

QUANTEP

QUANTum T echnologies E xperimental P latform

NQSTI Spoke 4

NATIONAL Q UANTUM S CIENCE AND T ECHNOLOGY
INSTITUTE

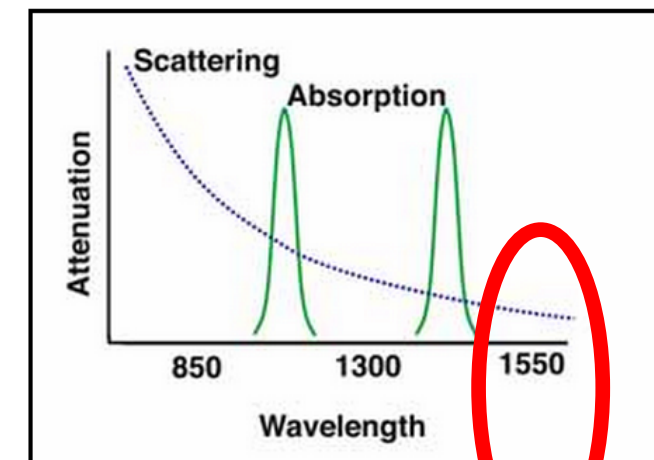
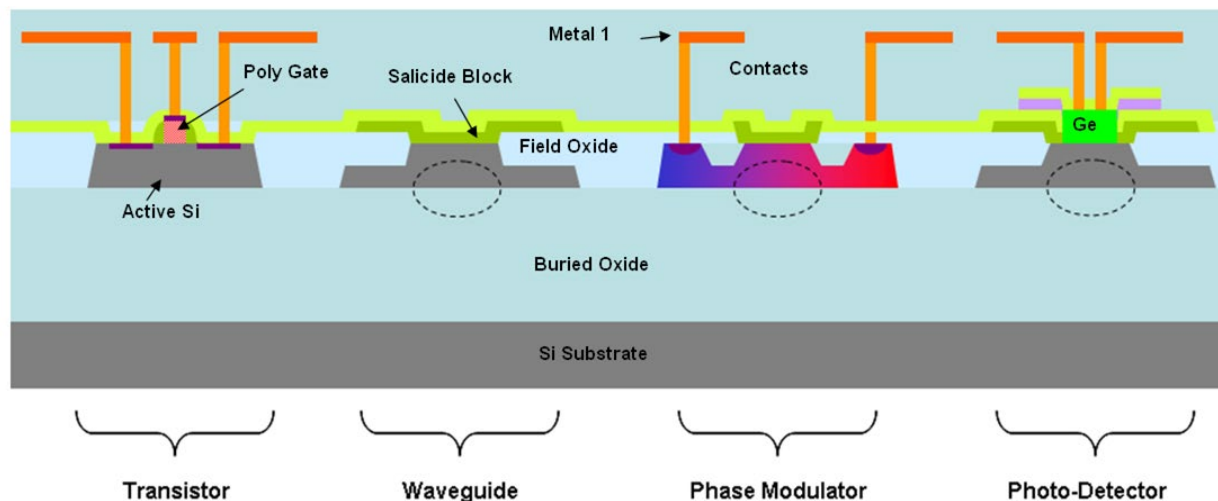
Franco Spinella

Preventivi 2024

QUANTEP

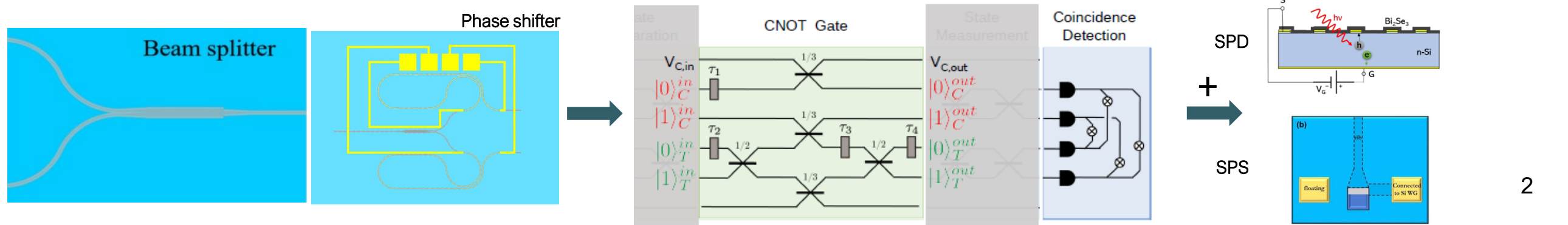
- Call tematica di Gr V 8 Sezioni coinvolte: LNL, MI, PG, PV, RM2, SA, TO. Chiesta l'estensione al quarto anno per completare le attività'.
- **Goal:** Sviluppo di circuiti integrati fotonici operanti in regime di singolo fotone per algoritmi di quantum computing, integrazione su silicio di rivelatori e sorgenti di singolo fotone e di circuiti per il controllo della polarizzazione

