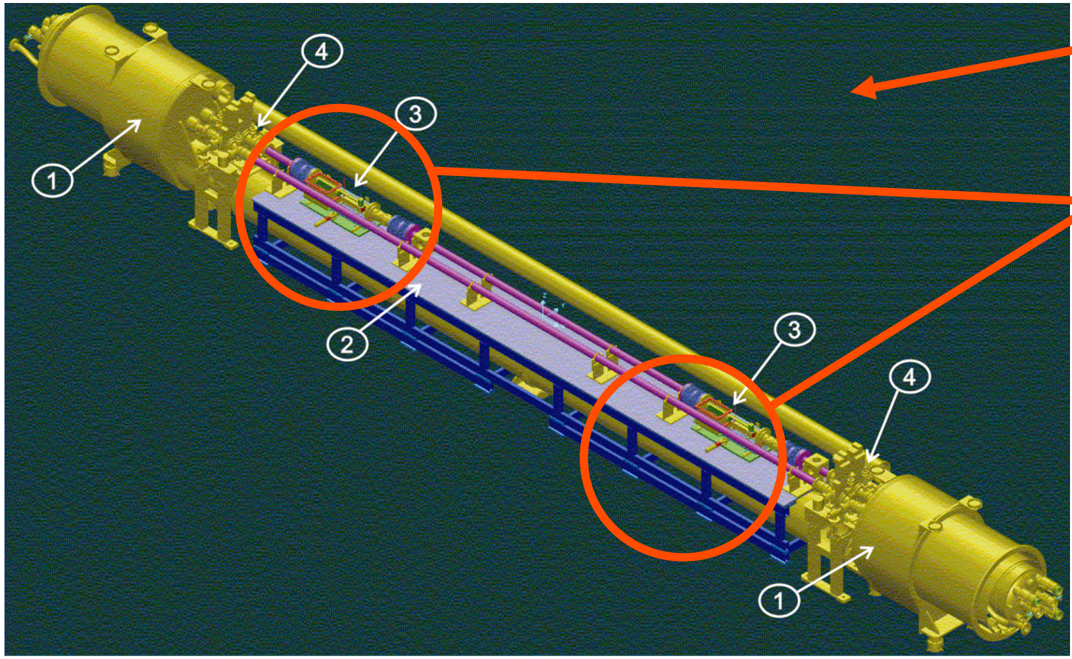
FP420/CMS

Scopo: equipaggiare con rivelatori le zone a ±420 m dal punto di interazione di CMS per rivelare protoni che hanno perso tra 0.2% e 2% del loro impulso (parte centrale dell'evento misurata in CMS e protone/i in FP420).



- **Necessario modificare 2 criostati di connessione (uno per parte)**
- **Due stazioni di misura (mobili lateralmente) per criostato**
- **Ciascuna equipaggiata con**
  - **tracciatore Si "3D" (resistenza alla radiazione, assenza di zone morte)**
  - **Cerenkov per misura tempo di volo dal punto di interazione (per abbattere il pile-up)**

NB identico progetto ad ATLAS

M. Arneodo, Torino, 7/7/2009

http://focus.aps.org/story/v23/st21

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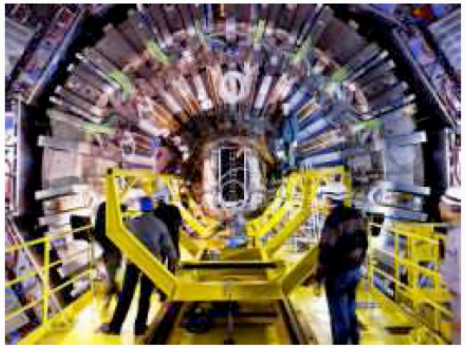
Phys. Rev. Lett. **102**, 242001
(issue of 19 June 2009)
Title and Authors

24 June 2009

A Higgs Boson without the Mess

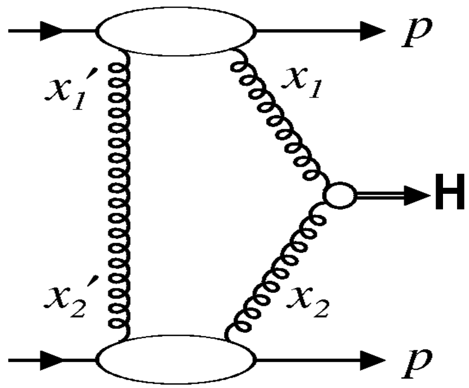
Particle physicists at CERN's Large Hadron Collider (LHC) hope to discover the Higgs boson amid the froth of particles born from proton-proton collisions. Results in the 19 June *Physical Review Letters* show that there may be a way to cut through some of that froth. An experiment at Fermilab's proton-antiproton collider in Illinois has identified a rare process that produces matter from the intense field of the strong nuclear force but leaves the proton and antiproton intact. There's a chance the same basic interaction could give LHC physicists a cleaner look at the Higgs.



CERN

Higgs machine. If CERN's Large Hadron Collider (LHC) can create Higgs bosons, a handful may appear in rare "exclusive" reactions that don't destroy the colliding protons--similar to a reaction now observed at Fermilab. CERN's ATLAS and CMS teams are considering adding equipment to their detectors (CMS shown here) to look for such events (click image to enlarge).

