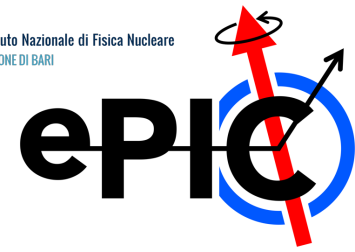


# Incontro ePIC Italia con referee INFN

Bologna, 16 Luglio 2024



Istituto Nazionale di Fisica Nucleare  
SEZIONE DI BARI



## ePIC Silicon Vertex Tracker (SVT)

- intro and references
- recent activity and plans for 2025
- financial requests

Domenico Elia

for the SVT INFN groups (BA, PD, PV and TS)

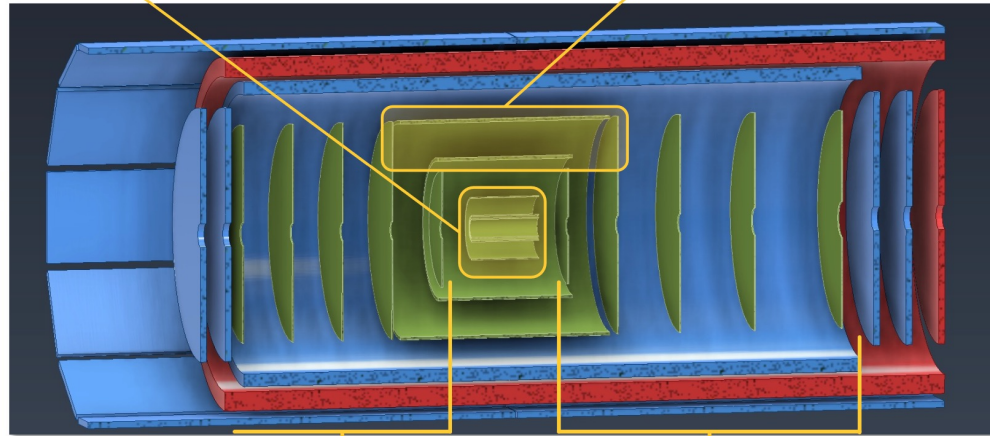
# ePIC SVT project and INFN

Inner barrel (IB)

INFN, LBNL, MIT

UK groups

Outer barrel (OB)



LANL, LBNL+UCB, Purdue

Electron and Hadron Endcap disks  
(EE, HE)

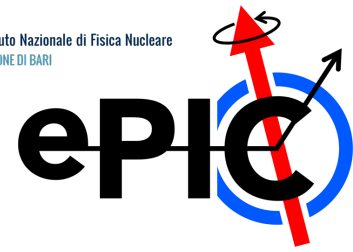
**SVT DSC organization, project timeline, INFN plans for in-kind:**

- SVT presentation @ meeting with referee on June 10: <https://agenda.infn.it/event/42132/>

**INFN group activity in 2023:**

- SVT sections in consuntivi: <https://cernbox.cern.ch/index.php/s/V326gINrfPtMU1t>

# INFN involvement in SVT



## Participation and main interests:

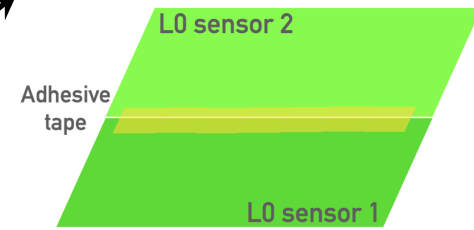
- currently involved groups: BA, PD, PV and TS
- interest focused on the IB (overlap/synergies with ALICE ITS3)
- sharing of the responsibilities within the INFN groups:
  - ✓ **BA**: leading IB project, main assembly centre of the two innermost layers L0-L1
  - ✓ **PD**: development and production of the global SVT IB mechanics and backup assembly/production centre for the two innermost layers
  - ✓ **PV**: test of the special gluing of the sensors with support structure (climatic chamber), development of dedicated transport boxes and shipping/handling to BNL
  - ✓ **TS**: qualification, test and production of the SVT IB FPCs
- recent activity (2024) oriented accordingly
- corresponding financial requests close to multi-year anticipated plan (next slides)

