TIMESPOT

Consiglio di Sezione INFN Padova

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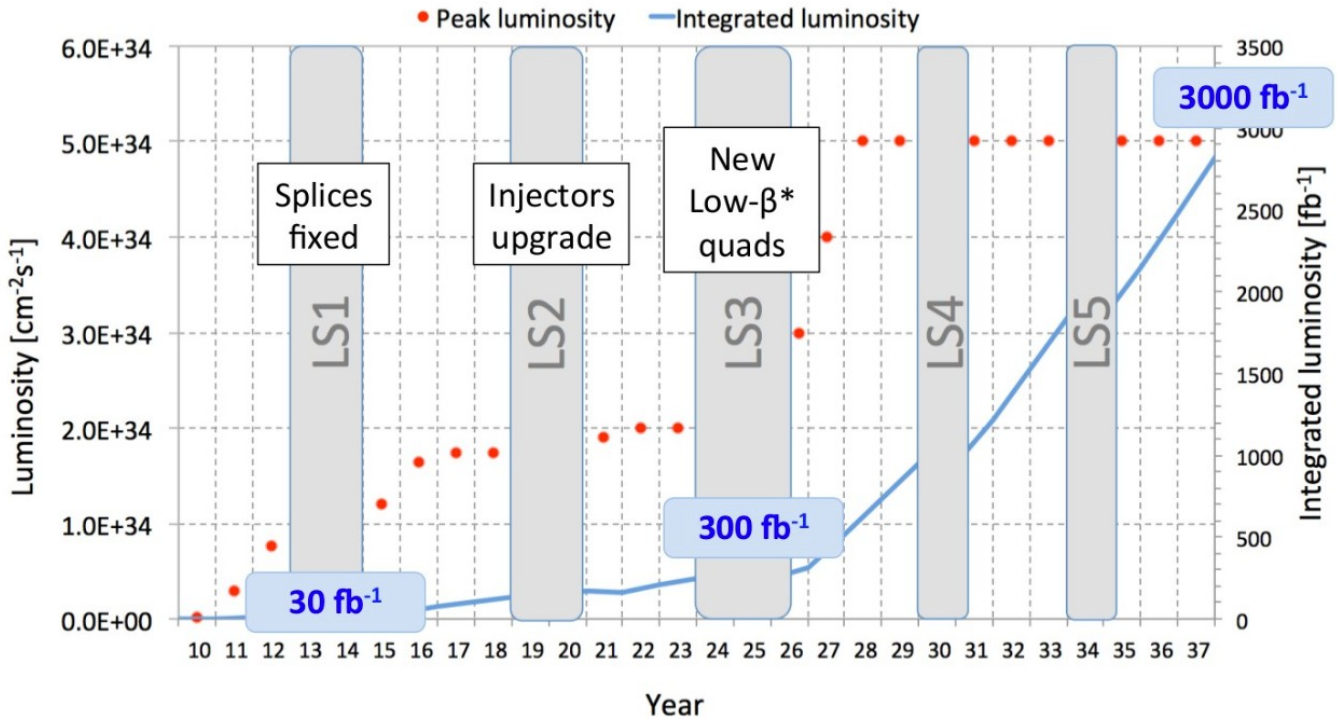
Outline

- General Motivation
- Call GR5
- Activities 2017/2018
- Prospects 2018/2019

General Motivation

- Fase di LHC con alta luinosita': 5×10^{34} $cm^{-2}s^{-1}$ con leveling (ATLAS and CMS) e $1\text{-}2\times10^{34}$ $cm^{-2}s^{-1}$ per LHCb
  - Numero medio di interazioni visibili ~140 (~40 per LHCb)
  - Precise tracking will be extremely challenging



