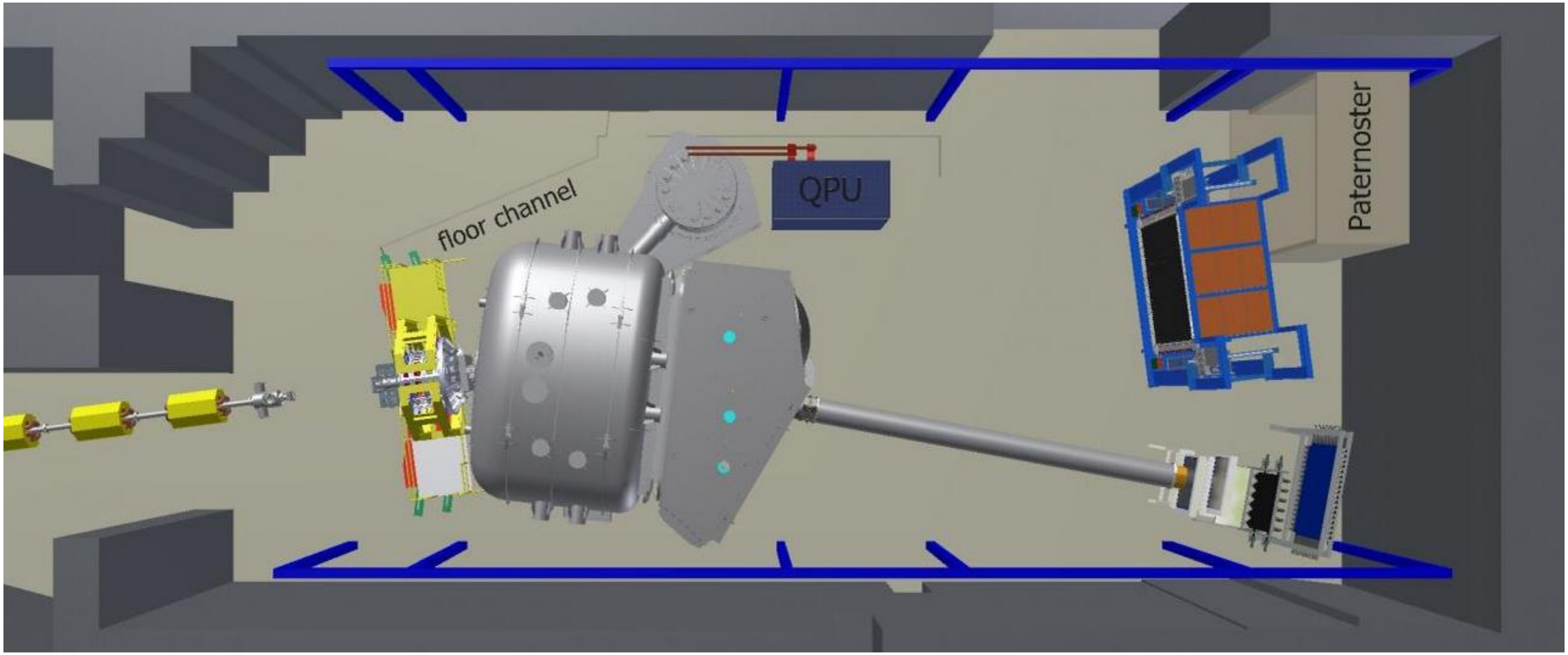
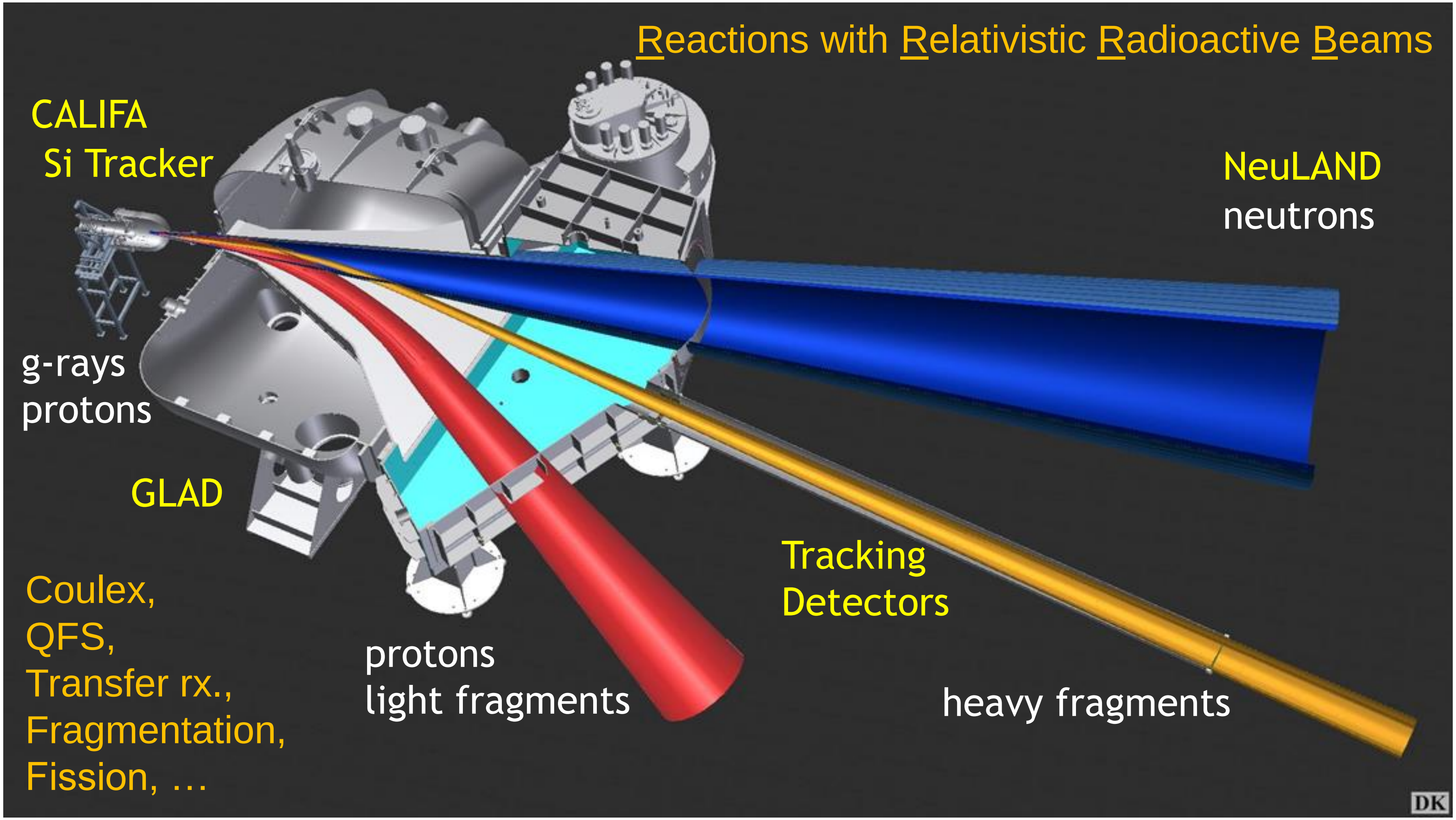
R3B Status Report

NUSTAR Annual Meeting 2018

Dominic Rossi



R3B Overview



R3B Overview

Tracking

L3T Si tracker

ACTAF 2 (1^{st} stage)

