Low Energy Particle Detector:
Laser Induced
DORELAS

- **Fisica vs Rivelatori a Bassa Soglia di Energia**
- **Da KeV a eV Breve sguardo d'insieme e prospettive**
- **Pompaggio Laser su " Mezzo Attivo " : RIVELATORE**

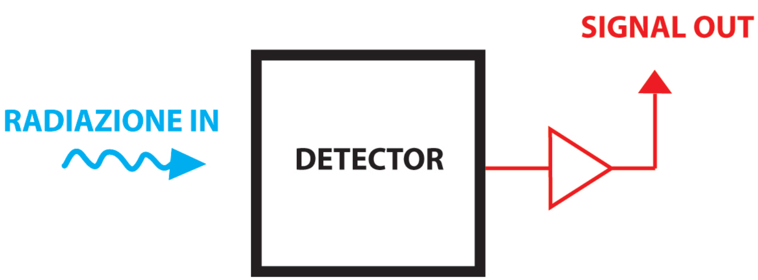
IL Fatto e il da Farsi

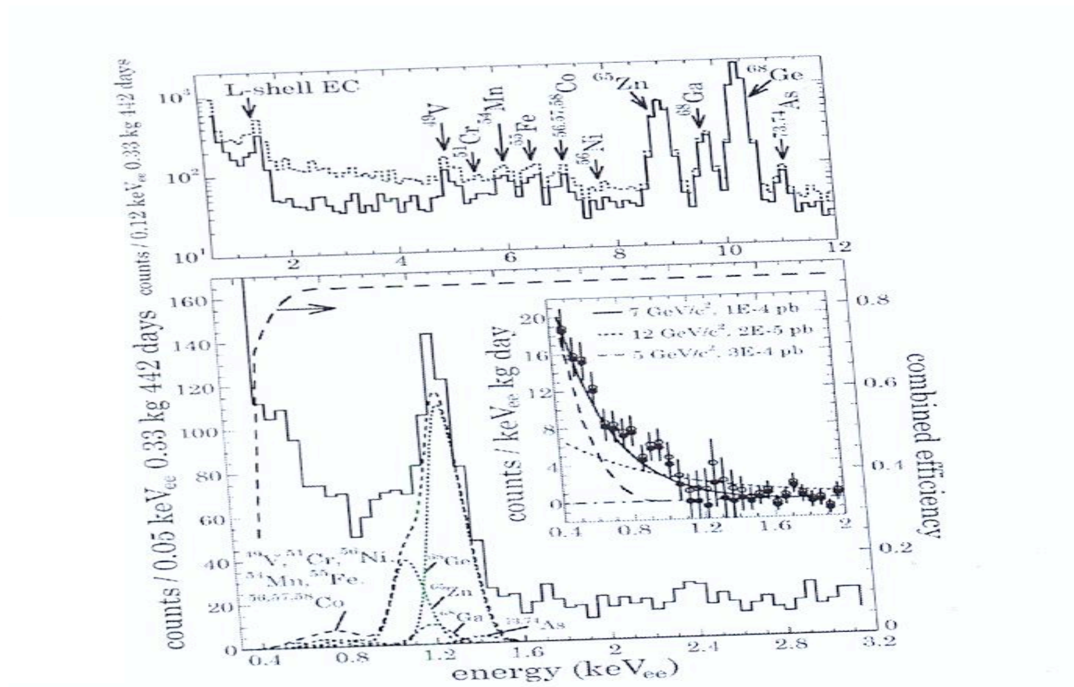
- **Richieste : Finanziarie ,Servizi ,**

Stato Attuale Rivelatori Basse Soglie

$$Segnale \propto E_{rilasciata} / w_{detector}$$ (Fano Factor , Quenching Factor,…)

$$W \approx 2,5 E_{gap}$$ Shockley





Scintillatori : Kev (40 ph/KeV) Q.F. elevato alle basse energie , F.F. alto

Semiconduttori : 400 eV (1 e/h /3,6 eV Si , 100 elettroni rumore a bassa Capacita')

Bolometri : 100 eV (Capacita termica totale, basse soglie piccole masse e milliKelvin)

Infrared Quantum Counter Idea

Bloembergen (Nobel Prize) suggested to detect IR photons with large Q.E.

where No Phototube are available at IR wavelenght (PRL '59)

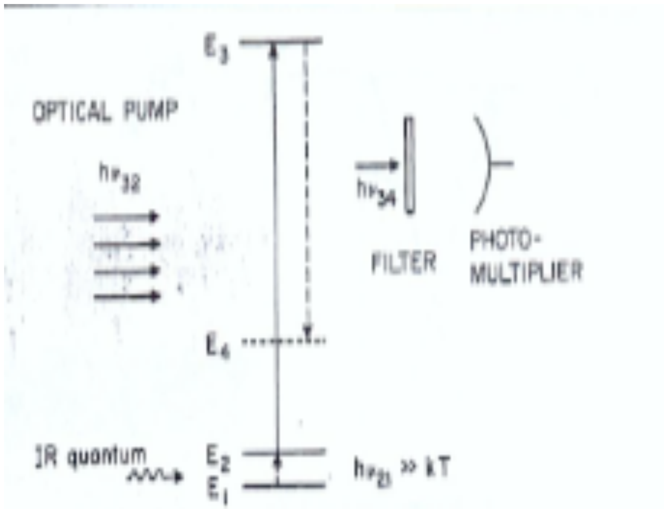


FIG. 1. Infrared quantum counter. Several ions of transition group elements have appropriate energy level diagrams: $h\nu_{21} = 1 - 5000$ cm^{-1}, $h\nu_{32} = 10^4 - 5 \times 10^4$ cm^{-1}.

