Approaching interesting nuclear processes from the developing of new instrumentation

Luis Acosta

IEM-CSIC

Instituto de Física, UNAM

Introduction

- During the last 20 years, the nuclear physics has been benefited with the impulse of new technology: most of the large facilities dedicated to nuclear studies are presently under the upgrading of beam production, like new rare nuclear species and with enough rates to allow the performance of new measurements.

- In parallel, several collaborations have developed a number of new devices to take advantage of all these future beams and also for the beams presently available. Thus, detection arrays, different kind of targets and separator devices have beam created or they are under construction.

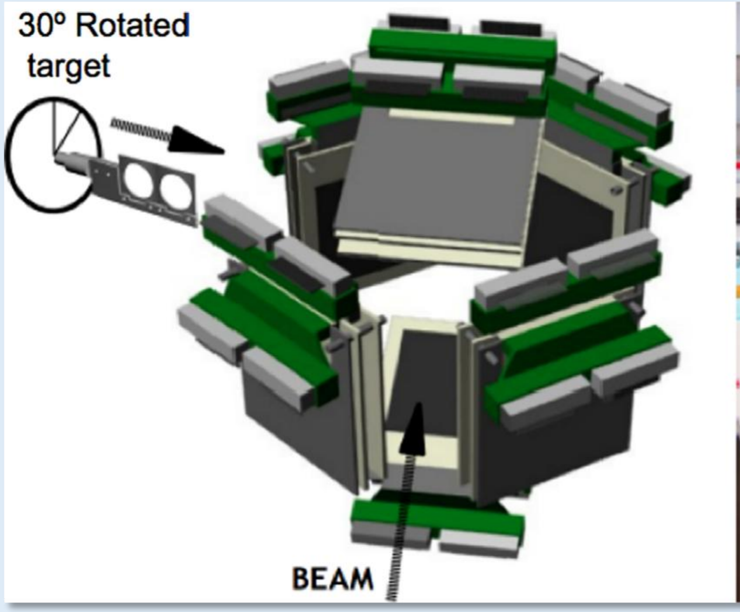
- In this presentation will be visited devices developed few years ago at IFUNAM, Mexico, and new ones led by Spanish institutions.

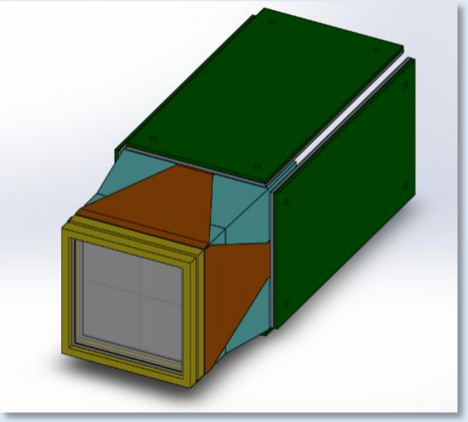
Introduction (2)

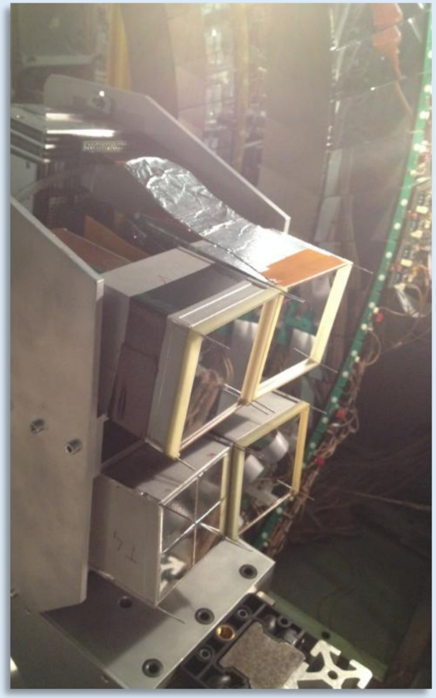
- The examples to be described are:
  - the new array for nuclear dynamics studies called SIMAS, successfully used since 2019 for the measurements of weakly bound nuclei at TwinSol/TriSol facility;
  - the supersonic jet target SUGAR, presently inside of the SUGAR@LNL collaboration to be developed in a near future at LNL-INFN;
  - and finally, the very resent project called ISRS/MAGDEM, a future spectrometer which is under demonstration phase, which is expected to be installed as part of the beamline SEC at the HIE-ISOLDE facility and the end of this decade.

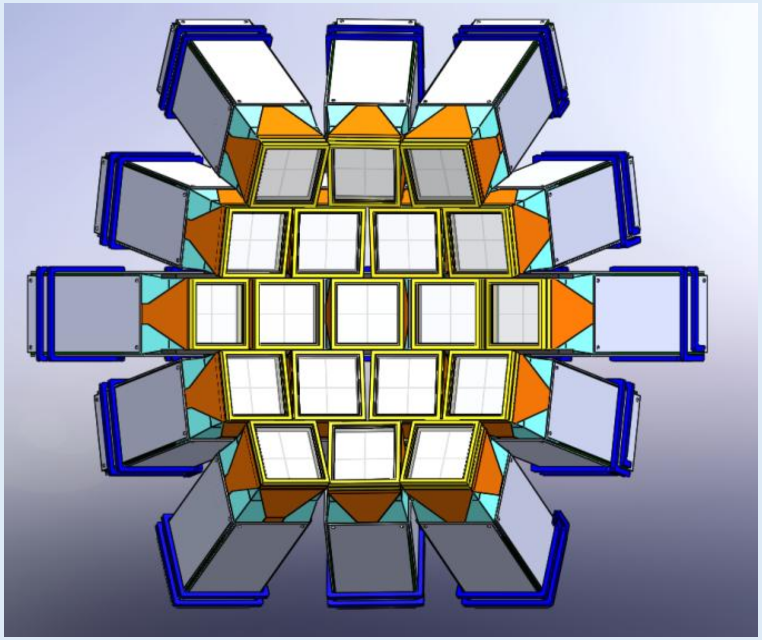
SIMAS array for nuclear studies at low energies

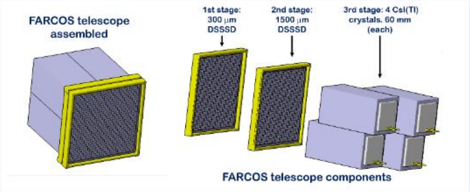
GLORIA and FARCOS





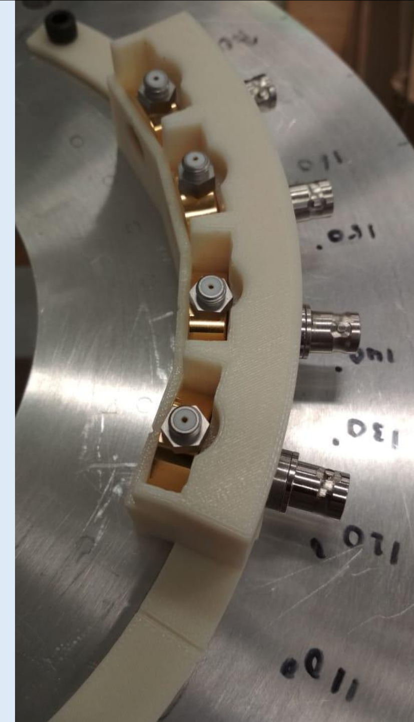


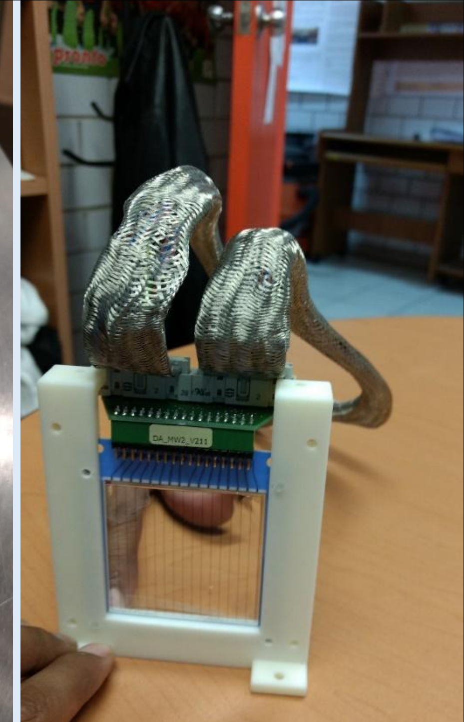




The charge particle array SIMAS

- SIstema Móvil de Alta Segmentación (high segmentation movil system) SIMAS.
- Though to be used principally at LEMA line but also at other facilities.

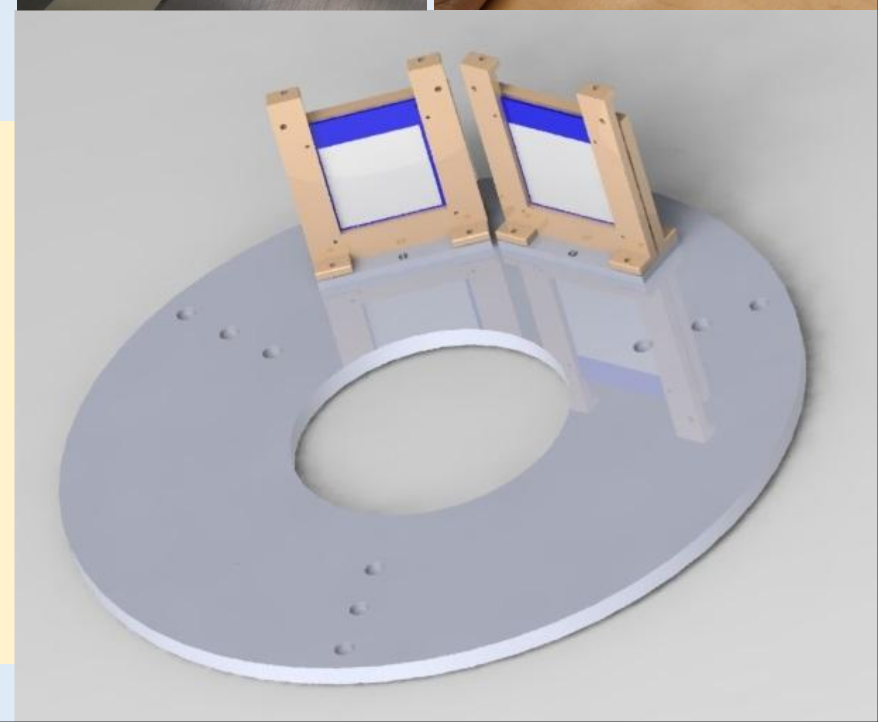




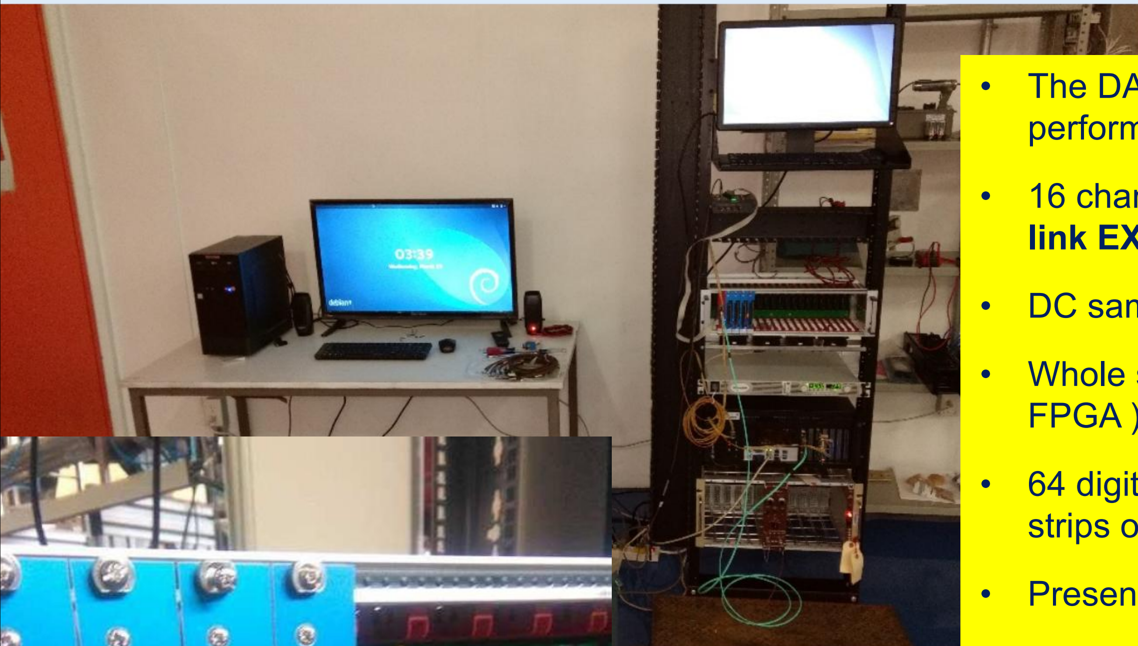
4 Double-sided silicon strip detectors (DSSSD) 20 micron. 16x16 strips, 5x5 cm^2 active area.
2 PAD (of 4), 130 micron. 5x5 cm^2 active area
Resolution FWHM ~ 20 keV.

4 single telescopes: ΔE = SB detector 15 µm (1x1 cm^2 active area). E = PIPS detector 300 µm (1x1 cm^2 active area) .

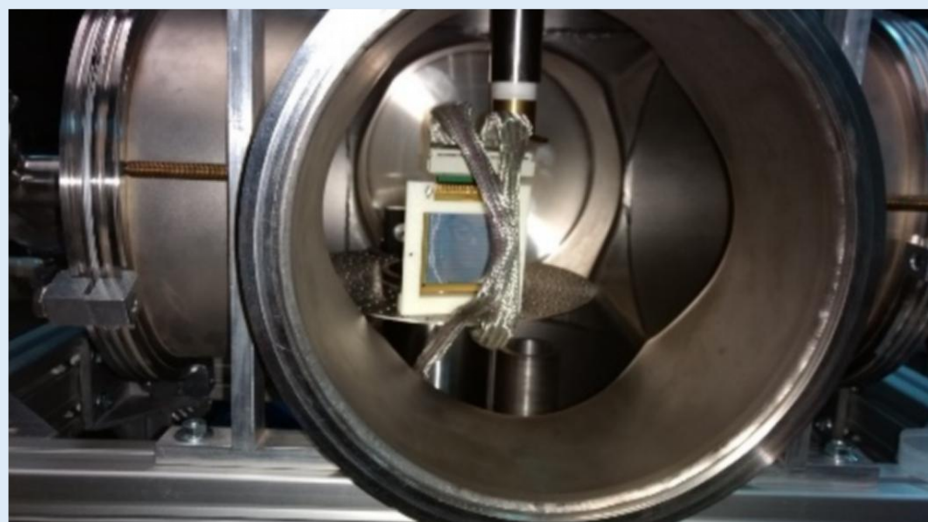
F. Morales and C. Flores-Vazquez



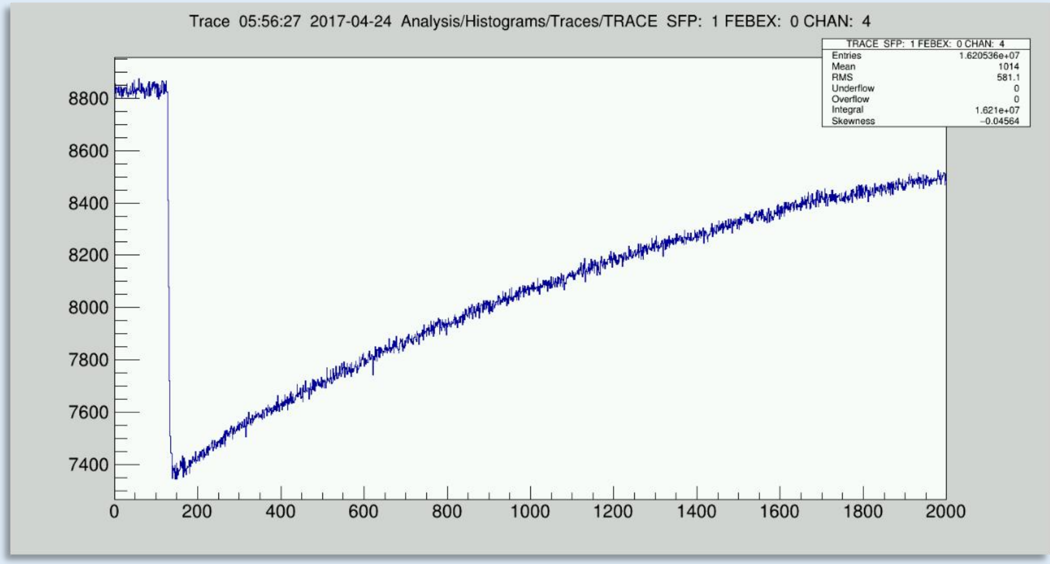
DAQ for SIMAS (FEBEX3-GSI/FAIR).



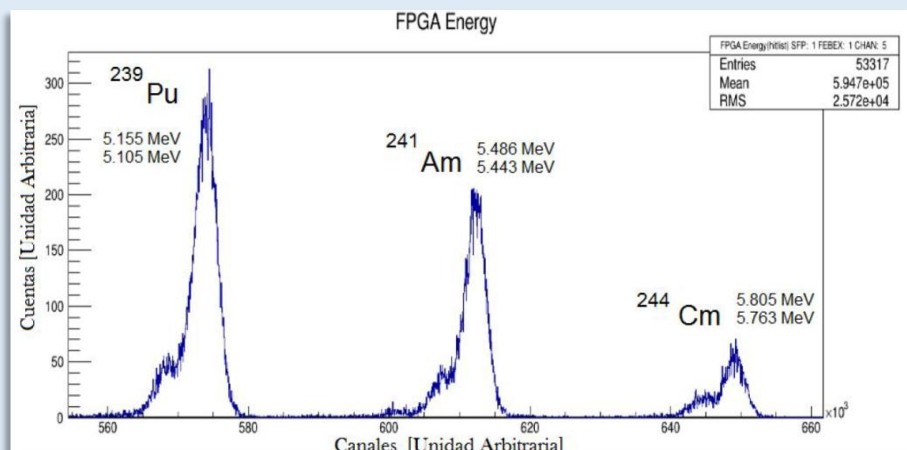
- The DAQ decided for SIMAS are FEBEX3 cards, performed by N.Kurz team at GSI.
- 16 channel pipeline ADC **Front End Board with optical link EXtension,** 60 MHz, 12 bit, Input -1V to +1V.
- DC sampling rate is max 65 Ms/s.
- Whole system PEXOR3 (Data collection, 600 MB/s FPGA) and TRIXOR (equivalent to TRIVA modules).
- 64 digitalization channels were tested by using a 32 strips of a DSSSD and a triple alpha source.
- Presently we have 128 operative channels.
- 16 channels Time digitizers (10 ps response).