# Recent activity & plans @INFN

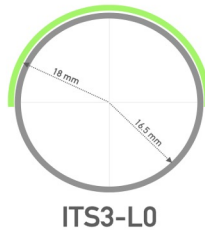
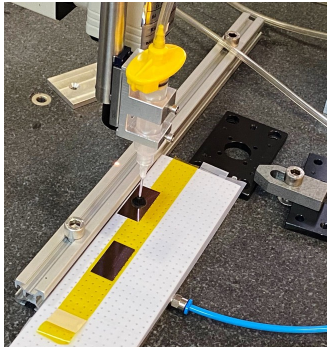
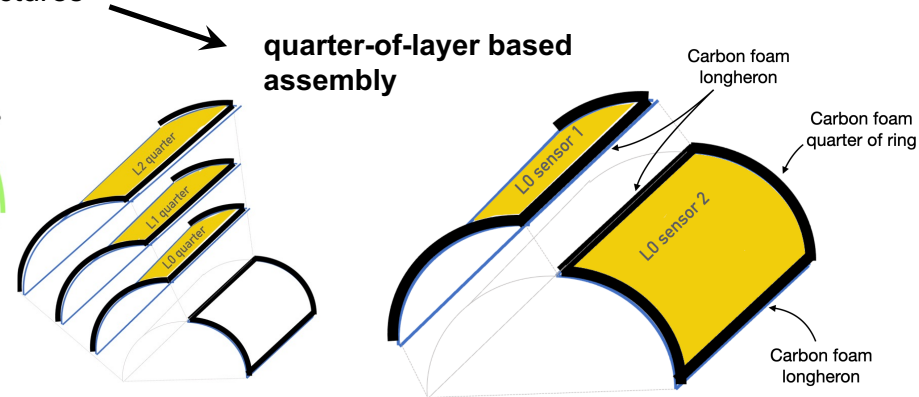
## BARI:

- Design, prototyping and construction of SVT L0-L1 barrel:
  - ✓ exploiting experience with bending and interconnection for ITS3
  - ✓ investigating two possible bending/assembly strategies:
    - ✓ **2-sensor bending**: try to “connect” the two sensors with kapton tape and bend them as a single object
    - ✓ **independent bending**: bend each of the two sensors separately and glue them on independent support structures

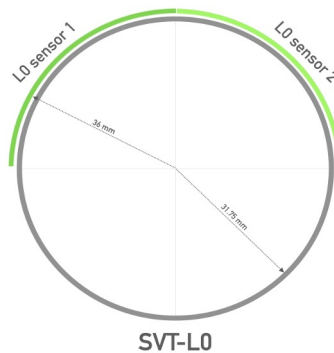
half-layer based assembly (a la ITS3)



quarter-of-layer based assembly



ITS3-L0



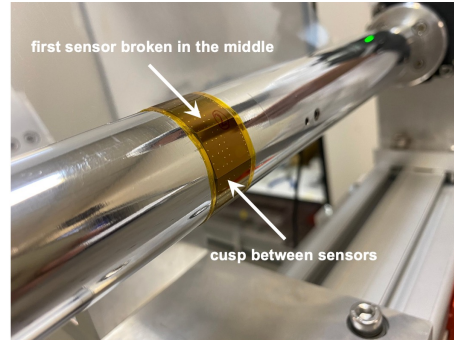
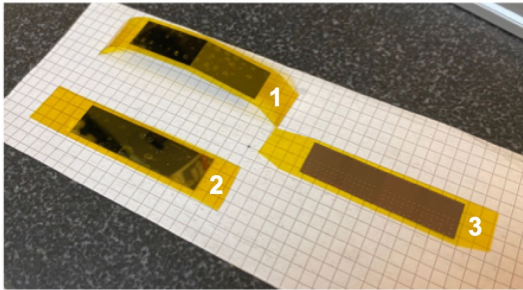
SVT-L0

# Recent activity & plans @INFN

## BARI:

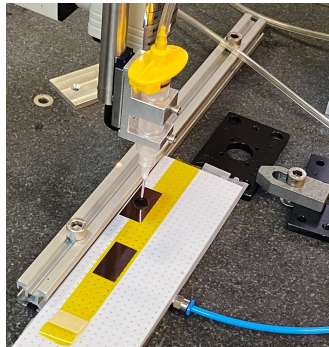
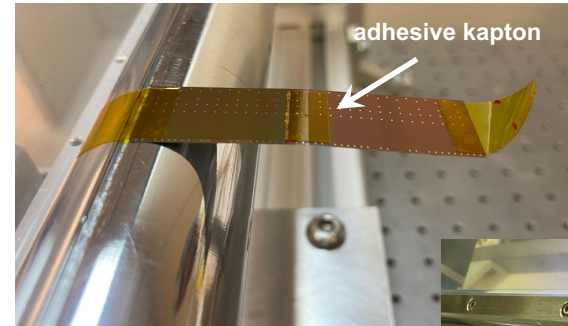
- Design, prototyping and construction of SVT L0-L1 barrel:

### Tape connection



### Test with ALPIDE sensors 50 $\mu\text{m}$ thick

- sensors connected with 12  $\mu\text{m}$  thick narrow kapton tape  
→ quite promising but still not finalized to work, ongoing



### Three different samples (ALPIDE 100 $\mu\text{m}$ thick):

#### S1:

- encapsulated sensors
- top kapton positioning by hand

#### S2:

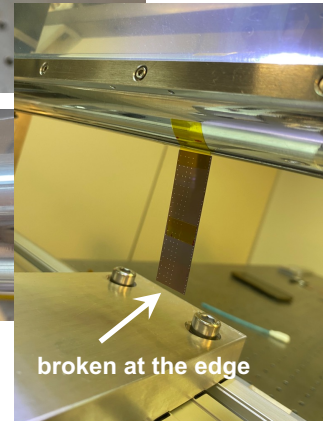
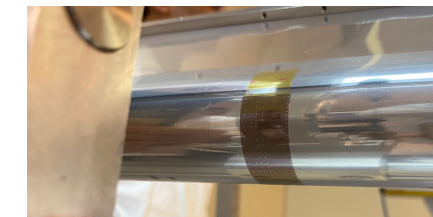
- encapsulated sensors
- top kapton by dedicated tool

#### S3:

- single kapton layer (kapton on one side of the sensors only)

### Embedding

- not working, likely due to large sensor thickness
- embedding would need quite some dedicated R&D

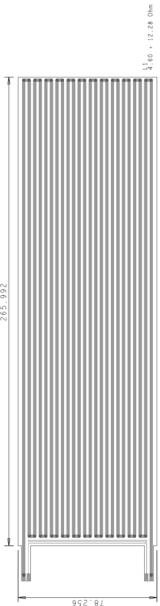
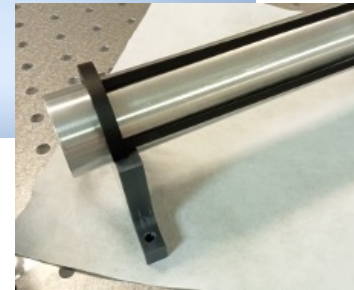
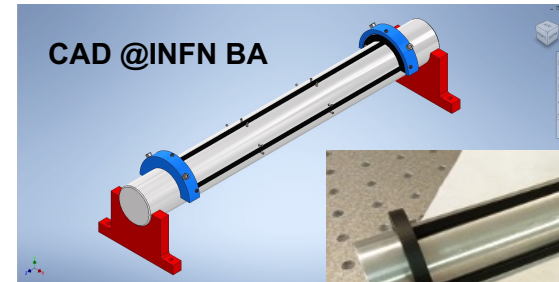
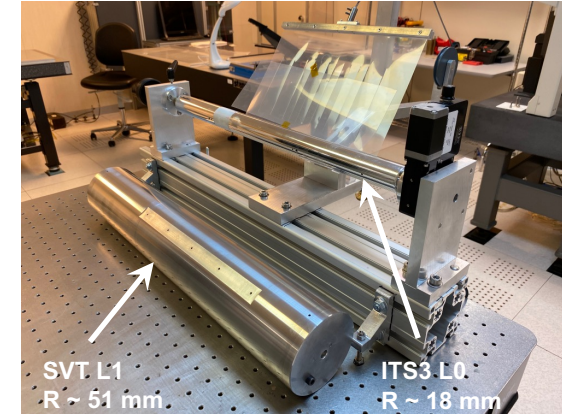




# Recent activity & plans @INFN

## BARI:

- Design, prototyping and construction of SVT L0-L1 barrel:
  - ✓ preliminary SVT-dedicated setup assembled:
    - all components available by procurements or local production
    - including first “home-made” mandrel for L1 ( $R \sim 51$  mm)
    - external contact for high-quality mandrels already in place
  - ✓ first ideas on local support structure being developed:
    - based on the assumption of 2-sensor bending works
  - ✓ **prototype campaign planned for the coming months:**
    - will proceed soon with dummy silicon ordered to DISCO
    - blank silicon with L0 and L1 size arriving by end July
    - a number of pieces going to be shipped to CERN:
      - to be kapton-embedded with dedicated heaters
      - will allow first assembly/test of thermo-mechanical prototypes



