HE Ageing – Proposed Diagnostic Measurements

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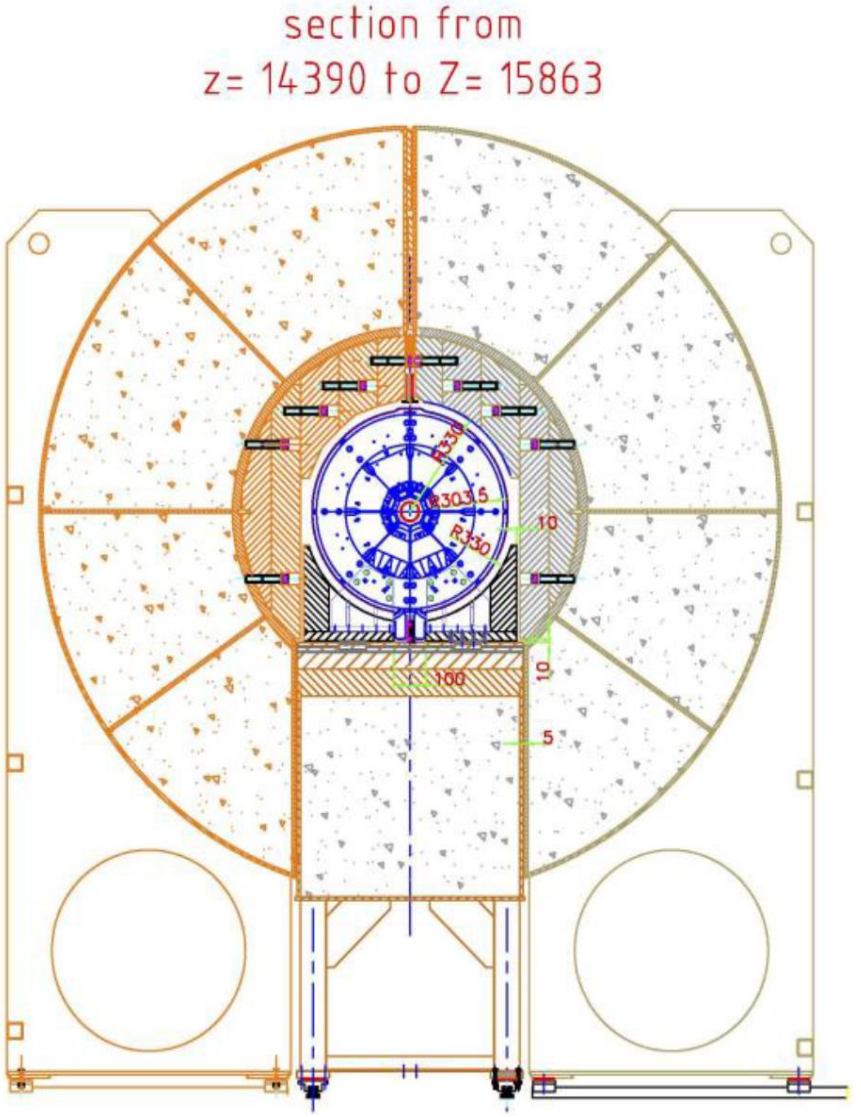
CERN Irradiations – CASTOR

- Irradiation of scintillators in similar conditions as HE
  - Readout: QIE11 HE SiPM
  - Laser system to excite scintillators
  - Make scintillators part of the CMS laser calibration system
- Expected integrated dose: about 10 times larger than in high-η HE towers
  - CASTOR dose rate post-LS2: 2-10krad/hr
  - High-η HE post-LS2: 3Mrad/yr ~ 0.5krad/hr