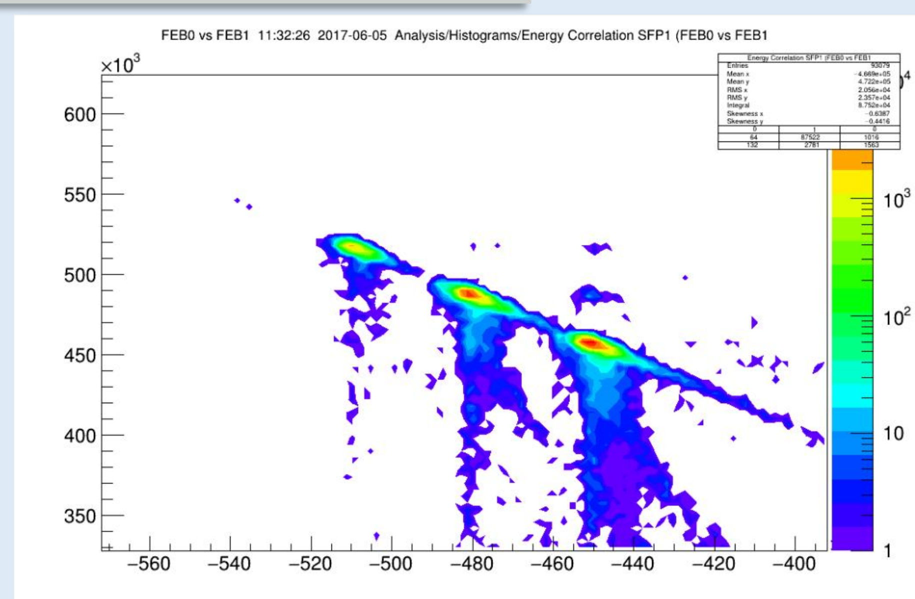


Energy spectra (using FEBEX-3).



Trace for a single strip





Matrix front-back for alpha source signal

FWHM: DSSSD = 29 keV. **Diploma Thesis: L. R. Ríos Álvarez**

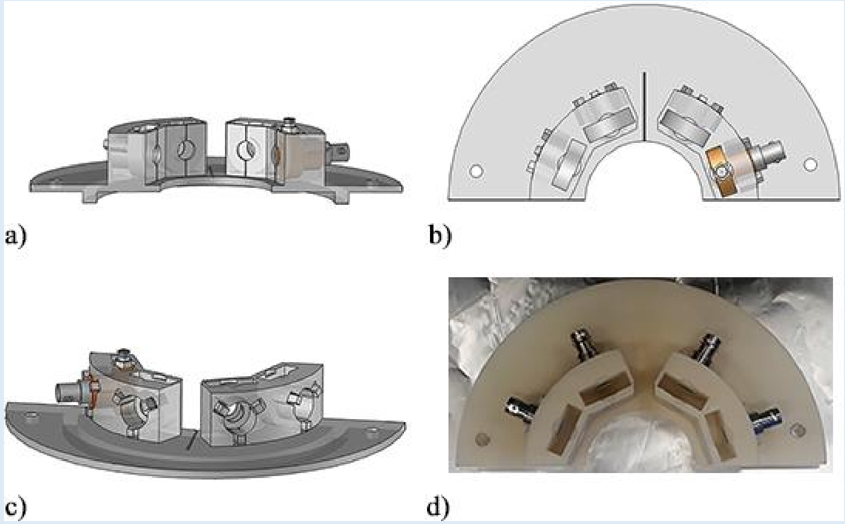
Triple alpha source on one DSSSD backward channel.

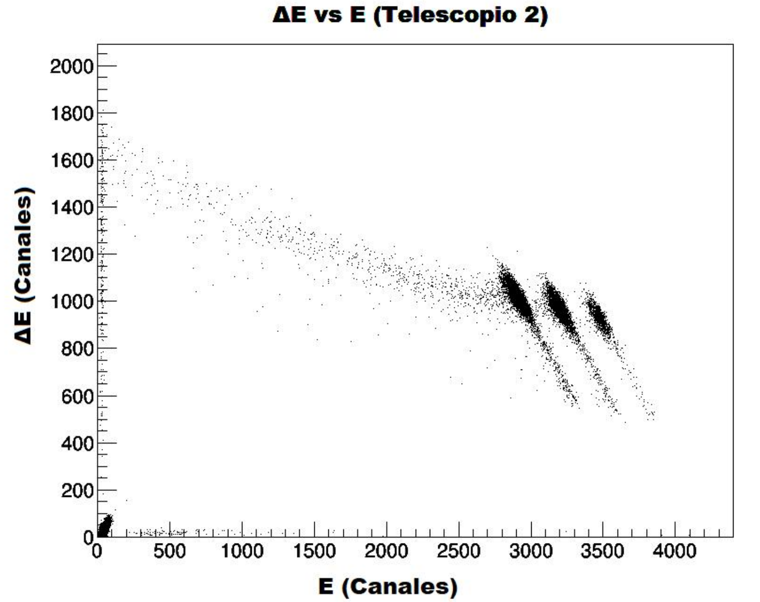
SIMAS commissioning (SB+PIPS)

$^{12}C+^{12}C$	$^{20}Ne+\alpha$	Q=4.62 MeV
$^{12}C+^{12}C$	$^{23}Na+p$	Q=2.24 MeV

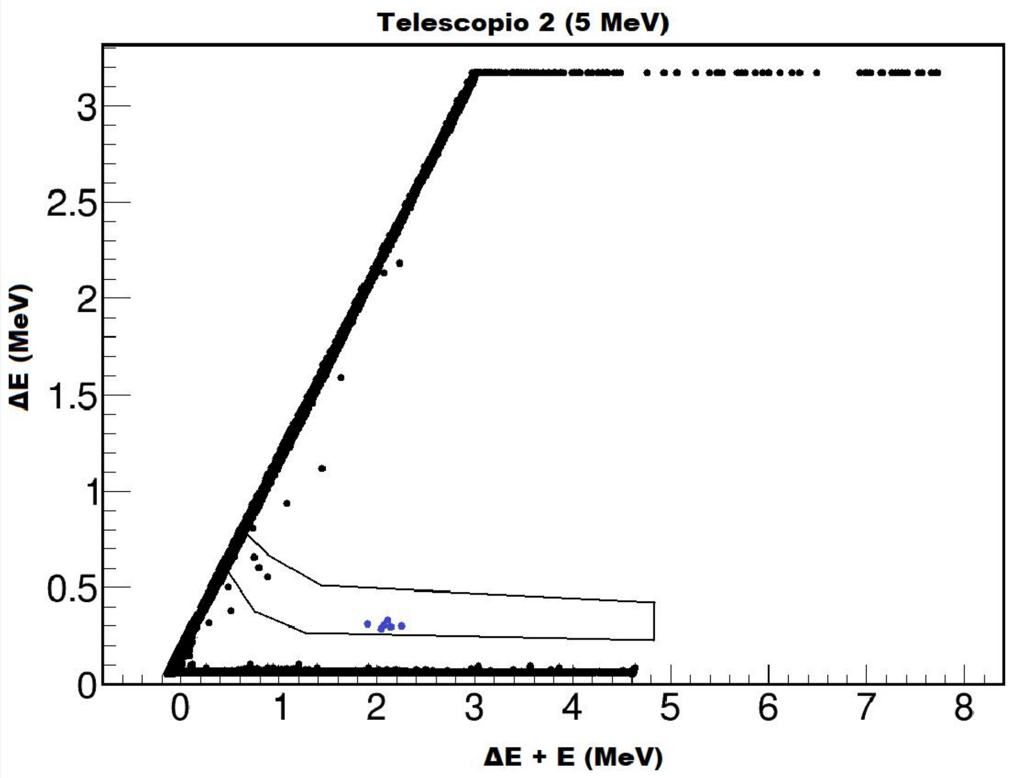
4 energies 7 days = 21 BTU

Luis Enrique Charón, Master Thesis



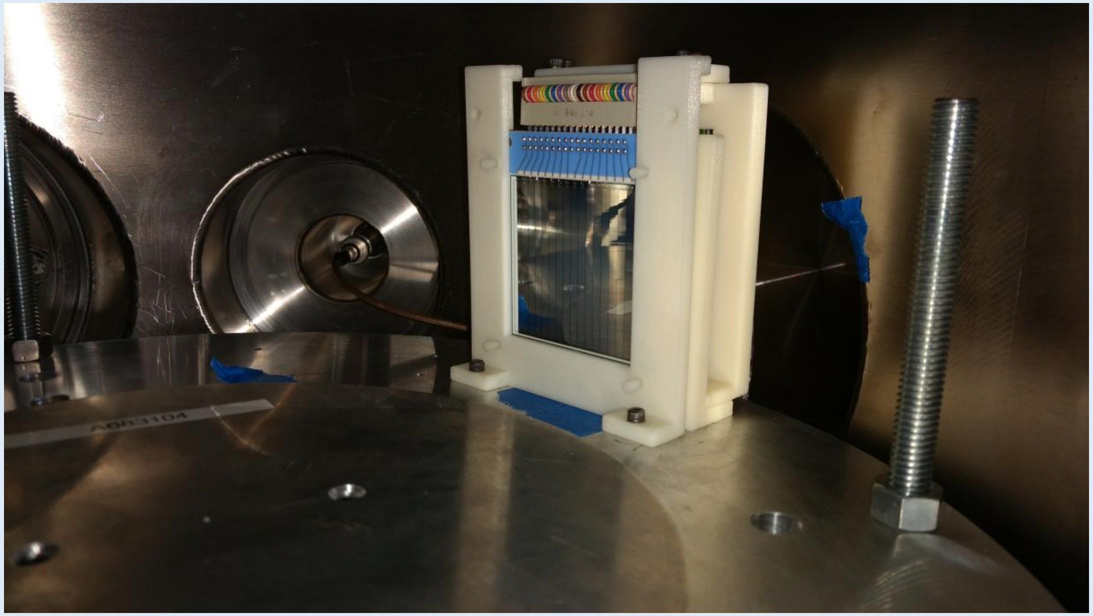


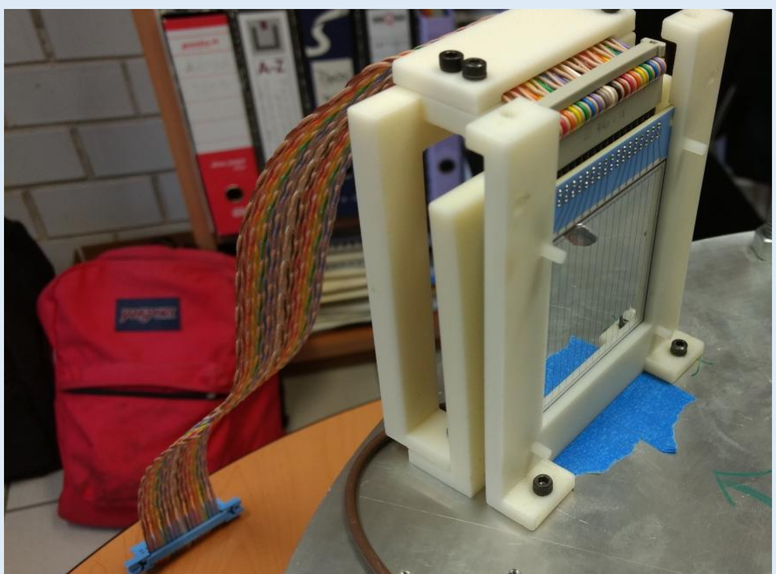
b)



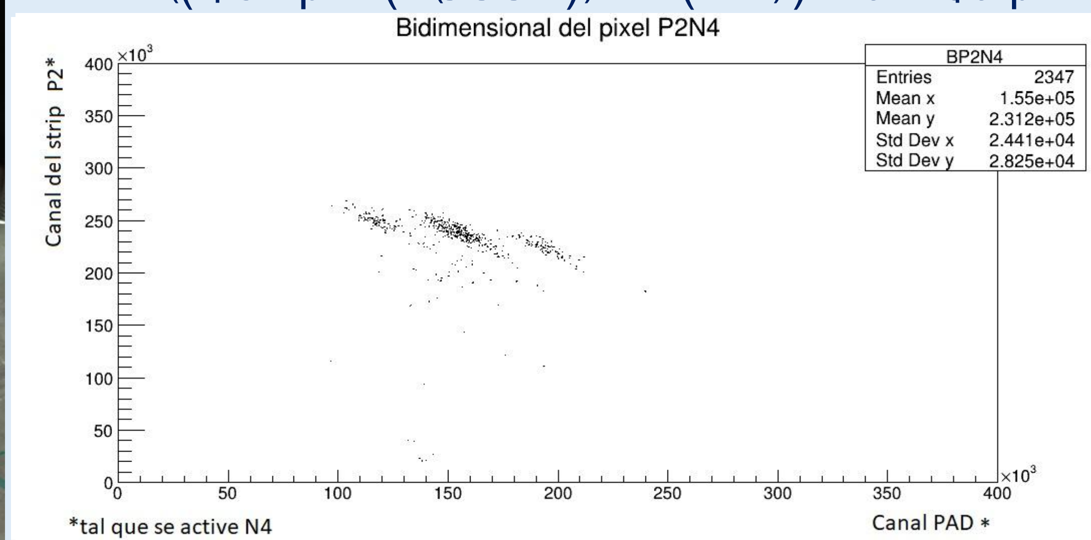
L.

SIMAS commissioning (DSSSD+PAD)





E-ΔE (1 strip P2 (DSSSD) + E (PAD)): 20+130 μm



SIMAS: a good array to launch again experiments with exotic beams (ININ-Notre Dame Collaboration).

Many years collaborating with ND

(Aguilera-Kolata)

2010

PRL **107,** 092701 (2011) PHYSICAL REVIEW LETTERS week ending 26 AUGUST 2011

Near-Barrier Fusion of the ^{8}B + ^{58}Ni Proton-Halo System

E. F. Aguilera,* P. Amador-Valenzuela, E. Martinez-Quiroz, D. Lizcano, P. Rosales, H. García-Martínez, and A. Gómez-Camacho
Instituto Nacional de Investigaciones Nucleares, Apartado Postal 18-1027, DF-11801, México

J. J. Kolata, A. Roberts, L. O. Lamm,† and G. Rogachev‡
Physics Department, University of Notre Dame, Notre Dame, Indiana, 46556-5670, USA

V. Guimarães
Instituto de Fisica, Universidade de Sao Paulo, P. O. Box 66318, 05389-970, Sao Paulo, SP, Brazil

F. D. Becchetti, A. Villano,§ M. Ojaruega, M. Febbraro, Y. Chen, and H. Jiang
Physics Department, University of Michigan, Ann Arbor, Michigan, 48109-1120, USA

P. A. DeYoung, G. F. Peaslee, C. Guess, and U. Khadka
Hope College, Holland, Michigan, 49422-9000, USA

J. Brown
Physics Department, Wabash College, P.O. Box 353, Crawfordsville, Indiana, 47933, USA

J. D. Hinnefeld
Physics Department, Indiana University South Bend, South Bend, Indiana, 46694-7111, USA

L. Acosta
Universidad de Huelva, E-21071 Huelva, Spain and LNS-INFN, I-95123 Catania, Italy

E. S. Rossi Jr
UNIFIEO-Centro Universitário FIEO-CEP 06020-190, Osasco-SP, Brazil

J. F. P. Huiza
Departamento de Química e Exatas, Universidade Estadual do Sudoeste da Bahia, 45206-190 Bahia, Brazil

T. L. Belyaeva
Universidad Autónoma del Estado de México, Código Postal 50000, Toluca, México
(Received 20 May 2011; published 24 August 2011)

Gathering new and old generations for new experiments

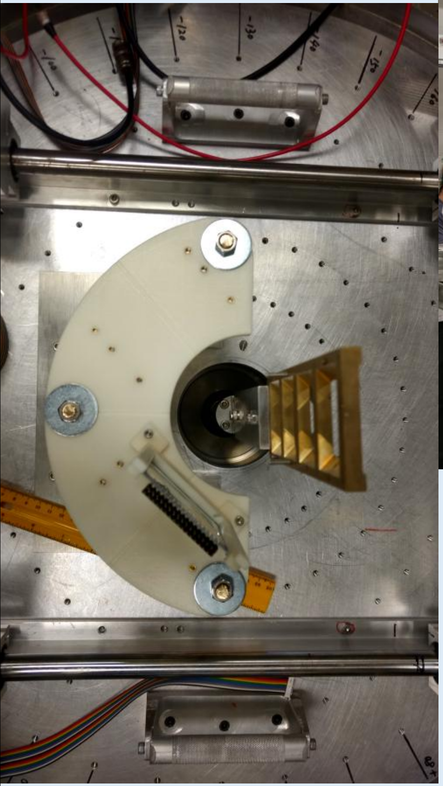
(A. Pakou, J. Kolata, L. Acosta, A.M. Sánchez, P. O’ Malley and E. Aguilera)