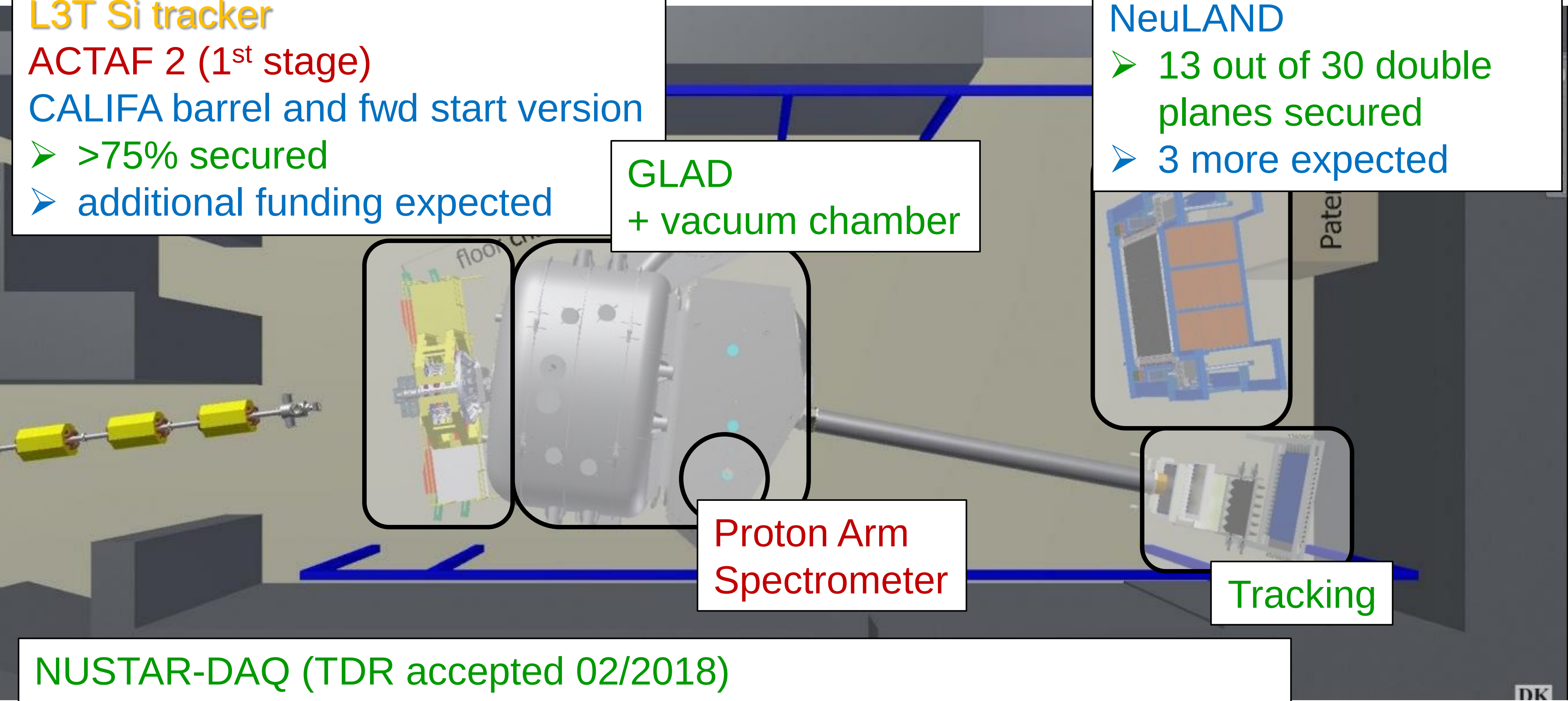
CALIFA barrel and fwd start version

- >75% secured
- additional funding expected

GLAD
+ vacuum chamber

NeuLAND

- 13 out of 30 double planes secured
- 3 more expected



Proton Arm Spectrometer

Tracking

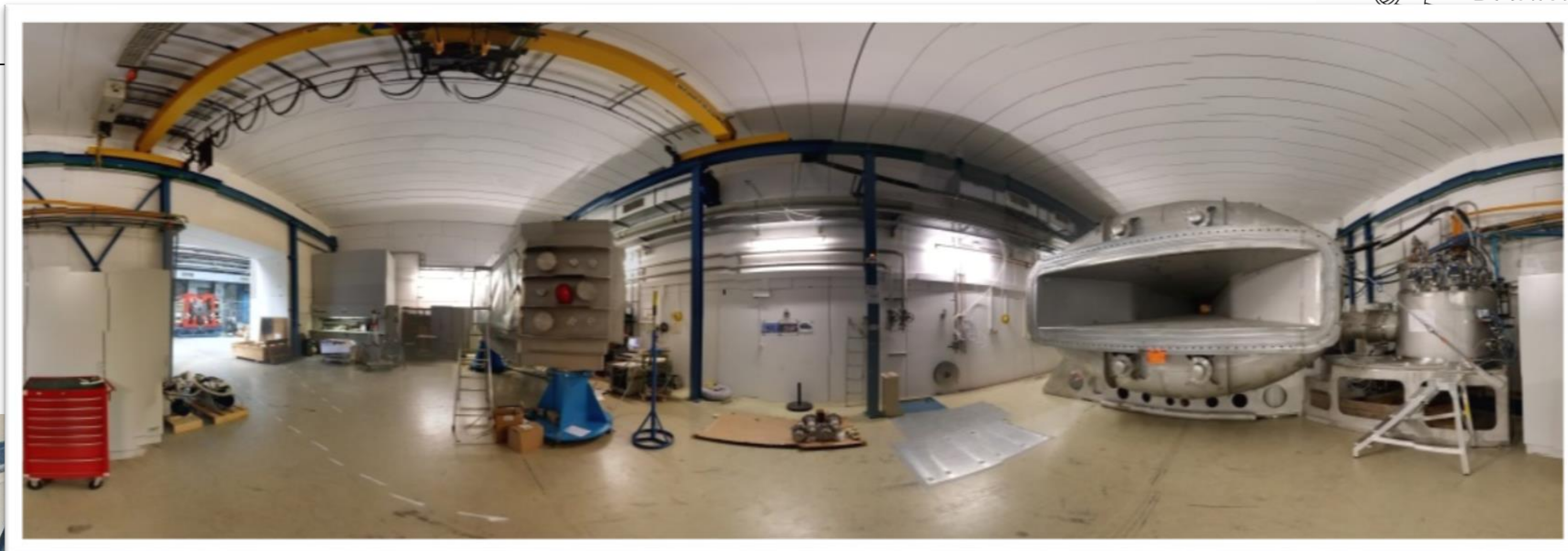
NUSTAR-DAQ (TDR accepted 02/2018)

-Time stamps (first implementation)/local trigger logics/readout libraries

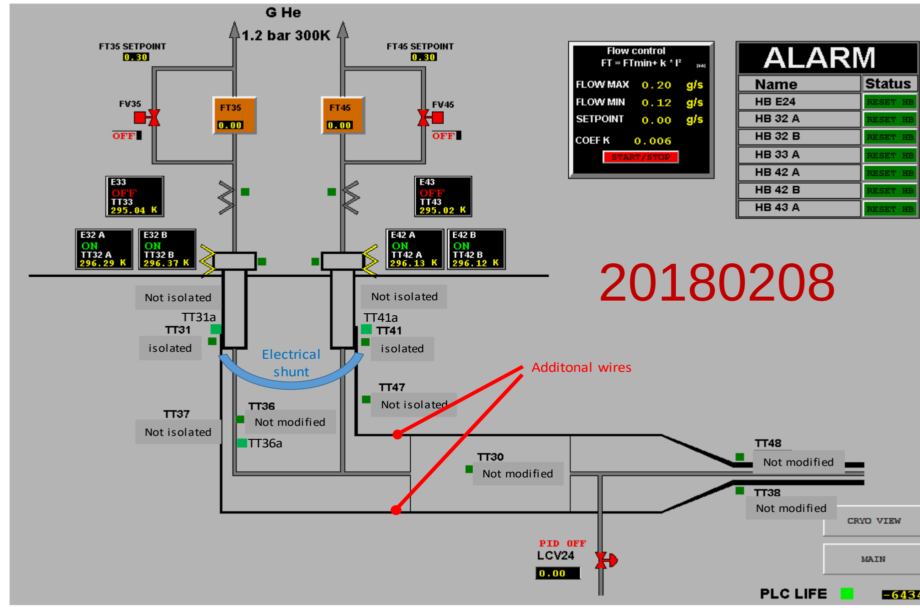
-Online analysis R³B-Root ← FAIR-Root

Courtesy of H. Simon

GLAD: Installation in Cave C in 2016



GLAD Commissioning



Open issues:

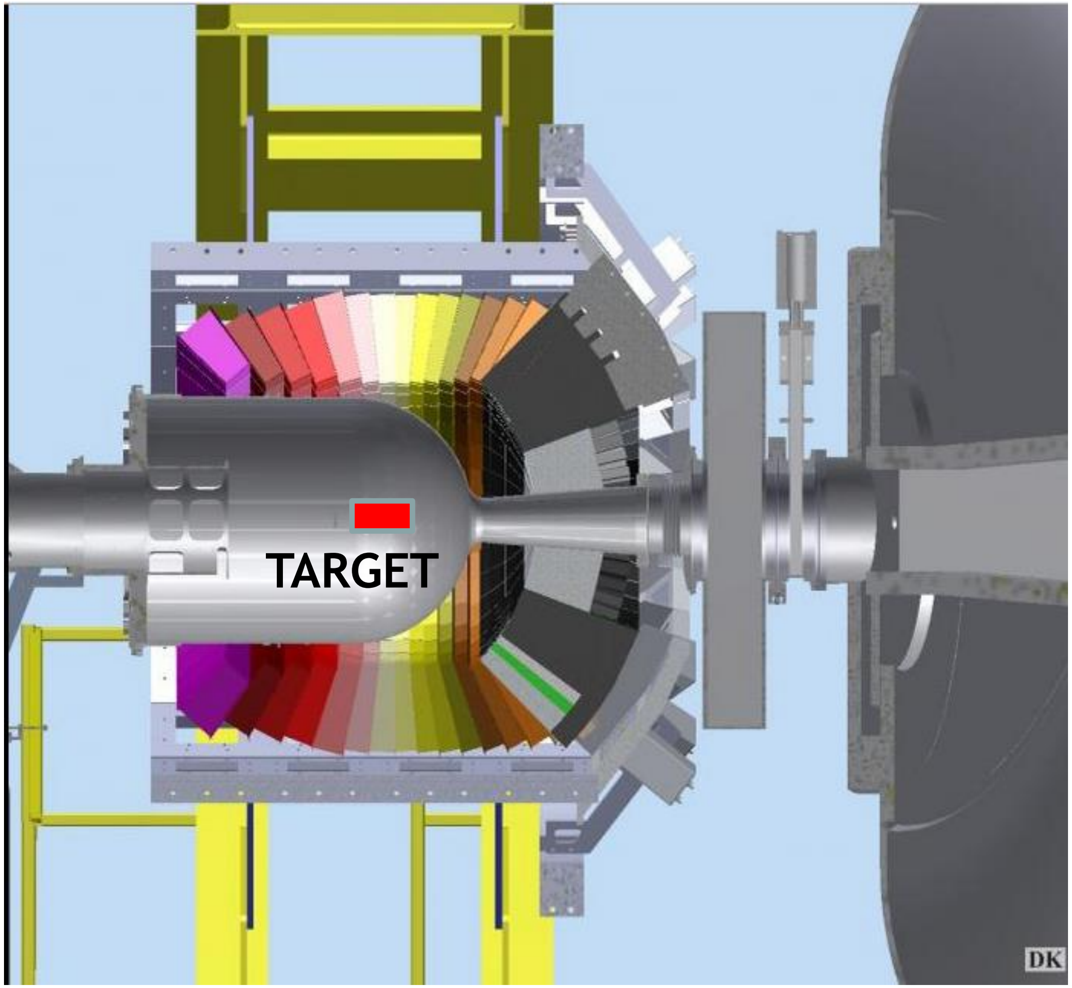
- Current lead foot cooling insufficient (20171115)

➔ new cl design

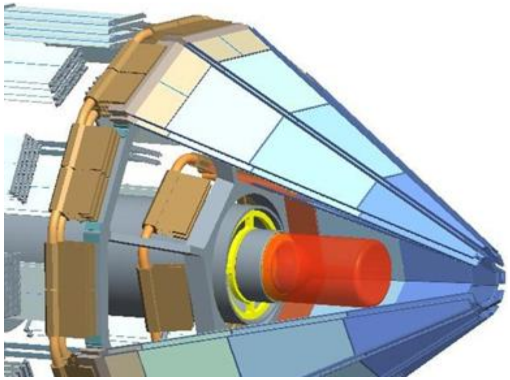
- current tests 20180222 with 3.5 kA
  → outcome in agreement with calculations (cl ok !)
- Modification in Satellite foreseen (decision on new cl‘s within next week…)
- GLAD expected to be ready in Q2/2018!