Il Silicio è un ottimo materiale per la trasmissione della luce, alto indice di rifrazione (> 3.5) e bassa attenuazione (alle giuste lunghezze d'onda)



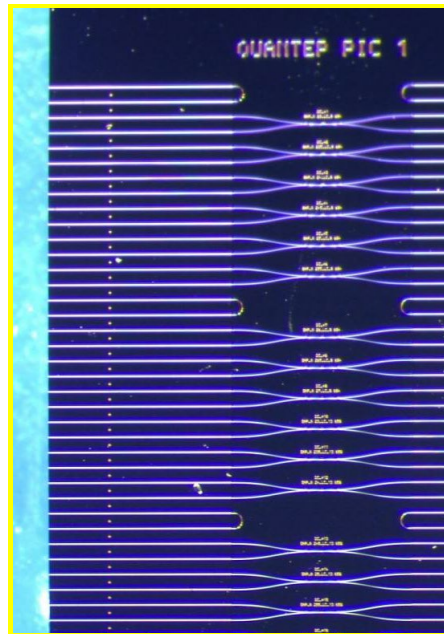
$\lambda = 1550$ nm
standard
telcom.

- Si possono realizzare strutture ottiche lineari con le stesse tecniche degli IC CMOS, possibilità di integrare sorgenti di singolo fotone e fotorivelatori tramite impiantazione

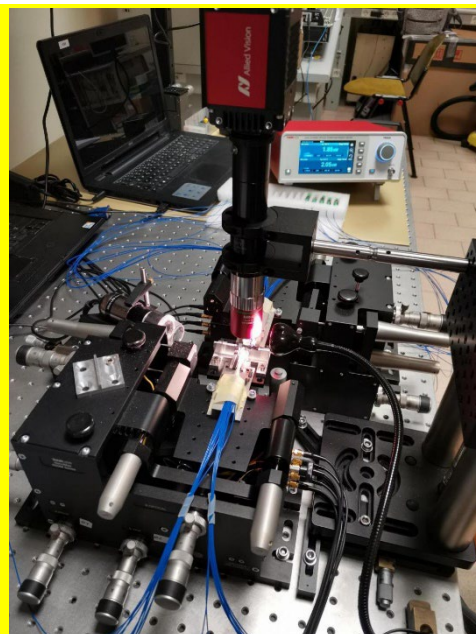


Attività 2022-2023-2024

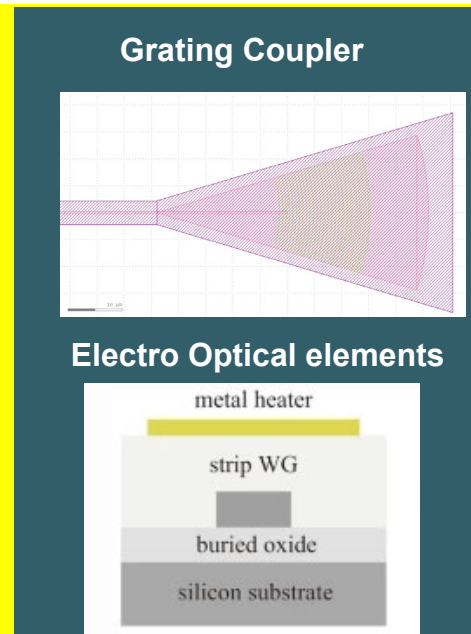
1° prototipo consegnato 08/2022 (MTU – Irlanda)



