Esperimenti CSN5 per il 2013

S. Dell'Agnello,
Coordinatore INFN-LNF
Frascati, 03-07-2012

Summary report della "Ottava giornata di GR5"
Tenuta ai LNF il 22-06-2012

2012: 15 sigle
2013: 18 sigle se tutte approvate

Attivita' di Gruppo V

8 R&D in Fisica degli Acceleratori

4 Nuovi esperimenti	*4 Attività che continuano*
NORCIA ✸	γ-RESIST
FEMTOTERA	!CHAOS
3L_2D ✸	POSSO ✸
ODRI2D	BEATS2

✸ Resp. Nazionale LNF

Laboratori Nazionali di Frascati
June 22th 2012

ODRI 2D
2 Dimensional Optical Diffraction Radiation Interference

Proposta per la realizzazione di uno strumento per la misura di emittanza, orizzontale e verticale (fatta con ODRI) con l'interferenza della radiazione di diffrazione ottica da utilizzare come diagnostica trasversa per fasci di elettroni di alta carica e alta frequenza di ripetizione

2013 – 2015 (3 anni)

Coordinatore nazionale: A. Cianchi (Roma 2)

Sezioni partecipanti:

LNF (M. Castellano, E. Chiadroni, D. Di Giovenale, R. Pompili)

Roma Tor Vergata (A. Cianchi, L. Catani, S. Tazzari)

Collaborazione:

FLASH @ DESY Hamburg (V. Balandin, N. Golubeva, K. Honkavaara, G. Kube)

FTE @ LNF

E. Chiadroni (Resp. Locale)	50%
M. Castellano (Associato in pensione)	0%
R. Pompili (Dottorando)	30%
D. Di Giovenale (Art. 23 Tecnologo)	30%

Non si richiede supporto tecnico né servizi ai Laboratori.

RICHIESTA FINANZIARIA @ LNF: Triennio 2013 - 2015

Missioni internazionali

2013: discussioni ed installazione apparato

4 keuro

2014: 2 turni di misura, 8 gg/turno

8 keuro

2015: 2 turni di misura, discussioni per analisi dati e report

8 keuro

Consumo (lavorazioni meccaniche, motorizzazioni e driver):

1 keuro/anno

Spedizione apparati

1.5 keuro/anno

Inventariabile

2013: Acquisto telecamera 30 keuro

γ-Ray Emitter from Self-Injected (Staged) Thomson Scattering

γ - ***RESIST***

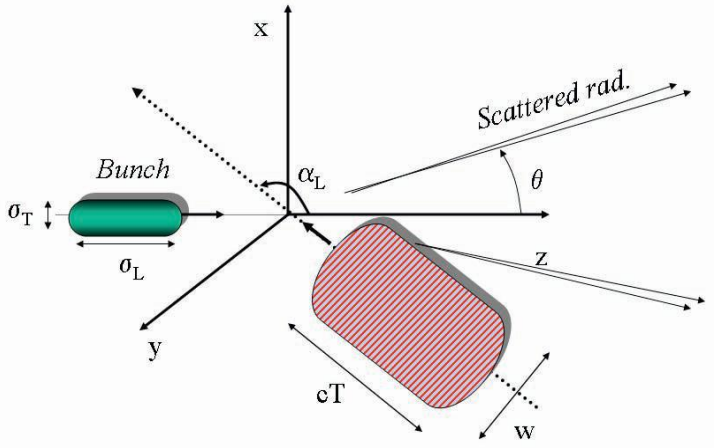
G.Gatti

Concept:

All optical γ –ray source based on Compton scattering by laser-plasma accelerated e^- and counter propagating intense laser beam

$E_{back} \approx 4\gamma^2 E_0$, Upshift of scattered photons

Head on collision of 100s MeV electron bunches of 100s pC with multi TW laser beam



Motivation

-Ultra compact, ultra fast, polarized, tunable γ source. No linac needed.
-All optical allows for direct, tight synchronization
-Interaction parameters span over a large range, driven by plasma dynamics (deep control Of sj acceleration, probing of high field effects)
-Large part of experimental setup already in place

γ - RESIST: 2012-13 achievements, next 2 come

2012

-CDR: Done, soon link on the web page
-TDR: ongoing (complete layout)

-Optimization of sj e-beam: in progress

2013

-TDR: complete with all numerical simulations modelling, given the inputs from sj beam results

-First collisions with (low energy) probe beam as scattered laser

-Setup preparation for full beam collisions

γ - RESIST: requests, FTE

Hardware

- Extended vacuum beamline (colliding laser setup) 23.5 k€
- High pressure gas mix distribution 22 k€
- Workshop time 2 months

Travelling allowance

- Italy 3 k€
- Abroad 3k€

TOTAL 49.5 k€+1 mese/uomo carpenteria+1 mese/uomo meccanica

FTE
S. Martellotti (100%), P. Antici (20%), M. Ferrario (20%),
C. Gatti (20%), G. Gatti (40%), A. Ghigo (10%),
C. Vaccarezza (10%),M. Anania 30%, F Villa 30%

TOT=2.8 FTE

Esperimento !CHAOS

Resp. naz. e Roma-TV: Luciano Catani (Roma-TV) *Resp. LNF: Alessandro Stecchi (LNF)*

L'esperimento **!CHAOS** dei LNF e della Sezione Roma-TV si propone di sviluppare e validare **un nuovo paradigma per i sistemi di controllo** (SdiC) e **di acquisizione** (DAQ) degli acceleratori di particelle. DAFNE e in prospettivaSuperB

Caratteristiche principali e obiettivi:

- definizione di una nuova topologia di SdiC che consenta la ridondanza di tutte le sue parti, l'assenza di *point of failure*, e l'*hot insertion* di nuovi HW
- integrazione di una modalità di funzionamento *Triggered DAQ* nel SdiC
- inserimento di un database orientato all'archiviazione dei dati di ogni dispositivo (*History Database*)
- inserimento di un sistema di *distributed object caching* per l'accesso *real time* ai dati (*Live Database*)
- astrazione dei componenti strutturali del controllo per ridurre la dipendenza dal particolare HW e dai moduli SW commerciali, permettendo quindi una estrema adattabilità
- intrinseca scalabiltà del sistema
- compatibilità con gli standard commerciali e con eventuali sviluppi di componenti *custom*

Esperimento !CHAOS – piano di finanziamento 2012 - 13

Le richieste finanziarie riguardano la realizzazione di **due** ambienti di sviluppo per il SdiC !CHAOS nelle due sedi di LNF e Roma-TV e l'acquisizione di piattaforme e componenti per il test e lo sviluppo della parte hardware.

	2013 LNF	
Missioni int.	Annual SuperB meeting (x2), SuperB Computing W.shop	4.0 k€
Missioni est.	IPAC, ICALEPCS, NIWeek (collaborazione con National Instruments)	11.0 k€
Consumo	Accessori per PXI	1.0 k€
Inventario	1 PXI-e system 9 slots with i7 Quad-Core and FPGA module Virtex-5	19.7 k€
	TOTALE	35.7 k€

	2013 Roma - TV	
Missioni int.	Miss. a LNF, Annual SuperB meeting (x2), SuperB Computing W.shop	4.0 k€
Missioni est.	IPAC, ICALEPCS, XLDB, collaborazione SLAC	8.0 k€
Consumo	Accessori per rack 19", altro	1.0 k€
Inventario	1 Storage unit SAN 24 TB + (1+1) servers per i clusters + 2 server per i processi client + 1 rack 19" compreso UPS e ventilazione	24.0 k€
	TOTALE	37.0 k€

Esperimento !CHAOS – risorse umane (LNF)

LNF	%
A. Stecchi (resp. locale LNF)	40 %
G. Mazzitelli	40 %
G. Di Pirro	25 %
L. Foggetta	20 %
S. Calabrò (tecnico)	50 %
P. Ciuffetti (tecnico)	20 %
TOTALE LNF	1.95 FTE

Oltre alle percentuali LNF dichiarate e a quelle di Roma-TV, si è creato un gruppo di lavoro che prevede la partecipazione di:

- Servizio Controlli della D.A. - LNF
- Servizio di Calcolo - LNF
- Gruppo di Padova (per il timing) (3 FTE: 3 tecnologi e 2 tecnici)

Inoltre, *National Instrument Corporation* ha dimostrato un vivo interesse per quanto riguarda un'integrazione di !CHAOS nel proprio programma commerciale dedicato alla *Big Phy*sics.

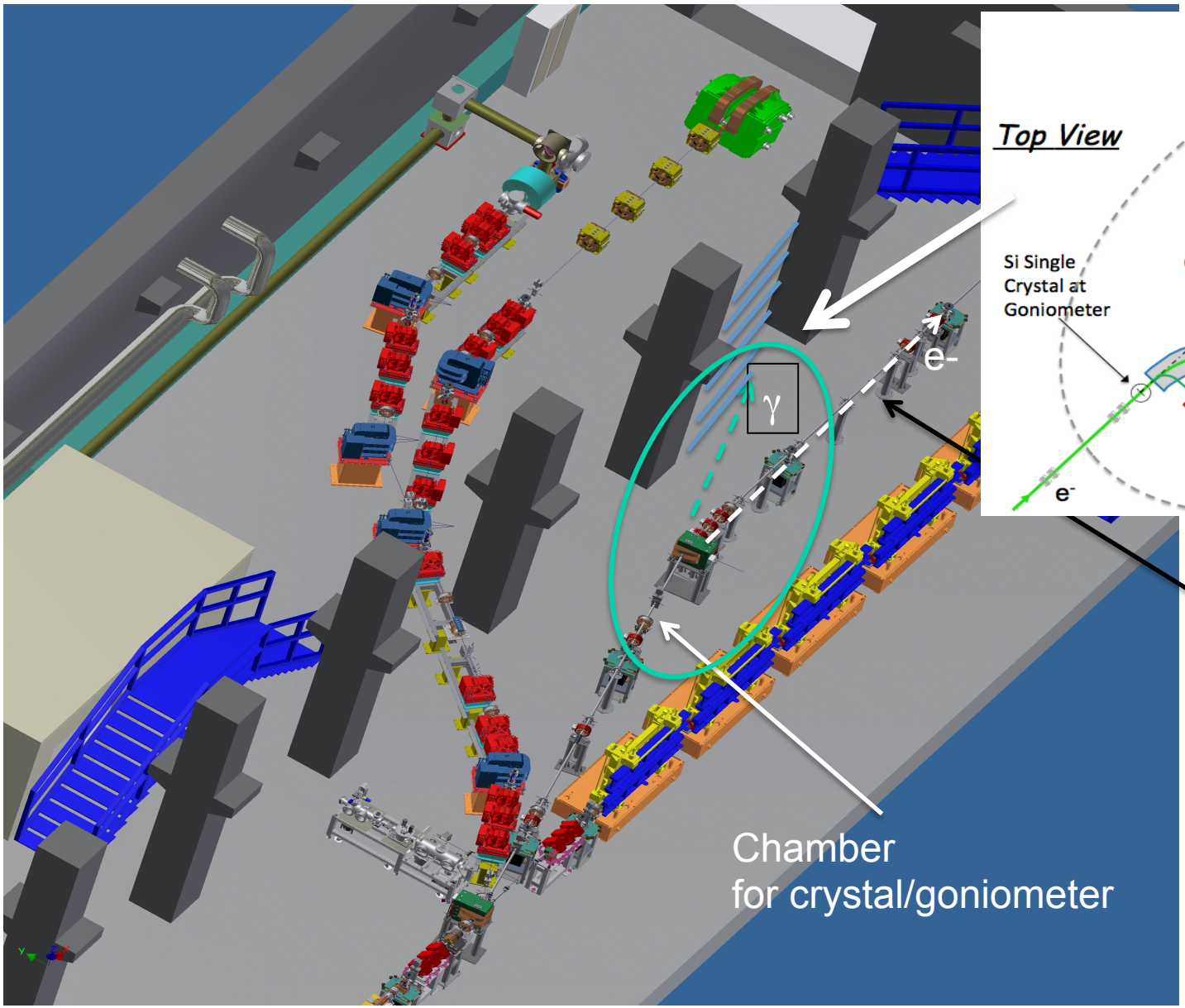
SL @ POSSO:

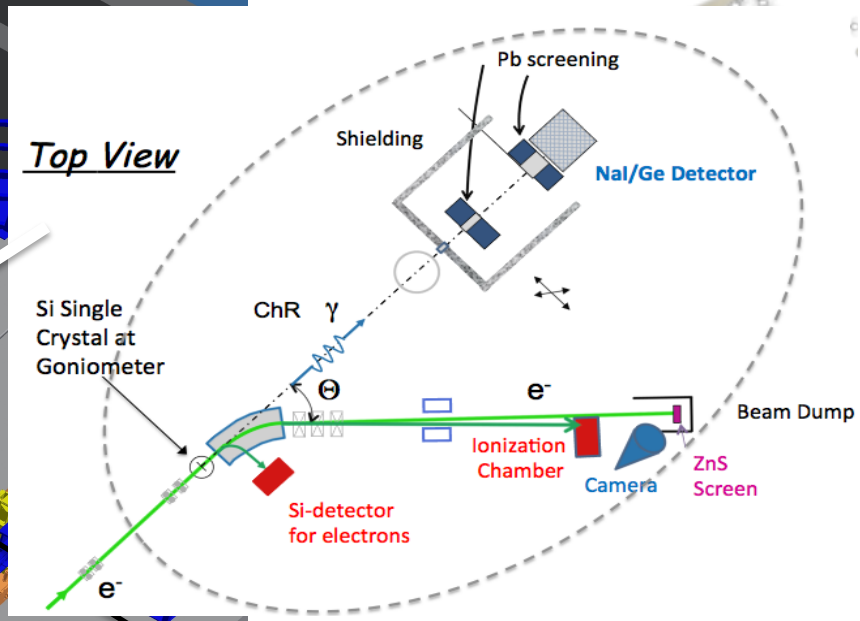
POSITRON SOURCE BASED ON SPARC CHANNELING

… studies on the use of electron channeling radiation to produce high brightness positron beams for SuperB …

@ Motivation: Analysis of last years studies on the use of channeling radiation instead of undulator radiaton in various origin fields (within various collaborations, i.e., POSIPOL, CLIC) as a powerful x ray and gamma radiation source has proved the feasibility of the technique. The optimized combination of the conventional methods for positron sources with channeling becomes more and more promising for getting high brilliant positron beams for the future e-/e+ colliders.