A proton is always surrounded by a swarm of ghostly virtual photons and gluons associated with the fields of the electromagnetic and strong nuclear forces. Researchers have predicted that when two protons (or a proton and an antiproton) fly past one another at close range, within about a proton's diameter, these virtual particle clouds may occasionally interact to create new, real (not virtual) particles. The original protons would merely lose some momentum and separate from the beam. Such an "exclusive" reaction--where the original particles don't break apart--gives unusually clean data because there are so few particles to detect.



Produzione centrale esclusiva

FP420: sviluppi recenti (1/2)

1. Giugno '08: Pubblicato il rapporto su R&D negli ultimi 3 anni:
   arXiv:0806.0302 [hep-ex] (180 pagine), in corso di pubblicazione su JINST
2. Settembre '08: Documento di valutazione da parte del CMS panel
   (J. Incandela, R. Castaldi, S.Ehran, J. Nash):

> The panel finds that the FP420 project has the potential to be a <u>valuable addition</u> to the CMS Physics program.
>
> **The panel recommends that the proponents formulate a draft proposal in the form of a <u>technical design report</u> (TDR) with resource loaded schedule.**
>
> The panel recommends that the new report should be completed and reviewed asap in view of issues related to cryostat procurement.
>
> Finally, the panel would like to acknowledge the significant work that has been done …….
> We encourage the proponents to now extend their efforts to the next stage in addressing the issues raised by the panel and Management Board.

FP420: sviluppi recenti (2/2)

3. **Interesse in CMS-Torino nello sviluppo e costruzione del tracciatore con rivelatori 3D.**
   - acquisizione di competenze utili per es. in vista dell'upgrade del tracker per SLHC e per applicazioni di Fisica Medica
   - competenze diversificate nel gruppo e disponibilita' di tecnici e tecnologi in sede

4. Da marzo '09: Partecipazione a test/caratterizzazione di sensori 3D al CERN in collaborazione con A. La Rosa (CERN) e C. Da Vià (Manchester) – studente di laurea specialistica (F. Rivero)

5. Maggio '09: Partecipazione a test beam al CERN con rivelatori 3D. Torino ben inserita nell'analisi dei dati dei rivelatori 3D prodotti da IRST (studente di laurea specialistica M. Borri)

6. Da luglio '09: test di irraggiamento di sensori 3D al CERN (studente F. Rivero con A. La Rosa, M. Glaser)

7. Contatti con R. Horisberger (PSI, CMS pixel), D. Bortoletto (Purdue, CMS SLHC upgrade), G.-F. Dalla Betta (Trento)

Sensori 3D in ambiente CMS

Nel lavoro di R&D finora considerati sensori interfacciati a FE e DAQ di ATLAS.

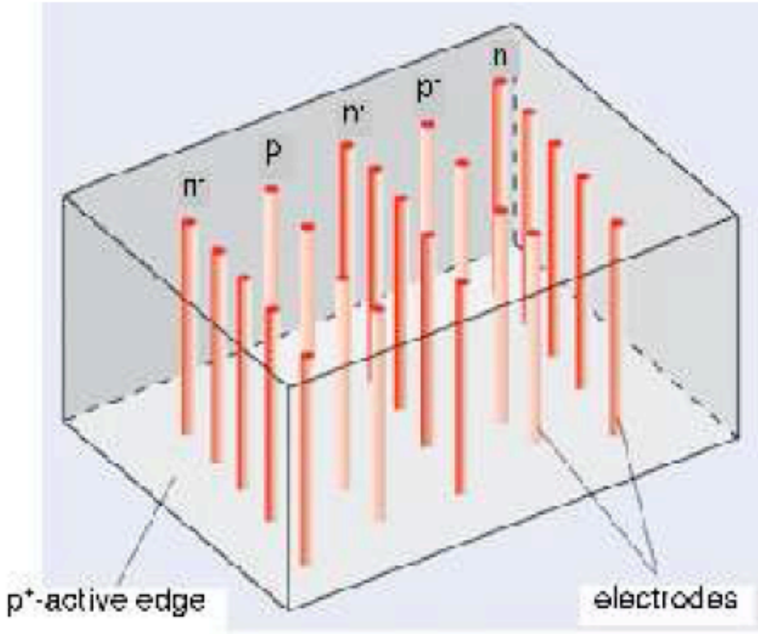
Sviluppare il tracciatore per FP420-CMS implica

1) interfacciare i rivelatori 3D al FE dei pixel di CMS

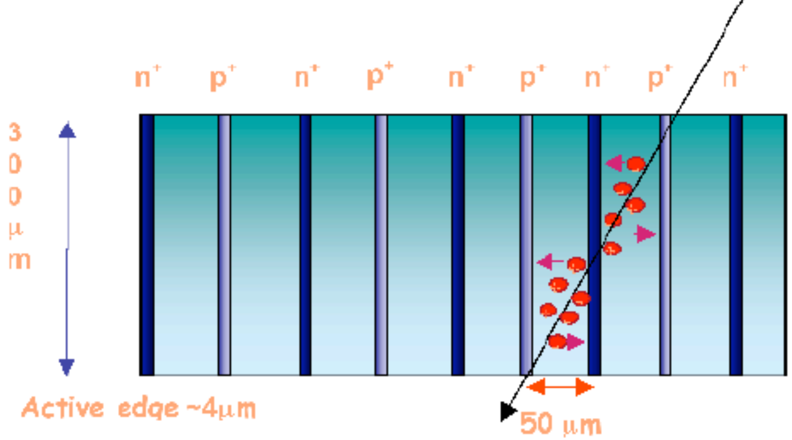
3) riprogettare l'alloggiamento meccanico delle stazioni o riadattare la soluzione ATLAS

