STATUS OF CUP

J.J. Gómez-Cadenas
On Behalf of the CUP consortium

Benasque, MAY 2012

CUP

- Canfranc Underground Physics

- Two activities: CAFE & NEXT

- CAFE: Phenomenological studies related with neutrino physics. It has produced a large number of papers. Main actors at UAB and IFIC.

- NEXT: Construction of the Neutrino Experiment with a Xenon TPC, a major experiment to search for bbOnu to be installed at the LSC.

NEXT Collaboration

U. Girona • IFIC (Valencia) • U. Santiago de Compostela
• U. Politécnica Valencia • U. Zaragoza• U. A. Madrid

LBNL • Texas A&M• John Hopkins

CEA (Saclay)

U. Coimbra • U. Aveiro

JINR (Dubna)

UAN (Bogotá)

THE NEXT COLLABORATION

http://next.ific.uv.es/next/

next

HOME PHYSICS DETECTOR COLLABORATION DOCUMENTS INTERNAL

ingenio 2010 Consolider

GOBIERNO DE ESPAÑA MINISTERIO DE CIENCIA E INNOVACIÓN

Links

- Laboratorio Subterráneo de Canfranc (LSC)
- arXiv:0907.4054 [hep-ex] - Letter of Intent to LSC
- arXiv:1106.3630v1 [physics.ins-det] - Conceptual Design Report

Gallery

Have a look at our pics here

Press

2011

- abc.es
- elmundo.es
- jotdown.es
- levante-emv.com

2010

- lasprovincias.es
- ecuadorciencia.org

Neutrinoless double beta decay searches with a high-pressure Xe TPC

ABOUT THE EXPERIMENT

NEXT (Neutrino Experiment with a Xenon TPC) is a neutrinoless double-beta decay experiment that will operate at the Canfranc Underground Laboratory (LSC). It is based on a novel detection concept for neutrinoless double-beta decay searches consisting in a Time Projection Chamber (TPC) filled with high-pressure gaseous xenon and with separated-function capabilities for calorimetry and tracking.

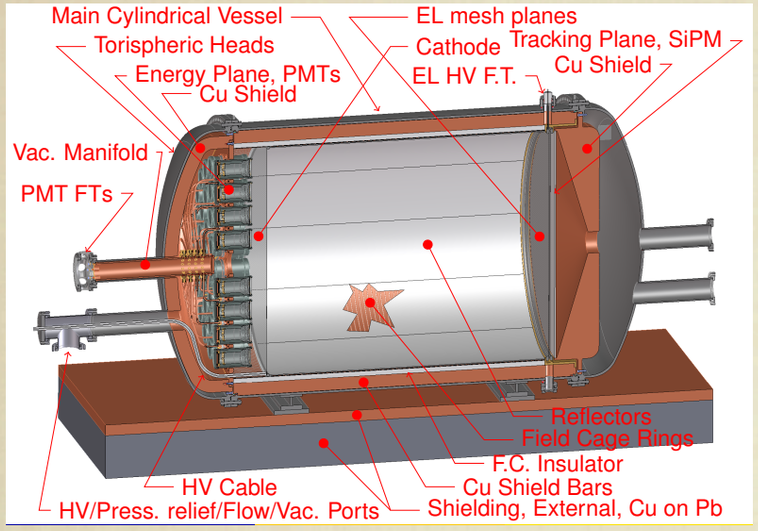
In neutrinoless double beta decay searches, two ingredients have crucial importance: energy resolution and background suppression. The $\beta\beta0\nu$ signal is a peak at the endpoint of the $\beta\beta2\nu$ energy spectrum ($Q_{\beta\beta}$). On one hand, a higher energy resolution excludes more events with energies close to (but different from) $Q_{\beta\beta}$. On the other hand, due to the large half-life of the searched decay, an optimal background identification is mandatory in order to reject events whose energy falls inside the energy window, to the greatest extent possible.

NEXT offers excellent performance in both aspects: an energy resolution of at least 1% FWHM at $Q_{\beta\beta}$ and a topological signature that provides an extra handle in background rejection.

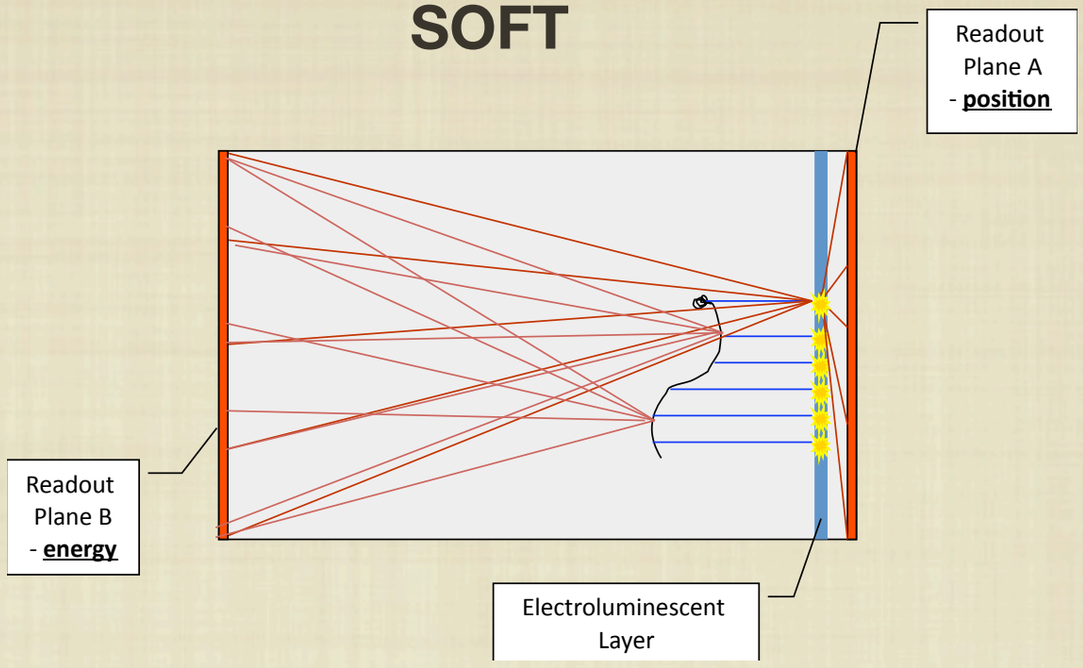
Why choosing xenon? Among the noble gases, xenon is the only one which has an isotope that decays $\beta\beta$ (^{136}Xe), whose natural abundance is quite high (9%) and can be easily enriched by centrifugation. Also, its $Q_{\beta\beta}$ value is acceptably high (~ 2480 keV), so that most of background is left outside the region of interest.

NEXT concept

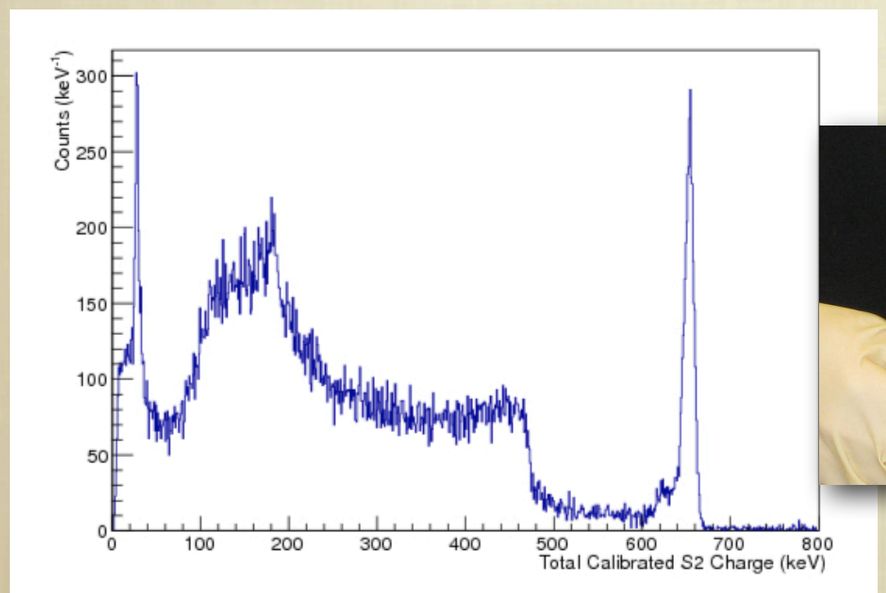
HPGXe

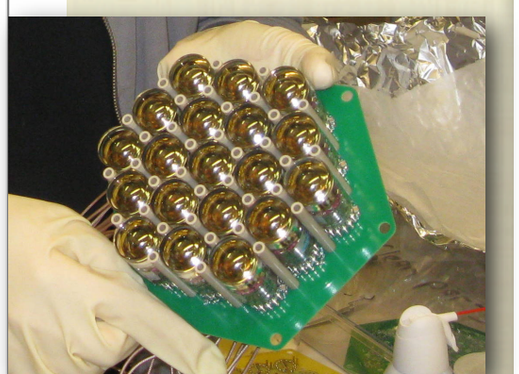


SOFT

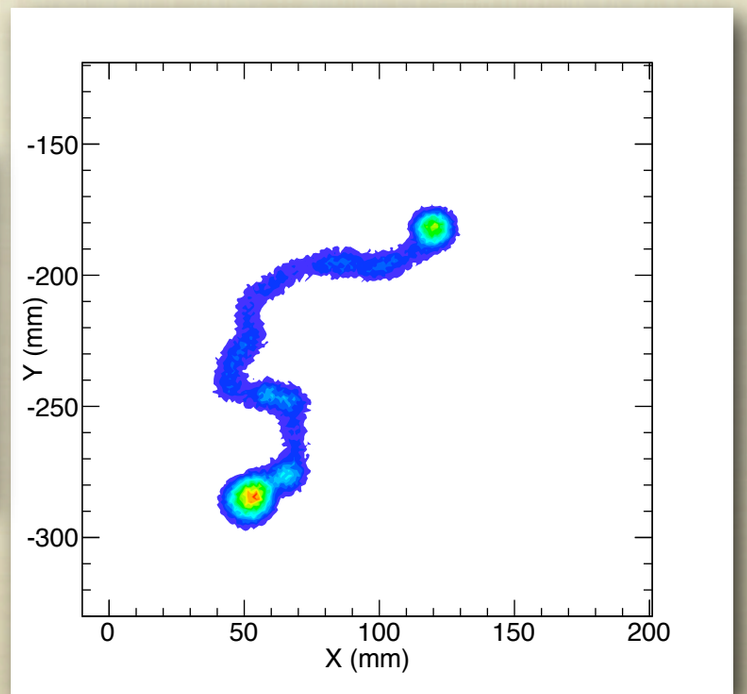


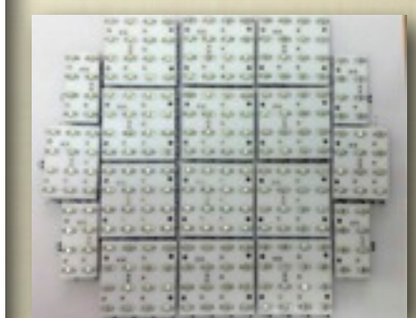
Energy resolution





Topological signature





NEXT TIME LINE

- LOI approved in 2009

- CUP project granted in 2010 with the main goal of building the NEXT experiment.

- 2010 & 2011 Intense R&D to develop prototypes, define the detector and demonstrate the technology. Effort continuously monitored by LSC-SC and always positively evaluated.

- 2011 CDR published (May): conceptual design of the detector, initial results of prototypes.

NEXT TIME LINE

- 2011 FPA committee of experts (including no expert from LSC-SC) gives the coordinated project requesting funds for NEXT a C and denies funding on the grounds that the technological solutions have not been proved. At the same time the CDR is very positively evaluated by the LSC-SC.

- 2011 (November) CUP passes with flying colors the "mid-term" exam of the CONSOLIDER committee.

- 2012 NEXT publishes TDR. The experiment is very positively evaluated by the LSC-SC referees.

Proyecto CSD2008-00037 CUP
Título: Canfranc Underground Physics
Investigador Coordinador: M. Concepción González-García

Además de las muy abundantes publicaciones en la parte fenomenológica del proyecto, el grado de desarrollo de la parte experimental (NEXT) es muy satisfactorio y ha dado lugar a una serie de prototipos y publicaciones que han sido muy bien recibidas por la comunidad internacional.

El proyecto ha incorporado una serie de colaboradores internacionales y ha fortalecido la relación entre diferentes grupos españoles en torno al LSC. Hay en marcha colaboraciones muy interesantes con industrias españolas y extranjeras.

Existe un esfuerzo decidido de transferencia de resultados, aunque es un poco pronto, para un proyecto de esta envergadura, ver todos los resultados que sin duda alcanzará en este aspecto.

La página web de NEXT es excelente. El proyecto tiene una gran visibilidad internacional. Como tal ha sido recogido en la hoja de ruta europea de física de astropartículas de la red ASPERA.