POSSO @ experimental layout for channeling studies





THz line

More space

Ready instruments

POSSO @ FTE/CIF/richieste fin

S. Dabagov	30%
O. Bogdanov	80%
M. Ferrario	10%
A. Esposito	20%
D. Hampai	20%
F. Murtas	20%
E. Sbardella	20%
C. Vaccarezza	10% /?/
G. Di Pirro	10% /?/
FTE	**2.2**

Contributi con **0%**
L. Serafini – INFN Milano
D. Giulietti – INFN Pisa
S. Guiducci
M. Biagini

Richieste CIF
Bending magnet chamber upgrade;
prolungamento linea “dogleg”
realizzazione camera sperimentale:
6 mesi/uomo

Collaborations::
CERN
Lyon – France
Mainz – Germany
Moscow – Russia
Tomsk – Russia

	k€
Missioni N.	3
Missioni E.	15
Inventariabile	70
Computer	3
Consumabile	5
Costruzione Apparati	19
Totale	**115**

Attivita' di Gruppo V

2 R&D su Detectors, Elettronica e Software

1 Nuovo esperimento

BEAM4FUSION

1 Attività che continua

Nescofi@BTF

Resp. Nazionale LNF

VIIII giornata di CSN V @ INFN-LNF

NESCOFI@BTF

NEutron Spectrometry in COmplex FIelds

http://www.lnf.infn.it/acceleratori/public/nescofi/

Esperimento TRIENNALE **(2011-2013)** per lo sviluppo di strumentazione per la caratterizzazione spettrometrica su un intervallo energetico esteso (10^{-8}-10^{2} MeV) di campi neutronici pulsati ed ad alta intensità.

Applications: Fast neutron irradiation, Medical field

Spherical and Cylindrical spectrometers

R. Bedogni (resp. LNF e nazionale) 80%, D. Bortot (80%), B. Buonomo (20%), A. Esposito (40%), G. Mazzitelli (30%), L. Quintieri (10%), A. Gentile (40%)
INFN-LNF
M.V. Introini (30%), A. Pola (30%)
INFN-Milano e Dip. di Energia Politecnico di Milano
J.M. Gomez-Ros (40%)
CIEMAT, Madrid - Associato LNF

Risorse umane - 2013

Ricercatori & tecnologi (include associati LNF)	3.0 FTE
Ricercatori altre sezioni INFN	0.6 FTE
CTER LNF	0.4 FTE

Richieste fatte a servizi LNF 2° semestre 2012

Officina meccanica	1 mese uomo

Richieste previste per il 2013

Officina meccanica	2 mesi uomo
Automazione e controlli	2 mesi uomo

2013 requests to CSN V

Missioni interne …… **12 k€**

Permanenze al Politecnico-Milano o LNF per messa a punto dell'elettronica di acquisizione
e testing degli spettrometri *(60 giorni uomo in 12 missioni)*
2 campagne presso centri di radioterapia *(20 giorni uomo in 4 missioni)*

Missioni estere …… **15 k€**

1 campagna CALIBRAZIONE low-E reference field *(10 gg x 3 persone)*
1 campagna CALIBRAZIONE high-E reference field *(10 gg x 3 persone)*
2 campagne Fast N irradiation in spettri diversi (TSL + ISIS) *(10 gg x 3 persone)*

Trasporto strumentazione (DHL via aerea assicurato) (*)…….. **8 k€**

4 campagne, 2 k€ cad.

Consumo (*) ……..…… **24 k€**

Semiconduttori per spettrometri finali (80 rivelatori da depositare a 120 €/cad)
polietilene, piombo e materiali borati per spettrometri finali

Inventario (*)…… **30 k€**

50 canali analogico-digitali da 2MS/s per canale e PC di acquisizione

Spese servizi (*) (beam time per calibrazioni**)**…… **10 k€**

Totale richiesta 2013: 99 k€

(*) *Al netto dei cofinanziamenti previsti.*
Costi basati su offerta economica in ns. possesso o price-lists ufficiali.
Frazione di costo supportato da offerte o price lists ufficiali: 73%. Sono escluse solo le missioni.

Attivita' di Gruppo V

8 R&D in Fisica Interdisciplinare

6 Nuovi esperimenti

- **ETRUSCO-GMES**
- **NEXT_ARCH**
- **TOMOSCIDOS**
- **MANESCO**
- **SLEAR**
- **RDH**

2 esperimenti che continuano

- **I-FCX**
- **Space Weather**

Resp. Nazionale LNF

Past & Present (2011-2012):

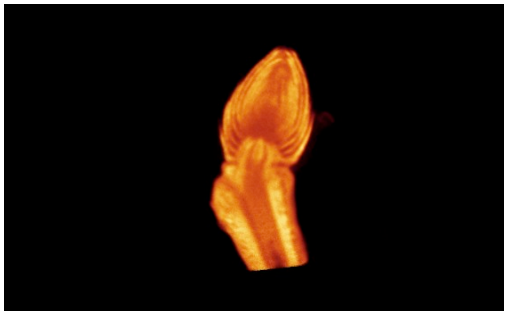
- "**LateX$_r$**": **La**rge **te**st **X**-ray facility; simulations on μ-imaging technique => 100% (μ-tomography)
- calculations on possible high-contrast optical schemes to be optional for various large-scale x-ray sources => 100%
- simulations of the use of polyCO in combination with small-scale x-ray sources based on electron accelerators to improve contrast resolution without increase of irradiation dose => 30%;
- developing special computer codes for fast imaging technique => 50%;
- design of dedicated imaging test facility => 80%;
- test of imaging/μXRF technique by means of typical samples for medical and biological applications => 50%;
- design and realization of an imaging unit prototype ("**poly-X-imager**") => 30%;
- realization of a new cabinet for μ-spectroscopy **ЯXR** ("rainbow X ray") => 40%

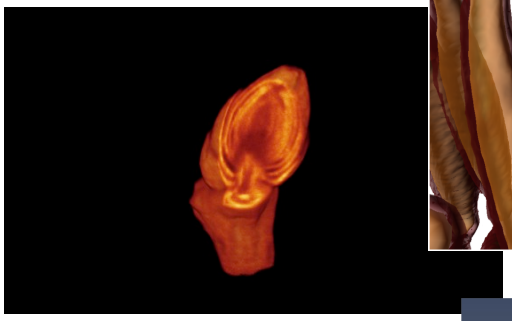
2013:

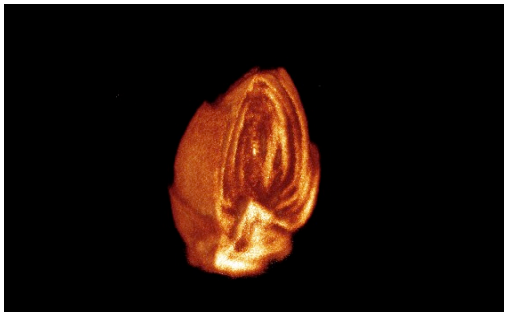
- completing above mentioned items;
- submicron imaging either via phase contrast or fine microscopy (nanoscopy) techniques;
- studies on fast developing (microsecond) processes in combination with novel laser-plasma sources

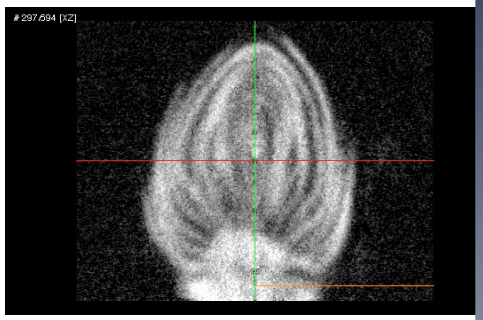
iFCX : "Fast Contrast X-ray Imaging" (2011-2013: 3 y.: 2+1)