NB sensori 3D compatibili con il chip CMS sono in corso di fabbricazione:
SINTEF (disponibili dall'autunno), IRST (disponibili adesso)

3D Si detectors



S. Parker, J. Hasi, C. Kenney, C. Da Vià
(Hawaii/Stanford, Manchester, MBC)

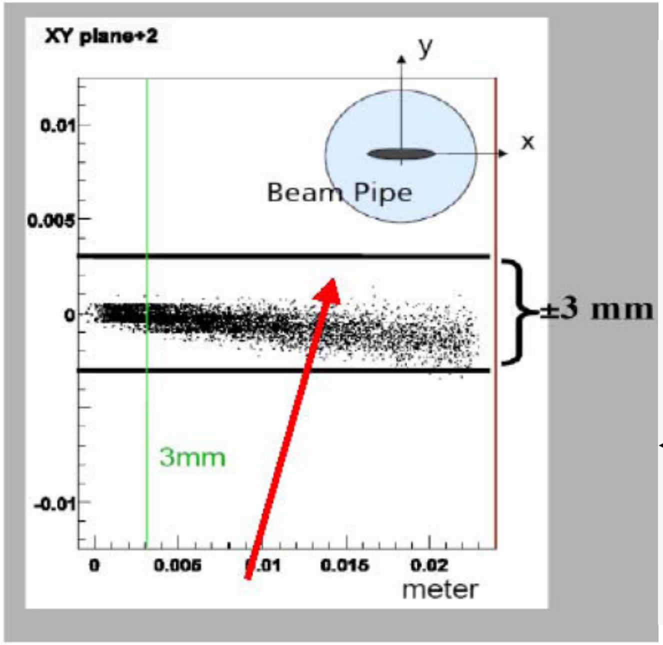


- Electrodes penetrate entire thickness of detector, perpendicular to surface
- Small collection distances, fast signals, radiation hardness
- Small dead region at edge

Transfer to industry in progress: SINTEF, IRST

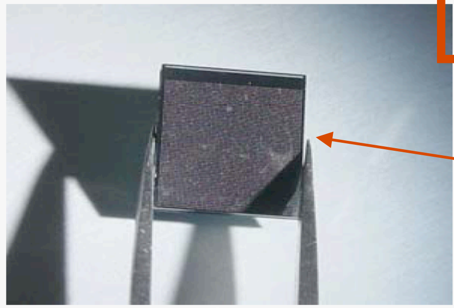
Candidate for ATLAS, CMS SLHC upgrades

Detector mechanical support



7.2 mm x 24mm (7.2 x 8 mm^2 sensors)

3D silicon with active edges



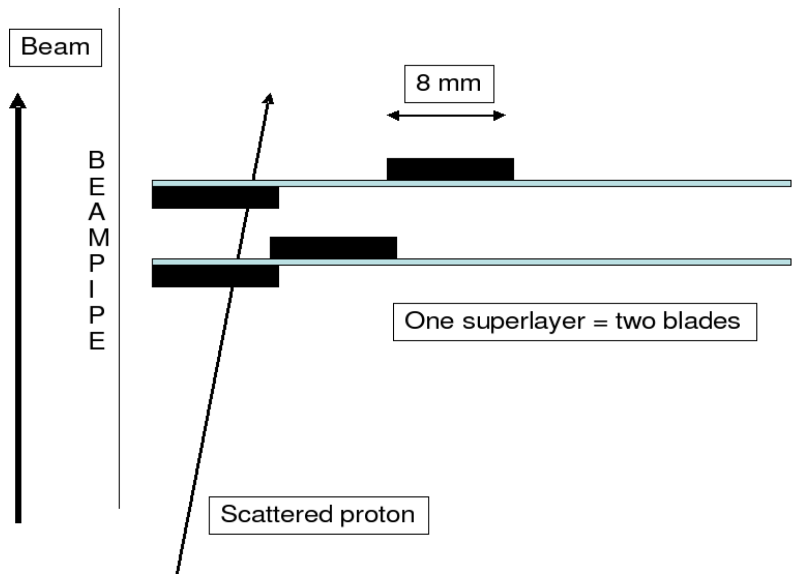
Front-end pitch:
50μmx400μm

(ATLAS)