1° chip



Test Roma2

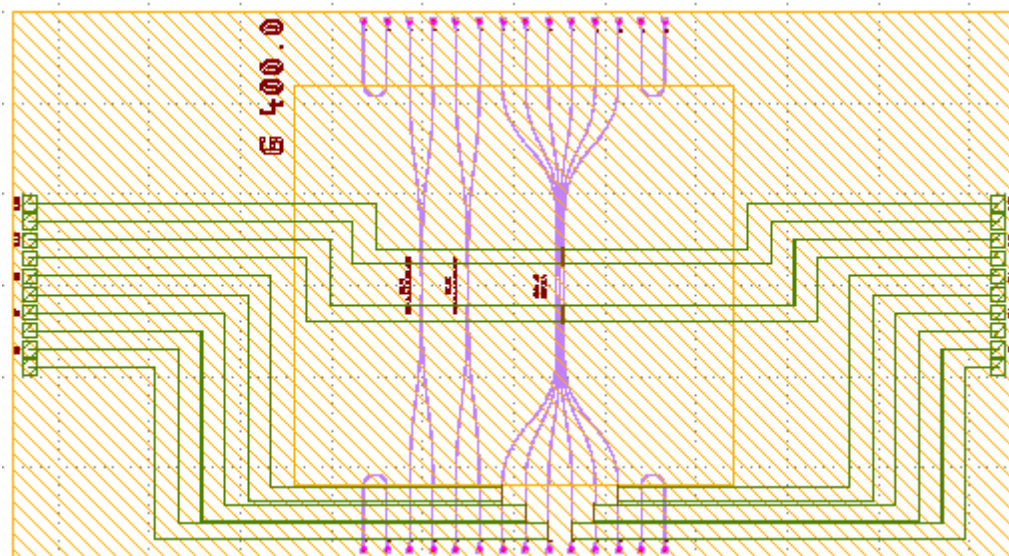


Progetto 2° chip

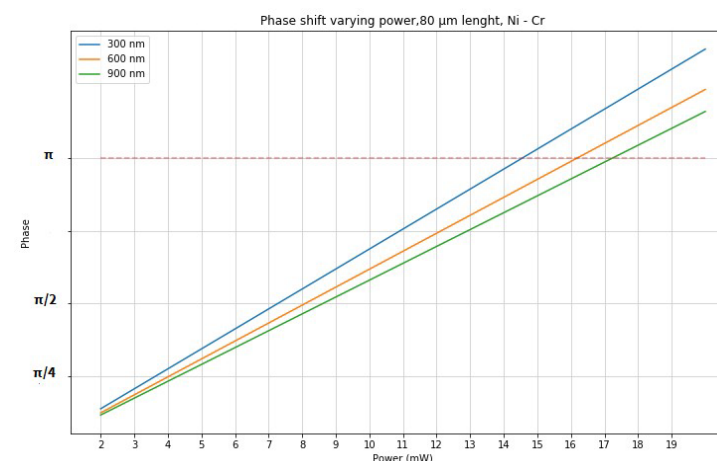


Foundry (IBM)

+ Test
2024



2° chip



Thermal Phase Shifter sim. (Pisa)

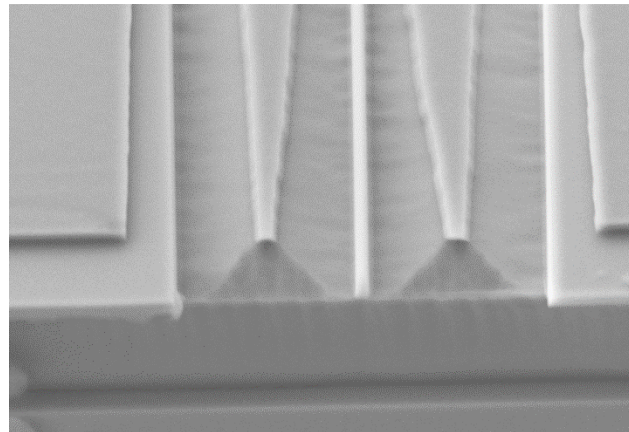
Attività svolta 2022-2023:

- Test in laboratorio chip in regime ottico
- Misure SEM del 1st chip
- Progettazione di nuove strutture passive più performanti:
Grating coupler
- Integrazione di strutture attive:
Thermal Phase shifter, electro optical elements
- Flow for 2nd and 3rd chip