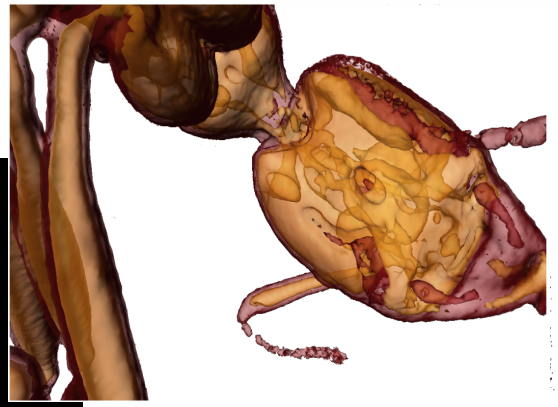
@ X imaging: μ-CT samples

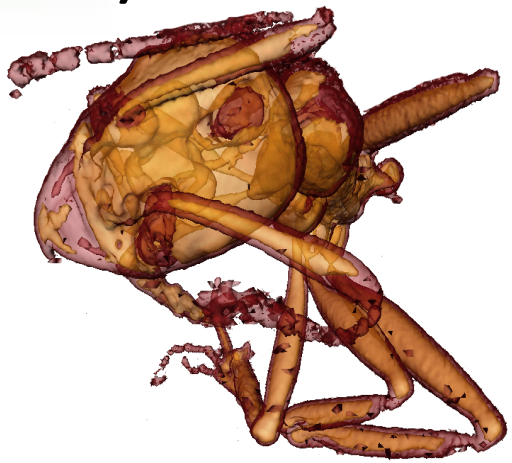


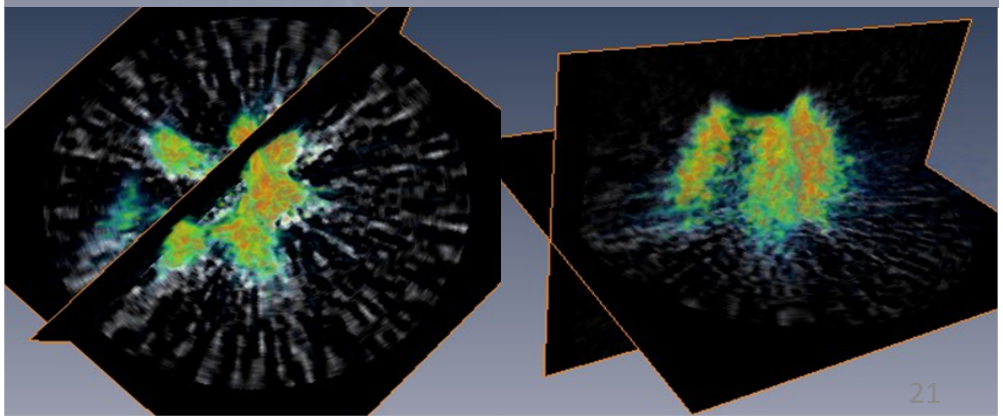






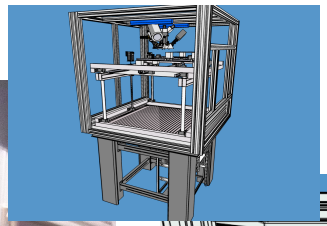


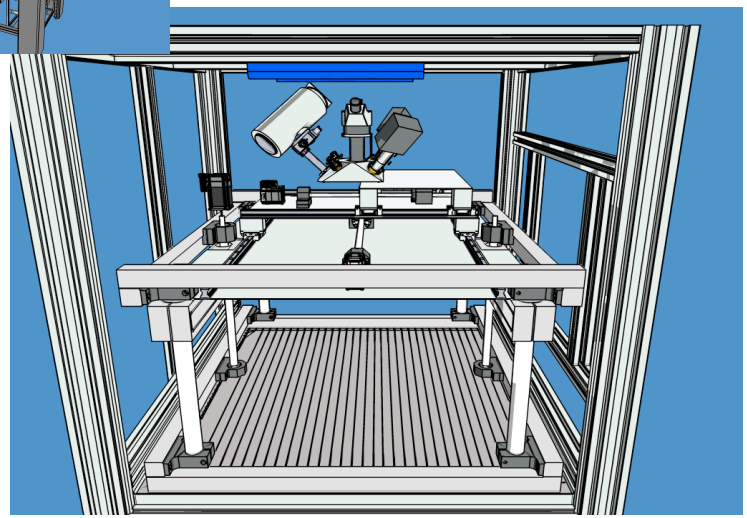




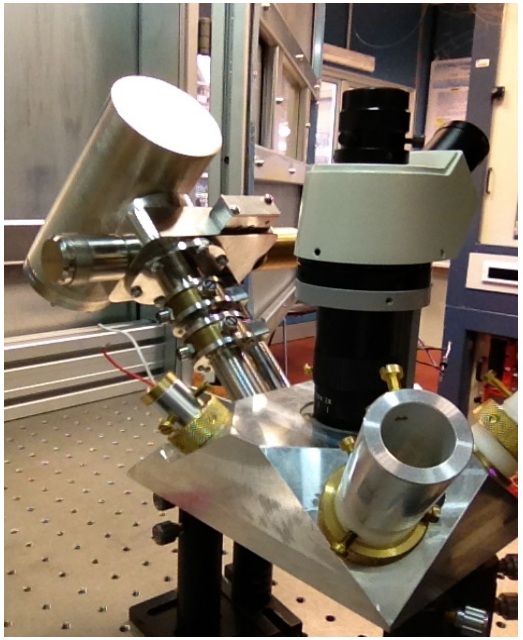
Immagini a raggi X con alto contrasto di campioni biologici trasparenti e in rapido sviluppo registrati allo X Lab di Frascati

@ new x-ray spectroscopy facility: "ЯXR": "rainbow X ray" unit





Collaboration with "Reparto Automatismi e Controlli LNF":
U. Denni, G. Papalino, G. Fuga and A. Frani



iFCX : FTE/CIF/richieste fin

Dabagov S.B.	20%
Hampai D.	50%
Marcelli A.	20%
Esposito A.	10%
Bogdanov O.	20%
Pace E.	20%
Cappuccio G. /pens./	0
Innocenti L. /st./	0
Ergunov I. /tesi di laurea 120-180 gg /	0-100%
FTE	**1.4**

Richieste CIF

1) costruzione movimentazione XYZ per esperimento RXR: 3 mesi/uomo

2) Studio di fattibilità per la gestione via ethernet dell'elettronica esistente: 1 mese/uom

3) Studio di fattibilità per la gestione completa di tutto il sistema RXR via Ethernet tramite LabView: 1 mese/uomo

Consumo :

Ottiche per raggi 25 k€

Inventariabile :

1st opt: Grating interferometer system /phase contrast imaging/ 70 k€

2nd opt: Nano CCD X-ray detector 55 k€

Cotruzione apparati :

Movimentazione da remoto 5 k€

Trasporto: 1 k€

M.Estero : collaborazione & conferences 11 k€

M.Interne : riunioni di collaborazione 3 k€

Total:

1st opt: 115 k€

2nd opt: 100 k€

Software di 5 k€ (+3k€ richiesta) non e' stato sbloccato

NdC: 5k sono stati sbloccati; 3k sono stati bocciati

Collaborators:

L. Allocca	30 gg.
L. Marchitto	90 gg.
S. Alfuso	90 gg.

SPACEWEATHER

(Bologna, LNF, Napoli, Perugia, Roma 2 Tor Vergata)

An interdisciplinar research line in Space

The Experimental Program

- Interaction between terrestrial geophysical events and Earth radiation belts.
- Physics of the space environment in Earth orbits.
- Biomedical effects of space radiation on human body.

These tasks will be performed by:

1. The study of the correlation between seismic events and perturbation of the Van Allen belts (Italian-Chinese mission CSES, Chinese Seismo-Electromagnetic Satellite).

2. Monitoring of the radioactive environment and of the nuclear abundances inside and outside the ISS (International Space Station) – mission ALTEA

3. Measurements of passive shielding to reduce the dose on Astronauts – mission SIRAD

4. Study of the "light flashes" phenomenon observed by astronauts in space.

SPACE-WEATHER 2013
Gruppo LNF

M.Ricci (Resp. 30%), A.Franceschi (10%), T. Napolitano (10%), B.Spataro (20%)

Attività di responsabilità del gruppo LNF 2011-2012:

- **Progettazione e realizzazione parti meccaniche rivelatore e prototipi: in particolare, progettazione CAD e realizzazione meccanica di supporto (frames per schede elettroniche e silici + box) per l'Engineering Model (SPCM-LNF) e sua evoluzione in configurazione di volo.**
- **Studi e simulazioni configurazioni ottimizzate rivelatori per CSES:**
  - **Messa a punto sensore campo e.m.; stima distribuzioni campi e.m. all'interno del sensore; stima campi parassiti electronic board.**

Attività prevista gruppo LNF 2012-2013:

- **Calcoli e simulazioni (Light flashes – Ambiente radiazioni ISS).**
- **Tests di qualificazione vibrazionali e termo-meccanici.**
- **Continuazione attività di studio e preparazione missione CSES.**
- **Realizzazione primi prototipi CSES.**

PREVENTIVO LNF 2013 (PRELIMINARE)

	(kEuro)
Miss. Int	2.0
Miss. Est	4.0
Consumo	10.0
Invent.	4.0
TOT	20.0

Nessuna richiesta di rilievo ai Servizi

TOTALE RICH. LNF+ROMA2+NA+ PG ≈ 100 KEURO

RDH (Research and Development for Hadrontherapy) work packages (not final)
Resp. Nazionale G. Battistoni

- **Kernel for Charged Particle Treatment Planning System**
- **Radiobiology for Hadron Therapy**
- **Proton Computed Tomography**
- **Development of a Real Time, Large Area, Particle Residual Range system for Hadron Therapy**
- **Dose profiling for Hadron Therapy**
- **Nuclear Fragmentation Studies for Hadron Therapy**
- **Detector for High Intensity Beam Monitor Design of New Components of accelerators for Hadron Therapy**

Groups involved

Cagliari, Catania, Firenze, LNF, LNL, LNS, Milano, Pisa, Roma II, Roma Tre, Torino

Includes all the activities of the previous Gr. V TPS project

LNF services requests:

- ***1 mu servizio progettazione meccanica***
- ***1 mu officina meccanica***
- ***2 mu officina elettronica***

LNF financial requests at Comm. V
Under definition

RDH group at LNF (3.2 FTE)

P. Ciambrone	*10%*
E. De Lucia	*20%*
E. Iarocci	
I. Mattei	*100%*
A. Paoloni	*10%*
A. Sarti	*30%*
*E. Spiriti **	*50%*
M. Toppi	*100%*

** Responsabile locale*

The **FIRST** (**F**ragmentation of **I**ons **R**elevant for **S**pace and **T**herapy)
Experiment motivation: train nuclear interactions MonteCarlo models (needed for TPS development) with real measurements

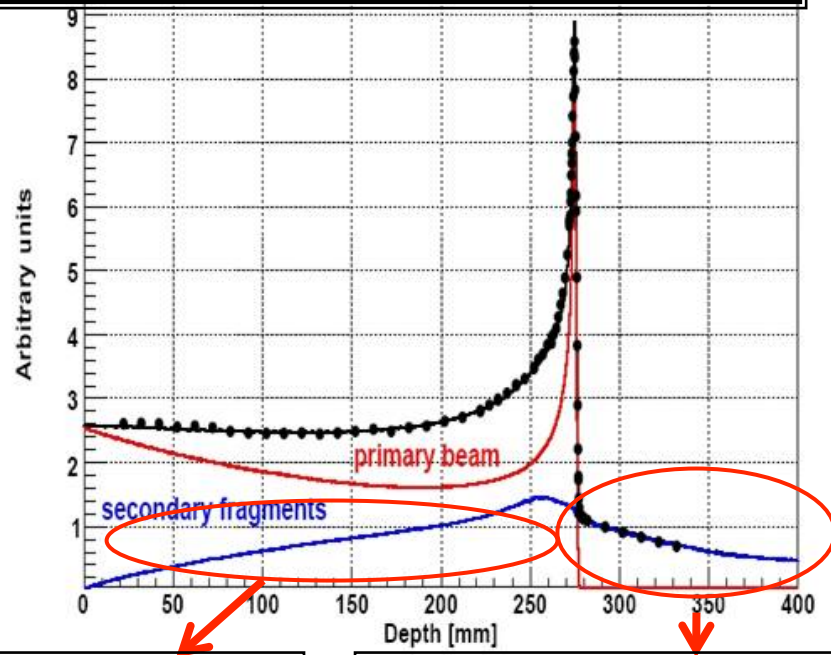
Carbon seems the next relevant ion for hadrontherapy.

Overall goal for FIRST
double differential cross section at 3% accuracy measurements for the following reactions:
C-C, C-Au, Fe-C, Fe-Si, O-C

GSI at Darmstadt choosen laboratory

FIRST time line:
- ❑ December 16th 2008, first talk at GSI
- ❑ January 29th 2009, proposal presented at G-PAC
- ❑ February 27th 2009, proposal approved for C-C.
- ❑ Beam in summer 2011
- ❑ Data analysis under way

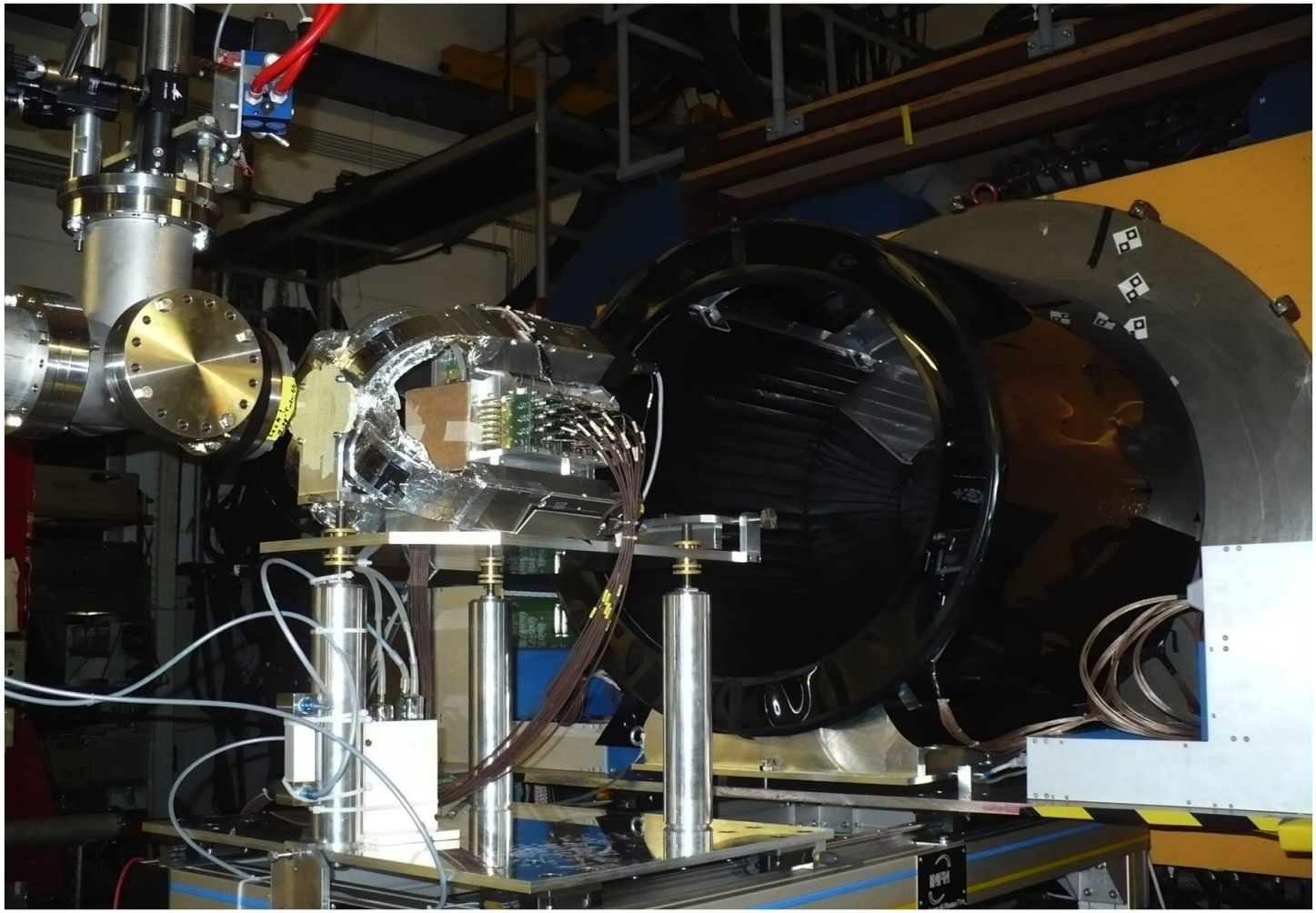
400 MeV/u Carbon ion Bragg peak in water
Exp. Data (points) take at GSI:
Haettner et. Al., Rad. Prot. Dos. 2006
FLUKA simulation: A. Mairani
(published in "Il NuovoCimento")



Fragments with different RBE outside the Beam path.