El proyecto, amén de la extensa red de colaboraciones internacionales de sus miembros, ha incorporado grupos experimentales de varias nacionalidades que contribuyen a la financiación del proyecto. Especialmente importante es la participación estadounidense. También es importante la participación de sus miembros en la red europea INVISIBLES financiada por el FP7.

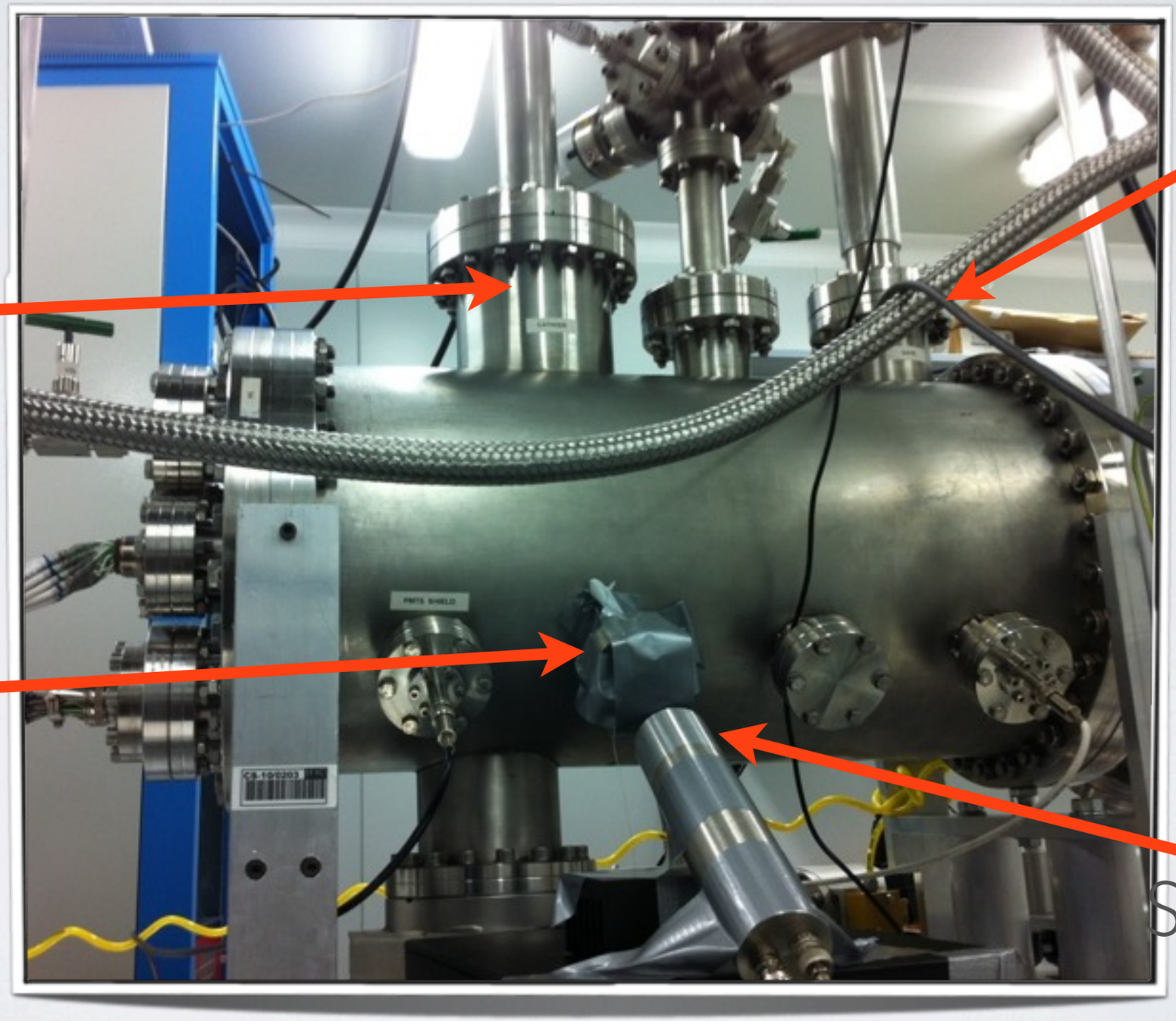
Se trata de un proyecto ambicioso, liderado por España, que en un tiempo record ha conseguido situarse como una opción reconocida en un campo muy competitivo. Todo ello, con un objetivo que está entre los más importantes de la física de partículas.

En conclusión, se valora de forma favorable la evolución del Proyecto y, por tanto, se propone su continuidad

NEXT-100 Technical Design Report (TDR). Executive Summary

V. Álvarez,[a] F.I.G.M. Borges,[b] S. Cárcel,[a] J.M. Carmona,[c] J. Castel,[c] J.M. Catalá,[d] S. Cebrián,[c] A. Cervera,[a] D. Chan,[e] C.A.N. Conde,[b] T. Dafni,[c] T.H.V.T. Dias,[b] J. Díaz,[a] M. Egorov,[e] R. Esteve,[d] P. Evtoukhovitch,[f] L.M.P. Fernandes,[b] P. Ferrario,[a] A.L. Ferreira,[g] E. Ferrer-Ribas,[h] E.D.C. Freitas,[b] V.M. Gehman,[e] A. Gil,[a] I. Giomataris,[h] A. Goldschmidt,[e] H. Gómez,[c] J.J. Gómez-Cadenas,[a*] K. González,[a] D. González-Díaz,[c] R.M. Gutiérrez,[i] J. Hauptman,[j] J.A. Hernando Morata,[k] D.C. Herrera,[c] V. Herrero,[d] F.J. Iguaz,[h] I.G. Irastorza,[c] V. Kalinnikov,[f] D. Kiang,[e] L. Labarga,[l] I. Liubarsky,[a] J.A.M. Lopes,[b] D. Lorca,[a] M. Losada,[i] G. Luzón,[c] A. Marí,[d] J. Martín-Albo,[a] A. Martínez,[a] T. Miller,[e] A. Moiseenko,[f] F. Monrabal,[a] C.M.B. Monteiro, J.M. Monzó,[c] F.J. Mora,[c] L.M. Moutinho,[g] J. Muñoz Vidal,[a] H. Natal da Luz,[b] G. Navarro,[i] M. Nebot,[a] D. Nygren,[e] C.A.B. Oliveira,[eg] R. Palma,[m] J. Pérez,[n] J.L. Pérez Aparicio,[m] J. Renner,[e] L. Ripoll,[o] A. Rodríguez,[c] J. Rodríguez,[a] F.P. Santos,[b] J.M.F. dos Santos,[b] L. Segui,[c] L. Serra,[a] D. Shuman,[e] C. Sofka,[p] M. Sorel,[a] J.F. Toledo,[d] A. Tomás,[c] J. Torrent,[o] Z. Tsamalaidze,[f] D. Vázquez,[k] E. Velicheva,[f] J.F.C.A. Veloso,[g] J.A. Villar,[c] R.C. Webb,[p] T. Weber,[e] J. White[p] and N. Yahlali[a]