# Requests for 2025

M1: Realizzazione prototipo termo-meccanico half-barrel per strati interni (L0-L1) SVT IB

## BARI:

- **Consumo / Sensor bending setup:**
  - ✓ 1 Motorino (spare) per rotazione controllata e automatica piegamento sensore 3.5 k€
  - ✓ 2 Mandrini per piegamento sensori a raggi L0-L1 SVT 4.0
  - ✓ Sviluppo e produzione jig per movimentazione/allineamento sensori per test bending/wirebond. 3.0
- **Consumo / Material for assembly test and prototyping:**
  - ✓ 10 wafer, in parte con pad (test wirebonding) e con heaters (studi cooling) incl. taglio/assott. 20.0
  - ✓ Strutture in schiuma di carbonio (Allcomp k9 standard density o ERG Duocell) 5.0
  - ✓ Stampe 3D strutture di supporti meccanici per costruzione prototipi L0-L1 SVT 1.0
- **Trasporto / Material and tools for assembly to PD:**
  - ✓ Trasporto materiali per assemblaggio prototipi verso PD 2.0
- **Missioni / SVT dedicated only:**
  - ✓ Partecipazione riunione DSC SVT (USA): 7gg x 1 persona 2.5 (sj)
  - ✓ Contatti ITS3 per sviluppi dedicati SVT (CERN): 5gg x 4 persone 4.0
  - ✓ Contatti tra sedi INFN per sviluppi dedicati SVT e dRICH: 2 viaggi x 3 persone 3.0

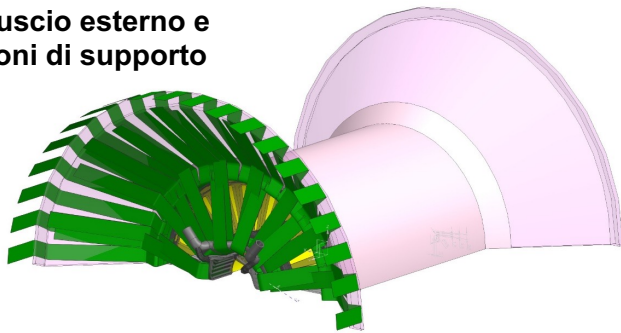
# Recent activity & plans @INFN

## PADOVA:

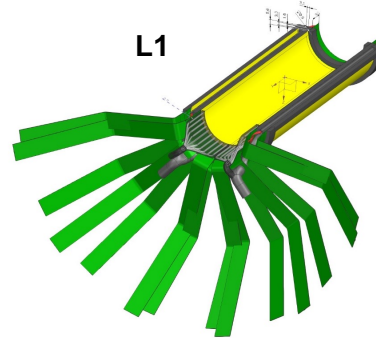
See more in **Rosario's** presentation

- Costruzione meccanica globale SVT:
  - ✓ responsabilità disegno e realizzazione meccanica globale Inner Barrel SVT:
    - realizzazione mock-up necessari alla qualificazione della procedura di integrazione sensori e servizi
    - realizzazione prototipo/i supporto finale
  - ✓ In fase di indagine:
    - studio vibrazioni indotte da flusso aria per raffreddamento sensori con utilizzo galleria del vento (dotazione UniPD?) e sensori confocali cromatici per rilevamento posizione con risoluzione (sub)micrometrica