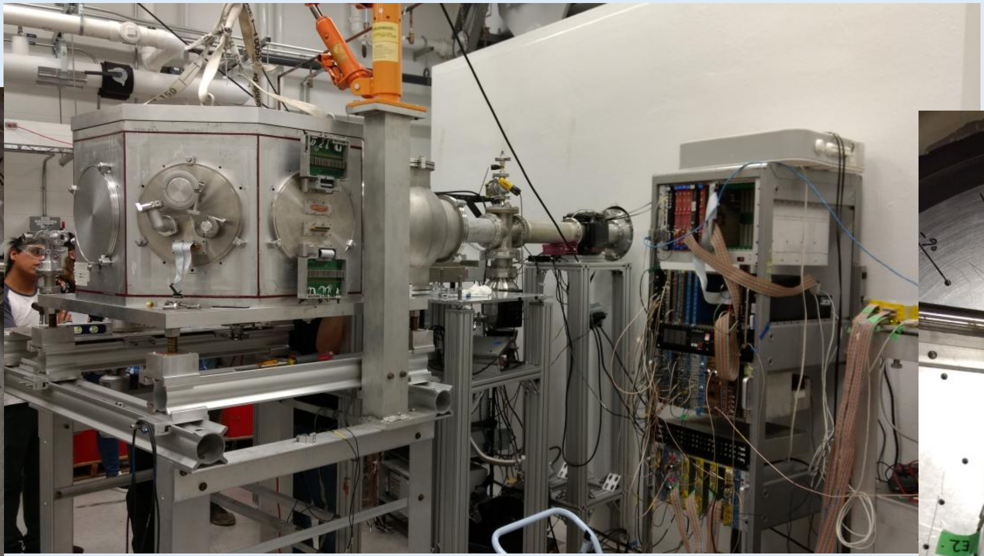
2019

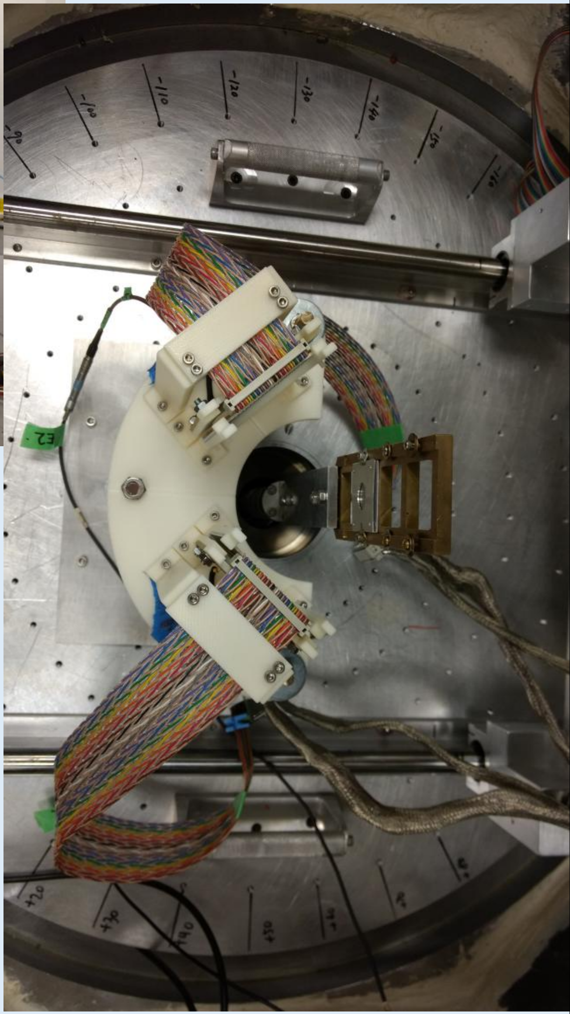
2022

2023

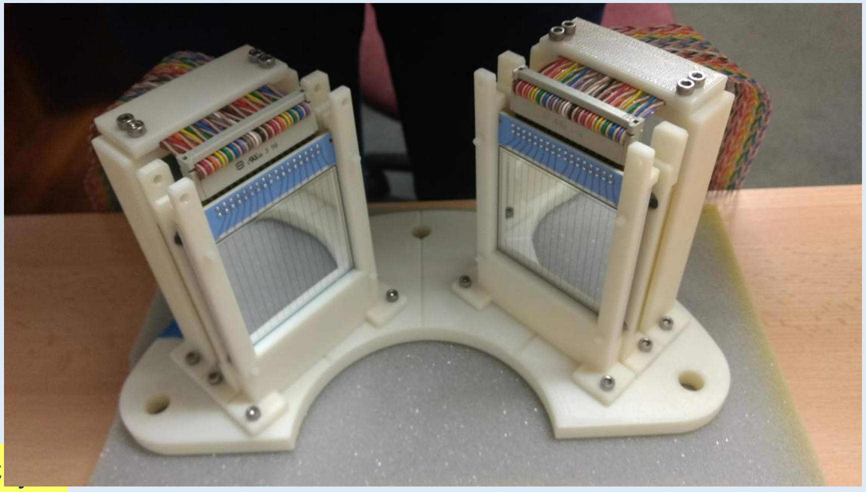
TwinSol Reaction chamber + SIMAS



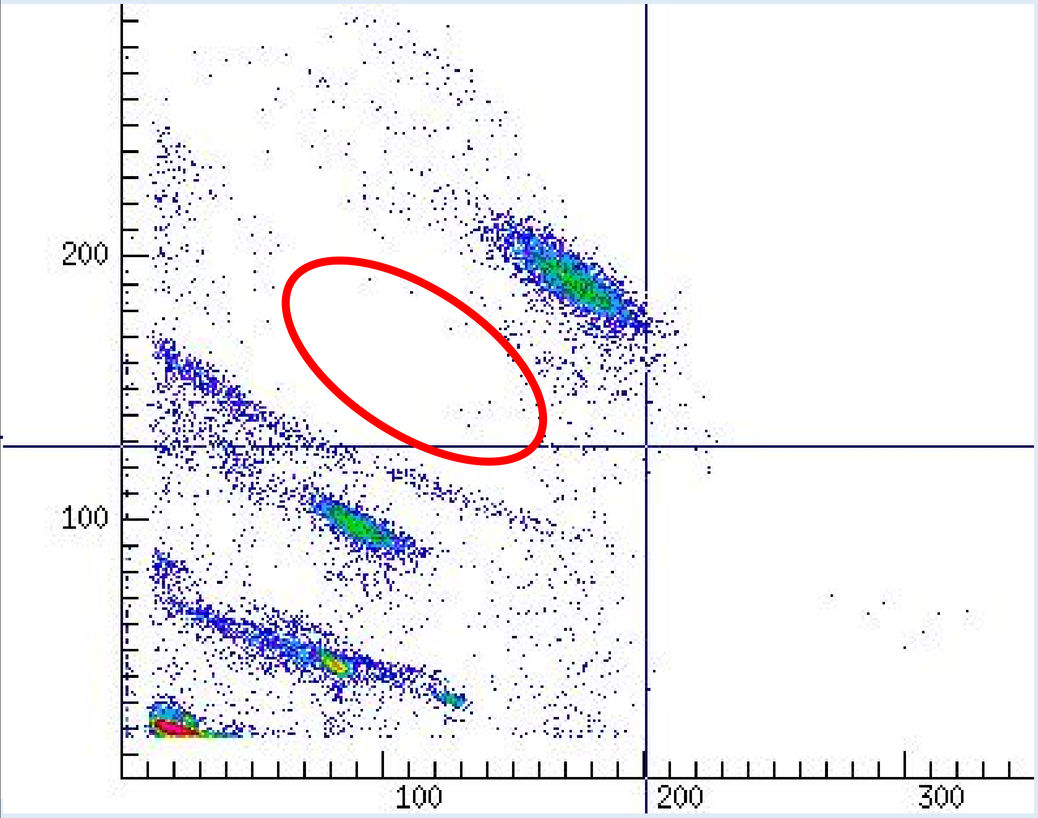


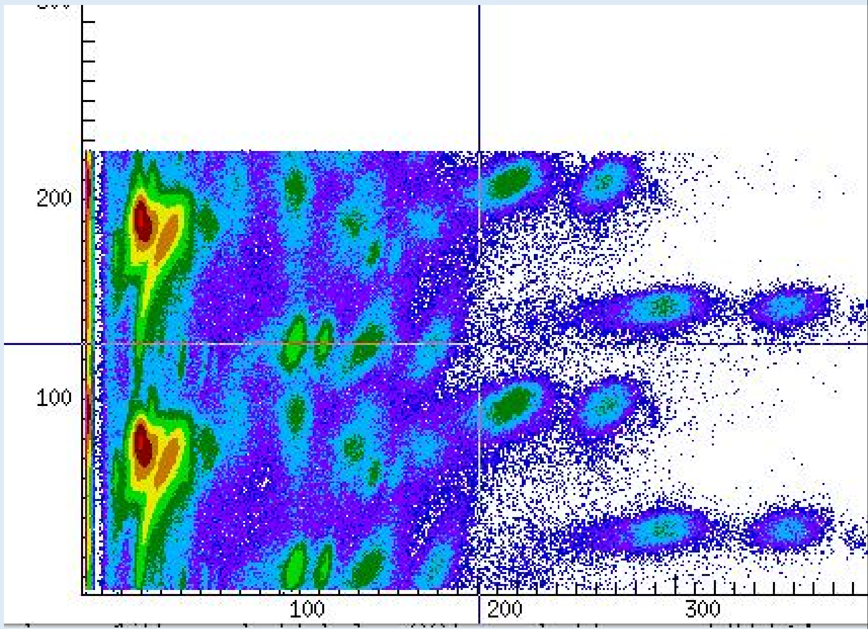


Fusion hindrance at sub-barrier energies for weakly bound nuclei on heavy targets: the ^{8}B + ^{208}Pb case. **A. Pakou, J. Kolata, L. Acosta et. al., (TwinSol, Notre Dame, August'19)**

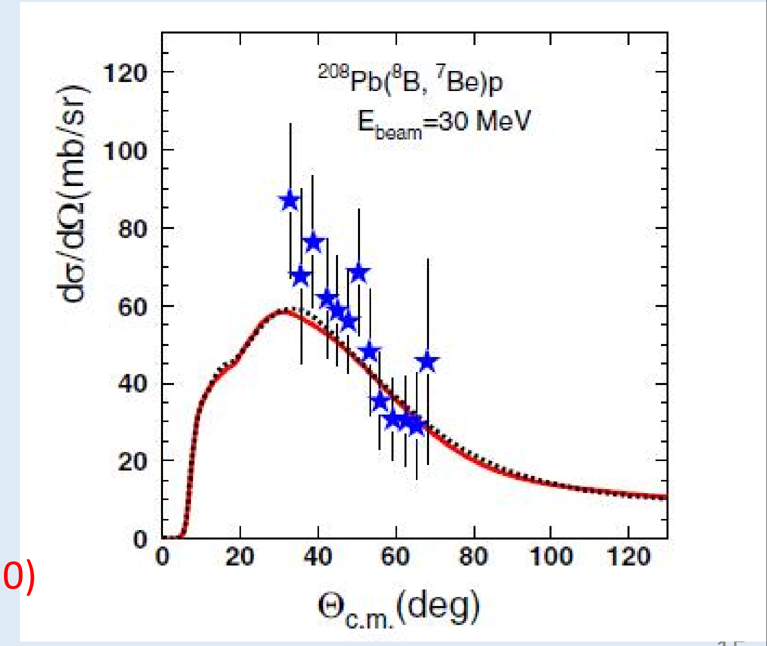


Analysis on-line, and results.





ToF Spectrum 2 days of ^{8}B beam

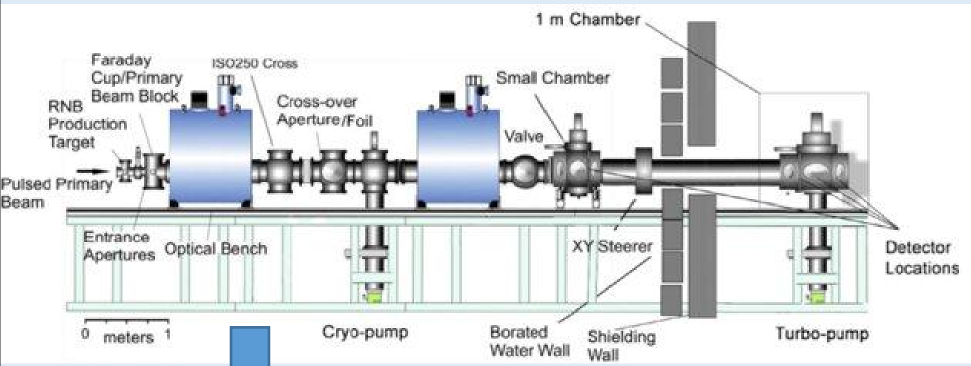


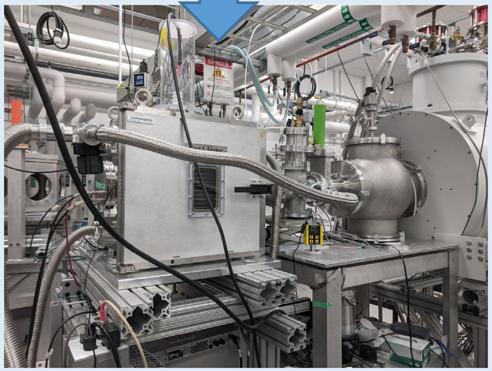
ΔE-E Spectrum, 2 days of ^{8}B beam
(ToF filter for ^{7}Be)

A. Pakou, L. Acosta, P. D. O'Malley et. al., PRC 102, 031601(R) (2020)

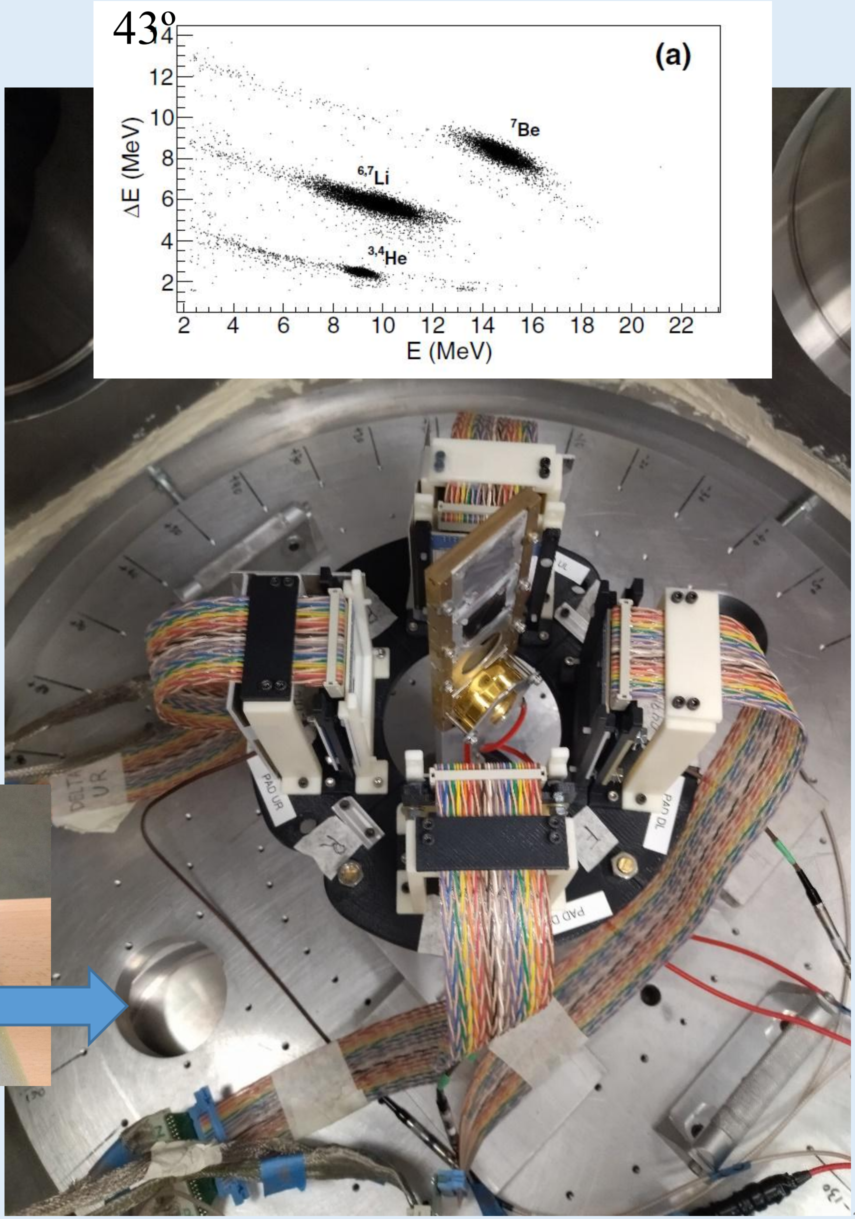
2nd measurement NDU (2022)

- "Reaction mechanisms at sub - barrier energies for weakly bound nuclei : the ^{8}B + ^{90}Zr case".
- Grouping Mexican and Spanish telescopes (20+130 micrón DeltaE-E).
- 1st ^{8}B experiment of TriSol Facility with 4 SIMAS telescopes.

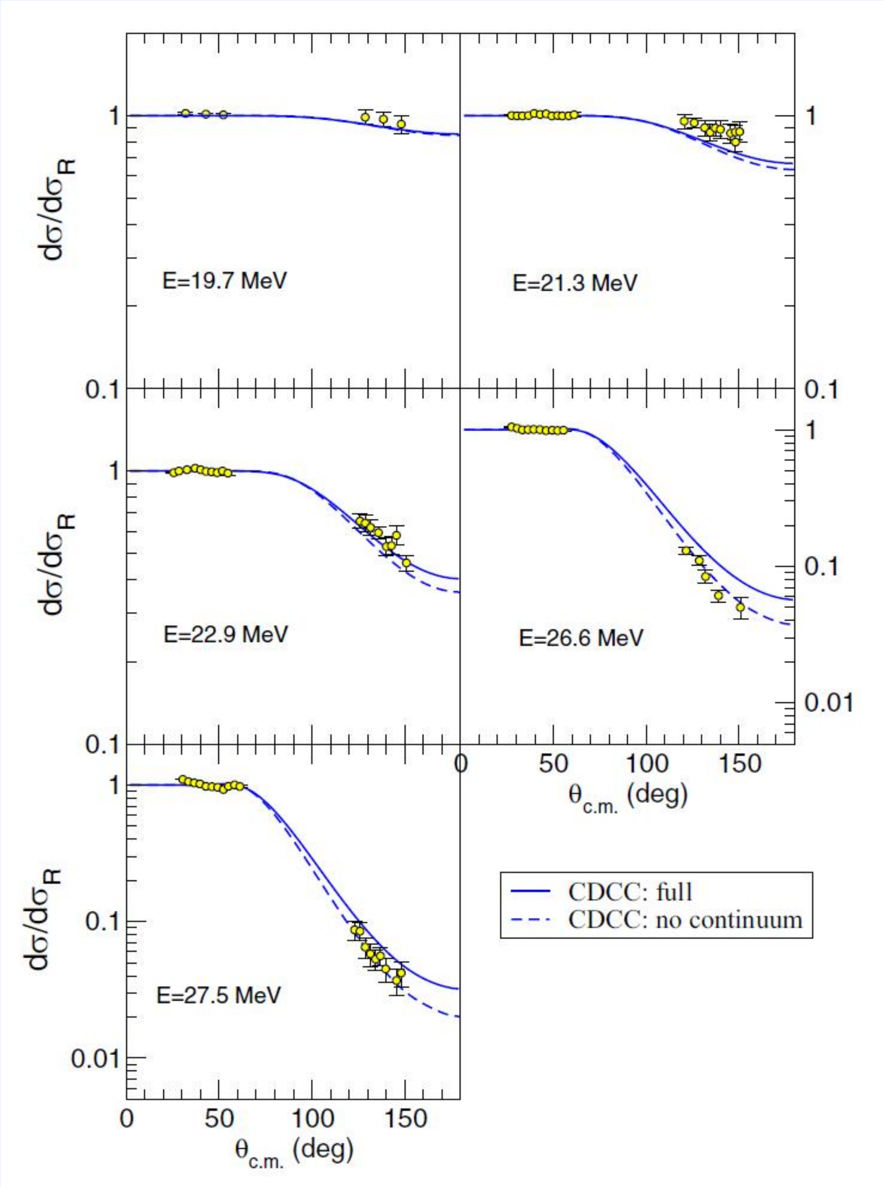




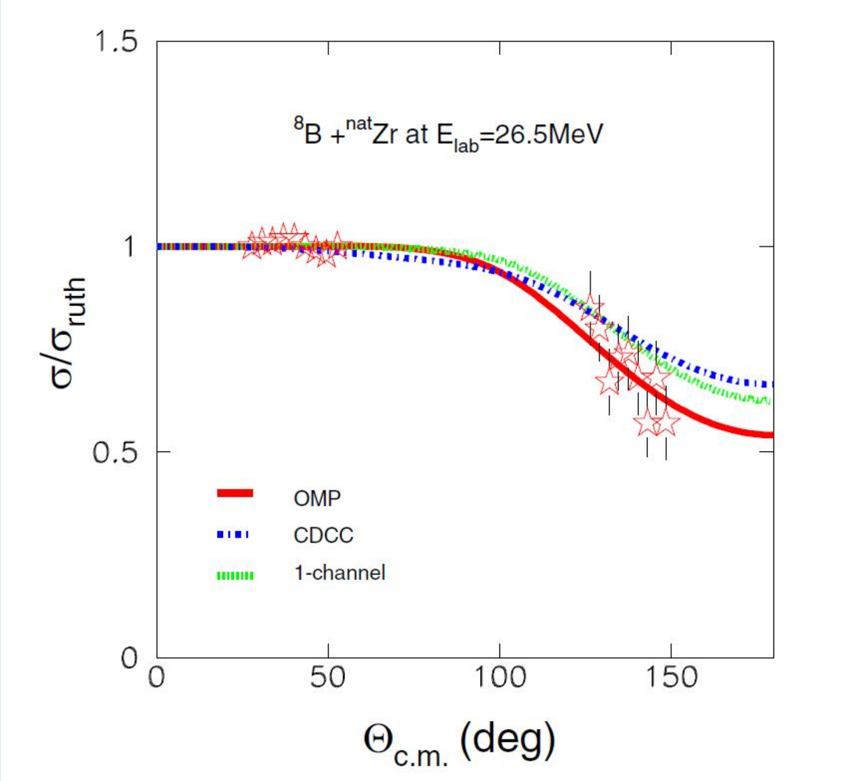
$^{7}Be+_{nat}Zr$ E_{proj} = 23.7 MeV θ_{lab} = 43º



Experimental results for ^{7}Be and ^{8}B on ^{nat}Zr at different energies

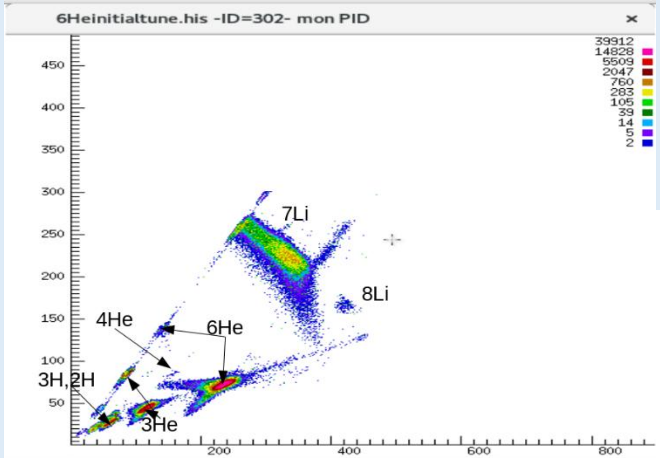


K. Palli, A. Pakou, A. M. Moro, P. D. O'Malley, L. Acosta, A. M. Sánchez-Benítez, G. Souliotis, E. F. Aguilera, E. Andrade, D. Godos, O. Sgouros, V. Soukeras, et. al., PRC 107, 064613 (2023).