Undesired dose released after the Bragg peak
p~ 1-2 %, C~15 %, Ne~30 %

FIRST experiment setup at GSI
(July/August 2011)



Proposta di esperimento: Caratterizzazione di rivelatori al silicio 3D e loro applicazioni:

Biosensori cellulari

Rivelatori di neutroni

INFN, Gruppo Collegato di Cosenza

Riunione commissione V, LNF, 22 giugno 2012

Partecipanti		F.T.E.
Anna Mastroberardino	R.U.	30%
Giancarlo Susinno	P.E.	30%
Marco Schioppa	P.A.	10%
Antonio Policicchio	Assegnista	30%
Daniela Salvatore	Assegnista	30%
Franco Pellegrino	Tecnico C	50%

5 fisici – 1.3 FTE

- Siamo tra i proponenti del **PRIN Sensori**, presentato da un'ampia collaborazione di gruppi INFN impegnati nello sviluppo e ottimizzazione di tracciatori al silicio in previsione di SLHC, sia per ATLAS che per CMS.

- Nell'ambito del Gr.V intendiamo allestire un'area sperimentale presso i Laboratori Alte Energie del nostro Dipartimento di Fisica per la caratterizzazione dei sensori al silicio 3D.
Disponiamo di camera pulita e area sperimentale da certificare per misure con sorgenti radioattive.

Sono in corso contatti con altri gruppi INFN con interessi analoghi per la realizzazione di una collaborazione su queste tematiche di ricerca

Richieste CIF II semestre 2012

	Richiest CIF II sem 2012 in mu / Servizio-Divisione (= DR, DT, DA) LNF							
Esperimento CSN5	SPCM-DT	SSE-DR	SEA-DR	CRYO-DA	LASER-DA	MAGN-DA	Fluido-DA	Vuoto-DA
g-RESIST	1 officina, 1 carpenteria							
!CHAOS								
BEATS-2								
POSSO (3 TBD)			3 autom.?					
NESCOFI	1 officina		2 automaz.					
I-FCX (2012? 13?)			5 autom.?					
SPACEWEATHER	0.5 progett.							
ETRUSCO	2 officina 1 carpenteria	1	4.5 autom. 0.5 elettr.	0.5	0.5			
MoonLIGHT	0.5 officina		4.5 autom. 0.5 elettr.	0.5				
MUEXC			1.5 autom.					
NIO2BEAM			5 elettr.					
TPS			1.5 elettr.					
DIAMED			1 elettr.					

Richieste CIF 2013 (proiezioni)

	Richiest CIF 2013 in mu / Servizio-Divisione (= DR, DT, DA) LNF							
Esperimento CSN5	SPCM-DT	SSE-DR	SEA-DR	CRYO-DA	LASER-DA	MAGN-DA	Fluido-DA	Vuoto-DA
NORCIA								
FEMTOTERA	TBD						TBD	TBD
3L_2D								
NEXTARCH	0.5 proget. 1 officina							
g-RESIST	TBD							
!CHAOS								
BEATS-2								
POSSO (3 TBD)			3 autom.?					?
NESCOFI	2 officina		2 automaz.					
I-FCX (2012? 13?)			5 autom.?					
TOMOSCIDOS	2 officina							
BEAM4FUSION			5 elettr.					
ETRUSCO	2 officina 1 carpenteria	1	5.5 autom. 0.5 elettr.	1	1			
MoonLIGHT	1 officina		4.5 autom. 0.5 elettr.	1				

ODRI2D (2013-2015)

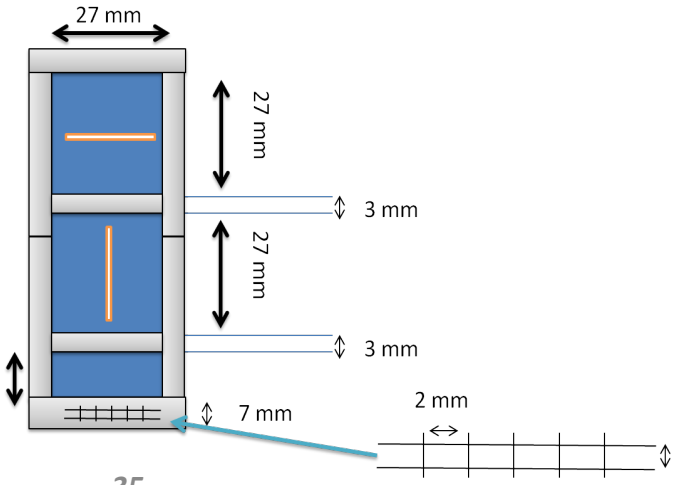
In the framework of ODRI we succeeded in performing for the first time a non intercepting quadrupole scan measurement to determine vertical emittance

➔ We propose an experiment called **ODRI2D** to determine the **transverse emittance**, i.e. **both horizontal and vertical**.

- The bypass is going to be dismounted
  - a dedicated vacuum chamber were reserved on the FLASH2 main line after the variable gap undulator
  - the same optical setup will be used, but mounted vertically, due to technical reasons
- DESY, whose strong interest is demonstrated by allowing to move our experiment from the bypass to the main line, will provide
  - technical support for drawings, installations, movements
  - hardware (optical system)
  - simulations of electron beam optics upstream from ODRI2D setup

Scientific Motivation

- Investigate the horizontal plane (SR plays different roles in the two planes) to measure also horizontal emittance
  - improvement of the system: two slits, one horizontal and one vertical to measure both vertical and horizontal emittance
- Investigate the contribution and the effects of coherent emission due to microbunching within the electron beam, i.e. Coherent Optical Diffraction Radiation Interference (CODRI)
  - the new chamber is downstream from the FLASH2 undulator
- Investigate different regimes, e.g. near field imaging

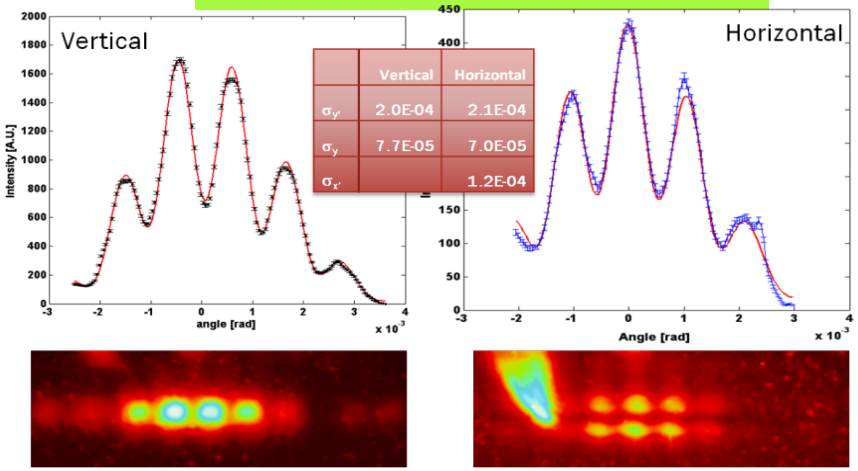


ODRI ACHIEVEMENTS IN 2010-2012

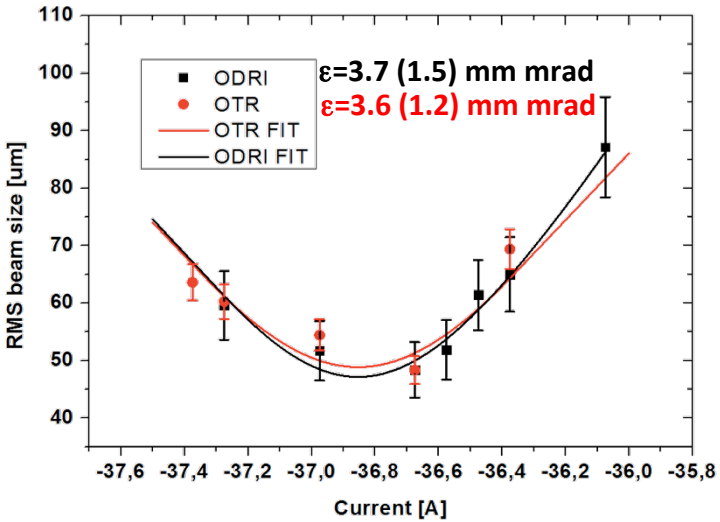
We have demonstrated that **ODRI effect can be successfully used as reliable non intercepting technique** able **to measure** the beam size with the accuracy needed to estimate **the emittance** via quadrupole scan technique.

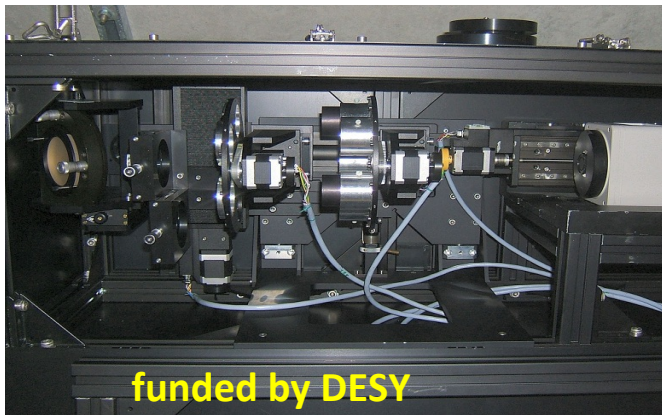
2010: New target holder and screens, and new optical system

2011: Characterization of the round beam => Horizontal and vertical ODRI polarization



2012: First non-intercepting emittance measurement in the vertical plane





Despite of the total error in the measurement the agreement, for both the emittance results and the shape of the curve of the quadrupole scans, are really excellent.

M. Castellano, E. Chiadroni, A. Cianchi, *Phase Control Effects in Optical Diffraction Radiation from a Slit,* NIM **A 614**, 163 - 168 (2010).

E. Chiadroni et al., *New Experimental Results with Optical Diffraction Radiation Diagnostics*, International Journal of Modern Physics A Vol. **25**, Supplement 1 (2010) 189.

A. Cianchi et al., *Non-intercepting electron beam size monitor using optical diffraction radiation interference,* PRST-AB **14** 102803 (2011).

E. Chiadroni et al., *Effect of transverse electron beam size on transition radiation angular distribution,* NIM A **673**, 56-63 (2012).

A. Cianchi et al., *Non-intercepting diagnostic for high brightness electron beams using Optical Diffraction Radiation Interference (ODRI),* Journal of Physics: Conference Series **357** (2012) 012019.

MOTIVATION

- For linear colliders (ILC), linac-driven FEL sources (XFEL), advanced radiation sources (Compton x-rays)
  - Small transverse beam size (≈ 10 μm)
- High energy, high charge density, high repetition rate beams require non-invasive diagnostics
  - Optical Diffraction Radiation as transverse diagnostics
    - Position, angular divergence, transverse dimensions => emittance
  - All other intercepting devices are easily damaged or destroyed from these type of beams
  - Even more desirable after recent observations of Coherent Optical Transition Radiation in linac-driven FELs.