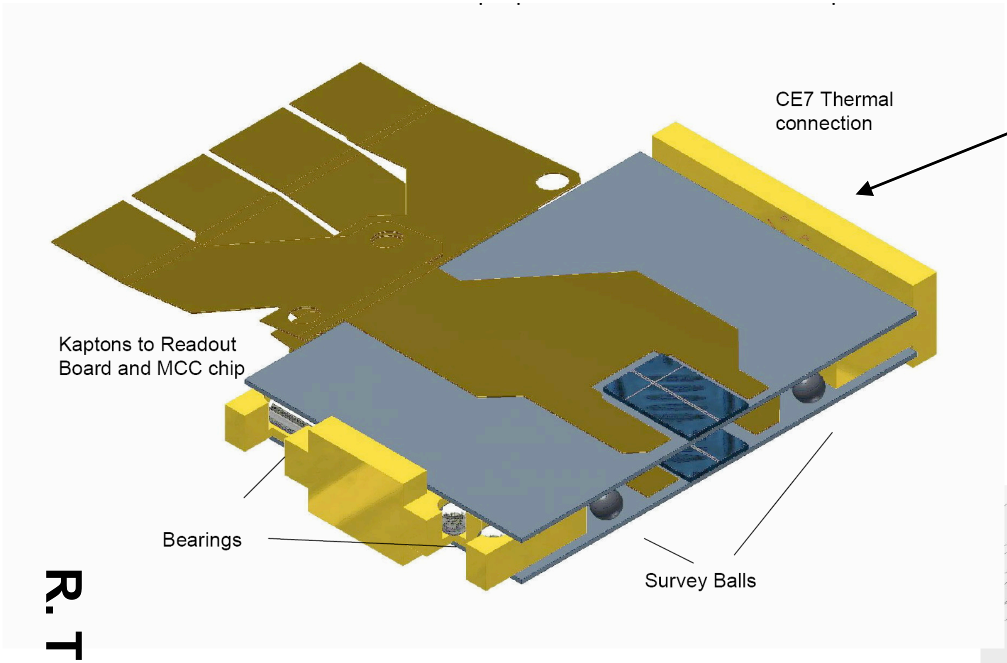
7.2x8 mm^2

Soluzione ATLAS:
FE pixel 50μm x 400 μm

<u>Soluzione CMS:</u>
FE pixel 100μm x 150 μm
Migliore risoluzione – sufficienti meno piani di rivelatori ?
(3 per superlayer anzichè 4 ?)



Detector mechanical support



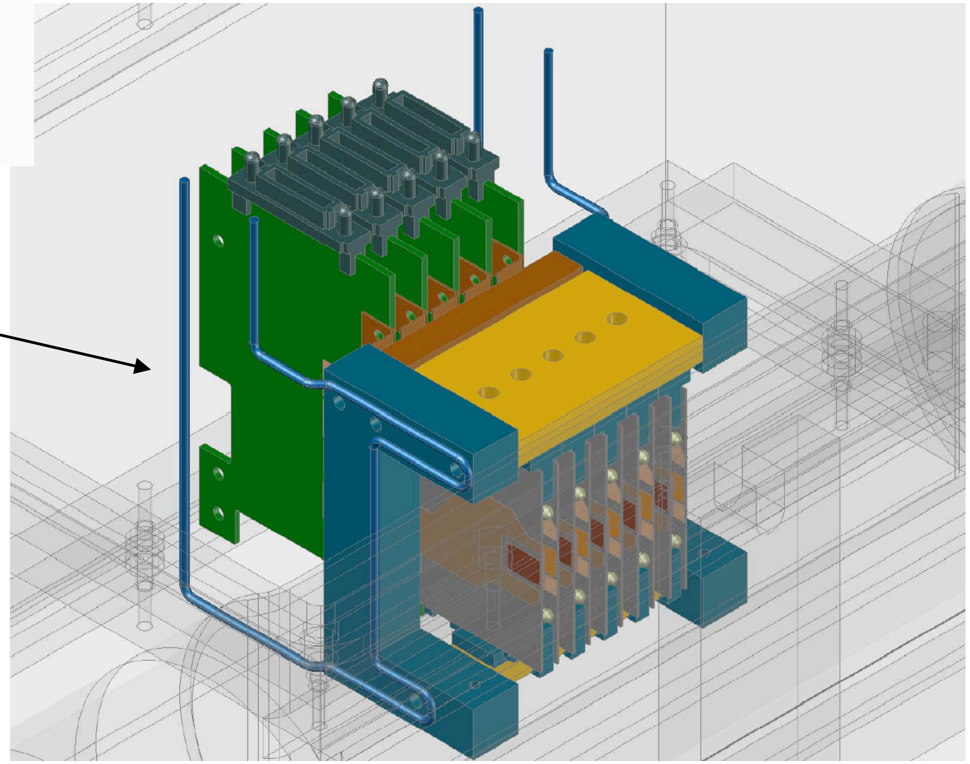
Superlayer

Il disegno va modificato
per tenere conto
- della diversa geometria dei chip CMS
- 3 sensori invece di 4

Materiale: CE7, Aluminium Nitride

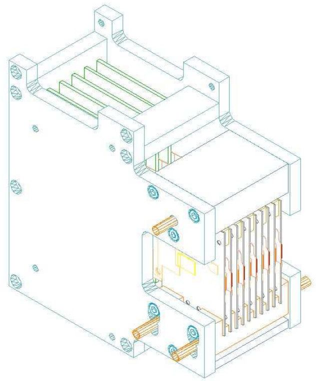
Tracking Station

Sufficienti 4 superlayers ?

