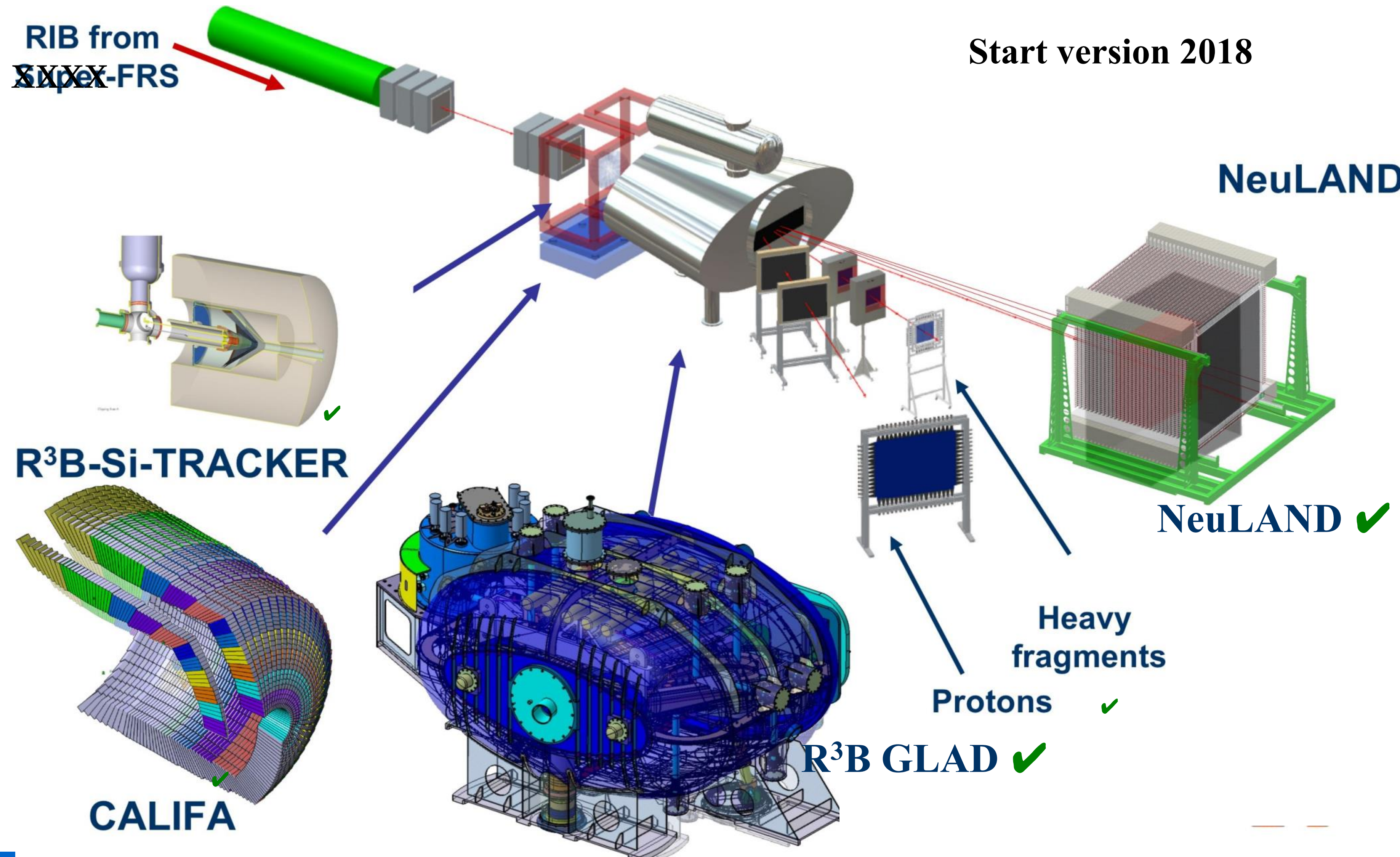
Statusreport R³B

NUSTAR Annual Meeting
Spring 2016

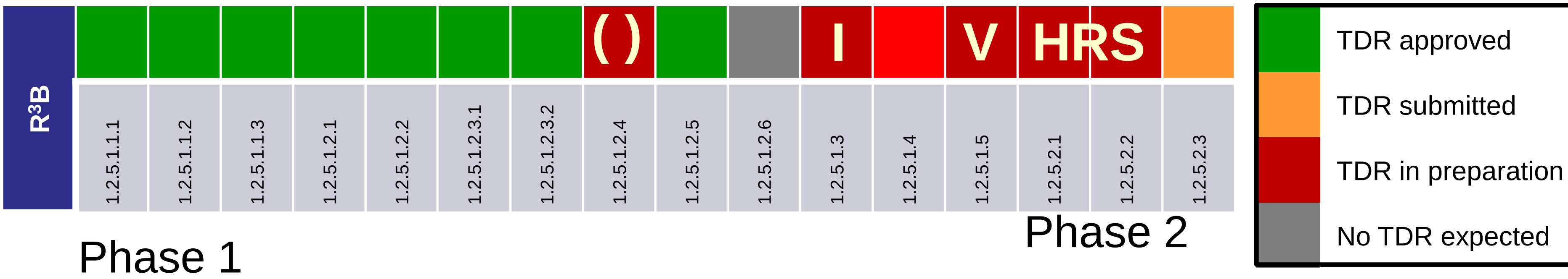
H. Simon ● GSI Darmstadt

HELMHOLTZ GEMEINSCHAFT

Menu:
Towards the R³B start version ...



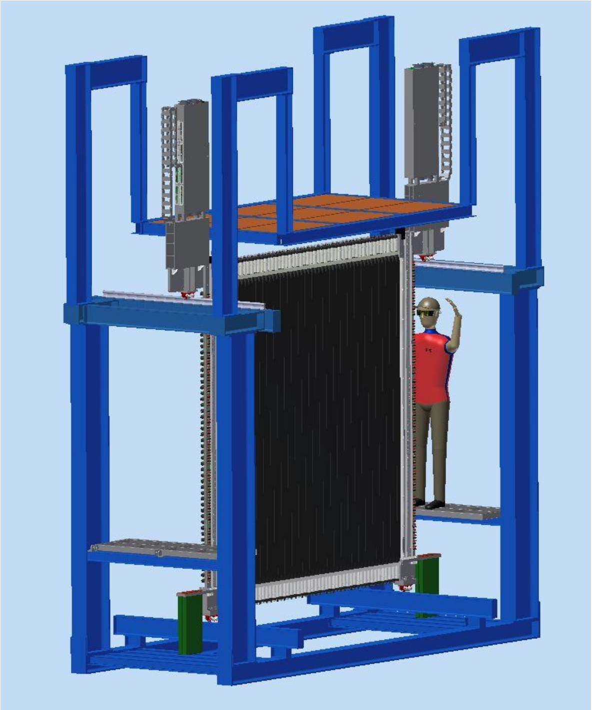
R3B TDR Status



- R^3B (6) (Multiplet, NeuLAND, CALIFA-barrel, CALIFA forward endcap, GLAD, tracking detectors)
- R^3B (1) (Active target, 'phase 2' ➔ ECE comments received.)
- 1.2.5.1.2.4 Si tracker: device soon ready, TDR to come
- 1.2.5.1.4 Common NUSTAR DAQ: final draft circulates
- 1.2.5.1.3/5 Infrastructure, Vacuum ➔ for later move to high energy cave

NeuLAND: The High Resolution Neutron Time-of-Flight Spectrometer for R^3B

K. Boretzky



NeuLAND detector parameters:

- full active detector using RP/BC408
- face sice 250x250 cm^2
- active depth 300 cm
- 3000 scintillator bars
- 6000 PM / readout channels
- 32 tons

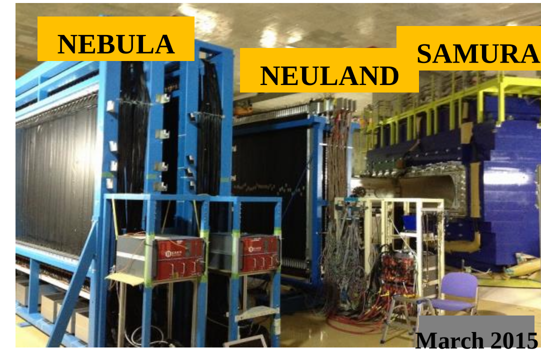
NeuLAND design goals:

- **>**90% efficiency for 0.2-1.0 GeV neutrons
- Multi-hit capability for up to 5 neutrons
- invariant-mass resolution: **NeuLAND-target distance 35 m**

  ΔE < 20 keV at 100 keV above the neutron threshold

NeuLAND: The High Resolution Neutron Time-of-Flight Spectrometer for R^3B

- NeuLAND demonstrator (40 cm depth with 4 double planes and 800 readout channels) at RIKEN up to end of 2017, participation in various beam times
- at GSI continuation of production (4 more double planes ready), production scheme dominated by funding profile, at least 11 d.p. in 2018
- HVDS (high voltage distribution system) as in-kind from PNPI, pre-series (200ch) in operation, 1000 ch delivery expected as of today, full system (6000 ch) up to spring 2018
- electronics: GSI inhouse further development of earlier Tacquila electronics. Now TAMEX, front-end design in pre-series
- One of the two NeuLAND support frames produced and mounted, allows to hold up to 20 double planes.



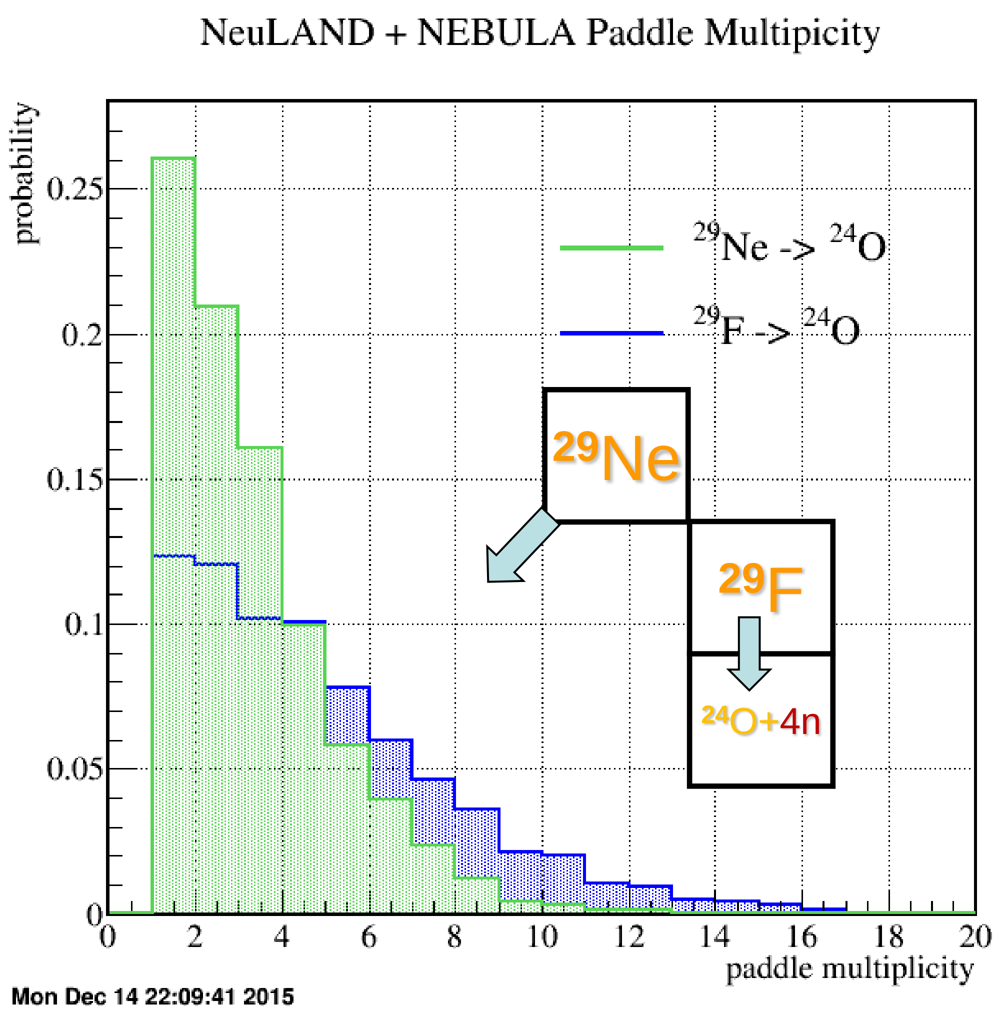
NeuLAND building blocks:
High Voltage Distribution System

