FIRST CYGNO MEETING

Welcome

La sigla CYGNO è stata approvata da parte della CSN2;

È stata finanziata tutta l'attività relativa ai test necessari per la stesura del TDR;

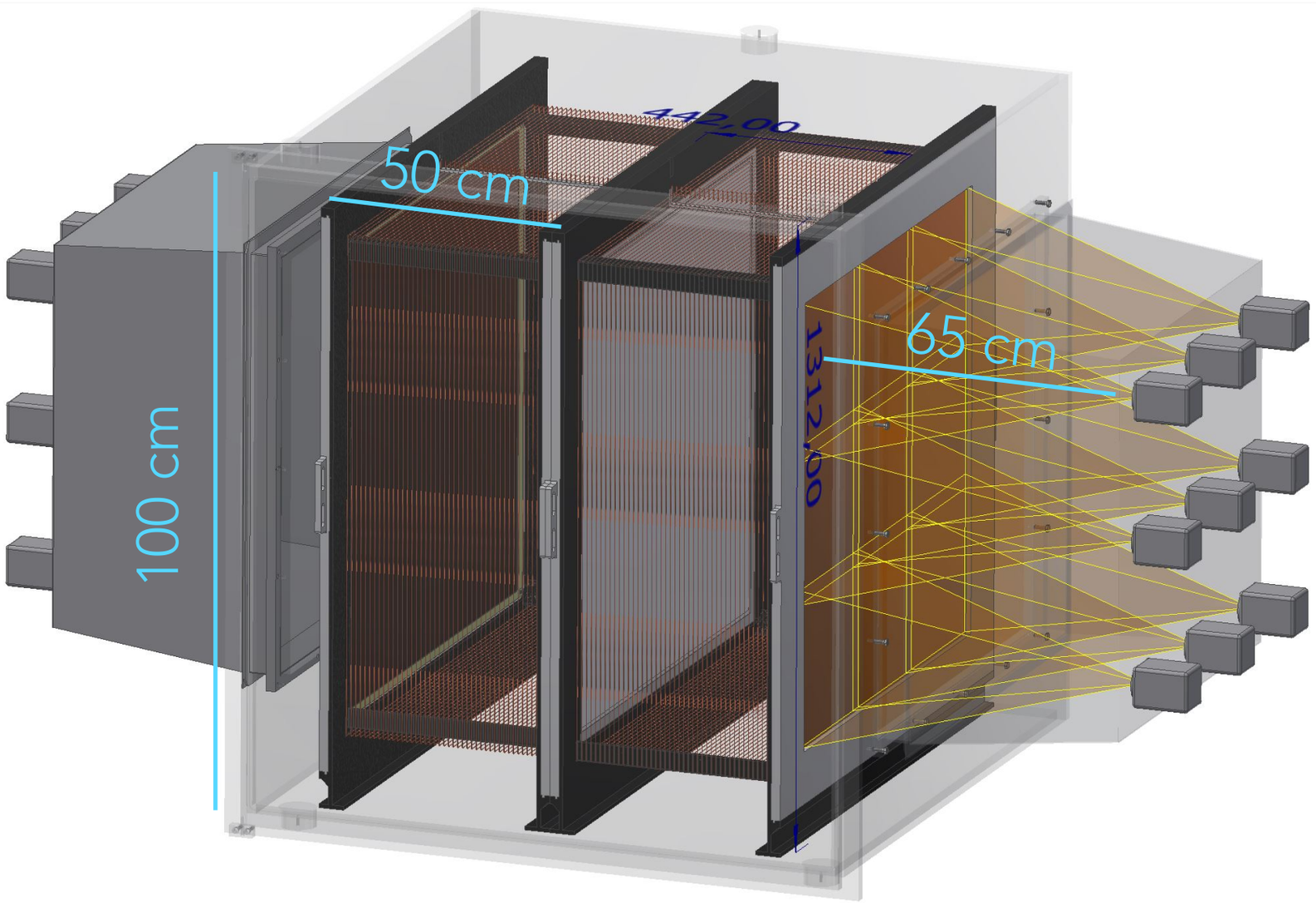
Sono state molto apprezzate le competenze dei proponenti;

Il percorso preliminare svolto in gruppo V;

CYGNO

1 m^3 of He/CF_4 60/40 (1.6 kg) at atmospheric pressure subdivided in two 50 cm long parts by the cathode;

A field cage will provide a drift field of about 1 kV/cm



Each gas volume is equipped by a 3x3 matrix with triple-GEM structure readout by:

- a sCMOS sensor 65 cm away from a transparent window;
- A fast light detector (PMT or SiPM).

