Goals FTM-Next

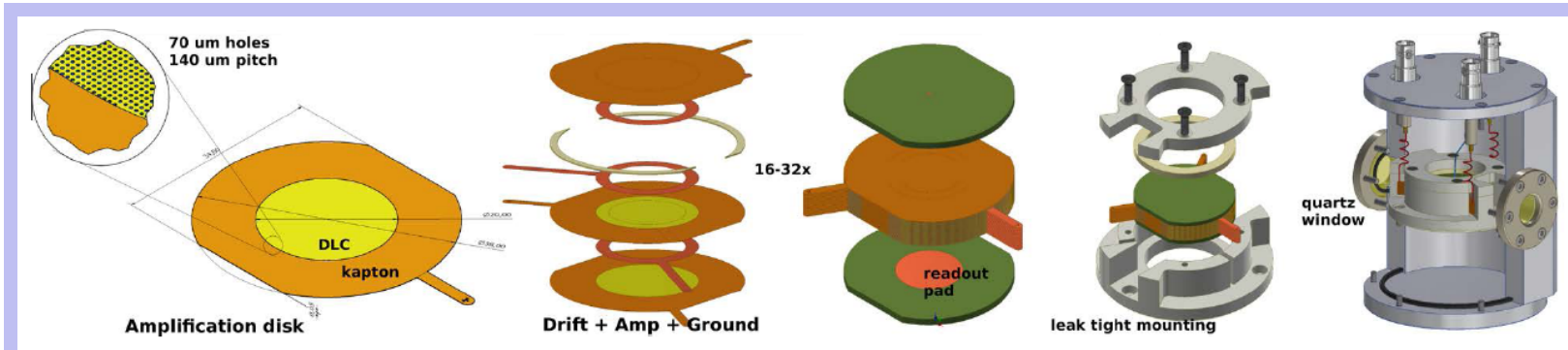
- **Reduce production time of Polyimide foils with thin DLC coating**
- Develop procedure for DLC deposition with **reproducible resistivity** through **Pulsed Laser Deposition** process & increase DLC strength
- Use small PLD produced DLC samples to instrument a small size FTM prototype with reduced noise design and **demonstrate FTM principle with small-size prototype**
- Pioneer **new Flexible Cupper Clad Laminates** (FCCLs) and pioneer etching of 125 μm FCCLs to allow reaching higher gas gains
- Asses **electrostatic stability** 250 μm gaps $\Rightarrow$ scale to larger area
- Continue **Fast Electronics** development for smal signals (1.6 fC)

High Quality Thin DLC films through PLD

- **Deposition of Uniform Low-Resistivity DLC layers: (Core)**
  - in a reproducible way;
  - with good thickness uniformity (hence good resistivity uniformity);
  - with good adhesion of DLC to polyimide;
  - with application-taylored surface resistivity values (Rate vs Res.).
- **Pulsed Laser Deposition:**
  - good control of DLC properties thanks to independent PLD param.;
  - will allow for fast iteration to converge to reproducible results
- **Characterization of DLC films:**
  - AFM & SEM to study morphology & topography of DLC;
  - DLC-PI bond & DLC internal stress investigated through Raman spectroscopy; 4-point Hall probe to characterise electrical properties
- **Excellent expertise in field of Thin Films in Italy (Lecce)**

