Movable TAXN Roadmap

HL-LHC PLC Meeting

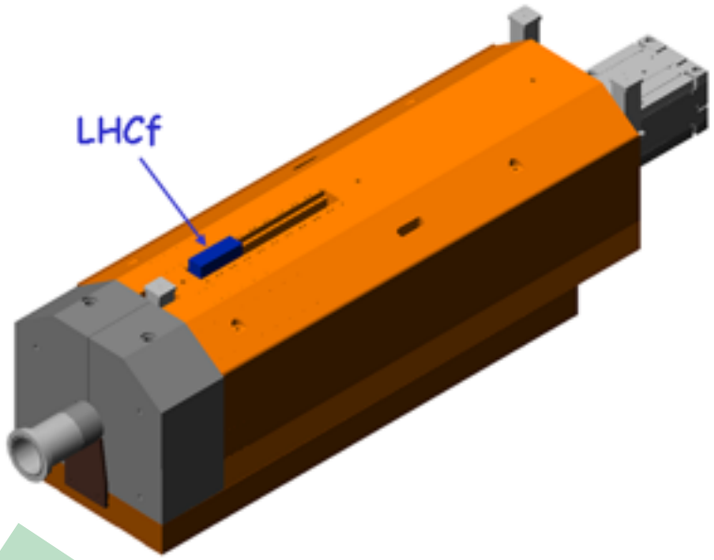
thanks to : R. deMaria, S. Redaelli, F. Cerutti, L. Esposito, P. Fessia, H. Burkhardt for input

….and stealing their slides!

