ITS Upgrade Proposal

1. Introduction

- **1.1 Introduction**
- **1.2 Current detector performance and limitations**
- **1.3 Motivations for upgrading**
- **1.4 Experimental conditions**

2. Physics Motivation

- **1.1 Current experimental situation in heavy-ion collisions and impact of the ITS upgrade**
    - 1.1.1 Introduction
    - 1.1.2 Heavy quark in-medium energy loss: present status and further measurements
        - **Figure: Predictions for D and B RAA**
        - **Figure: Predictions for R_D/h and R_B/h**
        - **Figure: Predictions from R_B/D**
        - **Figure: ALICE Preliminary RAA of D and leptons**
        - **Figure: ALICE Preliminary pt cross sections for leptons from beauty in pp**
        - **Figure: CMS Preliminary displaced Jpsi in PbPb and their RAA**
        - Impact of ITS upgrade on new measurements
    - 1.1.3 Heavy quark thermalization and in-medium hadronization: present status and further measurements
        - **Figure: ALICE Preliminary v2 for pion, kaons, and protons**
        - **Figure: ALICE Preliminary RAA for kaons and Lambdas**
        - **Figure: ALICE Lc signal in pp**
        - Impact of ITS upgrade on new measurements
    - 1.1.4 Quarkonia as a medium thermometer
        - **Figure: ALICE Preliminary RAA and RCP vs centrality**
        - **Figure: CMS Preliminary Y family in PbPb**
        - Impact of ITS upgrade on new measurements
    - 1.1.5 Long-range correlations
        - Impact of ITS upgrade on new measurements
- **1.2 Physics performance studies for the ITS upgrade**
    - 1.2.1 Simulation methods
        - 1.2.1.1 Hybrid detector-level simulation approach
            - **Figure: track impact parameter resolution in rphi and z (current and upgrade)**
            - **Figure: D0→Kpi secondary vertex position resolutions (x,y,z, current and upgrade)**
        - 1.2.1.2 Fast generator-level simulation approach (if it will be used…)
    - 1.2.2. D0 meson reconstruction as a benchmark for detector performance

- **Figure: Topology of D0→Kpi decay and cut variables definition**
- **Figure: Significance optimization for some variables (traditional and new, ie z, for current and upgrade)**
- **Figure: PbPb D0 invariant mass distributions for several pt intervals (current and upgrade)**
- **Figure: PbPb D0 reconstruction efficiency vs pt (tracking and cuts, current and upgrade)**
- **Figure: PbPb D0 S/B and significance vs pt (current and upgrade)**

o 1.2.3 Charm baryons (Lambdac)

- **Figure: secondary vertex resolution (current and upgrade)**
- **Figure: PbPb Lc invariant mass distributions for several pt intervals (current and upgrade)**
- **Figure: PbPb Lc S/B and significance vs pt (current and upgrade)**

o 1.2.4 B mesons at central rapidity

▪ 1.2.4.1 Measurement of B production via displaced D0

- **Figure: pp(?) D0 impact parameter distribution (current and upgrade)**

▪ 1.2.4.2 Measurement of B production via displaced J/psi

- **Figure: pp(?) J/psi pseudo-proper decay time (current and upgrade)**
- **Figure: PbPb Significance vs ptmin B (current and upgrade)**

▪ 1.2.4.3 Measurement of B production via electrons

- **Figure: normalized d0 for electrons from b, c, background (current and upgrade)**
- **Figure: S/B vs pt with 3 sigma cut (current and upgrade)**

o 1.2.5 D and B mesons at forward rapidity

▪ 1.2.5.1 D/B measurements via displaced single muons

- **Figure: normalized d0 for electrons from b, c, background**
- **Figure: Beauty muon S/B vs pt with 3 sigma cut**
- **Figure: Beauty muon fraction vs pt in PbPb**

▪ 1.2.5.2 B measurement via displaced J/psi

- **Figure: …. see LHCb separation variable**
- **Figure: displaced Jpsi significance vs pt (low pt reach!)**

o 1.2.6 Heavy flavour physics performance

▪ 1.2.6.1 Nuclear modification factors

- **Figure: D0 RAA vs pt**
- **Figure: Lc RAA vs pt**
- **Figure: B RAA using D0, Jpsi, electrons**
- **Figure: RAAB/RAAD at mid-y using D0 and B from D0 or Jpsi**
- **Figure: RAAB/RAAD at forward y using muons**