A total of 72 10^6 readout 165 x 165 μm^2 pixels.

The active apparatus will be contained in shields for gamma ray and neutrons

INVOLVED PEOPLE

Table 4: People involved in project (**14 people 4.9 FTE in total**)

	Name.	Institution	Role	FTE
	INFN - LNGS (0.8 FTE)			
	E. Baracchini	GSSI	Assistant Prof.	80%
	INFN - Roma1 (1.9 FTE)			
	G. Cavoto	Sapienza Univ	Assoc. Prof.	30%
	E. Di Marco	INFN	Researcher	20%
	M. Marafini	Centro Fermi	Researcher	20%
	A. Messina	Sapienza Univ	Researcher	30%
R. N.	D. Pinci	INFN	Researcher	50%
R. L.	F. Renga	INFN	Researcher	40%
	INFN - LNF (2.2 FTE)			
	R. Bedogni	INFN	Researcher	20%
	E. Benussi	INFN	Researcher	10%
	S. Bianco	INFN	Senior Researcher	20%
	G. Maccarrone	INFN	Senior Researcher	30%
R. L.	G. Mazzitelli	INFN	Senior Researcher	100%
	D. Piccolo	INFN	Senior Researcher	20%
	S. Tomassini	INFN	Engineer	20%

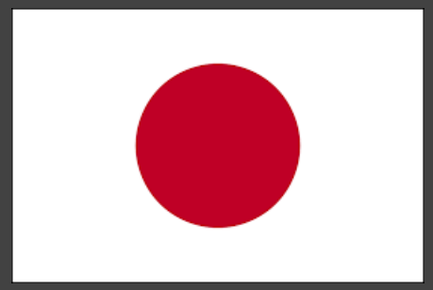
	FTE	PERS	FTE/P
LNGS	0.8	1	0.80
RM1	1.9	6	0.32
LNF	2.2	7	0.31
TOT	4.9	14	0.35

Colleagues from Cygnus Collaboration agreed working for CYGNO:

Neil Spooner , Warren Lynch, Anthony Ezeribe (Radioactive budget)

David Loomba (New Mexico) (Optical readout)

Sven Vahsen, Thomas Thorpe (Hawaii) (Simulation)



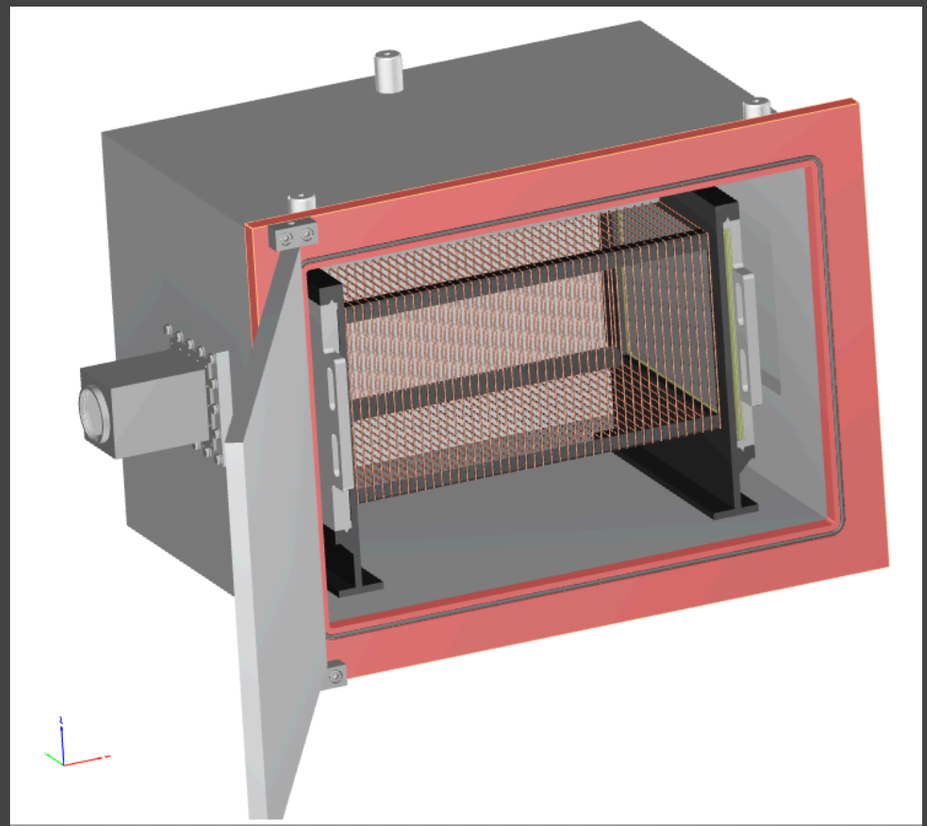
Kentaro Miuchi (Gas purification)