Tracking-Vertexing degration of LHCb at LH-LHC

Vertexnig Performance degradation

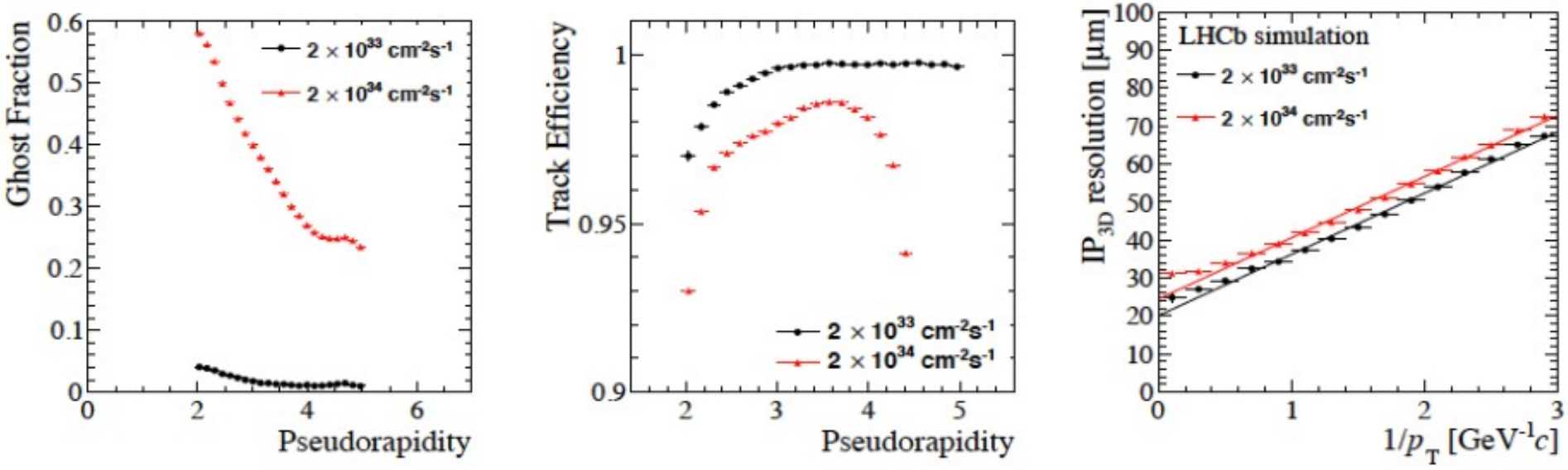
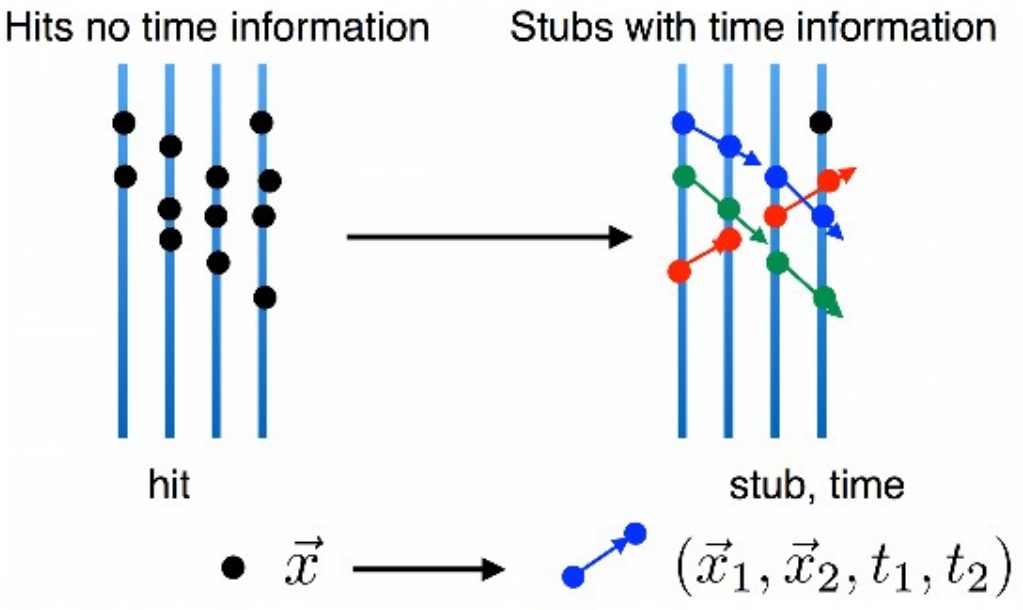
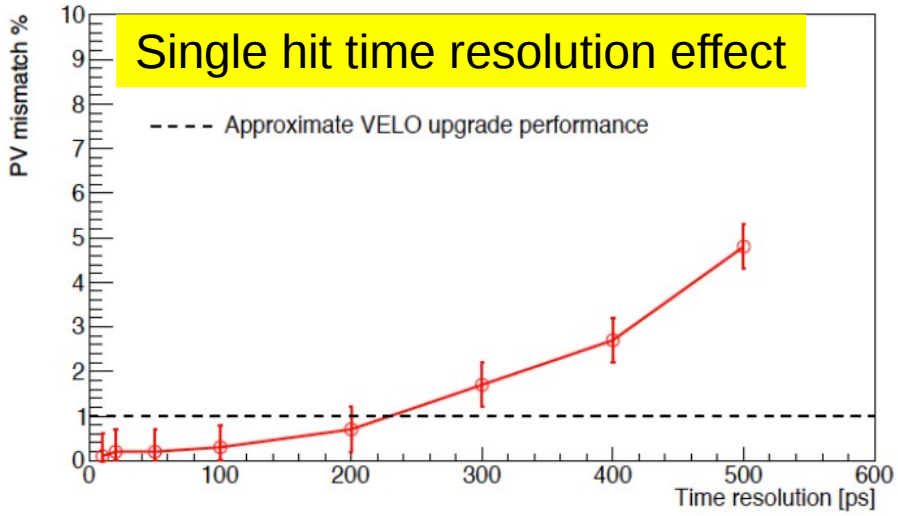