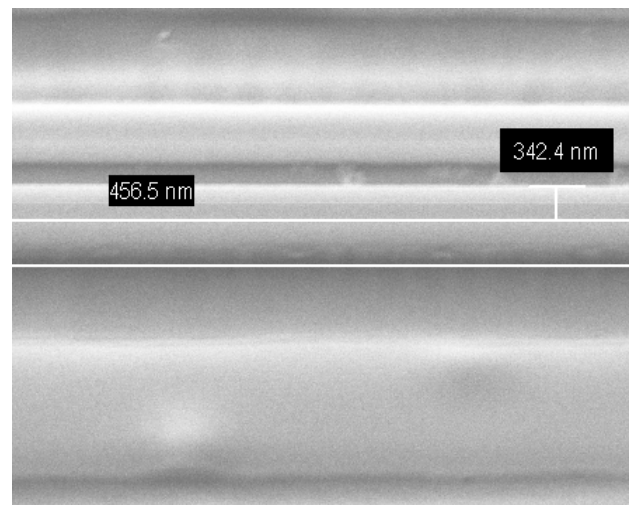
Attività svolte a Pisa con le strumentazioni CISUP

Obiettivo: Replica 1° chip con ZEISS CROSSBEAM 550 e AFM (CISUP Pisa)

Misure 1° chip SEM



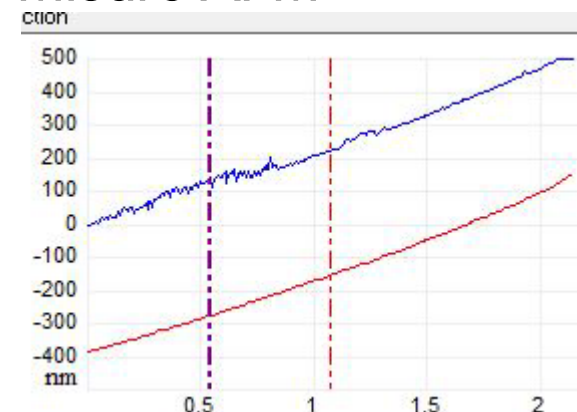
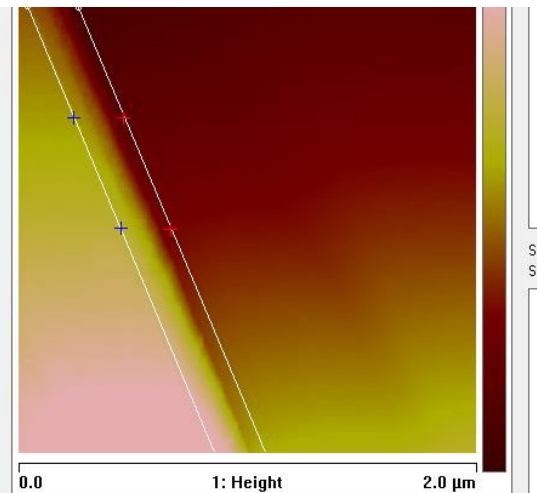
*Bordo chip
accoppiamento edge*



Dettaglio per misure C-Not.