October 14, 2014

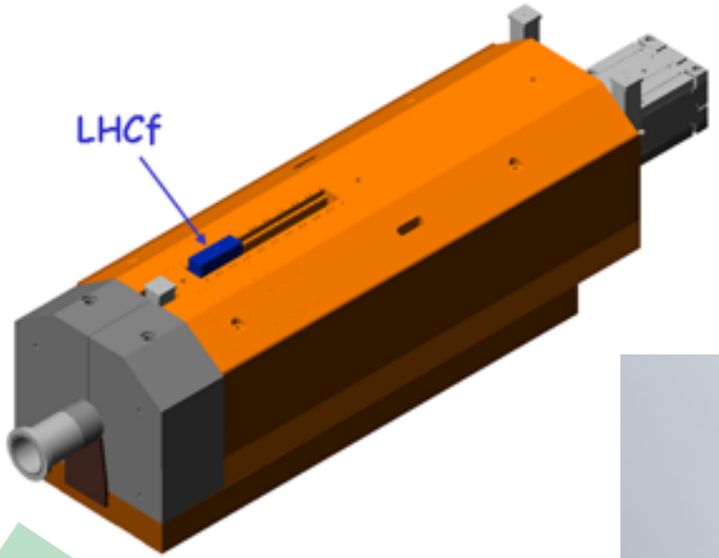
I. Efthymiopoulos — CERN

TAXN Roadmap

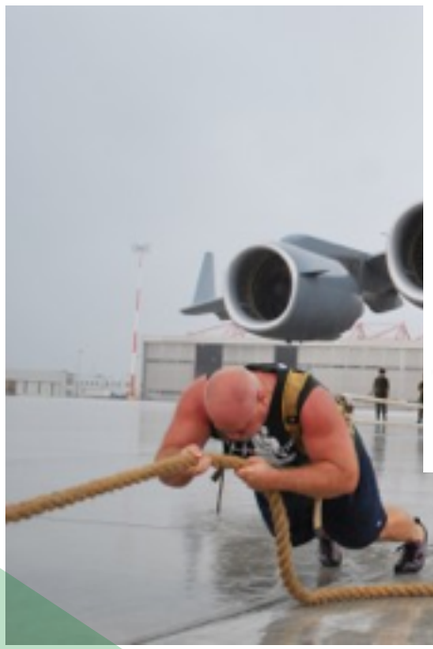


TAN

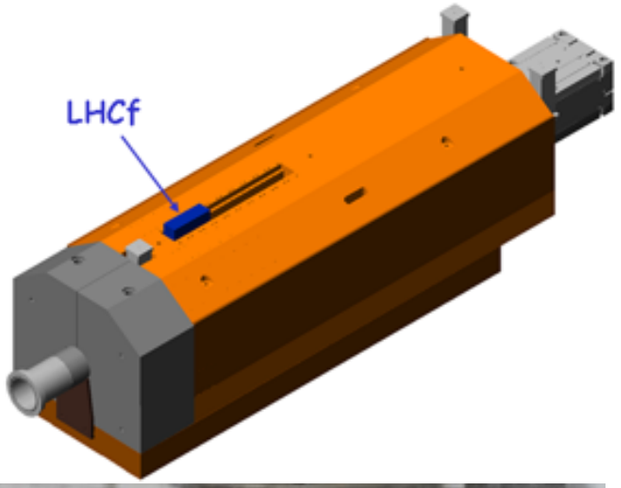
TAXN Roadmap



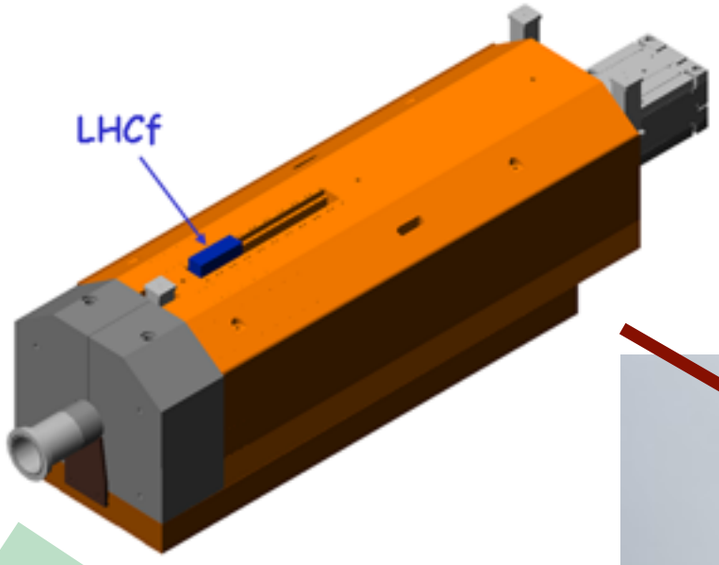
TAN



Movable TAXN

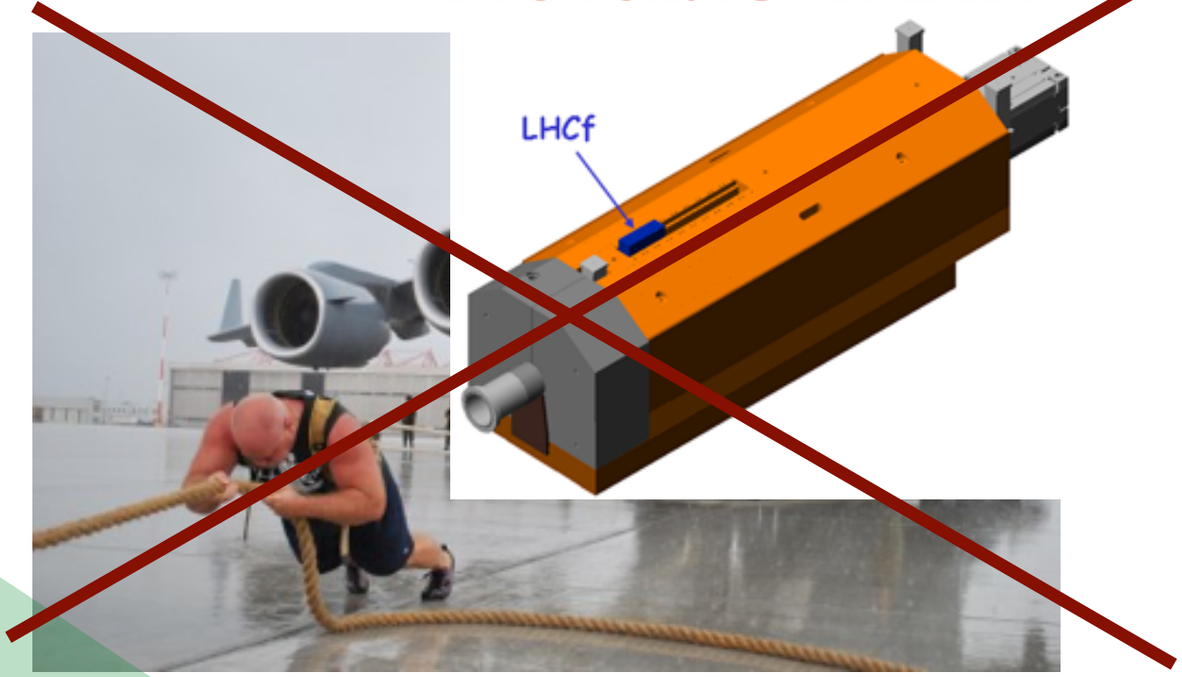


TAXN Roadmap

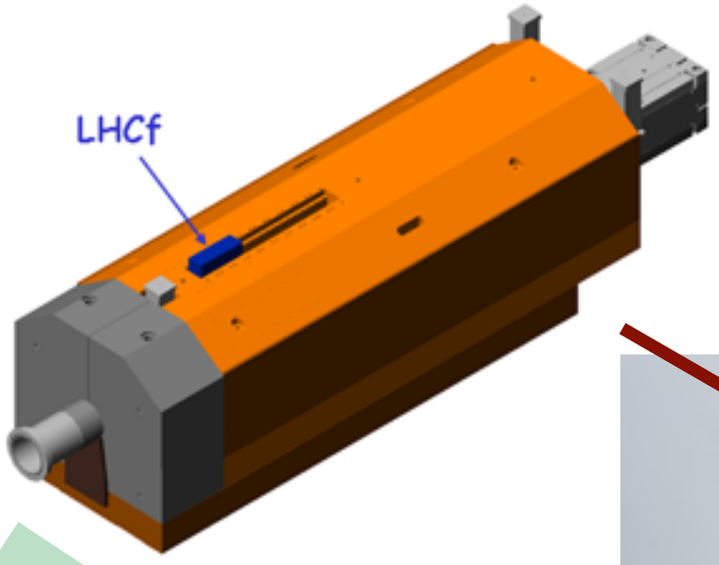


TAN

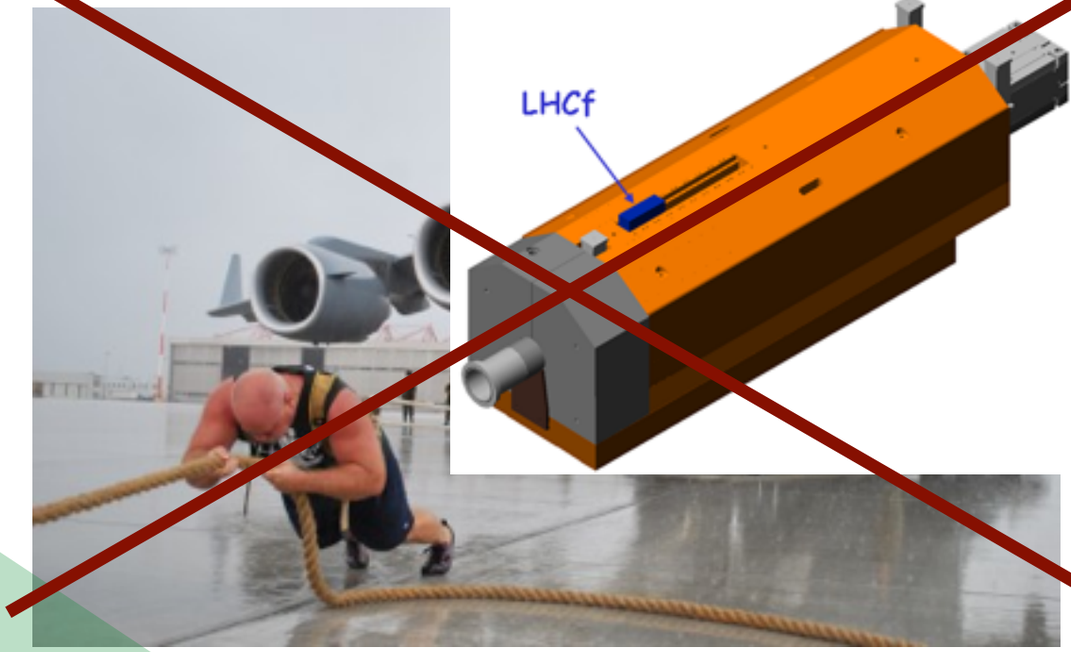
Movable TAXN



TAXN Roadmap

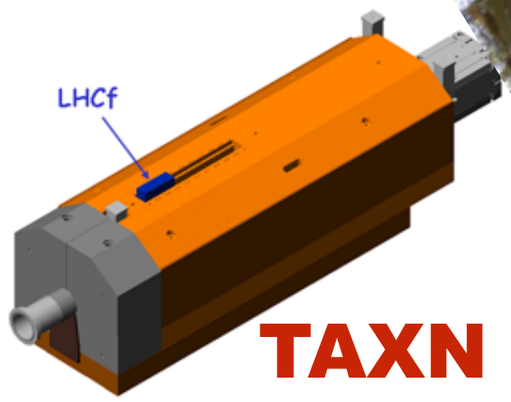


TAN



Movable TAXN

Collimator(s)



TAXN

TAXN Design Considerations

TAN/TAXN functionality:

- neutral beam absorber that should capture the outgoing flux of neutral particles produced at the high-luminosity regions IP1, IP5
- protect the downstream twin aperture magnet (D2 +) from quenching
- localise the induced activation to this massive absorber

- TAN specialties