Fig. 1 – Performance of the Phase-I upgrade LHCb Vertex detector at Phase-II conditions [3].

Tracking at LH-LHC

- L'uso di informazioni temporali precise puo' migliorare drammaticamente il sistema di tracciature nelle condizioni di alto pile-up in HL-LHCB
  - Semplificazione del pattern recognition e miglioramento della velocita' di ricostruzione
  - Riduzione delle tracce fantasma
- Bunch Crossing time ~250ps



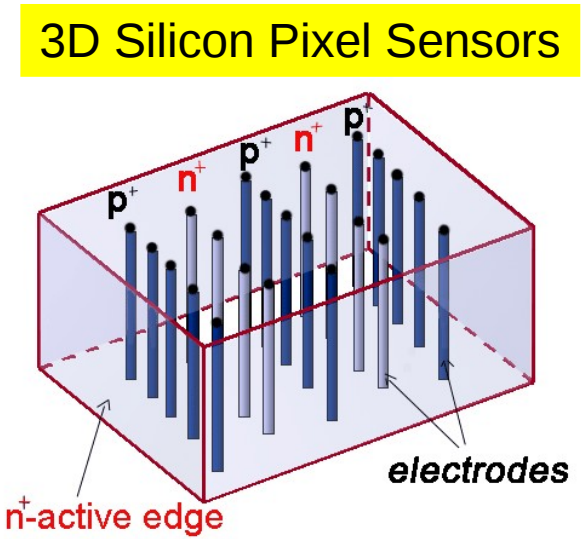


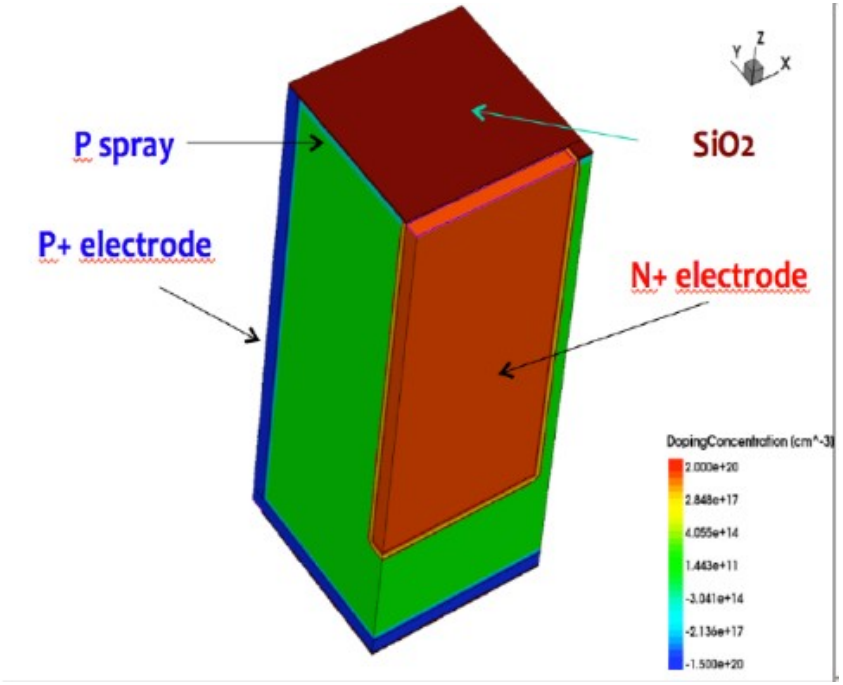
TIMESPOT: TIME & Space real-time Operating Tracker

- Plan
  - Partendo da tecnologie disponibili sviluppare un sensore per microvertice con misura del tempo
  - Sviluppo di front end per misura precisa del tempo
  - Sviluppo di sistema di tracking real-time
  - Costruzione di un dimostratore
- System requirements