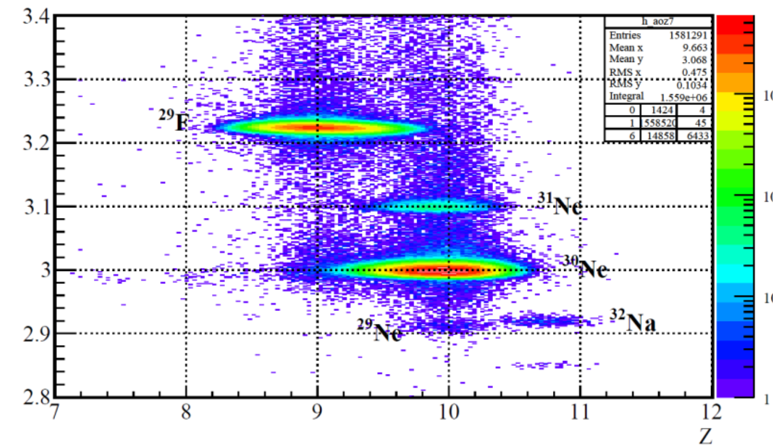
6000 HV channels needed

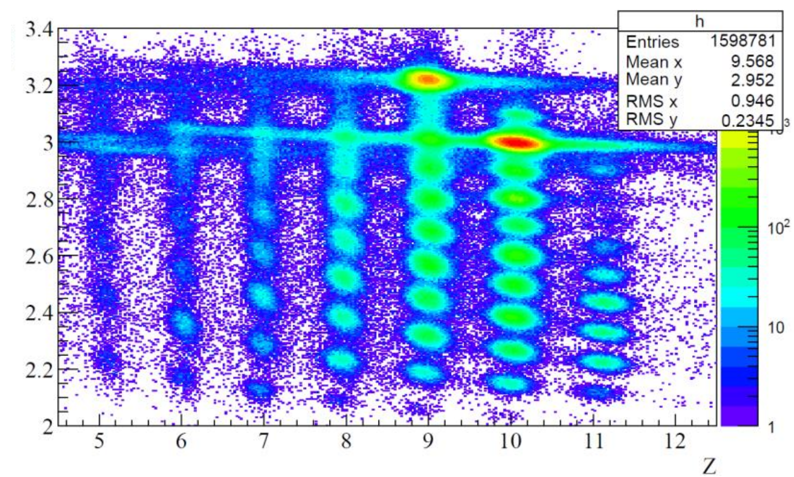
- HVDS system from PNPI (L. Uvarov et al.) is based on 2kV primary power supply with controllable dividers
- individual down-regulation of each channel
- form factor fits to NeuLAND double planes

- accepted as in-kind contribution from PNPI
- pre-series (200 channels) delivered in December 2014
- Site Acceptance Test ongoing
- Delivery of full system up to 2017

RIKEN: Performance studies



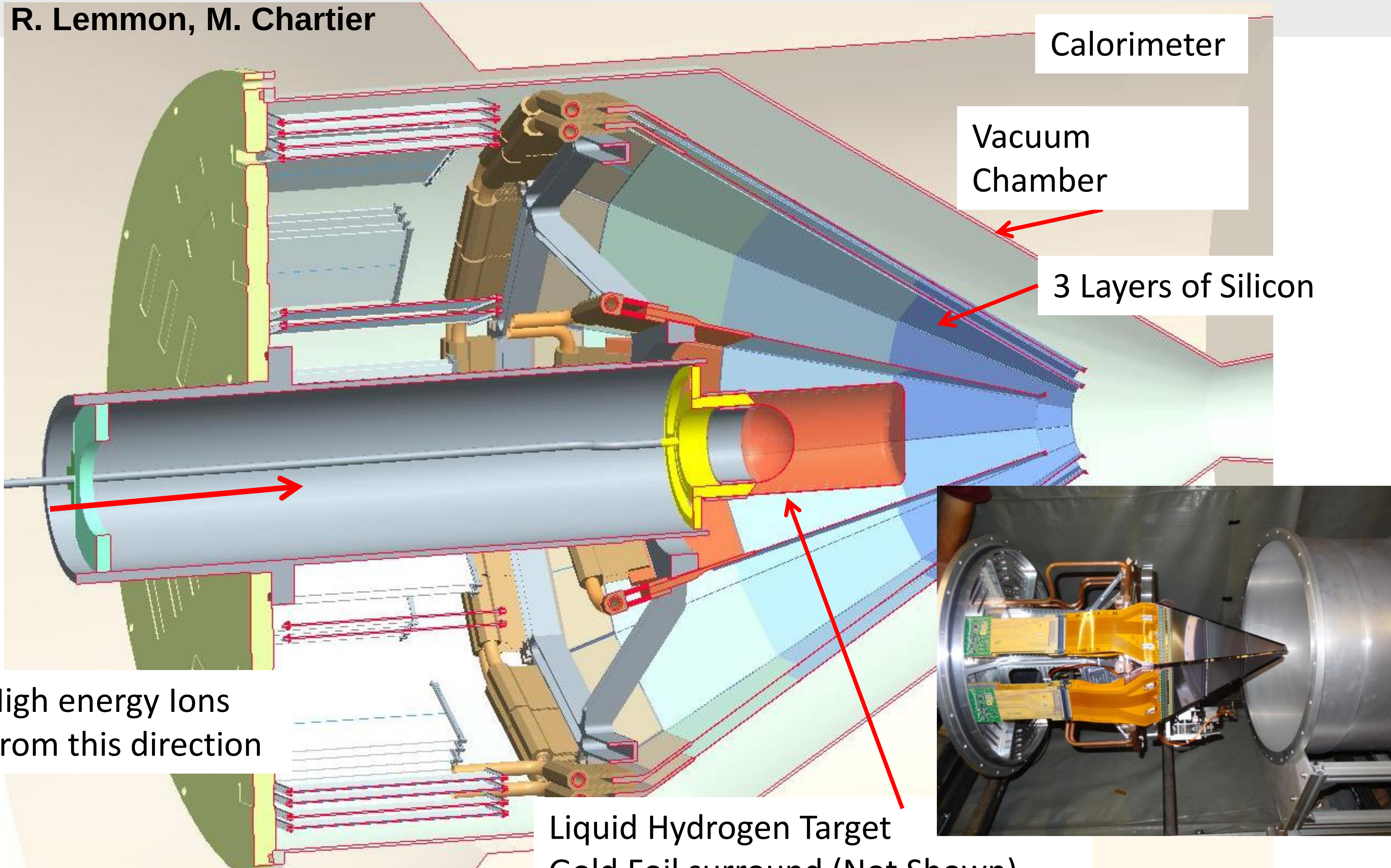




Efficiency evaluations in progress → J. Kahlbow see talk by Hans T.