- transition from single to double piping
  - variable aperture tubes
- slots for
  - beam instrumentation (Luminosity monitors)
  - LHCf experiment
- air cooled

- TAXN design

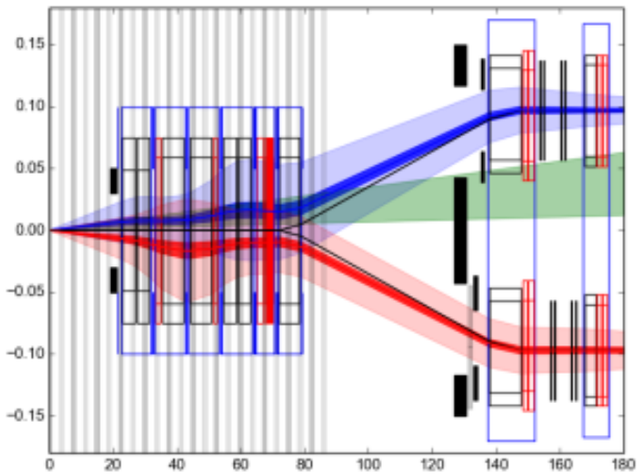
- transition from single to double piping
  - constant aperture tubes
- no design constraints from BI, Experiments (tbc)
- water cooled device (1-2 kW)
- designed to be installed/ disassembled in-situ in presence of other equipment

TAN – Present design criteria

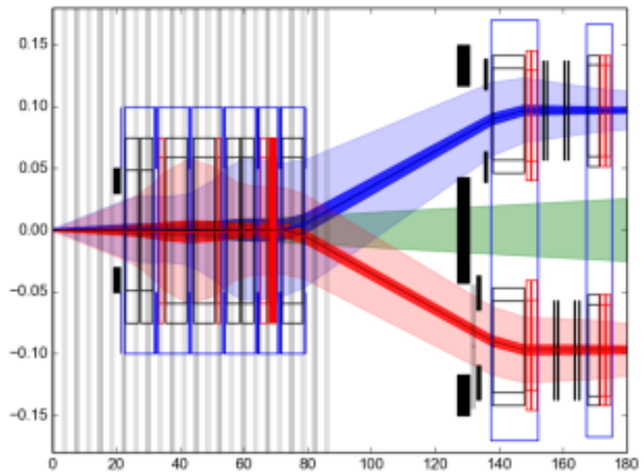
Courtesy : R. De Maria *et al.*

- HL-LHC layout compatible with 3 collision optics for IR1 and IR5:
  - β^*=15/15 cm, Round HV crossing,
  - β^*=7.5/30 cm, Flat V crossing,
  - β^*=30/7.5 cm, Flat H crossing,
- Energy deposition critical for H crossing, TAN aperture determined by Flat optics.
- If TAN H apertures change, protection would be optimized for all optics.