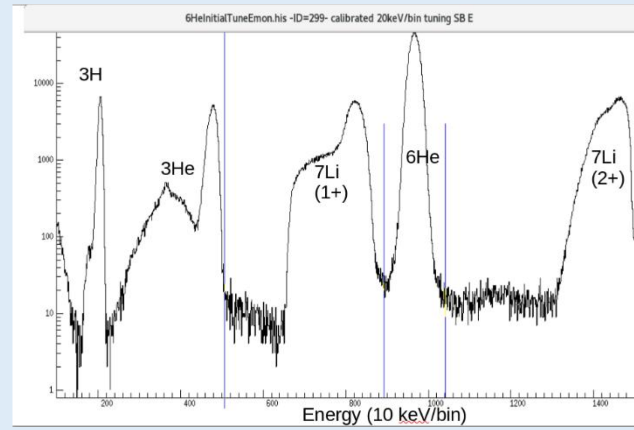


K. Palli, A. Pakou, P. D. O'Malley, L. Acosta, A. M. Sánchez-Benítez, G. Souliotis , A. M. Moro, E. F. Aguilera, E. Andrade, D. Godos, O. Sgouros, V. Soukeras et. al., PRC **109**, 064614 (2024)

^{6}He + ^{208}Pb @ 19 MeV (TriSol 2023)



- TriSol Facility, Nuclear Science Laboratory University of ND (USA)
- 70 mm (16 SSSSD) + 1000 mm (PAD) wedge telescopes (6 of them)
- Reaction used to produce ^{6}He is ^{7}Li(d,^{3}He)^{6}He
- Mesuring the direct breakup at very forward angles, 10-30 deg)



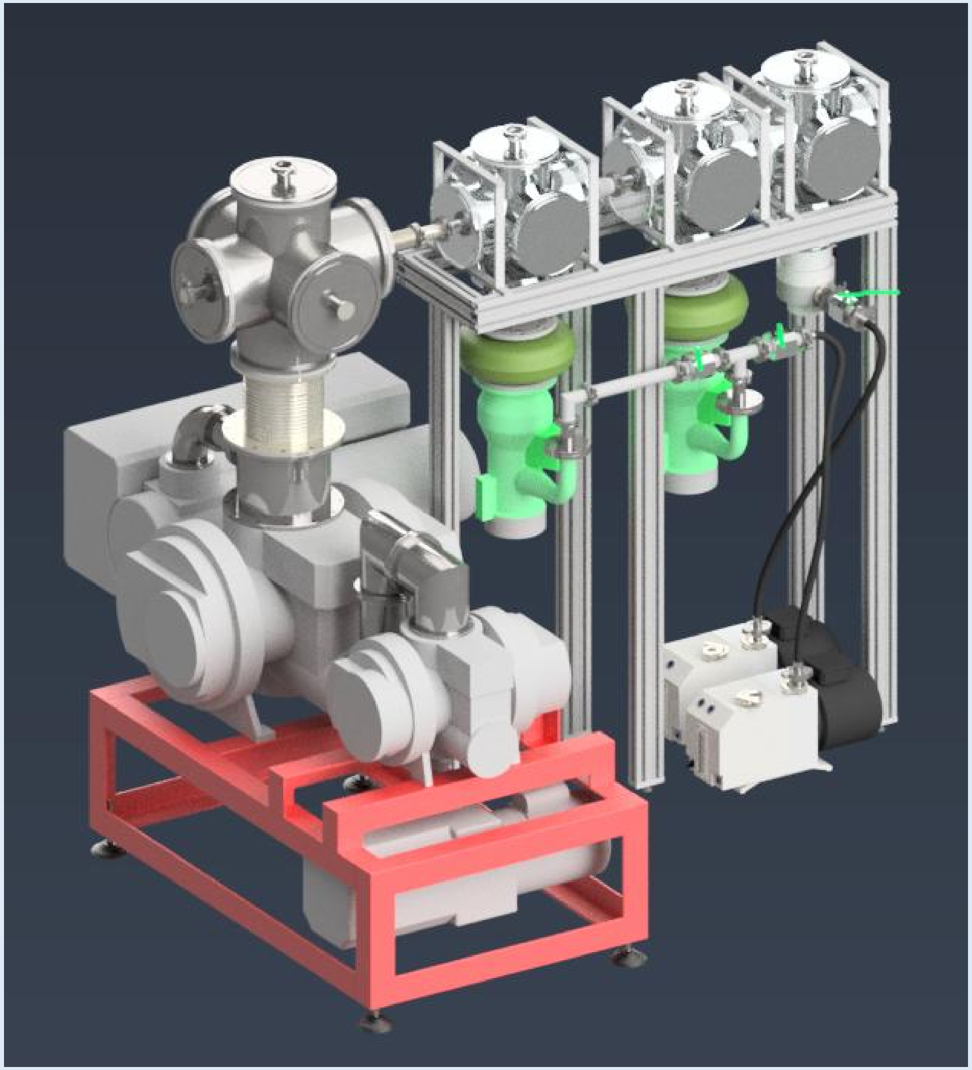
Promising analysis in progress!!!

1st IANNA-IReNA Workshop June 9-11 ‘24

The SUGAR gas-jet Target and the SUGAR@LNL Project

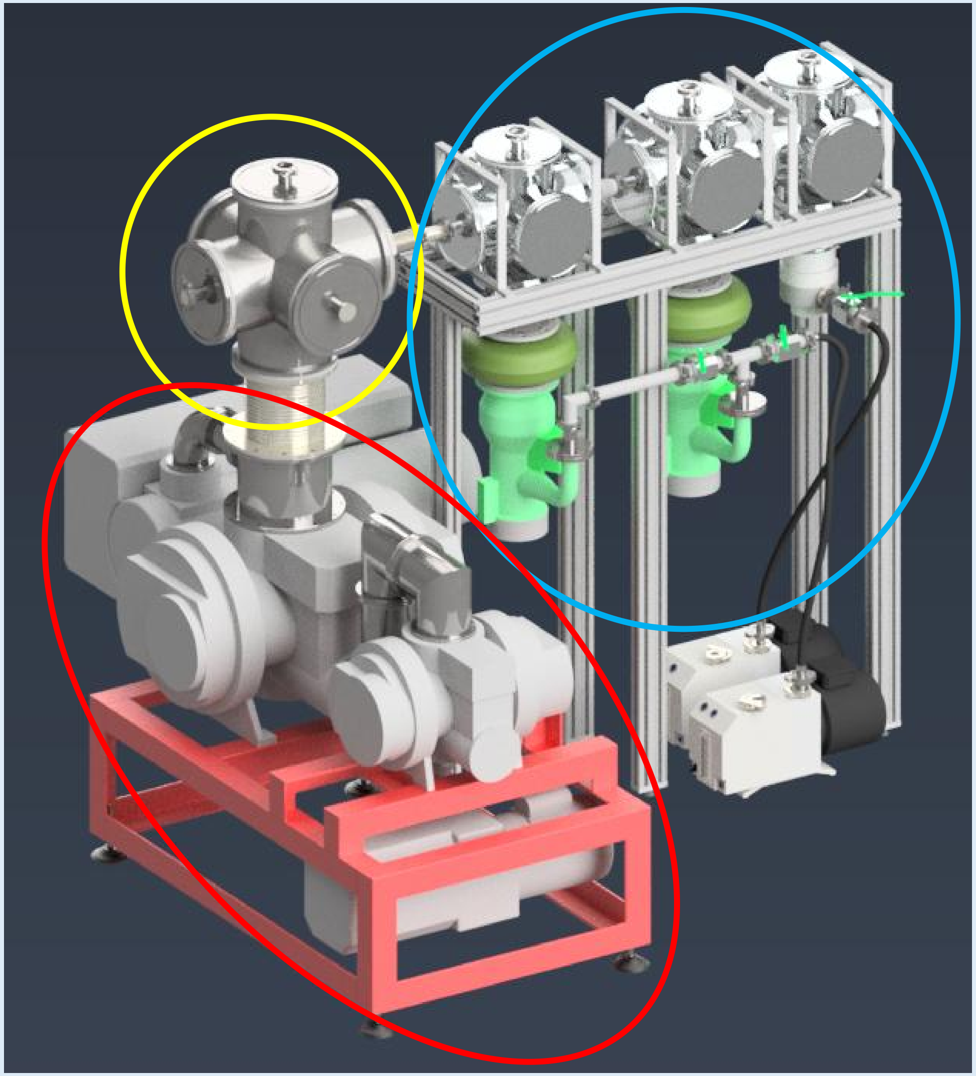
SUGAR, the Mexican Jet target

- SUGAR (**SUpersonic GAs jet taRget**) is a device developed at IFUNAM, Mexico City, commissioned in 2015.
- Such system has the capability to produce a gas target at supersonic velocities.
- The gas is continuously going in and going out of a reaction chamber, thank to a robust pumping system.
- A differential vacuum system allow the enough conditions to maintain the reaction chamber (jet chamber) in windowless mode.



Components:

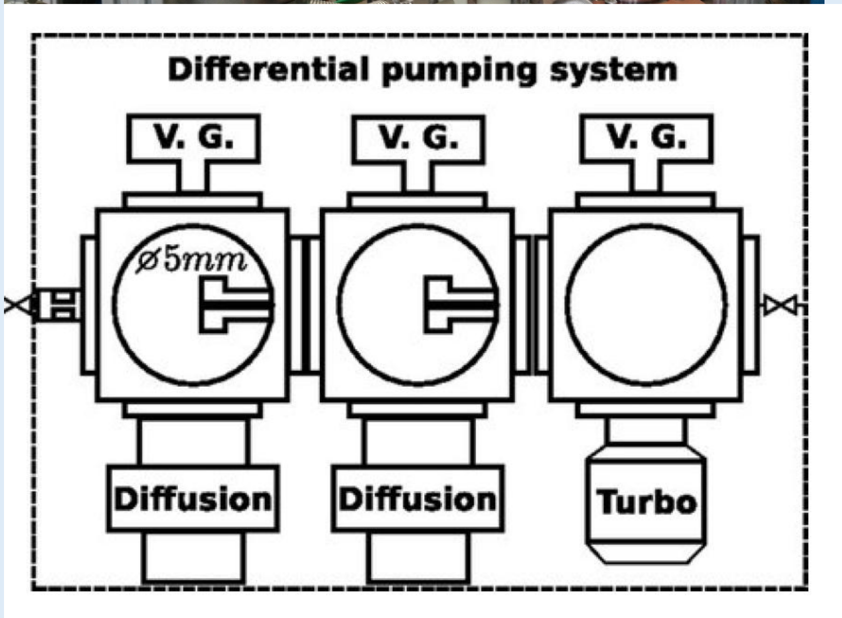
- Differential vacuum system.
- Jet Chamber.
- Jet pumping system.



How it works?

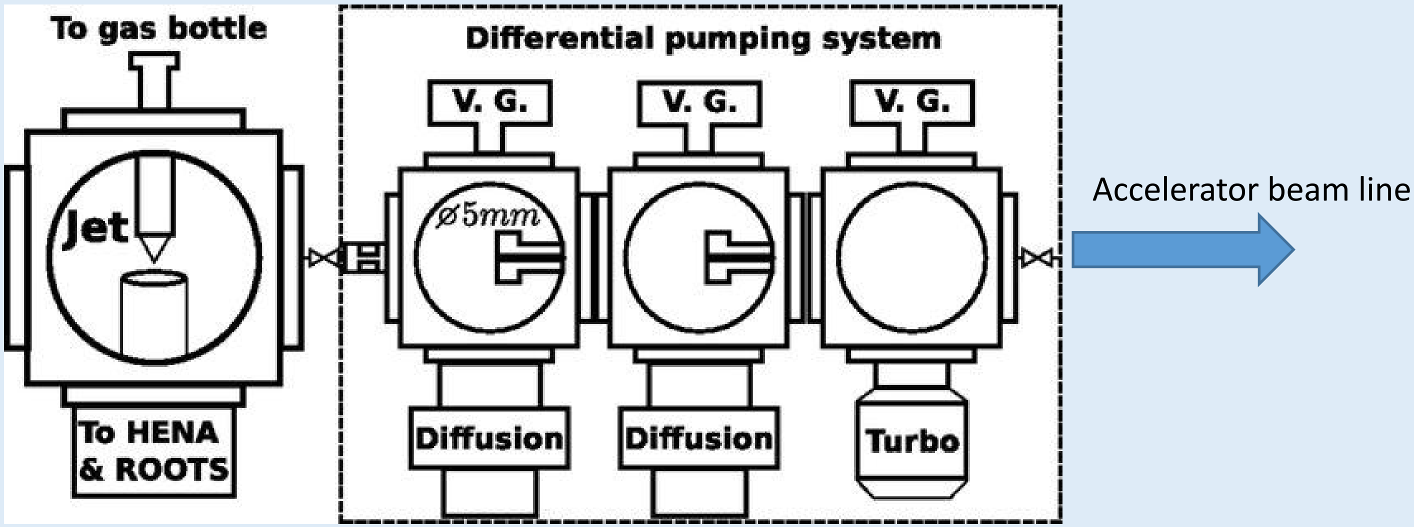
- Differential vacuum system is a train of 3 LF200 chambers connected to a turbo (ALCATEL ATP 400 l/s) and 2 high speed diffusion pumps (Varian M6 1200 l/s each).

- The interconnection among each chamber are small KF40 nipples (collimated till 5 mm), mounted inside each chamber.



- Jet chamber is immediately connected to the third D.V. chamber, with a KF40 nipple internally collimated to 5 mm.

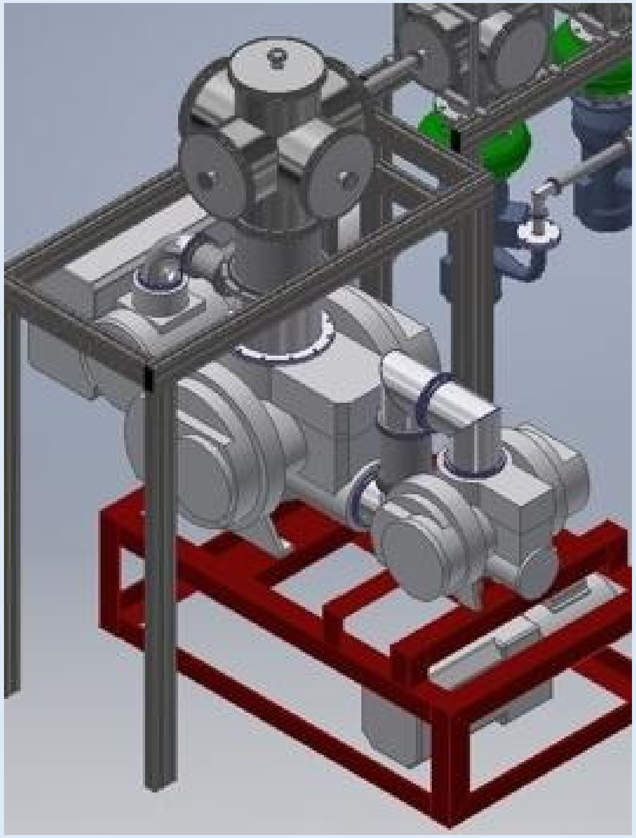
- Jet chamber and D.V.S. are separated by a gate valve (as well D.V.S with accelerator beam line), in order to start the vacuum process separately.

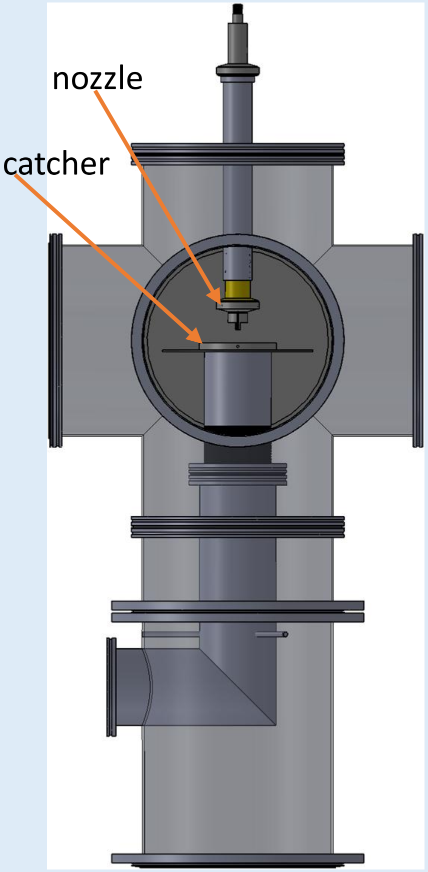


- Gas jet target is controlled by a specific pumping system:

- A high-speed mechanical pump (66 l/s Pfeiffer Hena 200) is connected to the central region of the scattering chamber (the catcher).
  - This pump removes most of the gas coming out from the nozzle (the upper part that completes the system).