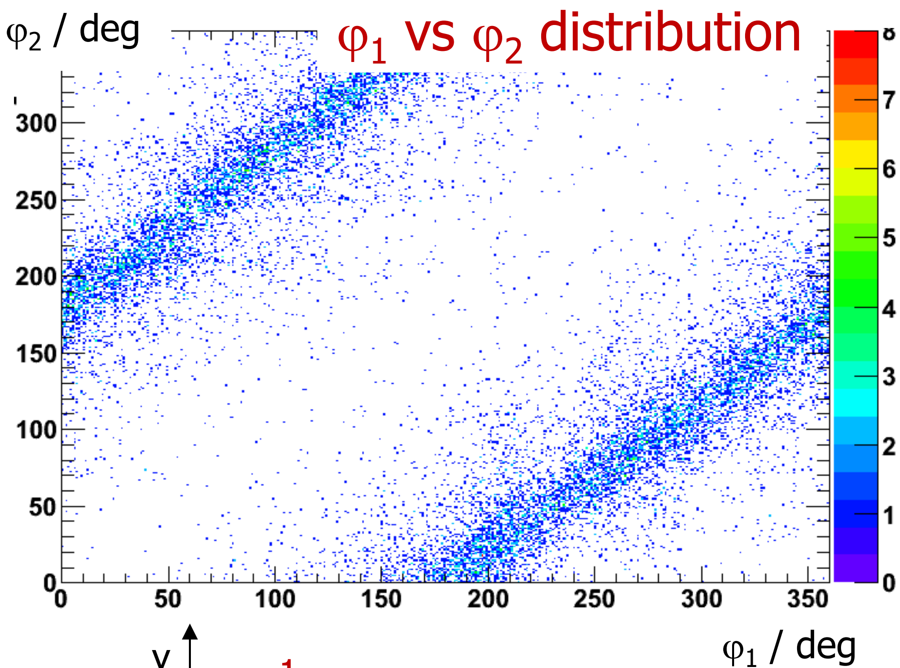
R3B Si Tracker

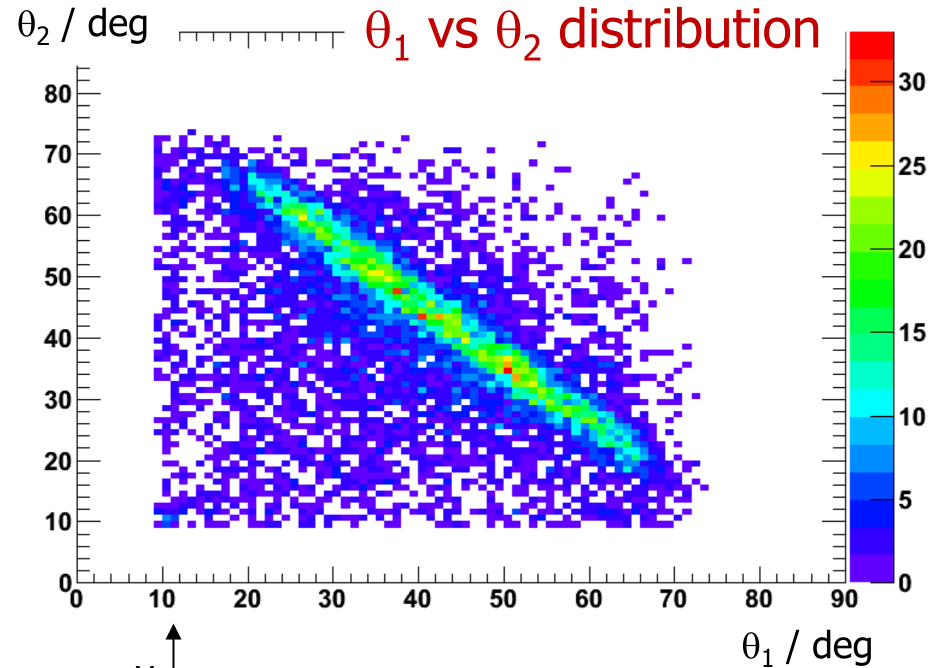
R. Lemmon, M. Chartier

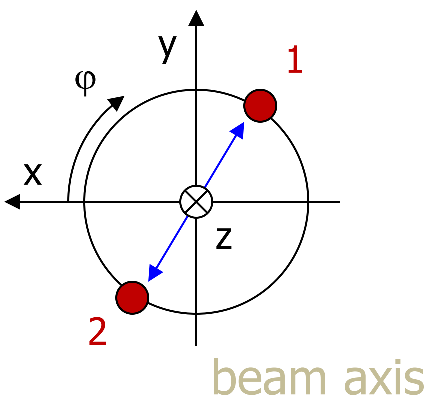


Target Recoil Detection

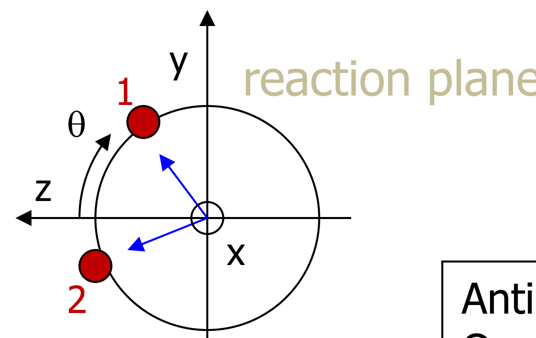
Data: F. Wamers $^{17}Ne(p,2p)$ @ 500MeV/u, CH_2







Correlation in φ:
$\Delta\varphi = 180°$



Anti-correl. in θ:
Opening angle $\approx$ 83°

➔ Clear signature for (p,2p) reactions

R3B Si Tracker Status – March 2016

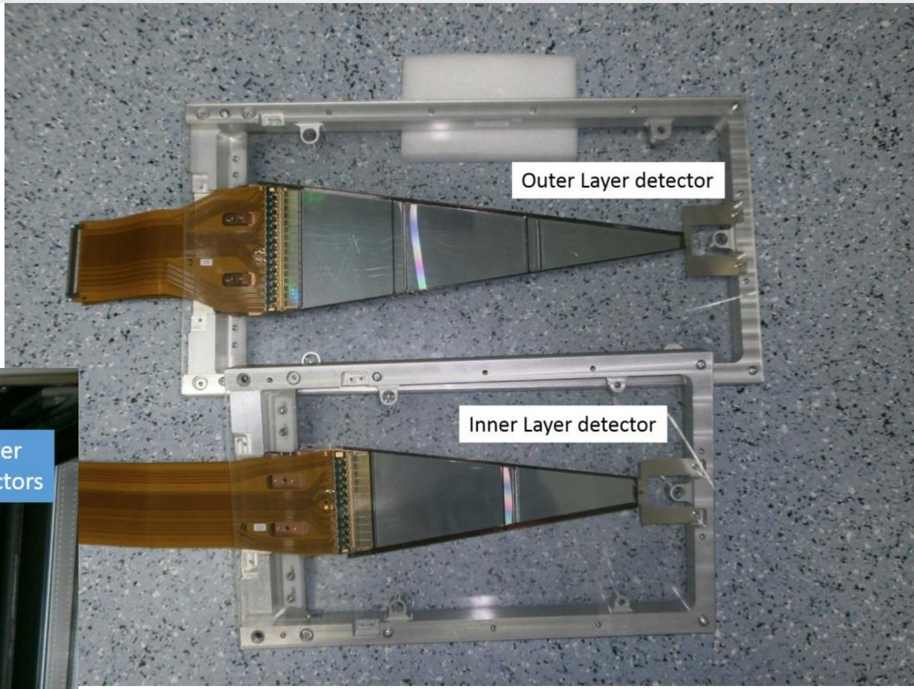
- Si Ladders in production
- 12 outer layer ladders finished and tested
- 6 inner layer ladders in various stages of production. Will be finished by mid-March
- All mechanics, vacuum chamber, target mechanism (without control system) and support structures finished
- All ASICs and readout electronics finished

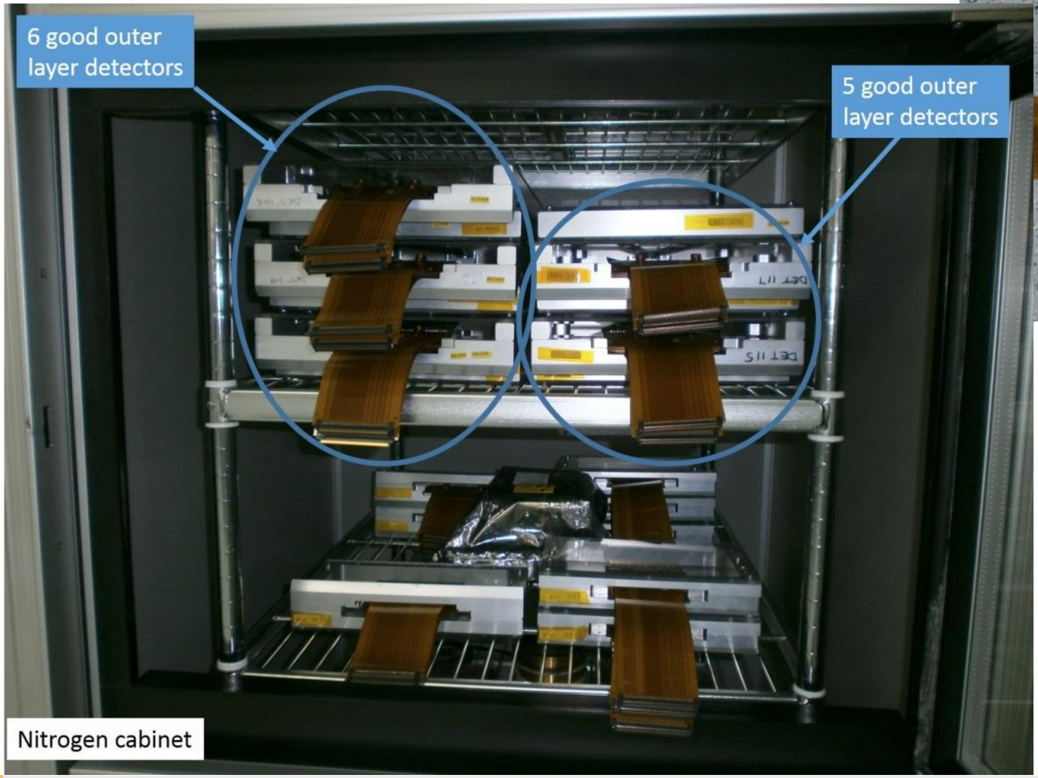
- By end of March, the ladders for one outer and one inner layer will be finished
- Assembly of full tracker, coupling to readout electronics and commissioning (without beam) will take place in Daresbury clean room facilities from April 2016 – March 2017
- Tracker will then be disassembled, boxed and shipped to GSI mid-2017

- Sufficient spares of all components will be available from April 2016 to allow assembly of a second outer layer if time allows

R3B Si Tracker - Status

"In brief, we will have by end of March the full system (in boxes)."   (R. Lemmon 20160226)



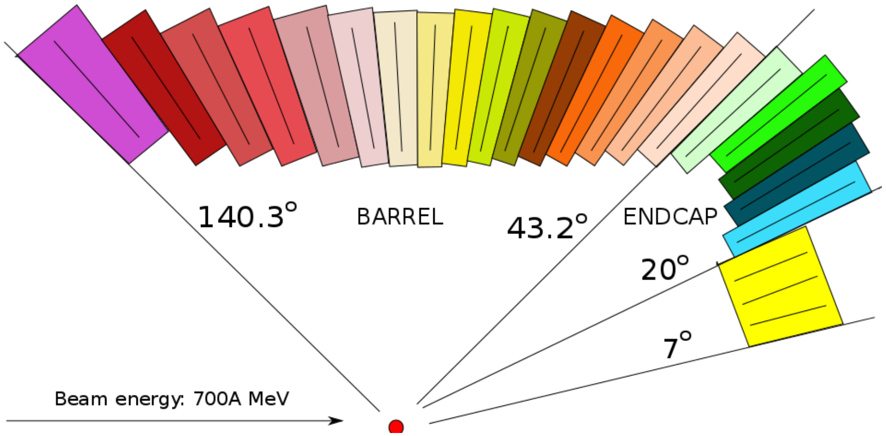


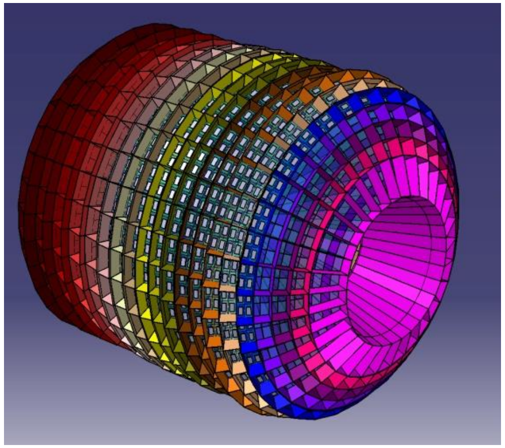
CALIFA : Calorimeter in-flight detection for g-rays and LCP

D. Cortina

Design dominated by the kinematics of particles emitted by relativistic sources
Detector split in two sections : BARREL and ENDCAP

TDR's approved 2013 and 2015





Intrinsic photopeak efficiency	40% (up to Eg=15 MeV PF)
Gamma sum energy resolution D(E$_g$sum)/<(E$_g$sum)>	< 10% for 5 g rays of 3 MeV
Calorimeter for high energy LCP	Up to 320 MeV in lab system
Gamma energy resolution	~5-6% (FWHM at Eg=1 MeV)
LCP resolution	~2%
Proton-g ray separation	For 1 to 30 MeV

Physics imposes the scientific requirements
- Huge dynamic range
100 keV γ-rays – 700 A MeV charged particles
- high efficiency, good resolution
- high granularity → Doppler correction
- particle identification

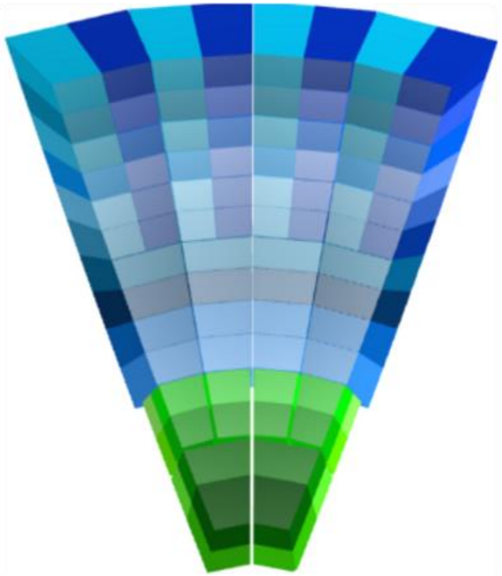
USC-IEM UVigo | GSI-TUM EMMI-TUD | Chalmers Lund | CFNUL | JINR NRC