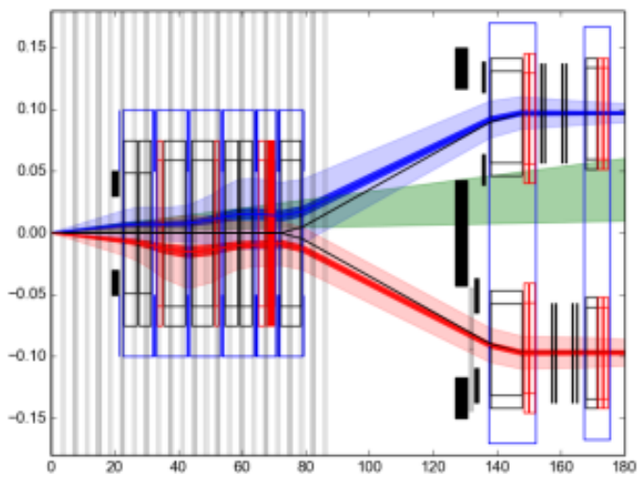
Round optics: H crossing



Flat optics: V crossing



Flat optics: H crossing



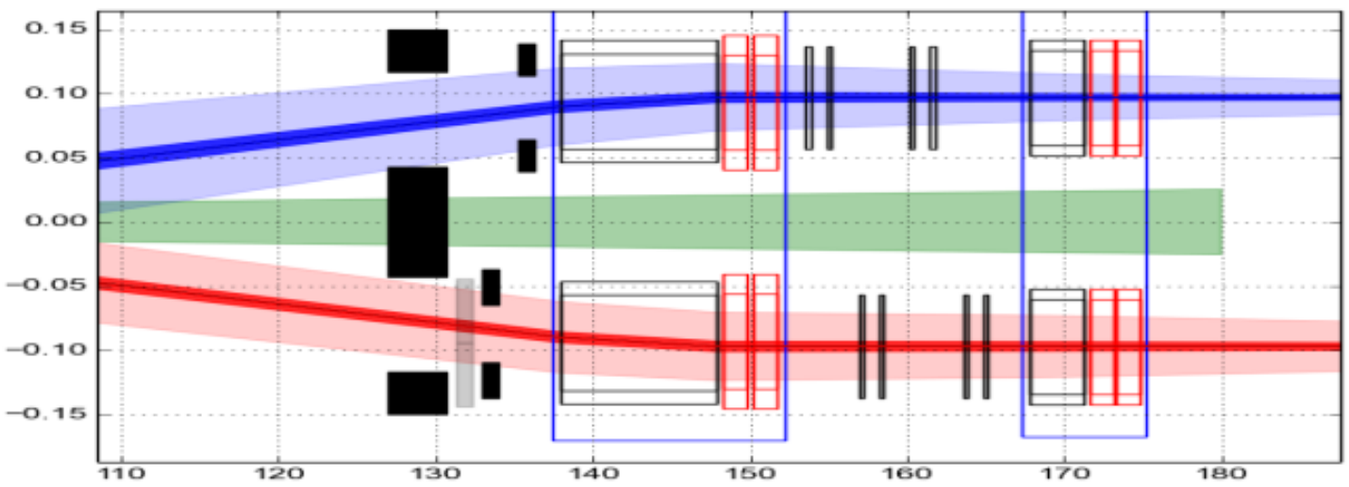
Beam 1, Beam 2, Neutral Debris (400 µrad cone)

Movable TAXN

Courtesy : R. De Maria *et al.*

TAN – Movable option

- The TAN could be split in two parts:
  - A fixed TAN to shield all radiation for vertical crossing and most of radiation for horizontal (e.g. closer to the IP by 4 m, larger aperture ~82mm, smaller separation ~140 mm) .
  - A second TAN with movable jaws in the H plane (+- 10 mm) only that protects only what is left by the first TAN (no material needed in the central part) and adjust at every change of optics (e.g. during a technical stop, if not every year).
- The movable TAN would need massive jaws (no like a TCL, it is not required to be moved with beam like a TCDQ).