NEXT DEMO



Cathode
32 kV

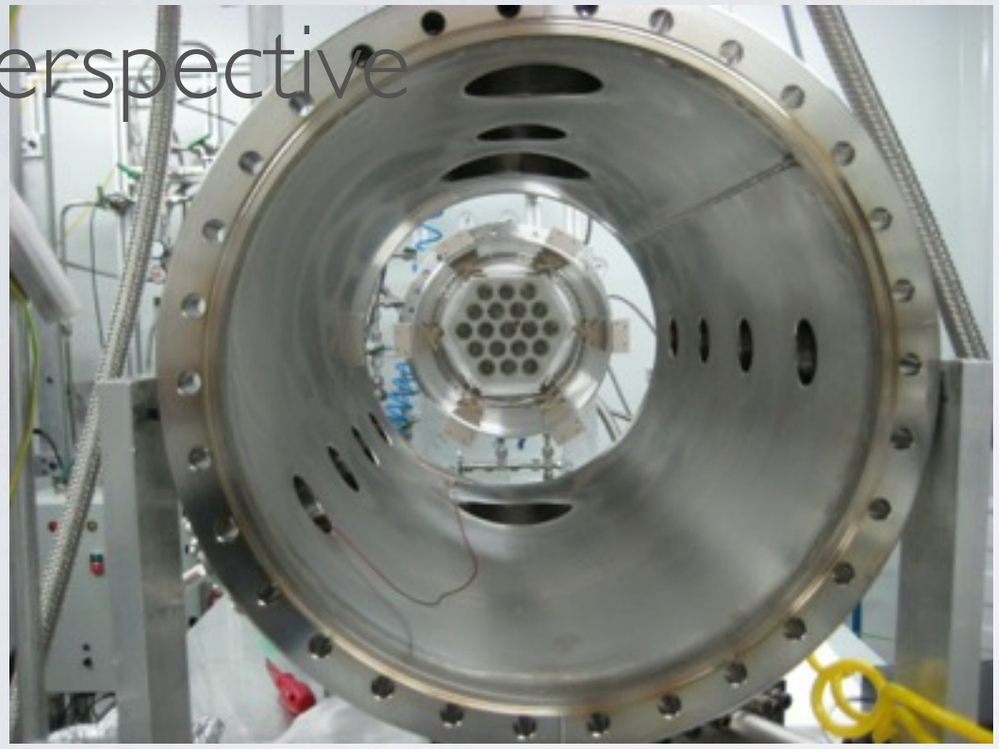
Gate
12kV

Na22
1uCi

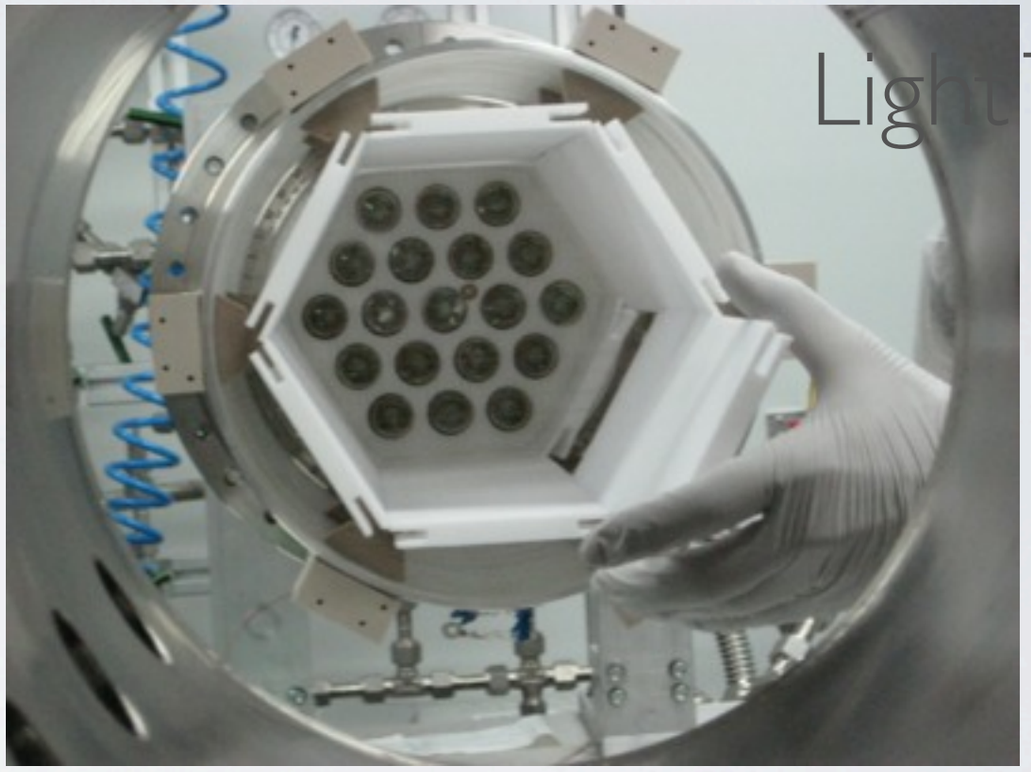
NaI
Scintillator

NEXT DEMO

Perspective



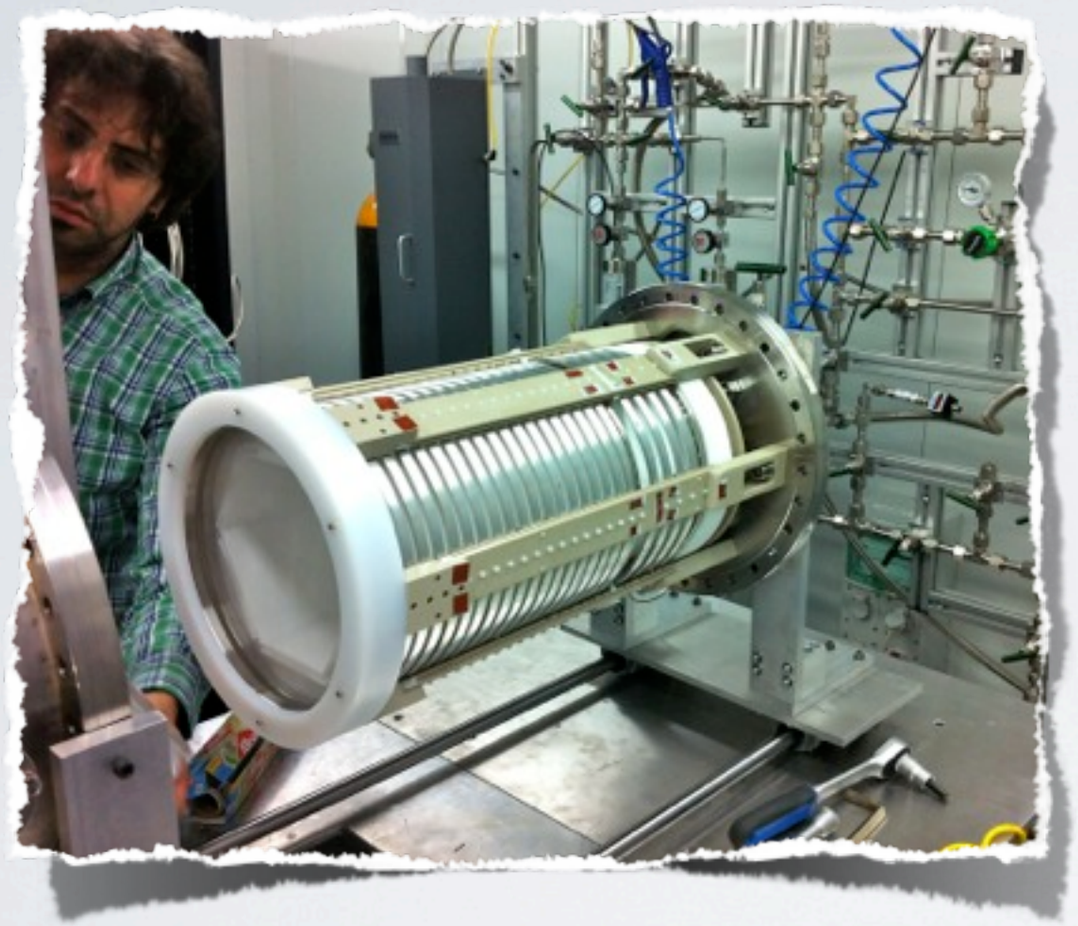
Light Tube



Mesh

Field Rings

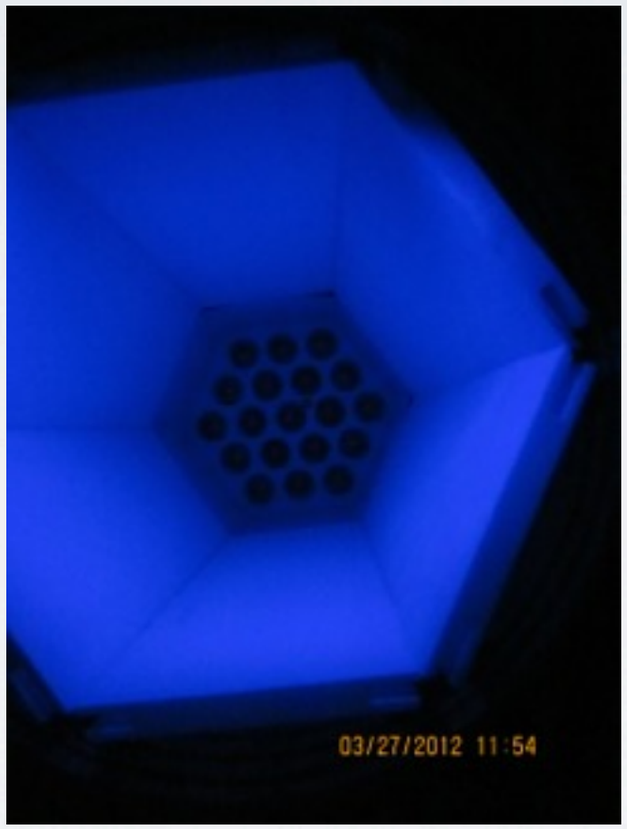
NEXT ON RAILS



NEXT-DEMO: Long drift (30 cm). Small solid angle (L/R = 1/2), Teflon light tube, realistic scale.

NEXT-DEMO: Tracking with PMT plane (the UV and Blue periods) and with SiPM plane (the Ultramarine period)