2019 PLAN

- Results obtained on 10 litre prototype are very encouraging (keV threshold and resolution);
- To apply this technology on DM search is crucial to study how this performance scale on larger volumes and longer drift paths;
- Moreover a detailed study of intrinsic radioactivity should be carried:
- in particular by studying and minimising radioactivity of GEM, Camera and light sensors;

In the second half of 2018 we will build a new Long Imaging ModulE (LIME, 50 cm long drift gap, 25 litre sensitive volume) to conclude the R&D project with CSN5;

A particular attention will be payed to the material choice.



TIME SCHEDULE

The proposal in CSN2 is subdivided in two steps:

- 2019 will be crucial to test LIME to make:
    - studies of the scalability of the performance;
    - gas purification, re-circulation and monitoring.
    - optimisation of PMT/SiPM readout and trigger.
    - detailed study, minimisation and simulation of radioactive background;

    - At the end of 2019 we'll produce and submit to CSN2 a TDR describing final setup and performance;

- If it will be approved in 2020/2021 we'll proceed with the realisation of CYGNO, and in 2022 we'll install it at the LNGS

REQUESTS FOR 2019

LIME “vessel” construction will start after the summer and is expected to be completed by the end of 2018;
In 2019 we want to test material for the field cages, gas purification and recirculation system, a more reliable HV system and start the DAQ development

	LNF	RM1	LNGS
HV		14.5	
HV for cathode (50 kV)	5		
Mechanics and material for radioactivity studies	14		
DAQ	10		
Gas (Bottles)	8		
Gas System and ancillary		19.5	
PMT and SiPM for combined readout study		5	
Travel	5	5	3
Tot	42	44	3

GOAL OF THE PROJECT

CYGNO will act as a demonstrator of the proposed technology;
Study the performance stability and scalability to a larger volume:

- O(keV) energy threshold on nuclear recoil tracks;
- 3D tracking reconstruction and head-tail determination at O(keV) energy;
- Full 3D detector fiducialization;
- High electron rejection power;
- All aspects related to intrinsic background induced by radioactivity of the material, apparatus shielding, gas circulation and purification.

Performance that will allow:

1) DM search in the low mass region;
2) Directionality measurement mandatory to study and confirm DM evidence found by other detectors.

COST TO COMPLETION

We tried to have a clear picture of the total financial needs (2019-2022);