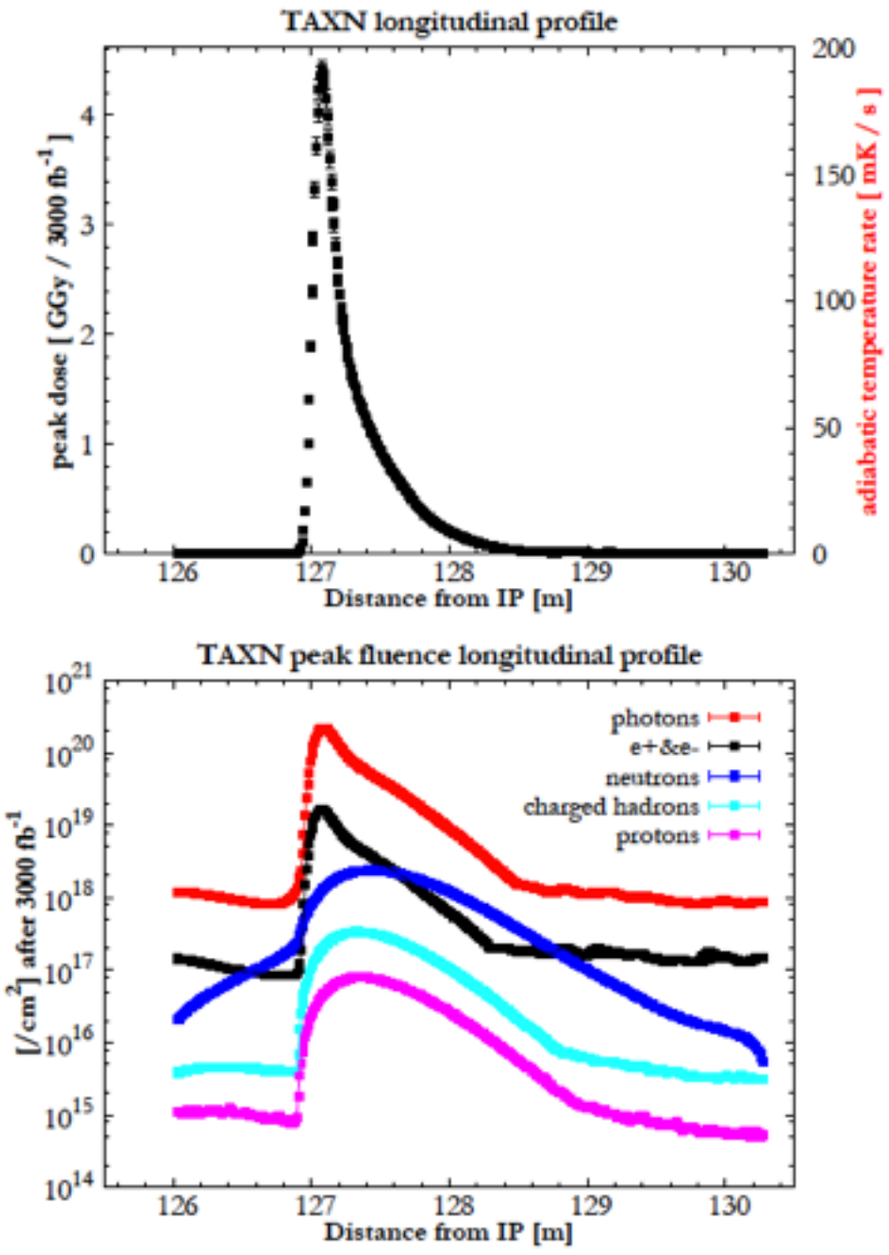


Beam 1, Beam 2, Neutral Debris (400 µrad cone)