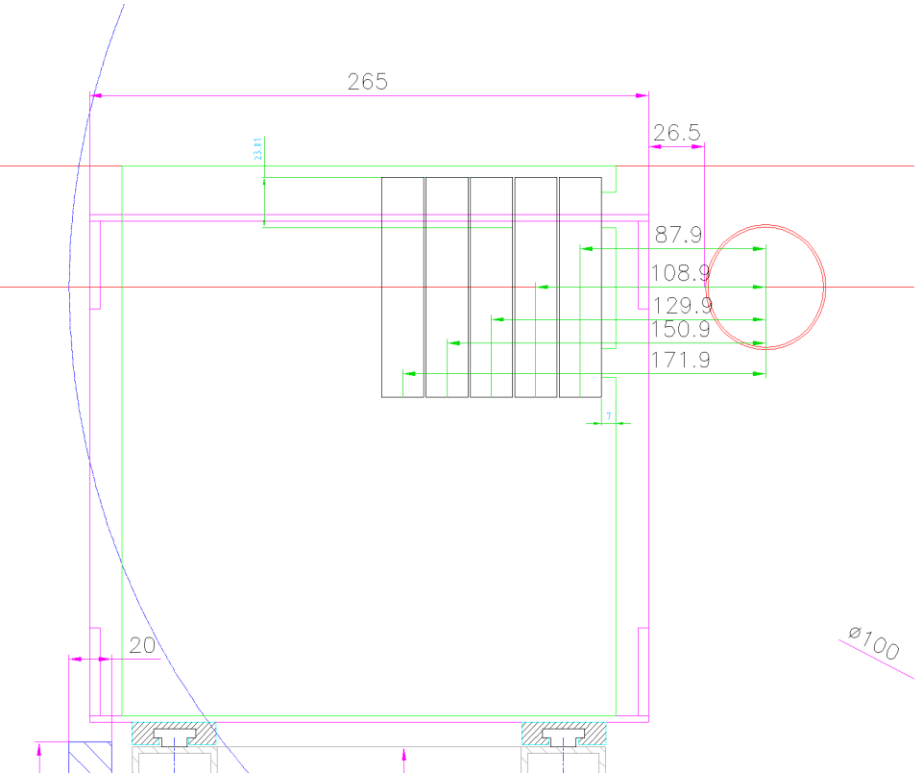


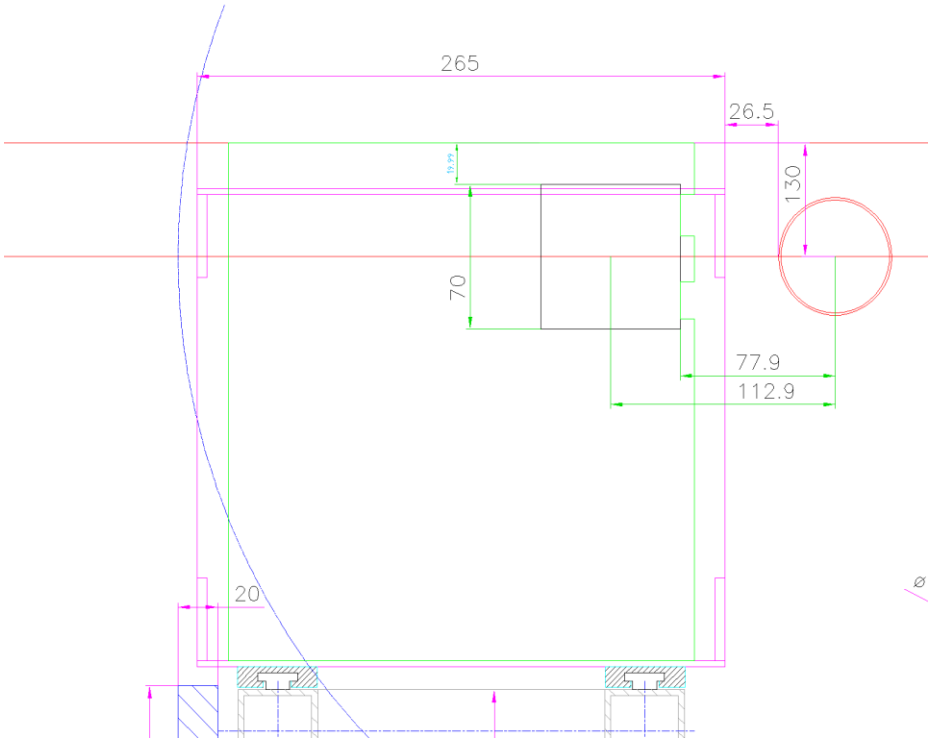
CASTOR Table and Beampipe

CASTOR Table Setup

- 3D-printed cassettes to hold the scintillator samples
  - Redundant setup: each cassette will contain two 10x10cm^2 σ-tiles and four 2x10cm^2 finger tiles
  - One 12-fiber connector per cassette, plus one SMA cable to deliver the laser light
- Readout system integrated with CMS data chain
  - 1 RM, with a custom-designed ODU to fully exploit available 48 pixels in RM
    - Each material will use 6 readout channels (2 σ-tiles and 4 finger-tiles)
  - Possibility of installing a second RM either immediately, or in a later technical shutdown
- Radio-protection issues must be considered in design
  - Make sure to design setup that can be promptly installed/removed from area next to beam pipe (~100μSv/hr)