Detector Architecture Design & Construction

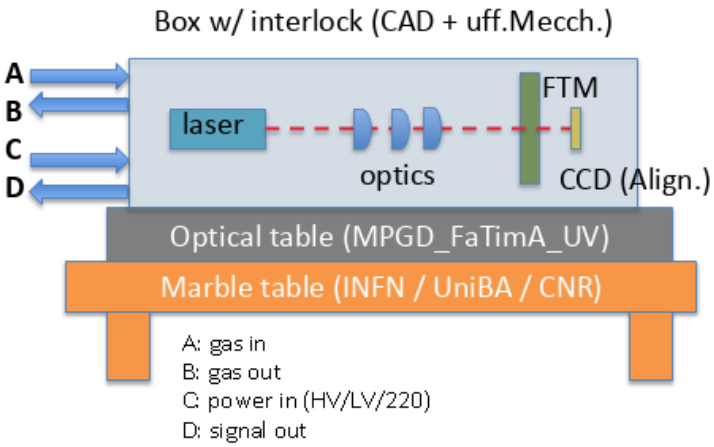
- Design **small-size FTM prototype** housing DLC coated PI foils from WP-2
- Prototype with **single-pad readout** and inside stainless steel housing to **reduce noise** and allow for testing with simple electronics (single-ch. fast pre-amps)
- Prototype equipped with two quartz windows to **allow testing with UV-laser** (allows single-layer testing, testing also the signal transparency of the structure)
- Modular prototype will **allow exchange of amplification disks** during the project with disks of **different thickness** (test higher gain) and **lower resistivity** (test higher rate capability & test signal transparency)
- PSPICE simulation to establish rate capability vs electrical transparency
- COMSOL & ANSYS simulations to understand optimal settings of electric fields & to **evaluate etching procerdure** (hole quality) on gain



Detector Tests

Grant NeoAssunti 2017: MPGD-FaTimA-UV

to test **gain** & response of individual layers



Cosmic Ray Muons lab tests before going to test beam

Charged Beams μ, π, p foreseen in 2nd and 3rd year

Large Area & High Gain

- **Continue test FTM-v4 with more layers** (already financed by MPGD-FaTimA) to test detection efficiency (need few mm to guarantee primary ionisation)
  - FTM-v4 (4 layers of 250 μm = 1 mm) $\rightarrow$ 12 layers of 250 μm = 3 mm
  - When ready FATIC-v2, then also test Time Resolution FTM-v4
- **Generic R&D Large Areas**
  - for detectors with micro-drift gaps to scale to large areas
  - FTM electric fields distorted by spacers (result MPGD-Next), therefore need spaceless design where foils are stretched (cfr. CMS Triple-GEM)
  - Electrostatic stability studies need to be performed (simulation & experiment) to understand stability of foils under HV at sub-mm

  $\Rightarrow$ **success of WP1 & WP3 will allow to propose large area FTM R&D**
- **Generic R&D High Gain**
  - MPGD detectors typically have low gain (discharges due to high charge density)
  - $\Rightarrow$ Enter Resistive Materials: no discharges at (some) price of Rate Capability
  - $\Rightarrow$ 50 μm PI foil can give gain up to 10,000 (cfr. uRWELL) $\Rightarrow$ try 125 μm PI Single-mask etching: max 75um; Double-mask etching of new 125 μm FCCL

  $\Rightarrow$ **success will allow faster timing (b/c of higher gain) + red. FE reqs.**