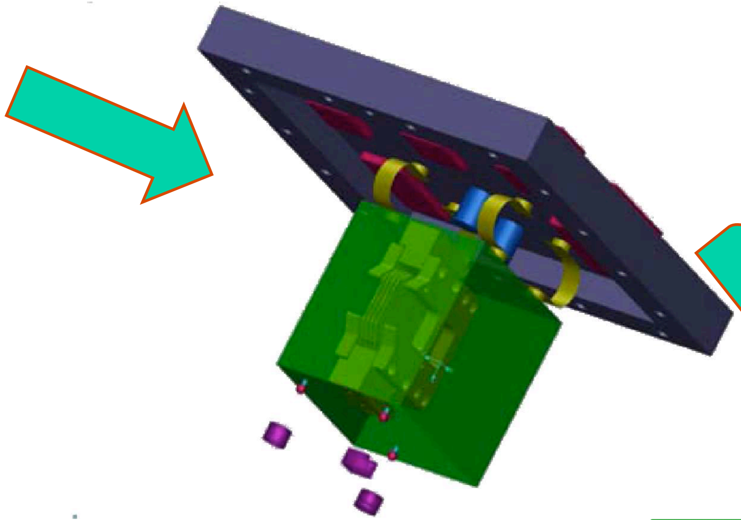


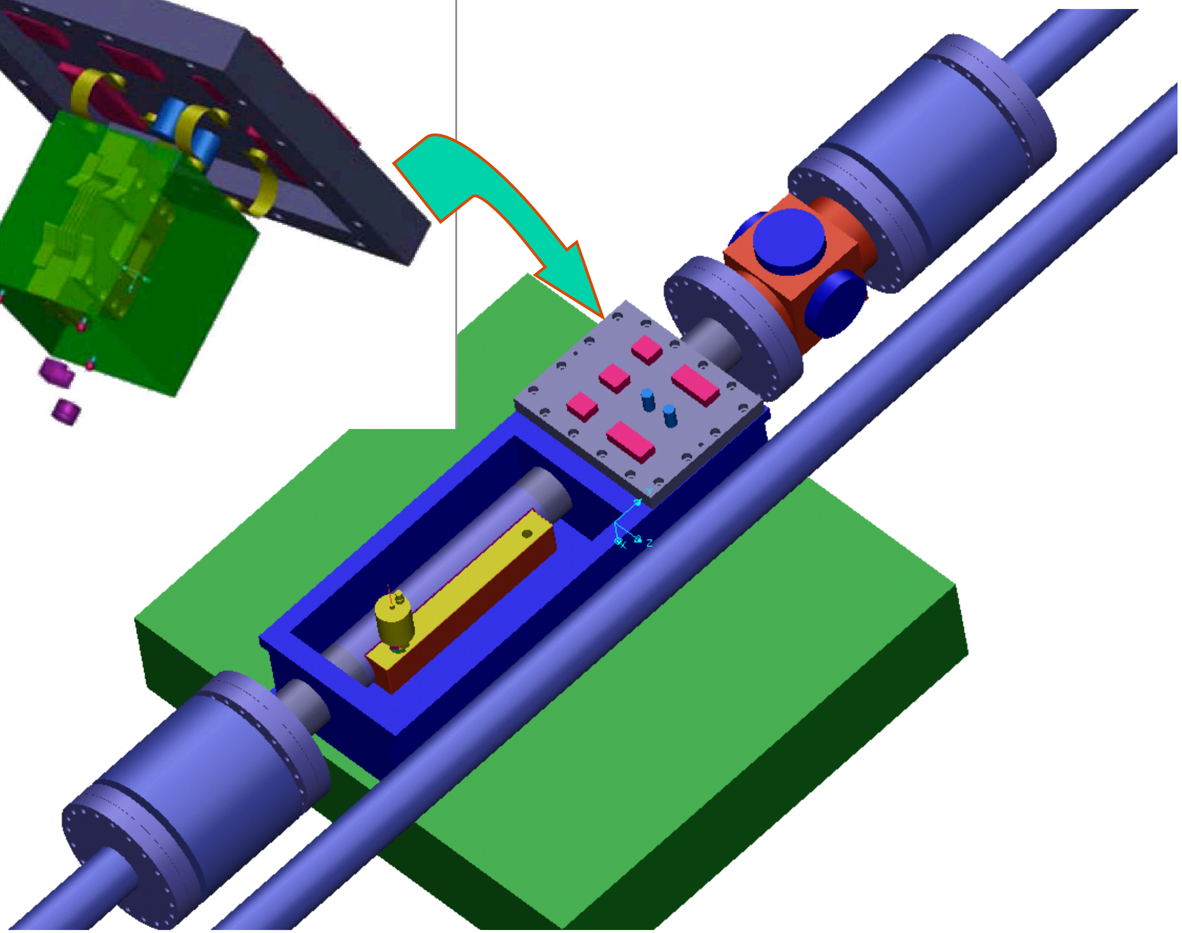
R. Thompson (Manchester)