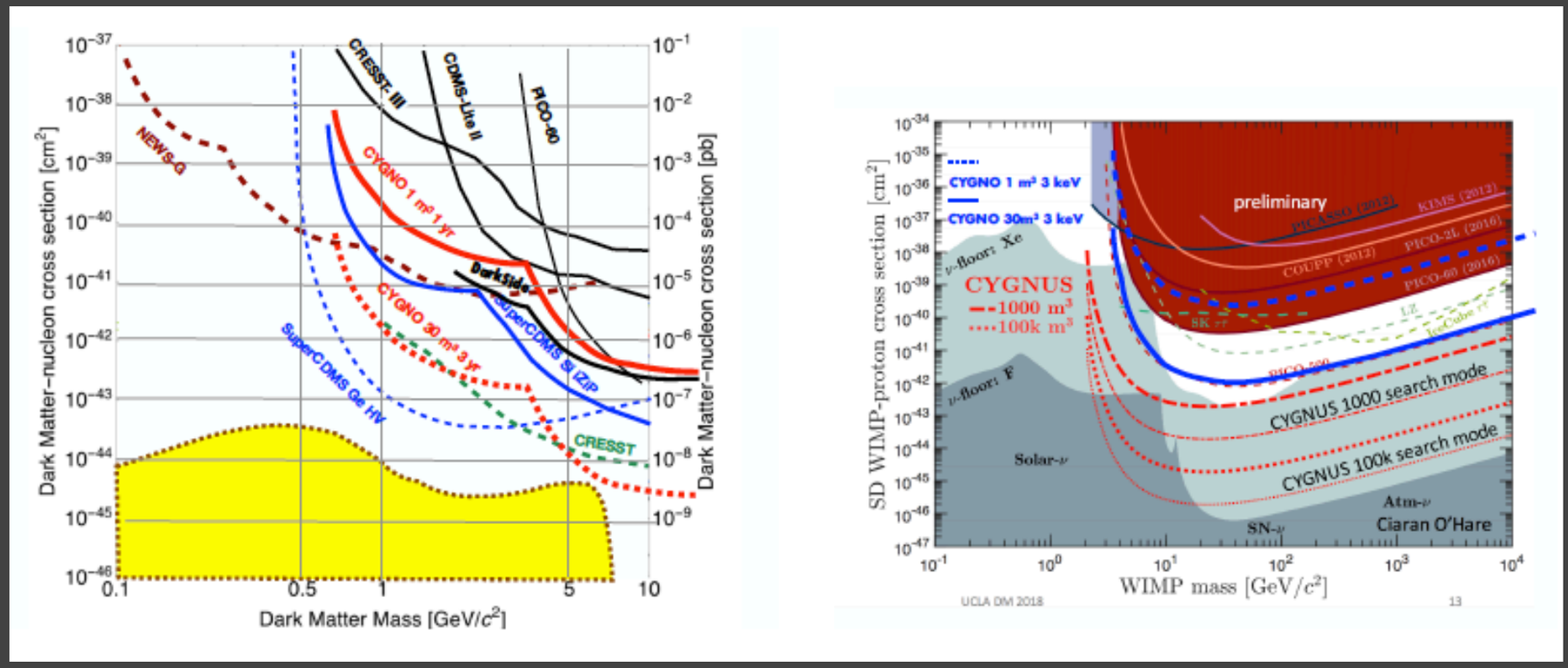
The requests are expected to have a peak in 2020-2021 during the construction and installation phase;

Year	Rich. (k€)
(CSN5) 2018	29
(TDR) 2019	89
2020	237
2021	284
2022	83
Tot (20-22)	604