DR THEORY

- DR generation via interaction between the EM fields of the moving charge, moving through a slit of aperture a, and the conducting screen
- extension of EM field of a relativistic particle is flat circle
  - Radius $\gamma\lambda/2\pi$
- radiation intensity scales proportional to $|E|^2$

$$I \propto e^{-\frac{a}{h_{imp}}} \quad \text{with} \quad h_{imp} = \frac{\gamma\lambda}{2\pi}$$

- dependency on impact parameter

$a >> h_{imp}$: no radiation

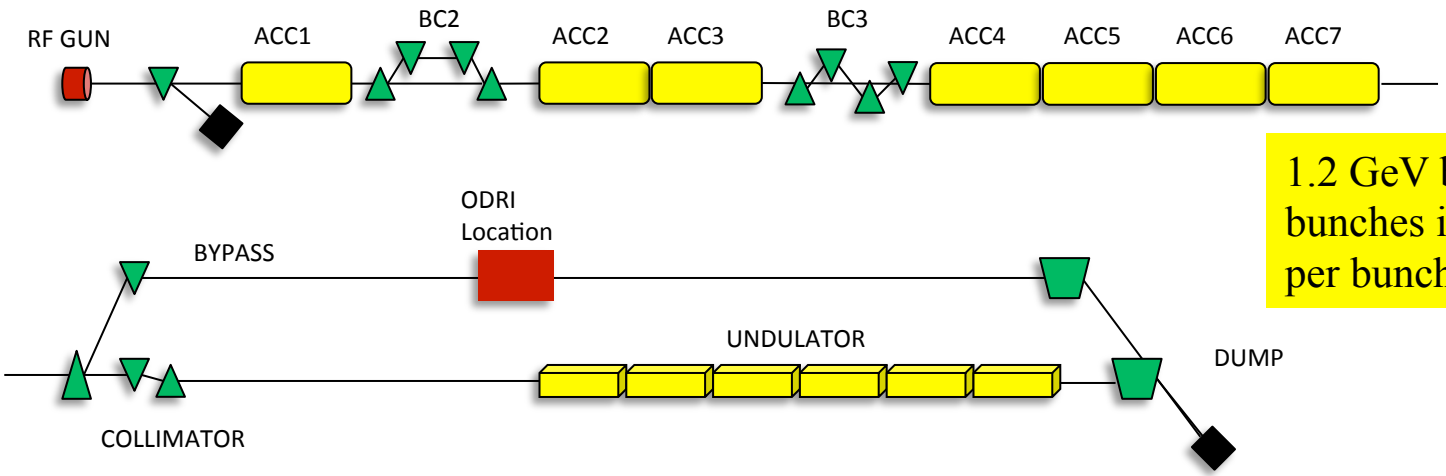
$a \cong h_{imp}$: DR

$a << h_{imp}$: TR

- excellent candidate to measure beam parameters **parasitically**

ODRI ACTIVITY

Optical Diffraction Radiation angular distribution depends on beam transverse size and angular divergence => a non intercepting emittance measurement become feasible



1.2 GeV beam energy, up to 30 bunches in the bunch train (up to 1nC per bunch), 10 Hz rep rate

M. Castellano, *A New Non Intercepting Beam size Diagnostics Using Diffraction Radiation from a Slit*, NIM **A 394**, 275, (1997).

E. Chiadroni et al., *Non-intercepting electron beam transverse diagnostics with optical diffraction radiation at the DESY FLASH facility,* NIM **B 266** (2008) 3789–3796.

E. Chiadroni, M. Castellano, A. Cianchi, *Diffraction as Ultra-High Intensity Electron Beams Non-Intercepting Diagnostics,* Il Nuovo Cimento **32 C,** N. 03-04 (2009).

M. Castellano, E. Chiadroni, A. Cianchi, *Phase Control Effects in Optical Diffraction Radiation from a Slit,* NIM **A 614**, 163 - 168 (2010).

E. Chiadroni et al., *New Experimental Results with Optical Diffraction Radiation Diagnostics*, International Journal of Modern Physics A Vol. **25**, Supplement 1 (2010) 189.

A. Cianchi et al., *Non-intercepting electron beam size monitor using optical diffraction radiation interference,* PRST-AB **14** 102803 (2011).

E. Chiadroni et al., *Effect of transverse electron beam size on transition radiation angular distribution,* NIM A **673**, 56-63 (2012).

A. Cianchi et al., *Non-intercepting diagnostic for high brightness electron beams using Optical Diffraction Radiation Interference (ODRI),* Journal of Physics: Conference Series **357** (2012) 012019.

γ - RESIST:final targets

-Demonstrating stable, controlled, high quality self injection routinely

-Demonstrating Gamma flux better than Brehmmstralung today sources In a compact all-optical source (on a small budget scale compared to European facilities)

-Probing radiaction reaction effect at "low" fiels regimes (1E24 should be the effective regime Where these effects get visible)*.

-Indirect measurement of e-beam properties inside the bubble

$$\frac{\Delta\nu}{\nu}\approx 2\frac{\Delta\gamma}{\gamma}+2(\epsilon_n\sigma_x)^2+\frac{a_0^2}{(1+a_0^2)}+\frac{\Delta\nu}{\nu}$$

* M.Tamburini,F.Pegoraro,A.DiPiazza,C.H.Keitel,A.Macchi,NewJ.Phys.10(2010)123005

Esperimento !CHAOS

L'attività si svilupperà in **2 anni** di lavoro durante i quali verrà definita in dettaglio la struttura del SdiC, verranno selezionati i software per le componenti fondamentali e verificate le loro prestazioni.

Presso i gruppi dei Sistemi di Controllo di **DAFNE** e **SPARC** dei LNF, sono già in corso dei test sul campo di sotto-insiemi di **!CHAOS**, anche al fine di verificare la possibilità di riutilizzare il *software* sviluppato nel nuovo sistema.

Lo studio della componente *software* del SdiC porterà ad una necessaria rivisitazione della parte hardware in modo da realizzare i servizi basandosi sui nuovi standard per la modulistica I/O e per diverse tipologie di *controllers* (PC, *µ*P, FPGA, strumentazione *intelligente*, etc...).

Nel complesso, il lavoro dovrà consentire di validare questa soluzione rispetto ad una sua candidatura come SdiC di una infrastruttura delle dimensioni della **SuperB**.

Allo stesso tempo, l'intrinseca scalabilità del sistema consentirà di mettere a disposizione il SdiC anche per applicazioni di dimensioni ridotte, proponendo così una soluzione il cui utilizzo e sviluppo potrà essere condiviso da un'ampia comunità scientifica.

POSSO @ activity 2012

***milestones for 2012**:*

-- *optimization of the beam dynamics for the SPARC beam up to the crystal position;*

-- *optimization of the experimental beamline to minimize the perturbation to the present SPARC layout;*

-- *design of the interaction chamber;*

-- *computer simulation studies on the optimization of crystal-beam system (crystal and beam parameters, alignment details) taking into account the scattering processes of the projectiles in various crystals;*

-- *theoretical channeling radiation studies to maximize the flux of emitted radiation;*

-- *preliminary studies on the positron beam diagnostics*

@ Studies for the period 1/01-31/05/2012: For the first ½ year of the project we have performed theoretical studies that finalized in:

- new computer codes for planar and axial channeling of relativistic electrons in various types of the crystals;
- detailed analysis of orientation features of electron scattering at axial channeling in very thin (submicron) monocrystals (studies on mirror reflection of the beam);
- detailed analysis of electron dechanneling and rechanneling at planar case based on solution of Fokker-Plank equations;
- getting the radiation power behind the crystals at the channeling orientations for various emittance parameters of the beam before the crystal;
- electron beam simulations by GEANT4 based codes for optimization of experimental layout.

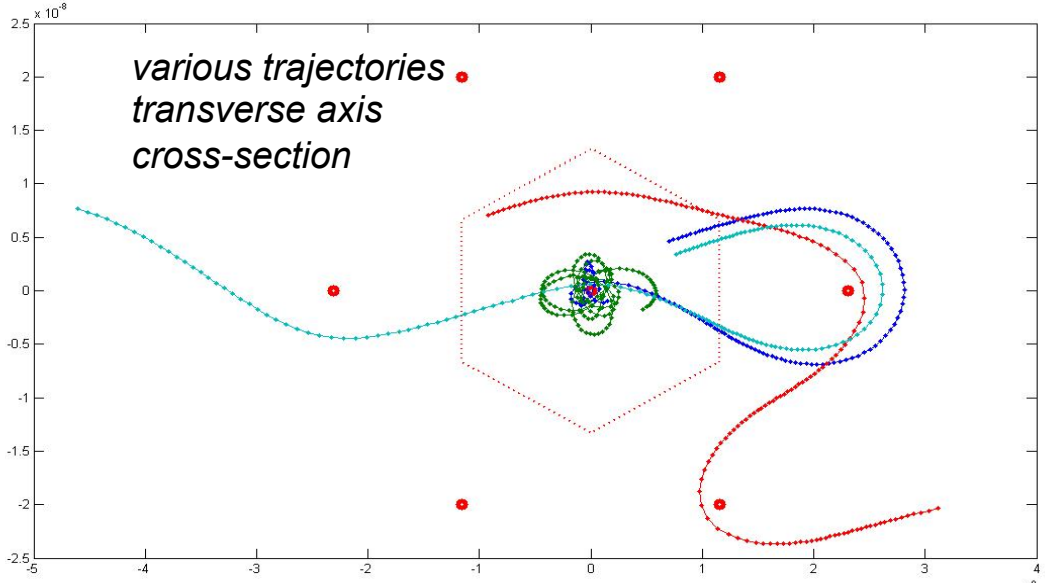
Additionally, together with the SPARC_LAB team we have:

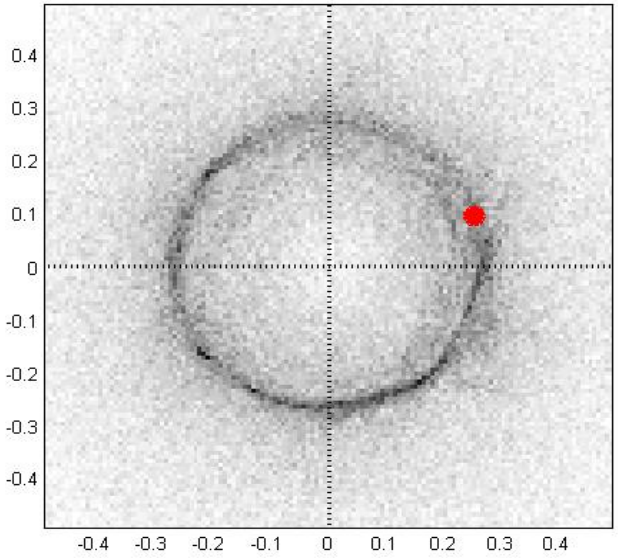
- evaluated various possible solutions for a new beam line dedicated to channeling studies;
- chosen the layout, to be constructed as a continuation of the dogleg piece of the THz beamline;
- prepared preliminary hardware evaluation that will be included in the budget to be requested to the commission for next year.