ULTRAMARINE



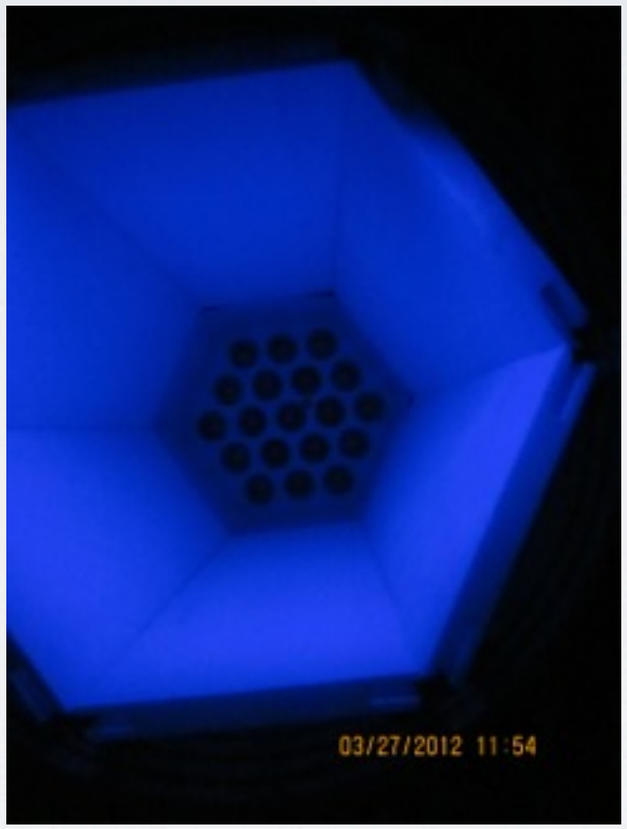
UV

Blue

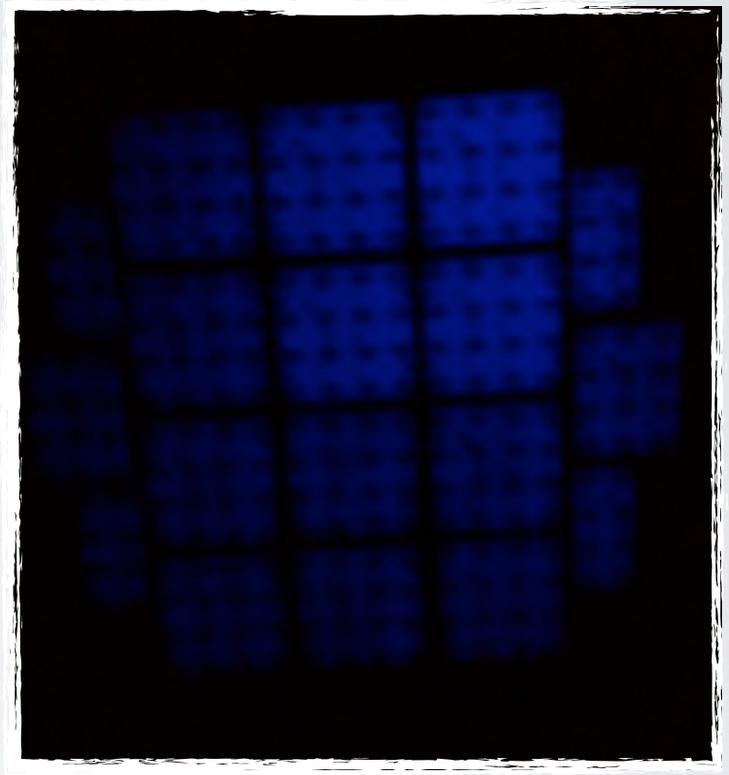
Ultramarine

ULTRAMARINE

UV

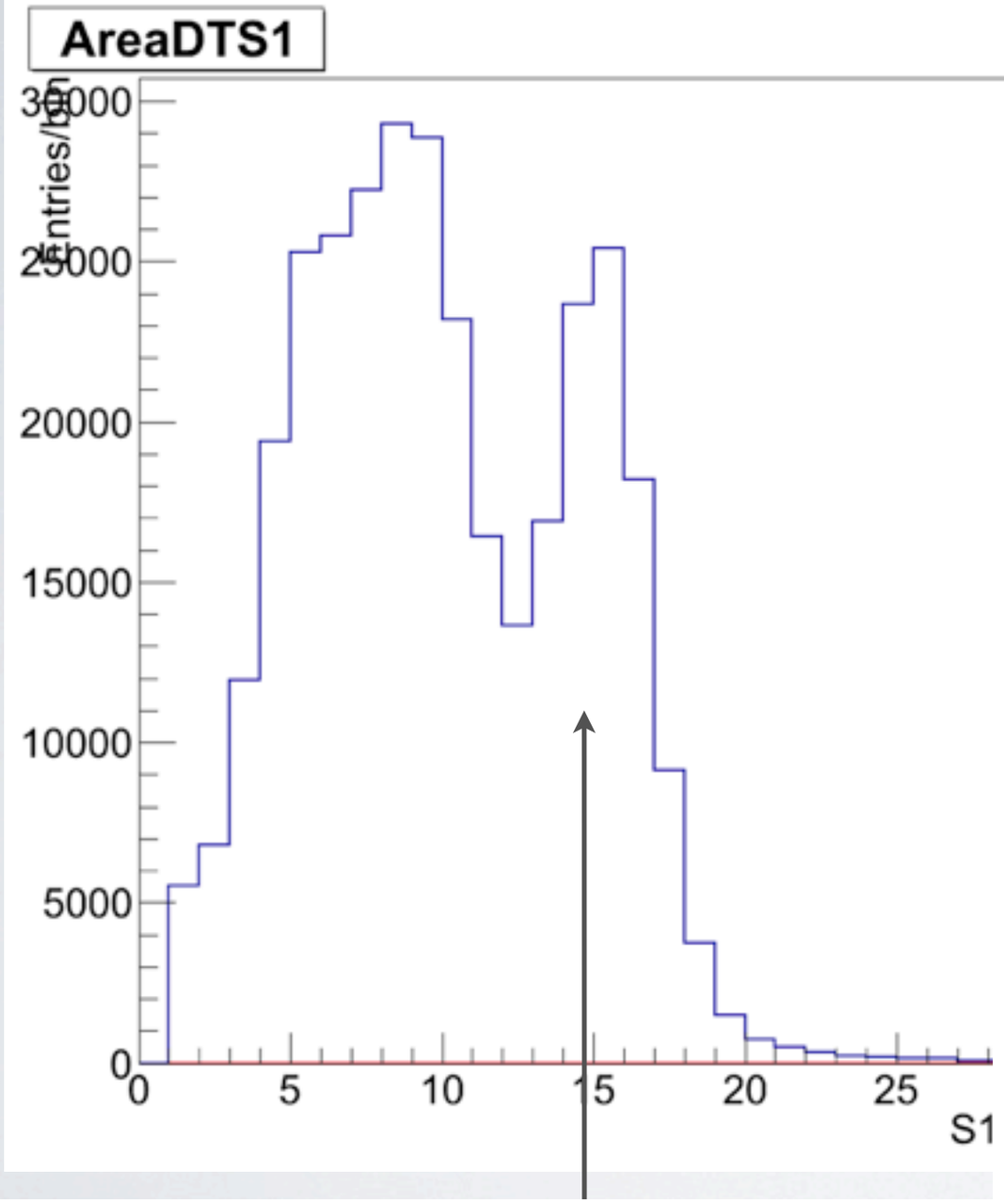


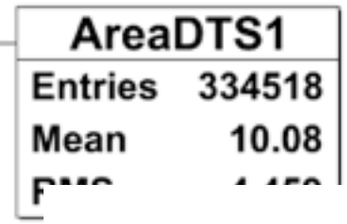
Blue



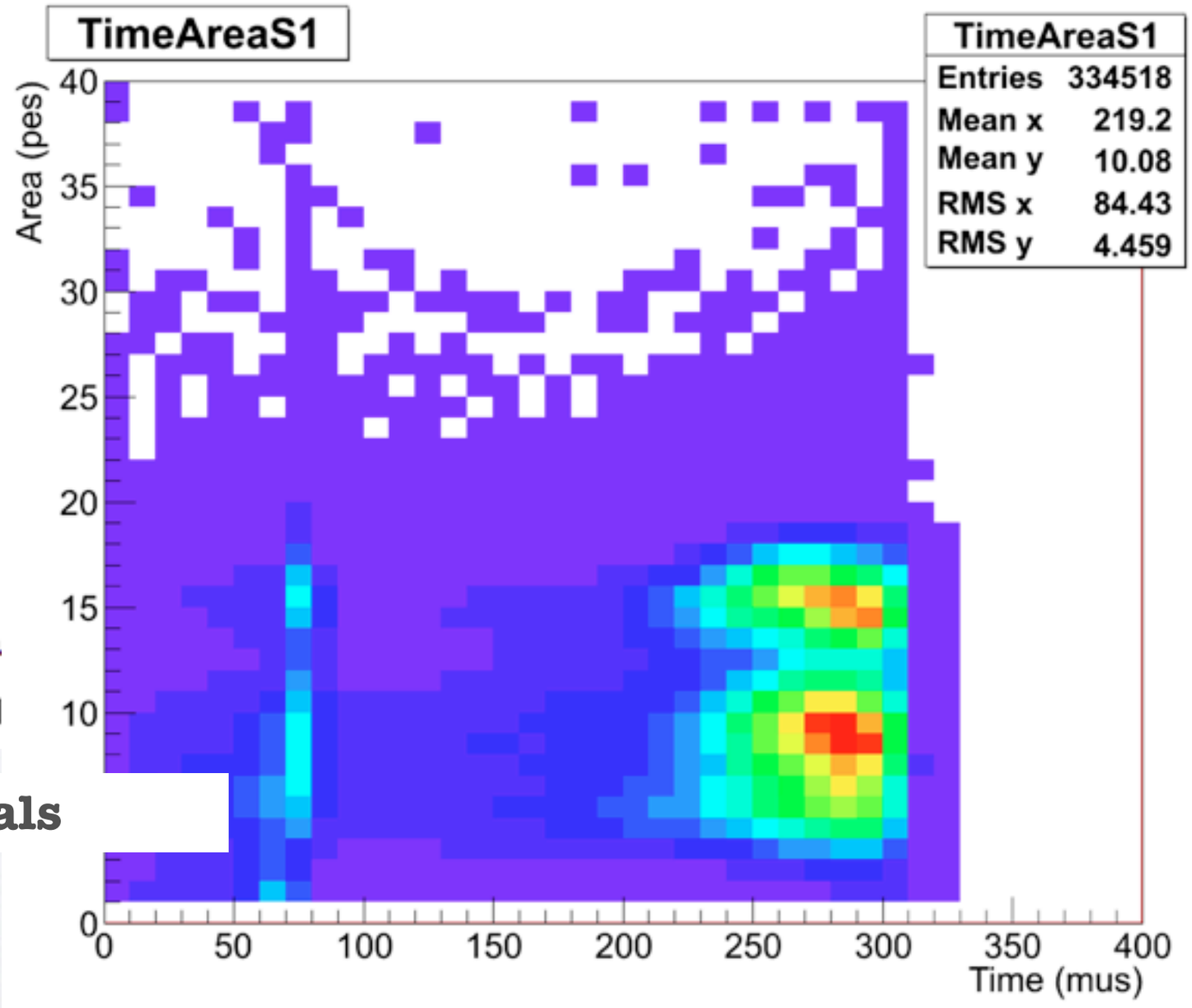
Ultramarine

3 times more light than in UV period





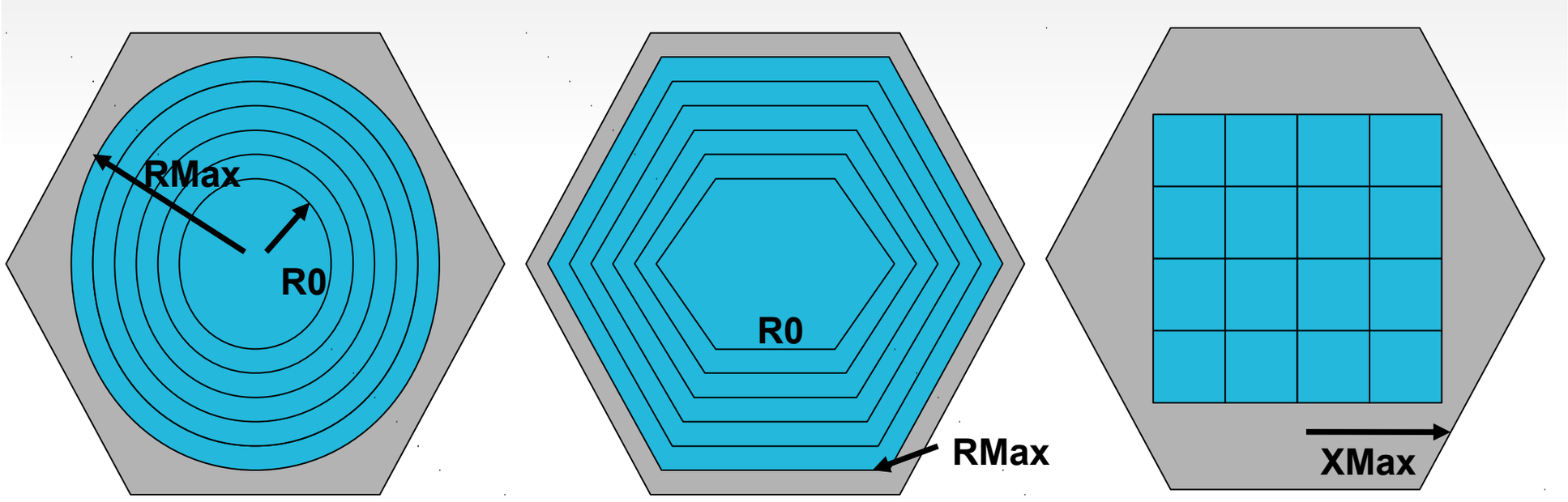
No attenuation in Z!



PE peak observed with S1 signals

EXTENDING RESOLUTION

- The area of the chamber is divided in different zones. The zones have the same area.



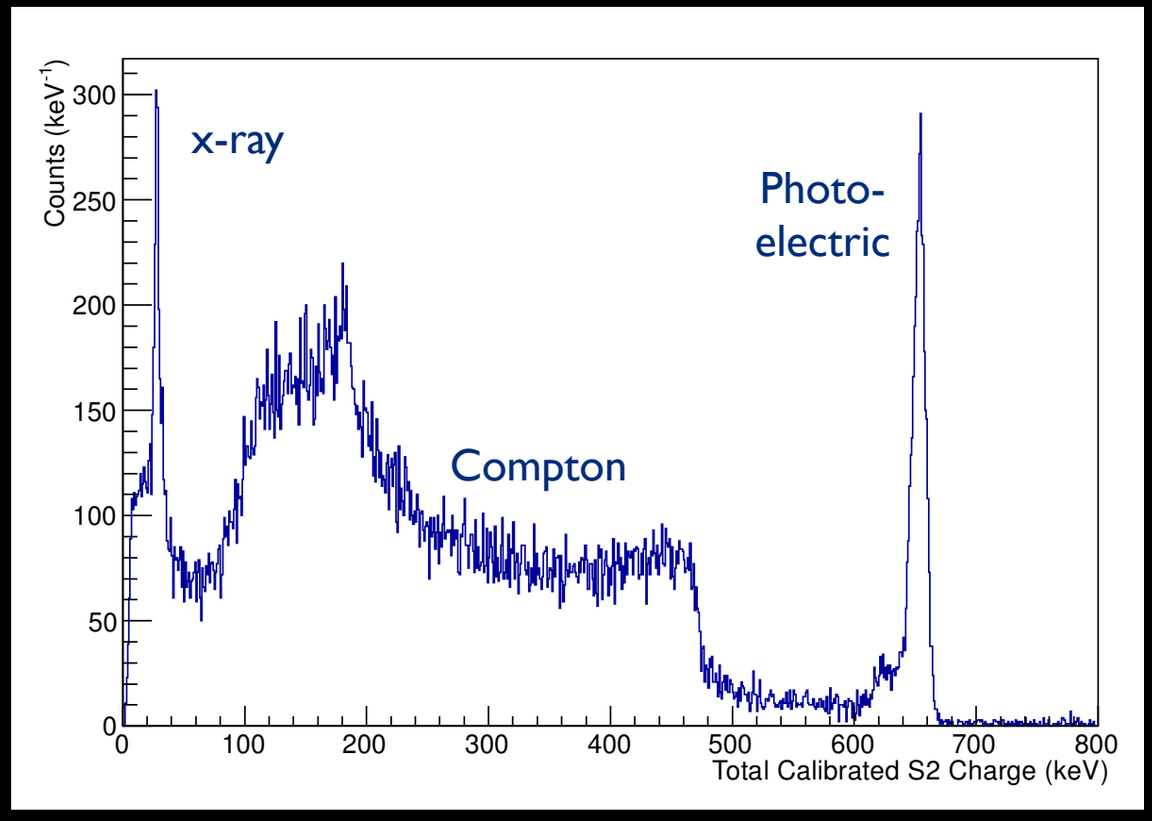
Circular zones | Hexagonal zones | Square zones

After full corrections in full fiducial: 1.% FWHM Qbb

Energy resolution demonstrated

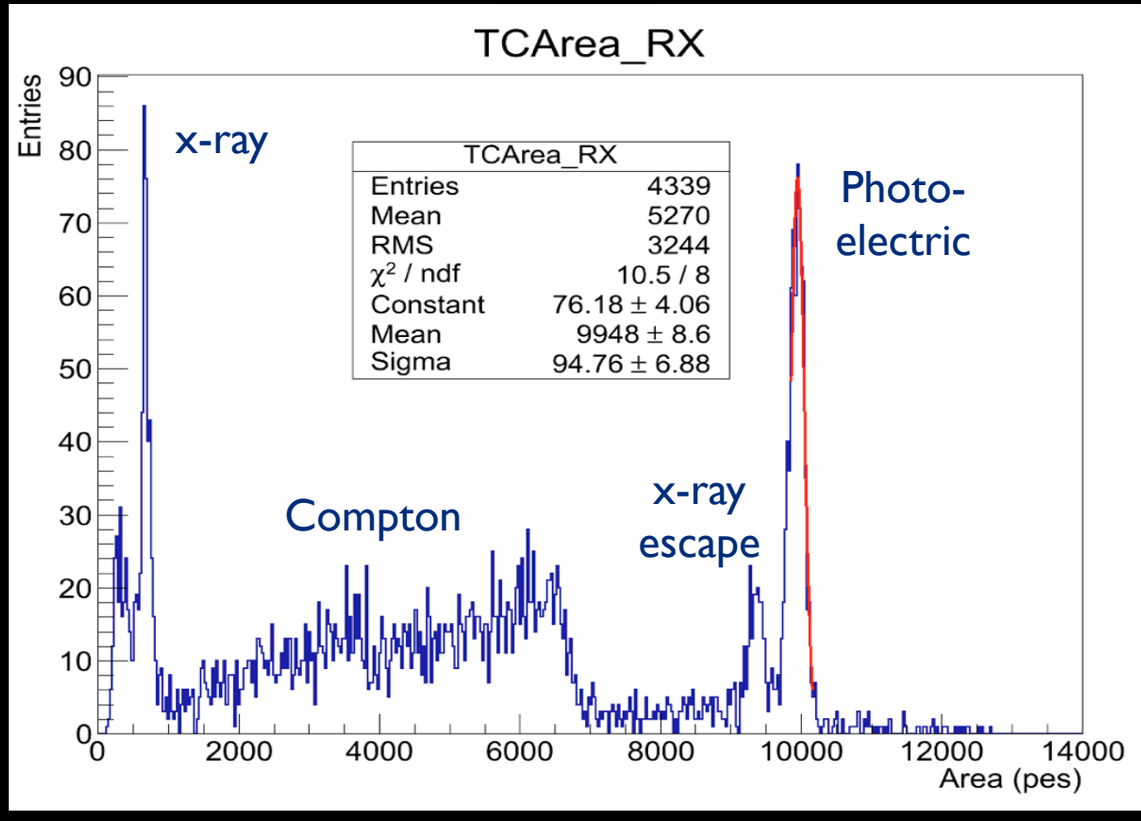
- **Experience and results from prototypes**
  - Testing ground for all foreseeable technical hurdles in NEXT-100
  - 0.5-1% FWHM energy resolution at $Q_{\beta\beta}$ demonstrated