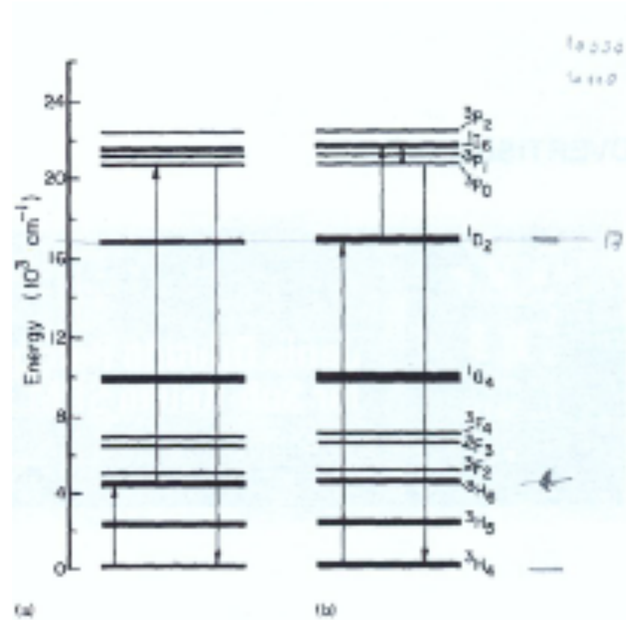
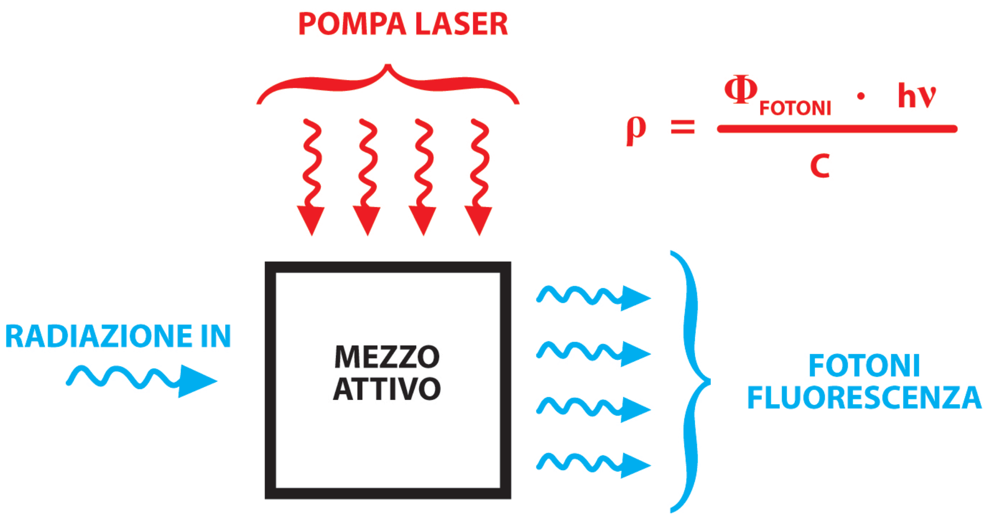


FIG. 1. Energy levels of Pr^{3+} and examples of double-resonance schemes used to detect infrared radiation.

Actual Quantum Efficiency for 10 micron IR photons almost at 100% level

A New Detector Approach for Low Energy Release

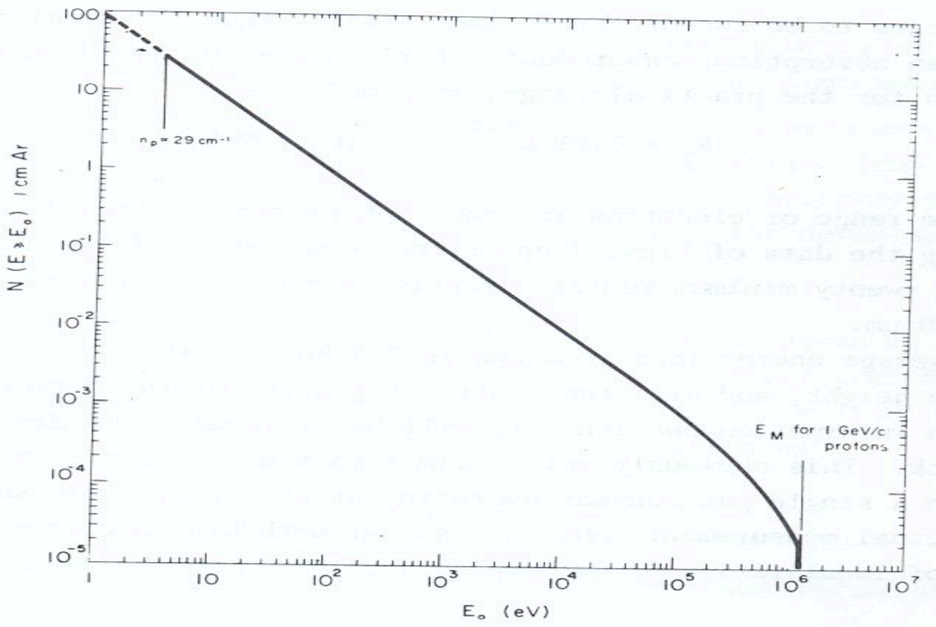


Radiazione in Attraverso dE/dx Promuove atomi su stati eccitati

Maggior probabilita' P(e) = 1/E^2 su stati di bassa energia

Campo Cristallino Mezzo Attivo rimuove la degenerazione sullo stato fondamentale

Generando primi stati eccitati a livelli di 10 meV



$$P(E)dE = \frac{K}{\beta^2}\frac{Z}{A}\frac{x}{E^2}dE = W\frac{dE}{E^2} \quad .$$