POSSO @ channeling studies at SPARC energies: simulations

Ge <111>
150 MeV

Computer simulations for angular distribution of a beam vs depth of penetration

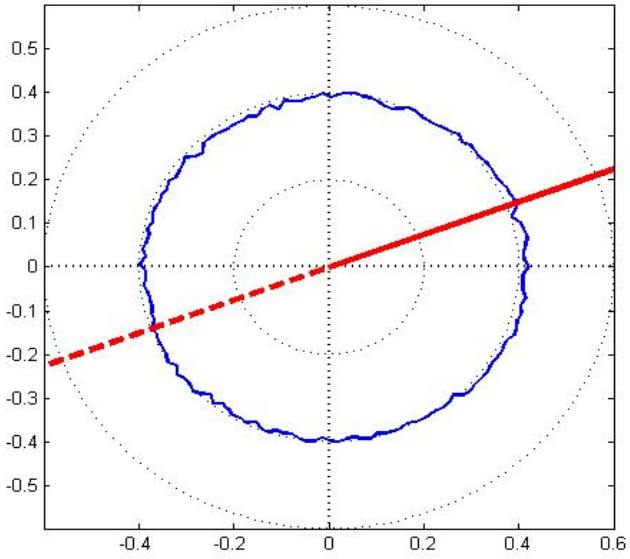




Δθ = 0 – beam divergence
θ_0=0.25 θ_c – incidence angle

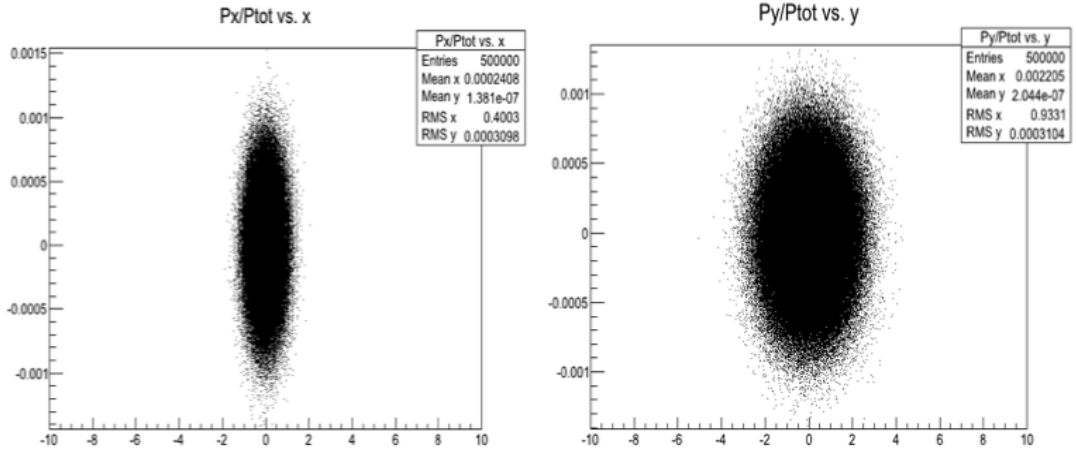
depth evolution
Δt = 81 nm ÷ 1.33 μm

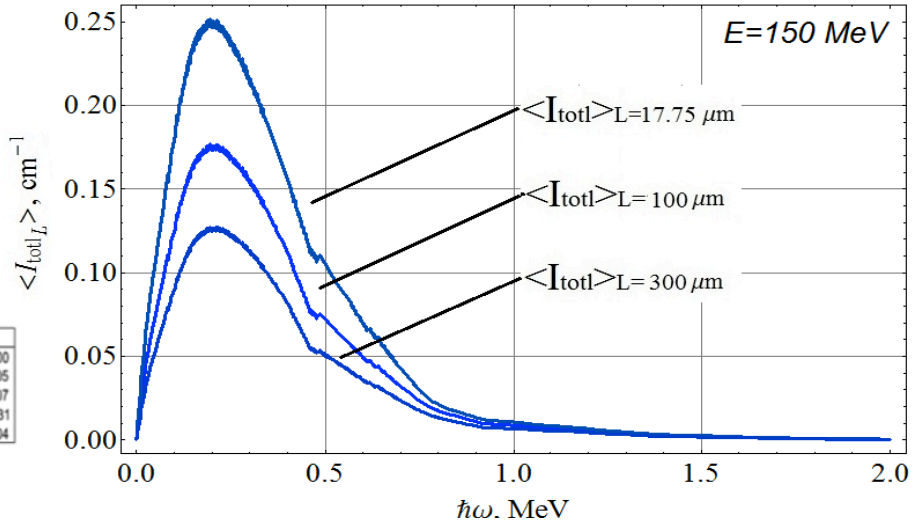
The efficiency of "reflection" in optimized conditions becomes rather high

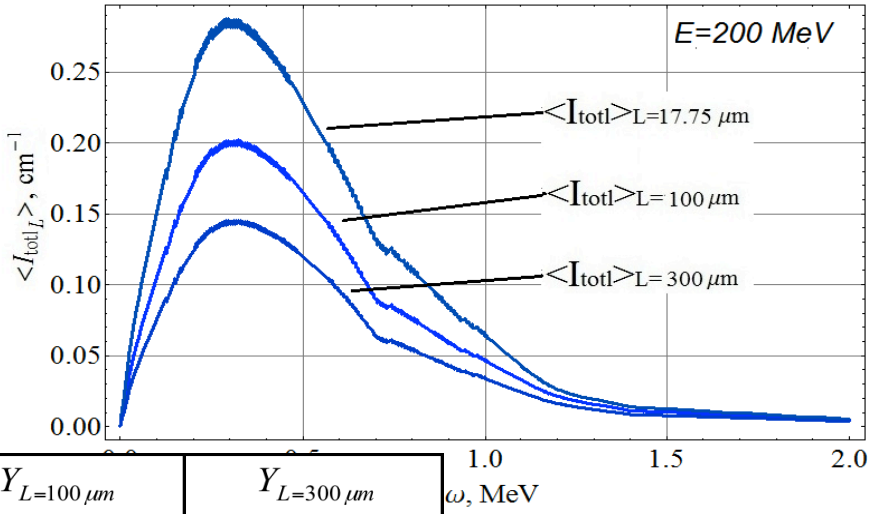


POSSO @ channeling/radiation at planar e- channeling: simulations

G4beamline simulation package which mainly extends GEANT4 toolkit for the accelerator applications







Channeling radiation studies

- *Monochromaticity*
- *Photon yield*

Energy of electron, (MeV)	Y_{thin}	Y_{F_0}	$Y_{L=L_d}$	$Y_{L=100\,\mu m}$	$Y_{L=300\,\mu m}$
150	0.14	0.12	0.11	0.08	0.07
200	0.24	0.21	0.19	0.14	0.10
855	2.23	2.19	2.13	1.49	1.09

Scientific highlights

Developing innovative neutron sensitive instruments for the spectrometric and dosimetric characterization of neutron fields, intentionally produced or present as parasitic effects, in particle accelerators used in **industry, research and medical fields**.

These neutron fields:

- range in energy from thermal (1E-8 MeV) to tens or hundreds MeV;
- range in fluce rate from few tens up to 10^5 cm^{-2} s^{-1}
- are accompanied by other particles (photons, high-E hadrons)
- Have pulsed structure

(1) Fast neutron irradiation

TRIUMF, LANSCE, TSL (ANITA), ISIS, **ESS**: dedicate neutron lines for material science, chip irradiation (electronics, avionics, aerospace) and radiation damage.

Neturon spectra are generally known by simulation only. Measurements performed in limited energy regions only. A large interest exists for broad-energy, on-line spectrometry that would allow

- estimating field pertutbation due to irradiated objects,
- evaluate the importance of room-return for different user positions;
- prevent beam alterations due to change in energy or space characteristics of primary beam.

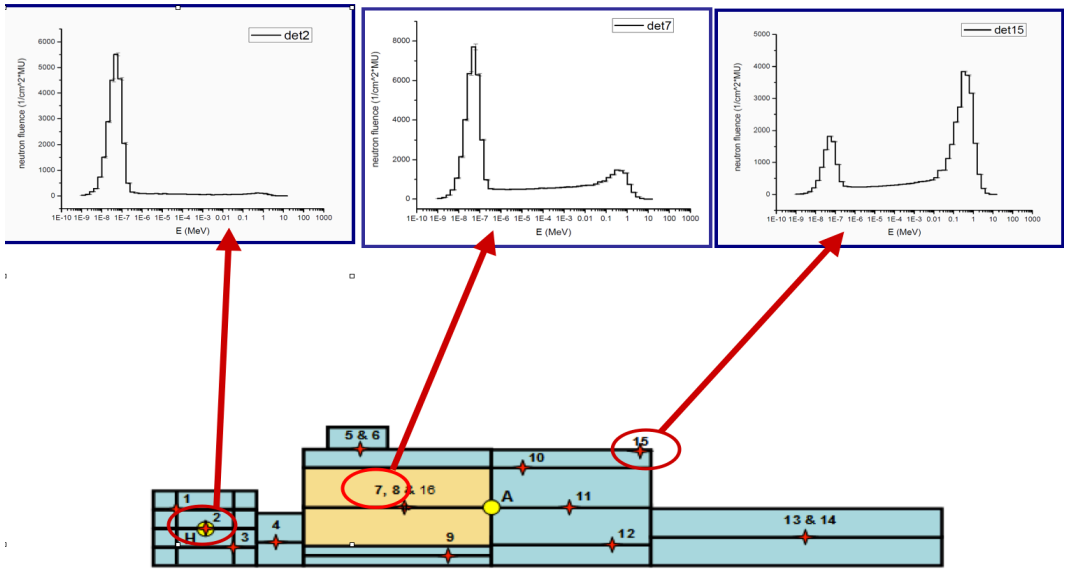
Scientific highlights

(2) Medical field

Modern radiotherapy techniques (including hadron-therapy) dramatically improved lifespan and life quality of patients. In parallel the interest for secondary cancers is increasing. **A significant fraction of secondary cancers is estimated to come from parasitic neutrons.**

The **medical physics** community is seeking on-line instruments to provide neutron-related field and dosimetric quantities in broad ranges of Energy (10^{-8} - 10^{2} MeV) and flux (10^{2}-10^{4} cm^{-2} s^{-1})

NESCOFI products may be immediately applied in the field of in-vivo (in-phantom) verification of simulated neutron quantities during radiotherapy (collaboration with Sevilla University)



NESCOFI's philosophy

To date, the Bonner Sphere spectrometer is the only existing device having the capability to simultaneously determine all energy components.
Disadvantage: need to sequentially expose the spheres.

NESCOFI goal is to provide real-time spectrometers to simultaneously provide all energy components (and their variation with time) in a single irradiation,
exploiting the same principle of Bonner Spheres (detection of moderated neutrons) but in a single moderator embedding multiple thermal neutron detectors.

General planning

Build TWO types of spectrometers for different field geometries:

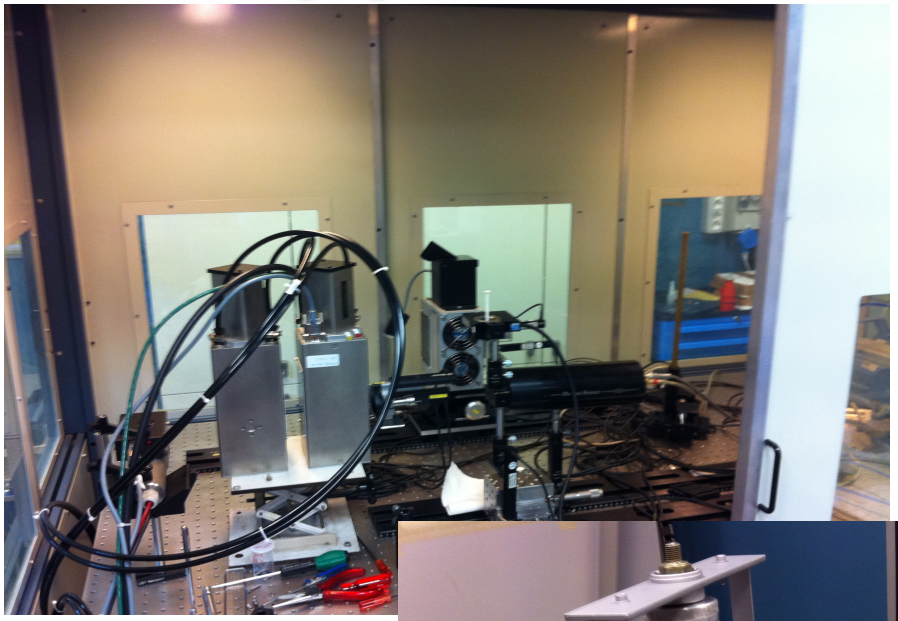
$(SP)^2$ **SP**herical-**Sp**ectrometer: measure the total spectrum independently from direction distribution

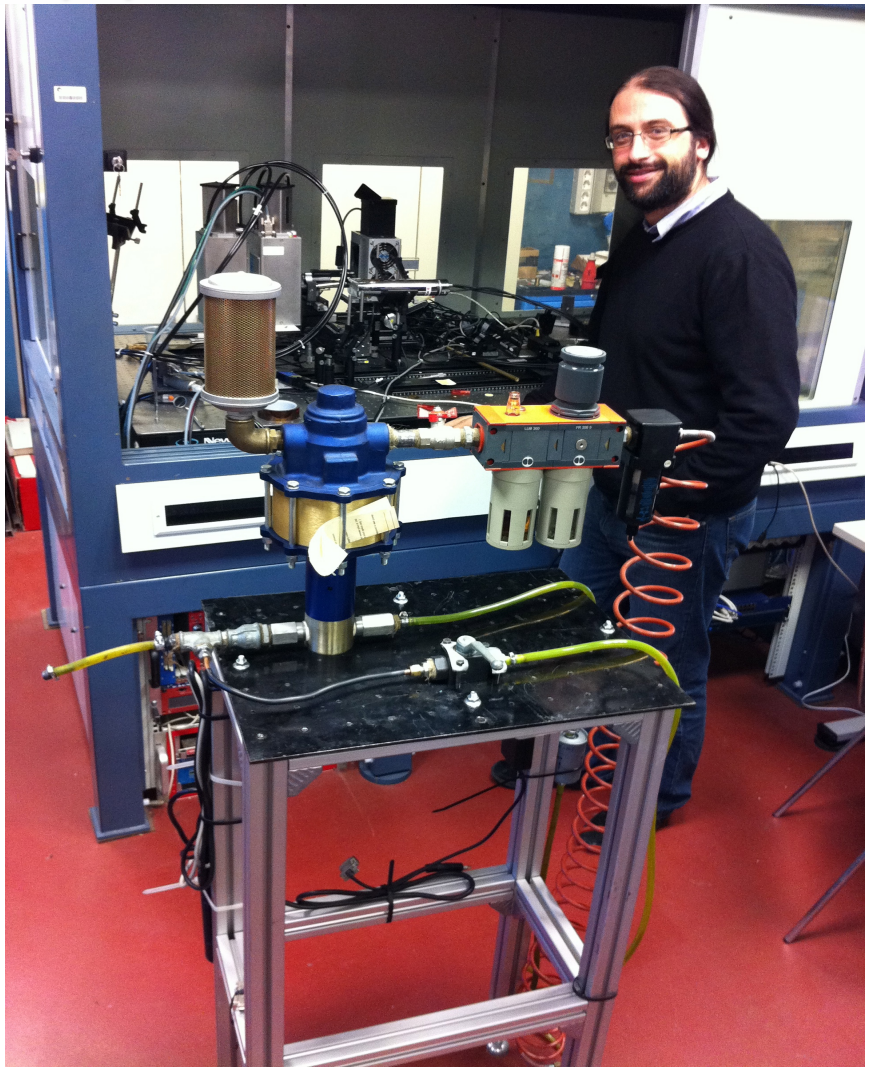
CYSP **CY**lindrical-**SP**ectrometer: determine the spectrum from a preferred direction (typ. from a target. Allows eliminating room return)

For each geometry: Identify suitable Active Thermal Neutron Detectors (ATND) to produce a low-rate & a high-rate version.