  - Space resolution: tens of μm
  - Radiation hardness: > 10^{16} 1 MeV n_{eq} /cm^2 (sensors) and > 1 Grad (electronics)
  - Time resolution: ≤ 100 ps
  - Real time track reconstruction algorithms and devices
- Progetto approvato nella CALL GR5 2017
  - Resp Naz A. Lai
  - Sedi: BO, CA, FE, FI, GE, MI, PD, PG, TIFPA, TO

3D sensors

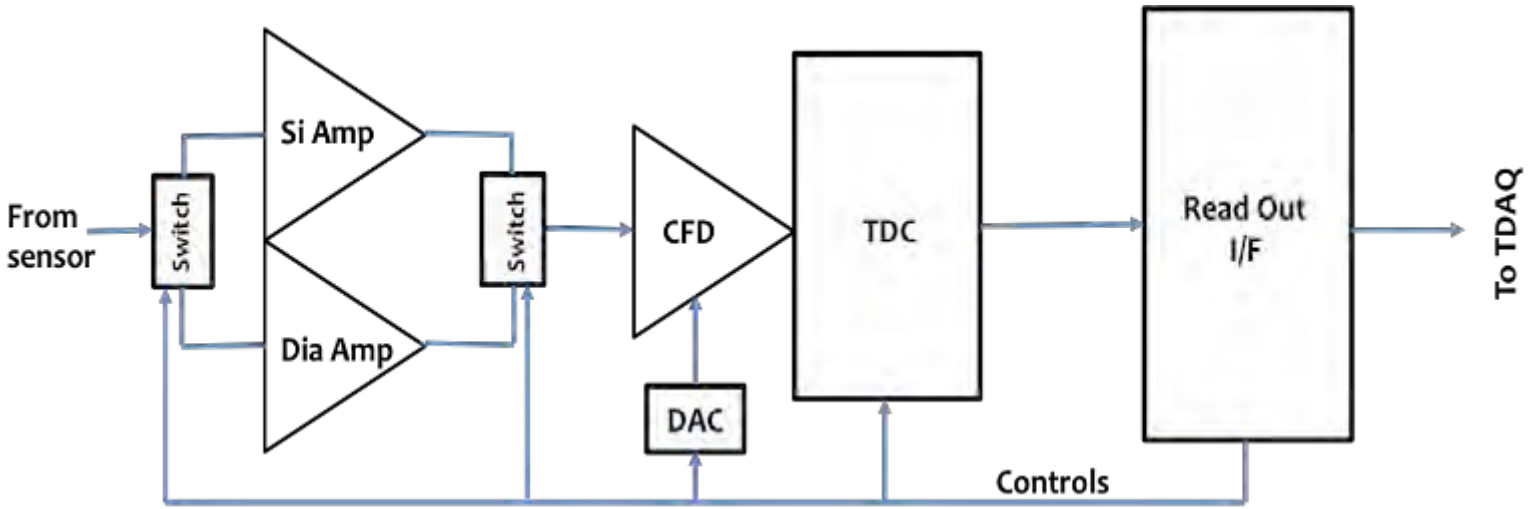
- Column 3D pixel sensors:
  - Good rad hardness
  - $I \sim v_d E_w$ (Ramo Theorem)
    - Non uniform signal
    - Signal position dependent
    - Not suitable for precise timing
- Si Trench 3D sensors
  - Uniform Weighting field
  - Good rad harness
  - Technologically more difficult
  - Bigger pixel capacitance
- Diamond graphitized sensors
  - Excellent rad hardness
  - Smaller signals
  - Technologically challenging