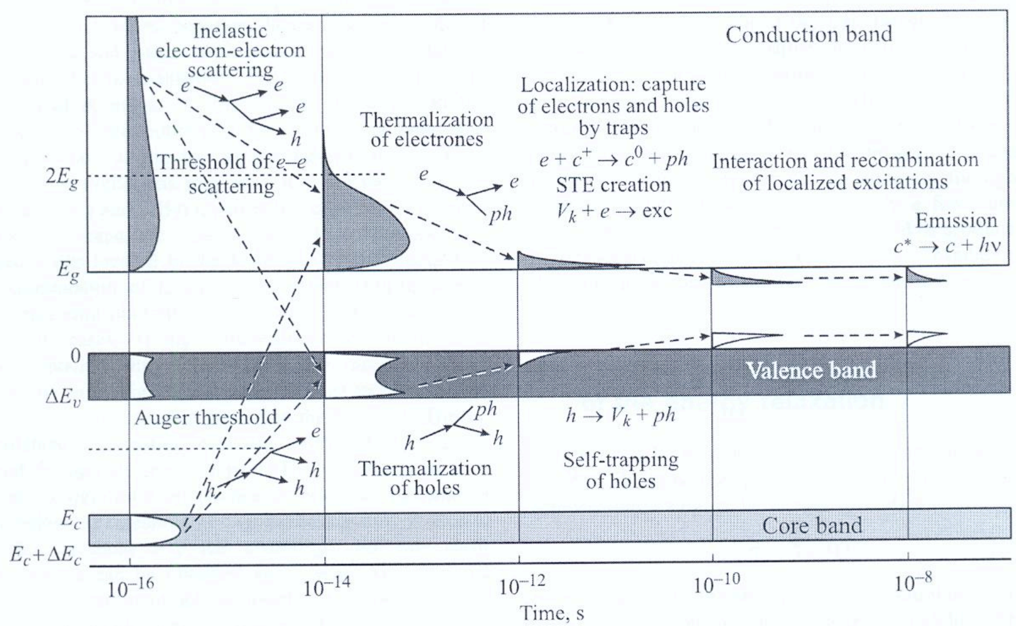
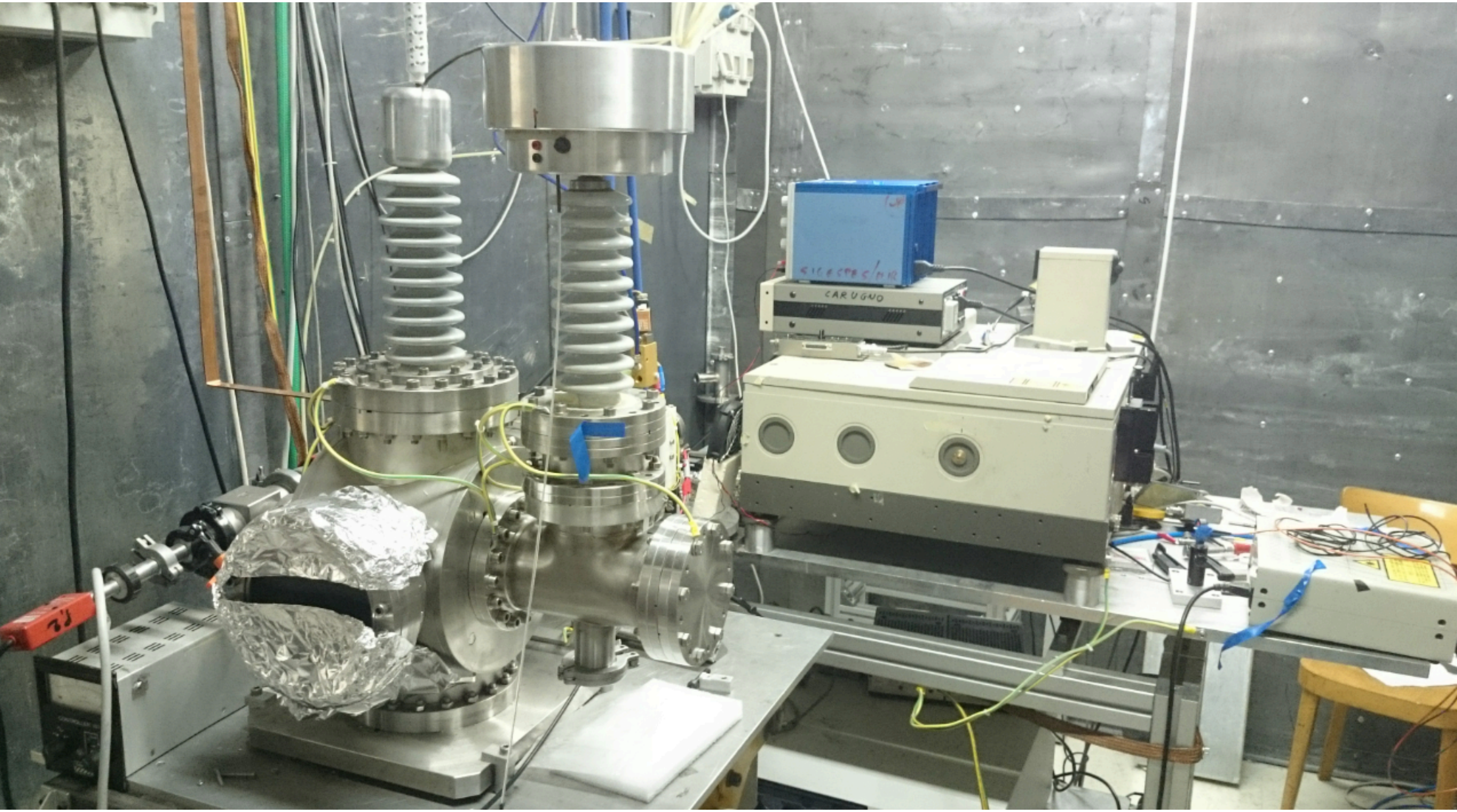


Figure 1. General scheme of relaxation of electronic excitations in an insulating material.

