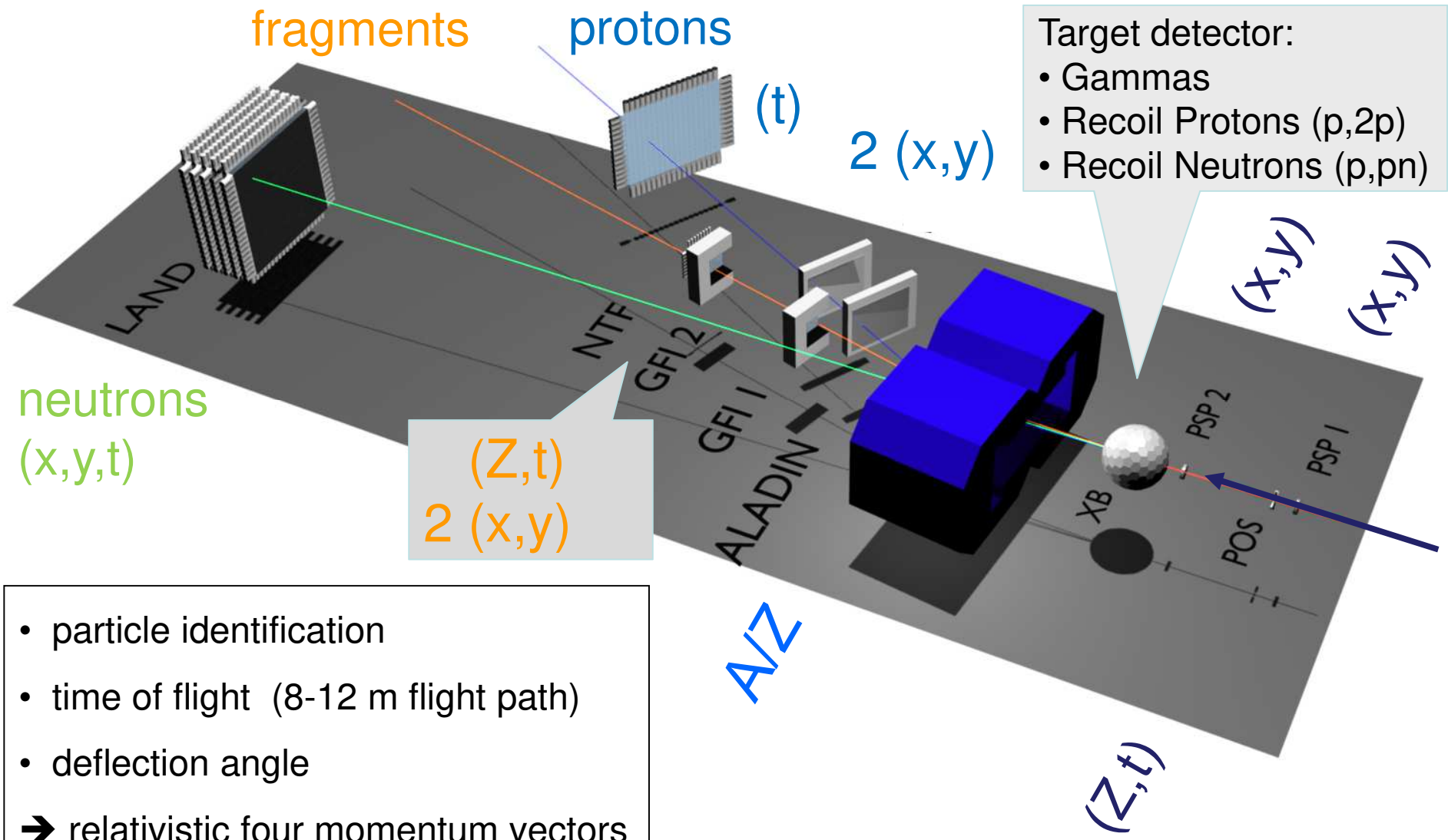
FAIR Phase-0
R3B
2018/19

H. Simon • GSI Darmstadt

NUSTAR
Annual Meeting 2018
20180227-0302

GSI FAIR EMMI

R³B/LAND Setup evolves to R³B/NeuLAND Setup + GLAD (kinematically complete)



- particle identification
- time of flight (8-12 m flight path)
- deflection angle