▪ 1.2.6.2 Elliptic flow

- **Figure: v2 vs pt for D0**
- **Figure: v2 vs pt for Beauty**
- **Figure: v2 vs pt for Lc**

o 1.2.7 Quarkonia at forward rapidity

- **Figure: mass resolutions J/psi**
- **Figure: mass resolutions Y**
- **Figure: some ratios or RAA vs pt (check PPR)**

- 1.2.8 Long range correlations
- 1.2.9 Competitiveness
  - vs STAR
  - vs CMS/ATLAS

3. Detector Functional Requirements

- **3.1 Introduction**
- **3.2 General Design Considerations**
- **3.3 Simulation tools and procedures**
- **3.4 Detector parameters**
  - Beam pipe radius and thickness
  - Number of layers and their geometry
  - Hermeticity, segmentation and alignment
  - Material budget
  - Detector efficiency, signal dynamic range and linearity
  - Event time resolution
  - Event readout time
- **3.5 Impact parameter resolution**
- **3.6 Tracking performance (efficiency and resolution)**
- **3.7 PID performance**
- **3.8 Trigger capabilities**
- **3.9 Readout rate capabilities**
- **3.10 Radiation environment**
- **3.11 Redundancy**

4. Detector Technical Implementation

- **4.1 Introduction and System Overview**
  - Reference to previous sections and outlook of the structure of the next sections
- **4.2 Design specifications**
  - Summarize design specifications from previous chapters
  - TABLE with main parameters
- **4.3 Detector layout**
  - Schematic description (geometry, structure and functions)
    - 3 pixel layers followed by n strips/pixel layers
    - Possible radii, limitations by beampipe
  - Picture: schematic view of the layers with labels
- **4.4. Pixel detector design options**
  - **4.4.1 Hybrid Silicon Pixel Detectors**

        - Sensor Choices
            - Technical challenges
            - Layout options
            - First results from prototypes
        - ASIC Development
            - Architecture
            - Physical layout
            - Submission schedule
        - Bum bonding
            - Impact on pixel size
            - Bum material and diameter
            - Cost reduction factors
        - TSVs
        - Module Layout and Assembly Considerations
        - PICTURES: sensors schematic of edgeless epi, test results as available, ASIC architecture scheme, bump SEM picture, TSV schematics or SEM, module schematics
    - **4.4.2 Monolithic Silicon Pixel Detectors**
        - MISTRAL
            - Schematic
            - Irradiation test + test beam plans
            - Prototype development
        - INMAPS
            - Schematic
            - Irradiation test + test beam plans
            - Prototype development
        - Le Pix
            - Schematic
            - Prototype development
        - Module layout and assembly considerations
            - Discuss module layout for different designs
        - PICTURES: schematics, possible module schematics, test results as available;
- **4.5 Strips detector Technologies**
    - Sensor Design
    - ASIC development (architecture and physical layout)
    - Module design and layout

- **4.6 Readout Electronics Architecture**
    - Front-end Link
    - Off-detector electronics
    - Interface to ALICE back-end systems

5. Mechanics, Services and Integration

- **5.1 Introduction and System Overview**
    - This section includes a discussion on the different upgrade options
- **5.2 Space and integration**
- **5.3 Beam pipe design**
- **5.4 Conceptual design for the global stave and services support**
    - Conceptual design of the single module
    - Design and implementation of dummy modules (status)
    - CAD drawings for insert-able layer 0
    - CAD drawings for 3-layer pixel detector
    - CAD drawings for the outer n-layer strips/pixel detector
    - CAD drawings for the forward telescope and its integration with the central barrel
- **5.5 Cabling and Service System**
    - Power distribution
    - Data links (optical fibres and cables)
    - Cooling lines
- **5.6 Alignment and spatial mapping**
- **5.7 Studies and support mechanics**
- **5.8 Cooling Studies**
    - Power consumption considerations
    - Working temperature considerations and mechanical stress
    - Cooling options: single and double phases
    - Coolant options
    - Single phase cooling simulations for the carbon foam and micro-channel scenario
    - Double phases simulations?
    - Characterization test for the available prototypes and comparison with the simulations

6. Cost Estimate, Time Schedule and Participating Institutes