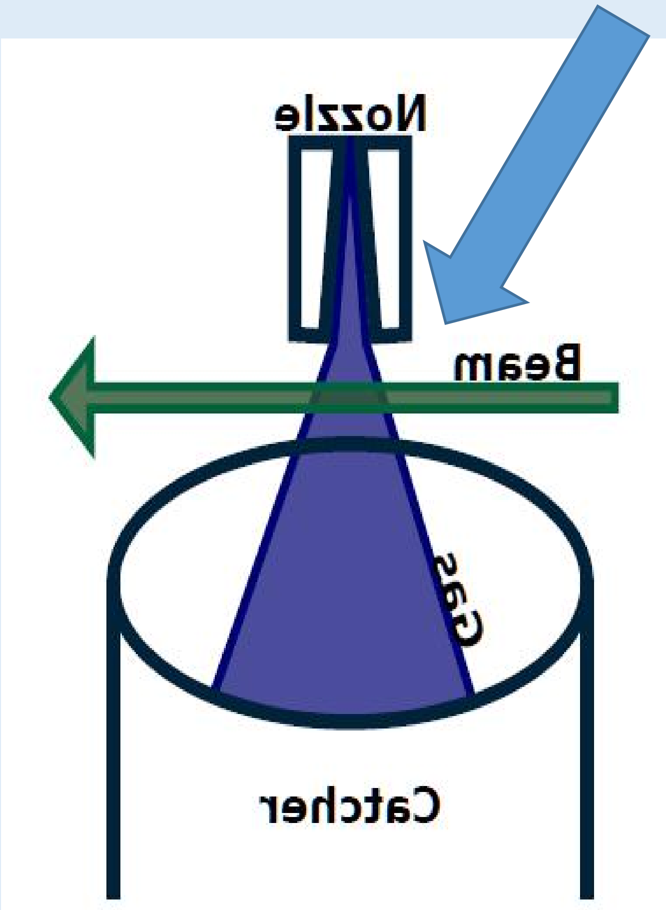
- Gas spilling out of the catcher into the scattering chamber is pumped out from the bottom by a large (13 kW) high speed roots pump (Pfeiffer WKP 4000 AM, 1400 l/s),
- backed up by a second roots pump (Pfeiffer WKP 1000 AM, 350 l/s) which in turn is
- backed up by a mechanical pump (Pfeiffer Hena 60, 20 l/s).



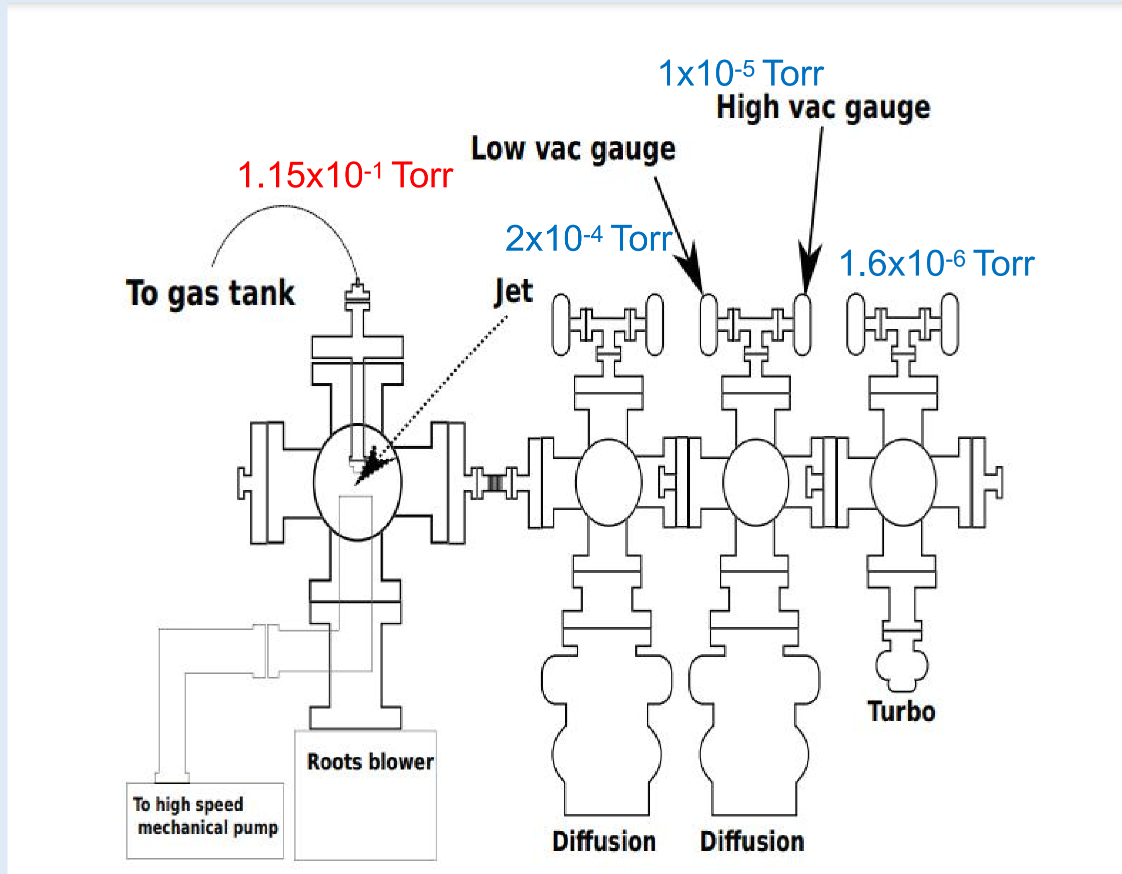


- Once the pressure in the scattering chamber is around 0.1 Torr, the valve between the scattering chamber and the differential pumping system can be opened.

JET

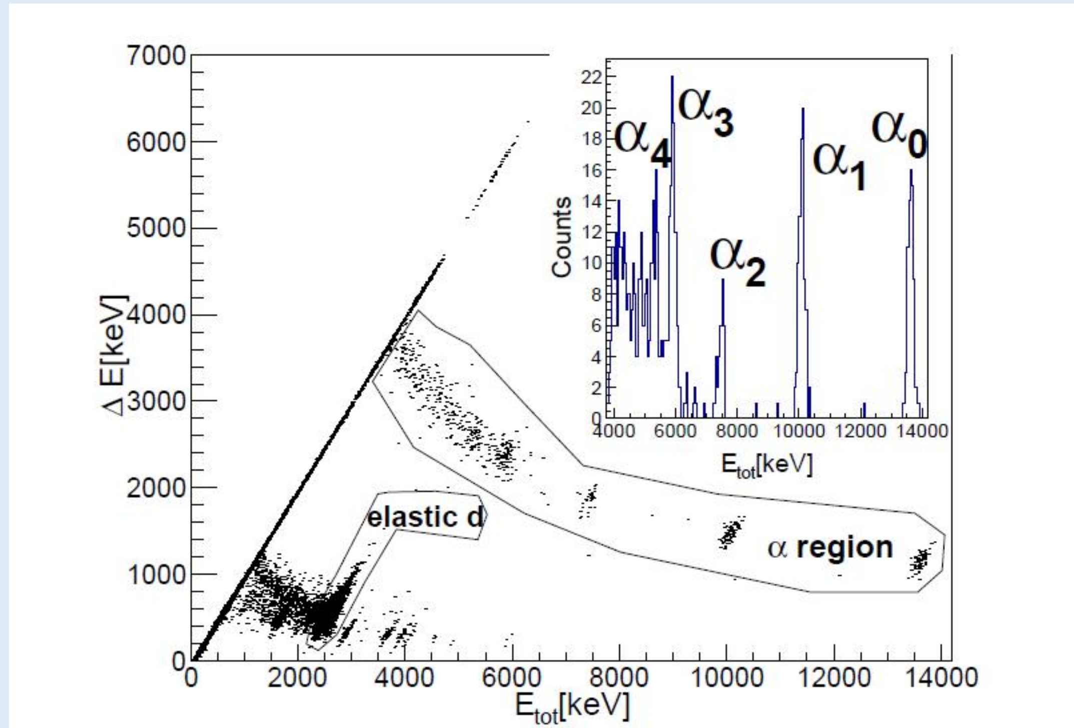


1 Torr = 1.33 mbar



Results of SUGAR commissioning

- Deuterium beam 1-3 MeV on air jet target. Pressure = 1 atm. (5.5 Van der Graaff)
- E-ΔE Telescope (60 μm + 11 μm) a θ_{lab} = 35°
- To study the reaction $^{14}N(d,\alpha)^{12}C$.
- Typical ΔE-E spectrum 2.51 MeV
- Target thickness = 10^{18} atoms/cm^2
- Projection energy resolution = 200 keV



PHYSICAL REVIEW SPECIAL TOPICS—ACCELERATORS AND BEAMS 18, 123502 (2015)

New supersonic gas jet target for low energy nuclear reaction studies

F. Favela,[1] L. Acosta,[1,2] E. Andrade,[1] V. Araujo,[1] A. Huerta,[1] O. G. de Lucio,[1] G. Murillo,[3] M. E. Ortiz,[1] R. Policroniades,[3] P. Santa Rita,[1] A. Varela,[4] and E. Chávez[1]

SUGAR @ LNL

In the framework of the March'19 meeting at Legnaro, called "AGATA@LNL", we presented a Letter of Intent searching the use of SUGAR as part of the scientific program of AGATA. Coupling NEDA and a silicon array. This would be a unique opportunity to measure charge particles, gamma and neutrons simultaneously, using a thin pure target.

The Supersonic jet Gas Target SUGAR, an alternative to measure reactions with pure thin targets.

D.J. Marín-Lambarrí[1], L. Acosta[1], E. Chávez-Lomelí[1], L. Barrón-Palos[1], A. Huerta[1], C. Flores-Vázquez[2], F. Favela[3], J. Valiente-Dobón[4], D. Mengoni[5,6], I. Lombardo[7], D. Dell'Aquila[8], A.M. Sánchez-Benítez[9] and T. Kurtukian-Nieto[10].

1. Instituto de Física, Universidad Nacional Autónoma de México, Mexico.

2. Facultad de Ingeniería, Universidad Nacional Autónoma de México, Mexico.

3. Instituto de Ciencias Nucleares, Universidad Nacional Autónoma de México, Mexico.

4. Laboratori Nazionali di Legnaro, Istituto Nazionale di Fisica Nucleare, Italy.

5. Università degli Studi di Padova, Italy.

6. Istituto Nazionale di Fisica Nucleare, Sezione di Padova, Italy.

7. Istituto Nazionale di Fisica Nucleare, Sezione di Catania, Italy.

8. National Superconducting Cyclotron Laboratory (NSCL), Michigan State University.

9. Depto. de Ciencias Integradas. Universidad de Huelva, Spain.

10. Centre D'Études Nucléaires de Bordeaux-Gradignan, France.

Physics case proposed: $^{16}O+^{16}O$

T. Kurtukian-Nieto, A.M. Sánchez-Benítez, L. Acosta

The ^{16}O + ^{16}O fusion reaction is a key reaction for the later oxygen burning phase of massive stars, influencing also the carbon burning phase.

The nucleosynthesis during carbon and oxygen burning depends not only on the $^{16}O+^{16}O \rightarrow {}^{32}S$ reaction rate but also on the branching between proton, neutron, or alpha decay channels of the fused compound nucleus.

Nuclear burning stages

(e.g., 20 solar mass star)

Fuel	Main Product	Secondary Product	T (10^9 K)	Time (yr)	Main Reaction
H	He	^{14}N	0.02	10^7	$4\,H \xrightarrow{CNO} {}^4He$
He	O, C	^{18}O, ^{22}Ne s-process	0.2	10^6	$3\,He^4 \rightarrow {}^{12}C$ $^{12}C(\alpha,\gamma)^{16}O$
C	Ne, Mg	Na	0.8	10^3	$^{12}C + {}^{12}C$
Ne	O, Mg	Al, P	1.5	3	$^{20}Ne(\gamma,\alpha)^{16}O$ $^{20}Ne(\alpha,\gamma)^{24}Mg$
O	Si, S	Cl, Ar, K, Ca	2.0	0.8	$^{16}O + {}^{16}O$
Si	Fe	Ti, V, Cr, Mn, Co, Ni	3.5	0.02	$^{28}Si(\gamma,\alpha)$...

Courtesy of K. Langanke

Major reaction sequences:

$$^{16}O + {}^{16}O \rightarrow {}^{32}S^* \rightarrow {}^{31}S + n + 1.45\ \mathrm{MeV} \quad (5\%)$$
$$\rightarrow {}^{31}P + p + 7.68\ \mathrm{MeV} \quad (56\%)$$
$$\rightarrow {}^{30}P + d - 2.41\ \mathrm{MeV} \quad (5\%)$$
$$\rightarrow {}^{28}Si + \alpha + 9.59\ \mathrm{MeV}. \quad (34\%)$$

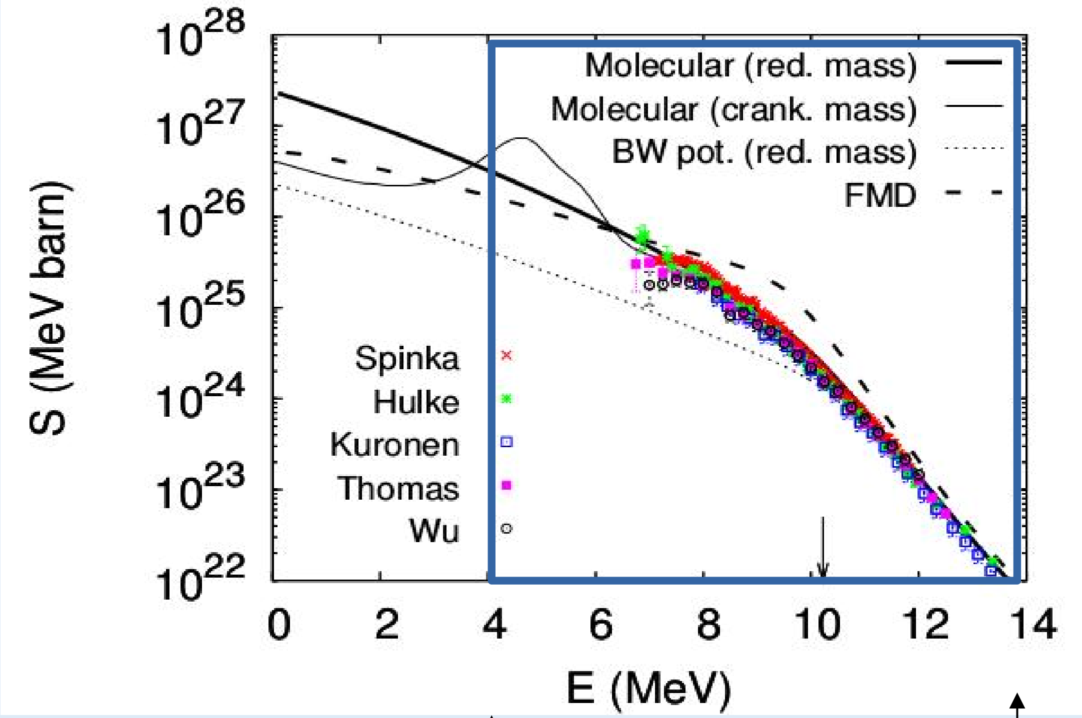
plus recapture of n,p,d,α

Main products:

^{28}Si,^{32}S (90%) and some $^{33,34}S$,$^{35,37}Cl$,$^{36.38}Ar$, $^{39,41}K$, $^{40,42}Ca$

Previous works on $^{16}O+^{16}O$ (Theor & Exp)

Int. J. Mod. Phys. E 2008.17:2194-2198



1< T9 < 4

- Dynamics of fusion at sub-barrier energies.

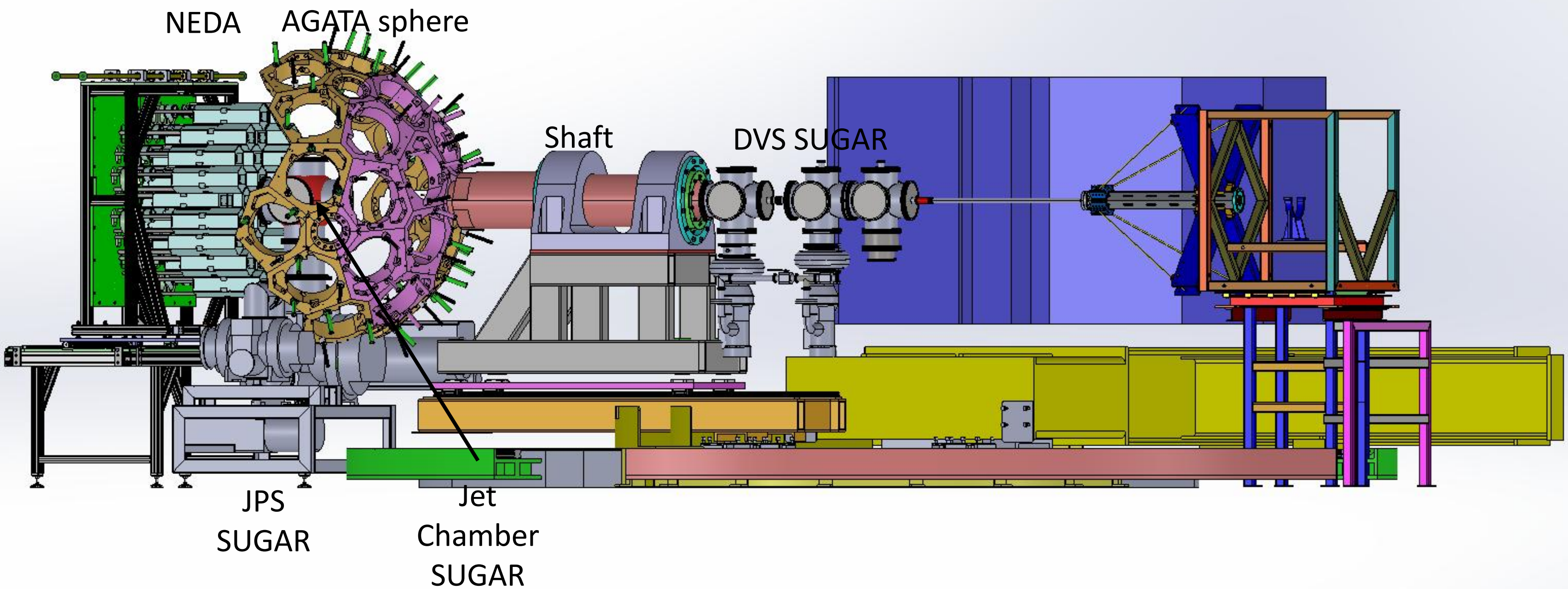
- Astrophysically interesting temperatures range from ~ 1 to 4 T9 (E_{cm} ~ 4 – 14 MeV)

- Discrepancies in predictions

We need to cover from 4 to 13 MeV using the tandem from HV platform from 2.7 to 4.5 MV using 2+ charge state, and the highest intensity available.
Low cross section will be compensated with triple identification (gamma, neutron, particle).