TAXN Energy Deposition & Coverage

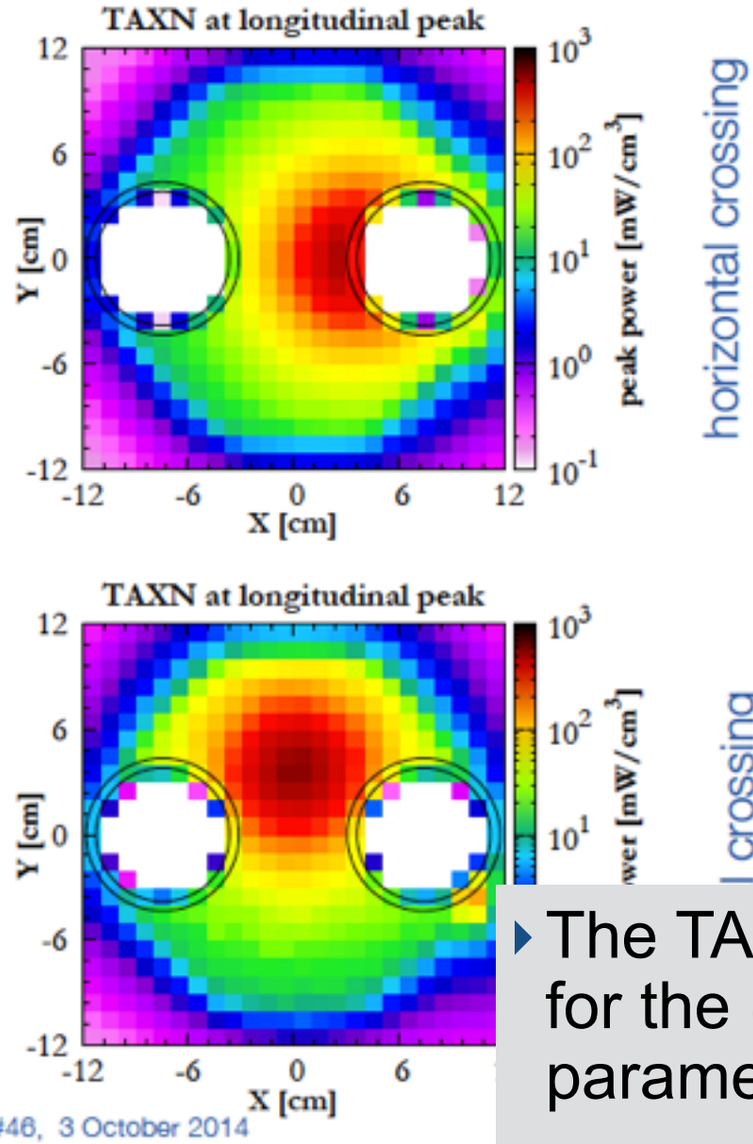
TAXN: energy deposition

Courtesy : L. Esposito, F. Cerutti



Total power = 1150 W @ 5 × $\mathscr{L}$0

Peak dose = 4.5 GGy @ 3000 fb^{-1}



- The TAXN will be designed for the ULTIMATE HL-LHC parameters

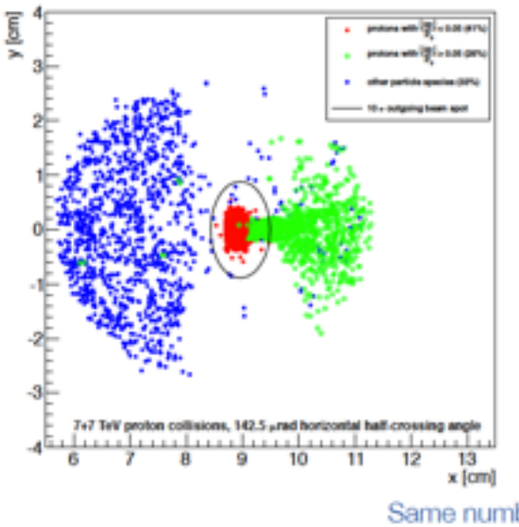
TAXN Energy Deposition & Coverage

Courtesy : L. Esposito, F. Cerutti

Debris after the TAN

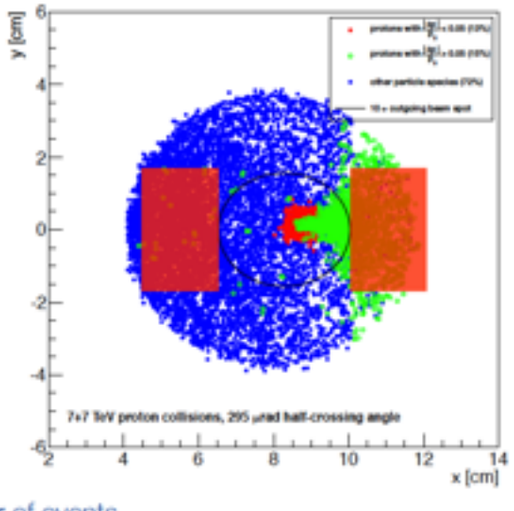
LHC

debris distribution at TCL.4R5 entrance



HL-LHC

debris distribution at TAN.4R5 exit (truncated cone)

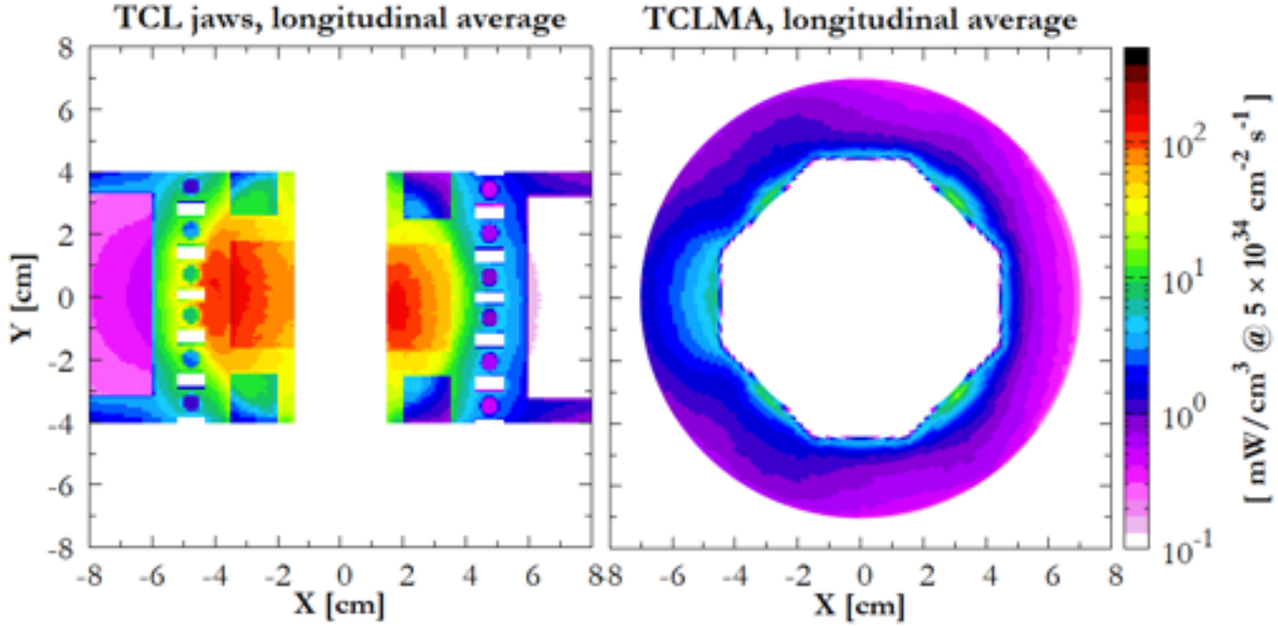


Same number of events

jaws at 10σ
(shown only the tungsten block)

For a more details, refer to L.S. Esposito at 13th HiLumi WP2 Task Leader Meeting, 13 August 2013

