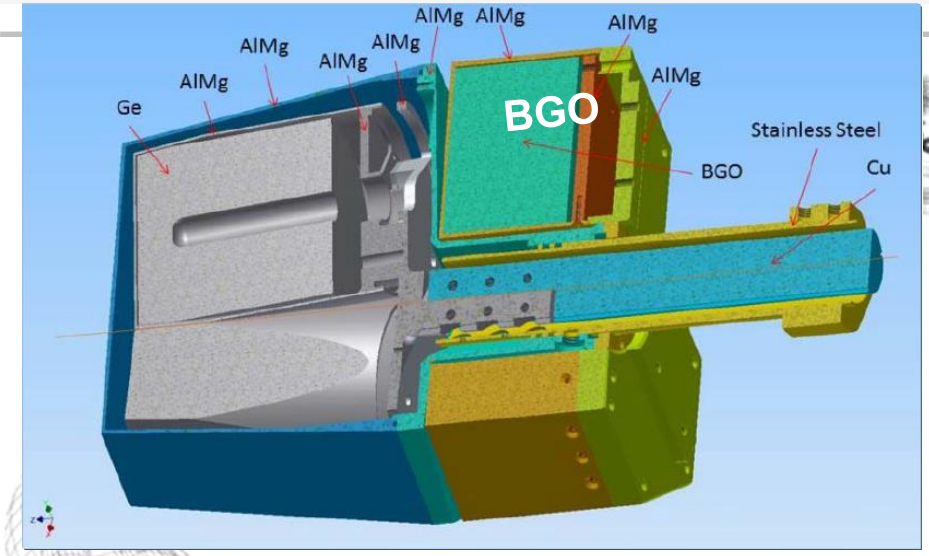


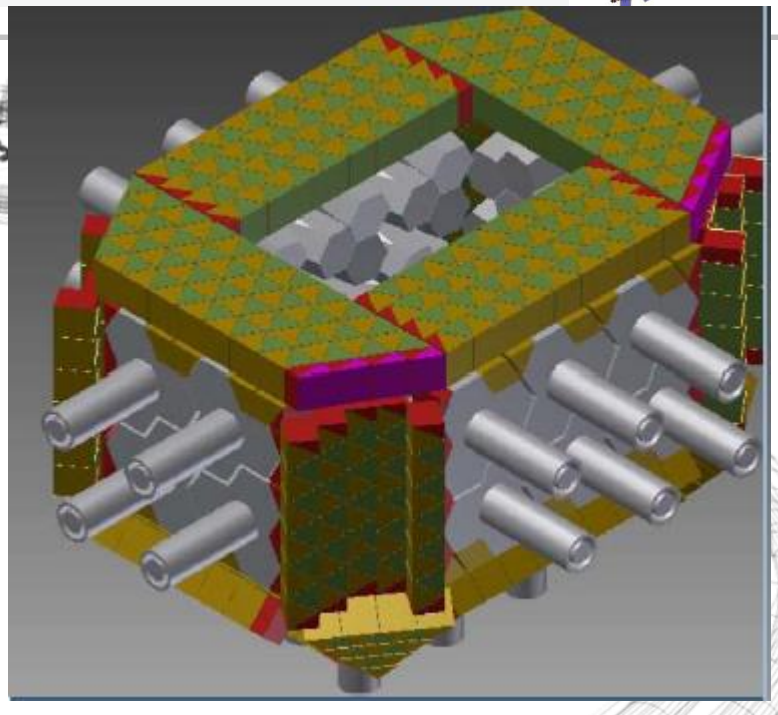
Pre-series construction started

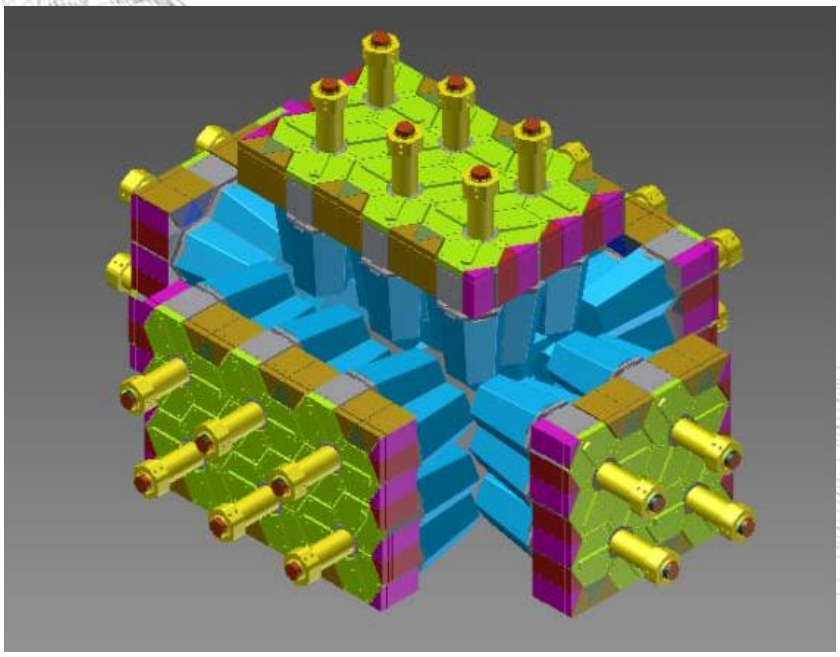