Detector mechanical support



Tracking station =
5 superlayers

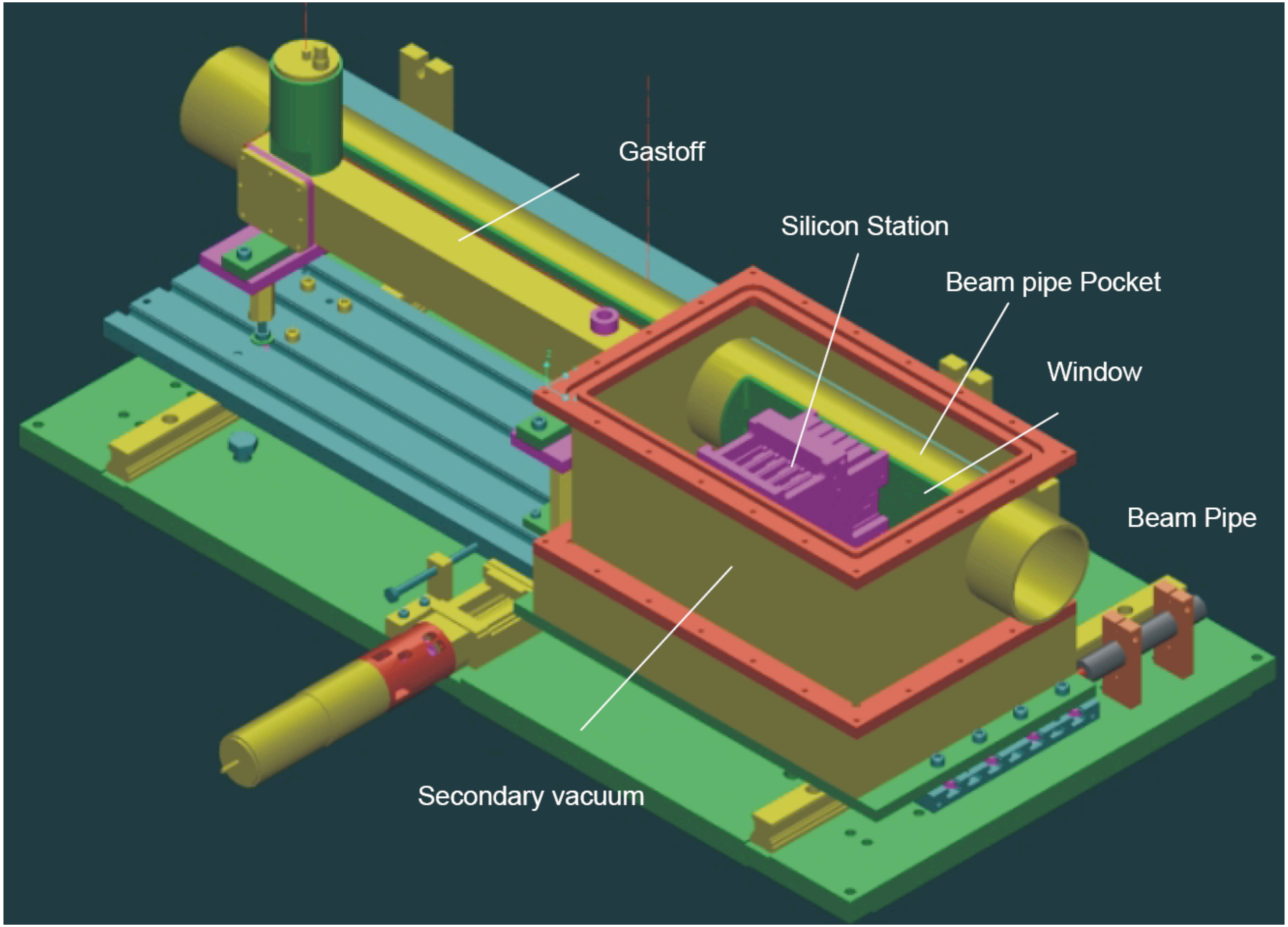




- Posizionamento con sfere di rubino (M. Dattola)

- Rivelatori raffreddati a -20 C in vuoto secondario

Full measurement station



Responsabilità

Responsabilità finora:

- **Coordinamento integrazione meccanica criostato-rivelatori (D. Dattola)**
- **Sviluppo/caratterizzazione/test power supplies (M. Obertino, P. De Remigis, A. Zampieri & H. Larsen)**
- **Coordinamento simulazione beam-line e rivelatore (M. Ruspa)**
- **Studio pp→ pHp, H → WW (A. Vilela Pereira)**
- **Management Board (M. Arneodo)**

Vorremmo assumere responsabilità nel tracciatore (NB finora sviluppato dai colleghi di ATLAS – Manchester), in particolare:

- **Sensori 3D**
- **FE (pixel CMS)**
- **Elettronica di controllo on detector (pixel CMS)**
- **Meccanica associata**

Nel 2010:
- **Installazione catena di lettura a Torino (sensore + FE)**
- **Test sensori/elettronica (anche su fascio)**
- **Prototipi meccanica (supporto rivelatori e box rivelatori)**

Scopo attivita' 2010:

✓ dimostrare fattibilita' utilizzo sensori 3D accoppiati con FE dei pixel di CMS

✓ avere un prototipo della meccanica intorno ai sensori (struttura di supporto, box con sistema di posizionamento)