Courtesy of H. Simon

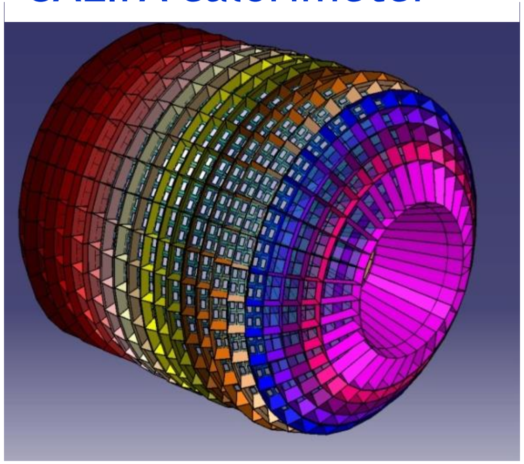
Target Area



Si - Tracker



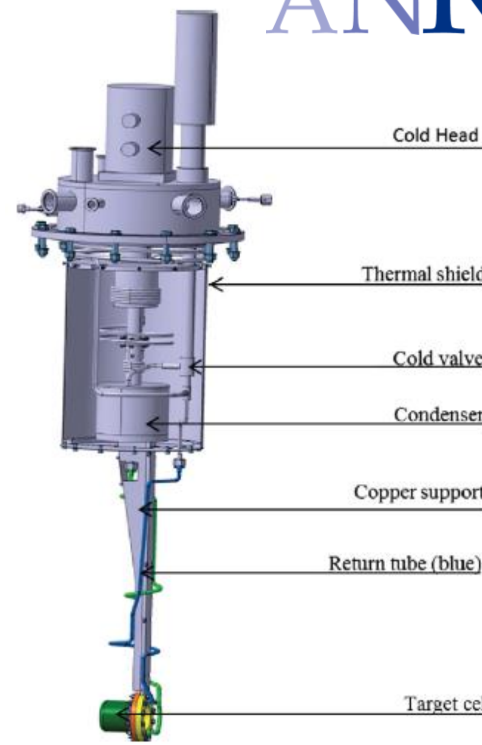
CALIFA calorimeter



Courtesy of D. Cortina

Liquid Hydrogen Target

- Pure LH_2 target for Quasi-Free scattering program at R^3B
- 4 cm diameter, 1.5 to 15 cm length
- Granted by French Research Agency (COCOTIER grant, 2017)
- Construction started in Oct. 2017 at CEA/IRFU
- Ready for 2019 campaign at GSI



Needed for 2019 R3B experiments!

Courtesy of A. Corsi

Si Tracker

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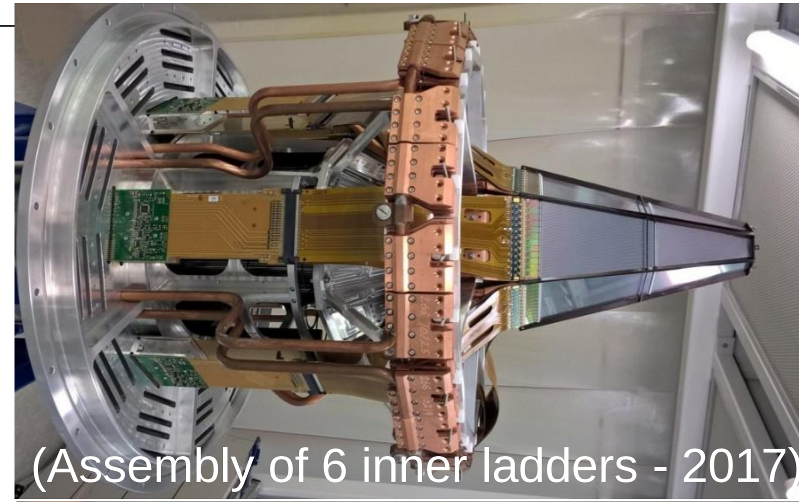
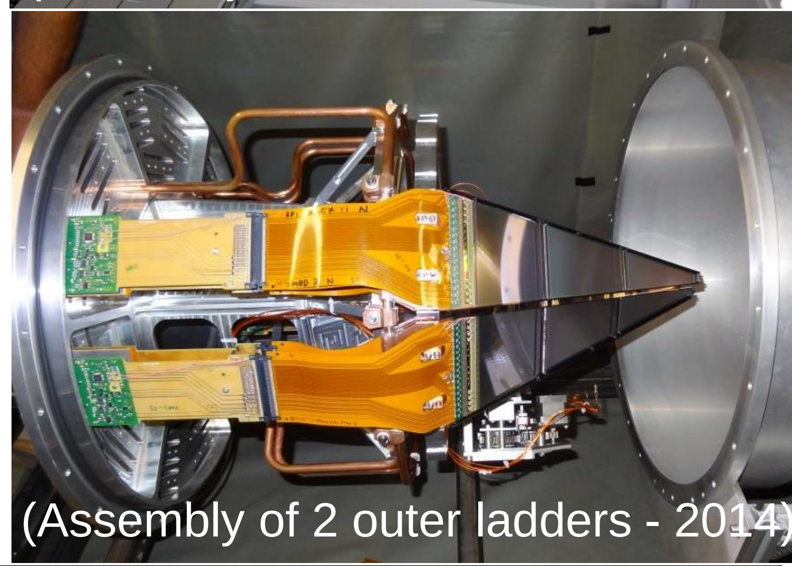
Two layers of trapezoidal DSSSD with 50 mm stereoscopic strips:

- Inner layer:
  - 6 ladders (+ 3 spares) delivered at DL, ~3k strips per ladder, 300mm thick.
- Outer layer:
  - 12 ladders (+ 3 spares) delivered at DL, ~4k strips per ladder, 300mm thick.

Readout Electronics + Cables:

- Asics Readout
- All ready to mount 6 inner ladders + 12 outer ladders


(Assembly of 6 inner ladders - 2017)


(Assembly of 2 outer ladders - 2014)

Courtesy of M. Labiche

Si Tracker

<u>Inner layer tests at DL:</u>

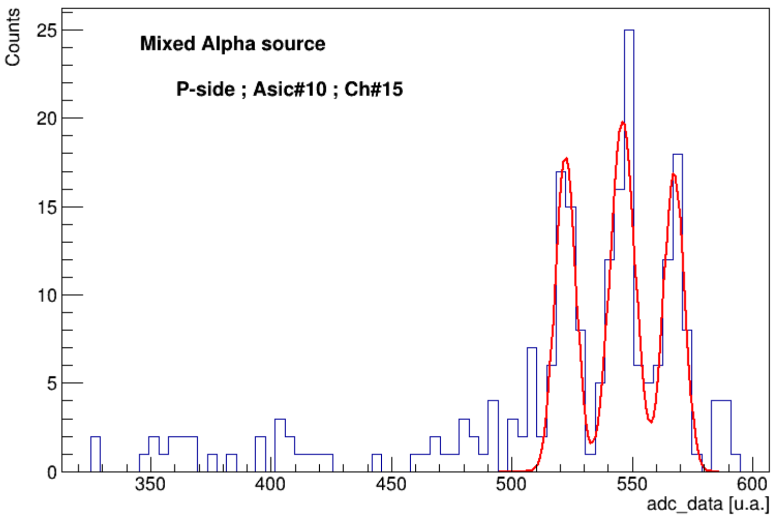
- Test with Mixed-Alpha source is ongoing
- Resolution (FWHM) ~150 keV on short strips but a noise issue for longest strips still to be solved !

<u>Outer layer:</u>

- Foreseen to be assembled in March

Both layers to be tested with cosmics in March/April.

+ Still lots of fine tuning to do ….



Courtesy of M. Labiche

CALIFA

CALorimeter for **I**n **F**light detection of γ-rays and light charged p**A**rticles

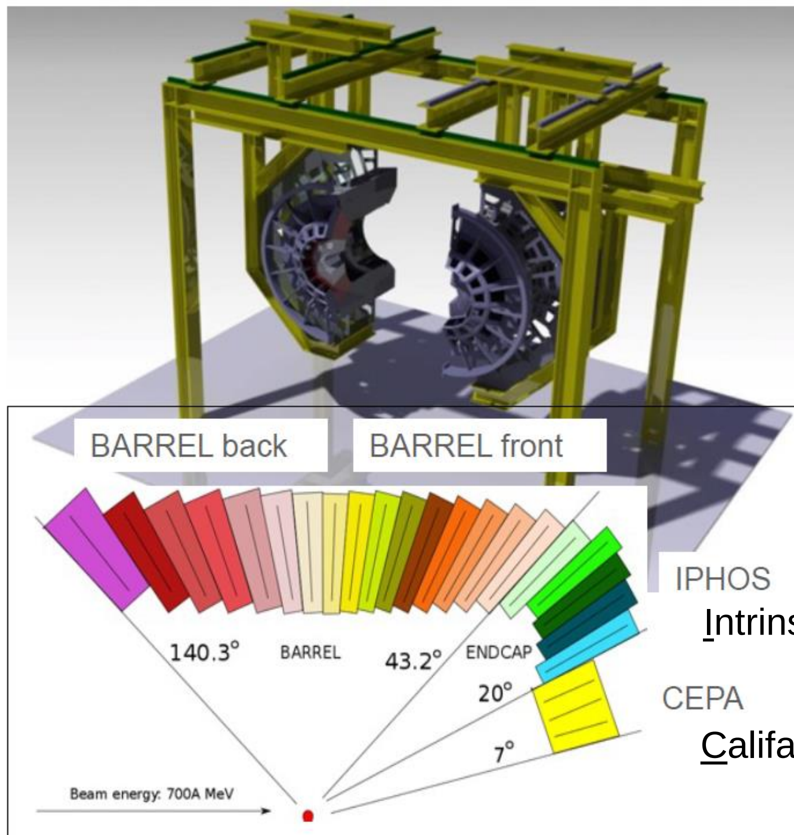
Surrounds the R³B target, 7° to 140.3°. The inner volume of CALIFA is designed to fit a vacuum chamber with a Si tracker system and LH target.

Broad experimental program:

- Nuclear structure far from stability
- Fission studies
- Reactions of astrophysical interest
- EOS of asymmetric nuclear matter

CALIFA will be the key detector in many of these experiments.