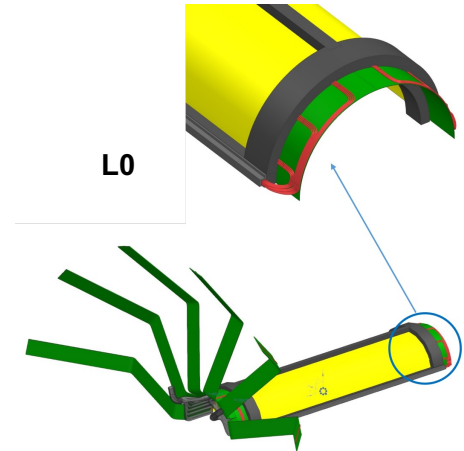
guscio esterno e  
coni di supporto



CAD design  
by M. Turcato



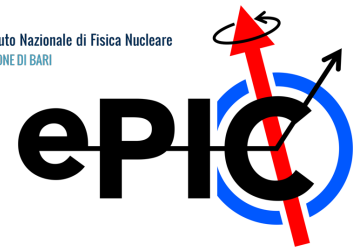
L1



L0



# Recent activity & plans @INFN



## PADOVA:

See more in **Rosario's** presentation

- Costruzione meccanica globale SVT
- Secondo punto di produzione layer interni L0-L1 di SVT:
  - ✓ possibilità di produzione tooling per piegamento sensori MAPS
    - mandrini prodotti in OM INFN-PD
    - lavorazione superficie per rugosità  $<0.1$  ai LNL (plasma) o ditta esterna (rettifica e doratura), da verificare la qualità e convenienza dei due processi
  - ✓ processo completo (piegamento, wire-bonding FPC, posa/incollaggio supporto, etc.) dipende da disponibilità macchina wire-bonder (gli FPC devono essere fissati prima di rimuovere il sensore dal mandrino):
    - la particolare operazione (bonding su superficie curva), le dimensioni del supporto e la procedura di fissaggio FPC e fissaggio su supporto definitivo pongono condizioni sul tipo di macchina bondatrice (bore, manovrabilità testa, non necessariamente automatica)
    - market survey in corso
    - contatti per coinvolgimento altri progetti interessati per acquisto condiviso con limitato contributo INFN

# Requests for 2025

## PADOVA:

M1: Realizzazione prototipo termo-meccanico half-barrel per strati interni (L0-L1) SVT IB

M2: Realizzazione prototipo e simulazioni termo-meccaniche struttura di supporto globale SVT IB

- **Consumo / Sensor bending setup:**
  - ✓ 1 Motorino per rotazione controllata e automatica piegamento sensore 3.5 k€
  - ✓ 2 Mandrini per piegamento sensori a raggi L0-L1 SVT + lavorazione/test rugosità < 0.2 3.0
  - ✓ Sviluppo e produzione jig per movimentazione/allineamento sensori per test bending/wirebond. 3.0
- **Consumo / Material for assembly test and prototyping:**
  - ✓ Materiale e lavorazioni per assemblaggio mock-up meccanica di supporto IB 5.0
- **Trasporto / Material and tools for assembly to BA and MIT:**
  - ✓ Trasporto prototipi supporto globale verso Bari e verso MIT 3.0
- **Inventario / Contributo wirebonder:** 20.0 (sj)
- **Missioni / SVT dedicated only:**
  - ✓ Partecipazione riunione DSC SVT (USA): 7gg x 1 persona 2.5 (sj)
  - ✓ Contatti ITS3 per sviluppi dedicati SVT (CERN) 1.5
  - ✓ Training e messa a punto procedure attività in condivisione PD/BA/TS/PV (2pp x 3gg x 2) 2.0

# Recent activity & plans @INFN

## PAVIA:

- Testing in climatic chamber Galli Genviro-030LC:
  - ✓ used in the past for ageing tests of ALPIDE chips assemblies for ALICE ITS2
  - ✓ plan to use it for checking possible deterioration of the SVT inner layer assemblies (including prototypes) in conditions of controlled/high temperature and/or humidity



|                           |                     |
|---------------------------|---------------------|
| inner volume              | 30 liters           |
| inner dimensions          | 330 x 280 x 330     |
| temperature range         | -70 °C ÷ +180 °C    |
| humidity range            | 10% ÷ 98%           |
| temperature precision     | ± 0.1 °C ÷ ± 0.3 °C |
| temperature uniformity    | ± 0.5 °C ÷ ± 1.5 °C |
| humidity precision        | ± 1 ÷ ± 3 %         |
| temperature gradient      | ± 3 °C/min          |
| internal heat dissipation | 100 W               |
| power                     | 1.4 ÷ 2.4 kW        |

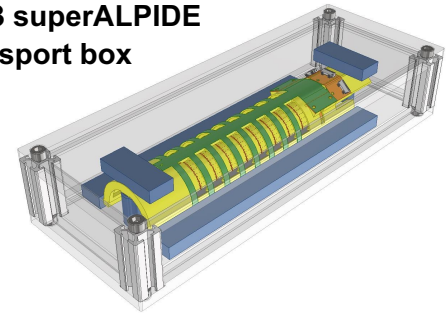
# Recent activity & plans @INFN

## PAVIA:

- Testing in climatic chamber Galli Genviro-030LC:
- Design and production of transportation boxes:
  - ✓ to be used for transport of SVT inner layer assembly prototypes in Italy and final detector assemblies in US → different prototypes will be needed along the various phases
  - ✓ two options currently under discussion:
    - plexiglass box where detectors are kept still by foam sponge
    - box similar to that for ALICE ITS2 OB staves, smaller in size