✓ completare la stesura del TDR con i risultati ottenuti come richiesto da CMS

RICHIESTE 2010

o) Missioni interne (contatti IRST/Trento …): **5 keu**

o) Missioni estere **15 keu**
(test, test beam, riunioni FP420/CMS, coordinamento con la macchina)

o) Consumo **15 keu**

Prototipi meccanica:

- struttura supporto silici:	3 keu
- prototipo box silici eposizionamento con rubini:	6 keu
- prototipo finestra beam-pipe (elettroerosione):	1.5 keu

Elettronica:

- board standalone per test sensori+FE	3.5 keu
- Bump-bonding:	1 keu

RICHIESTE 2010 *come attivita' CMS e perche'*

✓ la richiesta per il 2010 e' minima e simile a quella del 2009
➔ unica priorita' ora: scrittura del TDR e dimostrazione di fattibilita'

✓ molto lavoro fatto finora, riconosciuto dai referee ma..
➔ necessita' di concludere con un TDR e di arrivare a un SI/NO

✓ le persone coinvolte lavorano in CMS e la NOVITA' di quest'anno e' che il gruppo di Torino nel suo insieme ha deciso di contribuire all'attivita' sul rivelatore di tracciamento con sensori 3D (c'e' esperienza su rivelatori di questo tipo da ZEUS, supporto di tecnici e tecnologi) senza pregiudicare gli impegni su CMS

✓ questa attivita' ci pare utile/interessante per possibili sviluppi in SLCH, SuperB, ILC…..

✓ di sicuro importante per i giovani che "devono" imparare sul campo

Reserve

FP420 R&D report

The FP420 R&D Project: Higgs and New Physics with forward protons at the LHC

To be published in JINST

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FP420 R&D Collaboration

[1]Fermilab, [2]University of Manchester and the Cockcroft Institute, [3]Università del Piemonte Orientale, Novara, and INFN, Torino, [4]Yale University, [5]Universiteit Antwerpen, [6]Université Catholique de Louvain, [7]University of Texas at Arlington, [8]University of Glasgow, [9]University College London (UCL), [10]Mullard Space Science Laboratory (UCL), [11]INFN Torino, [12]University of Manchester, [13]CERN, PH Department, [14]Rockefeller University, NY, [15]Lawrence Livermore National Laboratory (LLNL), [16]University of Wisconsin, Madison, [17]UC Davis, [18]IFCA (CSIC-UC, Santander), [19]Molecular Biology Consortium, Stanford University, [20]Institute for Particle Physics Phenomenology, Durham, [21]DESY, [22]Brookhaven National Lab (BNL), [23]Università di Torino and INFN, Torino, [24]University of Alberta, [25]Helsinki Institute of Physics, [26]CERN, TS/LEA, [27]ITEP Moscow, [28]Universidade do Estado do Rio De Janeiro (UERJ), [29]Institute of Physics, Prague

Valutazione da parte del Review Panel

Overview

The FP420 project involves placement of fast timing and tracking detectors at 420 m from either side of the central CMS detector in order to detect protons deflected in interactions involving exchanges of gluons or photons. At 420 m from the central collision region, it is possible to detect protons that are deflected in low energy collisions. For example, in the case of Central Exclusive Production (CEP), the energies are low enough to potentially access single Higgs production for low Higgs masses where the decay $h \rightarrow b\bar{b}$ dominates.

The review took place in two main sessions on April 8, and April 28, 2008. The material presented to the review panel is now documented in a 176 page report from the FP420 joint ATLAS-CMS R&D collaboration.[1]

The review focused on physics potential, and feasibility. With regard to physics, a detailed case study of CEP Higgs with $h \longrightarrow b\bar{b}$ was considered. With regard to the experimental apparatus, the main considerations of the panel were; Timing resolution & timing reference system, Tracking, Cryostats, Schedule and Cost. Secondary issues considered were; Safety (Impact on beam conditions), and Collaboration strength.

Conclusions

Physics

With regard to FP420 Physics the panel agreed that this is an interesting program, with the potential to provide an alternative way of selecting/viewing CMS data. The understanding of CEP has advanced, and there is now evidence for these processes in Tevatron data. Backgrounds seem to have been evaluated in a reasonable way. First data will provide an important reference – particularly in forward regions.

On general grounds, isolating glue-glue and photon-photon collisions is of very basic interest. The program is not critical to CMS at this moment in time in the sense that it is not yet known what physics will be accessible already with the as-built detector. Under certain circumstances however, it could become critical to CMS for better understanding the Higgs sector and in particular, accessing otherwise inaccessible decay modes such as $h \rightarrow b\bar{b}$.

Technical Issues

Many detailed and high quality studies and developments have taken place to indicate that FP420 is potentially feasible. The panel believes that several additional demonstrations would resolve any lingering doubts about the feasibility and preparedness of the program. Namely

- Timing: This is critical to performance, particularly at high luminosity (when the FP420 program would likely turn on). Despite significant progress, several key milestones need to be demonstrated. First of all, it is important to demonstrate the operation of timing detectors with resolution of order 10 ps (though it should be noted that this may already have been achieved). Secondly, a reference timing system with resolution < 10 ps is needed. Designs look feasible, but an actual demonstration of such a system with the FP420 extended layout is necessary.