Contributing institutions:
Chalmers - Gothenburg (SE)
IEM – Madrid (ES)
JINR – Dubna (RU)
Lund University (SE, WG lead)
TU Darmstadt (DE, dpy WG lead)
TU Munich (DE)
USC – Santiago (ES)
University of Vigo (ES)



IPHOS: Intrinsic PHOSwich detectors

CEPA: Califa End-cap Phoswich Array

Courtesy of J. Cederkall

CALIFA: Barrel

Start version:

As of January 2018:

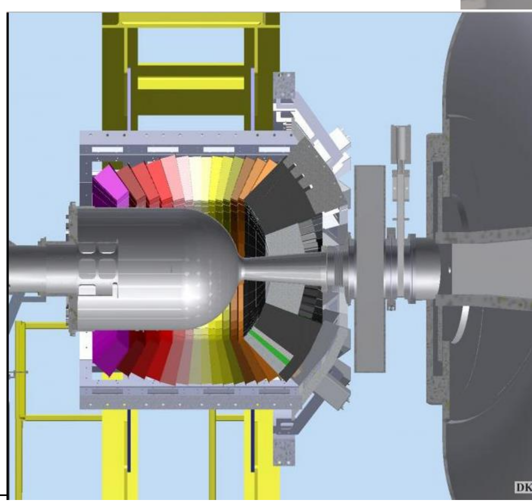
APDs

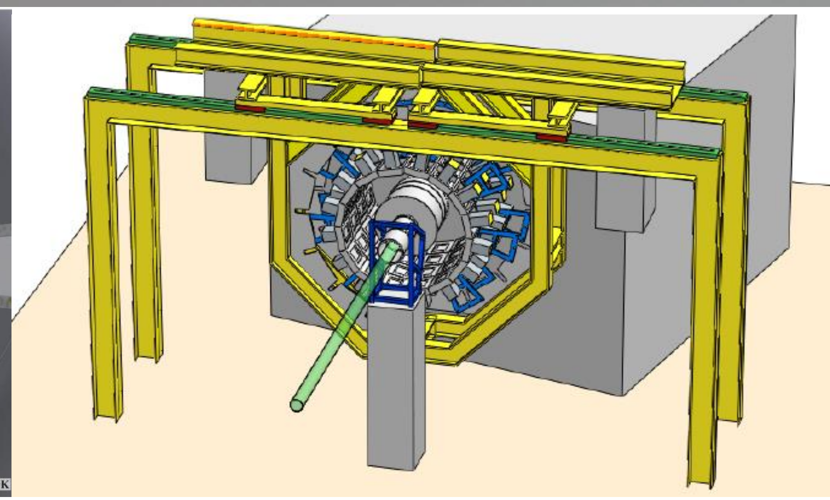
#	Institute
200	IEM
250	LU
360	TUD
320	USC
1130	Total

Crystals and wrapping

# delivered	# tested	Institute
480	450	LU
212	79	TUD
320	192	USC
1012	721	Total

Full detector:

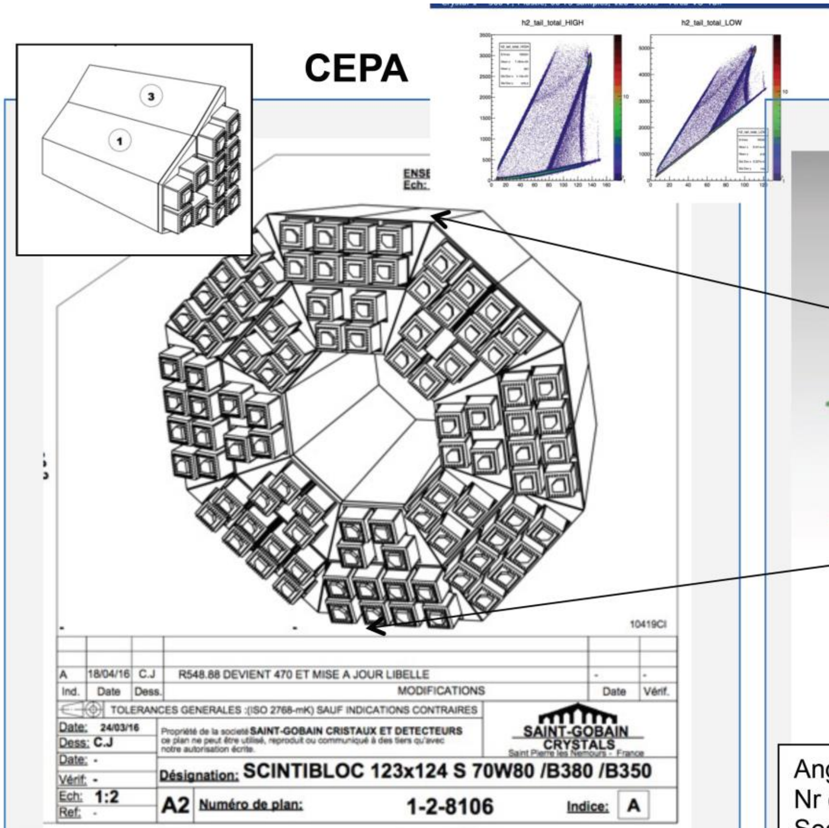




Courtesy of J. Cederkall

CALIFA: CEPA and iPhos

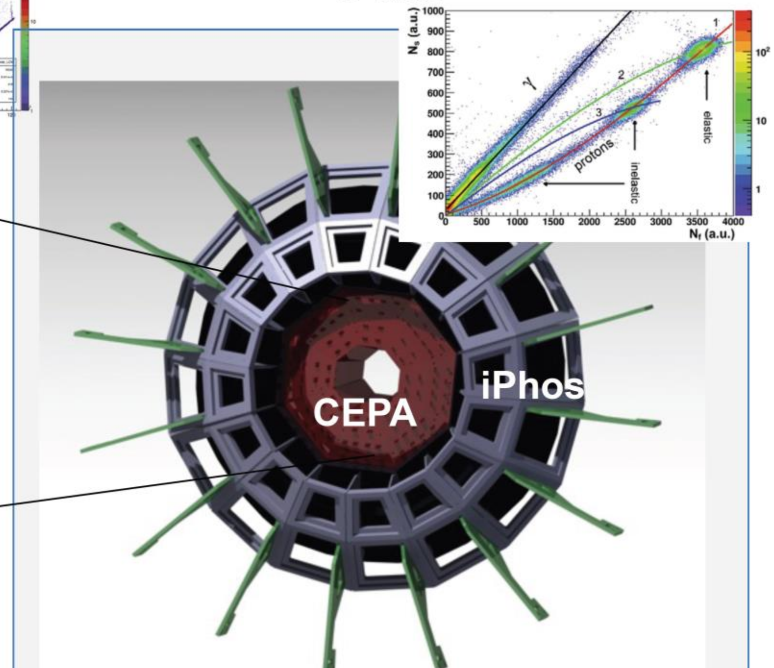
CEPA



Angular cover:	7 – 20 deg.
Nr of crystals:	2 x 96
Scintillators:	LaBr/LaCl

Fully funded via Chalmers. First segment module produced.

iPhos

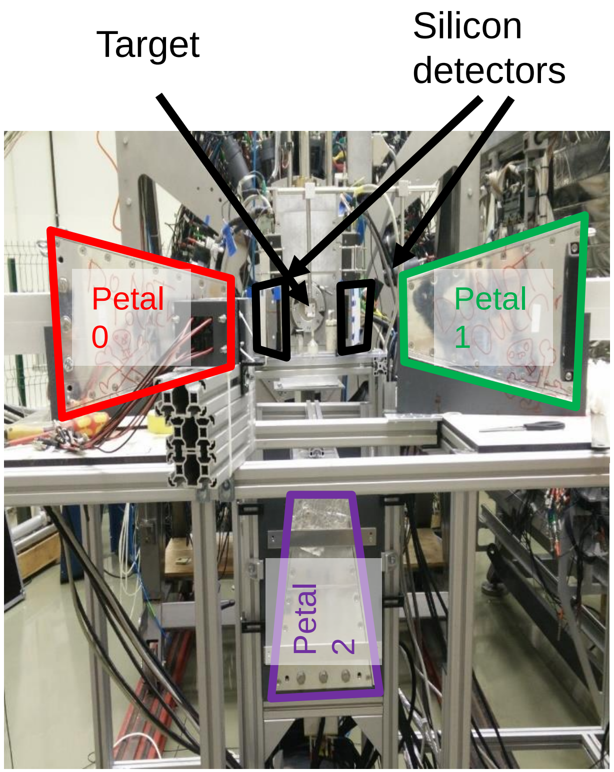


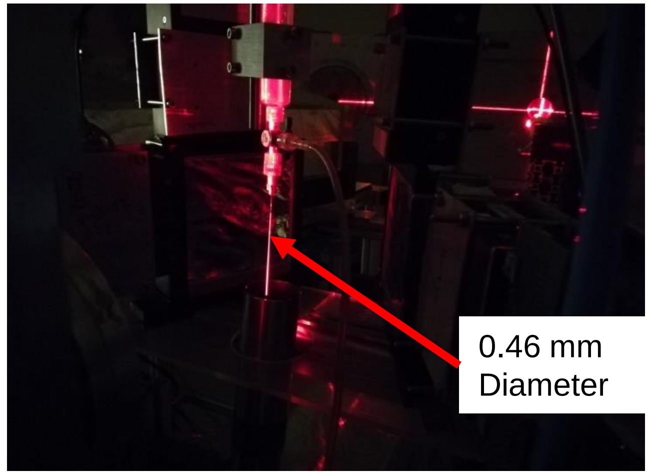
Angular cover:	20 – 43 deg.
Nr of crystals:	480
Sectors:	8
Scintillator:	CsI(TI) with PSA

The outer part of five sectors are covered by JINR.
Two sectors are covered by TUD and one by USC.
This makes iPhos 75% funded as of today.

