Outline of UoI-HEP Team
[Activities and Goals]

Experiments at CERN and FNAL, last CMS

Interest in DUNE (ND *and* FD)

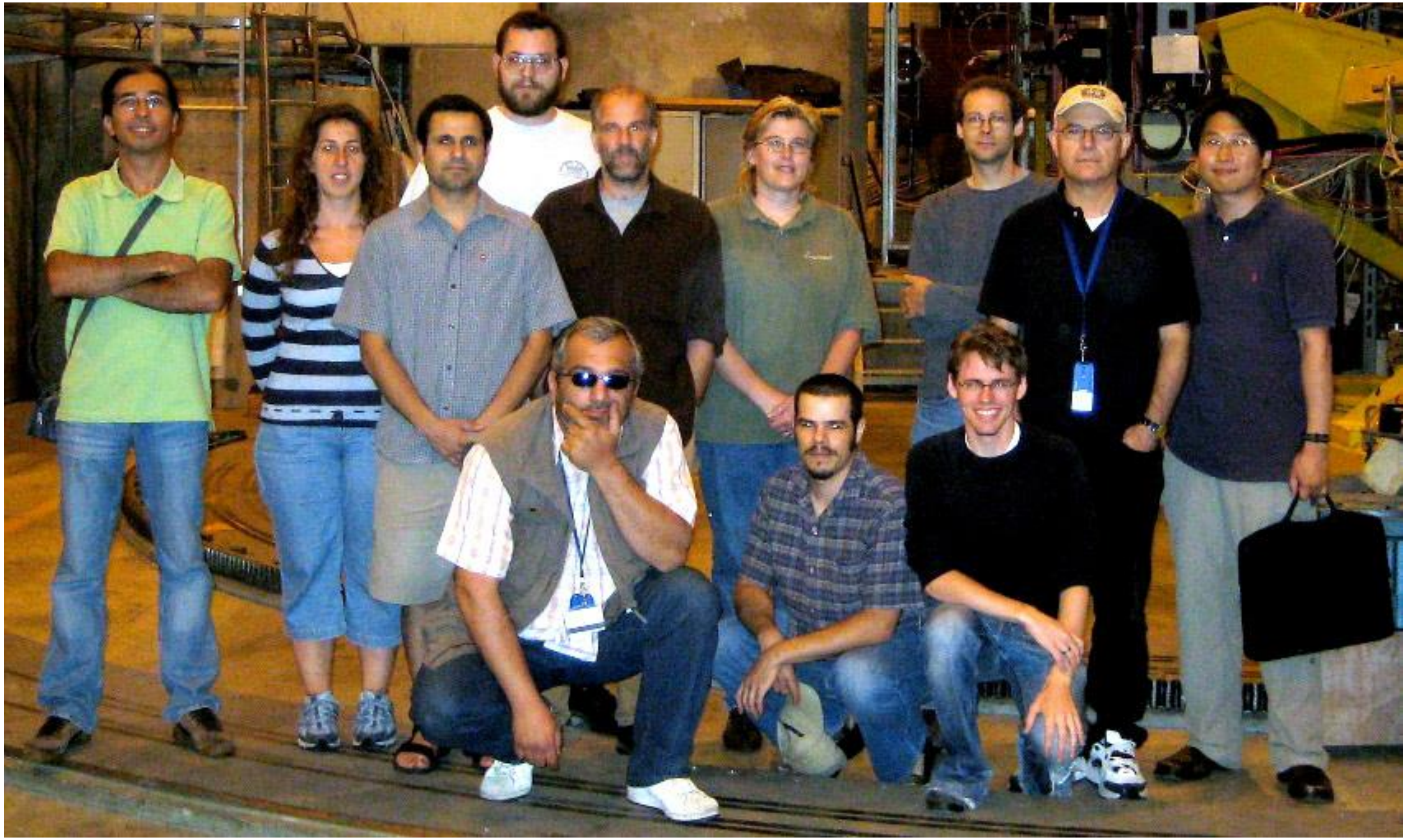
HW ability (mechanics, photodetectors, electronics)

SW expertise

Theory support

Aldo Penzo, Univ. of Iowa - 14 Nov 2017

CENF WG5: Detector Requirements and R&D



Professors Yasar Onel and Jane Nachtman with members of the CMS/DUNE HEP Group

CENF WG5: Detector Requirements and R&D

The HEP experimental group at the University of Iowa works on two major particle physics projects, the Compact Muon Solenoid (CMS) based at CERN, and the Deep Underground Neutrino Experiment (DUNE) based at Fermilab.