2011 MC Design of the geometries and test with passive detectors (Dy-foils)
2012 Identify suitable ATND
2013 Build and calibrate final spectrometers

@ X imaging: instrumentation for tomography

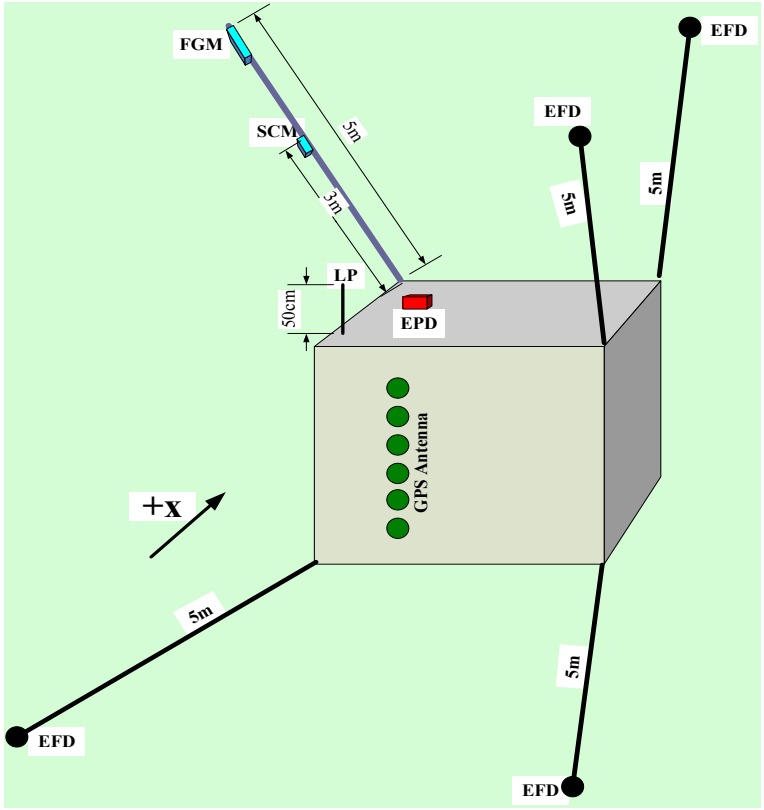




ALTEA

- In presa dati continua
- Utilizzata dalla NASA come strumento operativo per misura della radiazione in tempo reale.
- Programma ESA per lo shielding: ALTEA-Shield.
- Training Astronauta Paolo Nespoli: installazione e attivazione di ALTEA-Shield il 23/4/2011 sulla ISS.

Satellite



Payload Instruments:

- **Particle Detector Analyser** (PDA).
  - Energy range: 300 KeV÷ 100 Mev
  - Pitch angle accuracy < 4° with particle identification

- **Electric Field Analyser** (EFA)
  - frequency range: ~DC ÷ 10 MHz
  - accuracy: 300 nV/m
  - dynamic range: 120 dB

- **Magnetic Field Analyser** (MAFA)

  FLUX – GATE: • frequency range: ~DC ÷ 10 Hz
  - accuracy: a few (6-8) pT
  - resolution: 24 bit

  SEARCH – COIL: • frequency range: ~10 Hz ÷ 100 kHz
  - sensitivity: 10^{-2} pT /(Hz)½ (at 1 kHz)

- **Langmuir Probe & Retarding Potential Analyser**

  LP: • electron temperature: 300 ÷ 15000 K
  - electron density: $10^2 \div 10^7$ cm^{-3}

  RPA: • ionic temperature: 300 ÷ 10000 K
  - ionic density: $10^2 \div 10^7$ cm^{-3}

CSES ACTIVITIES 2011

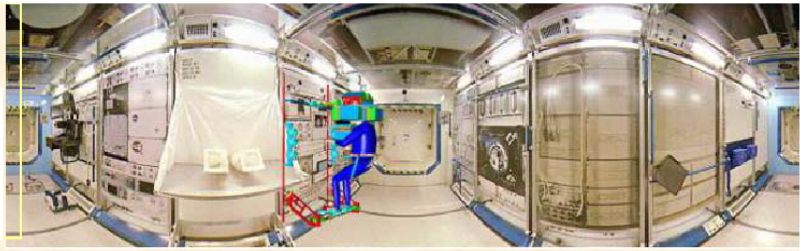
-Prototype hardware composed of 4 sensors and of an analog board for the elaboration of electrical field signals.

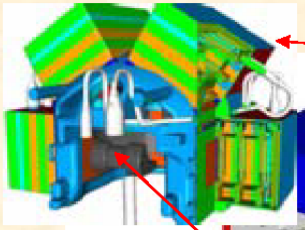
-Test and characterization of electrical field sensors, mainly for the electrical noise of the chosen preamplifier.

-Beginning of the modeling and simulation of the whole field measuring system (analog and digital part).

-International agreements between the Italian and Chinese Space Agencies ASI and CSNA have started during this year and are in progress.

ALTEA – ISS Facility





SDS 6 SDUs

SDU – Silicon Detector Unit:
3 silicon planes with double detectors, view X & Y
Area: 2 x (8 x 8) cm²
Maximum error of angular reconstruction: ±1.8°
Geometric factor: 160 cm2 sr

EEG

32 channels
128 - 16384 Hz
per channel

VSU

Two color LCD-TFT oculars
XGA, 1024 x 768 pixels at 60 Hz
Field of view: 35° diagonal (21° V 28° H)
Luminance 5-50 FL Contrast 40:1
256 colors out of a 16 million colors palette
Video memory: 2 MB

PushB.

Three independent
Push-buttons

EEG= ElectroEncephaloGraf

VSU= Visual Stimulating Unit

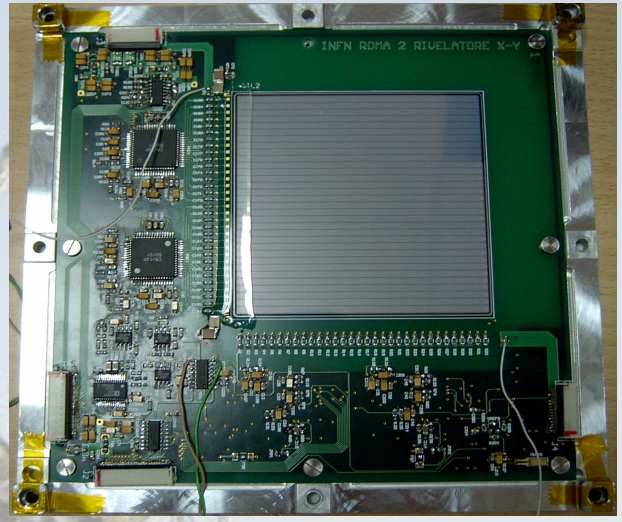
Apparato per l'esterno della ISS: Si-Rad

•Confronto ambiente radioattivo tra interno ed esterno della stazione.

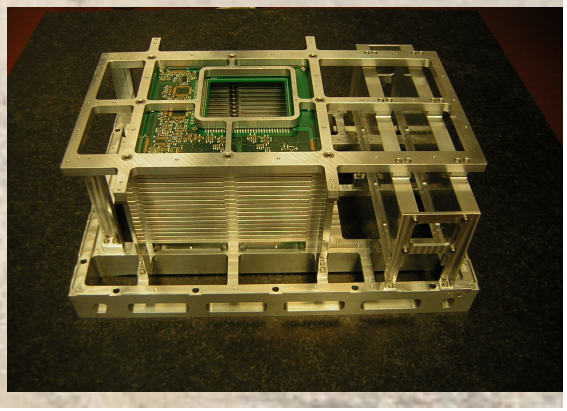
•Selezionato per studio di fase A bando Missioni di opportunità ASI

•Completata fase A, selezionato per fase B

•Completamento Schede front-end Sirad Flight model
•Realizzazione trigger flight model
•Realizzazione MiniCPU
•Realizzazione meccanica di volo



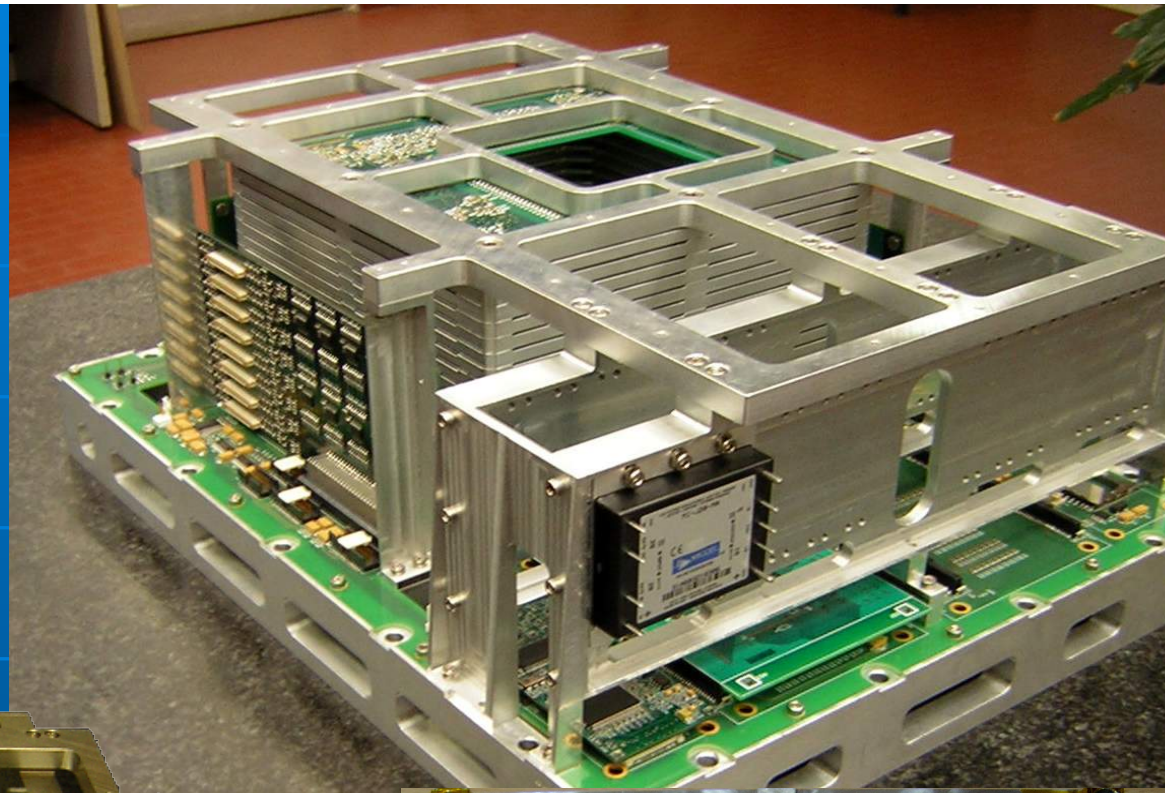
Board di Front End con rivelatori al silicio 8x8x 0.38 cm (32 strips). Un secondo rivelatore con strip ortogonali è collocato al di sotto di quello visibile in figura.