Funding: Phase I 100% secured

Phase II ≈80% secured

DEGAS Shield Design

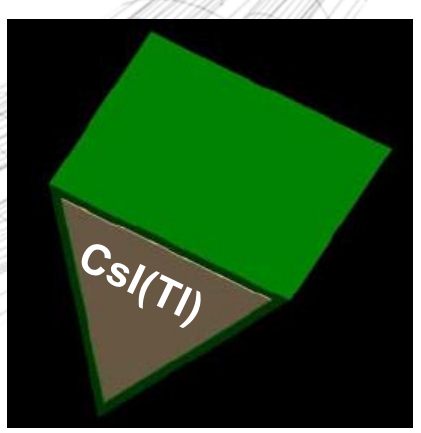




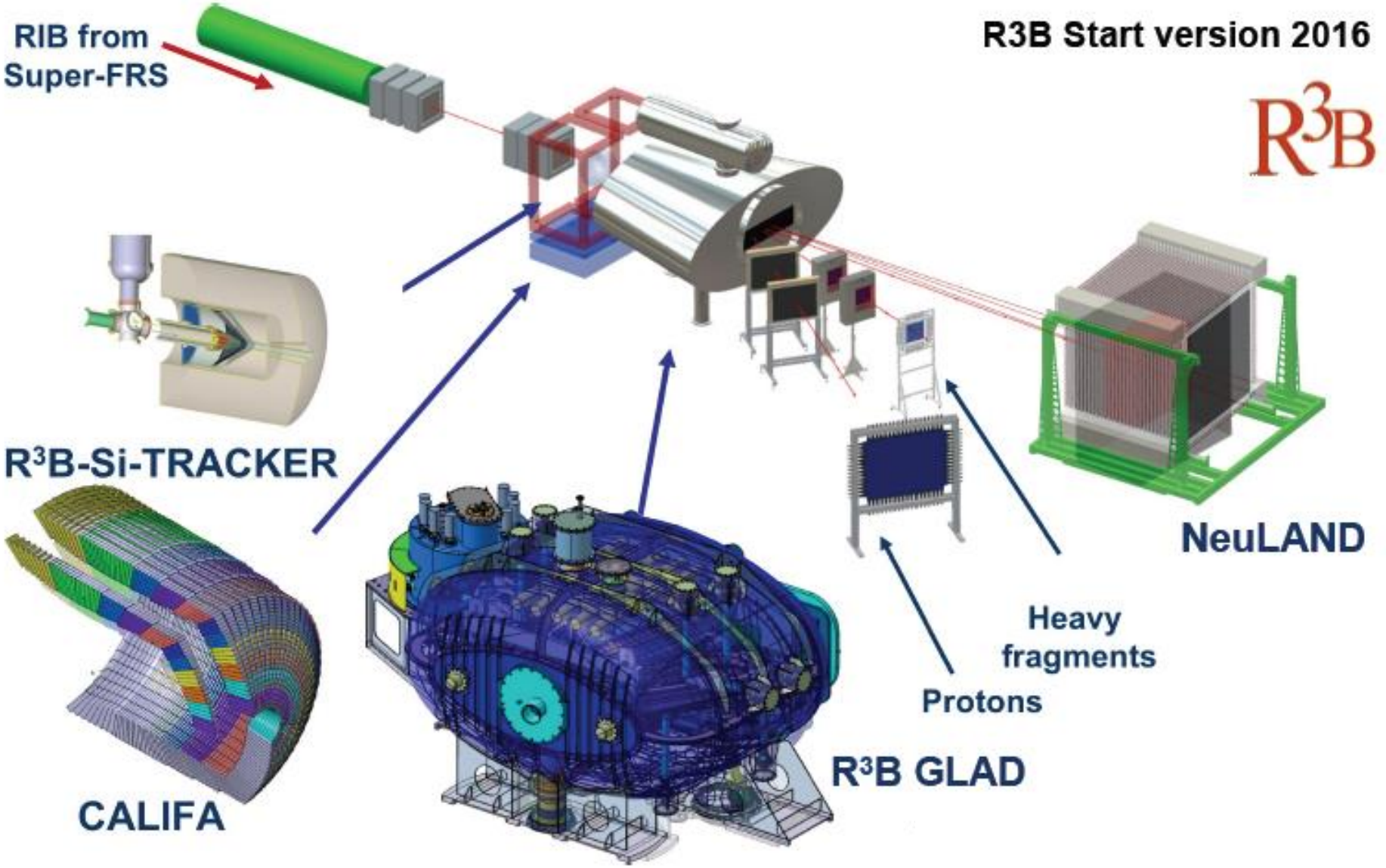


- Active scintillator shields
- Background reduction
- Compton suppression
- SiPM read-out
- time, energy