CMS – HF Calorimeters

2 Quartz Fiber Calorimeters for the forward region ($3< \eta <5$) of CMS

~ 250 tons iron absorber ($8.8\ \lambda$)

~ 1000 km quartz fibers (0.8mm)

~ 2000 PMT read-out

36 azimuthal wedges; 18 radial rings

Goals in DUNE: Physics and Detectors

UoI proposed program of research:

- **Physics studies**, simulations and modeling for ND to provide constraints on:
  - cross sections and flux required to **reach DUNE's oscillation sensitivity** limits,
  - a variety of **non-oscillating neutrino measurements** accessible with ND.
- Based on **hardware experience** we propose:
  - several possible **hardware contributions to ND and FD subsystems**,
  - **new detector options** to explore with simulation and R&D

Work in close connection with:

- Argon-Cube groups
- Photodetection groups (both FD *and* ND)
- Flux and cross-sections WG

Detector Options for ND

- **Argon-Cube** **(Photodetection Systems)**
- **EM Calorimeter System** **(CALICE style)**
- **Muon System** **(RPC Tracker)**
- **3D STT** **(Scintillator Target/Tracker)**

Established Experience with PMTs, SiPMs and Scintillating/WLS fibers

We have at Iowa a sophisticated optical test bench for full qualification of photodetectors (developed and successfully used for characterizing several thousands of CMS PMTs)

Experience accumulated on the RPC system for CALICE DHCAL, in particular

- *an innovative* ***gas recycling facility***
- *a system for* ***high voltage generation and distribution***

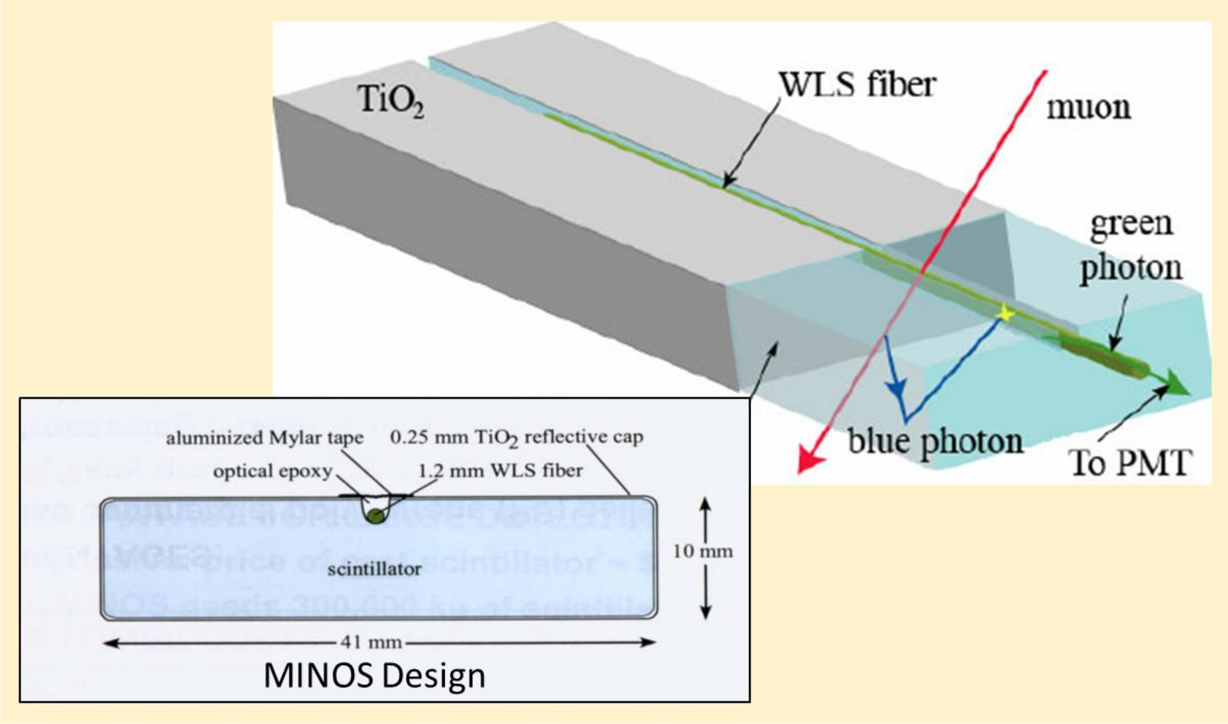
(crucial items impact on cost of large-scale RPC system and their environmental compatibility)