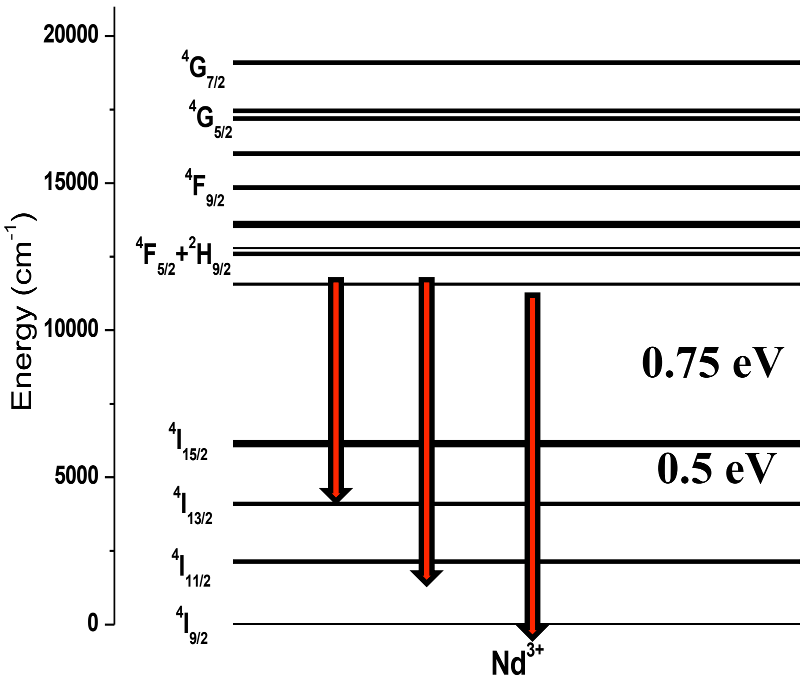
Scattering elettroni su Fononi Ottici

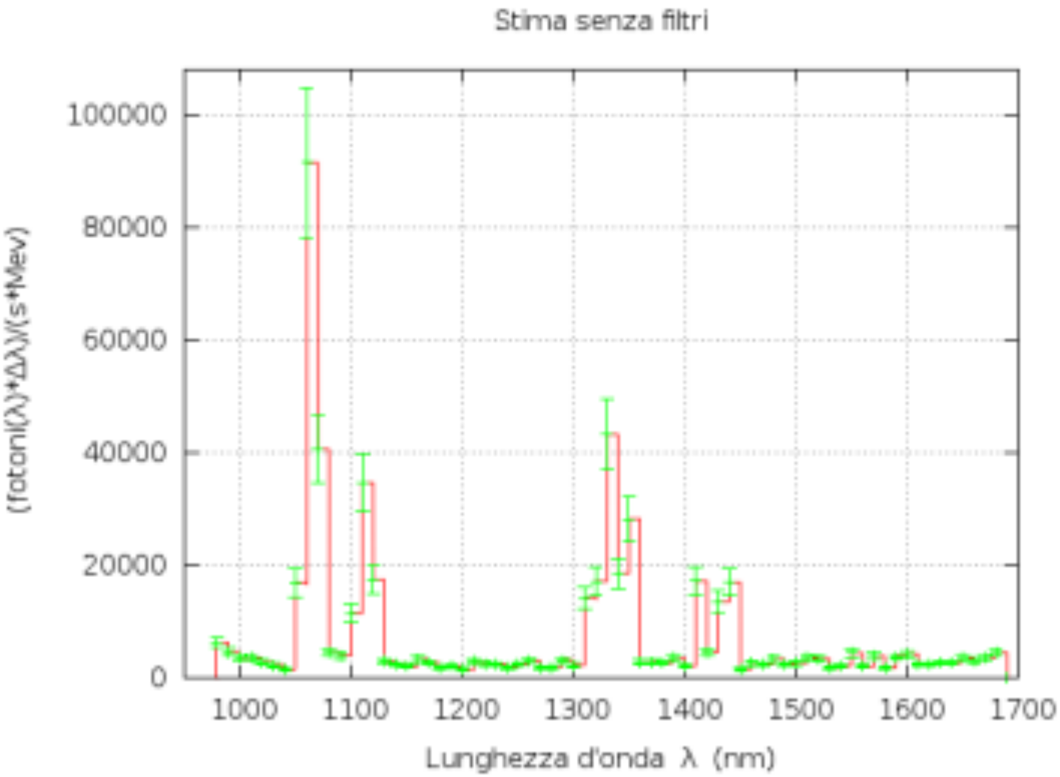
Electron Irradiation Facility @ Legnaro



Nd:YAG IR Transitions and Spectra

At Room Temperature

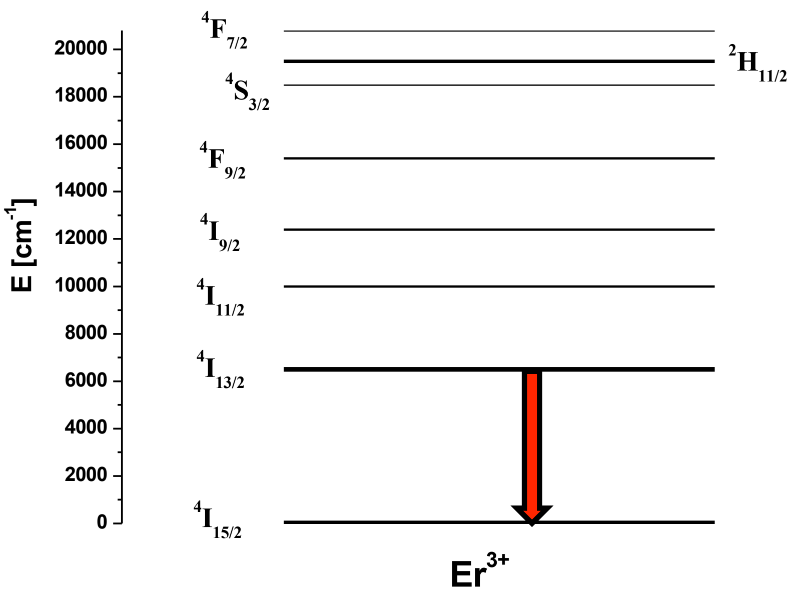