Energy, 662 keV gammas from ^{137}Cs in NEXT-DBDM prototype

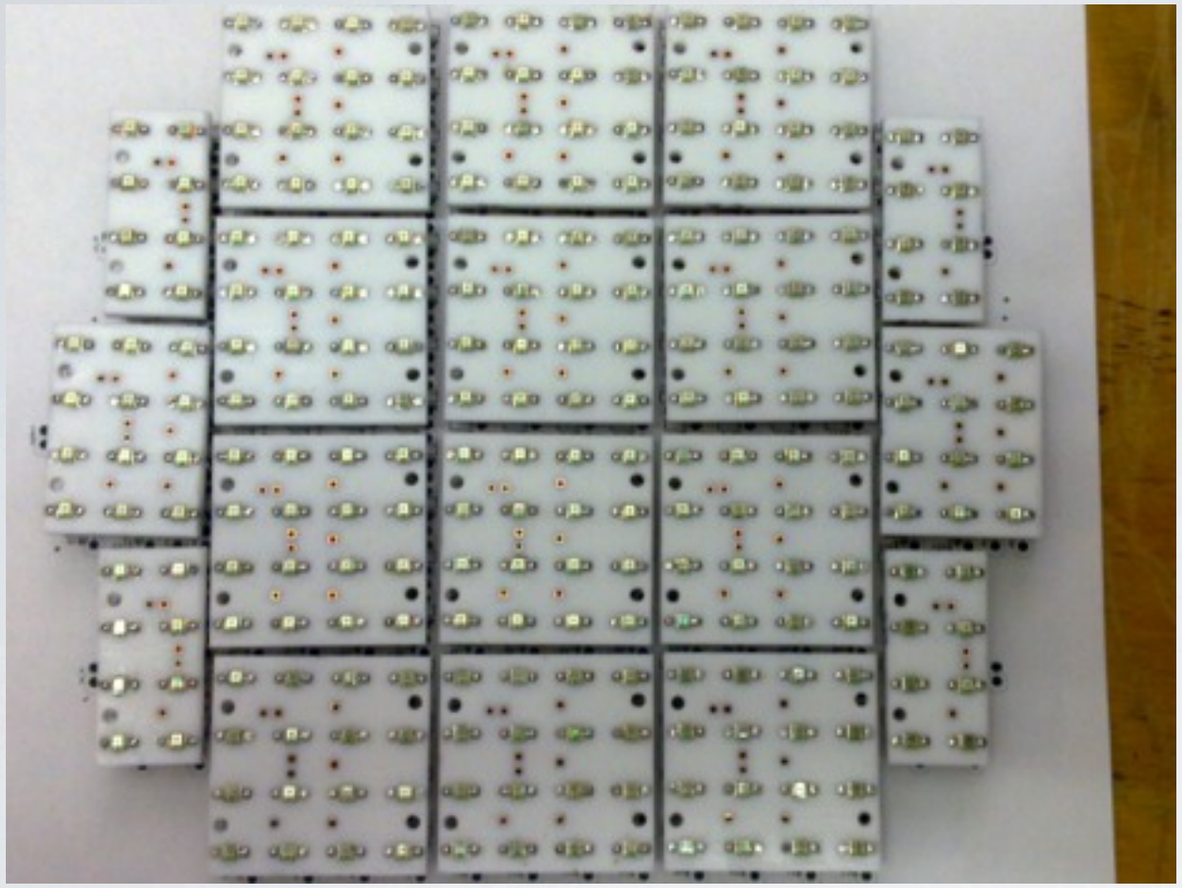


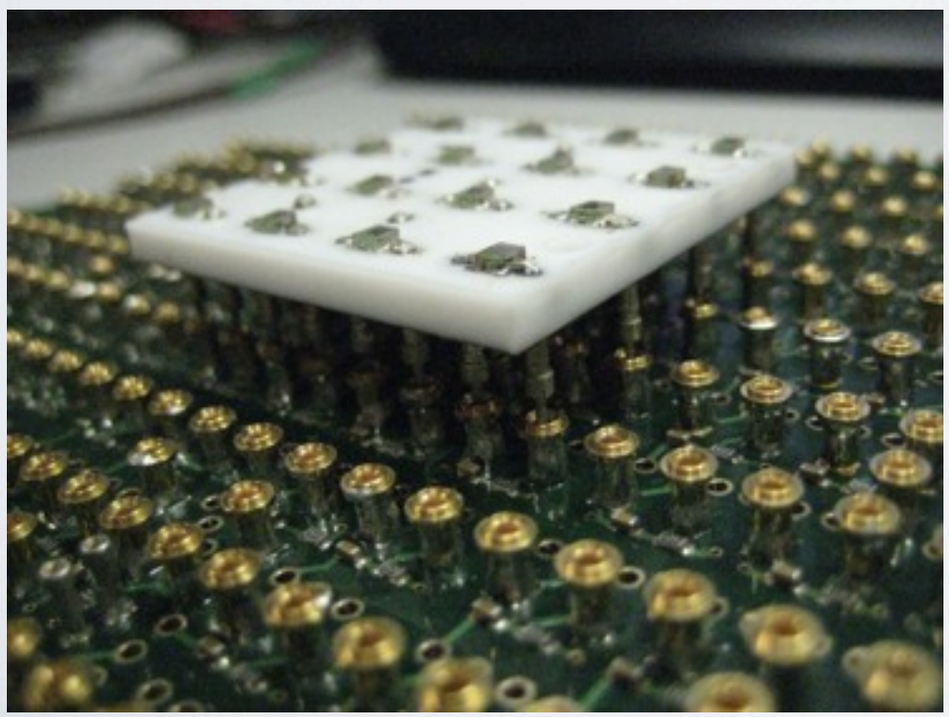
0.5% FWHM at Qbb in central region

Energy, 511 keV gammas from ^{22}Na in NEXT-DEMO prototype



1% FWHM at Qbb in full fiducial





Total: 248 Si-PMs

1 cm pitch

18 Daughter Boards

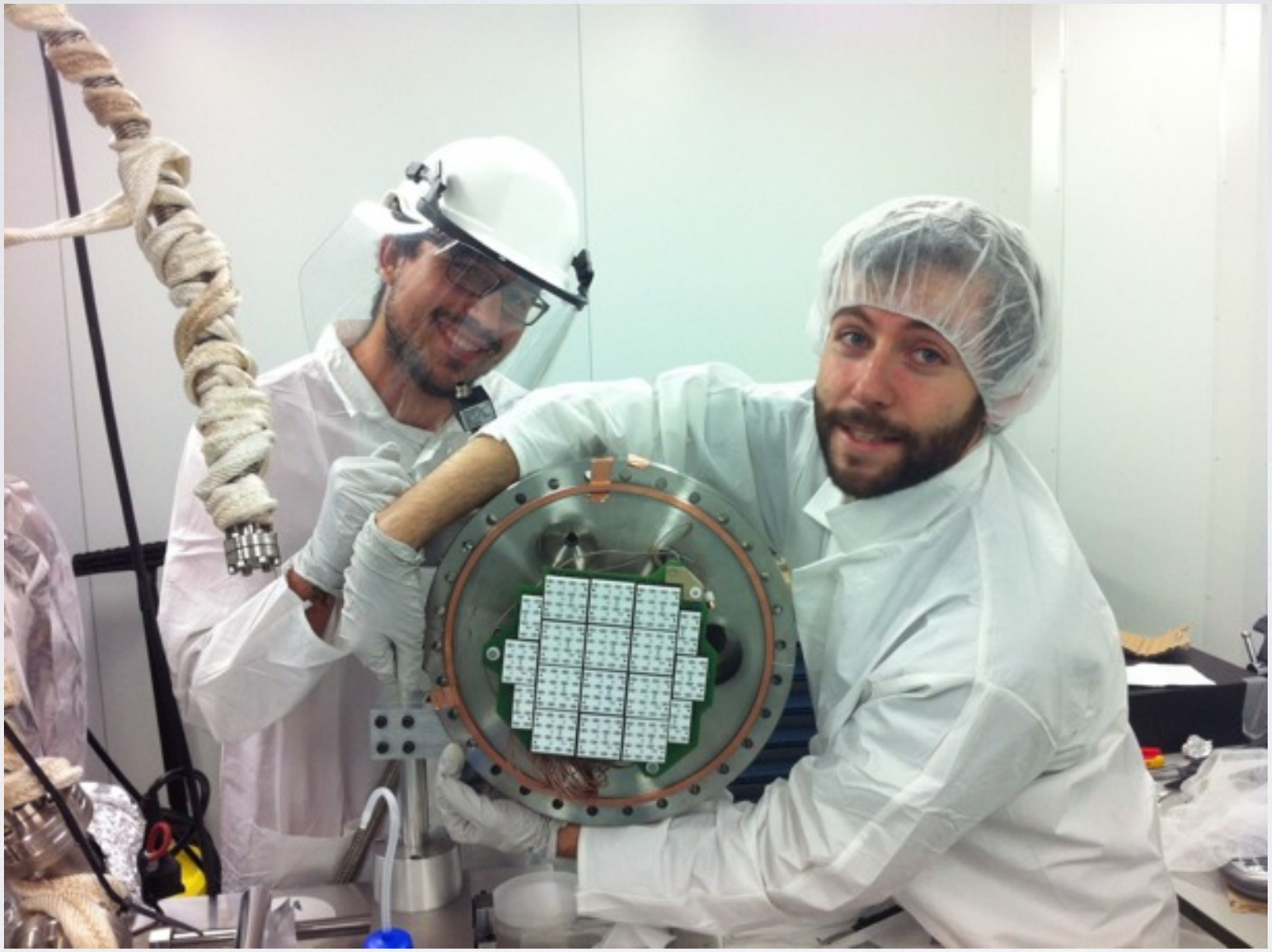
12 Boards with 16 SiPMs

2 Boards with 12 SiPMs

4 Boards with 8 SiPMs

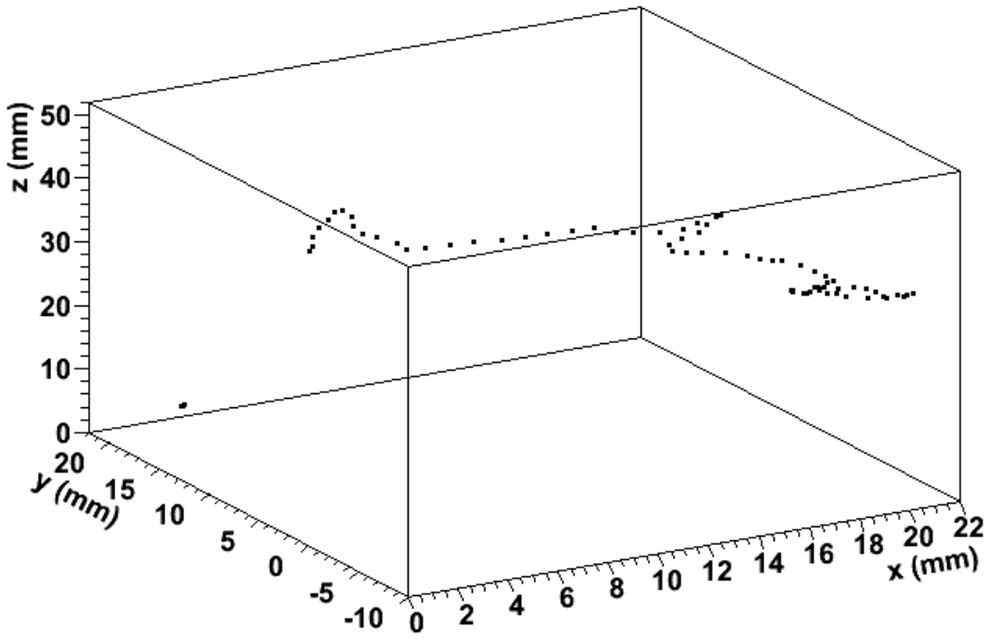
Spread in Gain < 4%

Installation in the detector



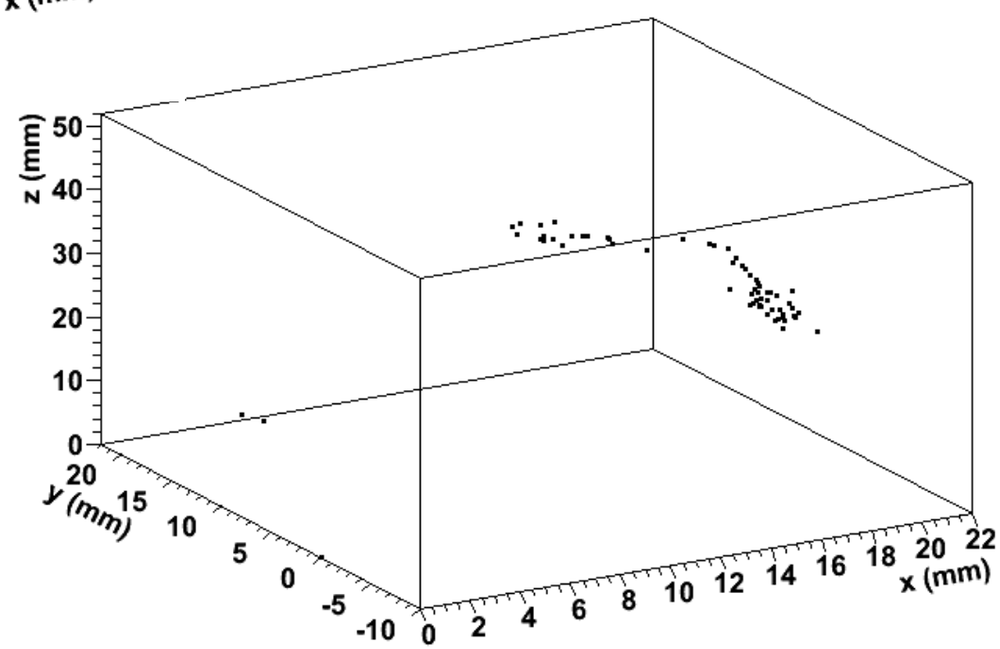
TRACK RECONSTRUCTION

Track reconstruction with SiPMs:

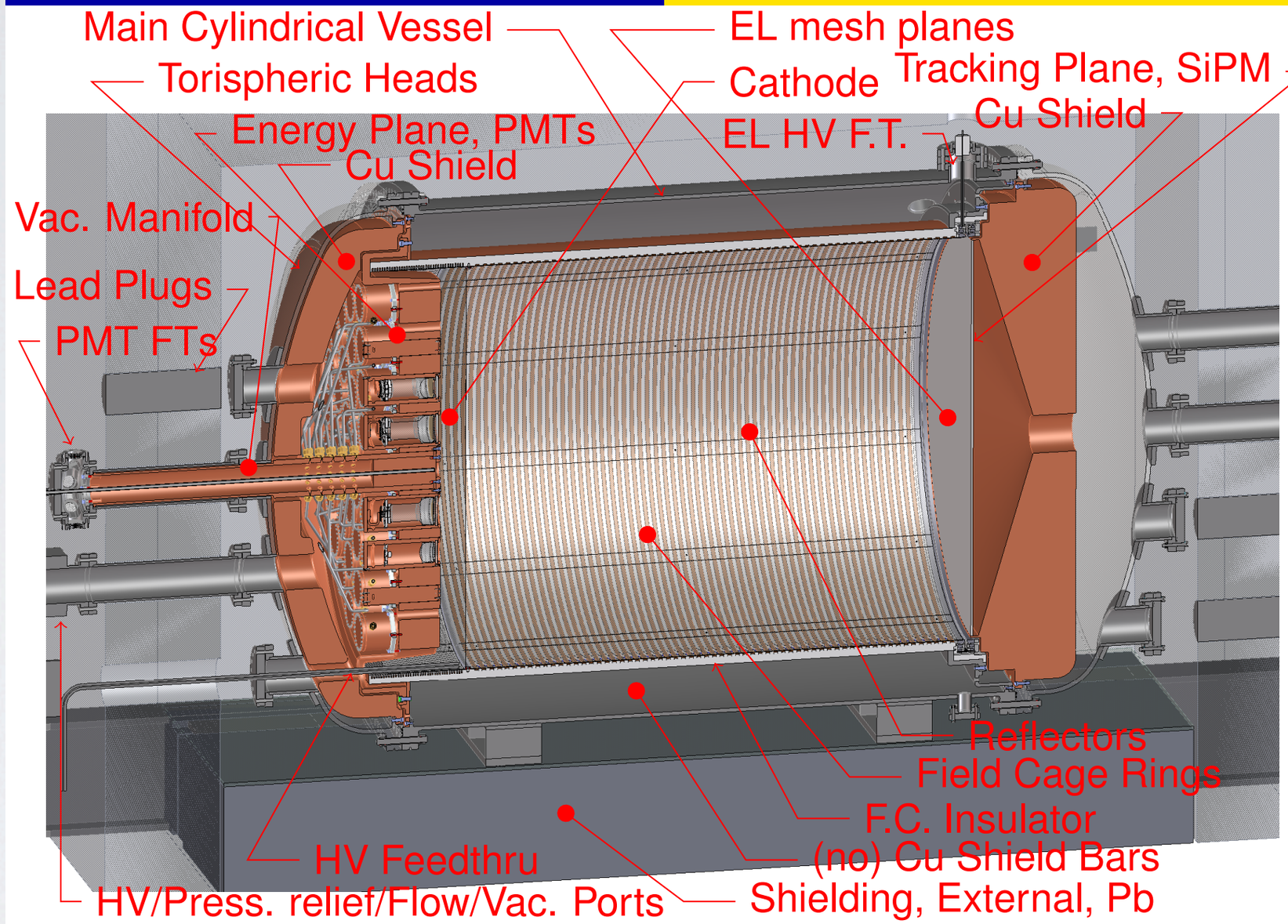


← MC Truth

Reconstructed →

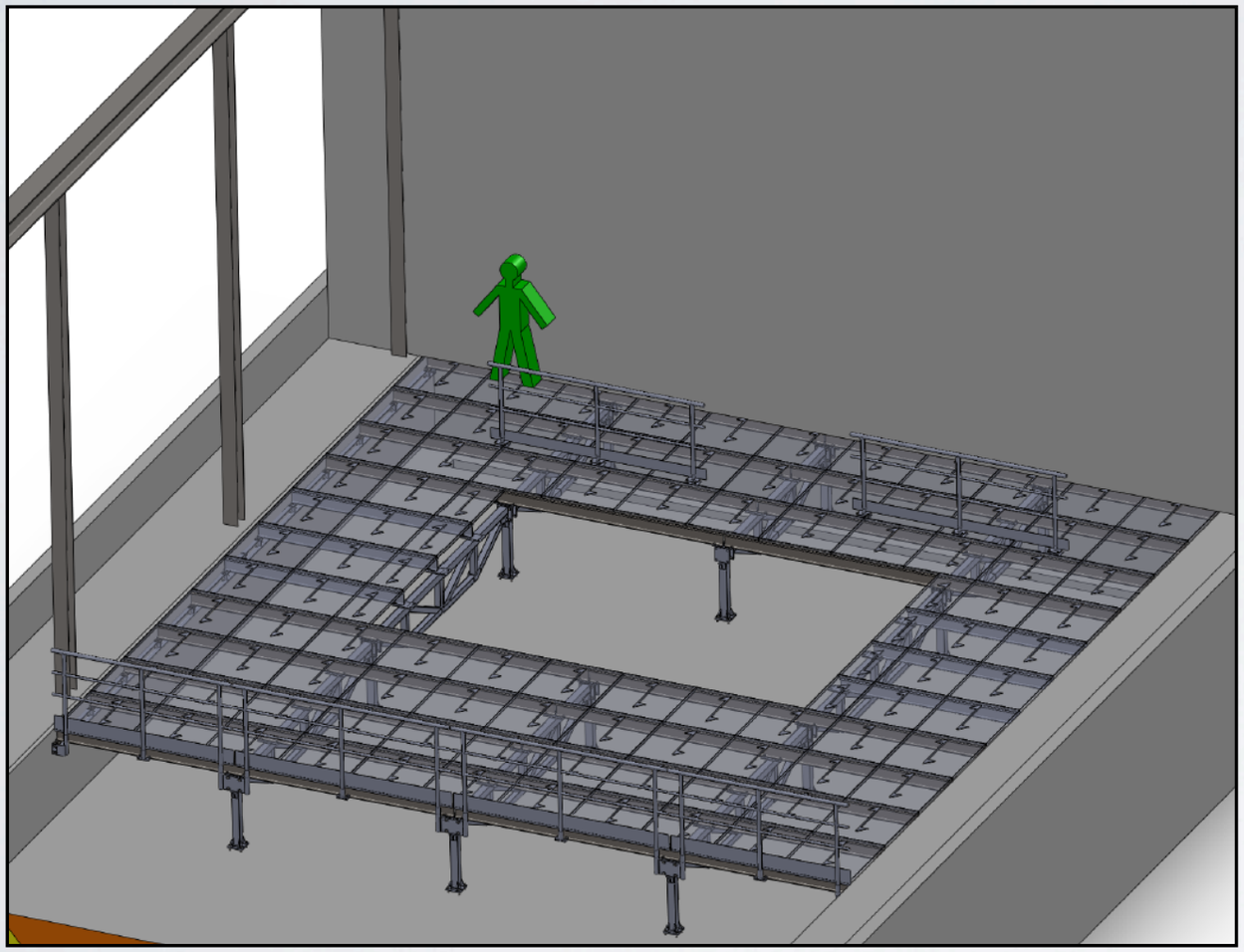


PRESSURE VESSEL

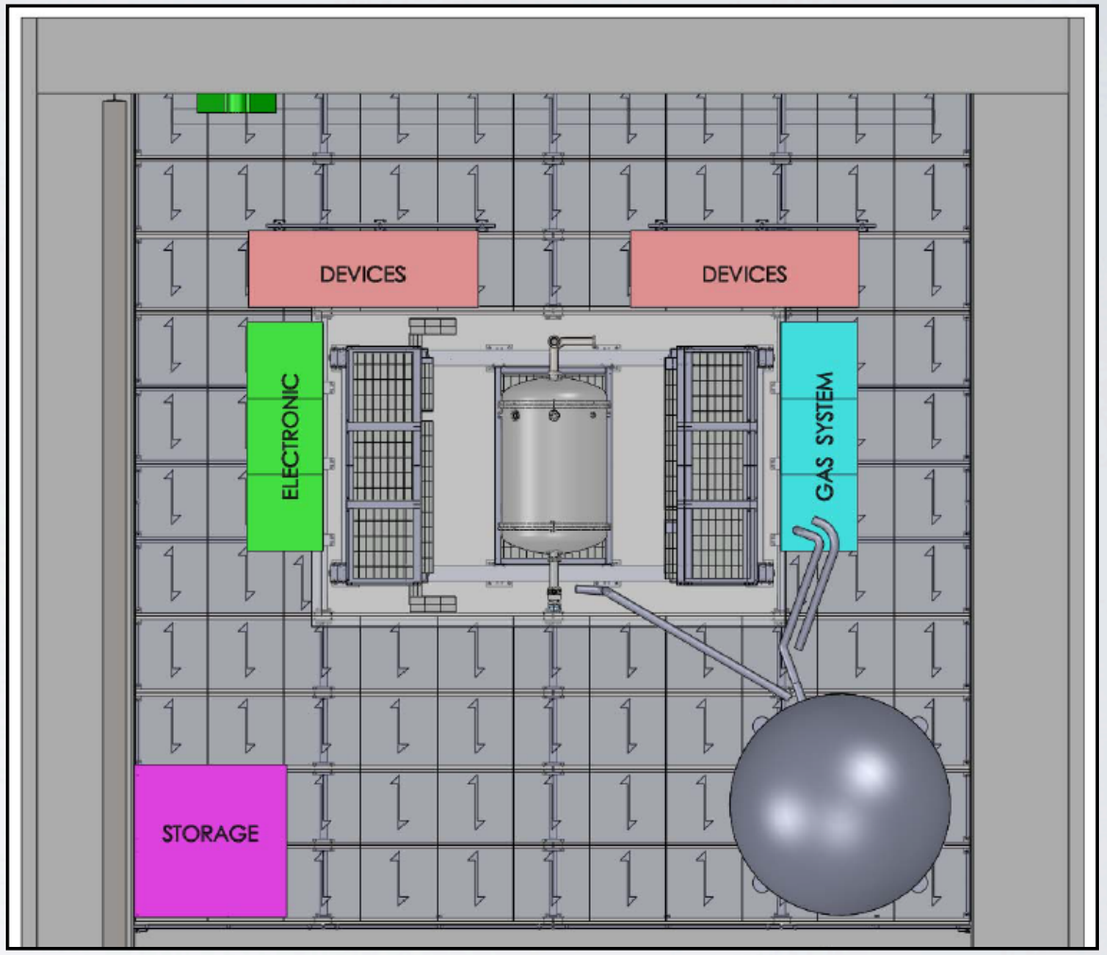


INFRASTRUCTURES

3D view of the work structure



Top view of the NEXT-100 layout



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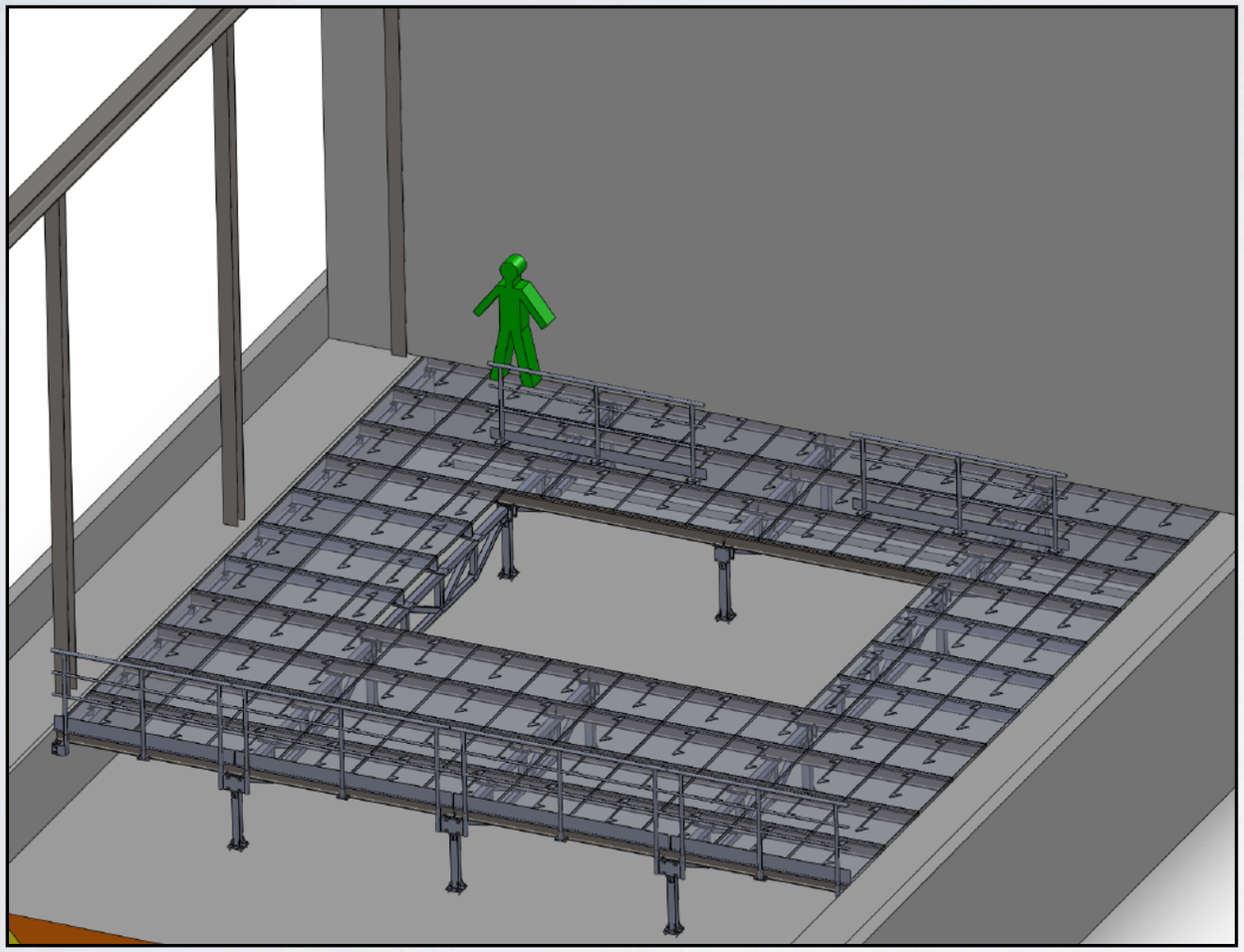