UoI has state-of-the-art facilities: mechanical shop and computer center

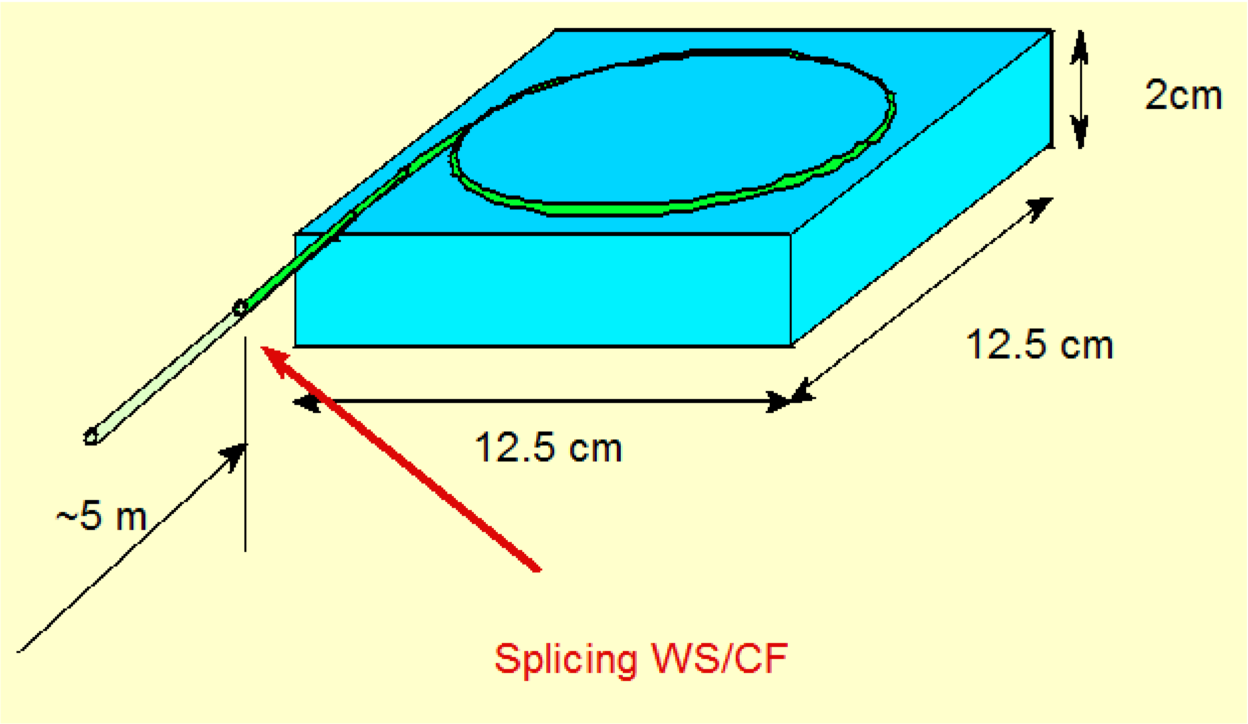
(engineers expert in design, construction and maintenance of large systems)

Backup (Photo Gallery)