➔ relativistic four momentum vectors

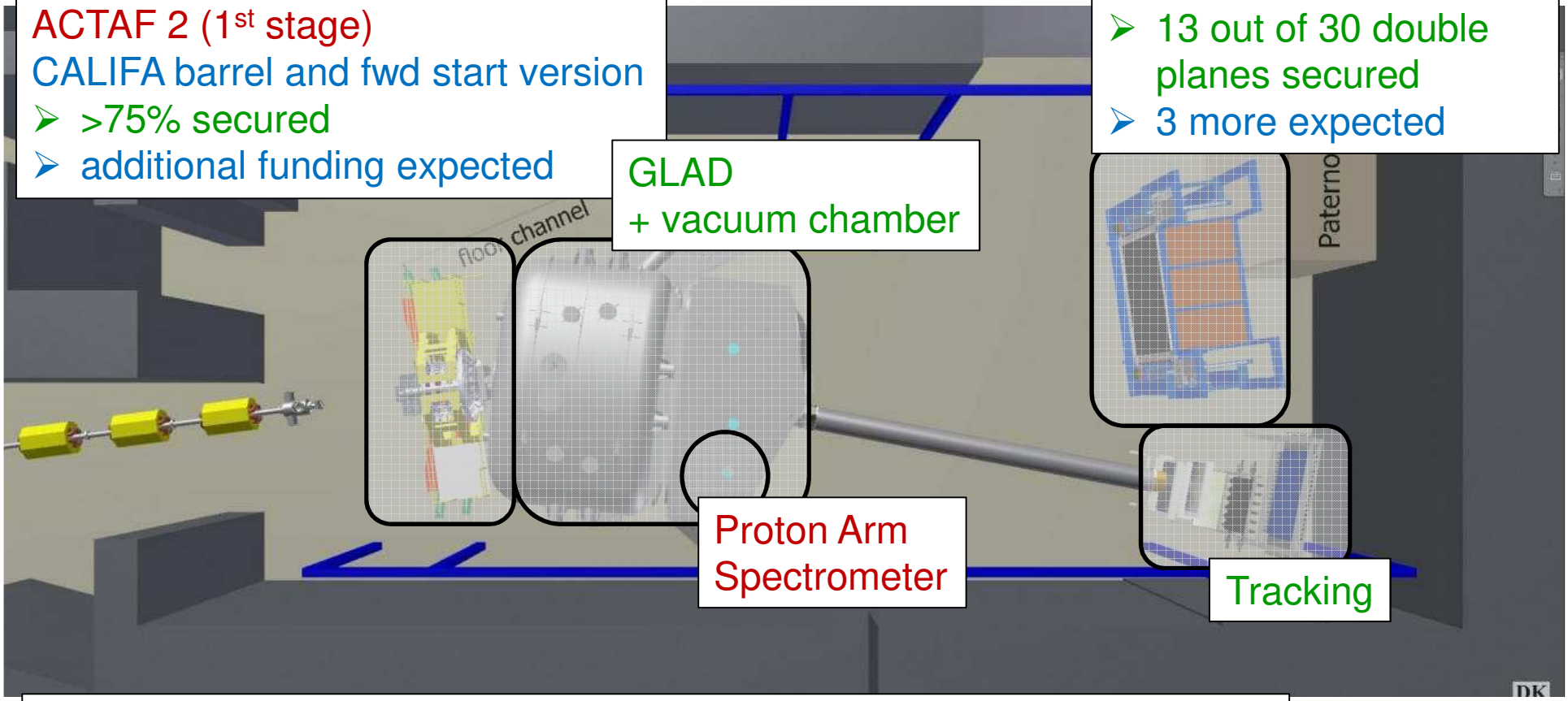
Starting point 2016

R³B (Status Phase-0 in 2018)

Tracking
L3T Si tracker
ACTAF 2 (1st 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

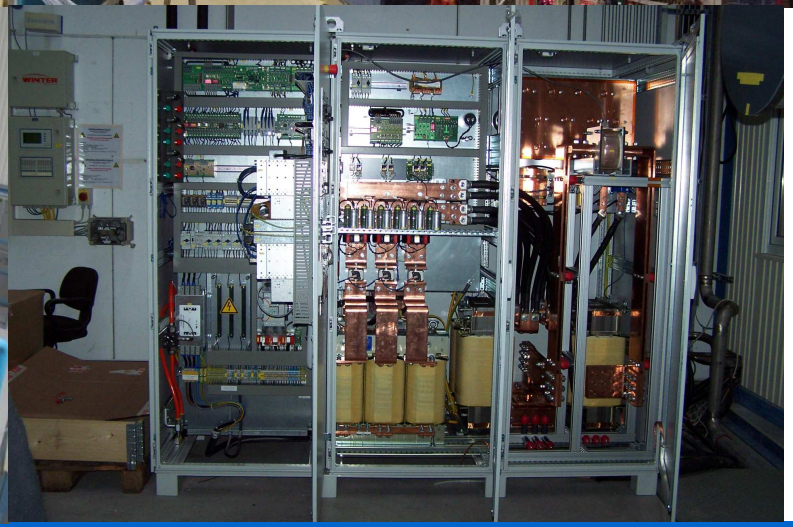


Proton Arm Spectrometer

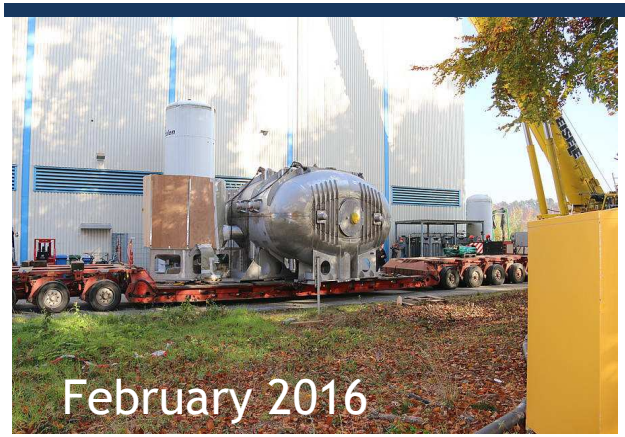
Tracking

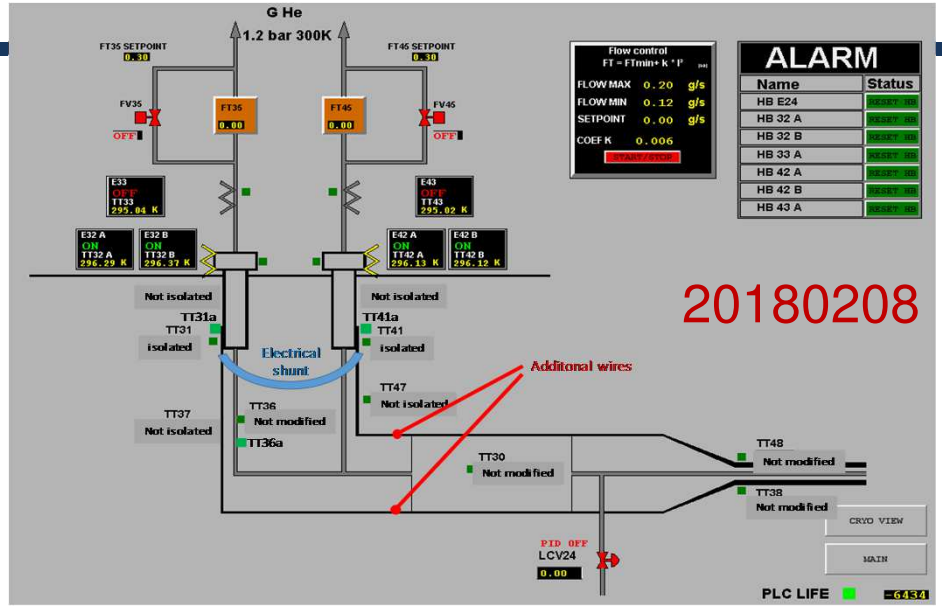
NUSTAR-DAQ (TDR accepted 02/2018)
-Time stamps (first implementation)/local trigger logics/readout libraries
-Online analyss R³B-Root ← FAIR-Root

All Infrastructure and magnet installed 2013-2016
Commissioning started



R³B / GLAD





@ CAVE C (02/16→ 11/16)