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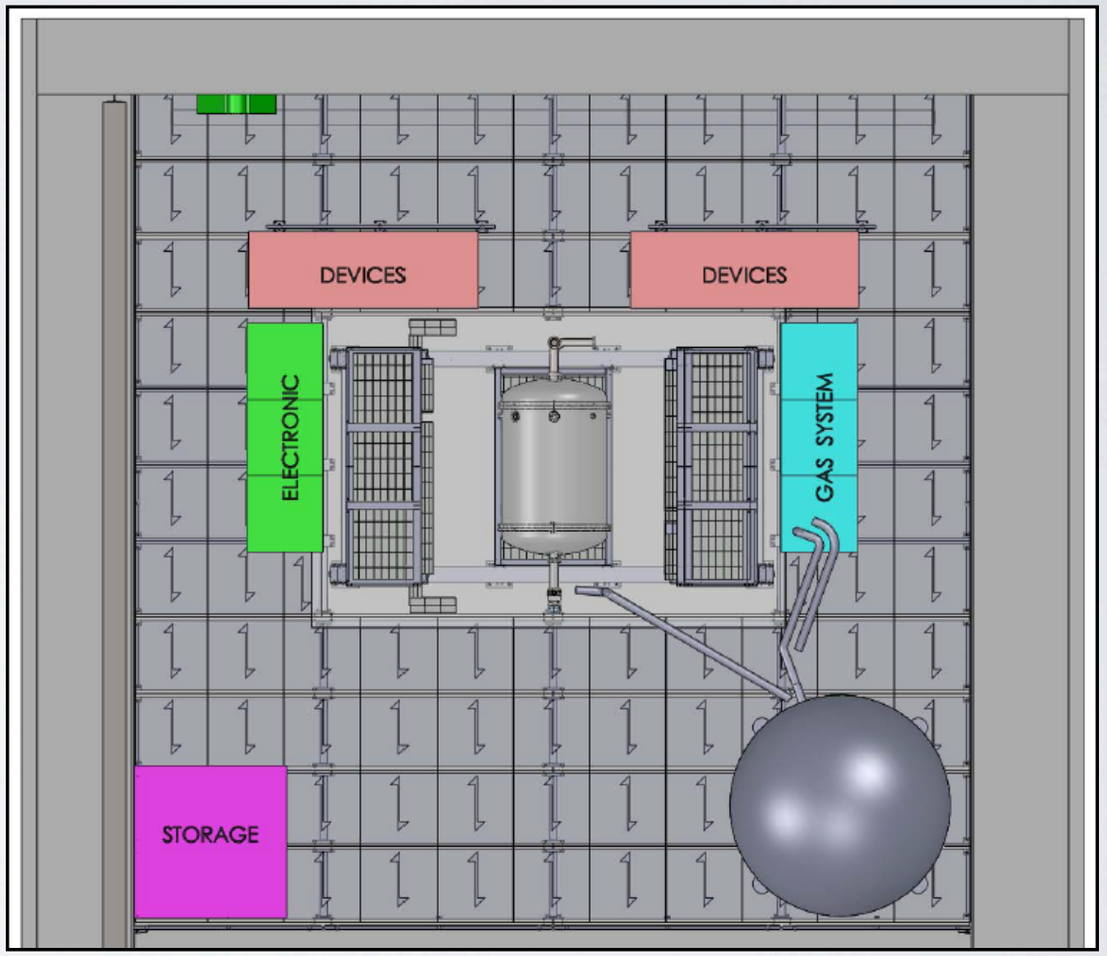
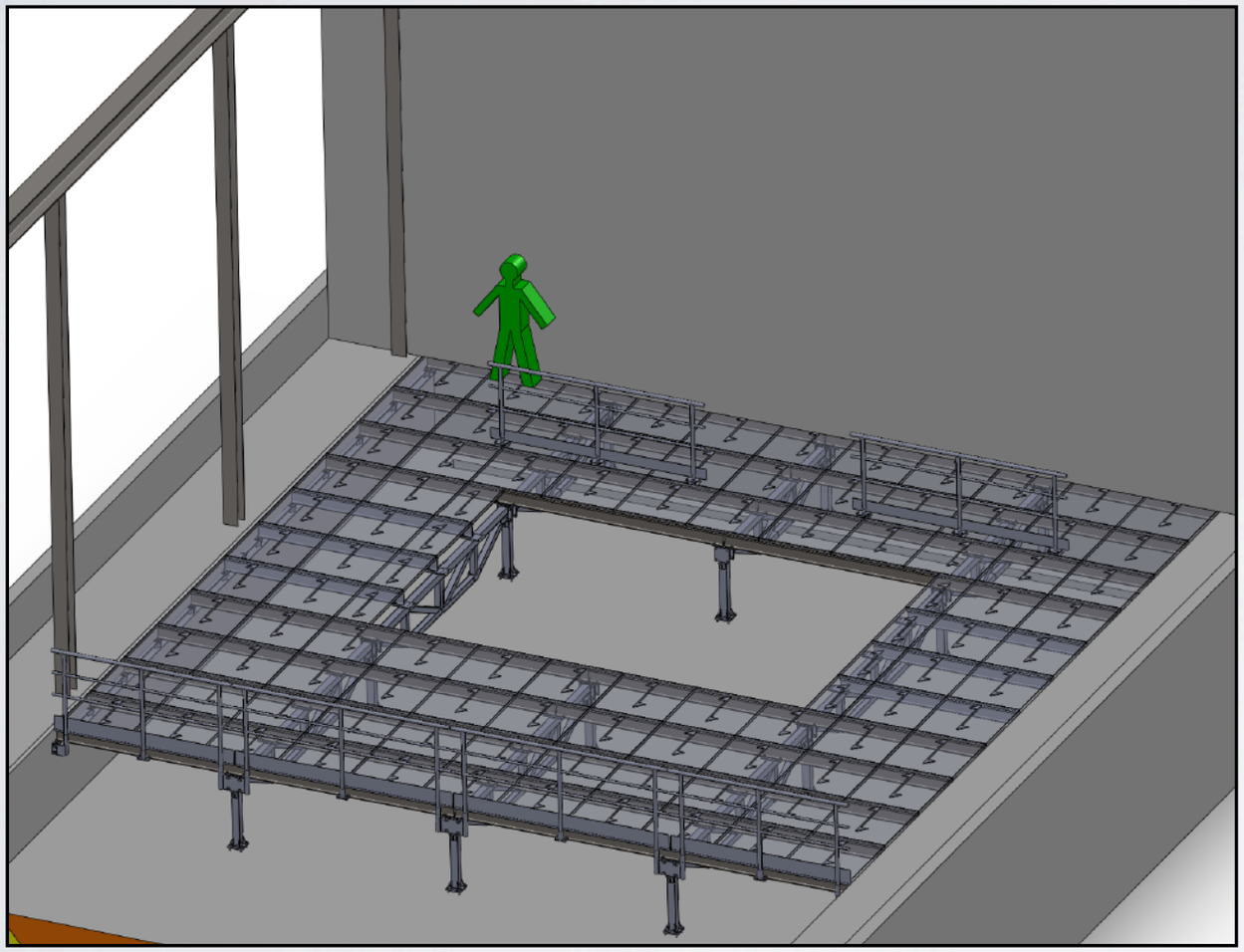


- Platform under construction!

INFRASTRUCTURES

3D view of the work structure



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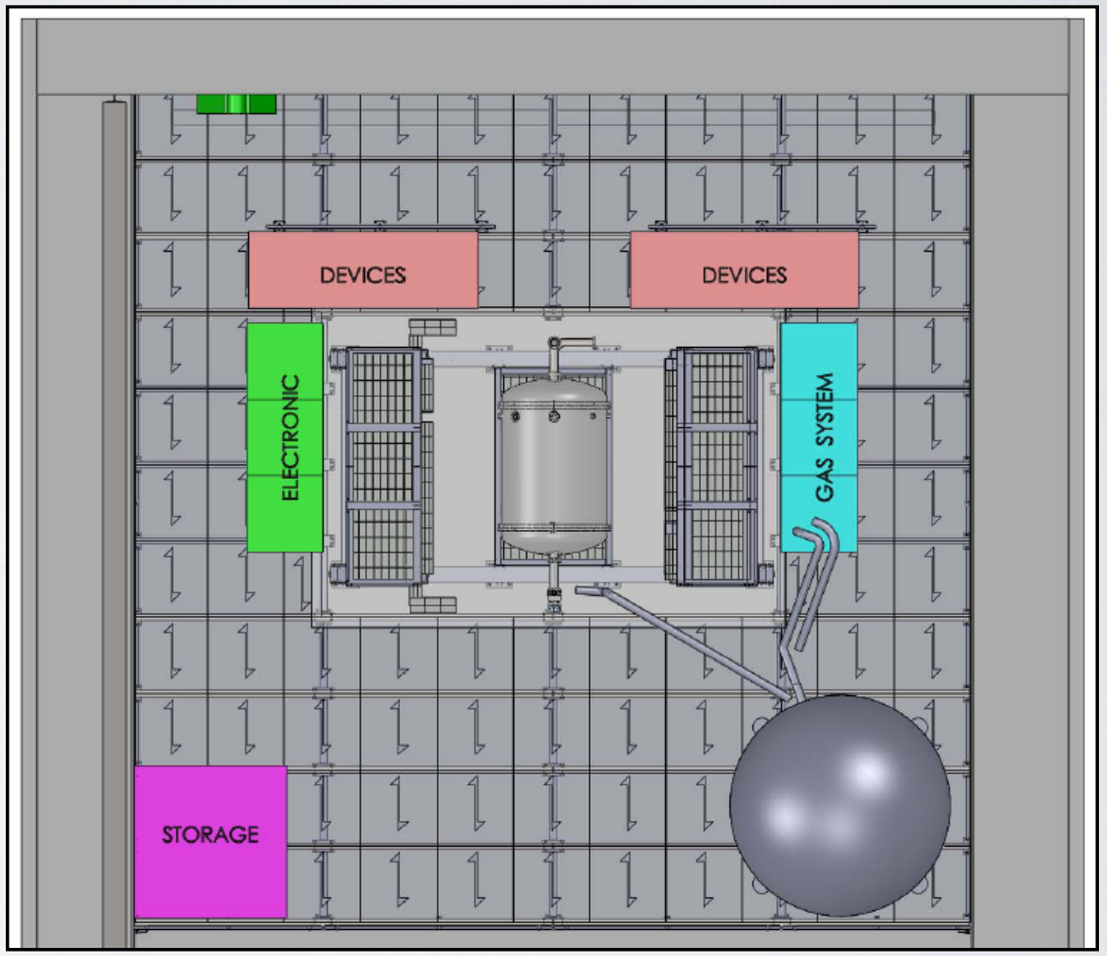
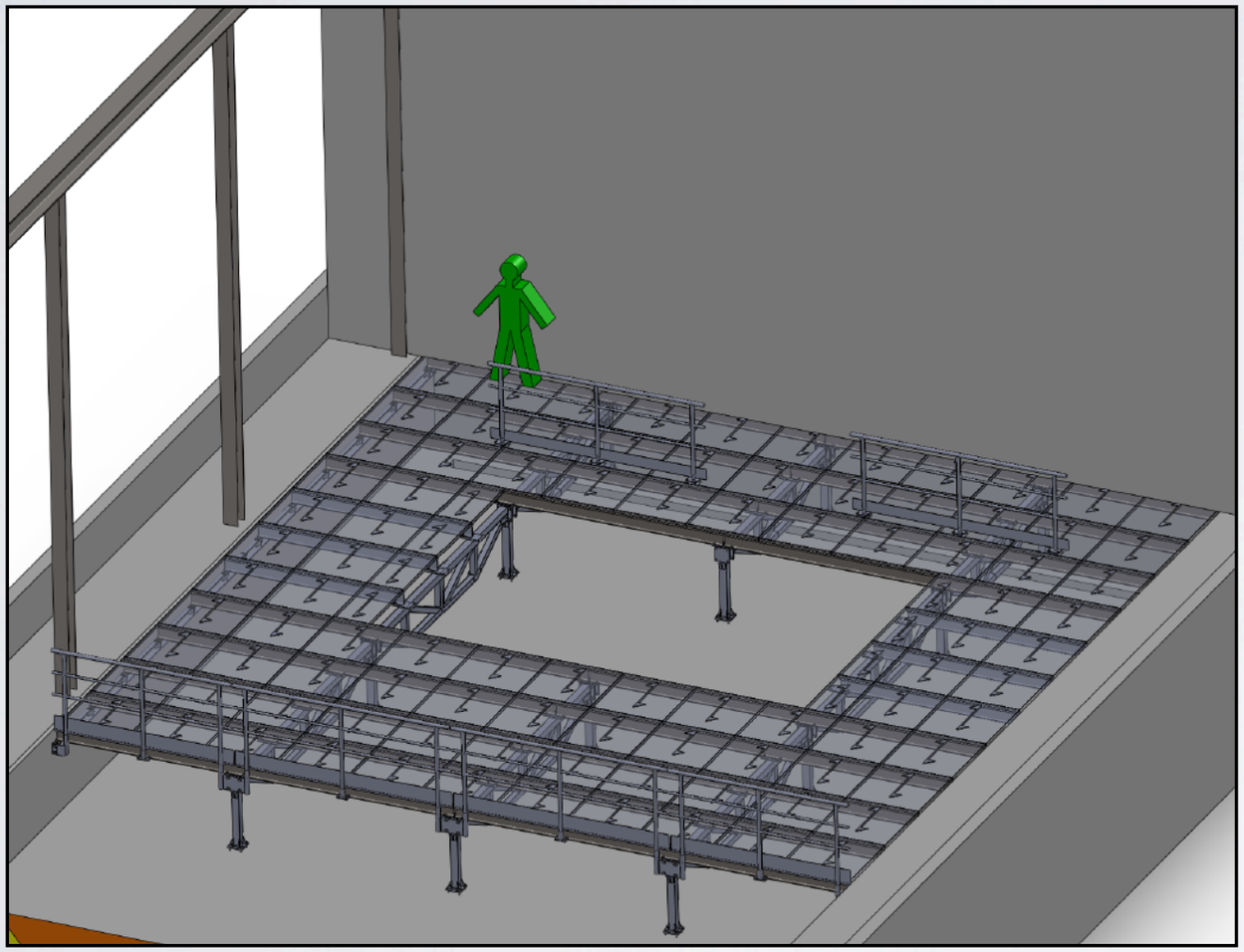