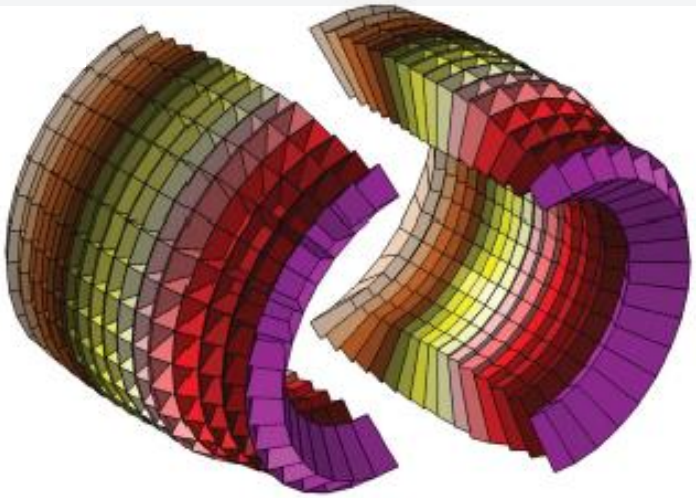
Sideshields to be supplied



R3B: reaction studies

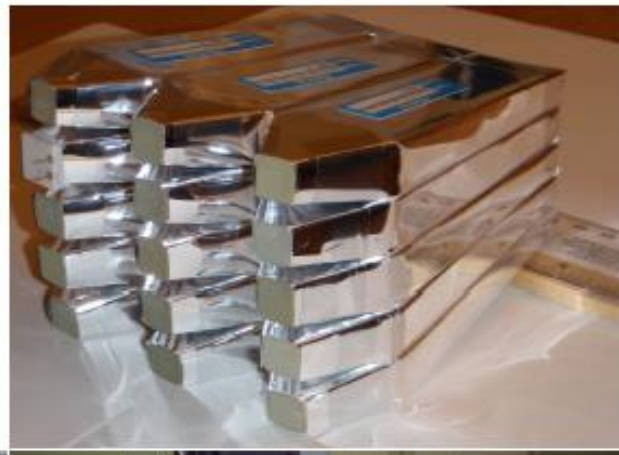


CALIFA

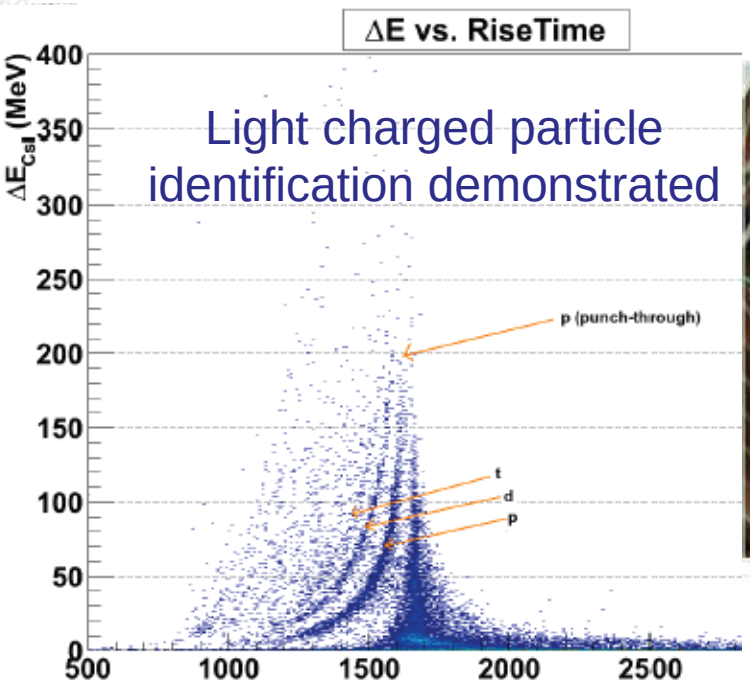


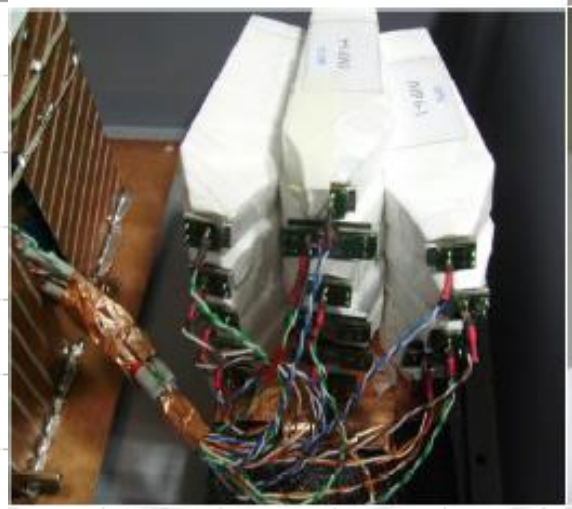
TDR submitted in 2012 and accepted!