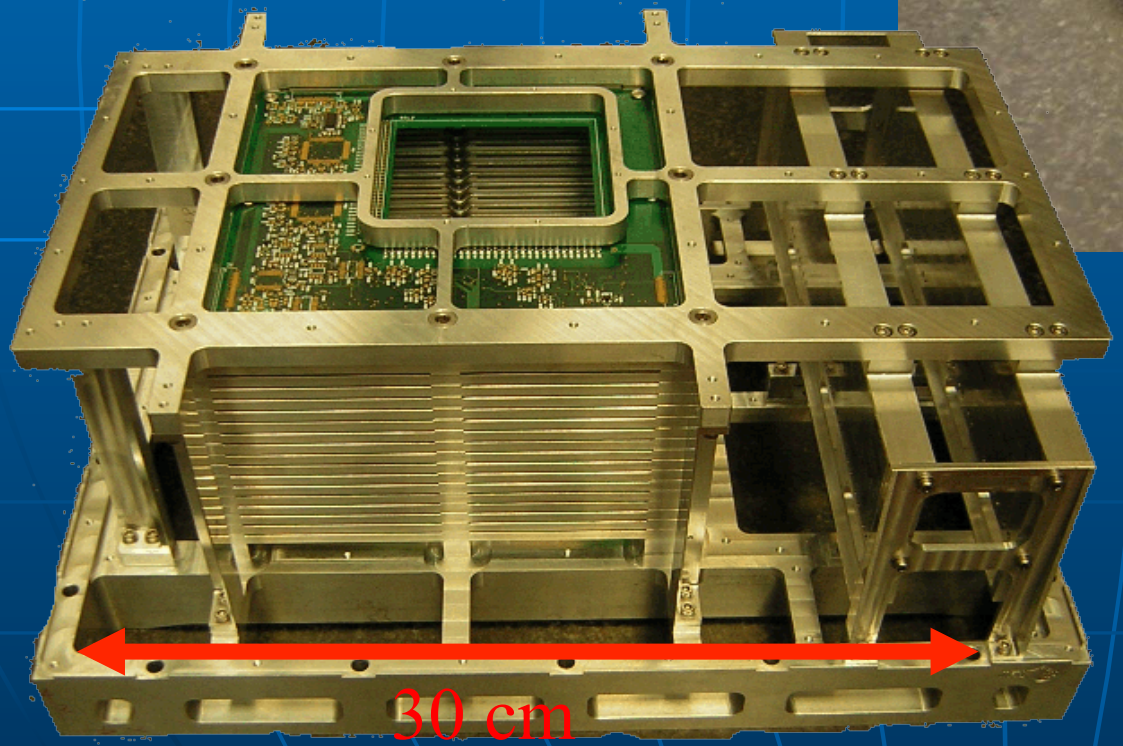


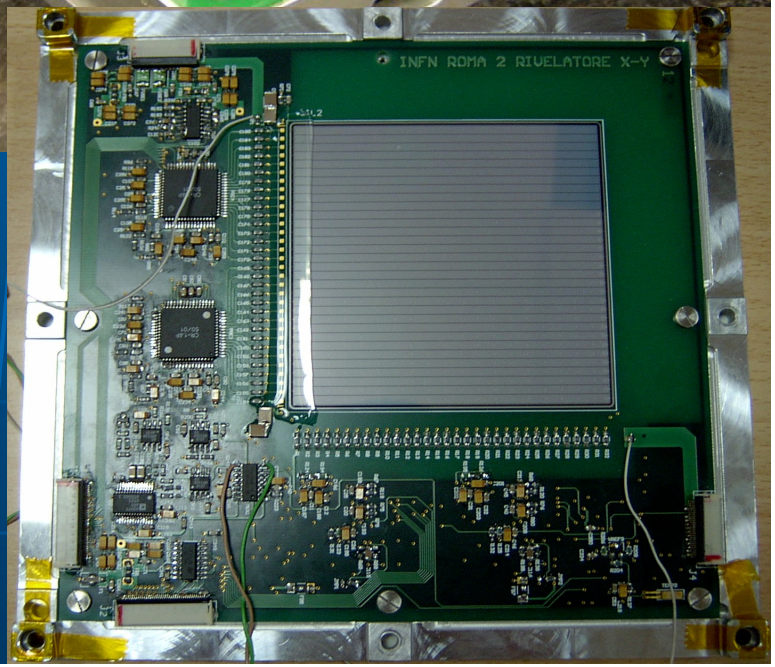
Si-Rad

Importante contributo LNF/SPCM

- Il modello tecnologico è terminato
- Vanno inseriti i silici
- Sistema di anticoincidenza
- Cablaggio finale
- Test alla BTF
- Test presso altri acceleratori
- Selezionato per la Stazione Spaziale. Progetto FEBO.







CSES

(Chinese Seismo-Electromagnetic Satellite)

- Studio delle variazioni repentine di flussi di protoni ed elettroni intrappolati nelle fasce di radiazione a seguito di perturbazioni causate da eventi sismici (terremoti)

- Realizzazione di una serie di rivelatori:
  - Mini spettrometro magnetico
  - Rivelatore di campo elettrico
  - Rivelatore di campo magnetico
  - Rivelatore di onde e.m. a bassa frequenza

Bologna
Laboratori Nazionali di Frascati
Perugia
Roma Tor Vergata

China Earthquake Administration
Chinese National Space Agency

Dose profiling for hadrontherapy: different possible approaches

- **Measure shape and absolute value of dose to check the agreement between the planned target volume and the actually irradiated volume**
- **The measurement should be done during the treatment (in-beam)**
- Must **rely on a given secondaries generated by the beam** that comes out from the patient, to spot the position of the dose release
- Must be able **to deal with the other secondaries** that come out that acts like background

Baseline for monitor in hadrontherapy is PET : autoactivation by p & ^{12}C beam that creates β^+ emitters.

- Isotopes of short lifetime ^{11}C (20 min), ^{15}O (2 min), ^{10}C (20 s) wrt conventional PET (hours)
- Low activity in comparison to conventional PET need quite long acquisition time (few minutes)
- Metabolic wash-out, the β^+ emitters are blurred by the patient metabolism
- No direct space correlation between β^+ activity and dose release (but can be reliably computed by MC)

Balance of promptly emitted particles outside the target:

Incident protons:	1.0	($\sim 10^{10}$)
γ-rays:	0.3	($3 \cdot 10^9$)
Neutrons:	0.09	($9 \cdot 10^8$)
Protons:	0.001	($1 \cdot 10^7$)
α-particles:	$2 \cdot 10^{-5}$	($2 \cdot 10^5$)

In-beam PET

- Less acceptance
- No patient movement
- Less methabolic washout
- Background from the beam

In-beam TOF-PET

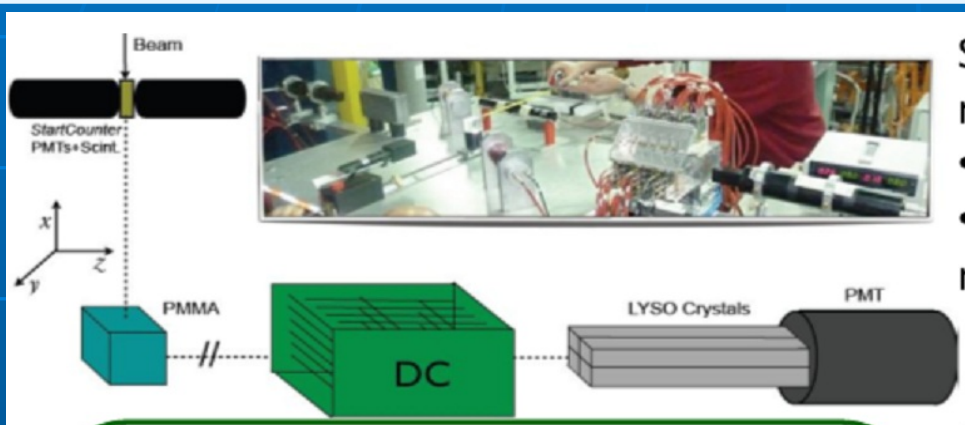
- Improvement in the S/B ratio
- Better accuracy with less statistic
- Easier events reconstruction
- O(100ps) time resolution on 511 keV γ needed

prompt γ monitoring: Gamma camera, Compton camera

And if we try to use fragments!

Dose profiling for hadrontherapy: measurement at LNS march 2011

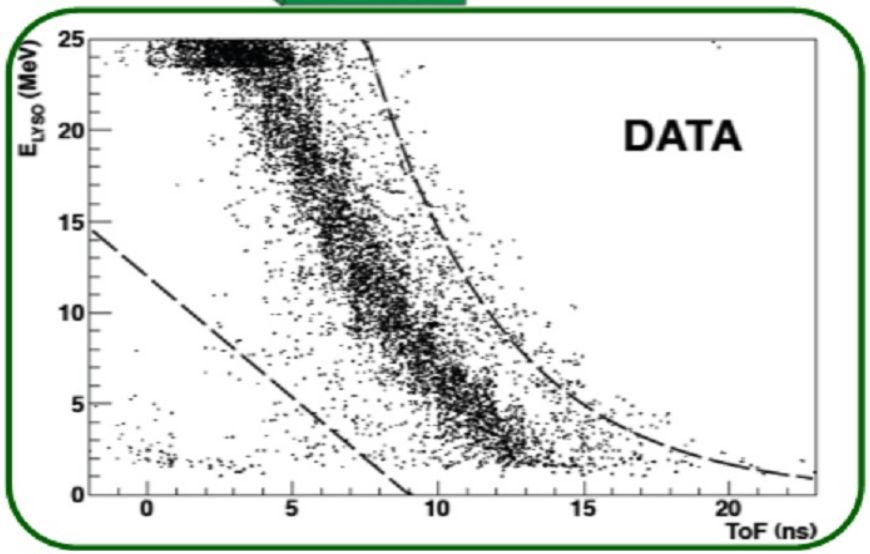
- "Charged particle's flux measuremnt from PMMA irradiated by 80 MeV/u carbon beam" arXiv:1203.4702v1 [physics.med.ph] 21 Mar 2012
- E. De Lucia – 13° International Conference on Nuclear reaction Mechanism

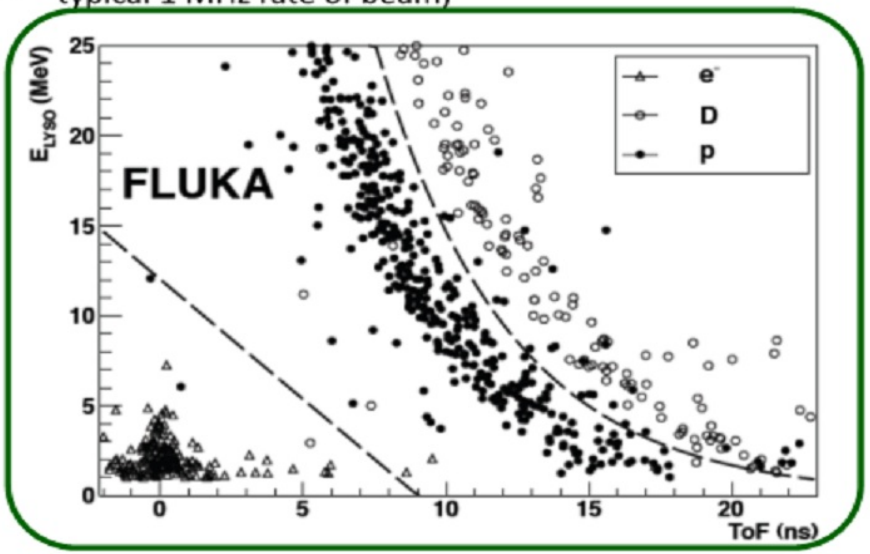


Secondary protons produced at 90° with respect to the beam axis (N_{HITS}>9)

- identified exploiting E and ToF from LYSO
- detailed simulation of setup geometry, materials, trigger logic and resolutions

(*FLUKA 2011.2 release*, simulated 10^9 ^{12}C ions with 80MeV/u, equivalent to 10^3 s of data taking at the typical 1 MHz rate of beam)





- Inoltre è stato espresso interesse a partecipare all'esperimento da parte di alcuni Ingegneri Elettronici coordinati da G. Cocorullo, P.O., direttore del DEIS, Dipartimento di Elettronica, Informatica e Sistemistica dell'Università della Calabria, non ancora associati INFN, il cui ingresso nel Gruppo Collegato ne allargherebbe in modo significativo le competenze.

- Le relazioni in corso ci hanno permesso la supervisione di un lavoro di tesi magistrale in Ingegneria Elettronica sulla caratterizzazione dei sensori 3D e dell'elettronica integrata, realizzata al **CERN**, nell'ambito della Collaborazione **ATLAS 3D**.

Finalità dell'esperimento è lo studio delle possibili applicazioni dei sensori 3D quali

- Biosensori cellulari
- Rivelatori di neutroni

Biosensori cellulari

- Interfaccia neuroni-silicio
- Studio della possibilità di utilizzare i sensori 3D quali biosensori cellulari

Rivelatori di neutroni lenti e veloci

- Sensori al silicio 3D ultrasottili per la rivelazione di neutroni (fusione e fissione nucleare)
- Rivelatori al silicio di neutroni termici (>50% efficienza di rivelazione)
- Camere micromegas per rivelazione di neutroni

Sono in corso contatti con altri gruppi INFN con interessi analoghi per la realizzazione di una collaborazione su queste tematiche di ricerca