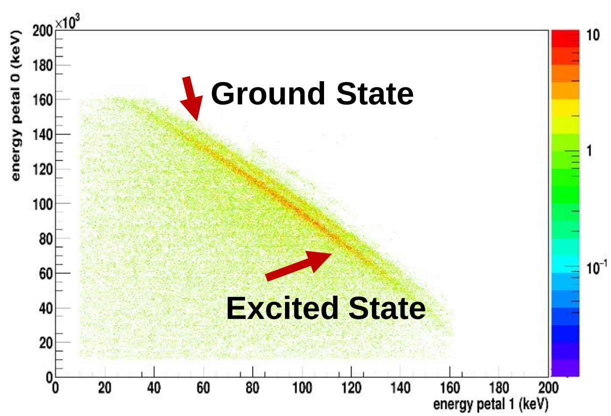
Courtesy of J. Cederkall

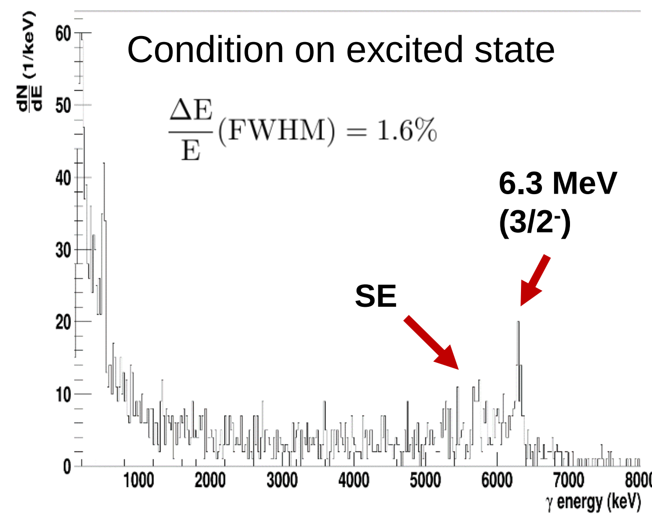
CALIFA Demonstrator Experiment in Krakow





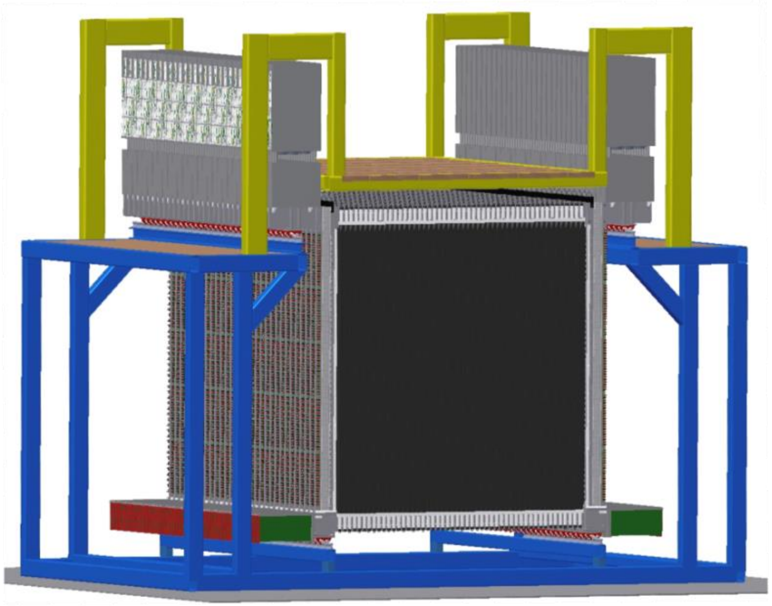
- $^{16}O(p,2p)^{15}N$ with a water target and 200 MeV protons
- Normal kinematics
- Measure γ in coincidence





Courtesy of R. Gernhäuser / B. Heiss

NeuLAND



Design goals:

- >90% efficiency for 0.2-1.0 GeV neutrons
- multi-hit capability for up to 5 neutrons
- invariant mass resolution down to
  ΔE < 20 keV at 100 keV above thr.

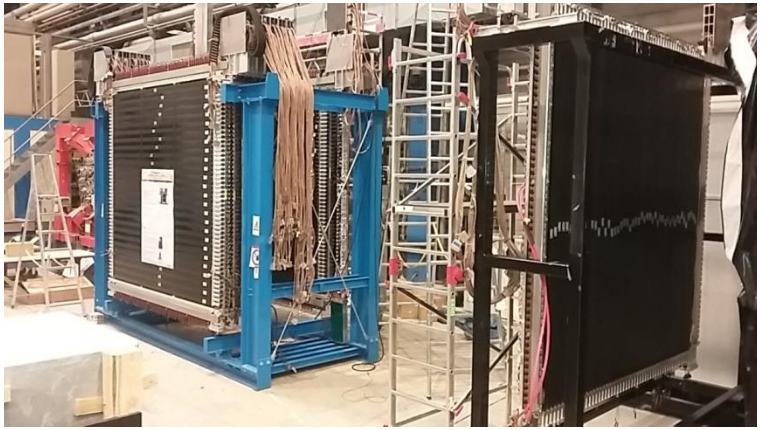
NeuLAND detector parameters:

- full active detector using RP/BC408
- face size 250x250 cm^2
- active depth 300 cm
- 3000 scintillator bars + 6000 PMTs
- 32 tons
- $\sigma_{x,y,z} \approx$ 1cm & σ_t < 150 ps

double plane 11 during bar mounting

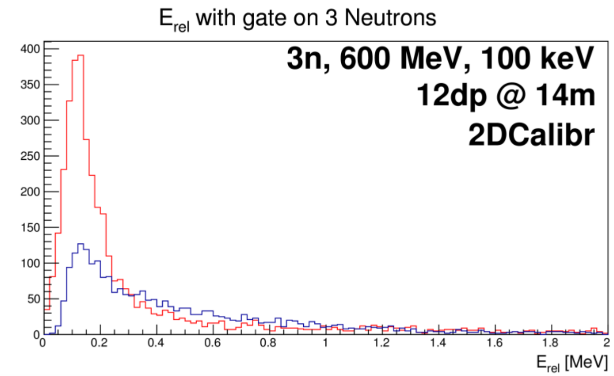
Courtesy of K. Boretzky

NeuLAND



NeuLAND Phase 0 Ok Q2-2018

- 130 cm active depth
- 2600 channels >40% detector



simulation prediction: **reconstruction efficiency** of the order of 20% for 3 n, 10 % for 4 n (600 MeV, preliminary)

NeuLAND demonstrator back from RIKEN after participation in 9 experiments, incl. studies of light exotic systems (4 n) up to EOS of heavy tin systems

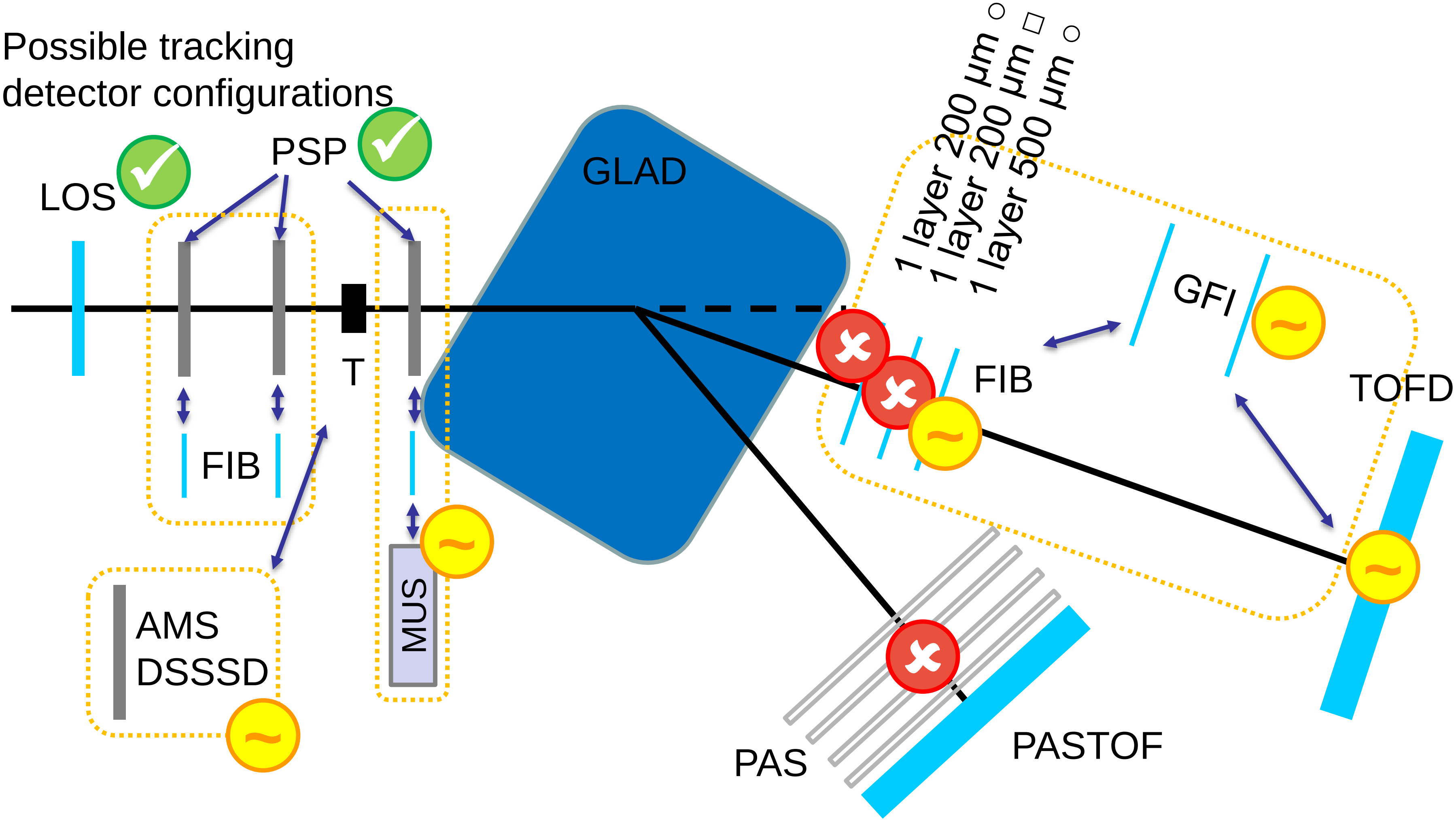
SAT test of in-house developed **NeuLAND electronics** underway:

- multichannel front-end electronic card TAMEX for high-resolution time and charge measurements

Courtesy of K. Boretzky

Status of tracking detectors

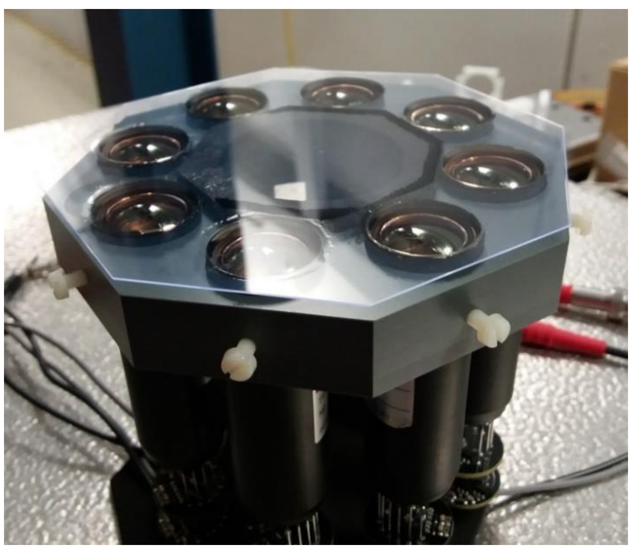
Possible tracking detector configurations

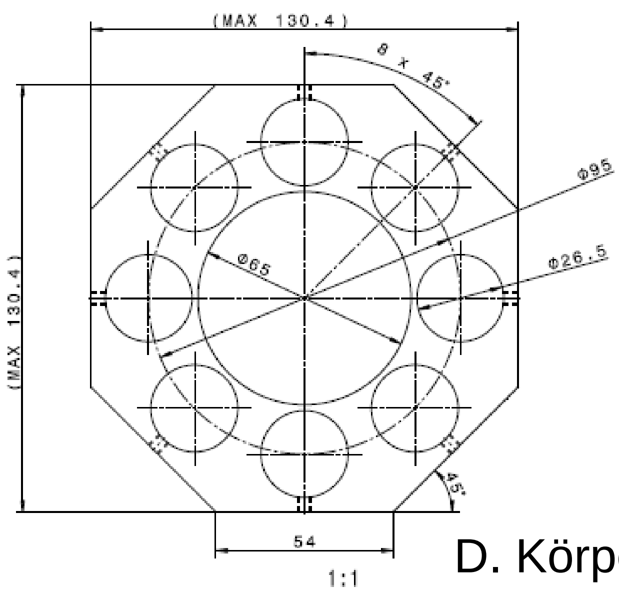


Tracking Detectors: LOS

- Scintillator foils read out on rear surface instead of edges
- Better light collection
- Use of thin foils possible
- Better stability

Z separation	**$\sigma_E < 1\%$**
A separation	**$\sigma_t < 10ps$**
Rate	**1 MHz**





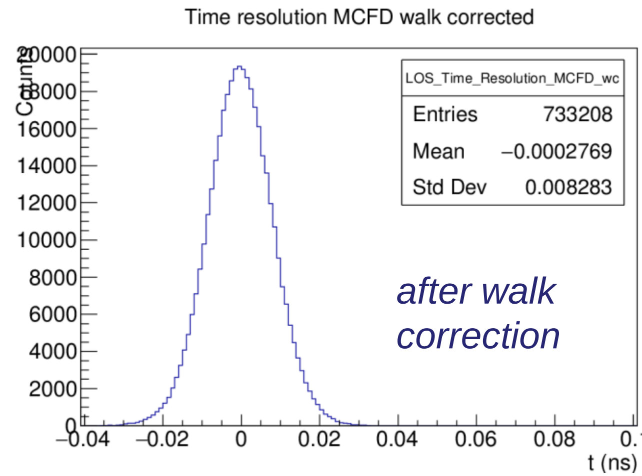
D. Körper

Tracking Detectors: LOS

Correction of saturation effect of PMTs.

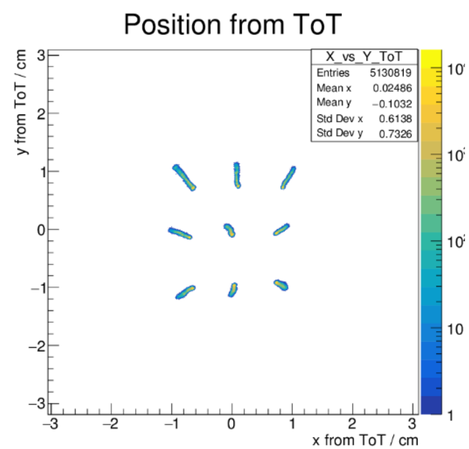
Walk corrections now included.

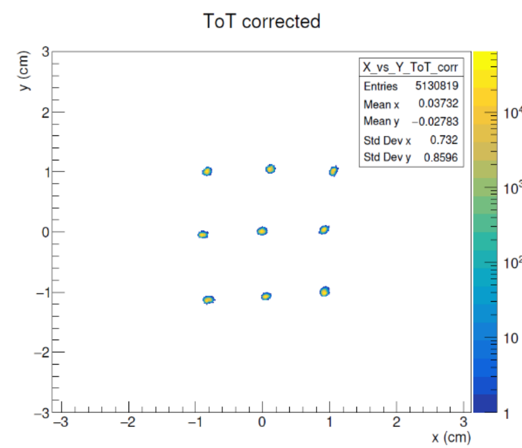
Correction for light transport ($E=\mathrm{sqrt}(E_1 \cdot E_2)$ does not work).



Achievements with laser for illumination of a point / full detector:

- Time precision of σ_t = 7.1 ps / 16 ps
  -> σ_t = 6.8 ps / 8.3 ps
- Position precision σ_{xy} = 150 µm / 380 µm
  -> σ_{xy} = 150 µm / 230 µm
- Charge precision σ_Q = 0.12 % / 0.6 %
  -> σ_Q = 0.09 % / 0.1 %



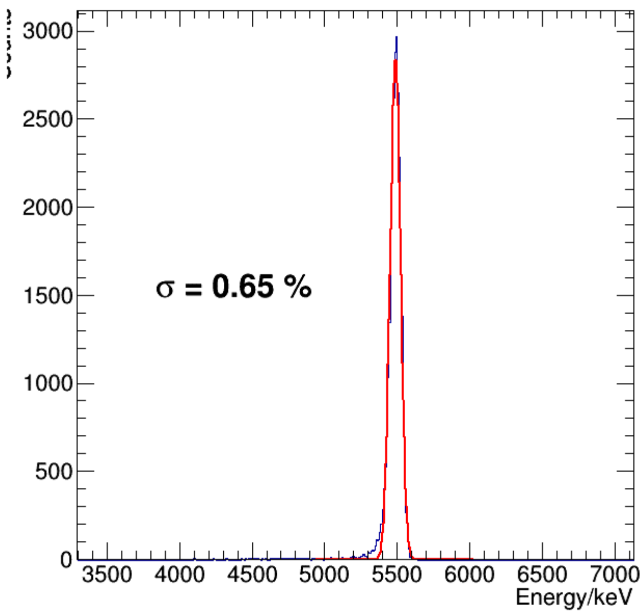


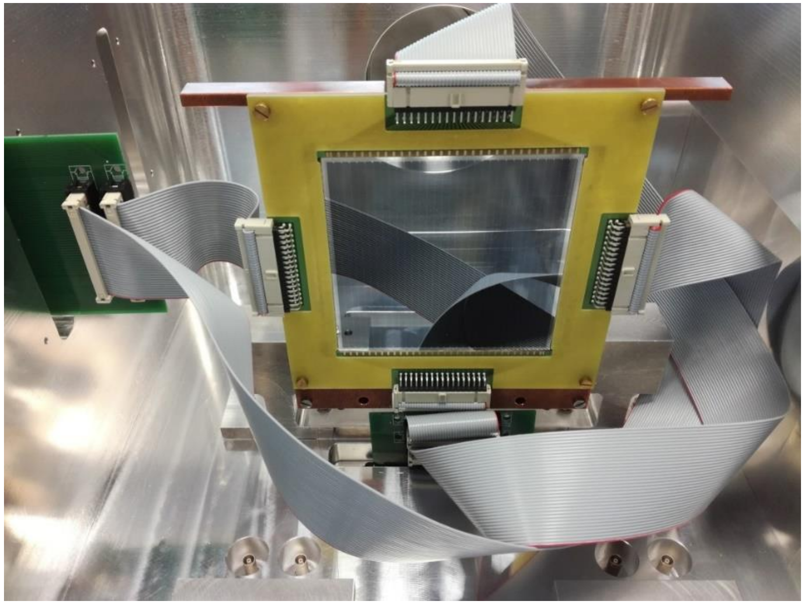
Courtesy of M. Heil

Tracking Detectors: PSP X5

- 32-strip (resistive), double-sided Si detector, 10 x 10 cm^2
- All strips read out on both ends
- 1x 200um (+1x 200um + 1x 300um) detectors available

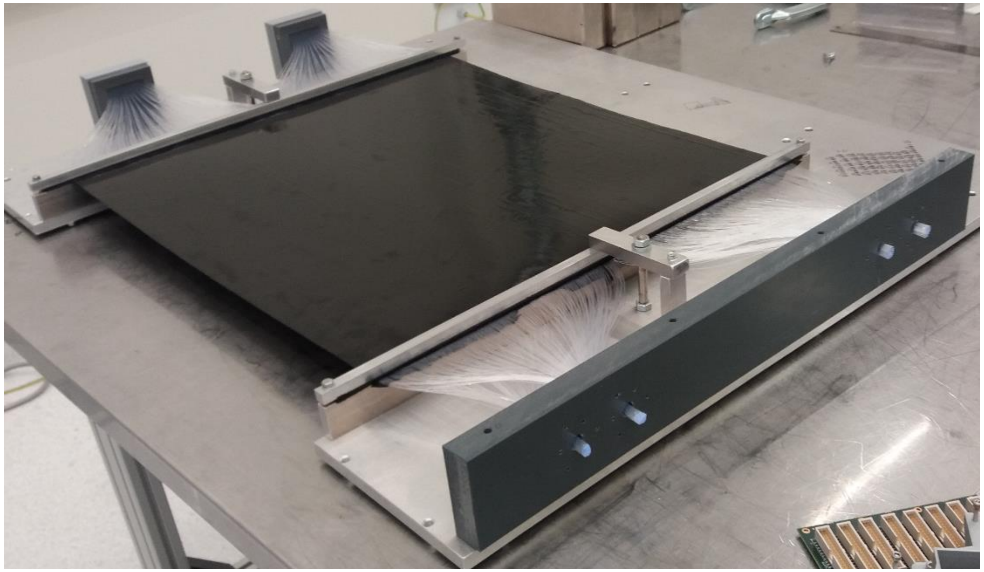
Z separation	$\sigma_E < 0.5\%$
Position x y	$\sigma_x < 100\mu m$
Rate	0.1 MHz/strip