Scintillator – based Hodoscopic Muon Counters and Calorimeters



Scintillator bars



Scintillator pads

CDF-II : Muon Counters Upgrade (CSP, BSU)

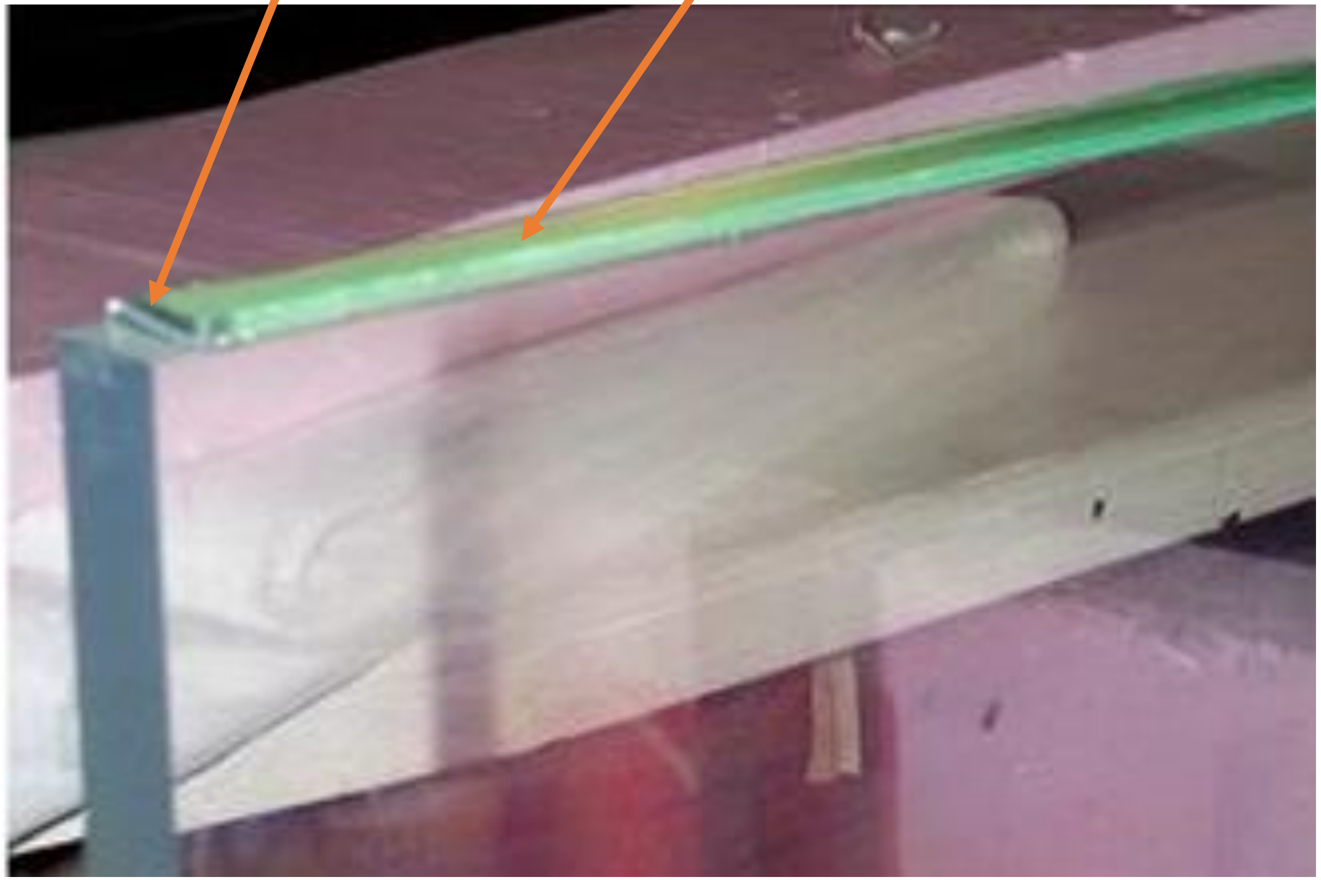
CALICE: Tail Catcher/Muon Tracker (TCMT)