- Tracking detectors: These are required with small dead space, fast response and good resolution. New 3D detectors appear to be a viable option but they have so far only been operated with ATLAS readout electronics. Interested and experienced members of CMS need to be found to demonstrate operation of these detectors with CMS readout electronics and data acquisition.

- Cryostats & Mechanics: The engineering and manufacture of the cryostat and mechanics are not a primary technical concern – but cost, schedule and manpower issues enter here.

Resources & Management Issues

The cost for two detector arms is estimated by the group to be of order 5 MCHF. It is difficult to ascertain how accurate the cost can be projected to be at this stage, but it seems very unlikely to be low by more than 40-50%.

The panel agreed that FP420 project funding should not compete with CMS upgrades.

The FP420 collaboration is currently a joint ATLAS - CMS entity. The CMS part of the collaboration is not strong enough to realize the project in CMS. This is not surprising because all efforts to date have been focused on R&D. CMS proponents now need to demonstrate that an adequately strong collaboration can be assembled, with good technical leadership that would not detract from planned CMS upgrades.

Valutazione da parte del Review Panel

Recommendations

The panel finds that the FP420 project has the potential to be a valuable addition to the CMS Physics program. The panel recommends that the proponents formulate a draft proposal in the form of a technical design report (TDR) with resource loaded schedule. The report should address all remaining open issues, including:

- Re-evaluation of backgrounds using collisions data.
- Technical Issues: Timing, tracking, DAQ, cryostats
- Schedule and costs
- Management / Letters of Intent of collaborating parties
- Funding plans (that don't conflict with higher priority CMS programs)

Several of these issues were emphasized by the CMS Management Board. In particular, the Management Board considered that before any TDR/proposal could be evaluated, it is essential to demonstrate the technical feasibility of the timing, to show that a realistic trigger rate on the order of 5 kHz at L1 could be used, that the conditions in the very forward regions should be understood from data in 2008, and that the interested persons need to be identified.

The panel recommends that the new report should be completed and reviewed asap in view of issues related to cryostat procurement. CMS should evaluate the TDR/proposal, when complete, within the broader context of CMS priorities and goals.

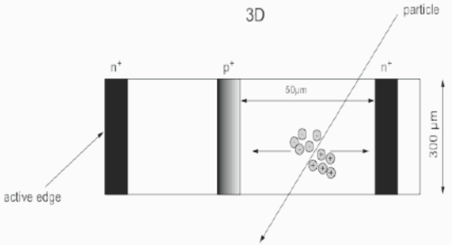
Finally, the panel would like to acknowledge the significant work that has been done by the proponents in preparation for the review and in response to the detailed requests of the review panel. We encourage the proponents to now extend their efforts to the next stage in addressing the issues raised by the panel and Management Board.

Valutazione da parte del Review Panel

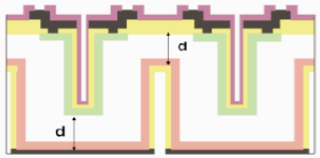
Test in laboratorio e su fascio

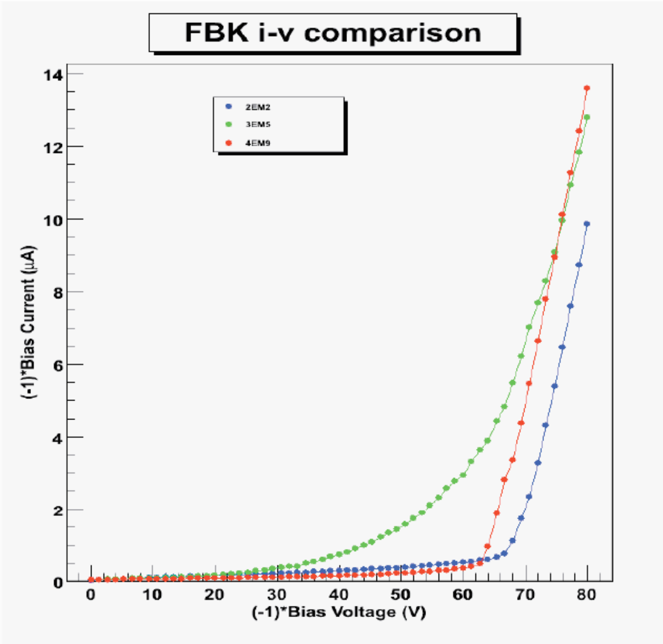
Caratterizzazione in laboratorio (CERN 161-1-024) di rivelatori 3D (F.Rivero)

Rivelatore 3D Stanford

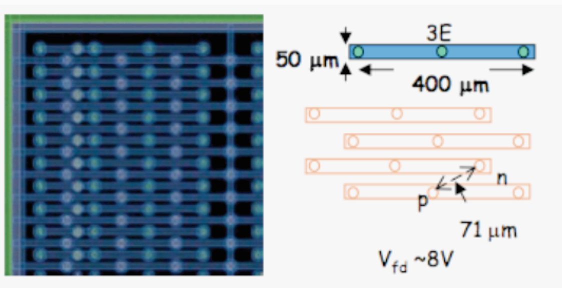


Rivelatore 3D FBK (Trento)





Testbeam in campo magnetico (26/5-2/6 2009)



Residui (prel.) Rivelatori 3D FBK - B OFF (M.Borri)