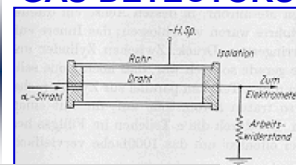


# AIDA<sub>innova</sub>

## WP7: Gaseous detectors

### Task 7.5

Silvia Dalla Torre



TASK	promotor of initial EoI	INFN								CERN	CIEMAT	CNRS/LPC	CNR/IP2I	CUNI	CISC/IFIC	RHUL	UOXF	USC	industries		
		BA	BO	LNF	LE	PV	RM3	TS	CAEN										ELTOS	Picotech	
7.1	Management																				
7.2.1	MRPC for fast timing	INFN-BO, CBRS																			
7.2.2	Eco-friendly gasses for RPCs	INFN-LNF																			
7.3.1	Resistive electrodes for MPGDs	INFN-BA, CERN																			
7.3.2	industrial engineering uR-WELL	INFN-FE																			
7.4.1	proto electr. board for cluster counting	INFN-LE																			
7.4.2	hybrid r-o HP gas TPC for nu physics	RHUL&UOXF																			
7.5.1	photon detectors for hPID at high p	INFN-TS																			

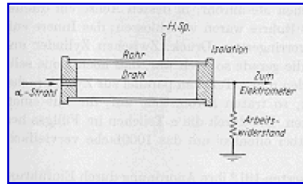
### COMMENTI

- Presenza trasversale e qualificata e prevalente INFN
- Tutte le industrie sono legate ad attività INFN

### Finanziamento

- INFN: 411.25 k€ / 1091 k€ (35%)

Work Package title	Gaseous detectors					
Participant number	1	8	22	43	44	30
Short name of participant	CERN	CNRS	INFN	UOXF	RHUL	CIEMAT
Person months per participant:	9.9 (8.1)	27.5(0)	62 (119)	14.2 (23.8)	8.6 (7.2)	4.1 (6.4)
Participant number	35	31	5	20	9	19
Short name of participant	USC	CSIC	CUNI	ELTOS	PICOTECH	CAEN
Person months per participant:	8.2 (19.8)	9 (15)	10 (10)	11 (1)	14 (0)	11 (10)

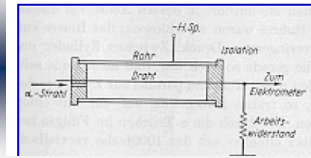


## R&D related to “MPGD” & to “PID”

- **Photon detectors for hadron particle identification at high momenta with compact RICHes**
  - Upgraded hybrid MPGD-based single photon detectors
  - Solid-state and vacuum-based single photon detectors are also comparatively considered
  - Both for compact (= short in length) RICHes for high  $p$  ( $> 10$  GeV/c)
  - Answering one of the major quests in hadron (and flavour) physics
  
- **Participants:**
  - INFN BA, BO, TS; Charles University (Prague) & USTC (Hefei)

## SINERGIES

Development of the compact RICH concept for h-PID at high momenta → EIC,  $e+e^-$ , COMPASS++/AMBER



## Compact RICH approaches

1 m-long radiator and visible light PDs

PDs: LAPPDs or SiPMs

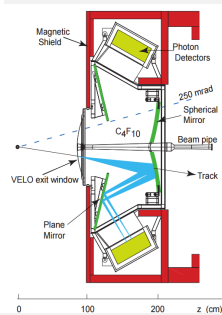
**C<sub>4</sub>F<sub>10</sub>** ( $n = 1.0015$ ,  $\theta_{max} = 55$  mrad)

- $\pi$  threshold : 2.5 GeV/c
- K threshold : 9.0 GeV/c
- $n_{det.ph.s} (\beta=1) / 1m : \sim 20$
- To exploit PID up to 50 GeV/c :  $\sigma_{C\_ph} < 1.5$  mrad (vis. range)

**CF<sub>4</sub>** ( $n = 1.0005$ ,  $\theta_{max} = 32$  mrad)

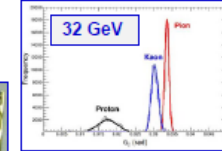
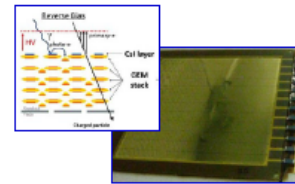
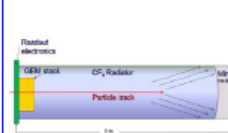
- $\pi$  threshold : 4.4 GeV/c
- K threshold : 15.6 GeV/c
- $n_{det.ph.s} (\beta=1) / 1m : \sim 10$
- to exploit PID up > 60 GeV/c :  $\sigma_{C\_ph} < 0.7$  mrad

### LHCb RICH-1



### CF<sub>4</sub> windowless RICH concept, test-beam results

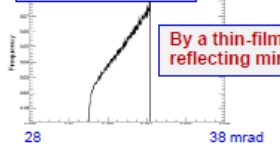
M. Blatnik et al., IEEE NS 62 (2015) 3256