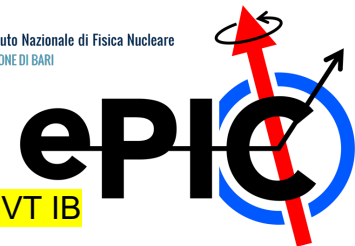
ITS3 superALPIDE transport box



ITS2 OB stave transport box:

- wire ropes recommended to achieve about 10 Hz cut-off frequency
- arbitrary low acceleration can be achieved at the cost of space: about linear in average acceleration

# Requests for 2025



## PAVIA:

M1: Realizzazione prototipo termo-meccanico half-barrel per strati interni (L0-L1) SVT IB

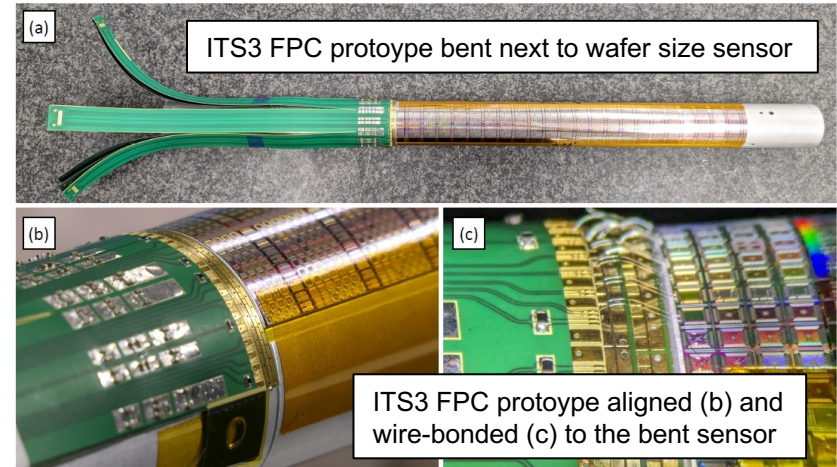
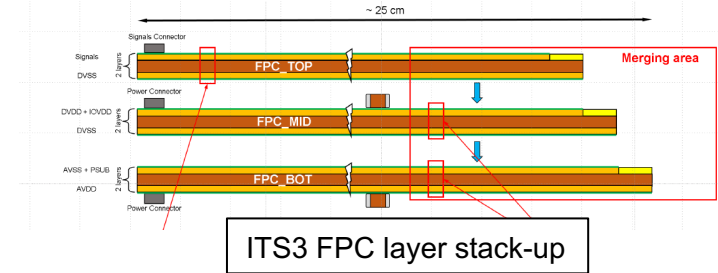
- Consumo / Transport box design and prototyping:
  - ✓ Scatole trasporto prototipi L0-L1 SVT 3.0 k€
- Trasporto / Material to BA:
  - ✓ Trasporto scatole per prototipi L0-L1 SVT verso Bari 2.0
- Missioni / SVT dedicated only:
  - ✓ Partecipazione riunione DSC SVT (USA): 7gg x 1 persona 2.5 (sj)
  - ✓ Contatti ITS3 per sviluppi dedicati SVT (CERN): 5gg x 2 persone 2.0
  - ✓ Contatti tra sedi INFN per sviluppi dedicati SVT: 2 viaggi x 2 persone 2.0

# Recent activity & plans @INFN

ITS TDR: [CERN-LHCC-2024-003](#)

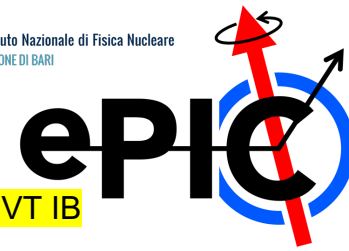
## TRIESTE:

- Activity on SVT IB FPC:
  - ✓ collaboration with Daresbury LAB and SVT WGs for FPC design adaptation from ITS3 version to the SVT constraints and characteristics
  - ✓ SVT FPC prototyping and qualification tests
  - ✓ production quality control
- Existing expertise from ITS2 OB FPCs:
  - ✓ definition of production specifications
  - ✓ vendor search and production tendering
  - ✓ qualification tests
  - ✓ final integration with power bus
  - ✓ vendor search and quality assurance