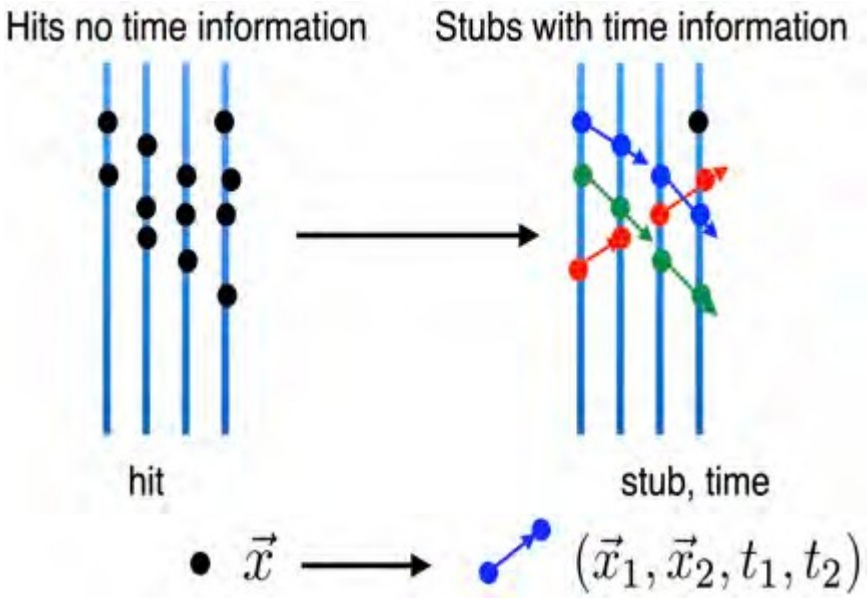


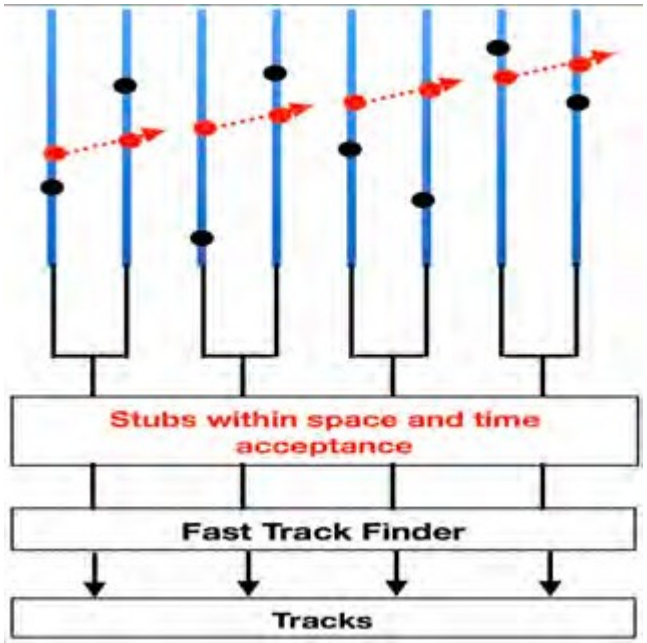
Front-End

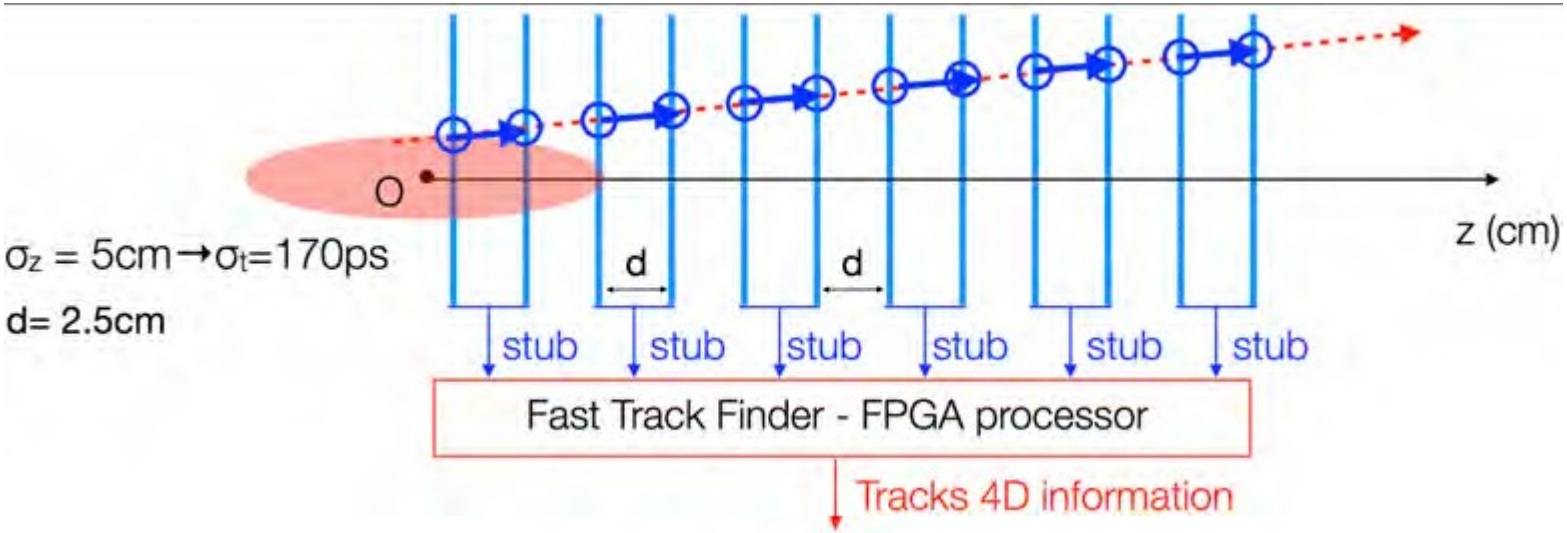
- Fast custom front end
  - Compromise between fast amplifier (noisier) and charge sensitive amplifier
    - Integrate the two for each channel



Real-time reconstruction







Activities

- WG1 [Cagliari, Ferrara, Genova, Padova, TIFPA, Torino.]
  - Sviluppo e caratterizzazione sensori 3D Silicio