Pad-size ~ 5 mm

$n_{det.ph.s} : 10$

Frequency vs  $\theta_C$



By a thin-film reflecting mirror

## REPLACING C-F GASES BY PRESSURIZED Ar

C-F, 1 bar

Chromatic dispersion

gas	P (bar)	VISIBLE (bialkali with ext. UV glass window)					
		$(n-1) \cdot 10^6$	$\sigma \cdot 10^6$	$\theta_{max}$ (mbar)	$\sigma_{\theta}$ (mbar)	$\sigma_{\theta} / \theta_{max}$ (chrom. only) (%)	$n_{ph}/m (\beta=1)$
CF <sub>4</sub>	1	497	11.5	31.5	0.4	1.2	10.0
C <sub>4</sub> F <sub>10</sub>	1	1367	46	52.3	0.9	1.7	27.5
Ar	1	294	10	24.2	0.4	1.7	5.9
Ar	1.5	441	15	29.7	0.5	1.7	8.9
Ar	2	588	19.5	34.3	0.6	1.7	11.8
Ar	3	882	29.5	42.0	0.7	1.7	17.7
Ar	3.5	1029	34.5	45.3	0.8	1.7	20.7

**HIGH PRESSURE-RICH: Eco-friendly alternative to C-F-gasses**

- Ar @ 3.5 bar  $\leftrightarrow$  C<sub>4</sub>F<sub>10</sub>
- Ar @ 2 bar  $\leftrightarrow$  CF<sub>4</sub>

Ar, P > 1 bar

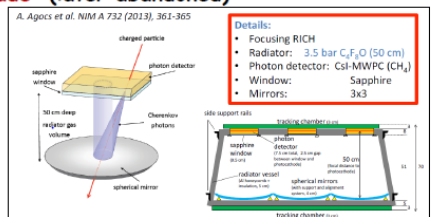
Number of detected photons at  $\beta = 1$  (scaling from yellow box, LHCb figure)

### An option for ALICE HMPID upgrade (later abandoned)

M. Weber at RICH2013

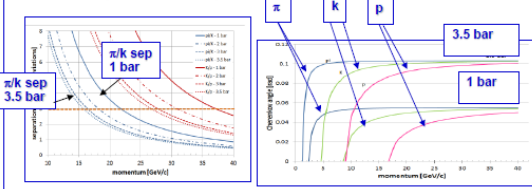
Goals:

- 1.5 mrad resolution
- $p/K$  3  $\sigma$  sep. up to 25 GeV/c
- $\pi/K$  sep. from 5 GeV/c
- $\pi/K$  3  $\sigma$  sep. up to 16 GeV/c



- Details:
- Focusing RICH
  - Radiator: 3.5 bar C<sub>4</sub>F<sub>10</sub> (50 cm)
  - Photon detector: CsI-MWPC (CH<sub>4</sub>)
  - Window: Sapphire
  - Mirrors: 3x3

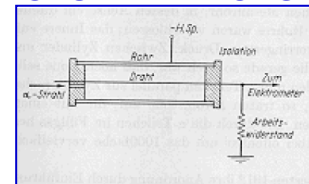
Expected (simulations):



**Test-beam :**

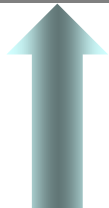
- n. of ph.s: 10 (saturation)
- $\rightarrow$  20 ph.s per m

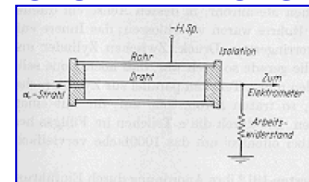
**Reminder:**  
at 1 bar with MWPCs +CsI:  
 $\sim 5$  ph.s per m



### Full costs budget per Task

Beneficiary short name	Person-months	Monthly personnel cost	Personnel costs	Travel	Equipment and consumables	Other direct costs	Sub-contracting	Material direct costs	Total direct costs	EC requested funding (without overheads)	EC requested funding (including overheads)
<b>Task 7.5.1 Photon detectors for hadron particle identification at high momenta</b>											
INFN	13.0	5,000.00	65,000.00	4,000.00	5,000.00	1,000.00		10,000.00	75,000.00	25,000.00	31,250.00 BA
INFN	14.0	5,000.00	70,000.00	4,000.00	1,400.00			5,400.00	75,400.00	25,000.00	31,250.00 BO
INFN	30.0	5,000.00	150,000.00	10,000.00	6,000.00	5,000.00		21,000.00	171,000.00	60,000.00	75,000.00 TS





SEDE	nome	categoria	mese-uomo (keuro)	FTE	mesi/anno	anni	mesi totali	mesi arrotondati	costo (keuro)	cofinanziamento richiesto (keuro)
BA	Eugenio Nappi	DR	7	0.1	1.2	4	4.8	5	35	
	Giacomo Volpe	ric. Univ.		0.1						
	<b>TOTALE</b>								<b>35</b>	
BO	Roberto Preghenella	ricercatore	4	0.15	1.8	4	7.2	7	28	
	Francesco Noferini	ricercatore	4	0.1	1.2	3	3.6	3.5	14	
	Neelima Agrawal	post-doc	2	0.1	1.2	1	1.2	1	2	
	<b>TOTALE</b>								<b>44</b>	
TS	Silvia Dalla Torre	DR	7	0.15	1.8	1	1.8	2	14	
	tecnico sezione	tecnico	3	0.3	3.6	4	14.4	14.5	43.5	
	borsa INFN stranieri		3	0.5	6	2	12	12	36	
	<b>TOTALE</b>						<b>0</b>		<b>93.5</b>	