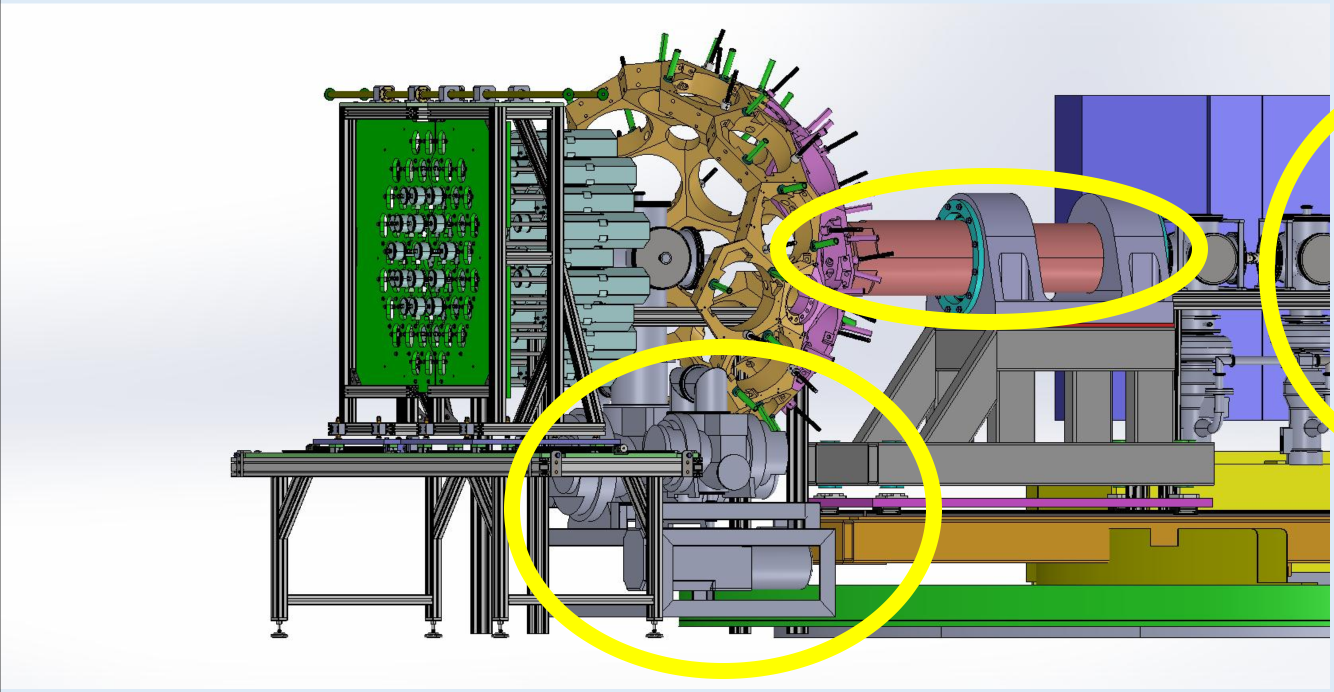
Facing the mounting of SUGAR with AGATA

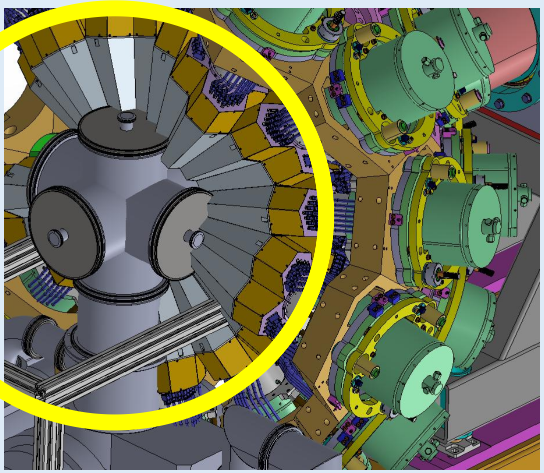
- First attempt, used to show at AGATA@LNL

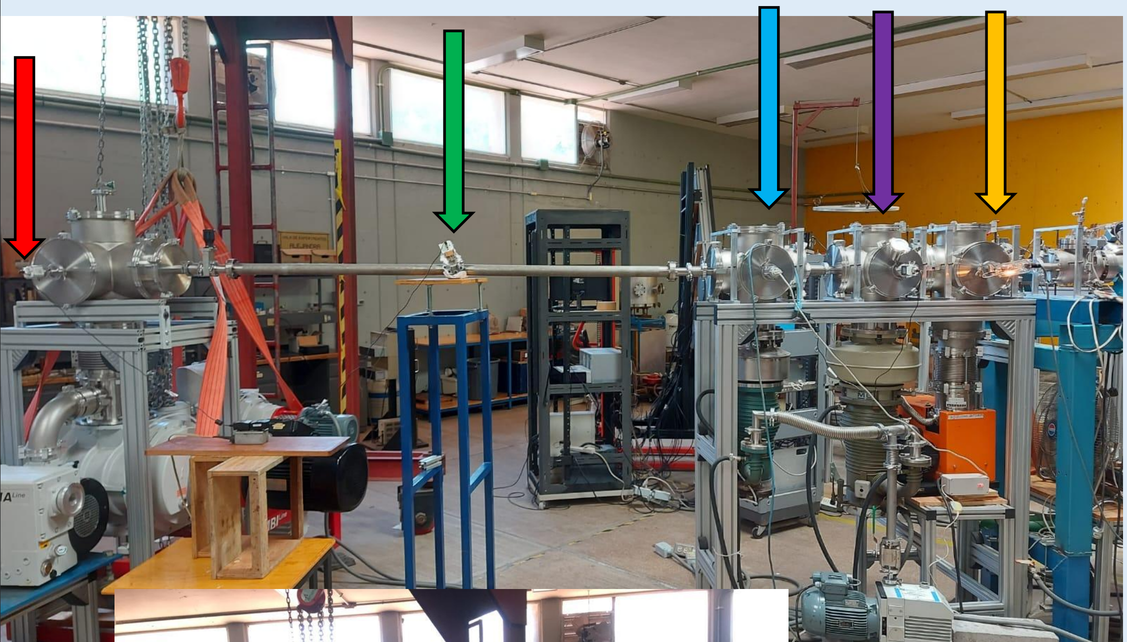


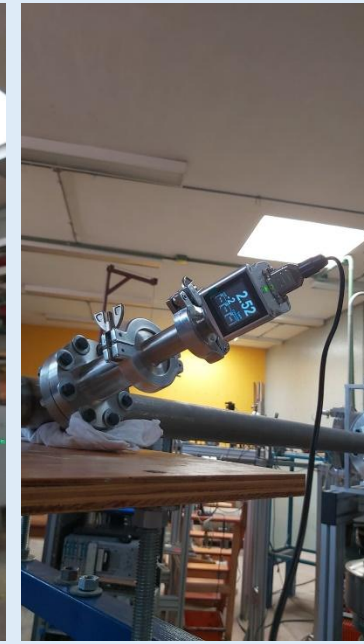
Three visible problems to be solved:

- Match of pumping system on the floor (50 cm height).
- Match of camera with AGATA crystals.
- Pipe of ~2 m between differential pumping and Jet chamber (inside shaft).





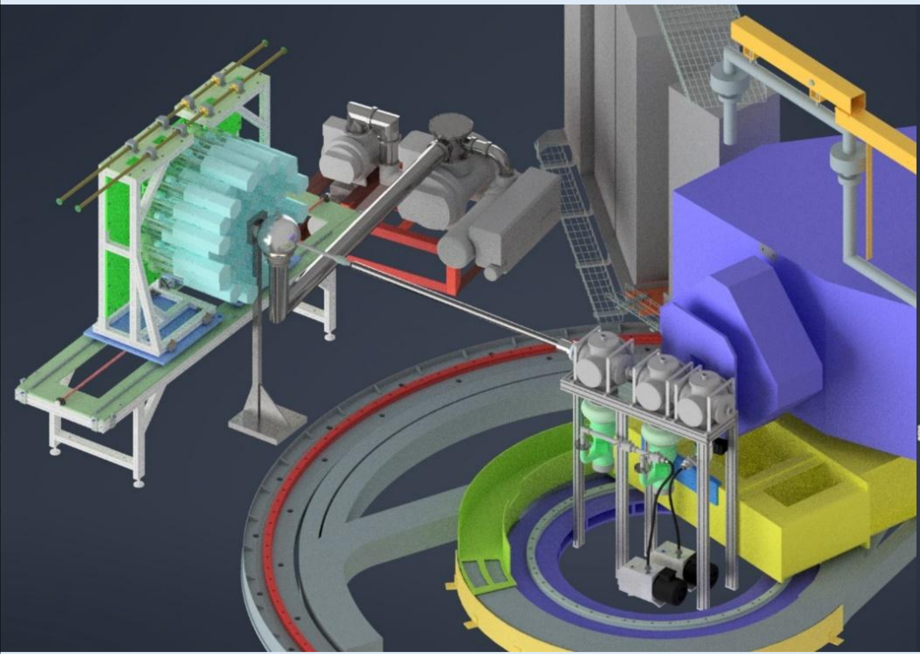


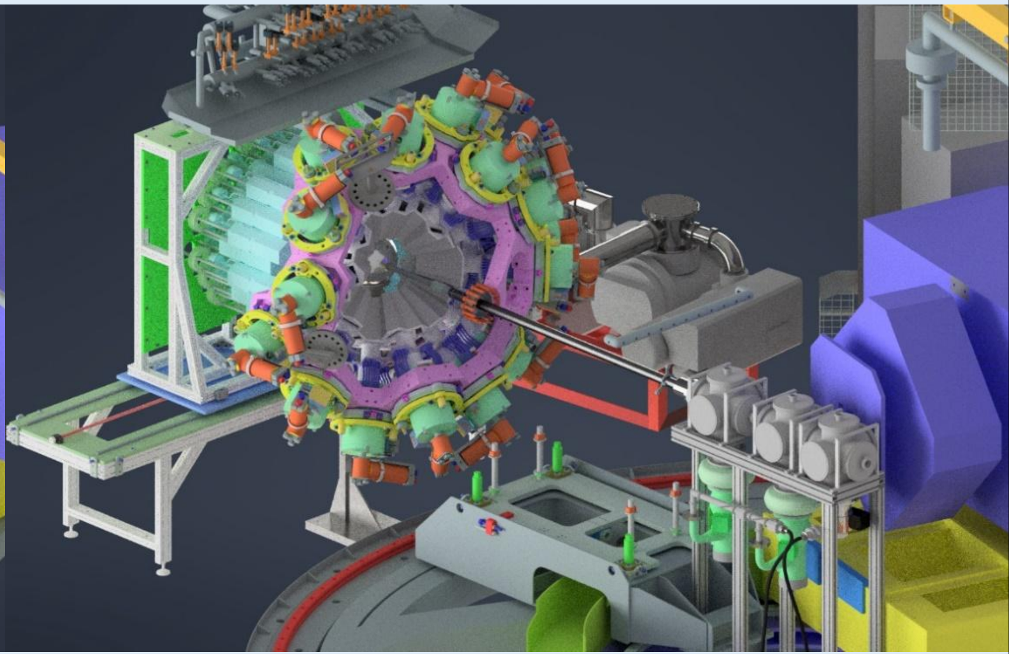


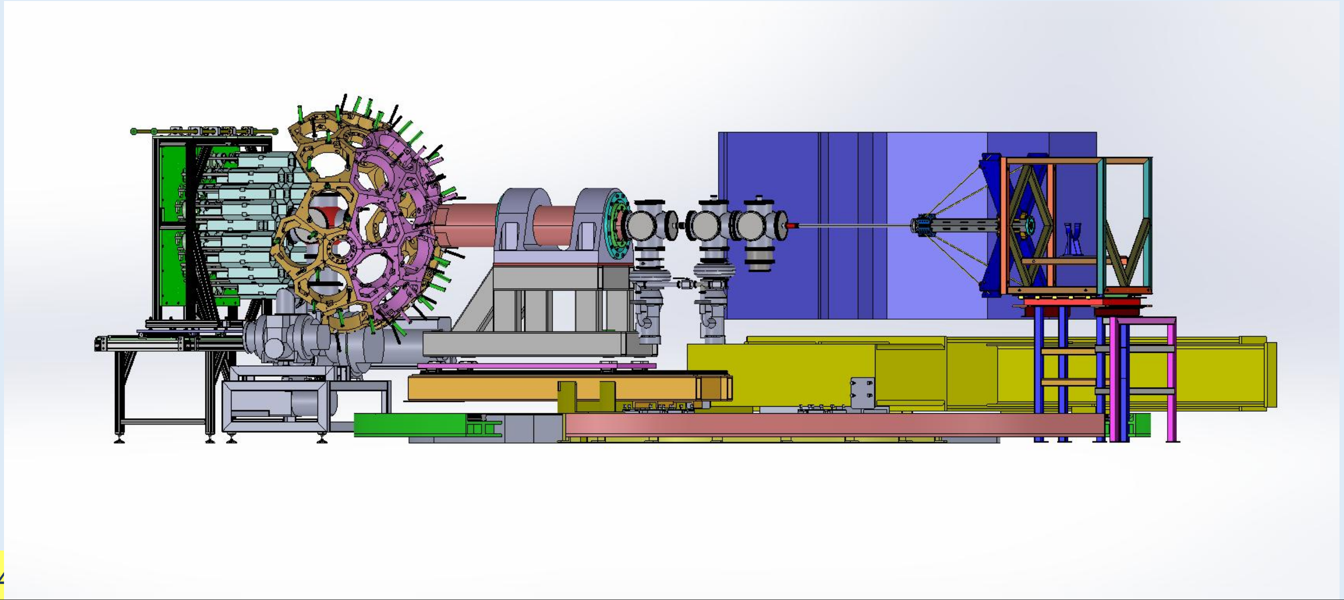
The test was successful, reaching:

1.5×10^{-1} Torr in Jet Chamber
2.5×10^{-2} Torr in the middle of the 2 m. pipe.
1×10^{-3} Torr in the first Diff Vacuum Chamber.
1×10^{-5} Torr in the 2nd Diff Vacuum Chamber.
4.1×10^{-6} Torr in the 3rd Diff Vacuum Chamber.

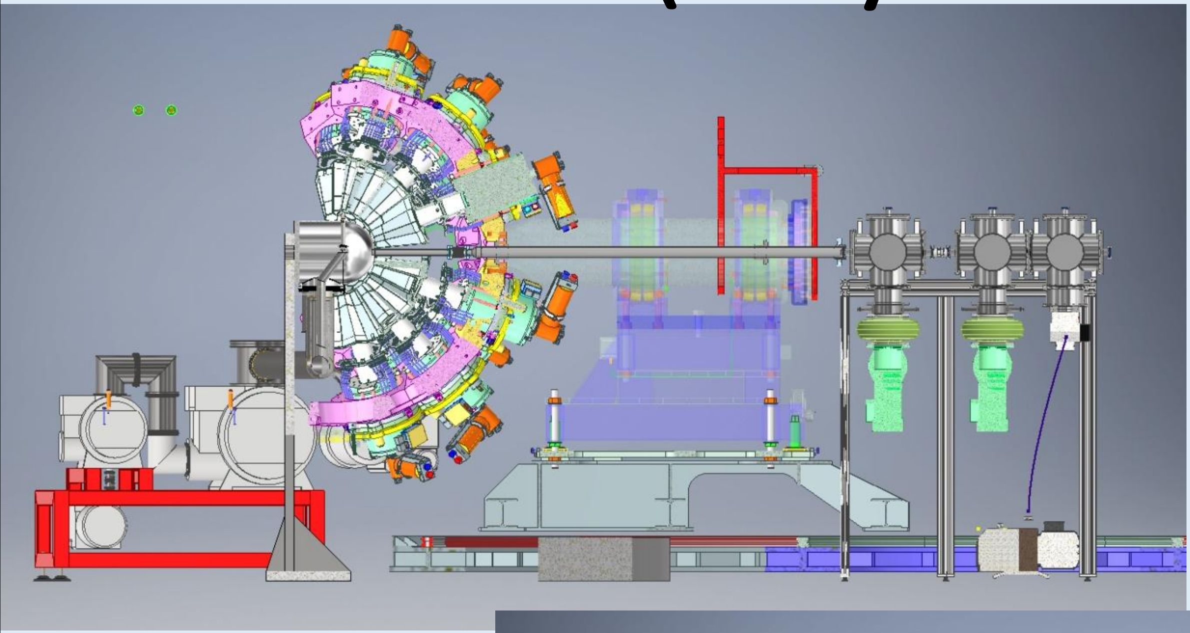
Mechanics (sept 2023)

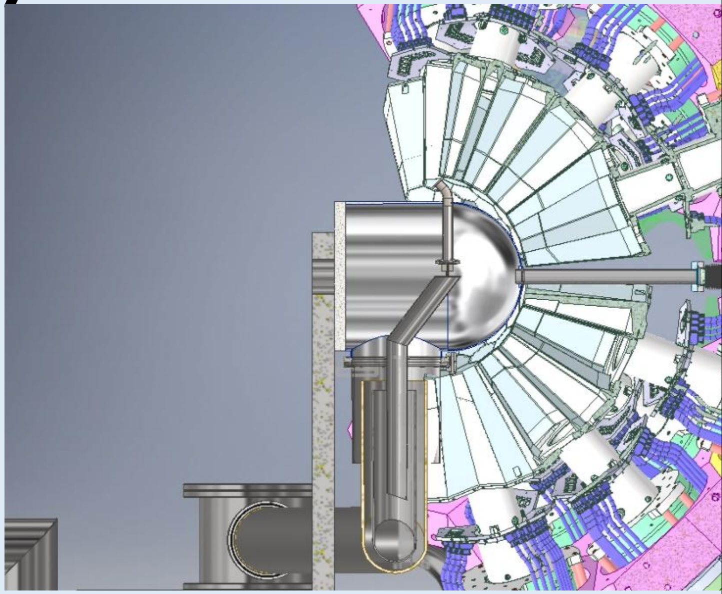


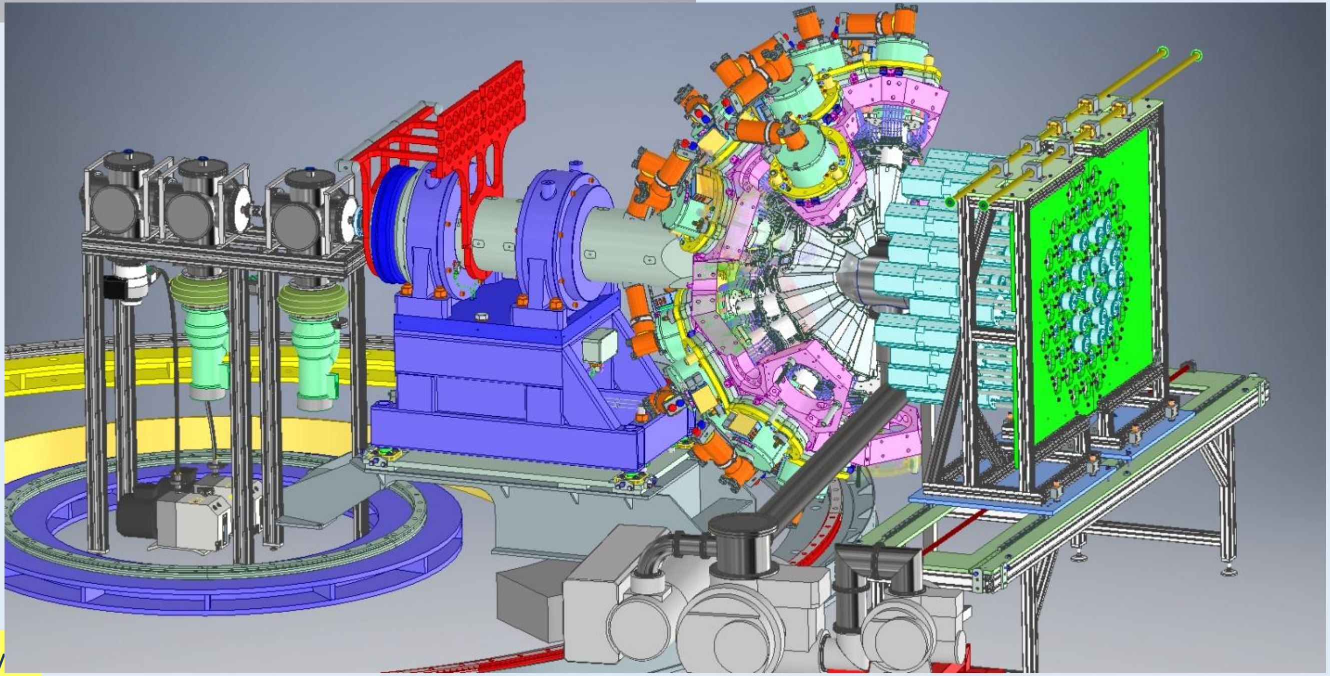




Mechanics (May 2024)