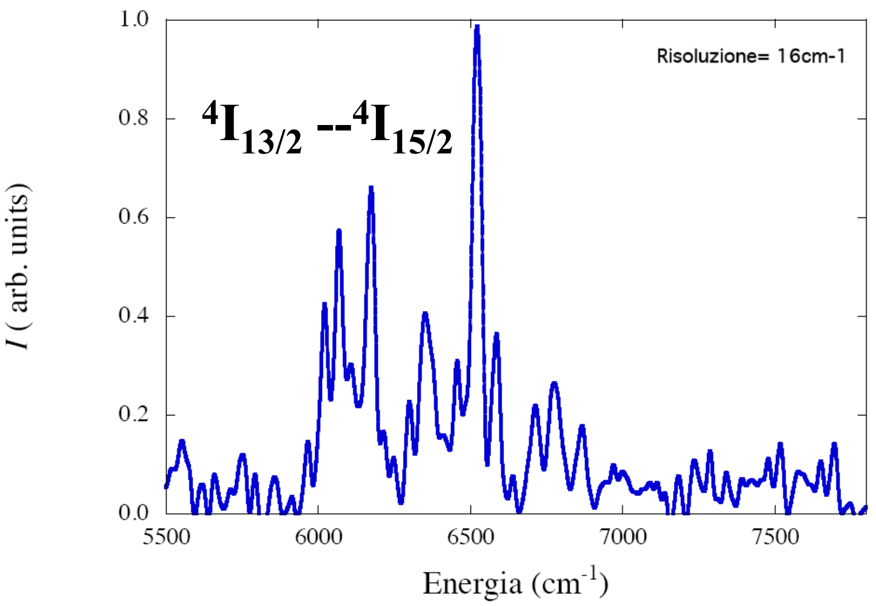


IR Emission Efficiency larger than 15%

Erbium:Yag Emission Spectrum

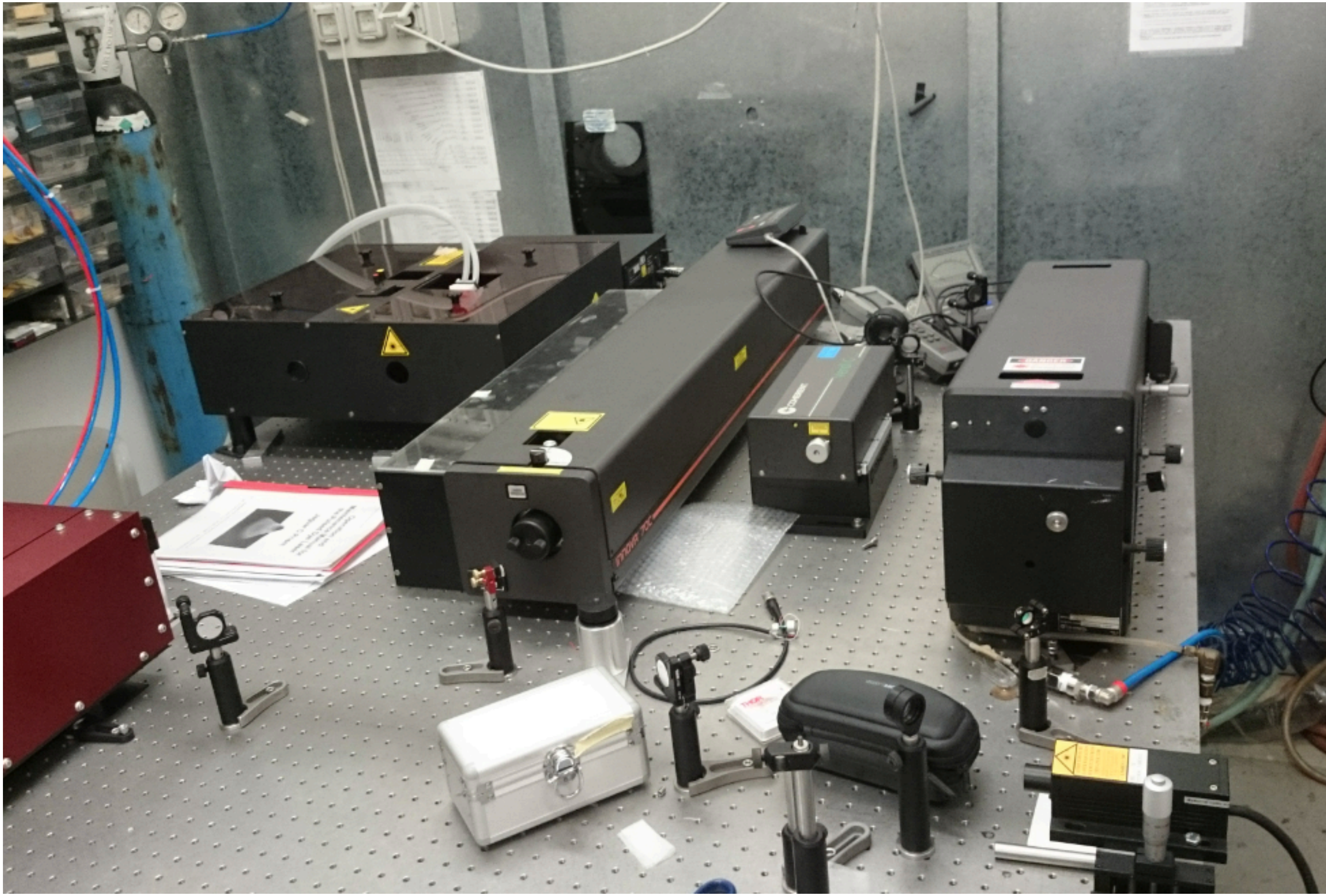
0,4% Er





Tunable CW Titanium:Zapphire Laser @ LNL

from 740 nm to 920 nm , Power higher than 100 mW