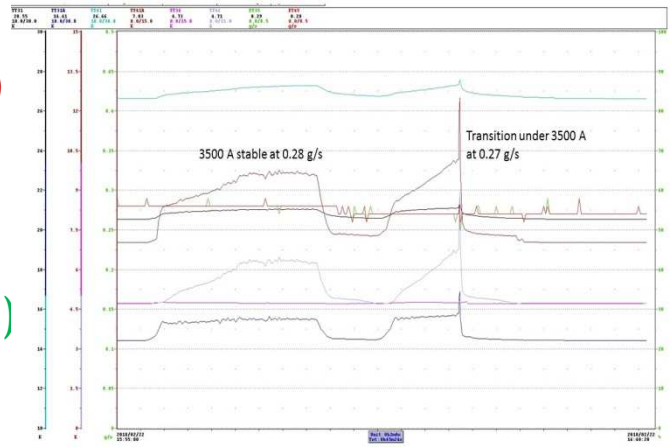
- Preparation for FAT, NCs removed
- Cryo Line, Cryo plant, Power supply, and Quench Protection System all ok
- Cooling down tests on going ➔ final commisioning

Open Issues:

- Current lead foot cooling insufficient (20171115)

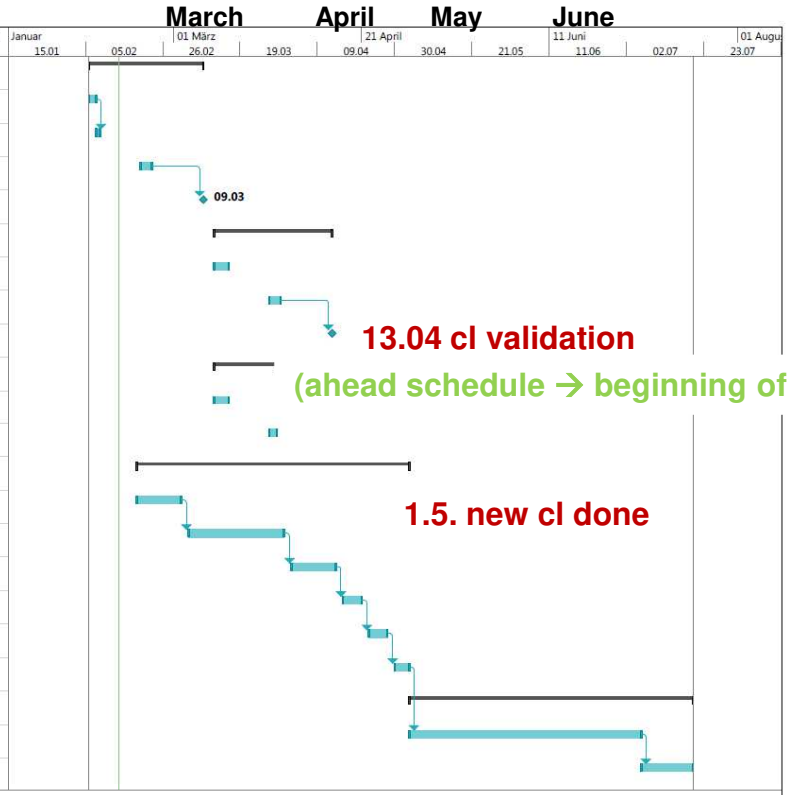
➔ Independend cooling of busbar and current lead prepared, **new cl design in ||**
current tests 20180222
→ @3500A/0.28g/s (0.27 g/s calculated) (cl ok !)

- Modification in Satellite foreseen
decision on new cl's within next week…



Worst Case Schedule (CEA, Ch. Mayri)

Nr.	Vorgangs	Nom de la tâche	Dauer	Anfang	Ende	Vorgänger	Ressourcennamen
1		**Glad tests**	**23 Tage**	**Die 06.02.18**	**Fre 09.03.18**		
2		Instrumentation improvements	2 Tage	Die 06.02.18	Mit 07.02.18		
3		CL foot modifications	1 Tag	Don 08.02.18	Don 08.02.18	2	
4		Test with electrical shunt	3 Tage	Die 20.02.18	Don 22.02.18		
5		CL validation or additional tests	0 Tage	Fre 09.03.18	Fre 09.03.18	4EA+2 Wochen	
6		**Additional tests**	**24 Tage**	**Mon 12.03.1**	**Fre 13.04.18**		
7		Remove of the junctions	4 Tage	Mon 12.03.1	Don 15.03.18		
8		Test with new junction	3 Tage	Die 27.03.18	Don 29.03.18		
9		CL validation	0 Tage	Fre 13.04.18	Fre 13.04.18	8EA+2 Wochen	
10		**CL replacement**	**13 Tage**	**Mon 12.03.1**	**Mit 28.03.18**		
11		Remove of the junctions	4 Tage	Mon 12.03.1	Don 15.03.18		
12		Dismount of the CL	2 Tage	Die 27.03.18	Mit 28.03.18		
13		**New current lead production**	**54 Tage**	**Mon 19.02.18**	**Don 03.05.18**		
14		Drawings production	10 Tage	Mon 19.02.1	Fre 02.03.18		
15		Pieces procurement	20 Tage	Mon 05.03.1	Fre 30.03.18	14	
16		CL1 fabrication at CEA	10 Tage	Mon 02.04.1	Fre 13.04.18	15	
17		CL2 fabrication at CEA	5 Tage	Mon 16.04.1	Fre 20.04.18	16	
18		CL test at CEA	5 Tage	Mon 23.04.1	Fre 27.04.18	17	
19		CL mounting on Glad	4 Tage	Mon 30.04.1	Don 03.05.18	18	
20		**Glad commisioning**	**55 Tage**	**Fre 04.05.18**	**Don 19.07.18**		
21		Cooling down	45 Tage	Fre 04.05.18	Don 05.07.18	19	
22		Electrical test	10 Tage	Fre 06.07.18	Don 19.07.18	21	



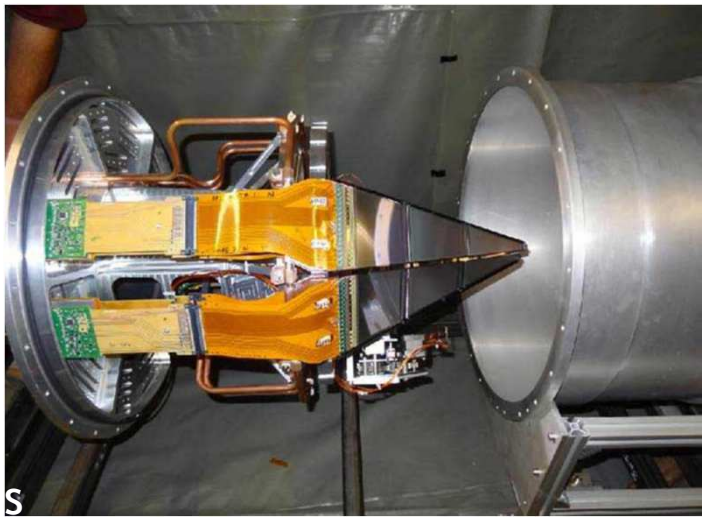
- **Phase-0 experiment status :**
  Expected to be ready Q2/2018