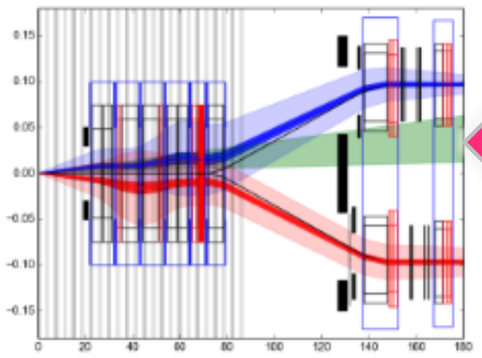
Energy deposition on the TCL and TCLMA



Power [W] 5E34 cm-2 s-1	TCL4 inner jaw	TCL4 outer jaw	TCLMA b1	TCLMA b2	D2	Q4
w/ mask	175	99	7	1.8	35+4+2	6+3+6
w/o mask	170	102	-	-	52+4+2	6+3+6

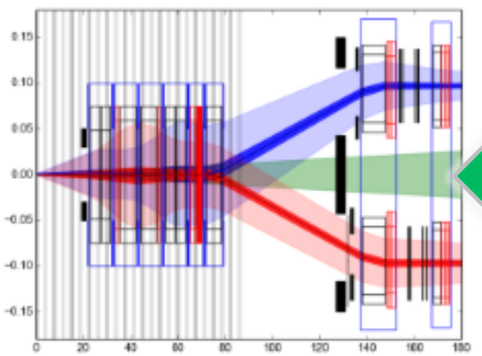
TAXN

β*=15/15 cm, Round HV crossing:
H crossing



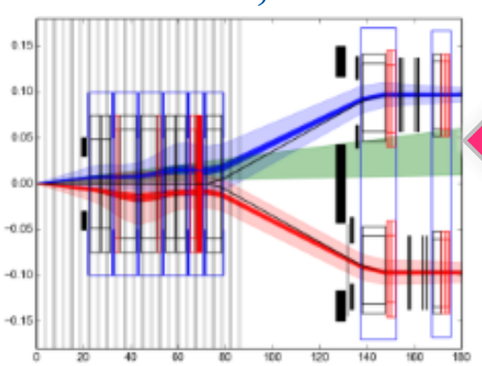
Critical

β*=7.5/30 cm, Flat V crossing



Determines TAXN aperture

β*=30/7.5 cm, Flat H crossing



Critical

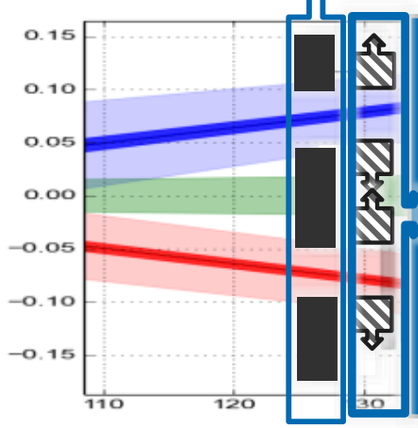
Beam 1, Bear

For any optics:

1. HL-LHC is designed for 10x LHC integrated luminosity -> more radiation
2. HL-LHC optics needs larger crossing angle -> more neutral debries in the 2-in-1 region for horizontal crossing.
3. HL-LHC optics needs larger beam size in the 2-in-1 region

A fixed TAXN to shield all radiation for vertical crossing and most of radiation for horizontal

(e.g. closer to the IP by 4 m, larger aperture ~82mm, smaller separation ~140 mm)



A second TAXN with movable jaws in the H plane (± 10 mm) only that protects what is left by the first TAN massive jaws and adjust at every change of optics

The movable TAXN can become a special collimator (redesigned and reinforced TCL) allowing better space use and become part of the collimator hierarchy

Decision on TAXN design to be taken for 2018

Courtesy of R. De Maria I. Efthymiopoulos, L. Esposito, F. Sanchez-Galan

TAXN Design - Roadmap

- A fixed TAXN of similar design as the present TAXN is required
  - sufficiently large/long absorber to protect the neutral debris and the vertical x-ing
  - adequate aperture in the H-plane
    - present simulation studies: 40mm Ø, 3.5m long separated pipes, 149/159 mm IP/non-IP beam separation
    - positioned 4m closer towards IP

- Designing a movable jaw TAXN would be rather similar effort as that of a special collimator

- Couple the fixed jaw TAXN to a downstream collimator (re-designed/re-infoced TCL) is a preferred solution
  - collimator design proven to work !
  - such a special collimator could remove some of the layout issues in the TAXN-D2 region
  - move jaws ±10 mm to follow beam optics, larger (wider) jaws

TAXN Timeline

- Update of simulation (E_dep, coverage) studies by the Annual Meeting
- Define set of parameter designs for the TAXN
  - apertures, length, use of W inserts, slots for instrumentation/experiments

Timeline for the TAXN baseline scenario - exchange from TAN to TAXN during LS3.