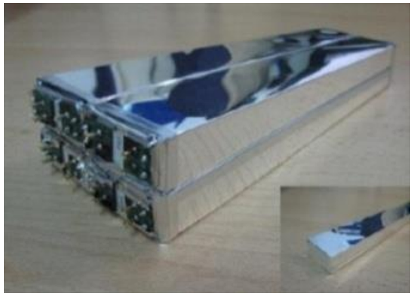
CALIFA : Calorimeter in-flight detection for γ-rays and LCP

CsI(Tl)+LAAPD

2464 units
Polar angle 20-140^0

- CsI (Tl) range between 15-22 cm long
- Packed in groups of four (VM2000 and Carbon fiber)
- APD collecting area 10x20 mm^2



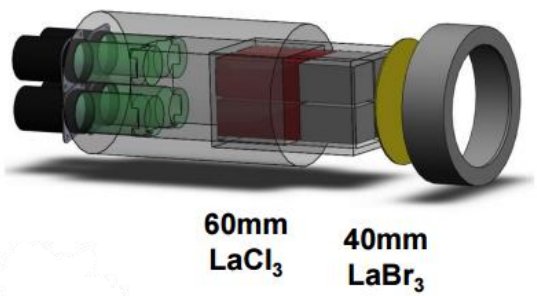


- Good $\Delta E/E$ ~6% @ 1 MeV for g and 2 % for p up to 320 MeV
- PID and E determination based on two different intrinsic times of CsI up to 700 MeV $\Delta E/E$ ~ 5%
- Background rejection

LaBr/LaCl+PM

96 units
Polar angle 7-20^0

- LaBr 6 cm and LaCl 8 cm long
- Packed in groups (Al cane)
- PM 1.5 ¨ diameter

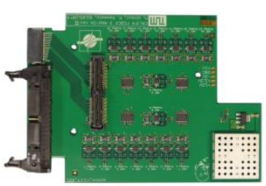


- Very good $\Delta E/E$ ~ 3% @ 662 keV for γ
- E determination based on two different time decay of LaBr/LaCl $\Delta E/E$ ~ 5%
- Good timing
- Background rejection

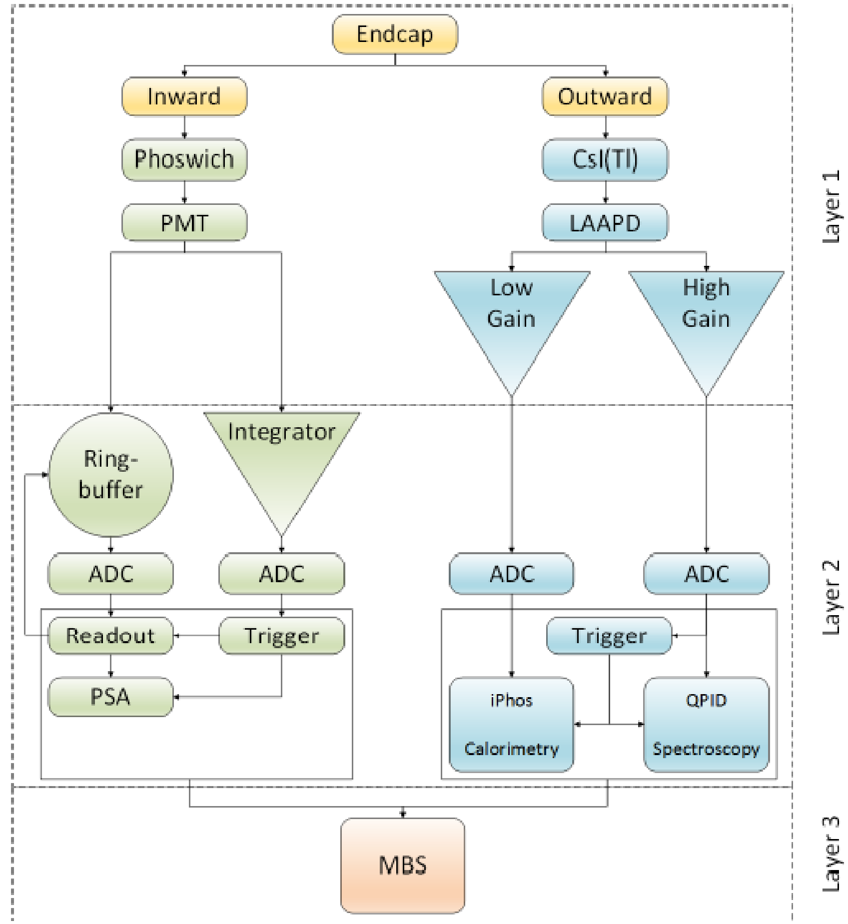
CALIFA : Calorimeter in-flight detection for γ-rays and LCP

✓**Preamplification for the CsI(Tl)** : mounted directly at the detector level (optimized for low noise and low power consumption and simple mechanical access)

✓**Digitizers** modules located on the movable support of the detector. They perform full signal processing and provide buffer memory for an asynchronous data collection.

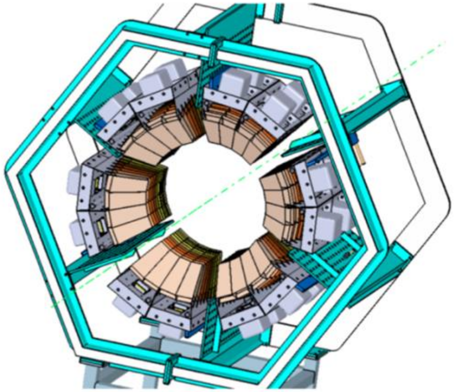


✓**DAQ** based on MBS and GOSIP protocol.

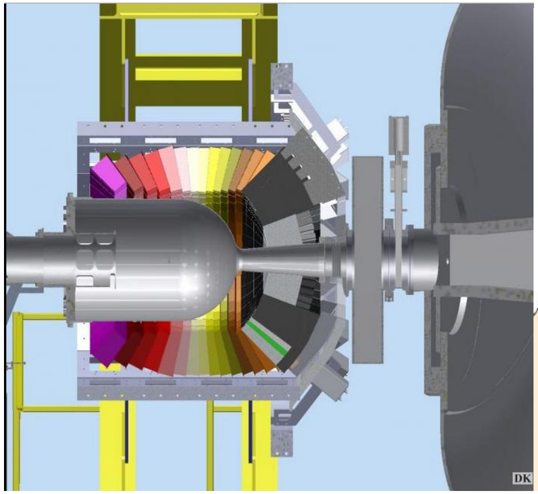


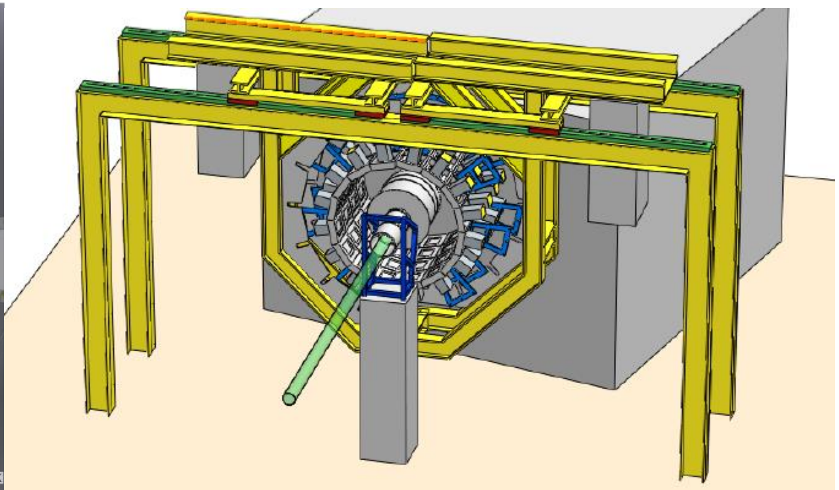
CALIFA : Calorimeter in-flight detection for γ-rays and LCP

The construction of 12 petals (~ 768 Barell detection channels) is foreseen to be completed withing the next 6 months



Full detector expected by 2018





Tracking WG: Si detectors

D. Rossi

X1

- 5 x 5 cm^2
- 140/300 um thick
- 16 strips on the front, read out on both ends (position)
- Cathode on the back

=> 33 channels each

X5.1

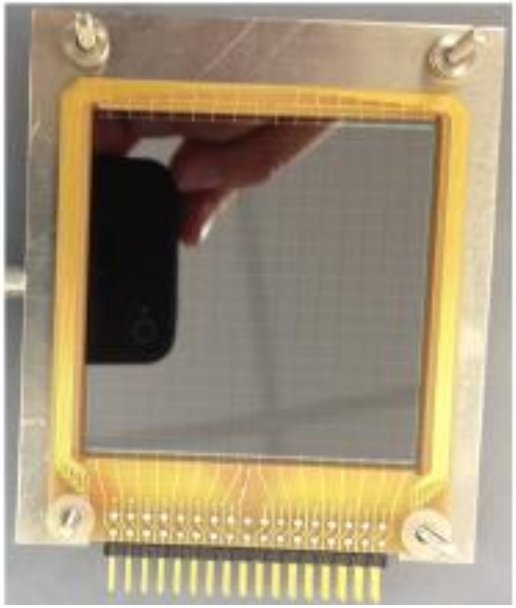
- 10 x 10 cm^2
- 200 um thick
- 32 strips on the front and the back, read out on both ends (position)

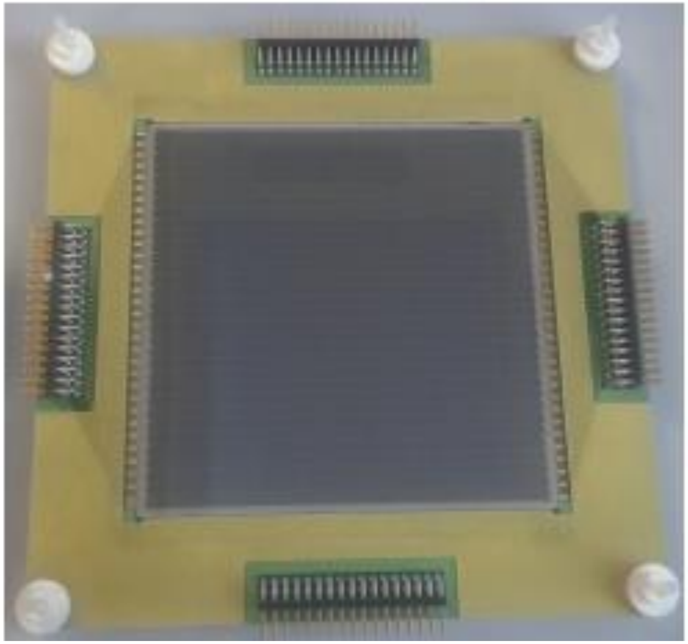
=> 128 channels

X5.2

- 10 x 10 cm^2
- 200 um thick
- 32 strips on the front and the back, read out between the strips (position)