Projet : Current lead productio
Date : Mit 14.02.18

Tâche	Récapitulatif du projet	Tâche manuelle	Début uniquement	Échéance
Fractionnement	Tâche inactive	Durée uniquement	Fin uniquement	Avancement
Jalon	Jalon inactif	Report récapitulatif manuel	Tâches externes	Progression manuelle
Récapitulative	Récapitulatif inactif	Récapitulatif manuel	Jalons externes	

Page 1

R^3B /L3T (Si- Tracker) is potentially delayed



On going tests @ Daresbury:

- Full inner L3T layer in working condition
- expected energy threshold of 100 keV in verification (150keV achieved)
- Test bench running, first results
- Tests with alpha-source and, subsequently, cosmic rays

➔ Outer layer to be mounted and tested

L3T configuration

-inner layer 6 detector ladders

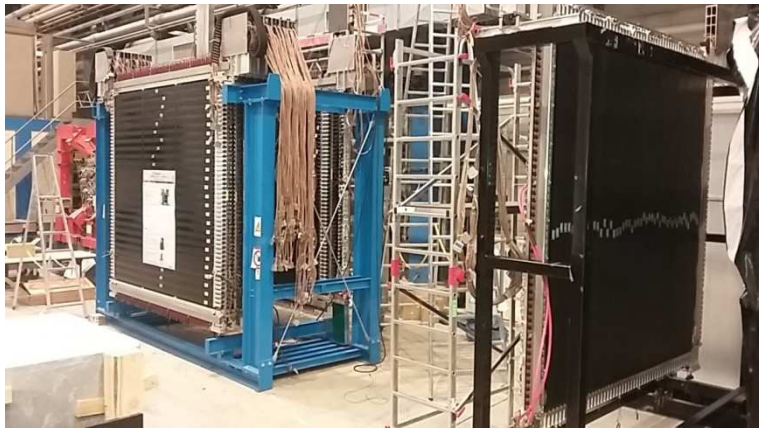
-outer layer 12 detector ladders (03-04/18)

Double-sided micro-strip Si sensors wire bonded to a dedicated ASIC (RAL: 120'000 channels) + time stamped FPGA based readout

TDR: L3T is a deliverable for the in-kind UK contribution. TDR is not need but R3B collaboration whish the presentation to ECE of an equivalent document including performance evaluation with up-coming tests

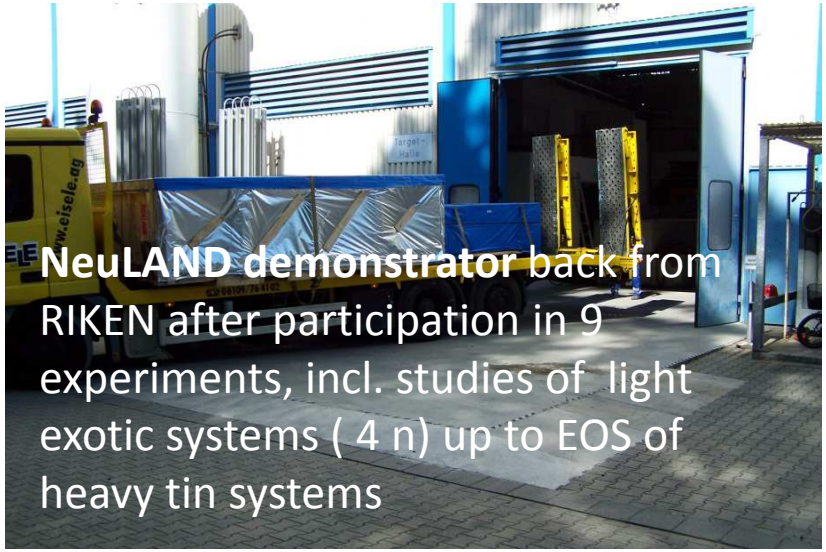
Phase-0 experiment status : Expected a functional detector for Q2-3 /2018

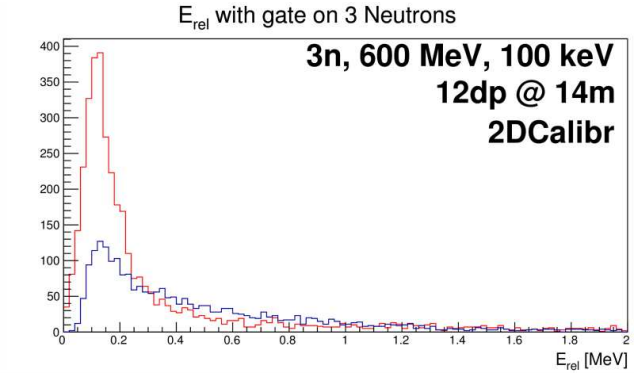
R³B /NeuLAND



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)

SAT test of in-house developed **NeuLAND electronics** underway:
multichannel front-end electronic card TAMEX for high-resolution time and charge measurements

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

Start version:

As of January 2018:

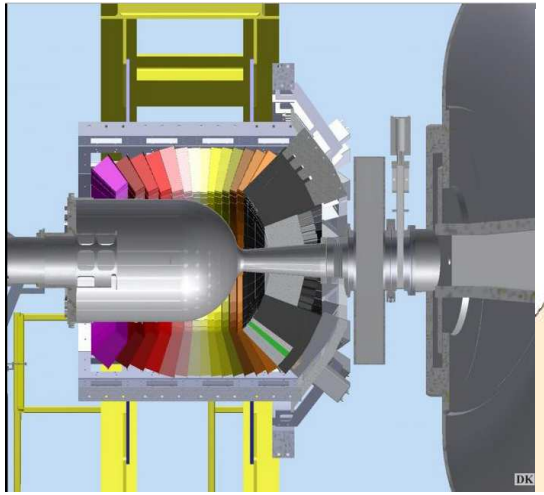
APDs

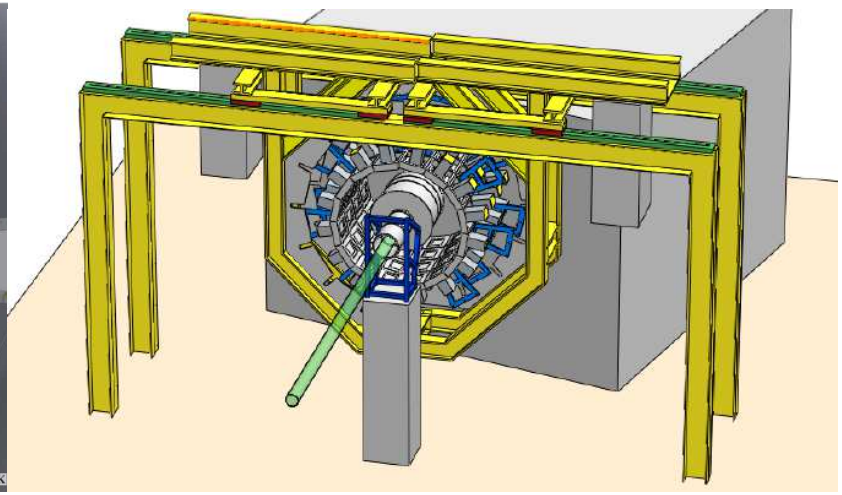
#	Institute
200	IEM
250	LU
360	TUD
320	USC
1130	Total

Crystals and wrapping

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

Full detector:



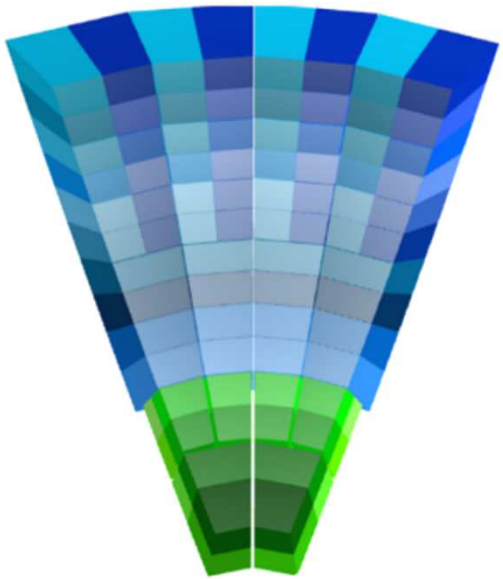


CALIFA : Calorimeter in-flight detection for γ-rays and LCP

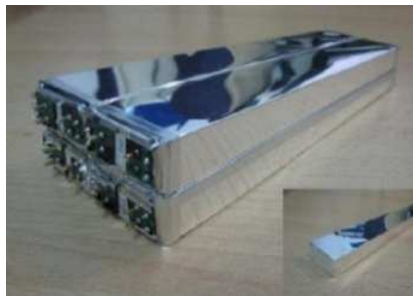
CsI(Tl)+LAAPD

2464 units (full detector)

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



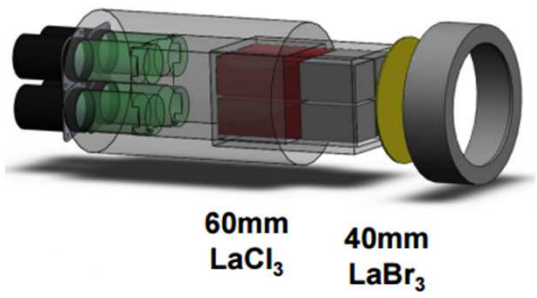
- Good ΔE/E ~6% @ 1 MeV for g and 2 % for p up to 320 MeV
- PID and E determination based on two different intrinsic times of CsI up to 700 MeV ΔE/E ~ 5%
- Background rejection

LaBr/LaCl+PM

96 units

Polar angle 7-20^0

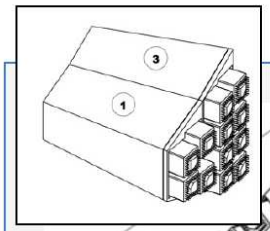
- LaBr 6 cm and LaCl 8 cm long
- Packed in groups (Al cane)
- PM 1.5 ¨ diameter

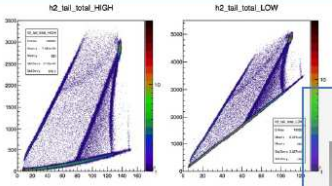


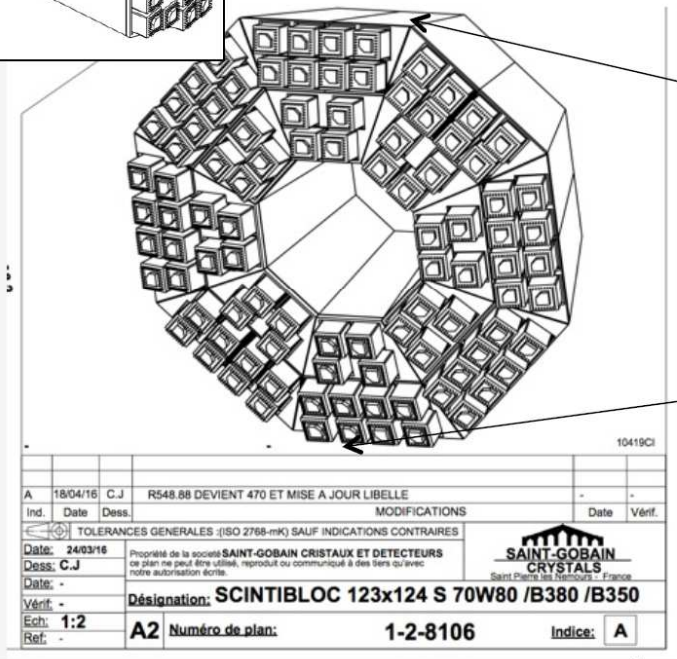
- Very good ΔE/E ~ 3% @ 662 keV for γ
- E determination based on two different time decay of LaBr/LaCl ΔE/E ~ 5%
- Good timing
- Background rejection

CALIFA Front Cap Basics

CEPA







A	18/04/16	C.J	R548.88 DEVIENT 470 ET MISE A JOUR LIBELLE	-	-
Ind.	Date	Dess.	MODIFICATIONS	Date	Vérif.

TOLERANCES GENERALES :(ISO 2768-mK) SAUF INDICATIONS CONTRAIRES

Date: 24/03/16 — Dess: C.J — Date: - — Vérif: - — Ech: 1:2 — Ref: -

Propriété de la société SAINT-GOBAIN CRISTAUX ET DETECTEURS ce plan ne peut être utilisé, reproduit ou communiqué à des tiers qu'avec notre autorisation écrite.