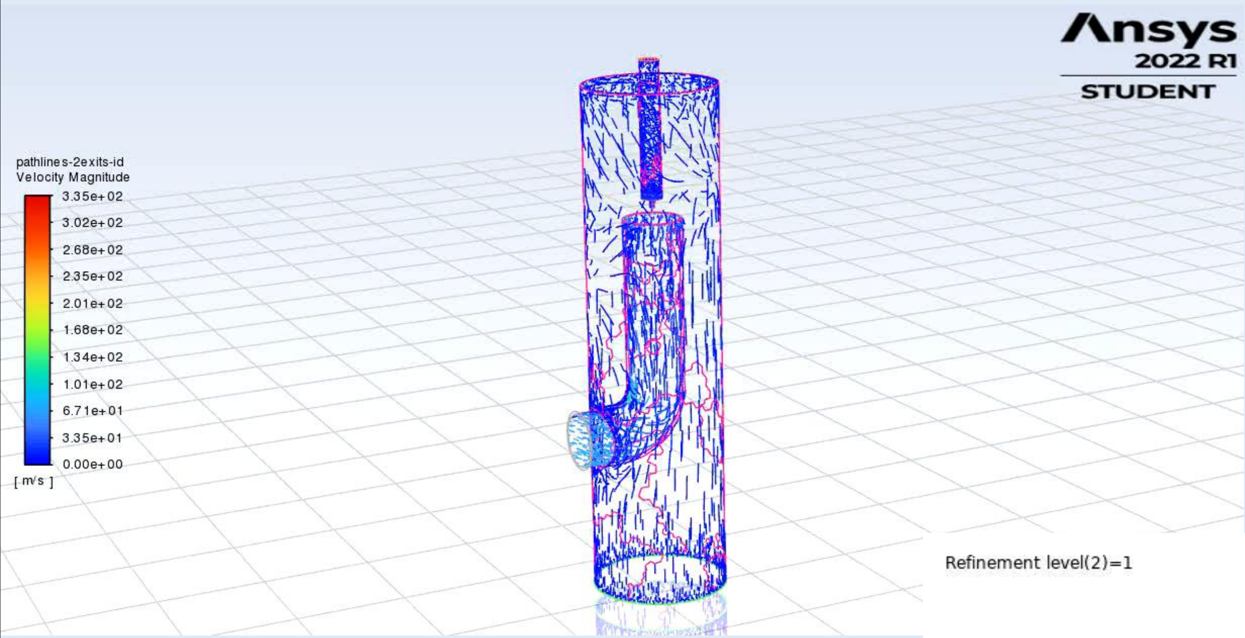


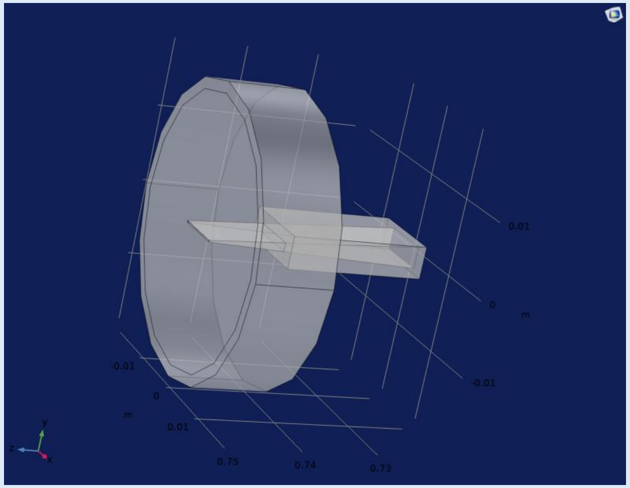




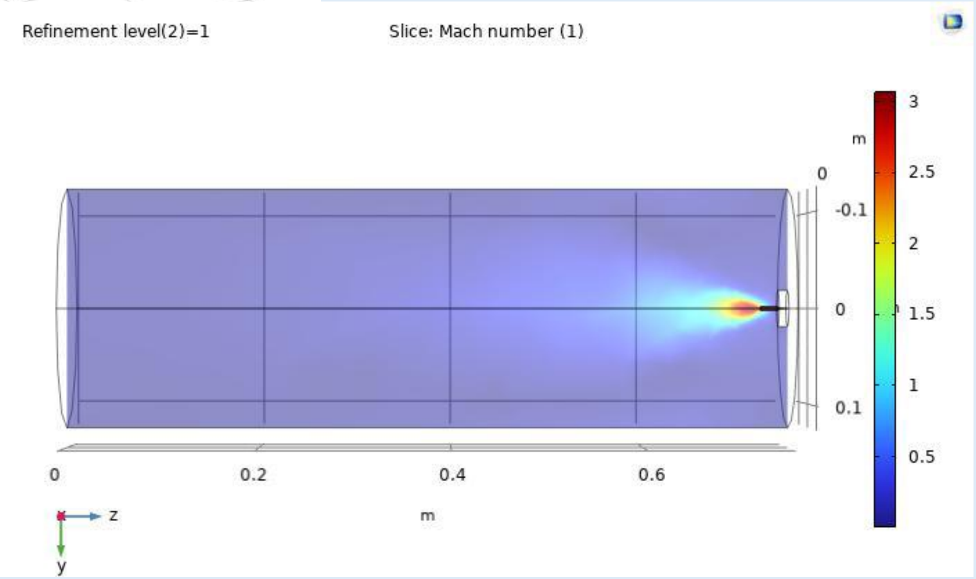
Carlos Valencia and Mirco Rampazzo

SIMULATIONS, ANSYS and COMSOL



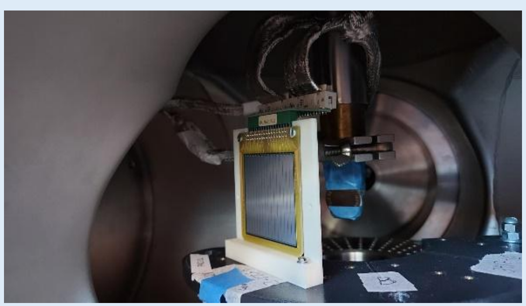


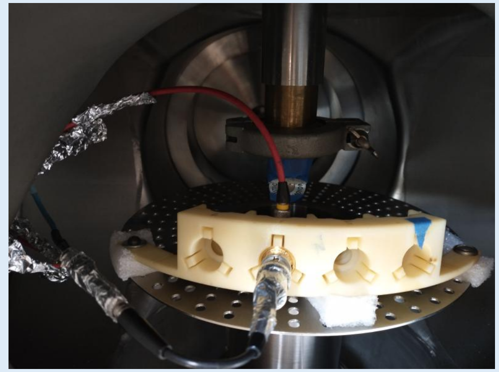
TOP-ANSYS RIGHT-COMSOL

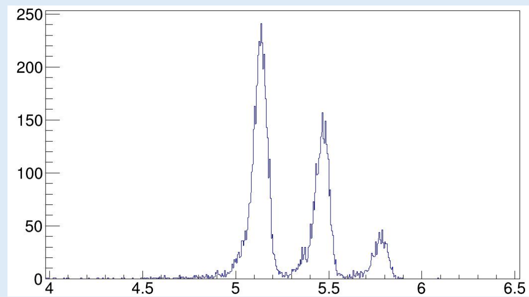


David Godos (PhD.)
José Juan Gómez (Engenieer)
Fabiola Silva-García. (Bachelor thesis)
Erika Ruiz-Martinez. (Bachelor tesis)
Carlos Valencia.

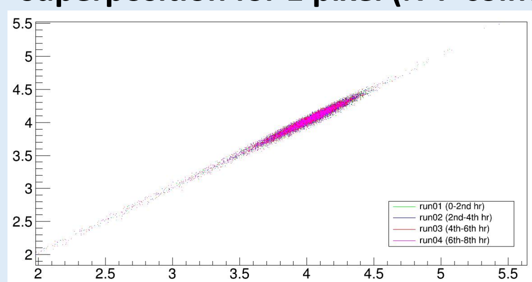
Tests of detectors stability

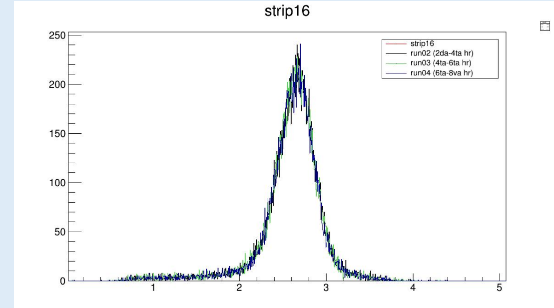




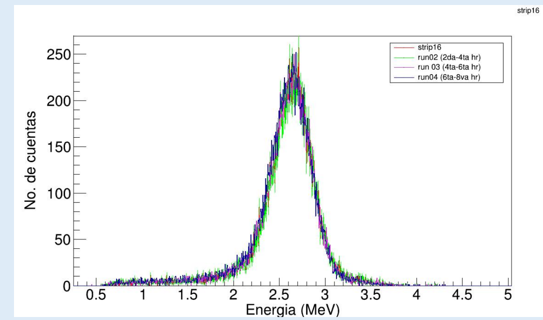


Alpha calibration (N-side) an spectra superposition for 1 pixel (N-P coincidence)

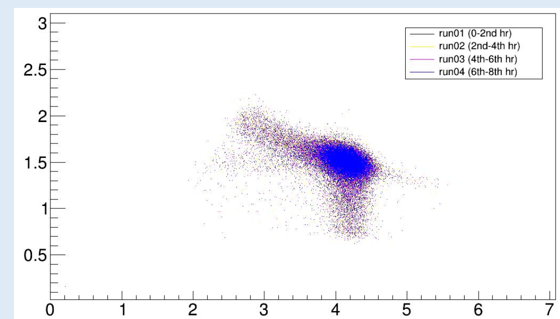




Without JET



With JET

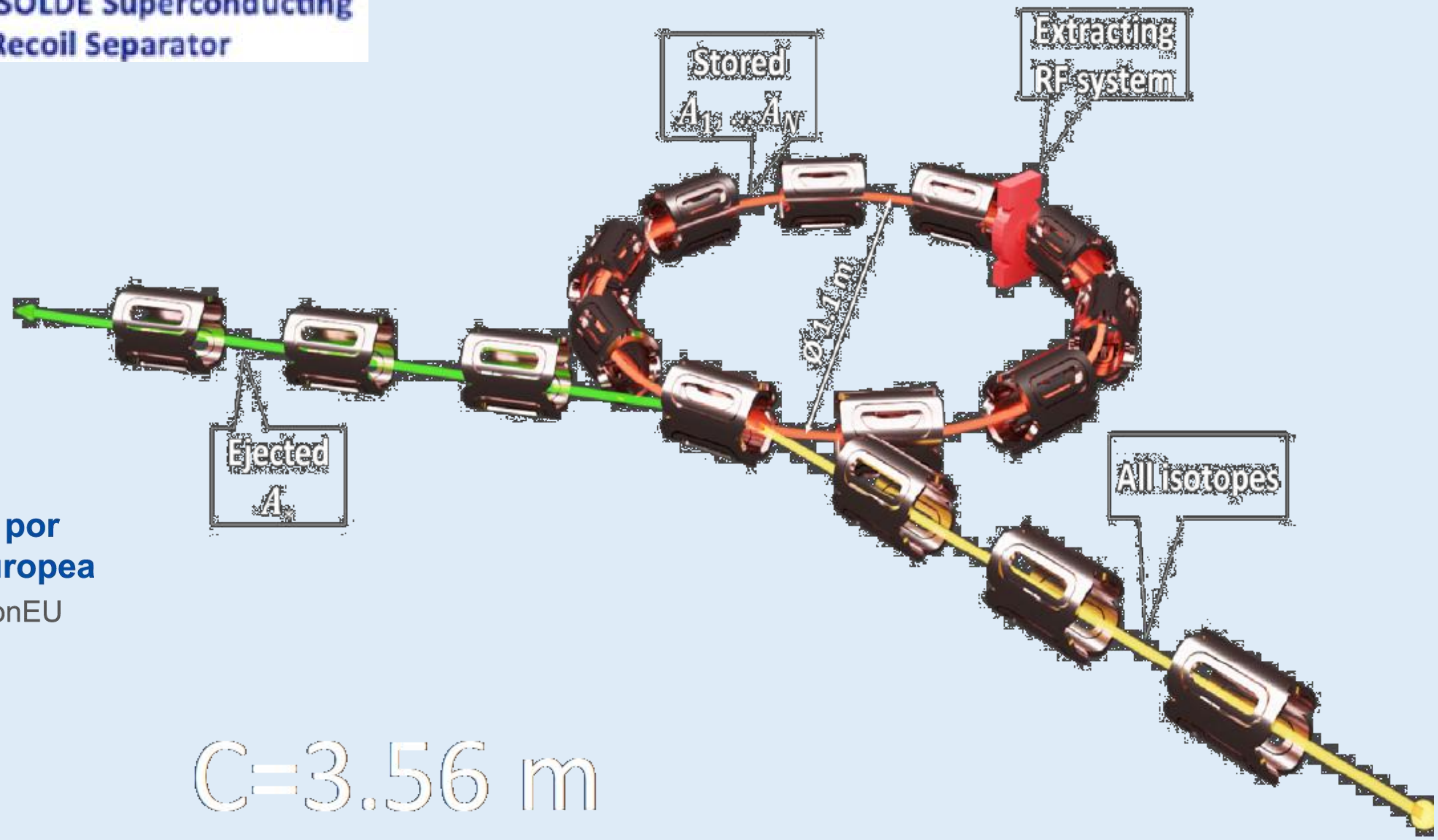


Superposition Spectra ΔE-E_{total}

M.F. Silva García, *Bachelor thesis*

NOT ANY EFFECT OBSERVED coming from turbulence or bad vacuum.

ISRS
ISOLDE Superconducting
Recoil Separator



Financiado por
la Unión Europea
NextGenerationEU

Plan de
Recuperación,
Transformación
y Resiliencia

ISRS ISOLDE Recoil Separator

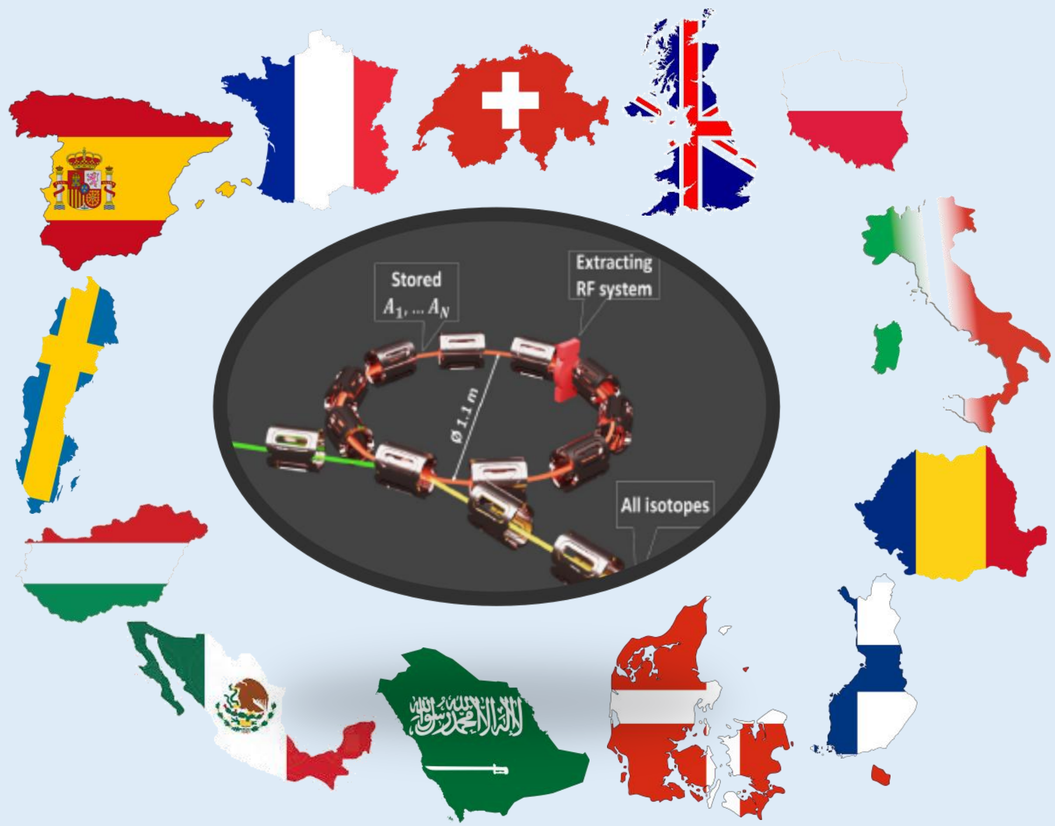
ISRS Collaboration

I. Martel[1], L. Acosta[2], J.L. Aguado[1], M. Assie[3], M. A. M. Al-Aqeel[4,25], A. Ballarino[9], D. Barna[5], R. Berjillos[6], M. Bonora[9], C. Bontoiu[4], M.J.G. Borge[7], J.A. Briz[7], I. Bustinduy[8], L. Bottura[9], L. Catalina-Medina[8], W. Catford[10], J. Cederkäll[11], T. Davinson[12], G. De Angelis[13], A. Devred[9], C. Díaz-Martín[1], T. Ekelöf[14], H. Felice[9], H. Fynbo[15], A.P. Foussat[9], R. Florin[26], S. J. Freeman[9,27], L. Gaffney[4], C. García-Ramos[1], L. Gentini[9], C. A. Gonzalez-Cordero[1], C. Guazzoni[29], A. Haziot[9], A. Heinz[16], J.M. Jimenez[9], K. Johnston[9], B. Jonson[16], T. Junquera[17], G. Kirby[9], O. Kirby[30], T. Kurtukian- Nieto[18], M. Labiche[22], M. Liebsch[9], M. Losasso[9], A. Laird[19], J.L. Muñoz[8], B.S. Nara Singh[20], G. Neyens[9], P.J. Napiorkowski[28], D. O'Donnell[20], R. D. Page[4], D. Perini[9], J. Resta-López[21], G. Riddone[9], J.A. Rodriguez[9], V. Rodin[4,22], S. Russenschuck[9], V.R. Sharma[2], J. Sánchez- Segovia[1], K. Riisager[15], A.M. Sánchez-Benítez[1], B. Shepherd[22], E. Siesling[9], J. Smallcombe[4], M. Stanoiu[26], O. Tengblad[7], J.P. Thermeau[23], D. Tommasini[9], J. Uusitalo[24], S. Varnasseri[9], C.P. Welsch[4], G. Willering[9].