Barrel under construction



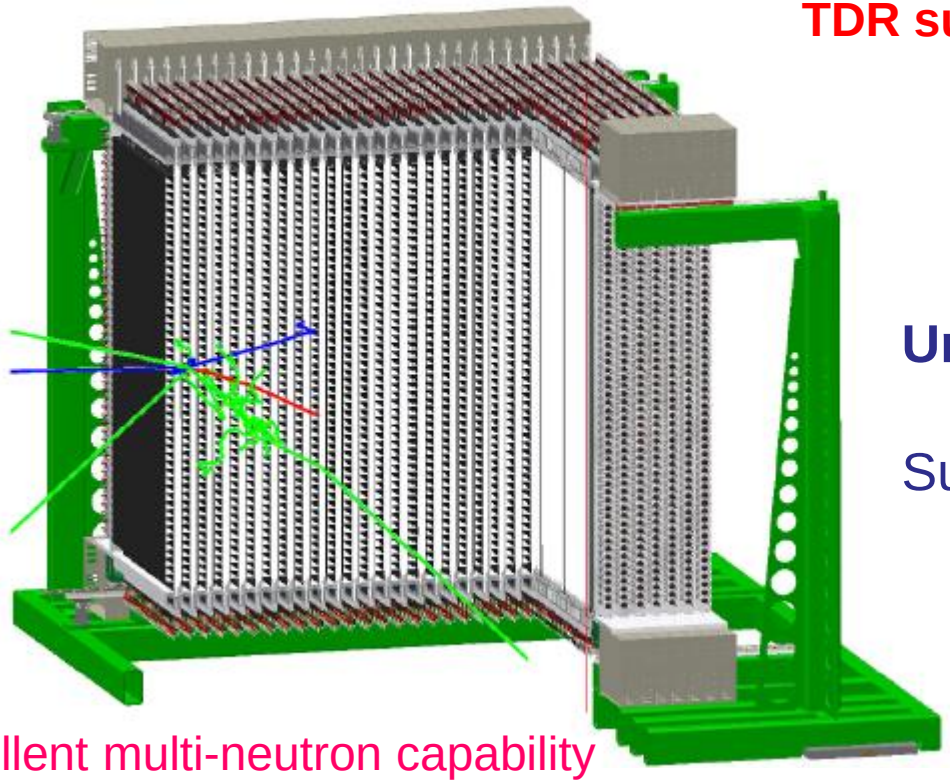
Further elements to be supplied





NeuLAND

TDR submitted in 2012 and accepted!



Under construction

Sub-array in operation at RIKEN

excellent multi-neutron capability

detected \ 200 MeV generated	%	1n	2n	3n	4n	5n
	1n	**88**	31	6	1	0
	2n	2	**62**	37	10	2
	3n	0	5	**49**	38	14
	4n	0	0	8	**48**	54
	5n	0	0	0	3	**26**
	6n	0	0	0	0	3

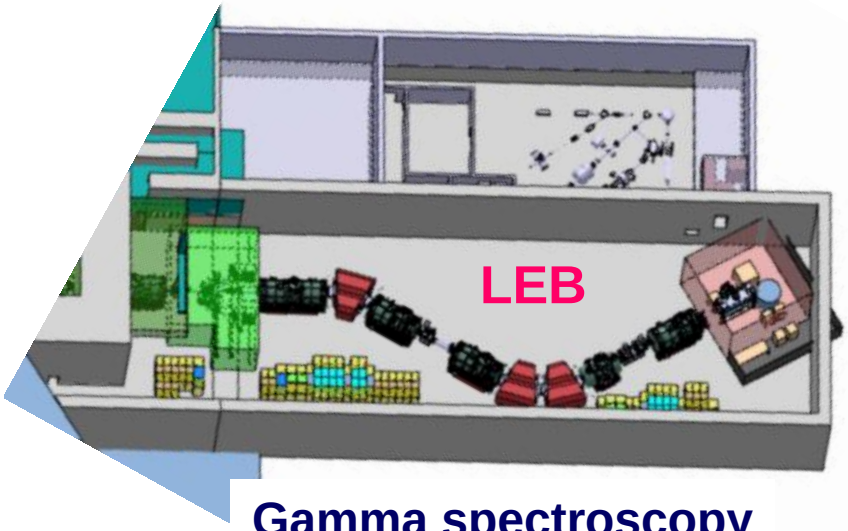
detected \ 600 MeV generated	%	1n	2n	3n	4n	5n
	1n	**92**	22	2	0	0
	2n	2	**71**	32	7	1
	3n	0	6	**55**	32	9
	4n	0	0	10	**57**	50
	5n	0	1	1	4	**35**
	6n	0	0	0	0	5