CDF-II : Central Preshower (CPR) Upgrade

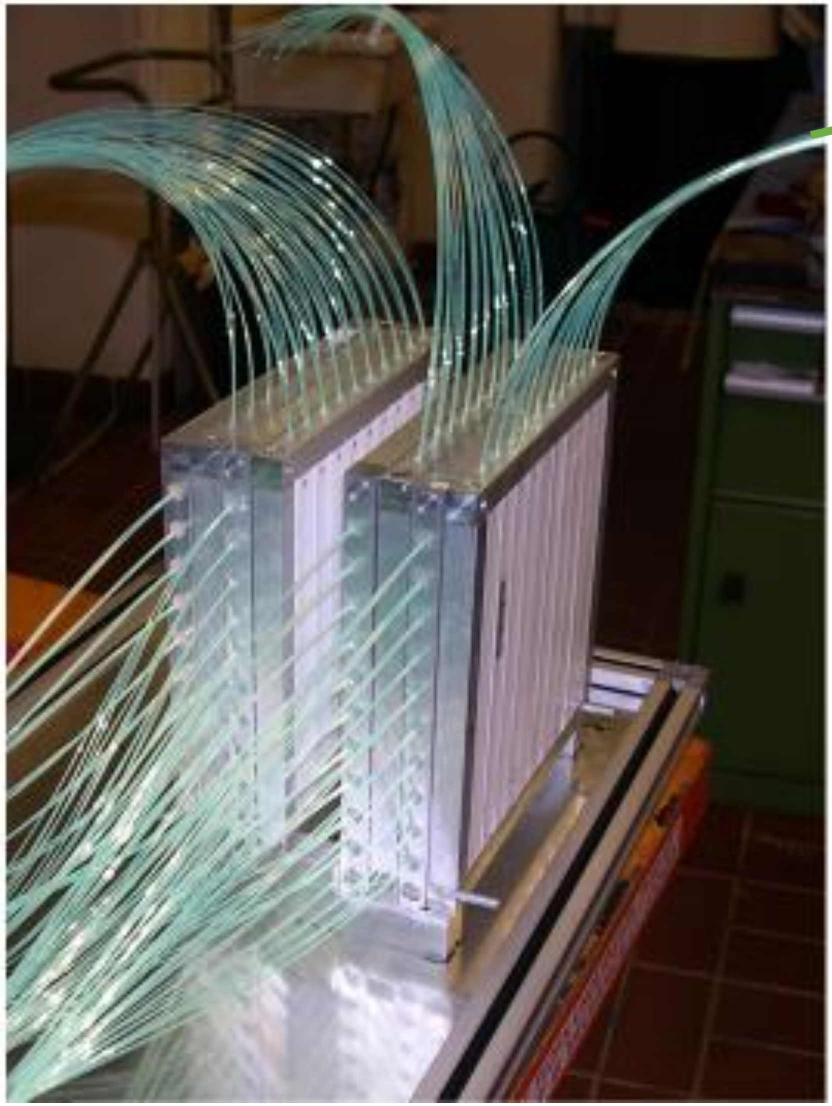
CALICE: Analog Scint. Tile Calorimeters

CDF-II Muon Upgrade

CSP : 320 cm x 32 cm x 2 cm   <Nphe> : 21.3 ; RMS 4.4
BSU: 164 cm x 16.5 cm x 1.5 cm   <Nphe> : 28.6 ; RMS 5.4
Scintillator: 923A; WLS: Y11   [MIP (Cosmic Ray) signal]
PMT : R5600 Hamamatsu



“Plastic scintillator bars with WLS fiber calorimeter for neutrino physics” (*)



R6568-M16 multi-anode PMT (Hamamatsu)

Electrons: $\Delta E/E \approx 0.20\ E^{-0.5}$
Pions: $\Delta E/E \approx 0.53\ E^{-0.5}$

Other projects with plastic scintillator – WLS calorimeter/tracker:

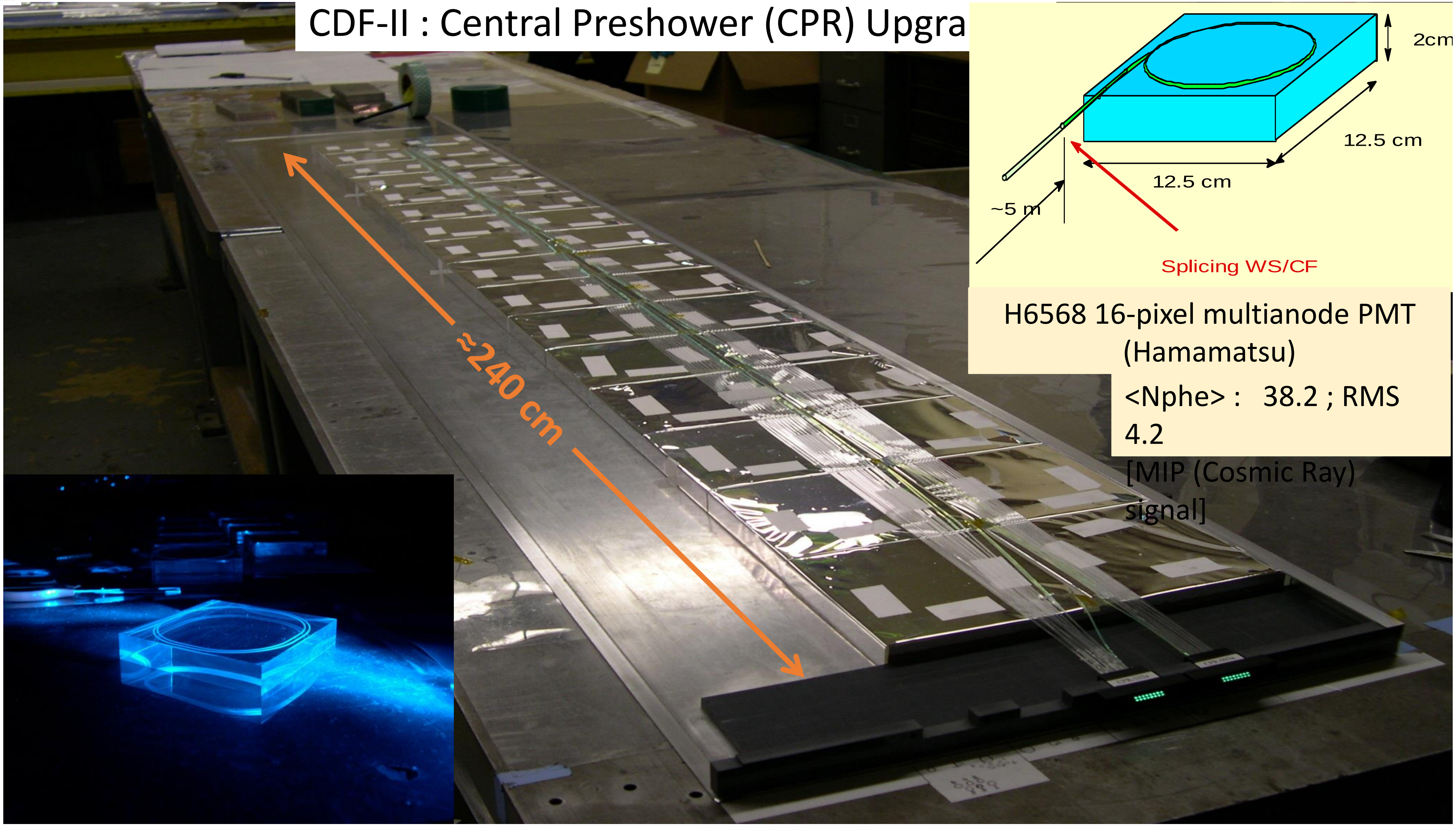
Project	Reference	Photosensors	Nphe/MIP	Energy resolution
NOE	G.Barbarino et al., NIM-PR A456 (2001) 259	PMT	15 phe	e: $\Delta E/E = 0.19\ E^{-0.5}$ π: $\Delta E/E \approx 0.42\ E^{-0.5}$
MINOS	D.G. Michael et al., NIM-PR A596 (2008) 190	MA-PMT	9 phe	e: $\Delta E/E \approx 0.23\ E^{-0.5}$ π: $\Delta E/E \approx 0.55\ E^{-0.5}$
MINERvA	L. Aliaga et al., NIM-PR A743 (2014) 130	MA-PMT	17 phe	CC recoil energy: $\Delta E/E = 0.29\ E^{-0.5}$
T2K ND280	D. Allan et al., 2013 JINST 8 P10019	MPPC	34 phe	e: $\Delta E/E \approx 0.08\ E^{-0.5}$