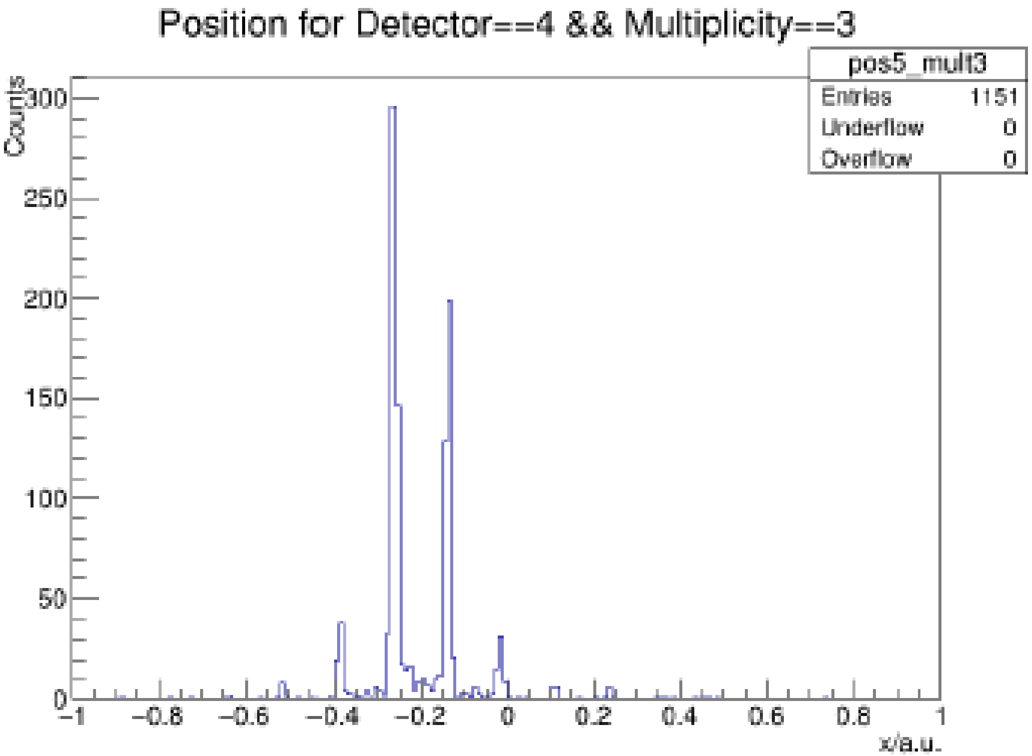
=> 128 channels

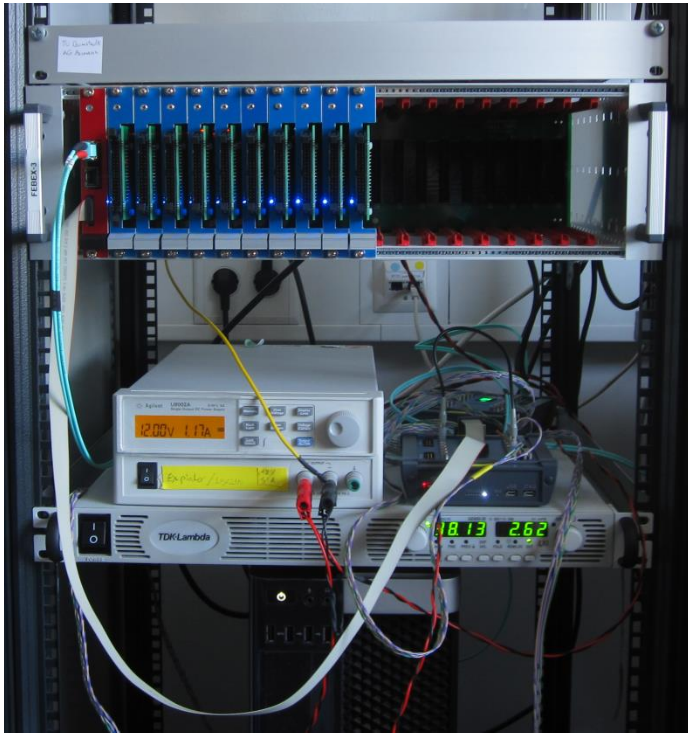




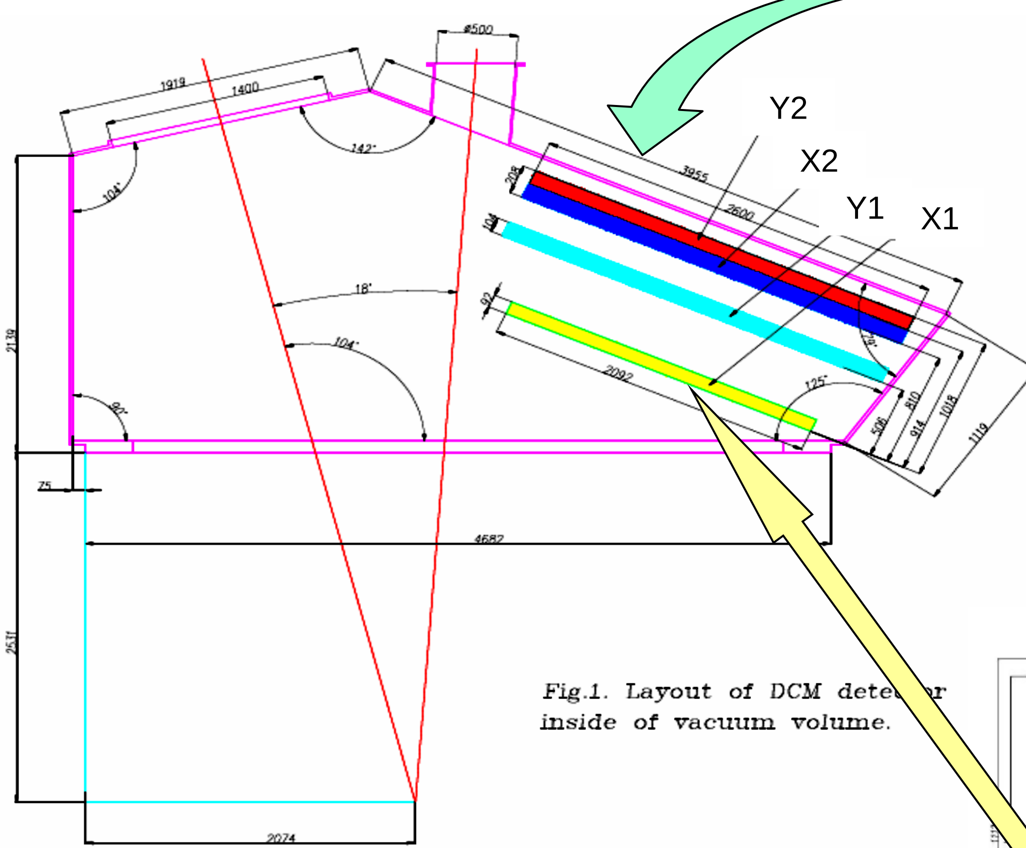
Tracking WG: Si detectors

- UCESB unpacker for Febex Multihit Readout: done (Ralf)
- RAW level in R3BRoot: almost done
- CAL level in R3BRoot: work in progress