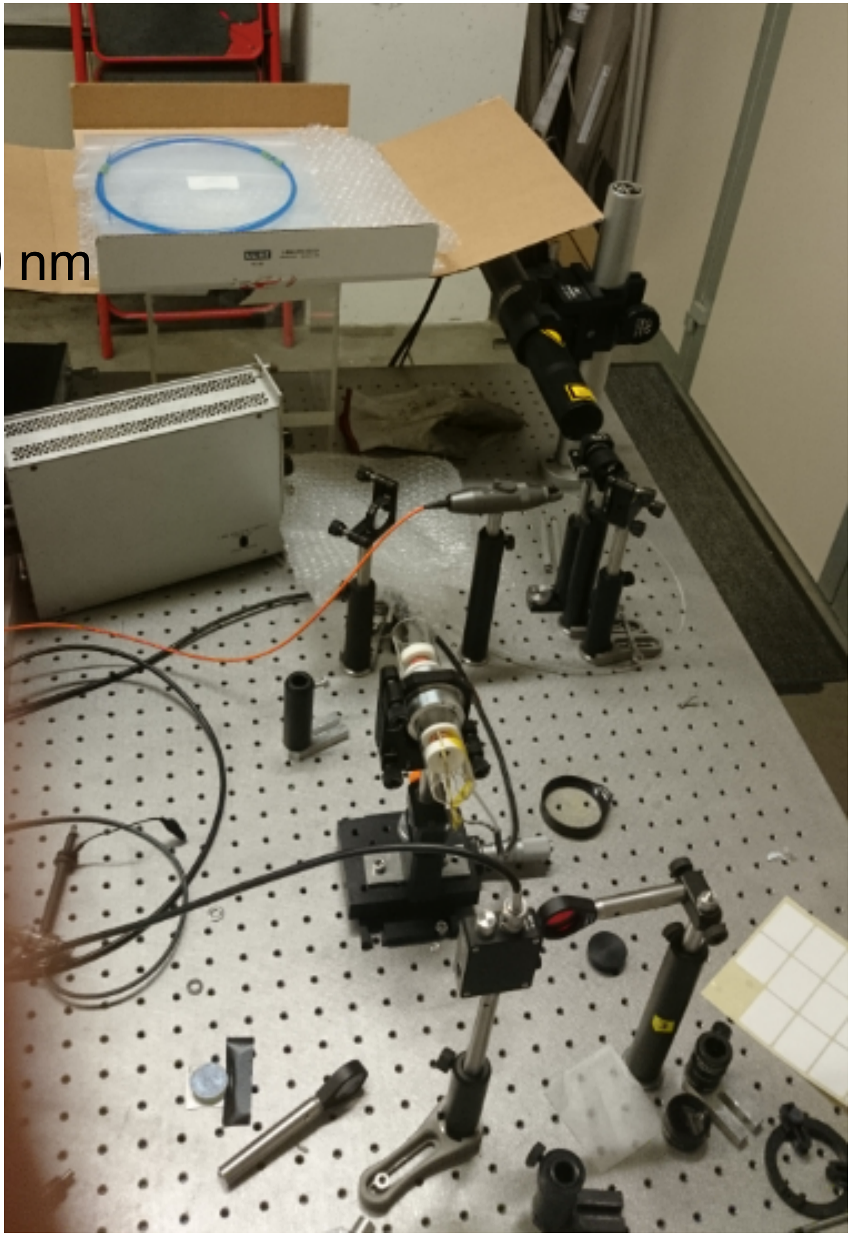


Fabry Perot Wavelenght Reference System

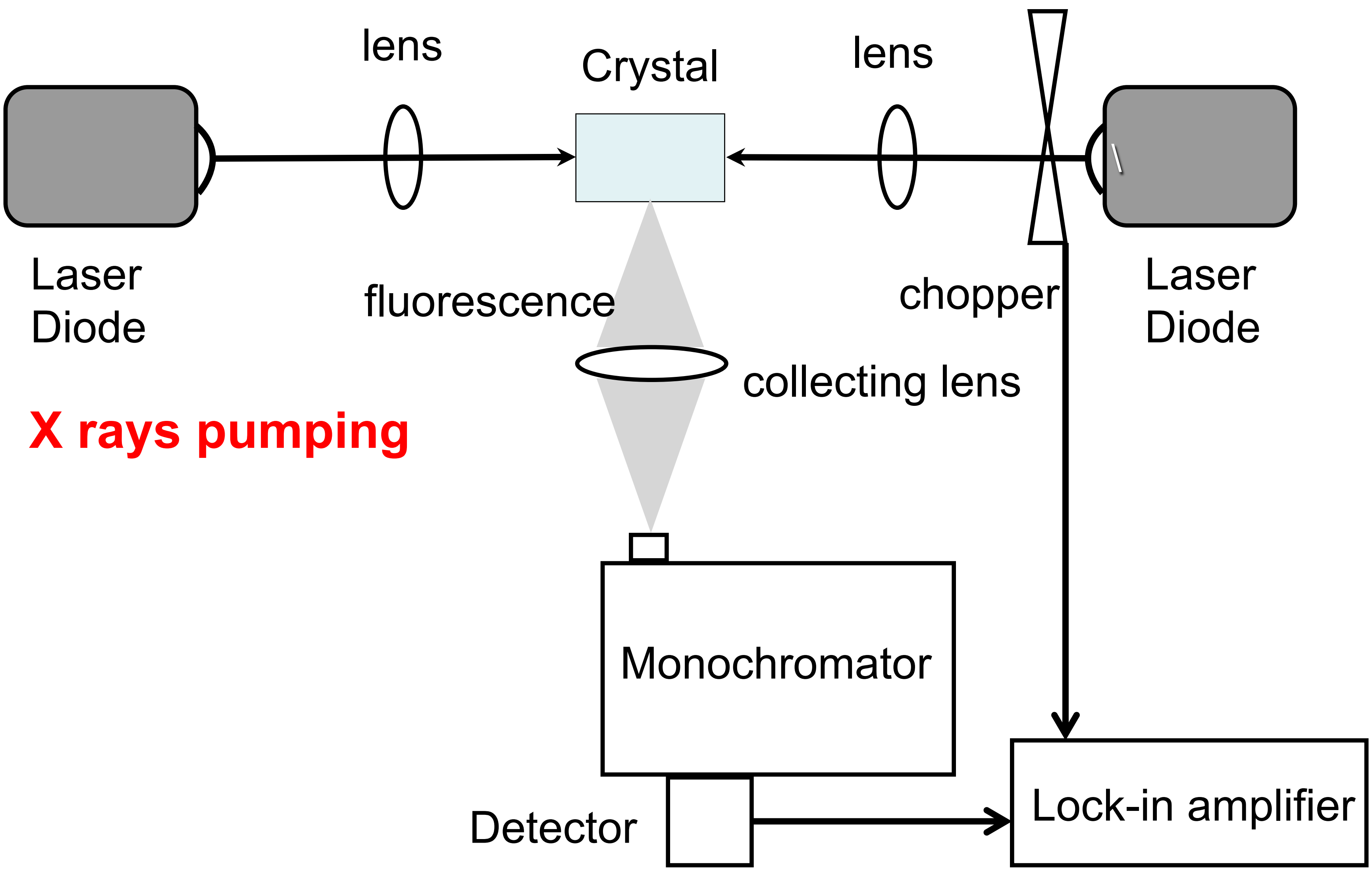
Reference Laser He:Ne P= 1 mW

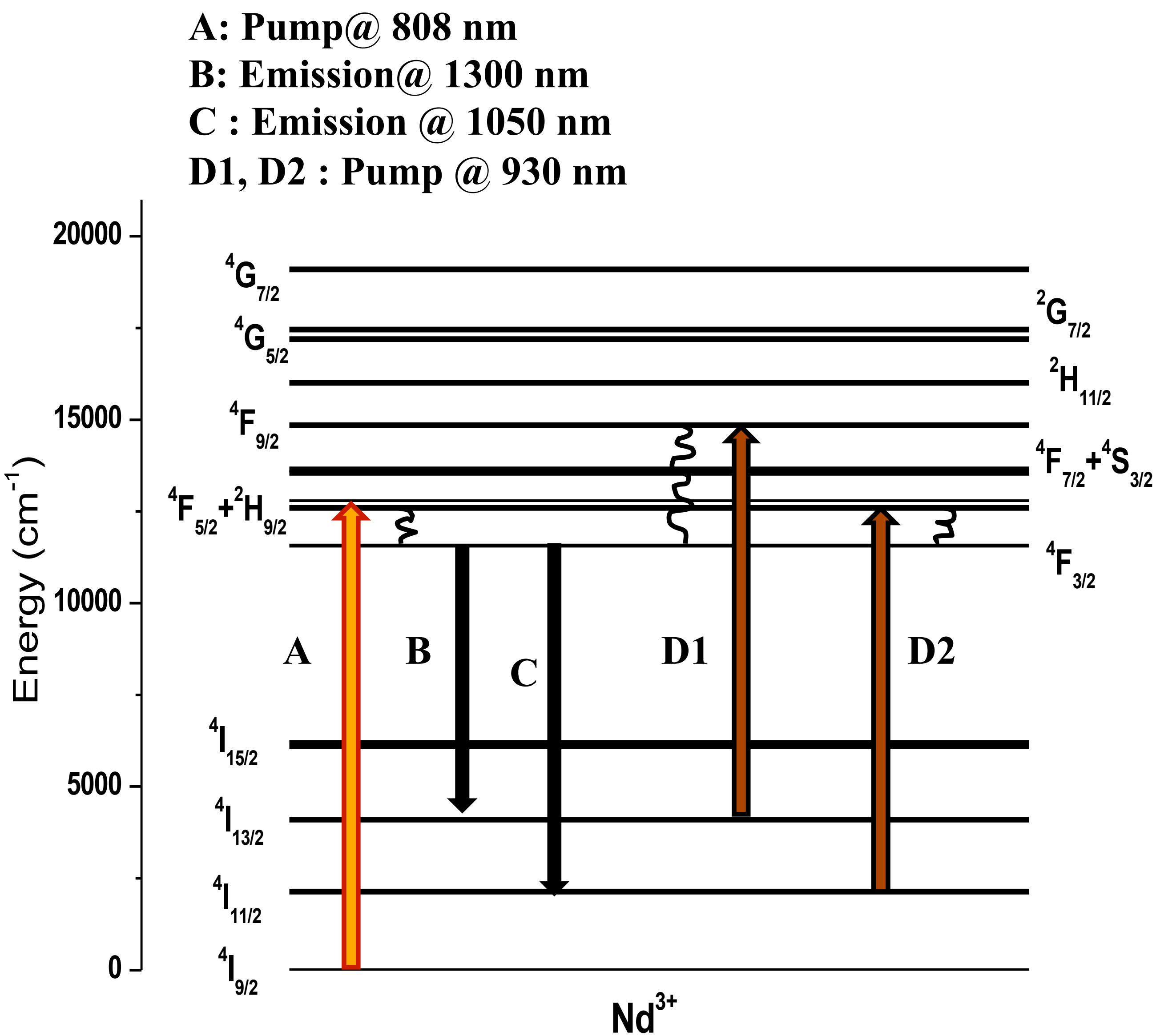
Cavity Wavelenght Acceptance 530 – 870 nm