WORK PACKAGE	ITEM	Task 2019 [CNS5]	assignm. 2018 [ke]	Tasks 2019 [CNS5]	Request 2019 [ke]	Tasks 2020 [CNS5]	Request 2020 [ke]	Tasks 2021 [CNS5]	Request 2021 [ke]	Tasks 2022 [CNS5]	Request 2022 [ke]
		LIME Design & Construction		LIME Test and R&M		CYGNO Construction		CYGNO Construction & run overground		CYGNO Commissioning and preliminary Data Taking	
DETECTOR	Design	LIME		CYGNO		Shielding & Veto					
	Vessel	procurement & assembly	2	material test & radioactivity measurement	2	procurement, assembly & qualification	30	overground test		installation & commissioning	
	Cathode, Field Cage, Feedthrough	procurement	2	material test & radioactivity measurement	2	procurement, assembly & qualification	10	overground test		installation & commissioning	
	GEM	procurement & assembly	10	mechanical test & radioactivity measurement	3	procurement, assembly & qualification	60	overground test		installation & commissioning	
	Windows	procurement & assembly	2	test & radioactivity measurement	1	procurement, assembly & qualification	10	overground test		installation & commissioning	
	Optics			design & test	1						
	Lens							procurement, assembly & qualification	96	installation & commissioning	
	CMOS sensors			camera tests, OEM scouting				procurement, assembly & qualification	140	installation & commissioning	
	PMT & SiPM			performance & low radioactivity test	5			procurement, assembly & qualification	20	installation & commissioning	
	Slow System							procurement and test	10	installation & commissioning	
	Shielding									procurement & installation	10
SERVICES	HV GEM System			procurement of R12 cards + 4 HV GEM board	15	full system procurement & test	35	overground test		installation & commissioning	
	HV Field Cage Power Supply			procurement and test	5			overground test		installation & commissioning	
	GAS System			procurement of recirculating filtering system prototype	20	full system procurement & test	60	overground test		installation & commissioning	
	DAQ System			DAQ custom board prototype	10	preliminary test		procurement, qualification & overground test	50	installation & commissioning	
	Data storage/ backup and Analysis infrastructure	setup of INFN-CC infrastructure		open access to the international community		test of scalability & integration with DAQ		overground test		installation & commissioning	
PHYSICS	LIME & CYGNO Simulation	evaluation of LIME & CYGNO expected sensitivity		fast simulation		full simulation		evaluation of systematics		comparison with first data	
	Background simulation, including natural radioactivity from detector materials	evaluation of CYGNO background radioactivity based on literature measurements		LIME comparison of background simulation with data		integration in the full detector simulation					
	Neutron Simulation & measurements	evaluation of LIME & CYGNO expected sensitivity		fast simulation of expected neutron flux at LNGS/LIME data comparison with simulation		full simulation of expected neutron flux at LNGS		LIME data analysis development for fast and thermal neutron flux		CYGNO data analysis development for fast and thermal neutron flux	
	Data Analysis and pattern recognition	development on pixel/ gas data on GRADE and LIMBIC data		fast implementation of algorithms on LIME data		validation algorithms on LIME data		test algorithms on CYGNO overground data		CYGNO data analysis	
	Detector calibration with sources			study of available sources and safety issues		procurement	10	installation & test			
	Test beam & quenching factor measurements	study and development of tools for precise test beam measurements		LIME Test beam at neutron sources & detector performance measurements		LIME underground run					
	Large scale Detector sensitivity	evaluation of CYGNO 30m^3 and 1000m^3 sensitivity		future gas mixture, ions, coherent neutrino, light DM, etc				fast simulation of CYGNO 30m^3		full simulation of CYGNO 30m^3 and 1000m^3 sensitivity	
Consumable [ke]			1		5		5		5		5
Gas bottle [ke]		procurement	3		8		4		8		8
Travels [ke]			5		13		13		15		50
Shipping [ke]			8		0		8		0		10
Total/year [ke]			29		89		237		284		83
Total [ke]		CYGNUS-TDR [CNS5]	29	TDR [CNS5]	89					CYGNO Project [CNS5]	604

BEYOND CYGNO

If the CYGNO project will confirm the expected performances and capabilities, we believe the development of a 30 m^3 CYGNO detector to be able to give a significant contribution to direct DM searches in the low 1-10 GeV WIMP



Fast developments in both MPGD and sCMOS sensor fields make the availability of improved detectors and sensors not unreasonable already during CYGNO 1m^3 project.

We consider feasible a CYGNO 30 m^3 to be operative in about 7-8 years from now (2025-2026).

Conclusione CSN2

Sigla loc.	Capitolo	Riunione	Note alla richiesta	Rich.	Rich. SJ	Assegn.	Assegn. SJ	Assegn. Dot.	Assegn. Ant.	Assegn. Ant. Dot.	Commento alla assegnazione
RM1	MISS	Assegnazioni	Missioni per conferenze, LNF e LNGS	5	0	3					Referee 4k.
		Totale MISS		5	0	3	0	0	0	0	
	CON	Assegnazioni	Consumo per sistema gas	2	0	2					Referee 2k.
		Totale CON		2	0	2	0	0	0	0	
	INV	Assegnazioni	PMT e SiPM per test lettura ottica combinata	5	0	5					Referee 5k.
		Totale INV		5	0	5	0	0	0	0	
	APP	Assegnazioni	HV System: HV crate 7k_ + 1 HV GEM board 7.5 k_ (come da preventivo CAEN)	14.5	0	0					Spesa rimandata.
		Assegnazioni	Gas system: (2 mass flow controllers: 4 k_ + 3 flow control valve: 4.5 _ + 1 absolute pressure transducer: 1.5 k_ + 2 vacuum pumps: 4 k_ + Control electronics: 3.5 k_)	17.5	0	15.5					Referee 17.5k. Commissione 15.5
		Totale APP		32	0	15.5	0	0	0	0	
Totale RM1				44	0	25.5	0	0	0	0	
Totale generale CYGNO				44	0	25.5	0	0	0	0	