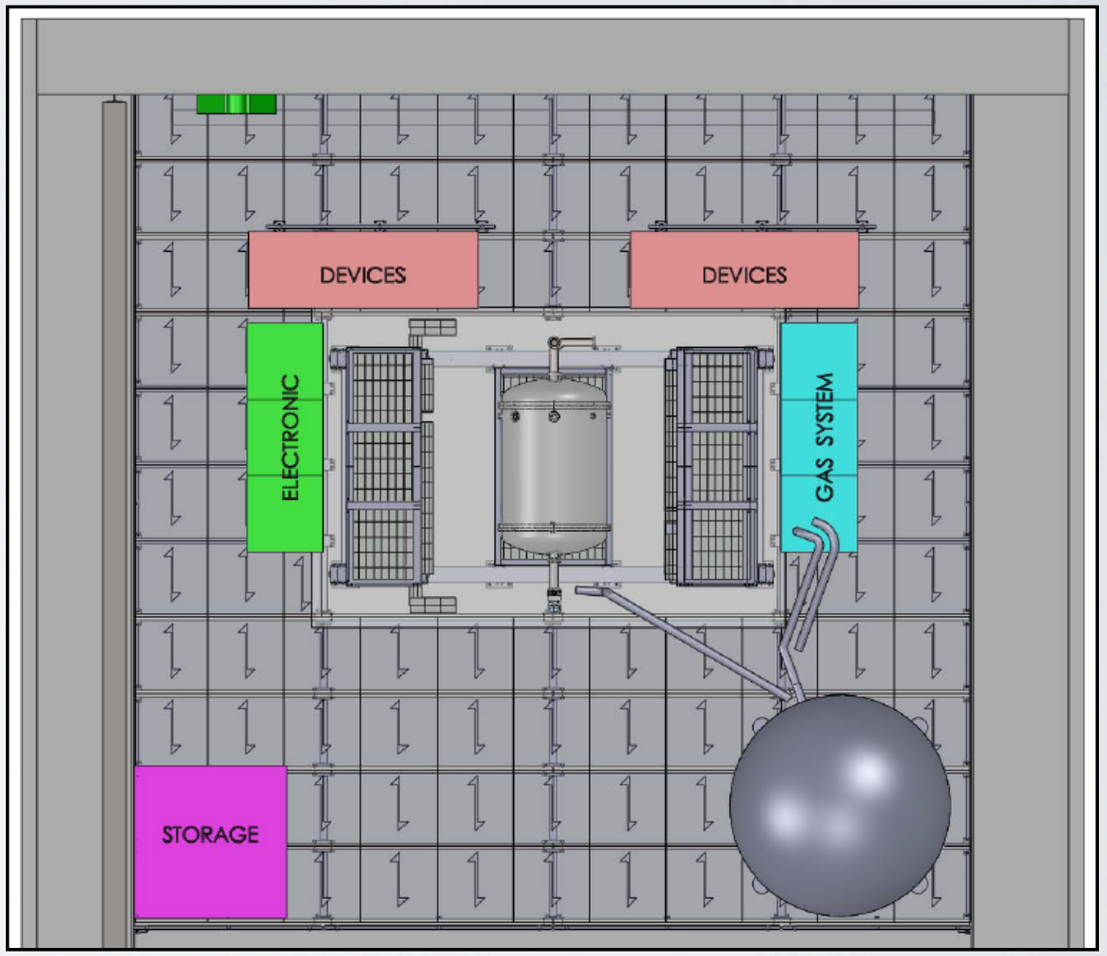
- Platform under construction!
- Gas system under construction!

INFRASTRUCTURES

3D view of the work structure



Top view of the NEXT-100 layout



- Platform under construction!
- Gas system under construction!
- Planning integration

Results: 316Ti stainless steel

Material: 316Ti stainless steel

Supplier: Nironit

Results: 316Ti stainless steel

Material: 316Ti stainless steel

Supplier: Nironit

➢ **10 mm** (PV body)

Sample: 49 pieces ~45x45x11 mm^3

Mass: **7.6837 kg**

Detector: GeTobazo

Time: 25 January - 8 March 2012, **33 d**

Results: 316Ti stainless steel

Material: 316Ti stainless steel

Supplier: Nironit

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Sample: 49 pieces ~45x45x11 mm^3

Mass: **7.6837 kg**

Detector: GeTobazo

Time: 25 January - 8 March 2012, **33 d**

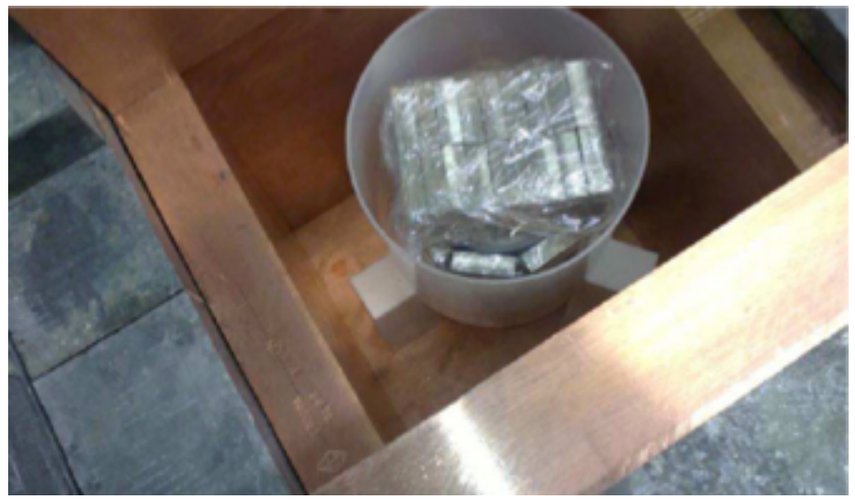
➢ **15 mm** (PV end-caps)

Sample: 40 pieces ~45x45x15 mm^3

Mass: **10.2051 kg**

Detector: GeTobazo

Time: 11 March – 24 April 2012, **35.61 d**



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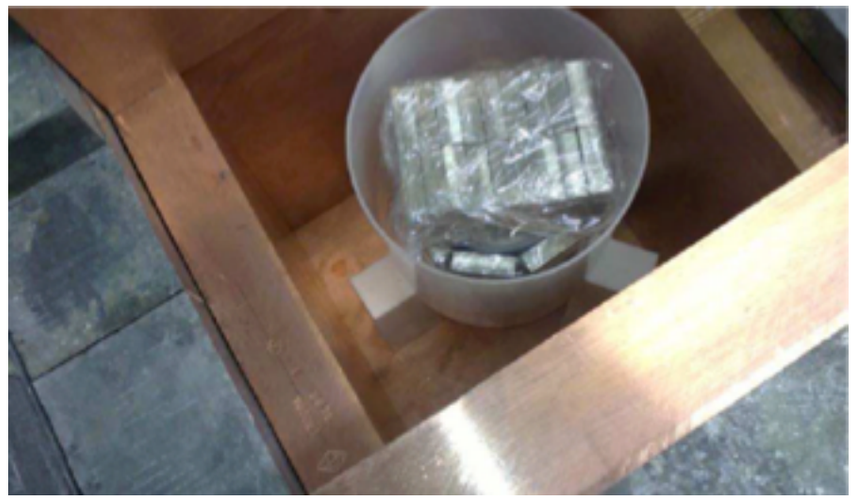
Mass: **10.2051 kg**

Detector: GeTobazo

Time: 11 March – 24 April 2012, **35.61 d**



➢ **50 mm** (PV flanges)

Sample: 6 pieces ~45x45x50 mm^3

Mass: **4.8159 kg**

Detector: GeAnayet

Time: 8 March – 19 April 2012, **34.72 d**

Project Concept

2012

Prototypes
Demonstrate performance
Validate technology

Screening/Rpurity
Select components
Background Model

Design
Mechanics/Electronics
Sensors

2013

Detector Construction
Build core systems
Assemble detector

Software Tools
Offline/Montecarlo/Calib
DAQ/Online

2014

NXE run
Commission detector
Upgrade systems
Demonstrate safety
Refine software tools

2015

EXE run
Calibrate detector
Physics

Budget

WP 1: Vessel	363,000	CUP (available)
WP2: Gas System	328,000	CUP + new funding
WP3: Infrastructure	419,100	LSC help. new funding
WP4: Field Cage	41,400	USA. Costs may rise due to prototyping
WP5: Energy Plane Mechanics	376,000	USA.
WP6: Energy Plane Sensors	380,400	CUP (payed)
WP7: Tracking Plane Mechanics	87,000	CUP (available)
WP8: Tracking Plane Sensors	103,000	CUP (payed)
WP9: Tracking Plane FEE	88,375	USA or new funding
WP10: DAQ	123,070	USA or new funding
WP11: Offline	12,000	
WP12: Slow Control	23,000	New funding
WP13: Radio Purity	5,000	
WP14: Calibration	24,000	
TOTALS	2,373,345	

SUMMARY

- Basic R&D essentially completed. Feasibility of the project demonstrated. Excellent results from prototypes. Excellent evaluations from LSC-SC and from CONSOLIDER.

- Strong and united collaboration. TDR published. USA groups contributing to a large share of the project.

- Goals of CUP achieved: know-how acquired in Spain, state-of-the art labs. NEXT-DEMO detector is the largest operating EL TPC in the world. Ready to build a major bb0nu experiment

SCHEDULE

- Construction schedule being kept so far.
- Funding from CUP available one more year.
- 1 M€ needed to complete construction
- 1 M€ needed to keep the man power.
- Applying to funds again in 2012 (not to FPA).

CONCLUSION

- CUP has made possible the launching of the NEXT project, which so far is being a success. An international collaboration has been built and the possibility of running a first class bbOnu experiment exists.

- However there is no funding plan for NEXT beyond CUP. We have no evidence that the FPA community has interest in supporting the effort (we have evidence of the contrary).

- Without additional resources the project will be jeopardized and a major scientific opportunity will be lost.

THANKS FOR YOUR ATTENTION