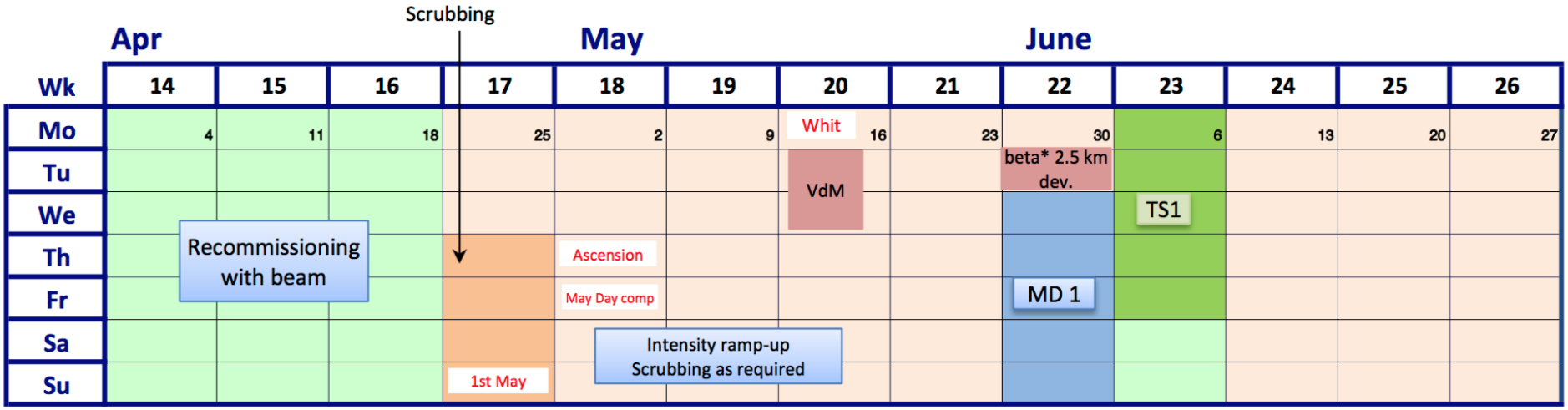
Lessons from 2015

- **Scrubbing** at 450 GeV allows to **mitigate e-cloud instabilities** and **beam degradation** occurring at low energy
- After this stage, relying on ADT and high Q' and octupoles, it is **possible to preserve good beam quality from injection to collision** in spite of the e-cloud still present in the machine, however high heat load in the arcs
- **Parasitic scrubbing** accumulated during intensity ramp up and physics run has **lowered the heat load** in the dipoles by roughly a factor two (in two months)
  - → The **doses needed** to see an evolution at this stage are **very large**, practically incompatible with a dedicated scrubbing run
  - → Relatively high intensity runs without electron cloud can cause **deconditioning**, visible both in heat load and beam quality, for which quick **re-conditioning fills** might be needed
- Doublet trains were **tested** for the first time in the LHC during the Scrubbing Run
  - → e-cloud enhancement could be **confirmed experimentally**
  - → Due to **violent e-cloud instabilities**, it was **impossible to inject enough beam** and keep sufficient beam quality **for efficient scrubbing** with doublets

Proposal for the 2016 start-up

- Arcs will be kept under vacuum → **scrubbing should be – at least partially – preserved** during the YETS
- Scrubbing **proposal for 2016**:
  - **4 days scrubbing run** deemed reasonable to recover high intensities at 450 GeV (assuming all necessary setup for high intensity is done before, e.g. injection, ADT)
  - A few **"refresh" scrubbing fills during first 1-2 weeks of intensity ramp up** in physics (to fight deconditioning)
  - **During intensity ramp up**:
    - → As long as no limitation is encountered, try to **maximize electron dose** by using long trains (up to 288b. per injection) → **it will pay off later**
    - → If/when cryo limit is reached, move to **optimized filling schemes** to gain luminosity
    - → Use **physics fills to accumulate more scrubbing** for further intensity increase
- **Doublet test** to be performed when **SEY is sufficiently low** (e.g. at least after recovering the end-2015 situation) to check whether good beam quality can be preserved
    - → In case of positive outcome, **first scrubbing stores with doublets**

Schedule


Scrubbing
Apr
May
June
Wk
14
15
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17
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19
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Mo
Tu
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6
13
20
27
beta* 2.5 km dev.
VdM
TS1
Recommissioning with beam
Ascension
May Day comp
MD 1
Intensity ramp-up
Scrubbing as required
1st May

Some points to check in preparation

- **Setup** to be done beforehand
  - 25 ns beam in injectors
  - ADT, diagnostics (including ObsBox and bunch-by-bunch tune)
- Scrubbing with some **beam screens at higher temperature** (~100 K) – some test cells
- Cryogenic **transients and limits**
- **TDI** (do we still have pressure interlocks, has the retraction policy stayed the same?)
- **MKI-Q5** (we know from 2015 that it could limit the total intensity in beam 2)
- **Magnetic field in the experimental areas** (discussed with G. Arduini, G. Bregliozzi, M. Taborelli, communicated to M. Lamont):
  - **Turning off the magnetic field of the CMS, ATLAS, ALICE solenoids** for the scrubbing run **does not seem to be necessary**, because
    - ✓ In terms of SEY, the solenoid field in standard operation anyway inhibits the electron cloud formation + SEY is low due to the NEG coating
    - ✓ Vacuum-wise, the area is 99%+ NEG-coated, no additional surface cleaning needed at this stage
  - **LHCb dipole** should be **on with positive polarity**