Sì SiPM e PMT

No HV

Sì Gas System

Conclusione CSN2

Sigla loc.	Capitolo	Riunione	Note alla richiesta	Rich.	Rich. SJ	Assegn.	Assegn. SJ	Assegn. Dot.	Assegn. Ant.	Assegn. Ant. Dot.	Commento alla assegnazione
LNGS	MISS	Assegnazioni	Missioni verso per conferenze e LNF	3	0	1.5					Referee 1.5k.
		Totale MISS		3	0	1.5	0	0	0	0	
Totale LNGS				3	0	1.5	0	0	0	0	
Totale generale CYGNO				3	0	1.5	0	0	0	0	

Sigla loc.	Capitolo	Riunione	Note alla richiesta	Rich.	Rich. SJ	Assegn.	Assegn. SJ	Assegn. Dot.	Assegn. Ant.	Assegn. Ant. Dot.	Commento alla assegnazione
LNF	MISS	Assegnazioni	Missioni per conferenze e sopralluoghi tecnici ai LNGS	5	0	3					Referee 4k.
		Totale MISS		5	0	3	0	0	0	0	
	CON	Assegnazioni	Gas bottle	8	0	8					Referee 10k a corpo. Commissione 8k.
		Assegnazioni	magazzino, minutaglia caveria, ecc	5	0	0					
		Totale CON		13	0	8	0	0	0	0	
	APP	Assegnazioni	Vessel material test & radioactivity measurement	2	0	2					2k
		Assegnazioni	Cathode, Field Cage, Feedthrough material test & radioactivity measurement	2	0	2					2k
		Assegnazioni	GEM mechanical test & radioactivity measurement	3	0	3					3k
		Assegnazioni	Detector windows test & radioactivity measurement	1	0	1					1k
		Assegnazioni	Optics design and test	1	0	1					1k
		Assegnazioni	HV Field Cage Power Supply procurement and test	5	0	5					5k
		Assegnazioni	DAQ custom board prototype	10	0	0					Spesa rimandata
		Totale APP		24	0	14	0	0	0	0	
Totale LNF				42	0	25	0	0	0	0	
Totale generale CYGNO				42	0	25	0	0	0	0	

Sì Gas

Sì Meccanica

Conclusione CSN2

La CSN2 sottolinea (più o meno comprensibilmente) il non banale confronto tra il nostro progetto ed i “giganti” nostri competitor (Dark Side, Ptolemy, SuperCDMS, CRESST);

Scopo del 2019 sarà convincerci delle effettive potenzialità di CYGNO e spiegare le nostre specificità a CSN2.

A questo si aggiunge la necessità di un lavoro completo di simulazione del detector, del background e del segnale.

Solo così potremo convincere la CSN2 a ricavare spazi (e soldi 200-300 k€) per 3/2 anni per la costruzione;

Test Ottobre

- gas ok per un lungo test;
- installata ieri una nuova telecamera da testare (ne avremo 3 in tutto);
- come sta ORANGE?
- DAQ?
- Sorgente ^{55}Fe?
- confronto con alimentatore Corradi.
- chi è disponibile?

Analisi dati LEMON

- ^{55}Fe (confronto con ORANGE)
- studio del Ferro vs deriva;
- neutroni FNG;
- scan in Z ed in generale tutta l'analisi di Test Beam (BTF_2017);
- cosmici guardando il PMT e trigger-software

- chi è disponibile?

Costruzione LIME

- a che punto siamo?
- GEM: Luigi è al CERN e dovrebbe concludere l'acquisto entro breve;
- Trovare finestra trasparente, che materiale?
- Come la facciamo la field cage?
- Connessioni e feed through?
- Acquisti?
- chi è disponibile?

Conferenze, pubblicazioni e meeting

- Conferenze:
- IEEE, Vienna Conference, Villa Olmo,?
- Pubblicazioni:
- CDR, Papero “Nature” LEMON, PID-JINST;
- Meeting:
- General CYGNO: Roma? Dicembre?