Phase	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
LS stops					***LS2***					***LS3***		
Freeze LSS layout - all IPs/experiments (latest)												
Requirements definition												
Functional specification												
Engineering specification												
Acquisition process												
Fabrication, assembly and verification												
Installation, commissioning												

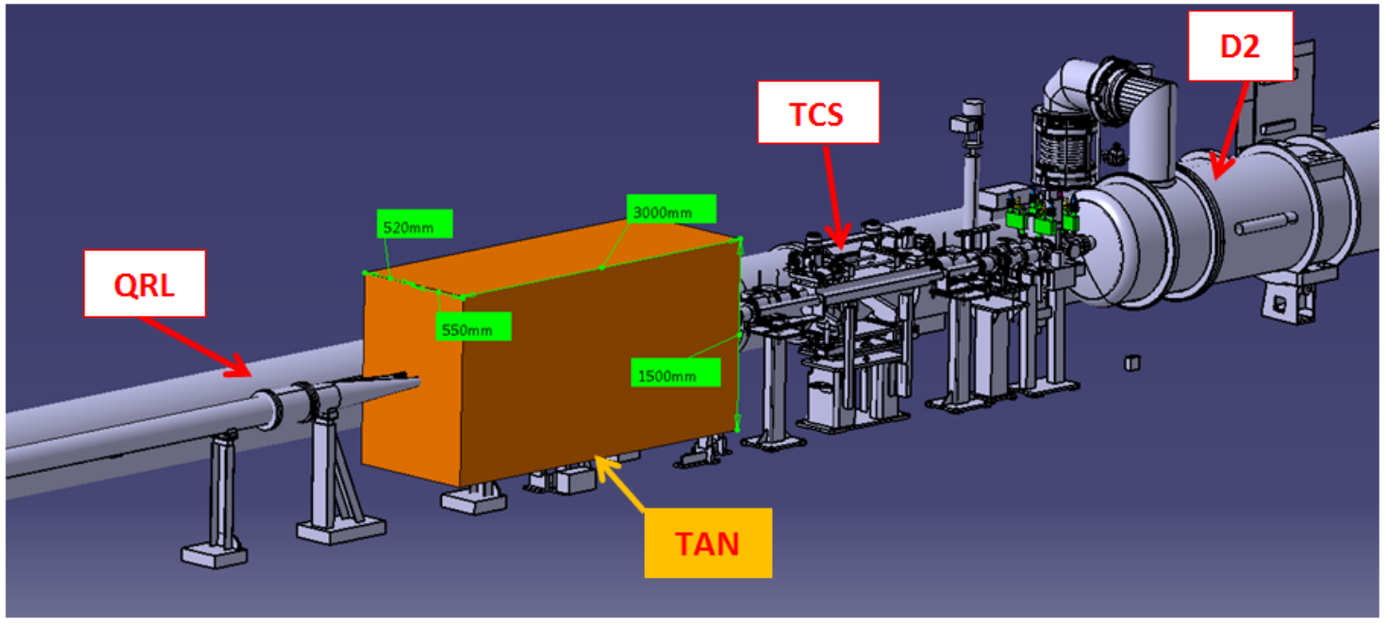
Last update: September 16, 2014

- TAXN design must be fixed by middle of 2018

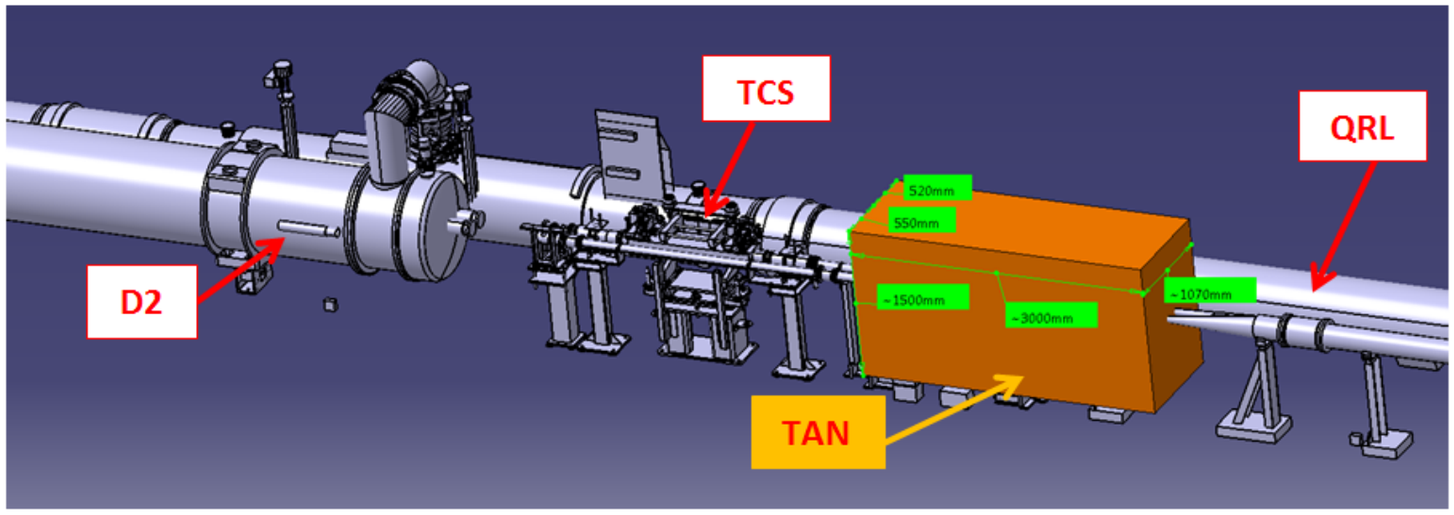
TAXN @ IP8/LHCb

- Layout reservation for a TAXN installation for LHCb/IP8
  - https://edms.cern.ch/document/1331944/1

- Design work should start soon:
  - Determine angular coverage and aperture needs (WP2)
    - TAXN like or absorber between beam pipes
  - Energy deposition, engineering and integration….



2. Point 8 Right (8R) general view. Dimension future TAN



2. Point 8 Left (8L) general view. Dimension future TAN

- Should be installed during LS2!