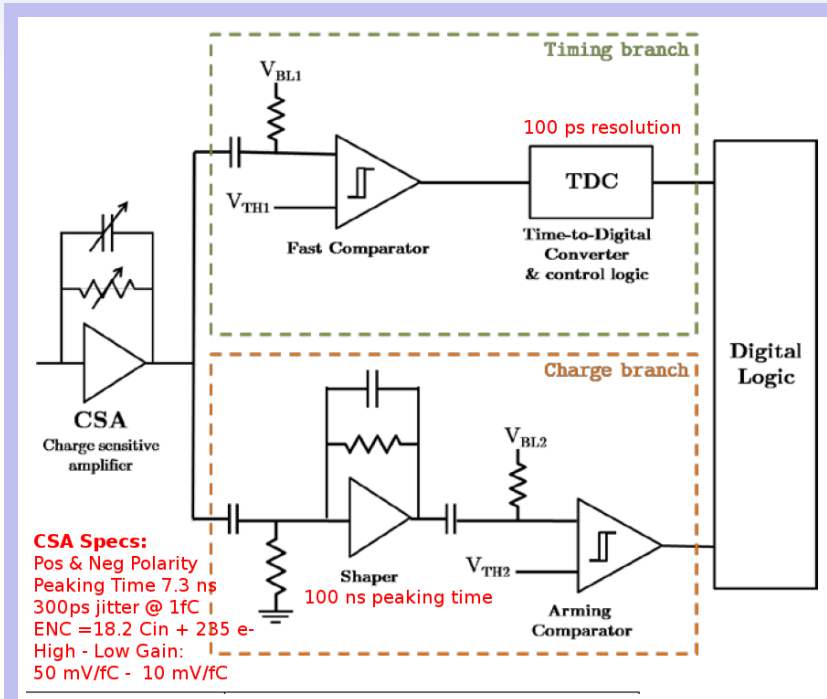
Fast Electronics Development

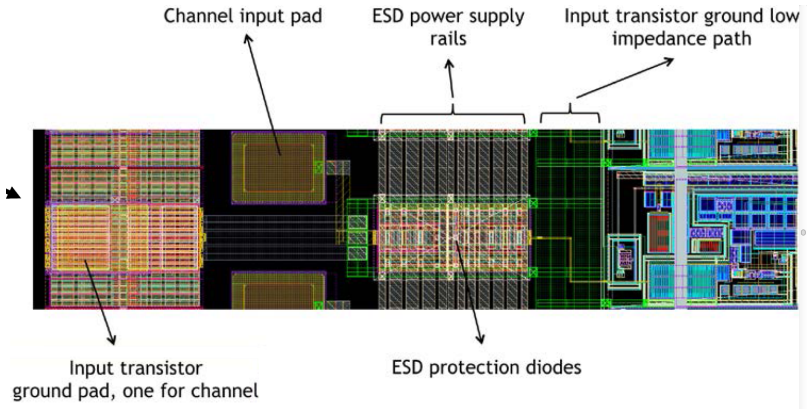
In MPGD-Next: FATIC-v1

- financed by CSN-I (30 kEUR)
- Low-Noise, high-gain, 32-ch, 15 pF. timing branch (TDC), charge branch
- Due to parasitic resistances, gain reduced by 50%. Details in Report MPGD-Next (S.Dalla Torre)
- 30 kEUR funding CSN-V restituted because of lack of understanding

Several tests conclusively proven origin of problems:

- FATIC-v2 solutions identified;
- Redesign Bonding Path
- ADC for charge branch;
- Internal Calibration Circuit;
- Design Ready by April 2019.





Project Management

Milestones 2019:

- ⋆ **MS-1:** Design of small size FTM that can hold DLC samples WP 2
- ⋆ **MS-2:** Development of a Procedure for reproducible DLC deposition
- ⋆ **MS-3:** Test FTM-v4 extended up to 12 layers for Efficiency Meas.
- ⋆ **MS-4:** Submission of improved FATIC-v2 to foundry

WP	Task Description	2019 Q1	2019 Q2	2019 Q3	2019 Q4	2020 Q1	2020 Q2	2020 Q3	2020 Q4	2021 27	2021 30	2021 33	2021 36
WP1 Detector Architecture Design Simulation, Construction & Test										WP Leader: Bari			
Task 1.1	Design of Small size FTM		★										
Task 1.2	Prototype Construction												
Task 1.3	Laser Tests												
Task 1.4	Test Beam (DESY/PSI)												
Task 1.5	Laser, Cosmics, Beam Tests												
WP2 Pulsed Laser Deposition of Diamond Like Carbon on PI Foils										WP Leader: Lecce			
Task 2.1	PLD w/ Resistivity Control				★								
Task 2.2	Creation new FCCL Structs												
Task 2.3	PLD w/ Resistivity Variation												
WP3 Large Area & High Gain R&D						WP Leader: Pavia							
Task 3.1	Eff w/ 12 foils (50 μm)				★								
Task 3.2	Electrostatic Stability Stud									Join WP1 for Test Beam			
Task 3.3	Etching Studies 125 μm												
WP4 Fast Electronics Development						WP Leader: Bari							
Task 4.1	Design & Prod of FATIC-v2		★										
Task 4.2	Lab Tests + Cosmic Tests												