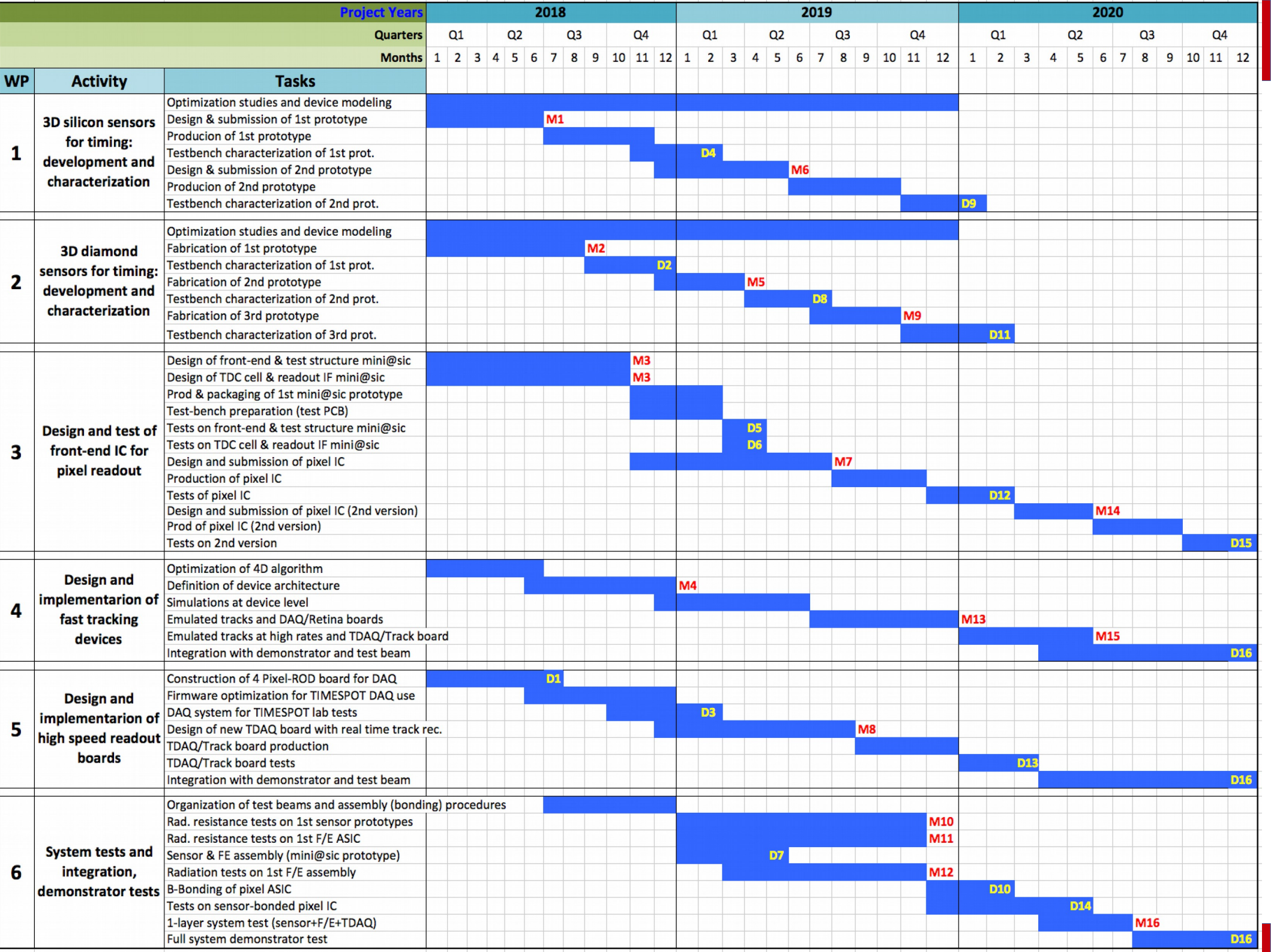
Padova

- WG2 [Firenze, Genova, Perugia.]
  - Sviluppo e caratterizzazione sensori 3D Diamante
- WG3 [Cagliari, Milano, Torino]
  - Front-end
- WG4 [Bologna, Milano.]
  - Fast tracking
- WG5 [Bologna.]
  - DAQ
- WG6 [All]
  - Integration and demonstrator