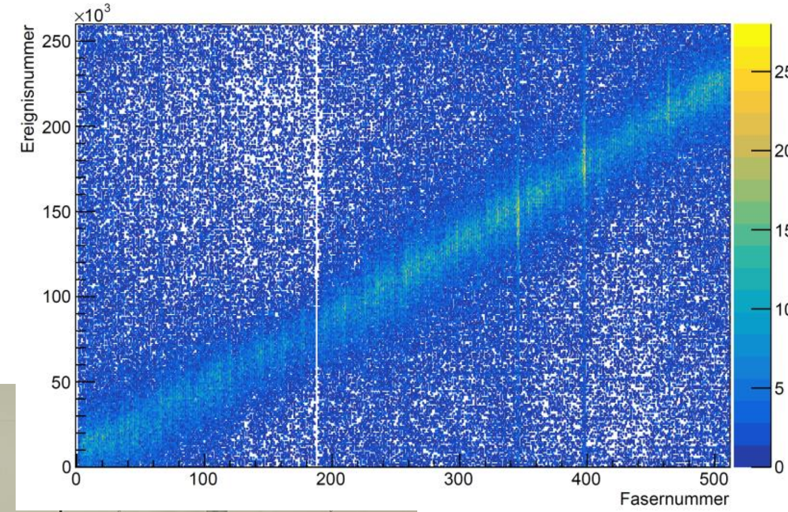
Tracking Detectors: Fiber Detectors

- 1 GFI to be refurbished for 2018 experiments: new MAPMT + new read-out electronics (PADI + FPGA-based TDC) (GSI development)
- Various prototypes in construction/test phase:
  - 50x50 cm² 500um round fiber
  - 25x40 cm² 200um square fiber
  - 50x50 cm² 200um round fiber
- Sensors:
  - Hamamatsu H13700 16x16 Multi-Anode PMT
  - SensL 1x1 mm² SiPM



Tracking Detectors: Fiber Detectors

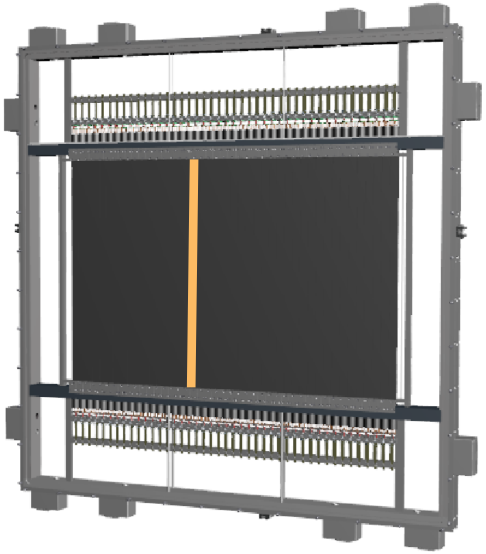
- 500um round FIB: test with ^{90}Sr source
  - Collimated source scanned automatically across detector surface
  - Correlation between fiber and event no.

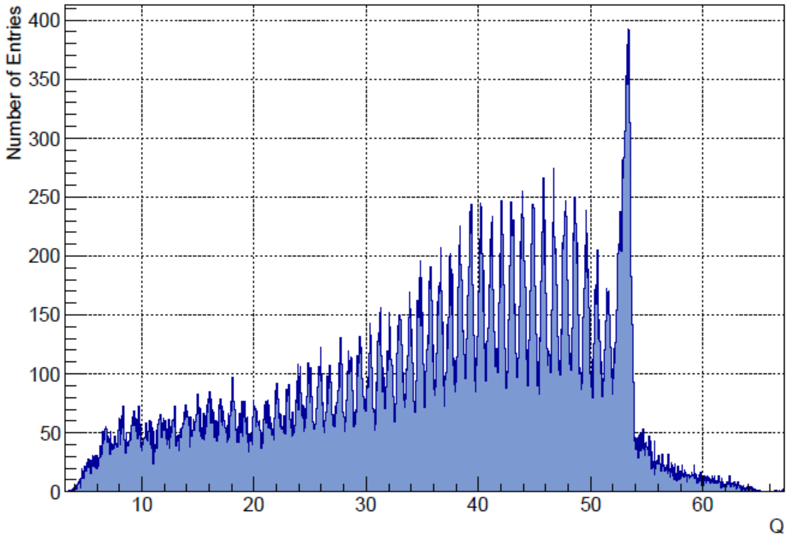


Tracking Detectors: TOF Wall

- Size: 120 x 100 cm²
- Total of 176 paddles, arranged into 4 layers
- No light guide, PMT R8619 coupled directly to scintillator
- Movable holding structure to sweep TOF wall across beam

Z separation	$\sigma_E < 1\%$
A separation	$\sigma_t < 38$ ps
Rate	1 MHz

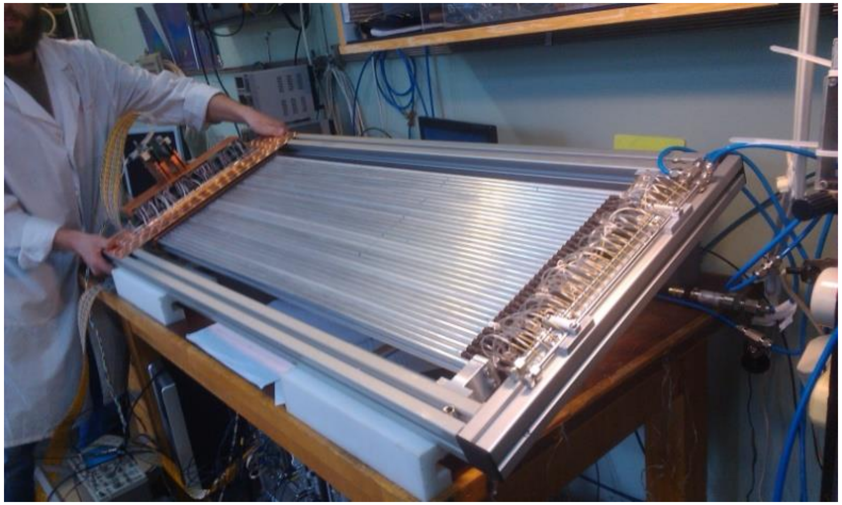




Courtesy of M. Heil

Proton Arm Spectrometer

- Large area detectors: 2.1 x 1.0 m^2
- 2000 straws of 10 mm diameter
- 4 planes, 2 x, 2 -y-oriented.



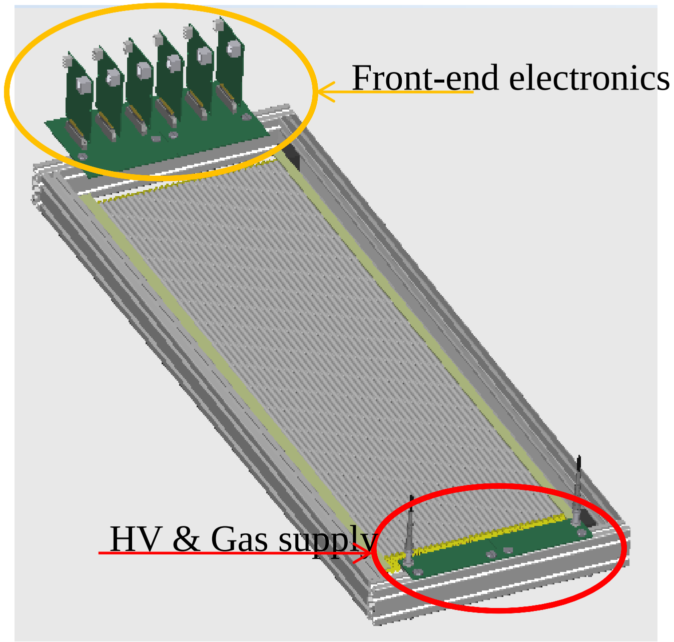
Read-out

- Front-ends to be produced by PNPI
- Digitizers to be provided by GSI

Funding status:

- In-Kind contract with PNPI ready to be signed
- Sub-contract with GSI for digitizers also ready