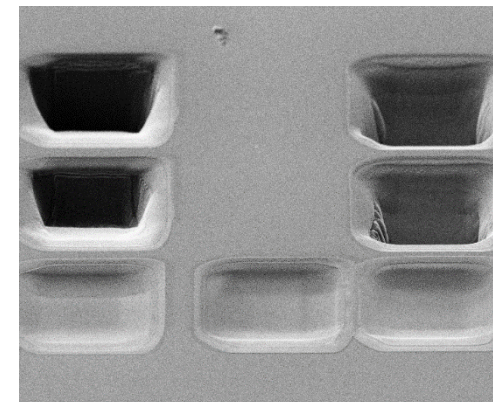
*Profilo waveguide e
larghezza di GAP*

Misure AFM



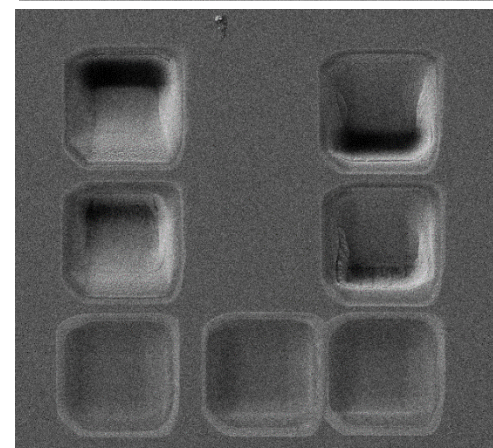
*Profondità
e profilo di
superficie*

Lavorazioni preliminari con FIB



*Vista
canale
secondario
ang = 54°*

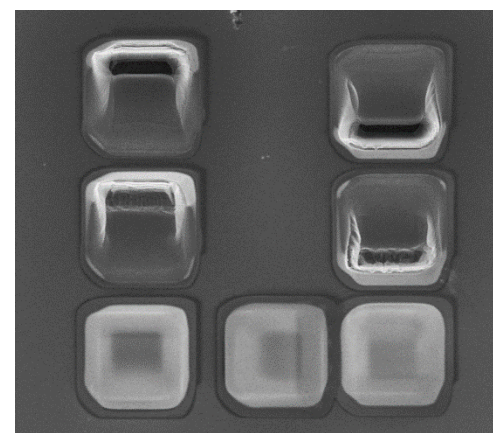
*Current
adjustment*



*Vista
canale
secondario
ang = 0°*

*Solchi quadrati
10 μm x 10
μm.*

*Differenti
correnti per
differenti
profondità*

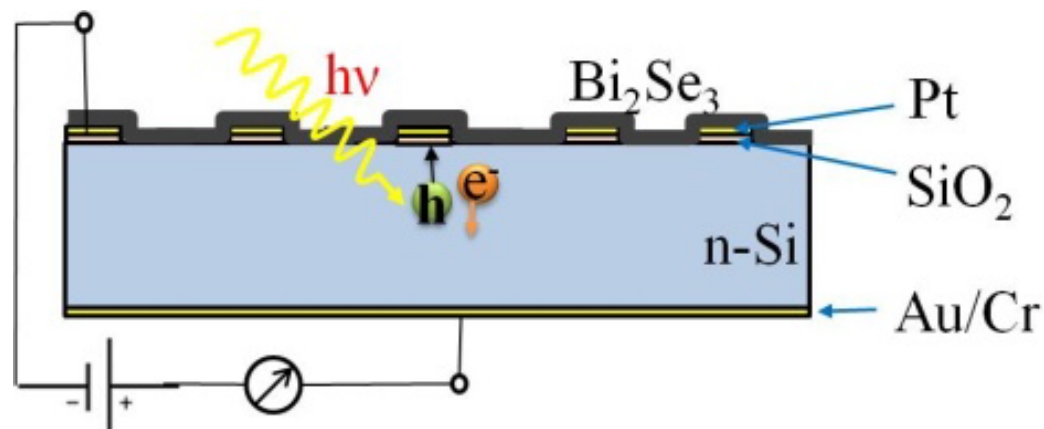


*Vista
INLens*

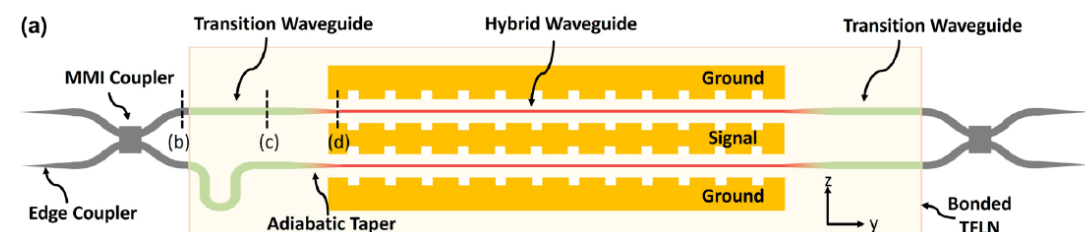
Attività 2023-2024: NQSTI Spoke 4

- PNRR: siamo stati finanziati nell'ambito del Partenariato esteso Scienze e Tecnologie Quantistiche (NQSTI) spoke 4 per lo sviluppo di dispositivi fotonici su silicio
- Finanziamento a Pisa: 180K inventariabile, 22k consumi, 60K assegno intermedio biennale (F. Spinella resp. attivita' 4.8.3)
- Sinergico con QUANTEP