Wavelenght stabilization @ 632,3.. nm

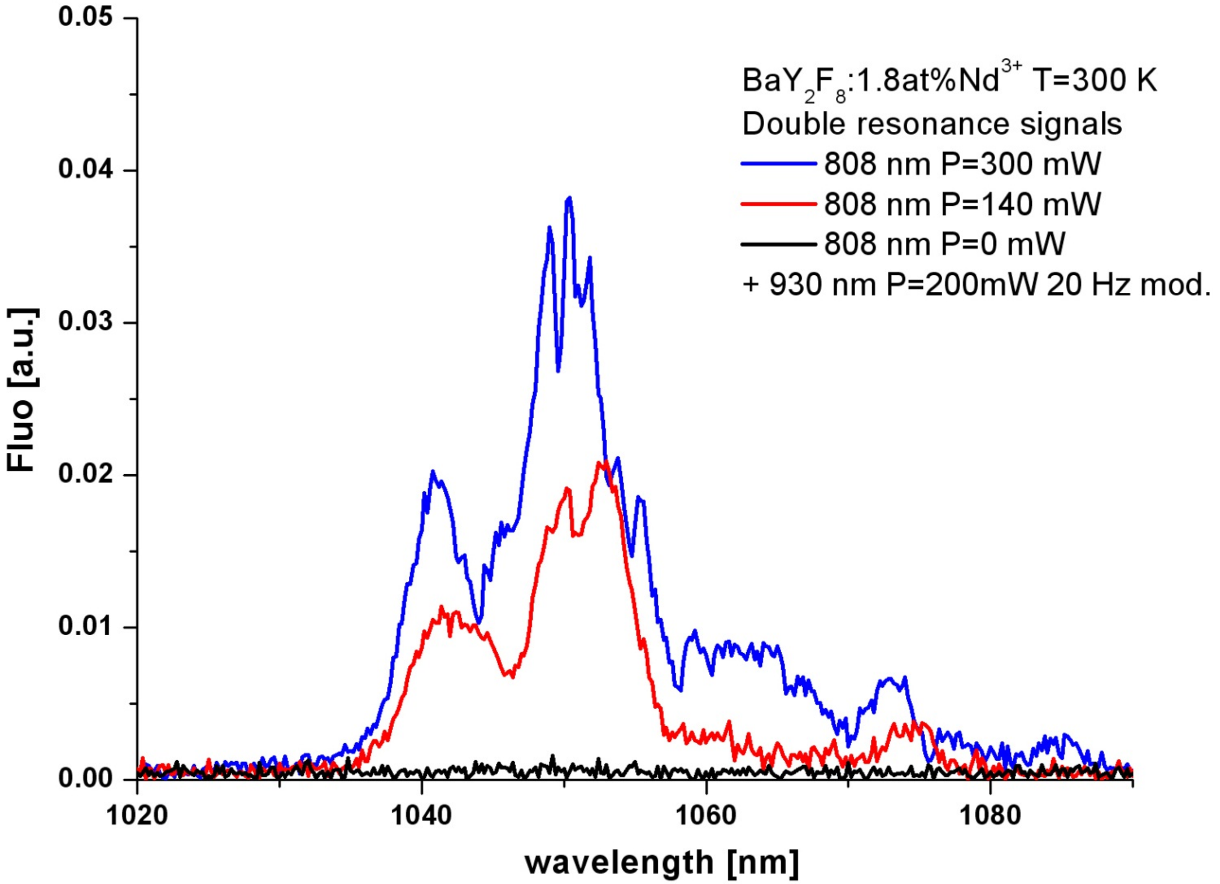


Double resonance experimental apparatus




A: Pump@ 808 nm
B: Emission@ 1300 nm
C : Emission @ 1050 nm
D1, D2 : Pump @ 930 nm
Energy (cm^{-1})
20000
15000
10000
5000
0
$^4G_{7/2}$
$^4G_{5/2}$
$^4F_{9/2}$
$^4F_{5/2}+^2H_{9/2}$
$^4I_{15/2}$
$^4I_{13/2}$
$^4I_{11/2}$
$^4I_{9/2}$
$^2G_{7/2}$
$^2H_{11/2}$
$^4F_{7/2}+^4S_{3/2}$
$^4F_{3/2}$
A
B
C
D1
D2
Nd^{3+}

Double Resonace Spectrum
Pump : $^4I_{11/2}$ ----- $^4F_{3/2}$ (930 nm)
Emission: $^4F_{3/2}$ ---- $^4I_{11/2}$ (1050 nm)



Philips Interests in Gamma Induced Stiumlated Emission for PET

On the possibility of producing a coherent scintillator

V. K. Lyapidevskiĭ and M. I. Ryazanov
Engineering-Physics Institute, Moscow

(Submitted 22 July 1980)
Pis'ma Zh. Eksp. Teor. Fiz. **32**, No. 8, 516–519 (20 October 1980)

It is shown that a coherent scintillator can, in principle, be produced in an external resonance electromagnetic field.

(19) **United States**
(12) **Patent Application Publication**
Szupryczynski et al.