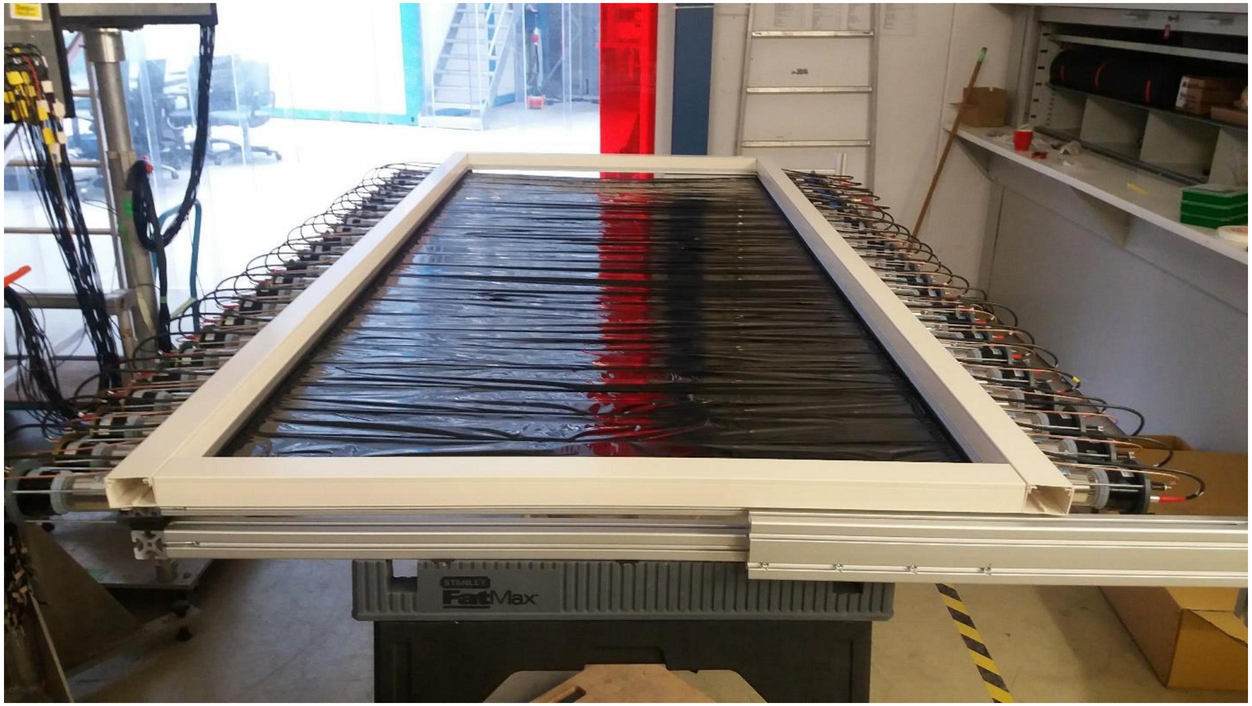
Efficiency 500-1000 MeV p	>95%



The first plane (x) will contain mylar or kapton straws, all others will be thin Al tubes.

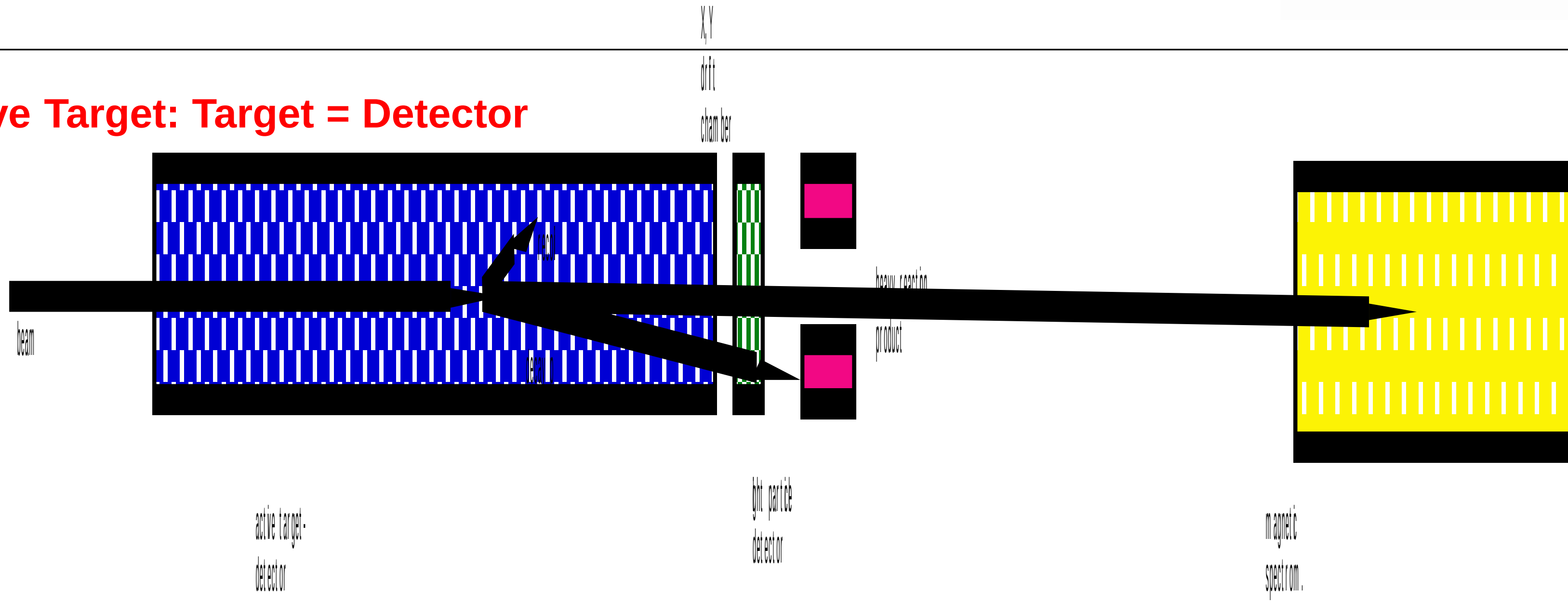
PASTOF

- 1 cm thick plastic scintillator, 10 cm wide, arranged in 2 layers
- Use of unused scintillator (initially for LAND) and PMTs
- Will provide trigger for PAS



Active Target

Active Target: Target = Detector



⇒ advantage:
- low threshold
- high detection efficiency (rel. thick target)

⇒ well suited as alternative technique to EXL for:
- short lifetimes (T ≤ 1 sec)
- low RIB intensities (≤ 10^5 sec^{-1})

Active Target Type 1:

⇒ for (p,p), (α,α`). (^{3}He,t), (d,^{2}He) etc. measurement

Active Target Type 2:

⇒ for (α,α`γ) measurements

(to be used in coincidence with CALIFA)

Current status:

- TDR passed Council in 12.2017
- FAIR-PNPI In-Kind contract in preparation
- Prototype used in e-p scatt. at MAMI and μ-p scatt. at CERN
- Prototype ready for FAIR phase-0

Courtesy of P. Egelhof

Data Analysis and Simulation

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R3BRoot Simulations and Data Analysis for R3B

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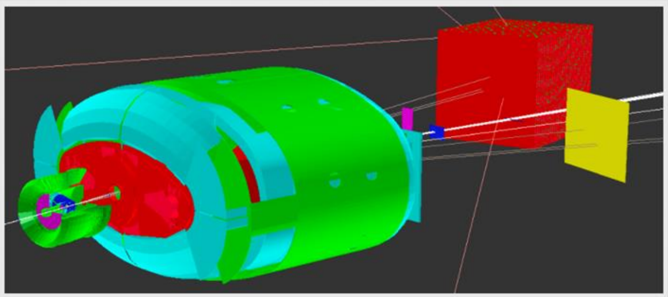

Event display

Visualisation of the detector geometry in simulation. As an option, particles trajectories and hits can also be displayed

1 2 3

https://github.com/R3BRootGroup/R3BRoot.git

R3BRoot is a software framework developed at GSI, used for simulations and data analysis of R3B experiments. It inherits basic framework functionality from FairRoot, extending it with R3B-specific detectors and algorithms implementation. R3BRoot has a modular design with shared libraries, which are loaded on demand. The simulation part is based on the Virtual Monte Carlo (VMC) concept. For the description of detector geometry and input for the simulation, multiple formats are supported. It also includes parameter handling, event display, etc.

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Issue Tracker (protected)

Announcements:

Release of R3BRoot apr17

Submitted by kresan on Thu, 04/27/2017 - 09:50

New stable version of R3BRoot is now available: "apr17". The release notes, compatibility issues and a download link can be found on the corresponding GitHub page. Note: master branch was updated as well.

Read more | kresan's blog

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- Request new password

Log in

Courtesy of H. Alvarez-Pol

R3B

Data Analysis and Simulation

- R3BRoot: ~ 300 000 total code lines (88880 lines in implementation files, 65670 lines in header files, 112920 total lines in C macros (mainly geo generators), 11793 lines in txt files, 20439 lines in root files, ...). Unpacker stage using UCESB + Readers.
- Active development in GitHub, 35 commits since July 2017 by 8 developers.
- Still many automatic procedures for calibration and parameter containers not ready for production. Tests required for software tools.

	LOS	PSPX	TOFd	NeuLAND	Si Tracker	CALIFA	Straw tubes
Mapped							
CAL							
HIT							

Mapped - raw data delivered from Ucesb to R3BRoot and stored
CAL - calibrated data: time [ns], charge [MeV]
HIT - physical hits, time [ns], charge [MeV], position [cm], all synchronized

Courtesy of H. Alvarez-Pol

Summary

- Minimal R3B setup is expected to be ready for start of FAIR phase-0 in 2018:
  - GLAD: crucial system for R3B operation
  - CALIFA barrel: partially
  - NeuLAND: >10 double-planes
  - Tracking detectors: minimal set of detectors, no redundancy
- Additional systems expected to be ready for 2019:
  - LH2 target
  - Si tracker
- Manpower problems in all R3B Working Groups

The R3B Collaboration

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Aksouh, Farouk; Al-Khalili, Jim; Algora, Alejandro; Alkhasov, Georgij; Altstadt, Sebastian; Alvarez, Hector; Atar, Leyla; Audouin, Laurent; Aumann, Thomas; Pellereau, Eric; Martin, Julie-Fiona; Gorbinet, Thomas; Seddon, Dave; Kogimtzis, Mos; Avdeichikov, Vladimir; Barton, Charles; Bayram, Murat; Belier, Gilbert; Bemmerer, Daniel; Michael Bendel; Benlliure, Jose; Bertulani, Carlos; Bhattacharya, Sudeb; Bhattacharya, Chandana; Le Bleis, Tudi; Boilley, David; Boretzky, Konstanze; Borge, Maria Jose; Botvina, Alexander; Boudard, Alain; Boutoux, Guillaume; Boehmer, Michael; Caesar, Christoph; Calvino, Francisco; Casarejos, Enrique; Catford, Wilton; Cederkall, Joakim; Cederwall, Bo; Chapman, Robert; Alexandre Charpy; Chartier, Marielle; Chatillon, Audrey; Chen, Ruofu; Christophe, Mayri; Chulkov, Leonid; Coleman-Smith, Patrick; Cortina, Dolores; Crespo, Raquel; Csatlos, Margit; Cullen, David; Czech, Bronislaw; Danilin, Boris; Davinson, Tom; Paloma Diaz; Dillmann, Iris; Fernandez Dominguez, Beatriz; 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