SAINT-GOBAIN CRYSTALS — Saint Pierre les Nemours - France

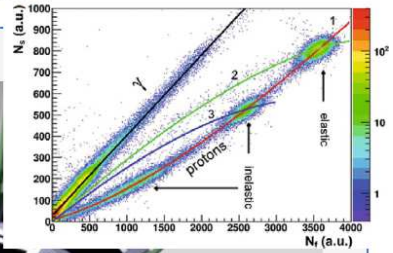
Désignation: SCINTIBLOC 123x124 S 70W80 /B380 /B350

A2 — Numéro de plan: 1-2-8106 — Indice: A

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

Fully funded via Chalmers. First segment module produced.

iPhos



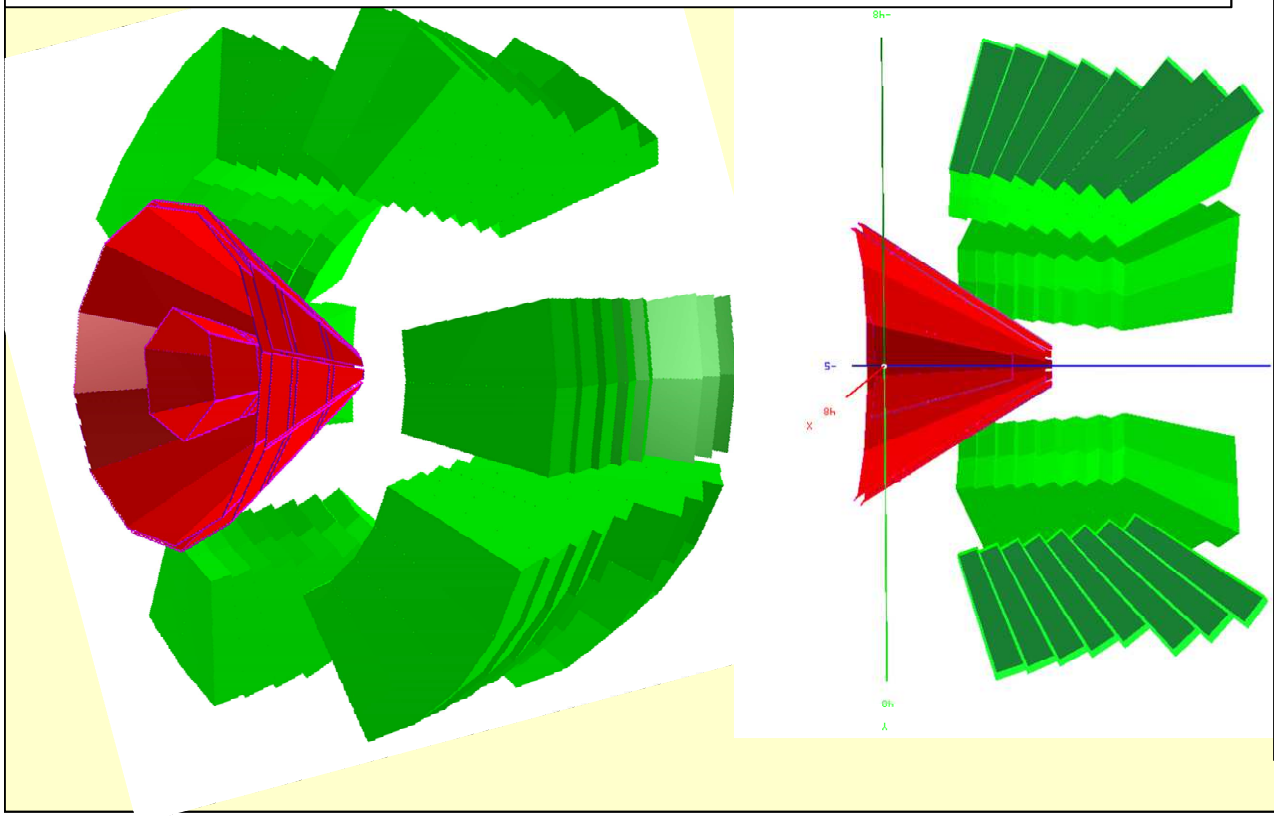
Angular cover:	20 – 43 deg.
Nr of crystals:	480
Sectors:	8
Scintillator:	CsI(Tl) with PSA

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.

Commissioning:
L³T with CALIFA Demonstrator

L3T: **L**amp shape **L**ow mass **L**ight particle **T**racker
CALIFA: **CAL**orimeter for the **I**n **F**light detection of γ-rays and light charged p**A**rticles

Geometry from Geant4 implementation :
animation 3D cut along the beam

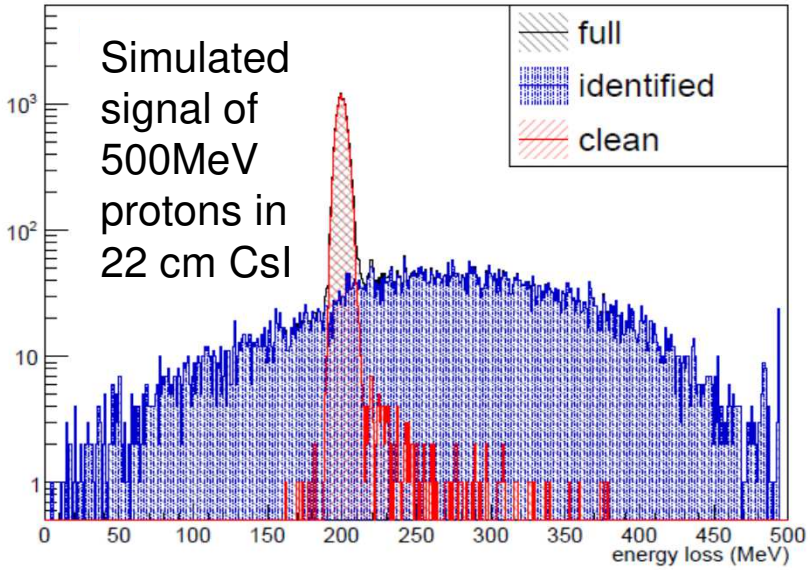


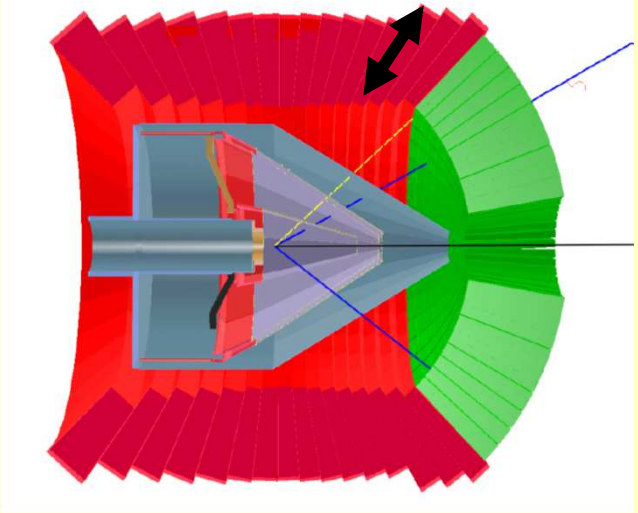
Existing setup:

L3T: (risk to be delayed)
Full coverage of solid angle
Full inner and outer plane
Full readout system.