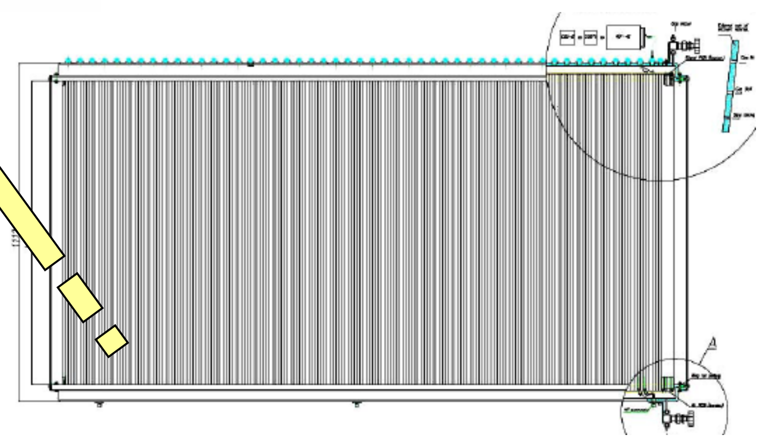




Tracking WG: Proton-arm spectrometer

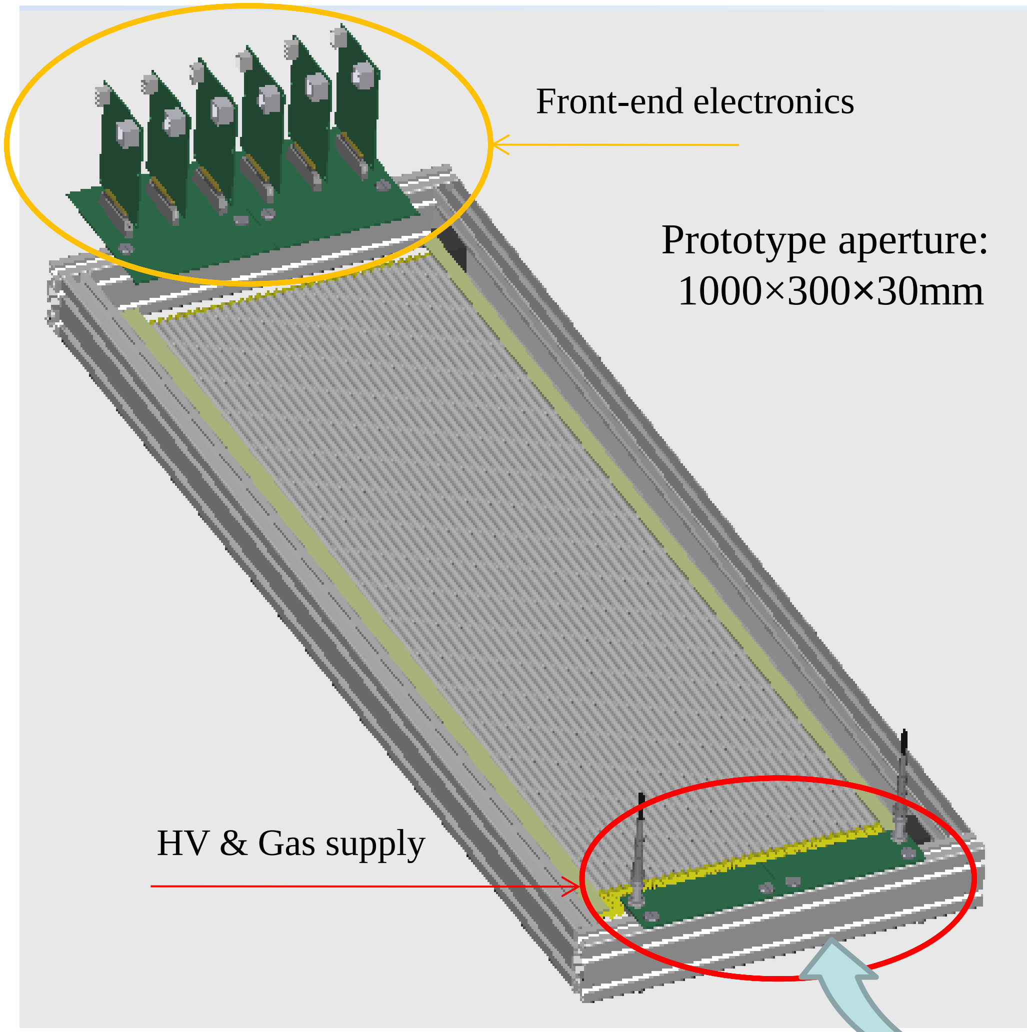


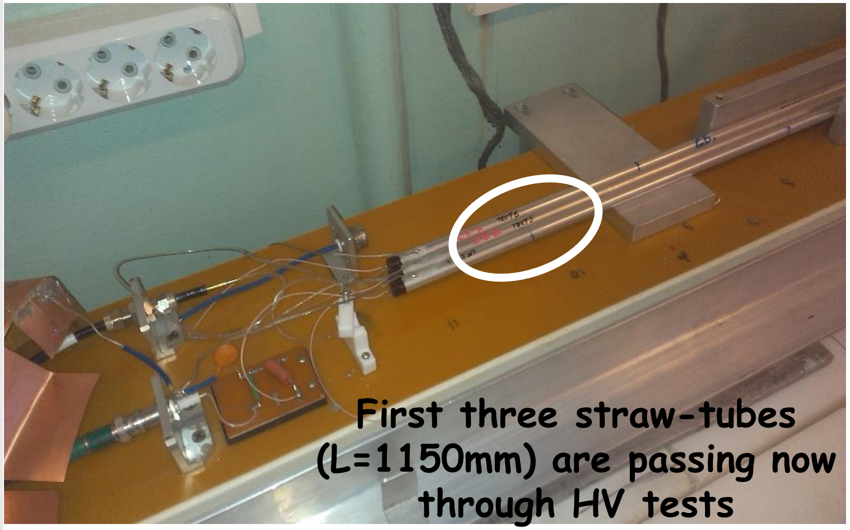
Layout of the drift chamber planes X1 (yellow), Y1 (light blue), X2 (blue and Y2 (red) inside the vacuum chamber behind the GLAD magnet.

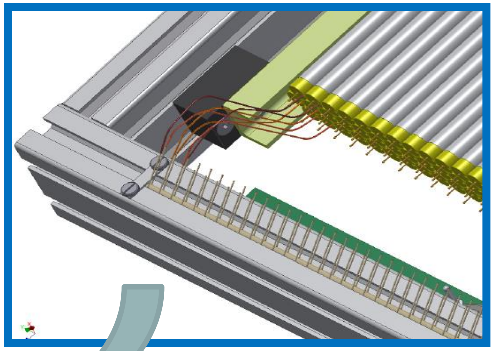


General view of first STW (X1 – coordinate)

Tracking WG: Proton-arm spectrometer







Inlet and outlet gas collectors are located on one side.

Consists of **96** ultrathin tubes

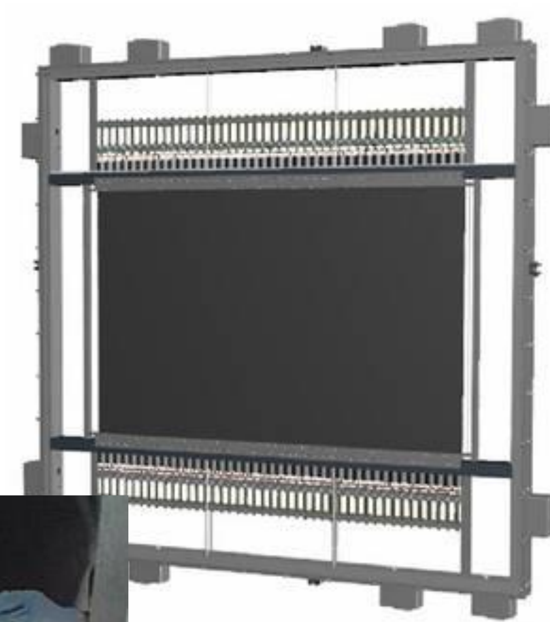
R³B: Time-of-flight detector prototyping

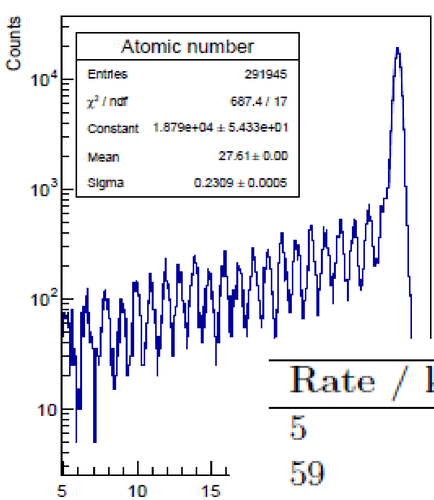
M. Heil, Tracking WG, RBEE

Performance goals:

- Time resolution σ_t/t = 2E-4
  ($\Leftrightarrow$ σ_t =20 ps for 20 m flight path at 1 *A*GeV)
- Energy resolution σ_E /E = 1%
- High-counting rate capabilities (~1 MHz)
- Large dynamic range (up to Pb-U).
- **FPGA based TDC** readout (ΔE via ToT Techniques)