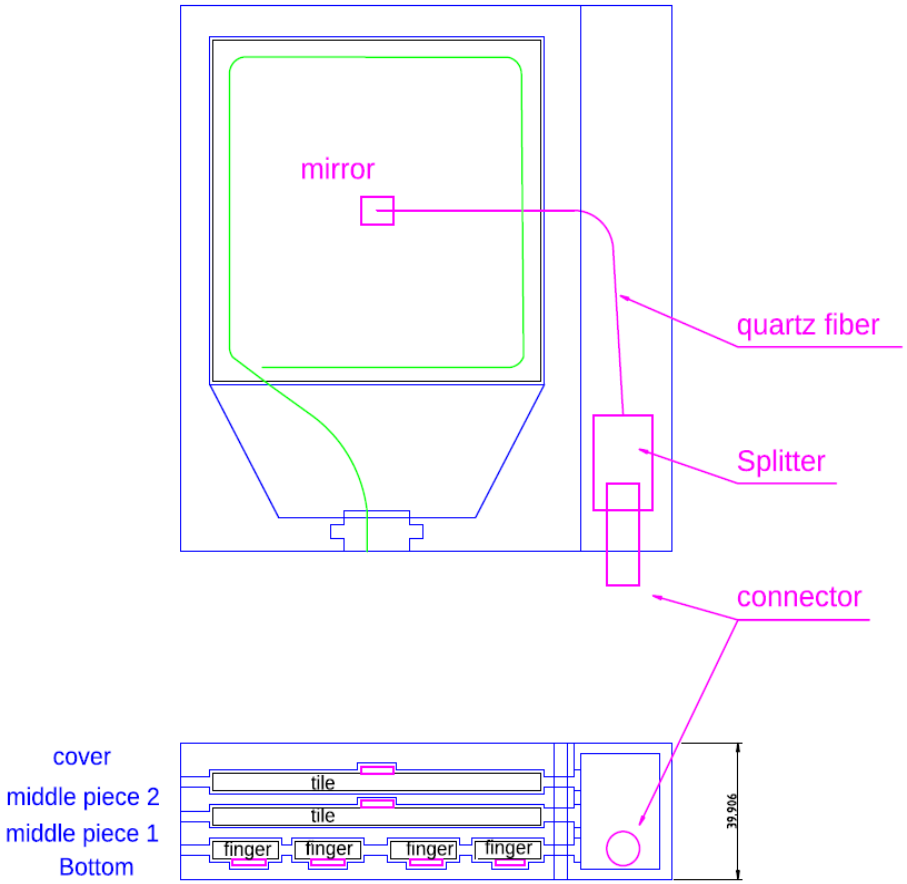
CASTOR Table Details





Cassette Design

- Preliminary designs of scintillator cassette are available
  - Envision each cassette as a sealed unit; do not expect to ever disassemble them
- Calibration light provided by single SMA connector
  - Splitter installed inside cassette provides light separately to each plastic sample
- On-going design of connection to readout
  - Single 12-fiber connector, with only 6 fibers internally serving each plastic sample
  - One 12-fiber connector per σ-tile and finger-tile set (i.e., 3 connectors per cassette)
  - Six separate SMA-like connectors



Material & Equipment Budget

- Detector side
  - Four 6m-long 12-fiber clear cables
    - Four 12→6+6 Y-cables to obtain 8 connectors, one per cassette
  - One clear cable for laser
  - Eight cassettes
    - 1→6 laser splitter per cassette
    - Pigtails w/ WLS fibers: 6 individual fibers attached to single 12-fiber connector
- Front-end Electronics
  - RBX, backplane, RM, special ODU, ngCCM, Calibration Module
  - Power supply, cooling pipes, cable trays and strain relief
- Back-end Electronics
  - AMC13, uHTR, FC7, MCH, power module, uTCA crate
- Commissioning hardware
  - Clock source, LV power supply, PC, laser and HW to fire the laser