# Requests for 2025



## TRIESTE:

M1: Realizzazione prototipo termo-meccanico half-barrel per strati interni (L0-L1) SVT IB

- Consumo / FPC prototyping and qualification:
  - ✓ Sviluppo e produzione scheda di contattazione e test circuito stampato flessibile (FPC) 5.0 k€
  - ✓ Prototipazione FPC 6.0
  - ✓ 2 supporti meccanici (simil-mandrini) a raggi L0-L1 e tool assemblaggio meccanico FPC 2.0
  - ✓ Strutture in schiuma di carbonio (incl. lavorazione) per assemblaggio FPC con dummy layer 1.0
  - ✓ Sviluppo e produzione jig meccanici per movimentazione e prove wire-bonding FPC 1.0
- Missioni / SVT dedicated only:
  - ✓ Partecipazione riunione DSC SVT (USA): 7gg x 1 persona 2.5 (sj)
  - ✓ Contatti ITS3 per sviluppi dedicati SVT (CERN): 5gg x 2 persone 2.0
  - ✓ Contatti tra sedi INFN per sviluppi dedicati SVT: 2 viaggi x 2 persone 2.0

# Requests for 2025

## Summary etc:

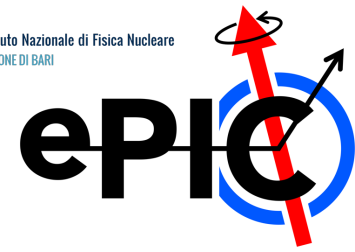
|           | Consumo     | Trasporto  | Inventario       | Total C+T+I           | Missioni            | Total                |
|-----------|-------------|------------|------------------|-----------------------|---------------------|----------------------|
| <b>BA</b> | 36.5        | 2.0        | 0                | 38.5                  | 9.5 (2.5 sj)        | 48.0 (2.5 sj)        |
| <b>PD</b> | 14.5        | 3.0        | 20.0 (sj)        | 37.5 (20.0 sj)        | 6.0 (2.5 sj)        | 43.5 (22.5 sj)       |
| <b>PV</b> | 3.0         | 2.0        | 0                | 5.0                   | 6.5 (2.5 sj)        | 11.5 (2.5 sj)        |
| <b>TS</b> | 15.0        | 0          | 0                | 15.0                  | 6.0 (2.5 sj)        | 21.0 (2.5 sj)        |
|           | <b>69.0</b> | <b>7.0</b> | <b>20.0 (sj)</b> | <b>96.0 (20.0 sj)</b> | <b>28.0 (10 sj)</b> | <b>124.0 (30 sj)</b> |

- Richieste consumo: preventivi caricati o in arrivo entro chiusura DB
- Indicazione DRD3: inserite con misura (e molti dubbi ...)
- Milestone proposte:
  - M1: Realizzazione prototipo termo-meccanico half-barrel per strati interni (L0-L1) SVT IB
  - M2: Realizzazione prototipo e simulazioni termo-meccaniche struttura di supporto globale SVT IB

# Backup



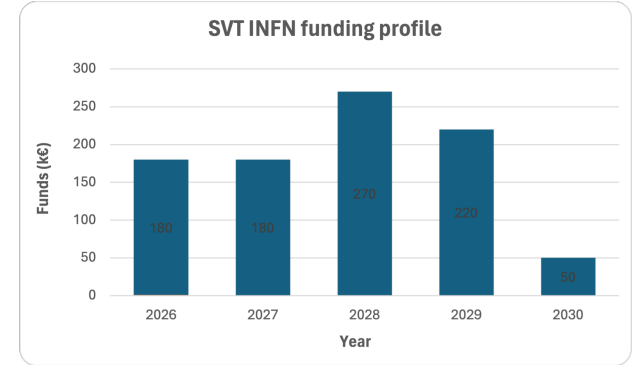
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SEZIONE DI BARI



# INFN funding profile for SVT

## Based on following assumptions:

- prototyping till 2026, construction ~2027 (2028?)
  - ✓ strongly dependent from ER2-ER3, sensor testing etc
  - ✓ some contingency for spares (may extend to 2029)
- spread of funding for sensors and FPC till 2030
  - ✓ project buffering may help overall INFN funding for ePIC