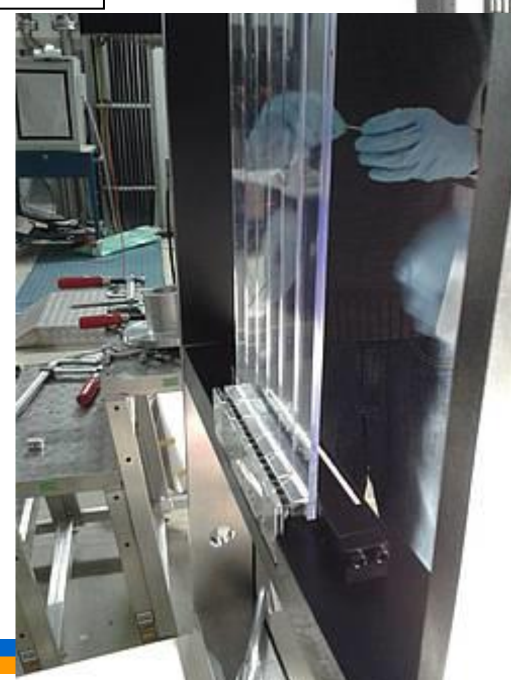
Detector layout





Excellent time and energy resolution at high rates

Rate / kHz	σ_t / ps	σ_t^{det} / ps
5	41	14
59	41	14
375	45	16
1000	64	23



Prototype studies @ Cave-C 08/2014 10/2014

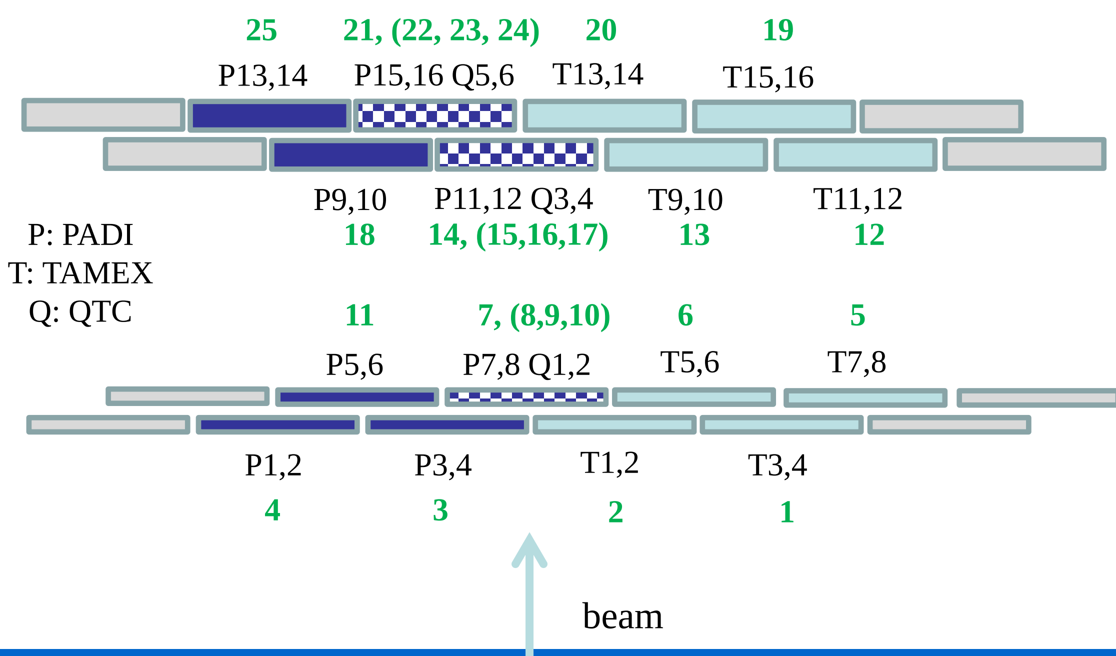
Test setup

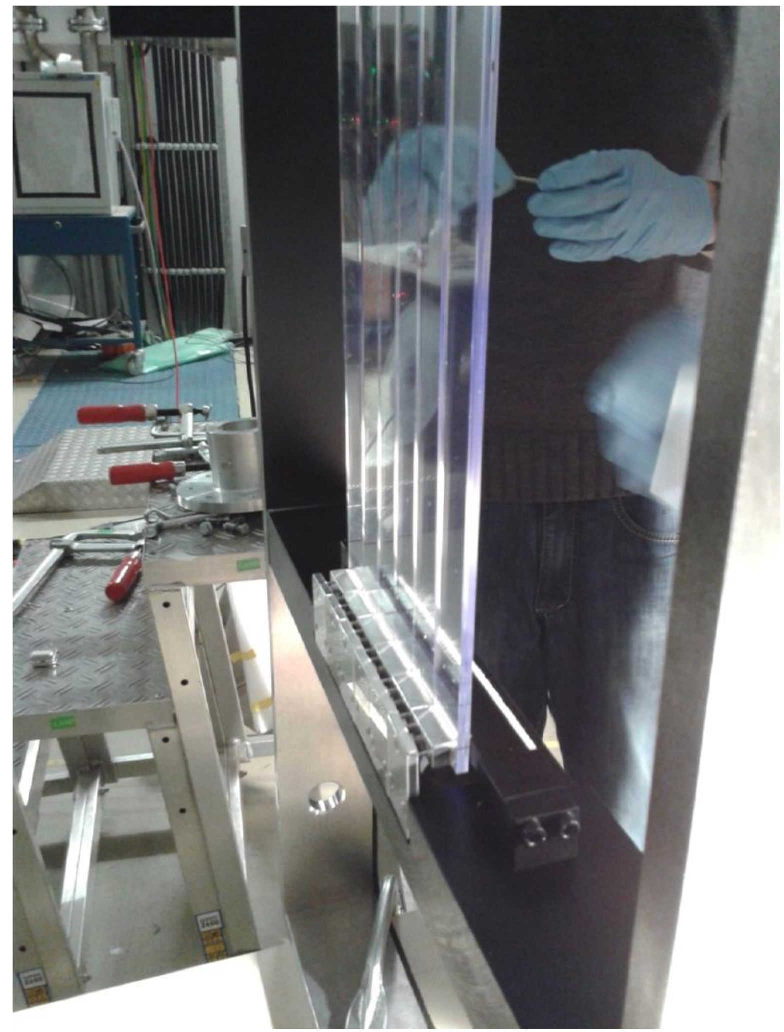
2x6 paddles with thickness of 3 mm

2x6 paddles with thickness of 5 mm

electronics: PADI, prototype TAMEX, QTC

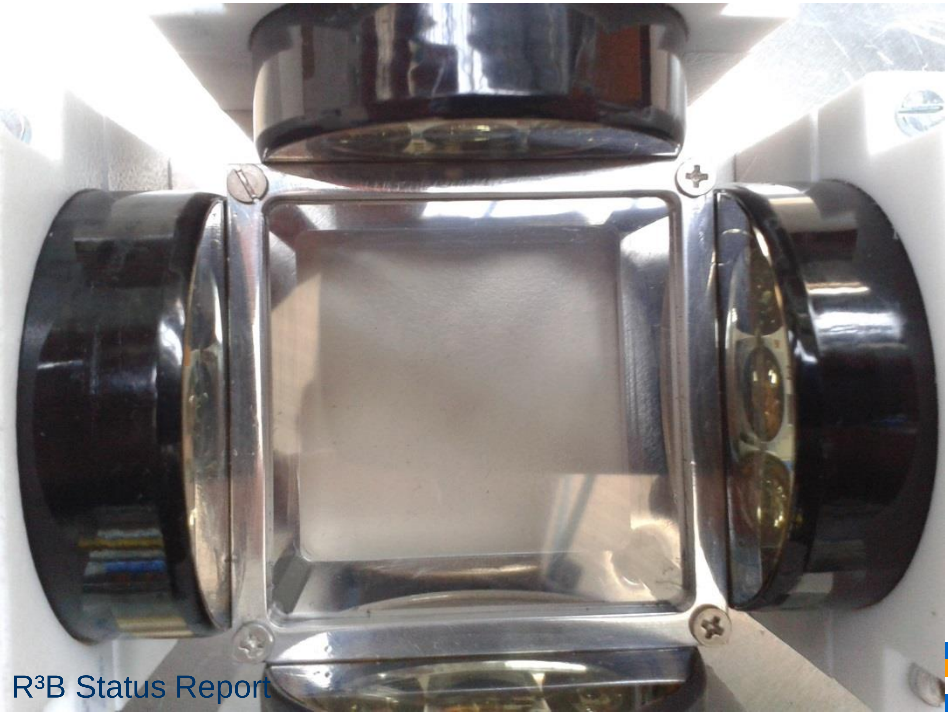
NeuLAND PMs with and without fully active base





The new start detector LOS

- EJ230 scintillator with thickness of 0.5 mm
- Aluminum frame for stabilization of thin scintillator foils (e.g. 50 µm)
- active area: 5 x 5 cm^2
- 4 Hamamatsu R9779-20 PMs, TTS: 250 ps
- Mesytec MCFD16-PMT constant fraction discriminator

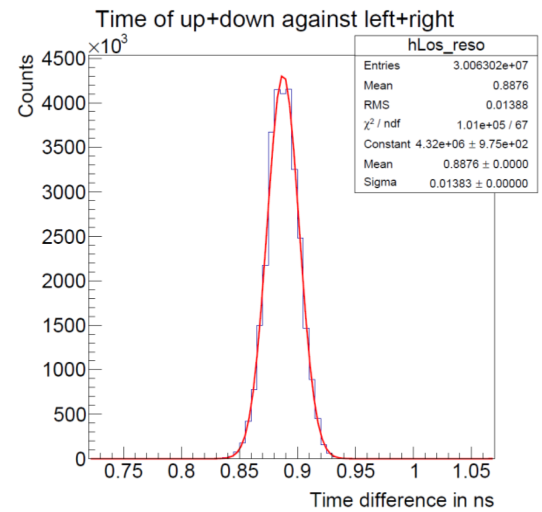


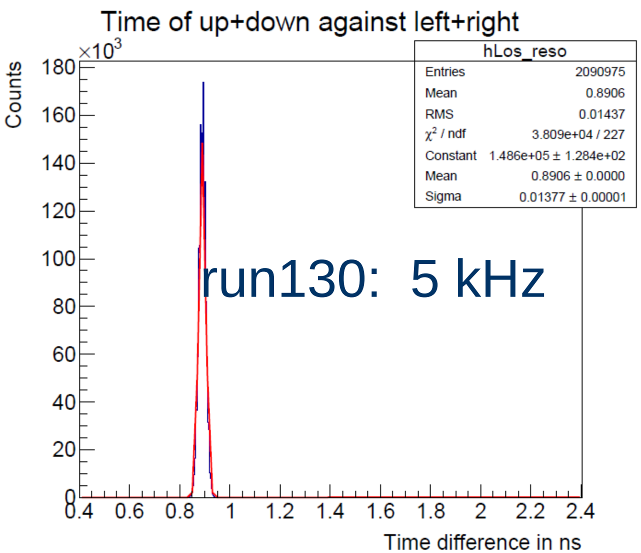
Results on time resolution

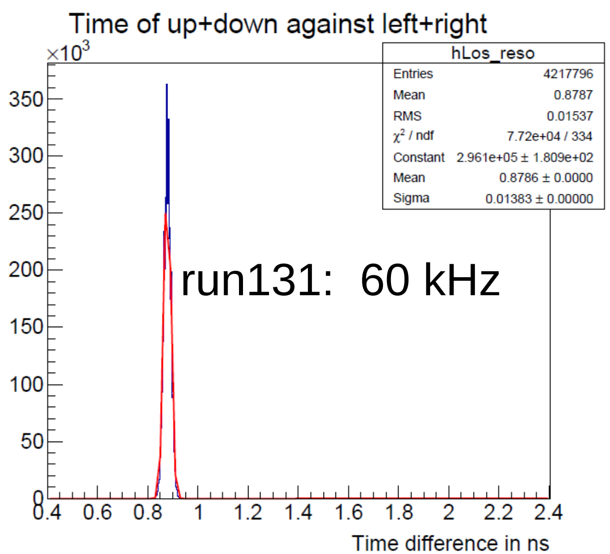
LOS: $t_{(up+down)}$-$t_{(left+right)}$ = 14 ps

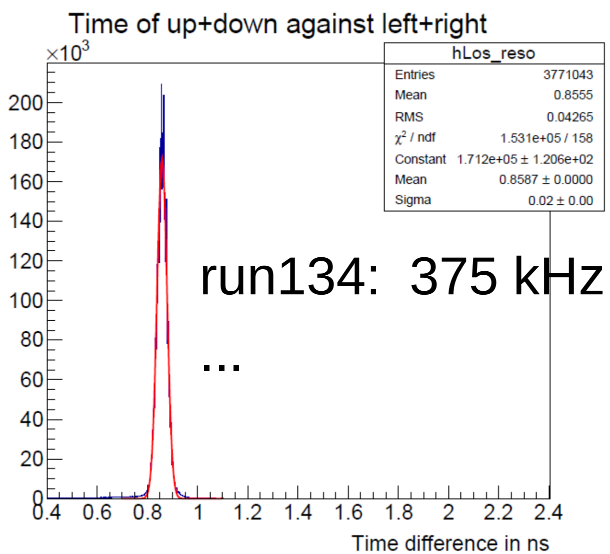
⇒ detector resolution: σ_t = 7 ps

⇒ .. stable at high rates



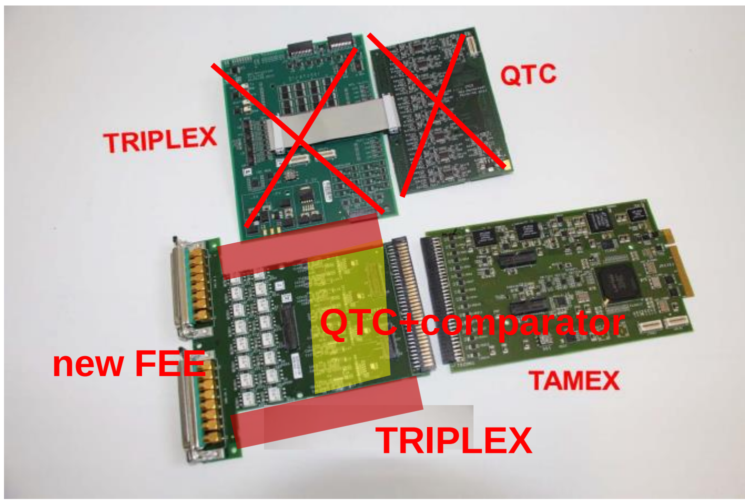


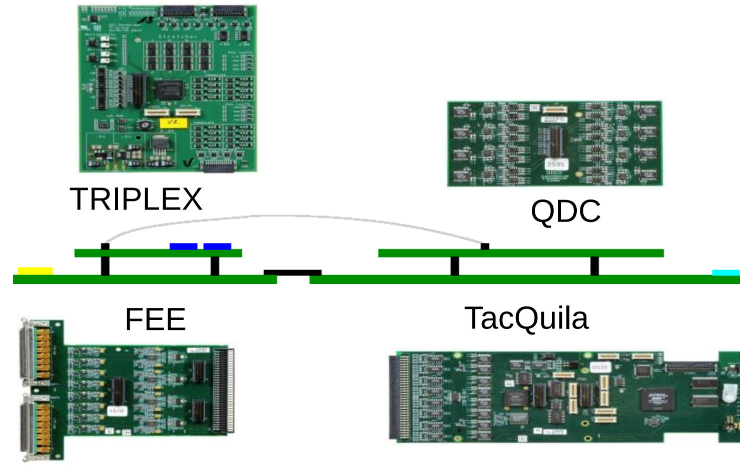




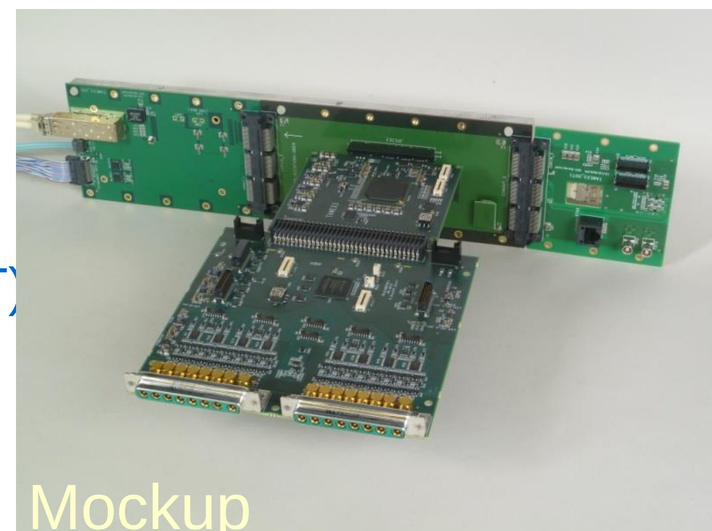
TAMEX, a versatile DAQ electronics for NeuLAND and other Timing applications with charge measurements

transition from
LAND-TacQuila readout
(ASIC based TDC + QDC)