(*) [NIM-PR A 461 (2001) 316]

INFN
Istituto Nazionale di Fisica Nucleare

The University of Iowa

CDF-II : Central Preshower (CPR) Upgra



H6568 16-pixel multianode PMT (Hamamatsu)

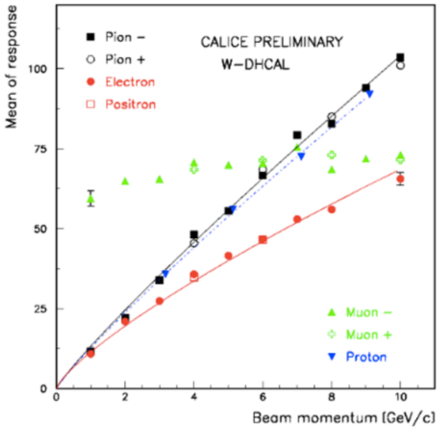
<Nphe> : 38.2 ; RMS 4.2

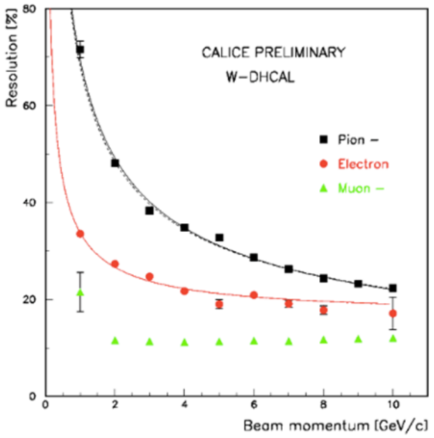
[MIP (Cosmic Ray) signal]

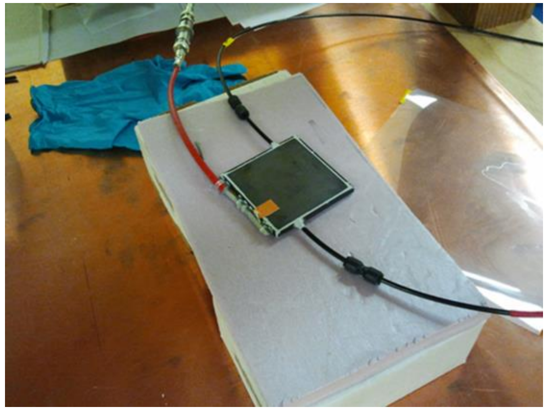
The Digital Hadron Calorimeter (DHCAL)

The DHCAL used Resistive Plate Chambers (RPC) as active elements
Each RPC measures 32 × 96 cm2 and is segmented in 1x1cm2 pads.
3 RPCs assembled into a cassette constitute an active layer of the calorimeter; the area of a cassette is approximately 96 ×96 cm2.