(10) **Pub. No.: US 2013/0032722 A1**
(43) **Pub. Date: Feb. 7, 2013**

(54) **RADIATION DETECTION WITH OPTICAL AMPLIFICATION**

(75) Inventors: **Piotr Szupryczynski**, Knoxville, TN (US); **Matthias J. Schmand**, Lenoir City, TN (US); **Mark S. Andreaco**, Knoxville, TN (US); **James L. Corbell**, Knoxville, TN (US)

(73) Assignee: **SIEMENS MEDICAL SOLUTIONS USA, INC.**, Malvern, PA (US)

(21) Appl. No.: **13/426,667**

(22) Filed: **Mar. 22, 2012**

Related U.S. Application Data

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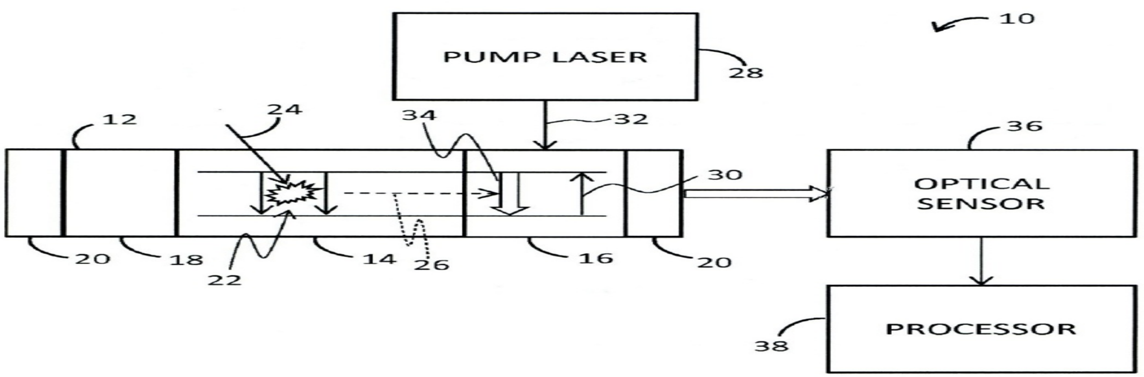
Publication Classification

(51) **Int. Cl.**
G01T 1/205 (2006.01)
G01T 1/20 (2006.01)
G01T 1/204 (2006.01)

(52) **U.S. Cl.** .... **250/366**; 250/487.1; 250/361 R

(57) **ABSTRACT**

A device for detecting ionizing radiation includes a radiation interaction region configured to generate light in response to an interaction with the ionizing radiation, an optical gain medium region in optical communication with the radiation interaction region and configured to amplify the light, and an energy source coupled to the optical gain medium region and configured to maintain a state of population inversion in the optical gain medium region. The optical gain medium region has an emission wavelength that corresponds with a wavelength of the light generated by the radiation interaction region.



Piano Ricerca 3 Anni:

Studio Combinato:

Amplificazione Laser su Cristalli
e Risposta alle Radiazioni Ionizzanti

Attraverso Emissione di Luce di Fluorescenza

Criostato Liquid Helium + Laser Tunabile 1 W + Cristalli + Low Temperature PD

Sezioni : Padova 2,1 FTE, Pisa 1,2 FTE , Cagliari 1,5 FTE

Richieste Finanziarie PD 2015 : 42 Keuro (Criostato ,Laser,Ottica)

Richieste Servizi : 4 MU OM , 4 MU OE

BaY_2F_8: 1.8% Nd^{3+}, Nd population density: 9.5 $\times 10^{21}$ ions/cm^3

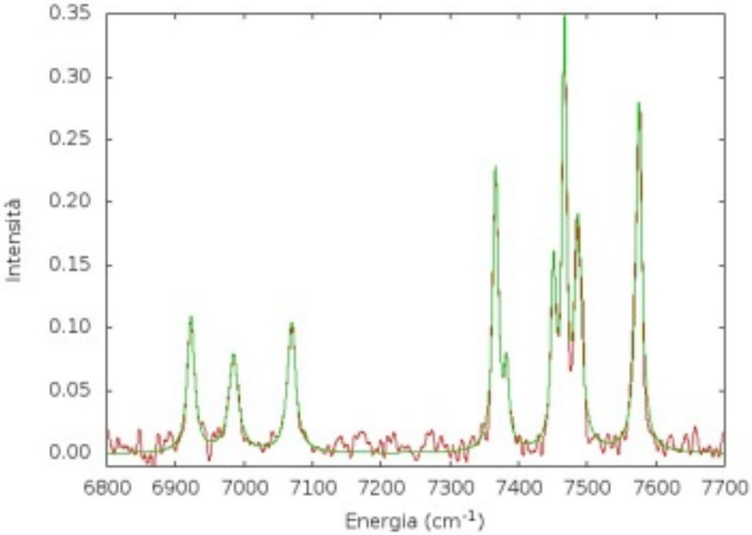
- **Excitated populations**

$^4I_{11/2}$: 10^{18} ions/cm^3
$^4I_{13/2}$: 2×10^{17} ions/cm^3

- **Excitated poulation by DR**

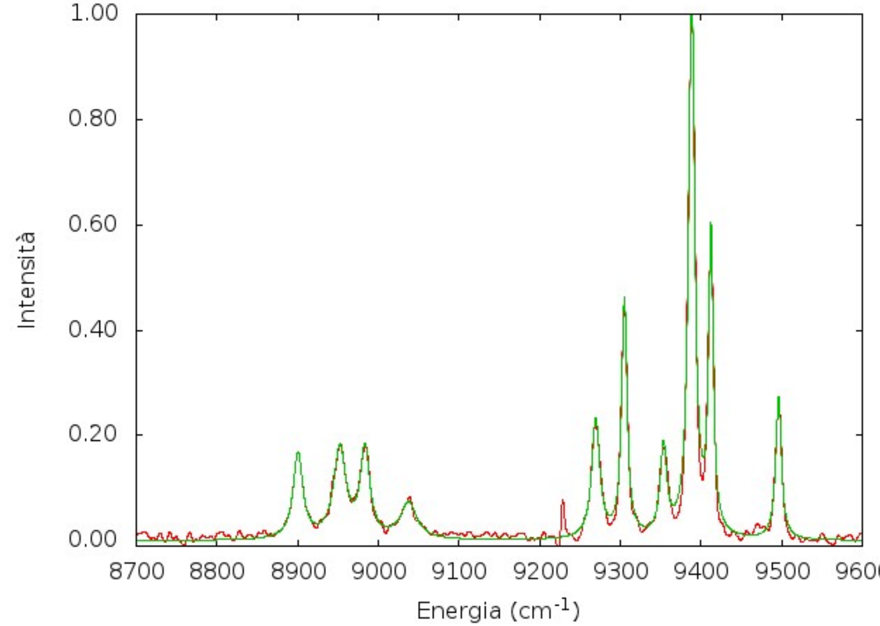
$^4I_{11/2}$ --- $^4F_{5/2}$+$^2H_{9/2}$: 4×10^{15} ions/cm^3
$^4I_{11/2}$---$^4F_{7/2}$: 10^{14} ions/cm^3

$^4F_{3/2}$ -- $^4I_{15/2}$ $^4F_{3/2}$ -- $^4I_{13/2}$



1470 nm 1300 nm

$^4F_{3/2}$ -- $^4I_{11/2}$



1150 nm 1040 nm