[1]CCTH, Univ. Huelva, Spain. [2]Inst. de Física, UNAM, Mexico. [3]Univ. Paris-Saclay, CNRS/IN2P3, IJCLab, Orsay, France. [4]Dept. of Physics, Univ. Liverpool, UK. [5]Wigner Research Centre for Physics, Budapest, Hungary. [6]TTI Norte, Santander, Spain. [7]IEM, CSIC, Madrid, Spain. [8]ESS-BILBAO, Bilbao, Spain. [9]CERN, Geneva, Switzerland. [10]Dept. of Physics, Univ. Surrey, UK. [11]Dept. of Physics, Lund Univ., Sweden. [12]Univ. Edinburgh, UK. [13]LNL INFN, Italy. [14]Uppsala Univ., Sweden. [15]Dept. of Physics and Astronomy, Aarhus Univ., Denmark. [16]Dept. of Physics, Chalmers Univ. of Technology, Göteborg, Sweden. [17]ACS, Orsay, France. [18]Univ. Bordeaux, CNRS, Gradignan, France. [19]Dept. of Physics, Univ. York, UK. [20]School of Computing, Engineering & Physical Sciences, Univ. of West Scotland, UK. [21]ICMUV, Univ. de Valencia, Spain. [22]Cockcroft Institute, Daresbury, UK. [23]Universite de Paris, CNRS, Astroparticule et Cosmologie, France. [24]Faculty of Mathematics and Science, Univ. Jyvaskyla, Finland. [25]IMIS Univ. Riyadh, Saudi Arabia. [26]IFIN-HH, Bucharest, Romania. [27]Department of Physics & Astronomy, Univ. Manchester, UK. [28]HIL, University of Warsaw, Poland. [29]Dept. Electronics, Info. and Bio., Politecnico di Milano, Milan, Italy. [30]Paul Scherrer Institute, Zurich, Switzerland.

72 members of 30 Institutions from 13 countries

Spain
UK
France
Italy
Switzerland
Poland
Sweden
Hungary
Denmark
Finland
Romania
Mexico
Saudi Arabia

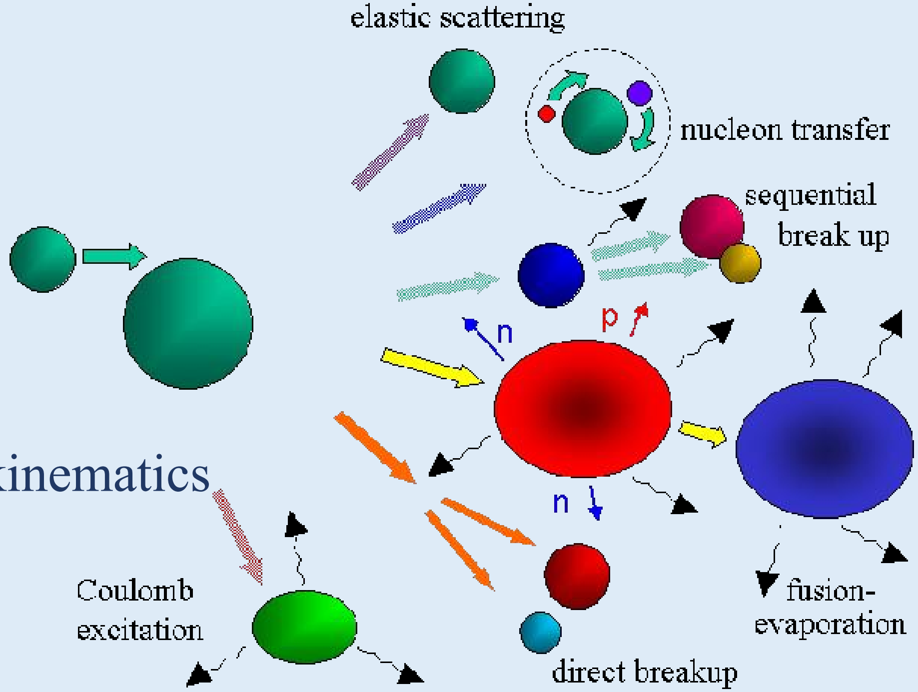


Physics opportunities

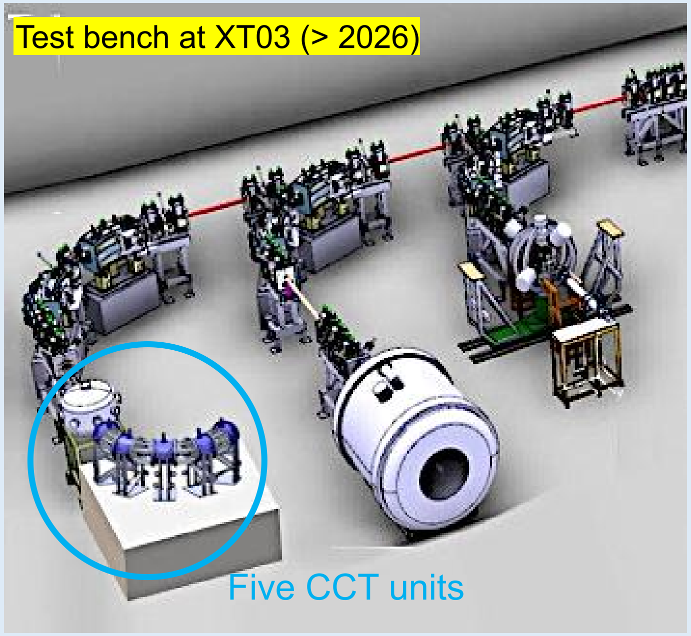
The ISRS allows an application of several reaction mechanisms to produce exotic nuclei in the energy levels of interest, decays of which can be observed by detecting particles or photons with the existing and planned detection systems

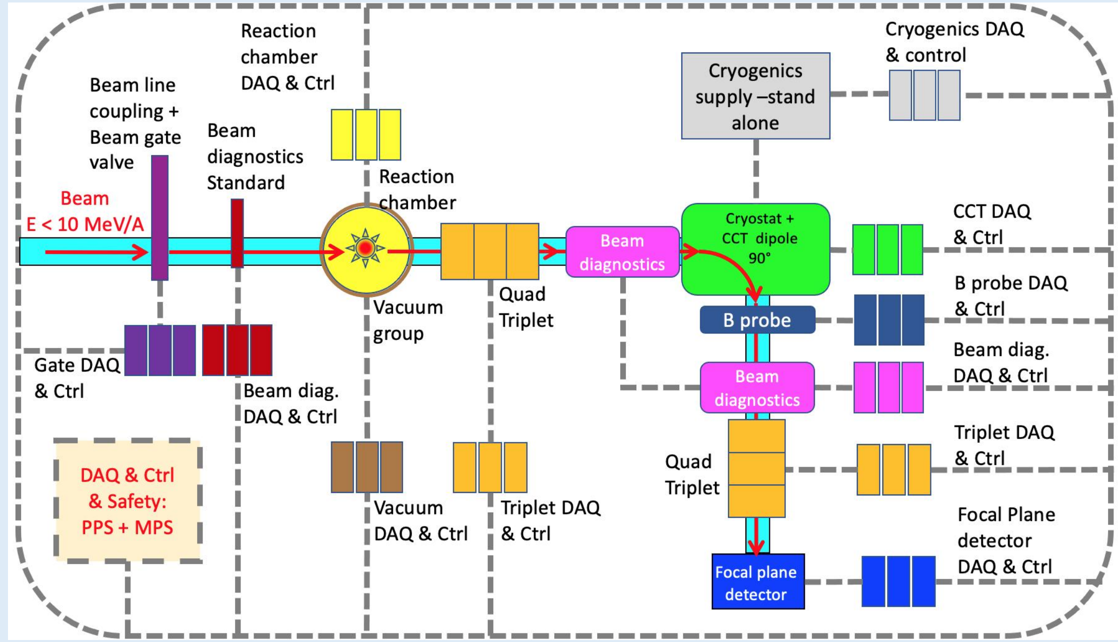
Reaction mechanisms

- ✓ Deep inelastic reactions
- ✓ Coulomb dissociation
- ✓ Transfer reactions in inverse kinematics
- ✓ Multinucleon transfer reactions
- ✓ Fusion evaporation reactions in inverse kinematics
- ✓ Transfer, breakup and fusion reactions
- ✓ Resonant elastic scattering

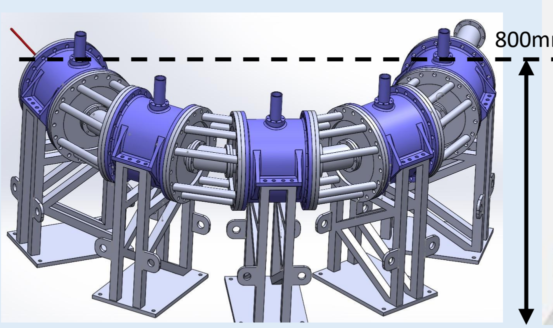


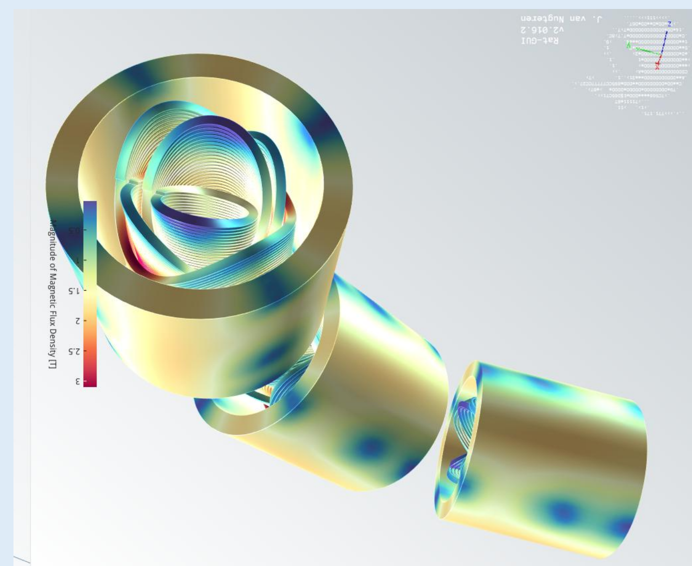
ISRS CCT test bench





3 M€ MMR funds Multifunction CCT Dipole + Quadrupole

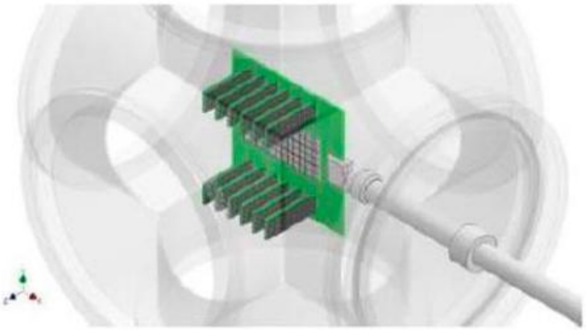


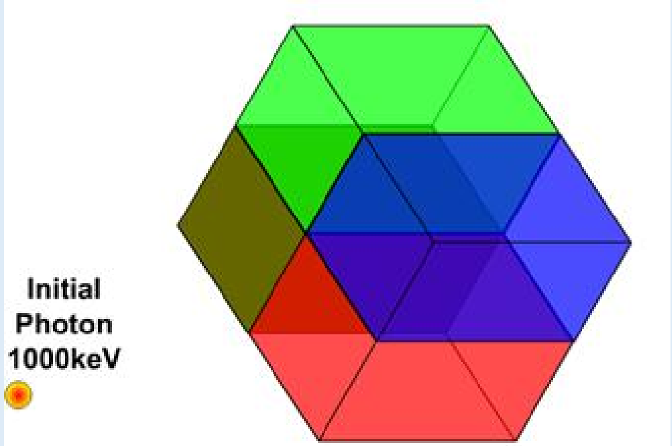


Critical elements of the focal plane

- Particle telescope with different detection layers and a dedicated readout system.
- The frontend electronics must face a twofold challenge, the wide dynamic range and the time resolution for ToF
  - ✓ Silicon Cardbide based detectors and fast scintillators.
    - ✓ Collaboration :
      - ✓ Chiara Guazzoni, Politecnico di Milano
      - ✓ Nara Singh Bondili, University of the West of Scotland

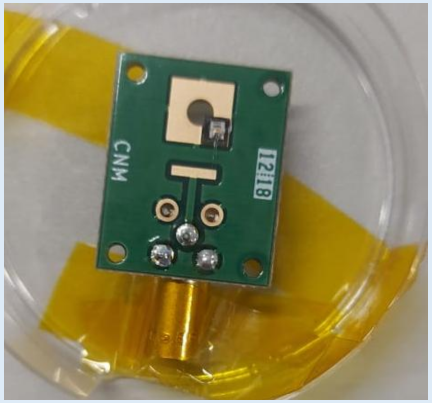
Ex. SiC developed for FRAISE INFN-LNS





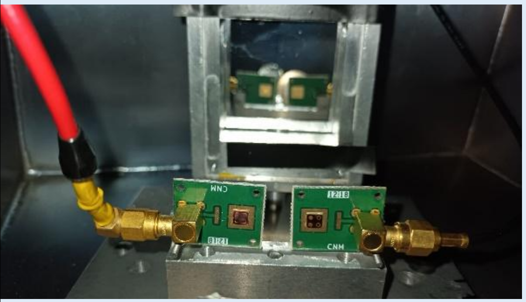
LaBr3 clover

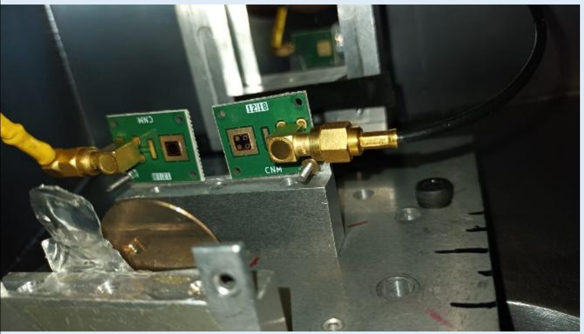
BGO



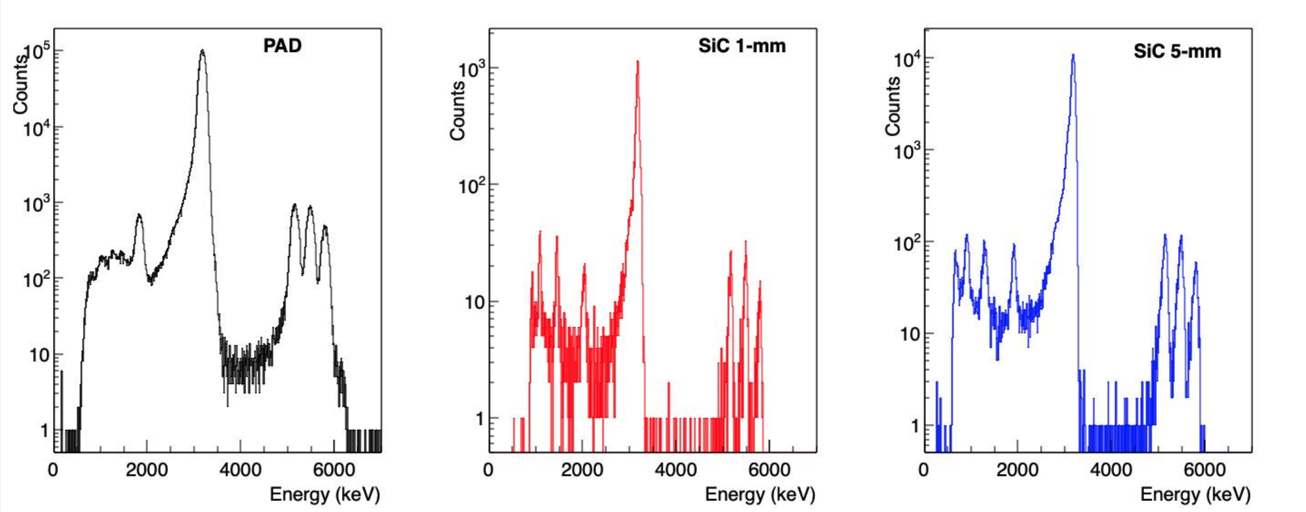
SiC

First characterization of SiC detector prototypes





IMB-CSIC SiC (5 mm and 1 mm side, and 50 micron thick) detectors comparing with a silicon PAD triple-alpha, gadolinium sources



	PAD 500-um				SiC 5-mm				SiC 1-mm			
Source	E (keV)	Sigma (keV)	FWHM (keV)	Rsltn (%)	E (keV)	Sigma (keV)	FWHM (keV)	Rsltn (%)	E (keV)	Sigma (keV)	FWHM (keV)	Rsltn (%)
148Gd	**3181.3**	**65.10**	**153.29**	**4.82%**	**3181.9**	**34.20**	**80.53**	**2.53%**	**3179.3**	**28.43**	**66.96**	**2.11%**
239Pu	**5158.8**	**70.53**	**166.08**	**3.22%**	**5153.1**	**41.20**	**97.03**	**1.88%**	**5165.5**	**30.72**	**72.35**	**1.40%**
241Am	5488.2	70.66	166.39	3.03%	5488.2	39.91	93.98	1.71%	5487.1	27.33	64.37	1.17%
244Cm	5800.3	67.45	158.83	2.74%	5802.9	40.21	94.68	1.63%	5793.6	28.46	67.02	1.16%

Summary

- The good performed SIMAS array was presented showing important results regarding weakly bound nuclei. The experiments were performed at TwinSol/TriSol NotreDame (2019-2023).

- The SUGAR@LNL project is in progress, simulations, detector behavior, coupling of new pieces and mechanical designs has been developed during this years (2022-2024). Physics cases are welcome for the future campaign at LNL.

- The ISRS project is starting! The prototype and crucial elements are under construction, along to simulations and several test. The first prototypes for SiC detectors started their characterization. Many other test and the construction of a test bench will be performed (2024-2025).

Thank you for your attention

SIMAS

IFUNAM, University of Huelva, University of Seville, University of Ioannina, University of Athens, UND, LNS-INFN, LNL-INFN, INFN-Sezione di Napoli, LIP

SUGAR@LNL collaboration

IFUNAM, INFN- Sezione di Milano, Sezione di Padova, LNL, LNS, GANIL, CENBG, University of Huelva, IEM-CSIC

ISRS collaboration (MADMAG subproject)

IEM-CSIC, Politecnico di Milano, LMB-CSIC, University of Huelva, IFUNAM

This work has been partially supported by DGAPA-UNAM IG101423, (Mexico), the ISRS-ISOLDE (BOE-A-2023-16885), the Recovery, Transformation, and Resilience Plan (Spain), and NextGeneration Program (European Union) and IANNA-IReNA networks.