Material Selection Criteria

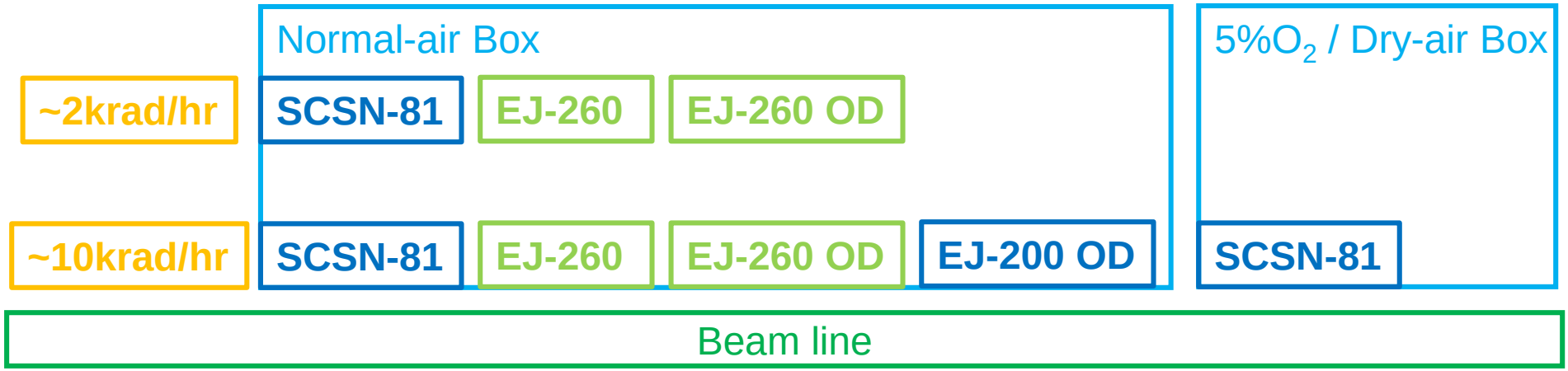
- Constraints
  - Assuming construction of boxes with 12-fibers connectors (two σ-tiles and one 4-finger sets per half-connector) and complete freedom on design of ODU, we can fit a total of 16 σ-tiles and 8 4-finger sets
    - Six fibers per material: can fit 8 different materials per RM
- Irradiation conditions
  - Oxygen concentration: tiles will be in dry air w/ ~5% O_2 during run, and dry air w/ 20% O_2 during shutdowns
  - Dose-rate effect: propose installation at different distance from beam
- Additional constraint: availability of materials
  - SCSN-81: current HE material; plenty available
  - Only a few pieces of over-doped scintillators (EJ-260, green; EJ-200, blue) are at hand

Materials for Plan-B

- SCSN-81: polystyrene base, blue scintillator
  - Kuraray-made current HE scintillator
- EJ-260: polyvinyl toluene base, green scintillator (O2 WLS readout fiber); nine versions:
  - Primary dopant concentration: 1X, 2X, 4X; secondary dopant: 1X, 2X, 4X: all combinations available
  - Plan to do a round of irradiations and measurements at UMD to reduce the set to a fewer number of options (e.g., base EJ-260 and two over-doped flavors)
- EJ-200: polyvinyl toluene base, blue scintillator; three versions:
  - 1X: primary dopant in commercial concentration
  - 2X: primary dopant in twice-as-large concentration
  - P2: new primary dopant; same concentration as 2X

Selection Proposal

- Proposal for (up to) eight cassettes
  - SCSN-81: two cassettes at different distance from beam line; dose rate can change by a factor of 5
  - EJ-260: green scintillator, commercial version; cheapest alternative material
  - EJ-260 over-doped: eight different materials, will select one
    - Personal comment: best candidate material
  - EJ-200 over-doped: do not expect commercial version to be competitive
- Enough SCSN-81 and EJ-260, may need to place an order for additional pieces of over-doped scintillators



Roadmap

Task	Needed by	Resource
Finalize design, materials	As soon as possible	All
Cassette design	Dec-15	Iowa
Scintillators at FNAL	Dec-15	UMD
Laser splitters and injectors at FNAL	Dec-15	FSU
Optical cables production	Dec-15	FNAL
Assembly and test at FNAL	Jan-10	FNAL
Cassette delivery to CERN	Jan-10	FNAL
ODU production	Jan-10	ND
RBX preparation	Jan-10	CERN
BE and FE installed at CERN	Jan-20	FNAL/CERN
Services installation in P5	Jan-25	CERN
Installation at P5	Mar-4	CERN

Summary and Milestones

- Objective is irradiation of plastic scintillator candidates for Plan-B connected to CMS DAQ
  - Design system that offers repeatable and frequent measurements of the light yield of the tiles under test
- Finalization of design should complete before end of the year
  - Prepare design of 3D-printed cassettes
  - Define all optical connections
- Material needs to be gathered at CERN by the second half of January
  - BE and FE electronics; special ODU; all optical connectors
  - One fully-assembled complete cassette to test mechanics
- The commissioning run will be in February
  - Production cassettes need to be all at CERN
- The setup needs to be installed in the CMS cavern before March