Padova

Attivita' previste a Padova

- Prima Produzione Strutture di test per sensori 3D da FBK prevista per settembre
- Test di caratterizzazione elettrica [2018]
  - Laboratorio Silici Padova
- Caratterizzazione sensori sotto fascio microbeam di legnaro [2018-2019]
  - Proposal per un esperimento con il microbeam di legnaro sottomessa
    - E = 2MeV , pentrazione ~ 60μm
    - Dimensione fascio = alcuni μm
    - Tempo fascio = 5 giorni
  - Misura di efficienza di collezione di carica
  - Caratterizzazione dei segnali in funzione della posizione
  - Misura del danno da radiazione localizzato per irraggiamento con protoni
- Caratterizzazione sotto fascio di MIP [2019-2020]
  - Misura risoluzione temporale dei sensori in funzione della posizione


Project Years
2018
2019
2020
Quarters
Q1 Q2 Q3 Q4
Months
1 2 3 4 5 6 7 8 9 10 11 12
WP
Activity
Tasks
1
3D silicon sensors for timing: development and characterization
Optimization studies and device modeling
Design & submission of 1st prototype
Producion of 1st prototype
Testbench characterization of 1st prot.
Design & submission of 2nd prototype
Producion of 2nd prototype
Testbench characterization of 2nd prot.
M1
D4
M6
D9
2
3D diamond sensors for timing: development and characterization
Optimization studies and device modeling
Fabrication of 1st prototype
Testbench characterization of 1st prot.
Fabrication of 2nd prototype
Testbench characterization of 2nd prot.
Fabrication of 3rd prototype
Testbench characterization of 3rd prot.
M2
D2
M5
D8
M9
D11
3
Design and test of front-end IC for pixel readout
Design of front-end & test structure mini@sic
Design of TDC cell & readout IF mini@sic
Prod & packaging of 1st mini@sic prototype
Test-bench preparation (test PCB)
Tests on front-end & test structure mini@sic
Tests on TDC cell & readout IF mini@sic
Design and submission of pixel IC
Production of pixel IC
Tests of pixel IC
Design and submission of pixel IC (2nd version)
Prod of pixel IC (2nd version)
Tests on 2nd version
M3
M3
D5
D6
M7
D12
M14
D15
4
Design and implementarion of fast tracking devices
Optimization of 4D algorithm
Definition of device architecture
Simulations at device level
Emulated tracks and DAQ/Retina boards
Emulated tracks at high rates and TDAQ/Track board
Integration with demonstrator and test beam
M4
M13
M15
D16
5
Design and implementarion of high speed readout boards
Construction of 4 Pixel-ROD board for DAQ
Firmware optimization for TIMESPOT DAQ use
DAQ system for TIMESPOT lab tests
Design of new TDAQ board with real time track rec.
TDAQ/Track board production
TDAQ/Track board tests
Integration with demonstrator and test beam
D1
D3
M8
D13
D16
6
System tests and integration, demonstrator tests
Organization of test beams and assembly (bonding) procedures
Rad. resistance tests on 1st sensor prototypes
Rad. resistance tests on 1st F/E ASIC
Sensor & FE assembly (mini@sic prototype)
Radiation tests on 1st F/E assembly
B-Bonding of pixel ASIC
Tests on sensor-bonded pixel IC
1-layer system test (sensor+F/E+TDAQ)
Full system demonstrator test
M10
M11
D7
M12
D10
D14
M16
D16

Anagrafica

- G.Collazuol 10%
- S.Gallorini 30%
- A.Lupato 30%
- S.Mattiazzo 10%
- G.Simi 20%
  - Tot 1FTE
- Acquisti 2018 [in corso]
  - Materiale per laboratorio silici
  - Elettronica di front end per lettura dei segnali delle strutture di test 3D
  - Sistema di trigger per microbeam
    - P-Terphenyl + SiPM readout
- Richieste 2019
  - 3kE consumo + 1kE inventariabil
    - Acquisto sistema di tag temporale per misure di timing
      - Cherenkov radiator + fast readout electronics

    2kE missioni per meeting interni, irraggiamenti, test beam