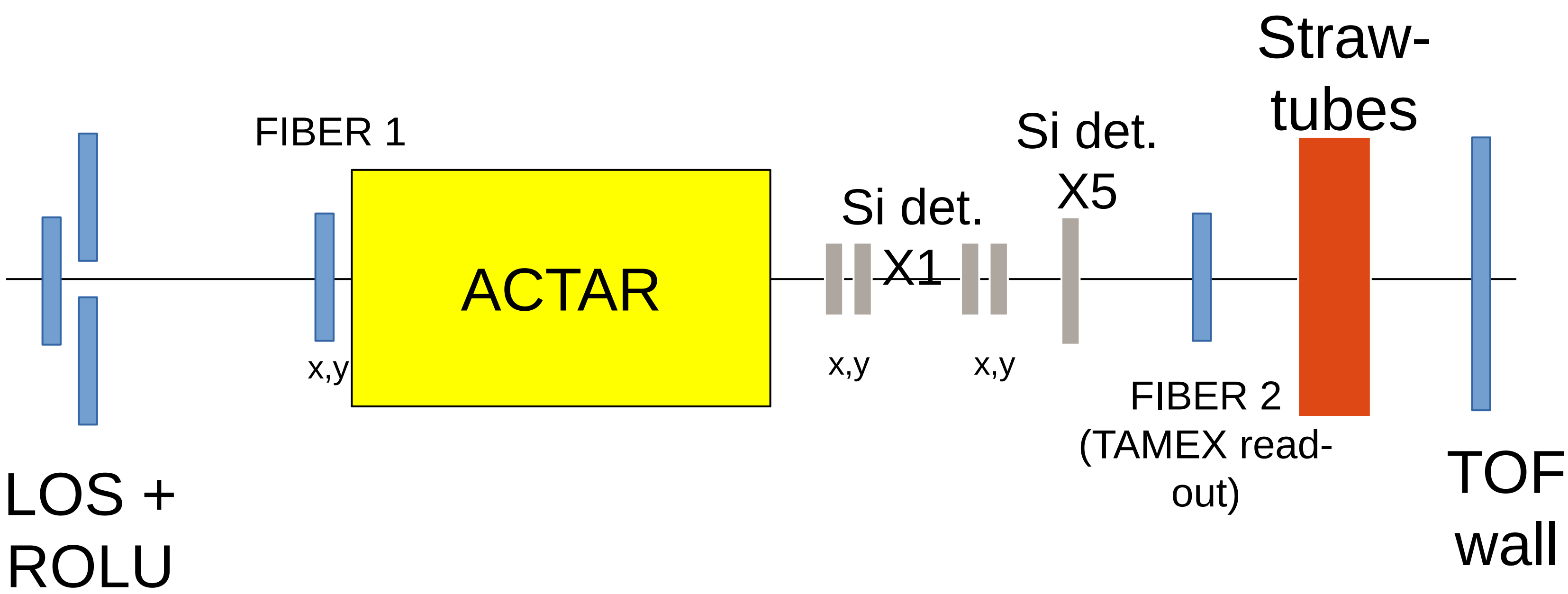


to TAMEX (FPGA based TDC+ QTC → ToT)
prototype (almost) available
by GSI RBEE

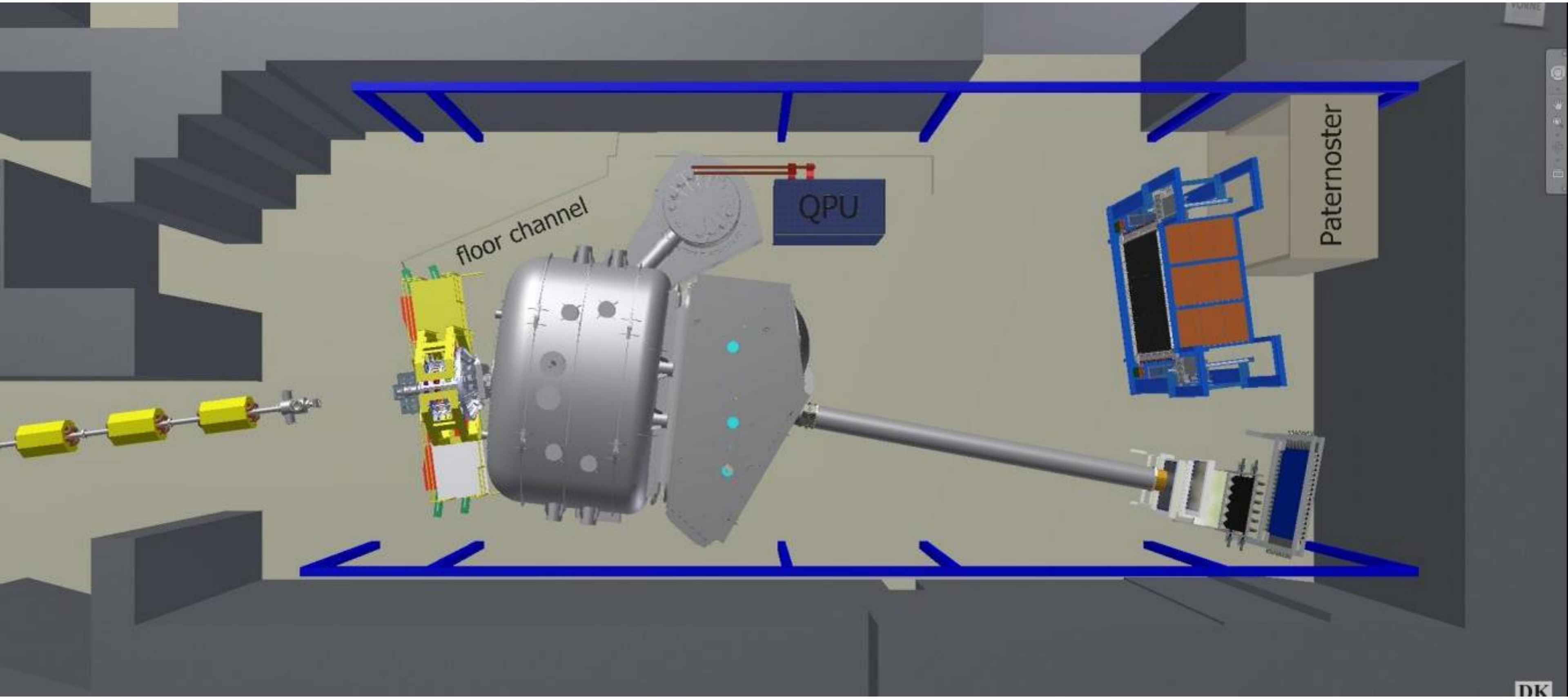


Tracking WG: June 2016 test beam time

- Planned setup in Cave C /HTD
- Expected beams: Xe (Two weeks mid June) and C (Second Week July) at 600 MeV/u



GLAD @ Cave-C



GLAD has arrived and is being installed in Cave-C

- Power supply there and tested
- Crypo plant installed and tested
- Magnet has arrived and passed first series of SAT tests

➔ non conformity in the exit flange mitigation in progress

- in-kind contracts with F/D in preparation

- 04/2016 installation of instrumentation and MSS/MCS by CEA
- End 2016 to get magnet into operation!

H. Alvarez-Pol, R. Plag

General status of data analysis code

- UCESB-unpacker integration done.
- Basic coding standards released. More to come.
- Launch of Redmine (issue tracker).
- Introduction of R3BRoot forum as general help center
- Mapped data (=land02 RAW level) nearly finished for most detectors.
- Cal and Hit level available for some detectors – work in progress.

R3BRoot – Implementation of analysis codes

	UCESB	R3BRoot Mapped	R3BRoot Cal-Level
LOS	ok	ok	devel
PSP	ok	ok	devel
SiTracker	-		
Actar	?		
Califa	?	ok?	ok?
Fiber4	ok	devel	
TofD	ok	devel	
Neuland	ok	ok	ok

Schedule and first experiments

2014 Installation of 20% detectors NeuLAND and CALIFA
Commissioning run in Q3/2014

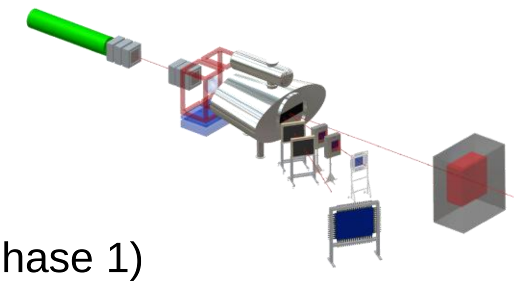
2015/16 Construction and installation of detector components

2018 Commissioning of full R3B setup (Cave C)

2018-202x Physics runs at GSI (Cave C) (phase 0)

202x-202x+1 Move to High-Energy Branch building

202x+1 → Commissioning and first experiments at Super-FRS (phase 1)



Experiments will make use of uniqueness of R³B:

- Reactions at high beam energies up to 1 GeV/nucleon
- Tracking and identification capability even for the heaviest ions
- Multi-neutron tracking capability, high-efficiency calorimeter

→ **Experiments possible for the first time:**

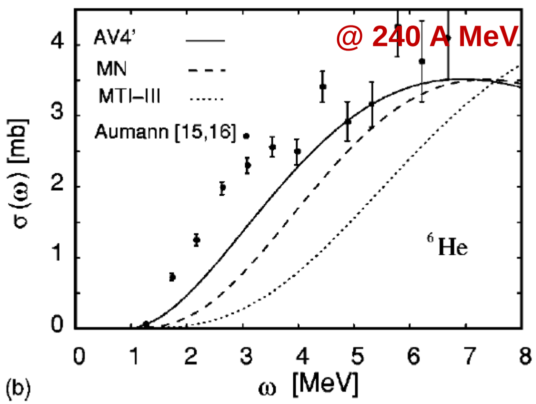
- 4 neutron decays beyond the drip-line and for heavier n-rich isotopes
- Kinematically complete measurements of quasi-free nucleon knockout reactions
- Electric dipole and quadrupole response of Sn nuclei beyond N=82, and of neutron-rich Pb isotopes (polarizability, symmetry energy)
- fission barriers from (p,2p) reactions (→ r-process)

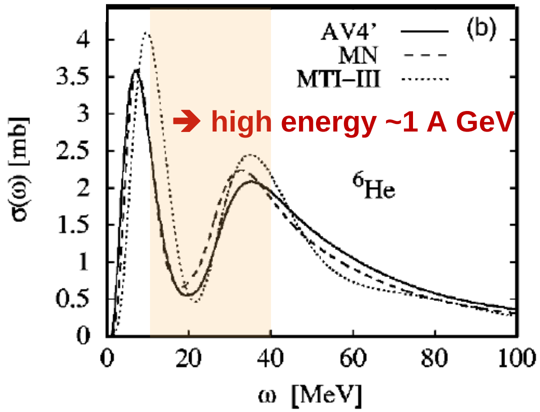
Dipole strength Distributions

neutron-rich nuclei → start with an ‘easy case’

^{6}He beam (!)

- core vs. neutron skins & halos → density / asymmetry





S. Bacca et al.
PRL **89** (2002) 052502
PRC **69** (2004) 057001

- Phase-0 program viable and in preparation
- Major components become all operational

Common developments !
→ Common EDAQ, systems...
controls, software ...

„We‘ll be ready for 2018 ff“

... stay tuned


Ausgabe Nr. 13

target

FAIR
GSI

Januar 2016

Ankunft eines Schwergewichts

Der Magnet GLAD hat das GSI Helmholtzzentrum für Schwerionenforschung und FAIR (Facility for Antiproton and Ion Research in Europe) erreicht. Der in Frankreich gefertigte supraleitende Magnet GLAD (GSI Large Acceptance Dipole) wird Teil des sogenannten R3B-Experiments an der Beschleunigeranlage von FAIR

Lesen Sie mehr auf Seite 3