CALIFA demonstrator:
4 single petals
2 double petals
$28^o < \Theta < 78^o$
50% Φ coverage
+ CEPA first segment
Full readout system.

Comm: Proton Energy in CALIFA 2018

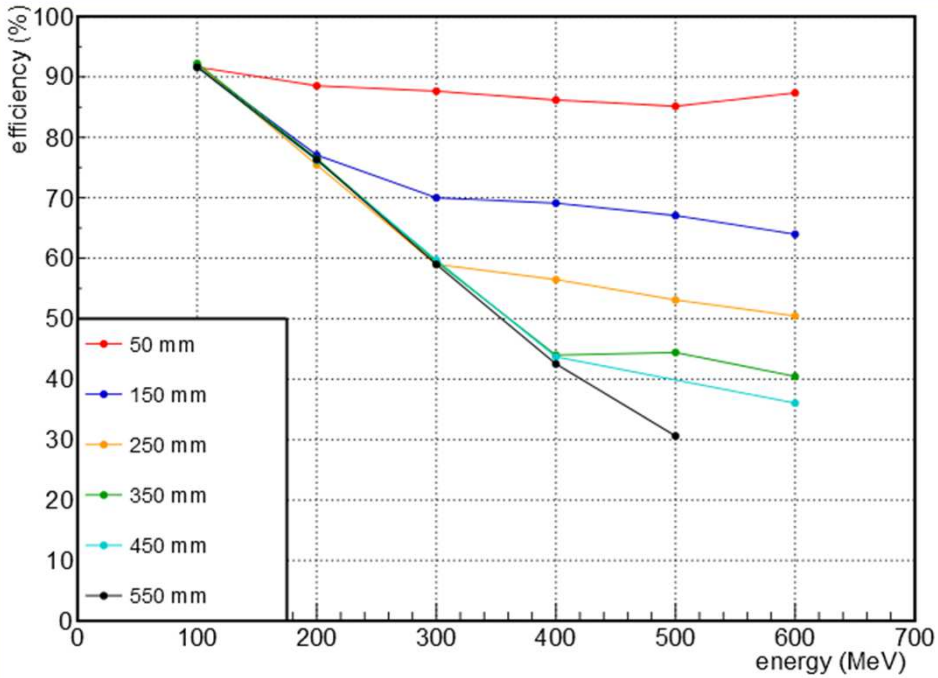




Pulse shape analysis (PSA) cleans up the reactions in the active material

Protons up to 285MeV are stopped in 22cm CsI, **ΔE/E < 1%**
iPhos PSA for larger energies

Probability to detect true proton energy



Comm: ^{12}C Beam Commissioning of GLAD, FAT 2018/19

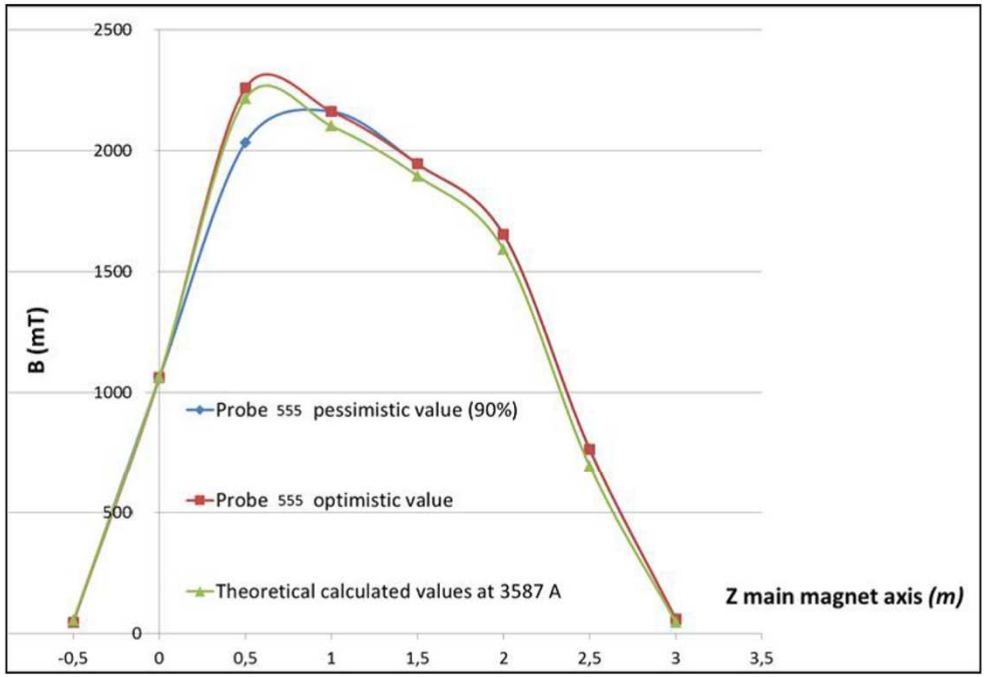


Figure 31: Vertical field measurements on the magnet axis

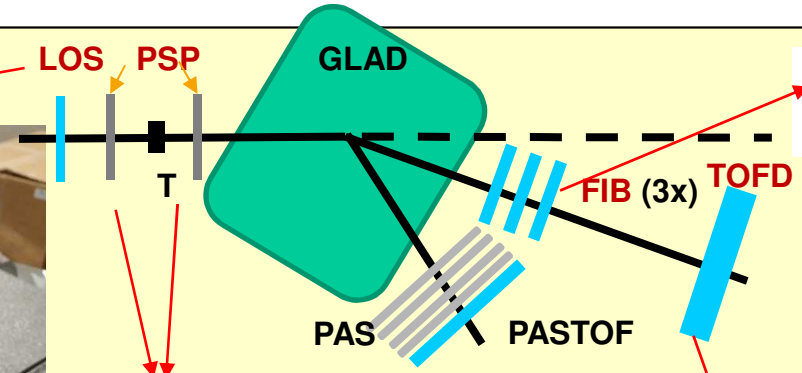
Table 15: Vertical magnetic field integral along the magnet axis at 3584 A

