TI8/WIC Incident & UJ87/UA87 Radiation Levels & Analysis

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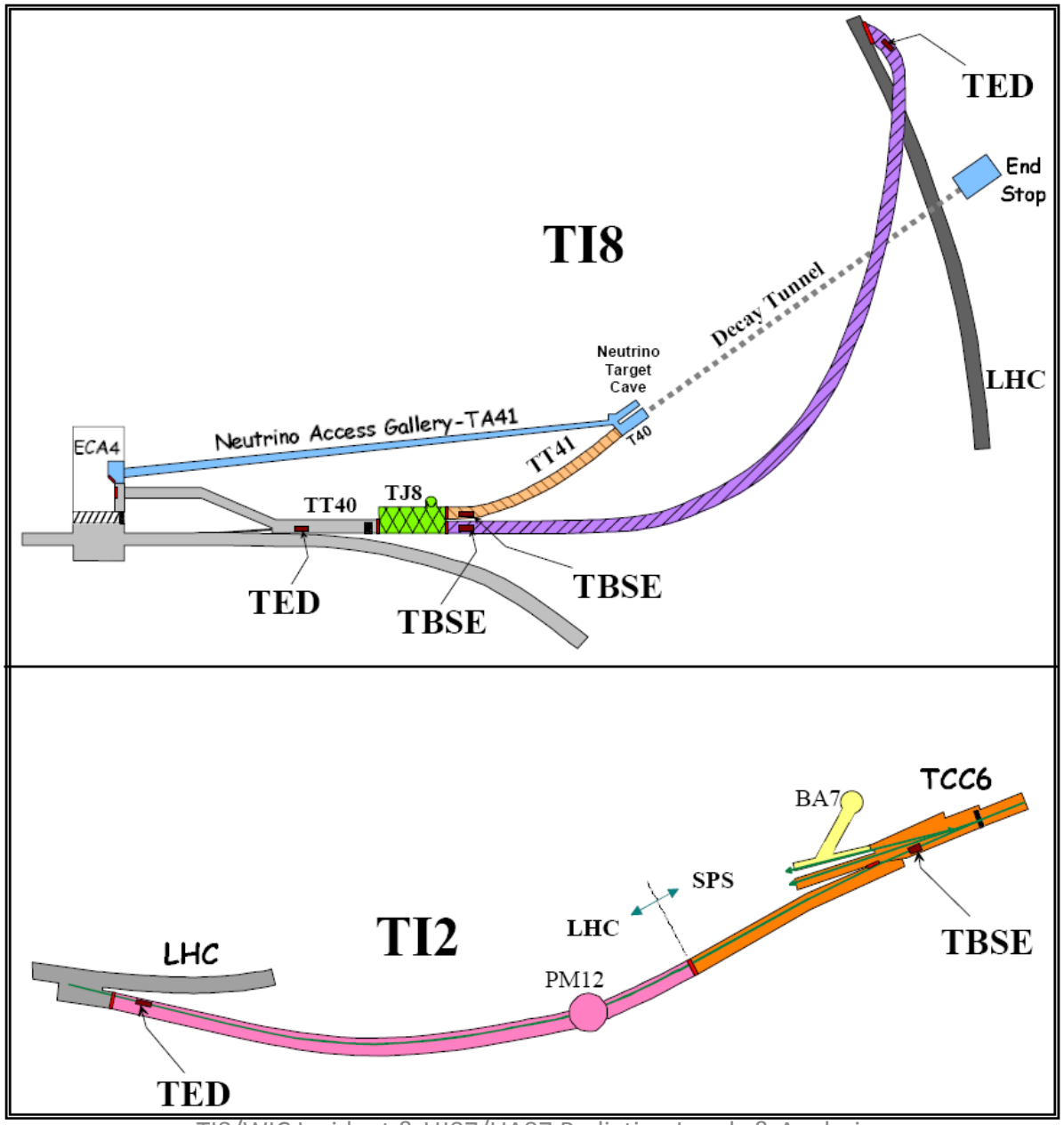
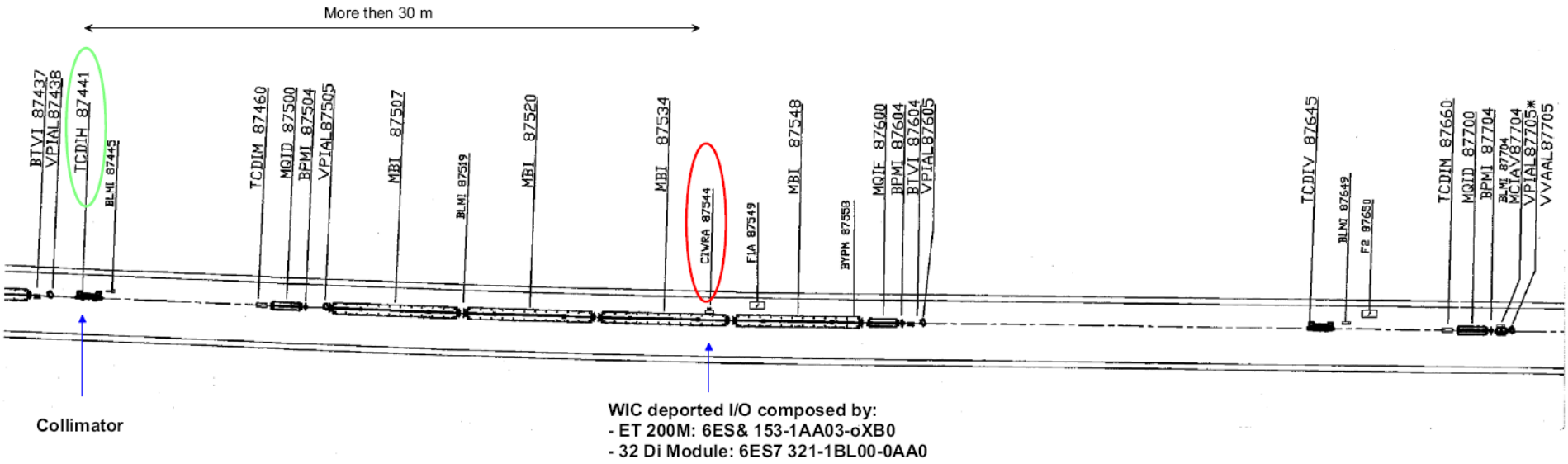
The Injection Lines