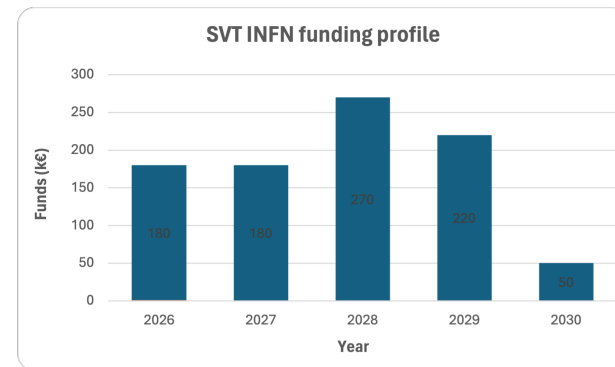
| Profilo spesa SVT 2026-2030  |            |            |            |            |           |            |
|--|------------|------------|------------|------------|-----------|------------|
| Item   | 2026       | 2027       | 2028       | 2029       | 2030      | Tot        |
| Design e produzione tool sensor bending setup                        | 15         | 10         | 10         |            |           | 35         |
| Design e produzione local support structure L0-L1, carbon foam etc   | 10         | 10         | 10         |            |           | 30         |
| Produzione e test prototipi, assembly finale e spare L0-L1           | 20         | 10         | 10         |            |           | 40         |
| Design e produzione prototipi e soluzione finale global mechanics IB | 10         | 20         | 20         | 20         |           | 70         |
| Design e produzione prototipi e soluzione finale box trasporto       | 5          | 10         | 10         |            |           | 25         |
| Test e produzione prototipi e soluzione finale FPC                   | 20         | 20         | 60         | 50         |           | 150        |
| Contributo run di produzione sensori                                 | 100        | 100        | 150        | 150        | 50        | 550        |
| <b>Profilo</b>   | <b>180</b> | <b>180</b> | <b>270</b> | <b>220</b> | <b>50</b> | <b>900</b> |

# INFN funding profile for SVT

## Comparison:

### 1) assumed with buffering from project

| Profilo spesa SVT 2026-2030  |            |            |            |            |           |            |
|--|------------|------------|------------|------------|-----------|------------|
| Item   | 2026       | 2027       | 2028       | 2029       | 2030      | Tot        |
| Design e produzione tool sensor bending setup                        | 15         | 10         | 10         |            |           | 35         |
| Design e produzione local support structure L0-L1, carbon foam etc   | 10         | 10         | 10         |            |           | 30         |
| Produzione e test prototipi, assembly finale e spare L0-L1           | 20         | 10         | 10         |            |           | 40         |
| Design e produzione prototipi e soluzione finale global mechanics IB | 10         | 20         | 20         | 20         |           | 70         |
| Design e produzione prototipi e soluzione finale box trasporto       | 5          | 10         | 10         |            |           | 25         |
| Test e produzione prototipi e soluzione finale FPC                   | 20         | 20         | 60         | 50         |           | 150        |
| Contributo run di produzione sensori                                 | 100        | 100        | 150        | 150        | 50        | 550        |
| <b>Profilo</b>   | <b>180</b> | <b>180</b> | <b>270</b> | <b>220</b> | <b>50</b> | <b>900</b> |



### 2) no buffering

| Profilo spesa SVT 2026-2030  |            |            |            |            |           |            |
|--|------------|------------|------------|------------|-----------|------------|
| Item   | 2026       | 2027       | 2028       | 2029       | 2030      | Tot        |
| Design e produzione tool sensor bending setup                        | 15         | 10         | 10         |            |           | 35         |
| Design e produzione local support structure L0-L1, carbon foam etc   | 10         | 10         | 10         |            |           | 30         |
| Produzione e test prototipi, assembly finale e spare L0-L1           | 20         | 10         | 10         |            |           | 40         |
| Design e produzione prototipi e soluzione finale global mechanics IB | 10         | 20         | 20         | 20         |           | 70         |
| Design e produzione prototipi e soluzione finale box trasporto       | 5          | 10         | 10         |            |           | 25         |
| Test e produzione prototipi e soluzione finale FPC                   | 20         | 30         | 70         | 30         |           | 150        |
| Contributo run di produzione sensori                                 | 100        | 250        | 100        | 50         | 50        | 550        |
| <b>Profilo</b>   | <b>180</b> | <b>290</b> | <b>280</b> | <b>100</b> | <b>50</b> | <b>900</b> |