The DHCAL resolution has typically a stochastic term of 64% for pions





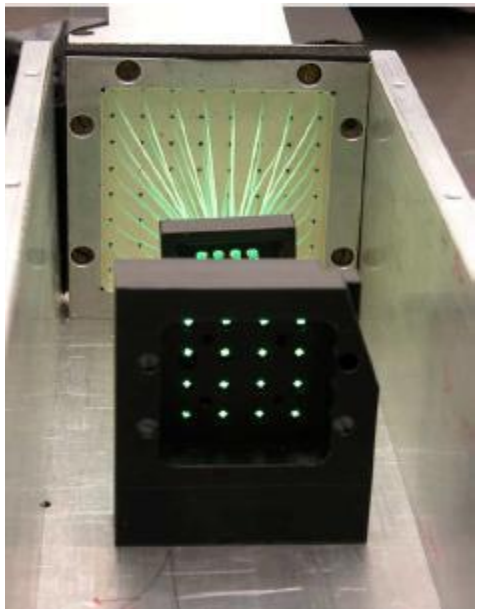


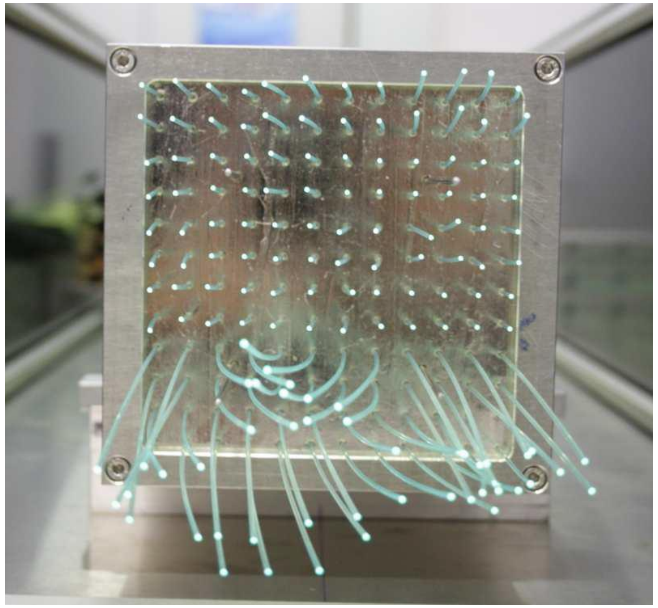
The development of low resistivity glass

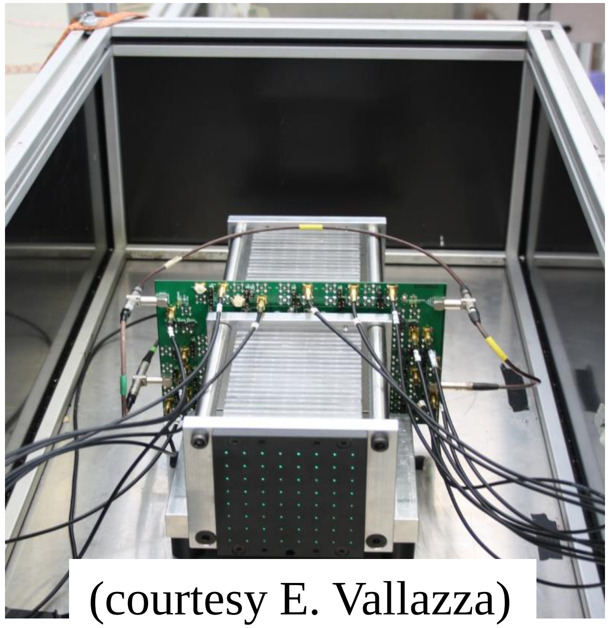
The RPC signal is fast, however, the rate capability of the RPCs is low, at the order of a few hundred Hz/cm2. This is mainly controlled by the resistivity of the RPC glass. Glass with an optimum low (107 Ω/cm2) resistivity to allow larger counting rates but still the desirable RPC performance is being developed in collaboration with Coe College, in Cedar Rapids, one leading glass lab in the world.

Shashlik EM calorimeters

With the development of solid state photodetectors, in particular SiPMs, the shashlik technology has been rejuvenated: various prototypes have been built and tested using different SiPMs, including some custom models produced by FBK. Prototypes have been tested at CERN PS and SPS.







(courtesy E. Vallazza)

High density crystal-based shashlik

In the framework of the CMS Phase II Upgrades we built a Tungsten-LYSO shashlik prototype, with a resolution stochastic term of 16% and constant term of 1%.