	∫B. dl (T.m)	diminished value of 3% (T.m)	comparison to the nominal value
Hypothesis on Hall probe 555: Pessimistic value (90%)	4.87	4.72	98%
Hypothesis on Hall probe 555: Optimistic value (100%)	4.98	4.83	100%

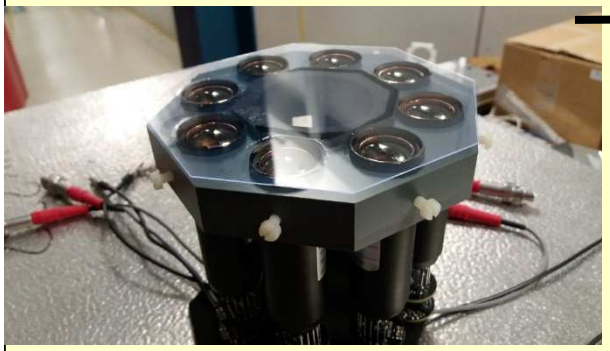
Measurement with ^{12}C:
400,600,800,1200 AMeV @ 10^5 1/s
GLAD field map probed over a wide range of p/Q and large acceptance

high res: 2018/9 (EOS, fission runs)

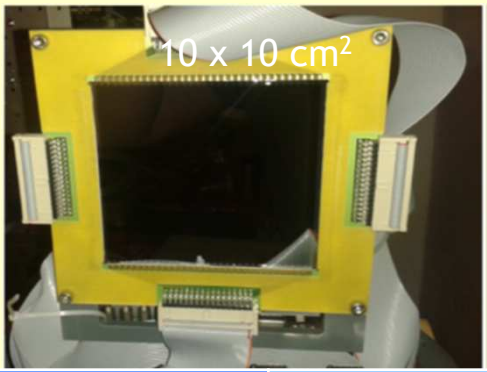
Comm: Tracking Detectors 2018/19+



200 µm square fiber for FIB4a
200/500 µm round fiber FIB4b/5

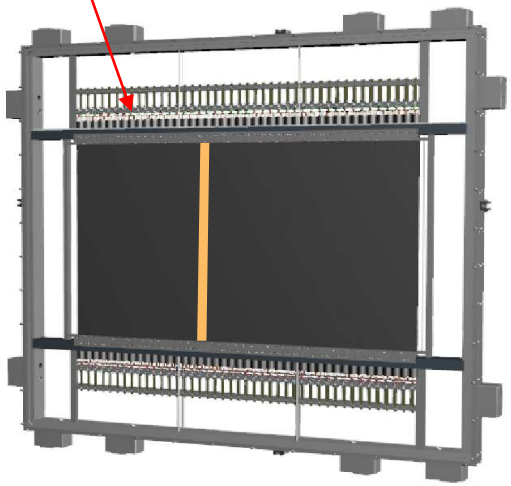


Z separation	$\sigma_E < 1\%$
A separation	σ_t < 10ps
Rate	1 MHz



Z separation	$\sigma_E < 0.5\%$
Position x y	σ_x < 100µm
Rate	0.1 MHz/strip

Proton Arm Spectrometer



Z separation	$\sigma_E < 1\%$
A separation	σ_t < 38ps
Rate	1 MHz/strip

Commissioning beam time: red. request

beam	E (AMeV)	rate (1/s)	Nr of shifts	Goal	comments
light ^{12}C,^{18}O. .	400 -800	10^5	5p	start up detectors, electronics, trigger system, rough timing adjustment, first set of GLAD with beam (2018)	distributed in time over a full week
p	500	10^7	3+6p	L3T site acceptance test, proton response CALIFA (2018/19)	4 shifts to collect statistics, 1 shift for BG evaluation
^{12}C	500	10^7	2p	CALIFA Doppler correction. Background comp. to prev. run normal/inverse kinematics (2018/19)	rate test of tracking detectors.
^{12}C	400, 700, 1200	10^5	9+6p	Commissioning of GLAD, (2018/19) Systematic Doppler studies in CALIFA	L3T under realistic (p,2p) conditions.
^{2}H	400, 800	10^5	4	1n response of NeuLAND, (p,2p) energy response in L3T + CALIFA	(2019, beam driven)
^{197}Au	400	10^5	6p	**ASY-EOS II detector test** S464 (LoI),	Tbd.

Not all tests can be done still in 2018

Experiments proposed in phase-0: Summary

	Prop. ID	Spokesperson	Local Contact Person	Proposal Title
A	NUSTAR: R3B + FRS + DESPEC			
2018/9	S444	Gernhäuser, Roman	Simon, Haik	R3B - 2018 COMMISSIONING (CALIFA, L3T, GLAD, NeuLAND & Tracking) p,2p not reasonable without commisioned L³T
	S465	Aumann, Thomas	Simon, Haik	Dipole response of the drip-line nuclei ^{6}He and ^{22,24}O
2018	S473	Aumann, Thomas	Simon, Haik	Constraining energy-density functionals and the density-dependence of the symmetry energy by measurements of accurate cross sections with large acceptance at R3B NeuLAND characterisation
		A- (accepted change)		
	S464, LoI	Russotto, Paolo	Simon, Haik	Determination of Symmetry Energy at Supra-Normal Densities: a feasibility study
(2018)	S454	Heil, Michael	Simon, Haik	Studying the astrophysical reaction rate of ^{12}C(alpha,gamma)^{16}O via Coulomb dissociation of ^{16}O into ^{4}He and ^{12}C High rate tracking
		A- (potential fall back)		
	S478	Khanzadeev, Alexey	Egelhof, Peter	Study of the nuclear spatial structure of neutron-rich B isotopes by proton elastic scattering in inverse kinematics
	S441	Tengblad, Olof	Simon, Haik	Study of the 13Be structure from the 14B(p,2p)13Be -> 12Be + n + gamma (+ 2p) reaction
2019	S442	Sorlin, Olivier	Simon, Haik	Study of multi-neutron configurations in atomic nuclei towards the drip line requires calorimetry
	S466	Kröll, Thorsten	Simon, Haik	Evolution of nuclear structure east of ^{208}Pb studied by (p,2p) reactions
2019	S467	Paschalis, Stefanos	Simon, Haik	Single-particle structure of neutron-rich Ca isotopes: shell evolution along Z=20 p,2p
2018/9	S455	Taieb, Julien	Simon, Haik	Fission investigated with relativistic-radioactive beams and the advanced SOFIA@R3B setup partly p,2p