Sviluppare rivelatori a singolo fotone attraverso nanowires di Bi_2Se_3 per applicazioni su QKD (protocollo BB84)



Sviluppare un modulatore elettro-ottico su silicio, attraverso directional coupler (FIB e drogaggi a Dip. Ingegneria)



Acquisti PNRR 2024

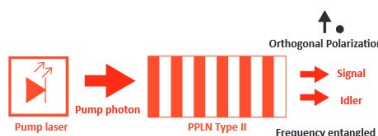
Banco per test e misure su chip ottici in regime single photon

- Sorgente di singolo fotone
- Rivelatore di singolo fotone
- Manipolatori a 6 assi

TPS_1550_TYPE_II

Quantum photon source

Self-contained entangled photon source
[Telecom wavelength - 1550 nm]



BROADBAND POLARIZATION-ENTANGLED PHOTON SOURCE

Features

- High-quality polarization and frequency entanglement
- Broad bandwidth covering C- and L- bands
- High fidelity and excellent stability
- Turn-key and room-temperature operation
- Low power consumption
- Compact and light weight platform
- Rugged, alignment free, all fiber design
- Built-in Optical switch and WDM

Applications

- Quantum imaging
- Quantum metrology
- Quantum key distribution networks
- Quantum computing and information processing

Product Description

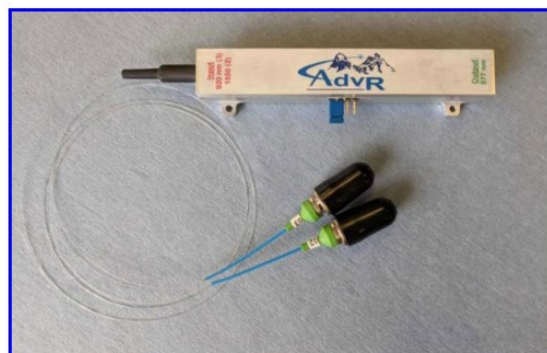


TEM-F-1550/1~30mW (TEM₀₀)



INFRARED DIODE LASER AT 1550nm

It features TEM₀₀ mode, ultra compact design, long lifetime, cost-effectiveness and easy operation. They are used in measurement, communication, spectrum analysis, etc



"Self-contained" Time-Correlated Single Photon Counting TCSPC module



The LYNXEA_NIR is the next generation of high-performance and self-contained time-correlated single Photon Counting module in the 900nm -1700nm range. Engineered with "high performance, and ease-of-use" innovative mindset, the SPD_A includes the world's most advanced Geiger-mode avalanche photodiode (Geiger-APD) technologies, integrated cooling systems, Time-to-Digital, the latest fast data processing and the most intuitive and practical user interfaces.

With its disruptive architecture and its outstanding detection and timing performances, the LYNXEA is the essential analytical tool for your time resolved, time correlation and antibunching measurements.

- Anagrafica

- | | | |
|---------------------------|--------------|---|
| - G. Magazzu | 20% | |
| - F. Spinella | 25% | Resp. Loc. + Spoke 4 (massa critica PNRR 25%) |
| - S. Donati | 10% | |
| - E. Pedreschi | 25% | Resp. Loc. Spoke 6 (massa critica PNRR 25%) |
| - A. Toncelli | 20% | |
| - L. Morescalchi | 10% | |
| - F. Morsani | 5% | |
| - Francesco Amanti | 100 % | Ass. ricerca progetto PEPE (sinergico) |
| - S. Saponara | 0% | (part. esterna) |
-
- The diagram illustrates synergistic relationships between project components. The word "sinergico" is written in purple. Two arrows originate from it: one points to the entry for F. Spinella (25% Resp. Loc. + Spoke 4) and the other points to the entry for E. Pedreschi (25% Resp. Loc. Spoke 6).

Richieste alla Sezione e budget

Budget QUANTEP: consumi & missioni (non molto essendo il 4° anno)

Richieste alla Sezione:

- Spazio in camera pulita per un setup di test per chip fotonici (sorgenti/rivelatori/manipolatori/microscopio IR)
- Nessuna richiesta sui servizi