Sez.	Name	Pos.	Time	Gender	CSN	Task
BA	**Verwilligen Piet (PI)**	Ric.	30%	M	CSN-I	Sim, Design & Test
BA	Colaleo Anna	P.R.	10%	F	CSN-I	FTM Test
BA	Maggi Marcello	P.R.	30%	M	CSN-I	FTM Test
BA	Venditti Rosamaria	A.d.R.	10%	F	CSN-I	FTM Test
BA	**Ranieri Antonio**	D.R.	30%	M	CSN-I	FATIC v2 Test
BA	Licciulli Francesco	A.T.	20%	M	CSN-I	FATIC v2 Design & Test
LE	**Serra Antonio (RL)**	P.A.	30%	M	CSN-V	**DLC Characterization**
LE	Calcagnile Lucio	P.O.	10%	M	CSN-V	DLC Characterization
LE	Manno Daniele Erminia	P.A.	20%	F	CSN-V	DLC Characterization
LE	Quarta Gianluca	Ric.	10%	M	CSN-V	DLC Characterization
LE	**Caricato Anna Paola**	P.A.	10%	F	CSN-V	**DLC Deposition**
LE	Di Giulio Massimo	P.A.	20%	M	CSN-V	DLC Deposition
LE	Martino Maurizio	P.A.	20%	M	CSN-V	DLC Deposition
PV	**Vai Ilaria (RL)**	A.d.R.	30%	F	CSN-I	FTM Test & Large Area
PV	Riccardi Cristina	P.A.	10%	F	CSN-I	Large Area
PV	Salvini Paola	Ric.	10%	F	CSN-I	Large Area
PV	Vitulo Paolo	P.A.	20%	M	CSN-I	FTM Test & Large Area

Financial Requests 2019

Chapter	WP	Motivation	Req. k€	S.J. k€
Bari			**25**	**30**
MIS	1	Etching sessions at CERN	5	
CON	1	**Prototype Constr. Mat.**, Polyimide, Etching Sessions	10	
CON	4	Front-End chip FATIC-v2 submission		30
INV	1	2 $\times$ Large Bandwidth Current Pre-Amp CIVIDEC (40 dB)	5	
L-SW	1	Licenze COMSOL (€ 3k) ed ANSYS (€ 2k)	5	
Lecce			**7**	
MIS	2	Meeting Attendance & Publication Fees	2	
CON	2	Reagents, C tape, Cu grids, Au target, Laser Gas (He,Ne)	5	
Pavia			**8**	
MIS	3	Electrostatic Stability Setup Design at CERN	2	
CON	3	Lab consumables for testing FTM	1	
INV	3	CAEN A1561H 12 ch High Resolution (50 pA) HV PS	5	
2019		*Total inserted in DB Preventivi*	**40**	**30**

Future Financial Requests

Chapter	WP	Motivation	Req. k€	S.J. k€
2020		*not yet inserted in DB Preventivi*	**35**	
MIS	1	Test Beam	5	
CON	1	Test Beam setup: triggers, electronics, mechanics	5	
CON	1	Construction 2^{nd} prototype	10	
CON	2	Consumi DLC deposition & characterization	5	
CON	4	Test Board & Front End Boards for FATIC-v2	5	
L-SW	1	Licenze COMSOL ed ANSYS	5	
2021		*not yet inserted in DB Preventivi*	**30**	
MIS	1	Missioni Test Beam	5	
MIS	2	Conferenze Internazionale & Publications	5	
CON	1	Consumi Test Beam	5	
CON	1	Acquisition Test Beam time	5	
CON	2	Consumi DLC deposition & characterization	5	
L-SW	1	Licenze COMSOL ed ANSYS	5	