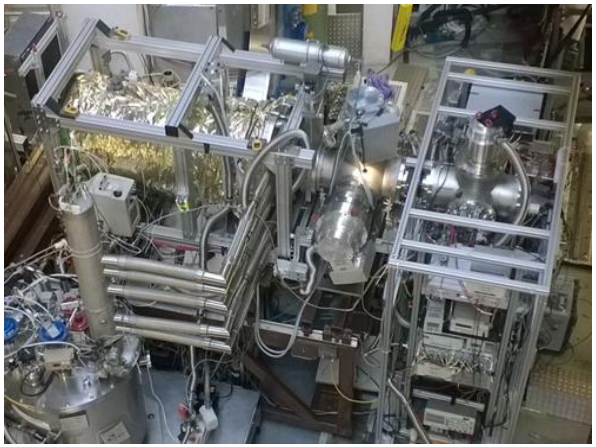
detected \ 1000 MeV generated	%	1n	2n	3n	4n	5n
	1n	**89**	12	1	0	0
	2n	7	**78**	23	3	0
	3n	0	8	**63**	26	5
	4n	0	0	12	**63**	40
	5n	0	0	0	7	**46**
	6n	0	0	0	0	8

Further planes to be supplied

Preparing slow beams

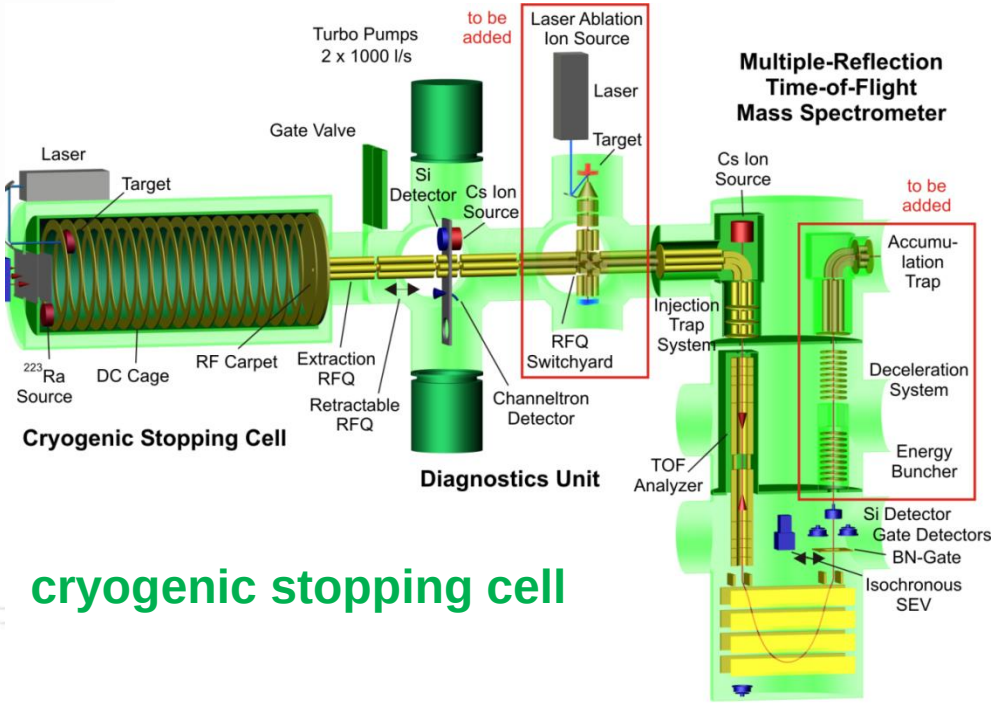
Traps and
Laser spectroscopy





Gamma spectroscopy

buncher/spectrometer



...novel concepts

cryogenic stopping cell

Conclusions

- NUSTAR at GSI/FAIR enables unique and important contributions to our understanding of the atomic nucleus
- Planned and available instrumentation is state-of-the-art
- Planning and preparation for NUSTAR Phase-0 experiments at GSI from 2018 onwards has started
- Nw collaborators are highly welcome
- Various fields of engagement: physics (experiment and theory), instrumentation development, and infrastructure