Observations TI8/WIC

- **~2x10^{12} protons** were 'dumped' on an injection line collimator (TCDIH 87441), *i.e.*, ~1.2x10^{11} protons per shot [J. Wenninger, S. Redaelli]
  - how many protons have been lost on this collimator before during earlier operations (scaled BLMI 87445)?
- a **WIC crate installed ~30m downstream** (below MBIs) got stuck and this is most probable due to an SEE [P. Dahlen]



Beam Loss & Normalisation

- how do the ~2×10^{12} (and ~1.2×10^{11}) protons compare **to 'normal' operation**
  [based on an old loss analysis by B. Goddard]:
  - **full injected batch: ~3×10^{13}**
    (such a loss could arise through a steering error or a converter trip during the interlock dead time prior to extraction -> this was estimated to happen once every few years)
  - **regular loss** (depending on sigma and beam): between **1.5×10^{10} and 2.6×10^{11} per injection and collimator**
    (this fits to the estimated 1% of full injected batch)
  - 2.5×10^{10} per injection and collimator was at that time the given 'work estimate'
- the possible number of annual WIC **failures will however scale with the integrated fluence**, *i.e.,* one has to consider *e.g.*, the annual number of injections, thus about 400!
  (in case the operational scenario of one full injected batch per LHC fill is kept)

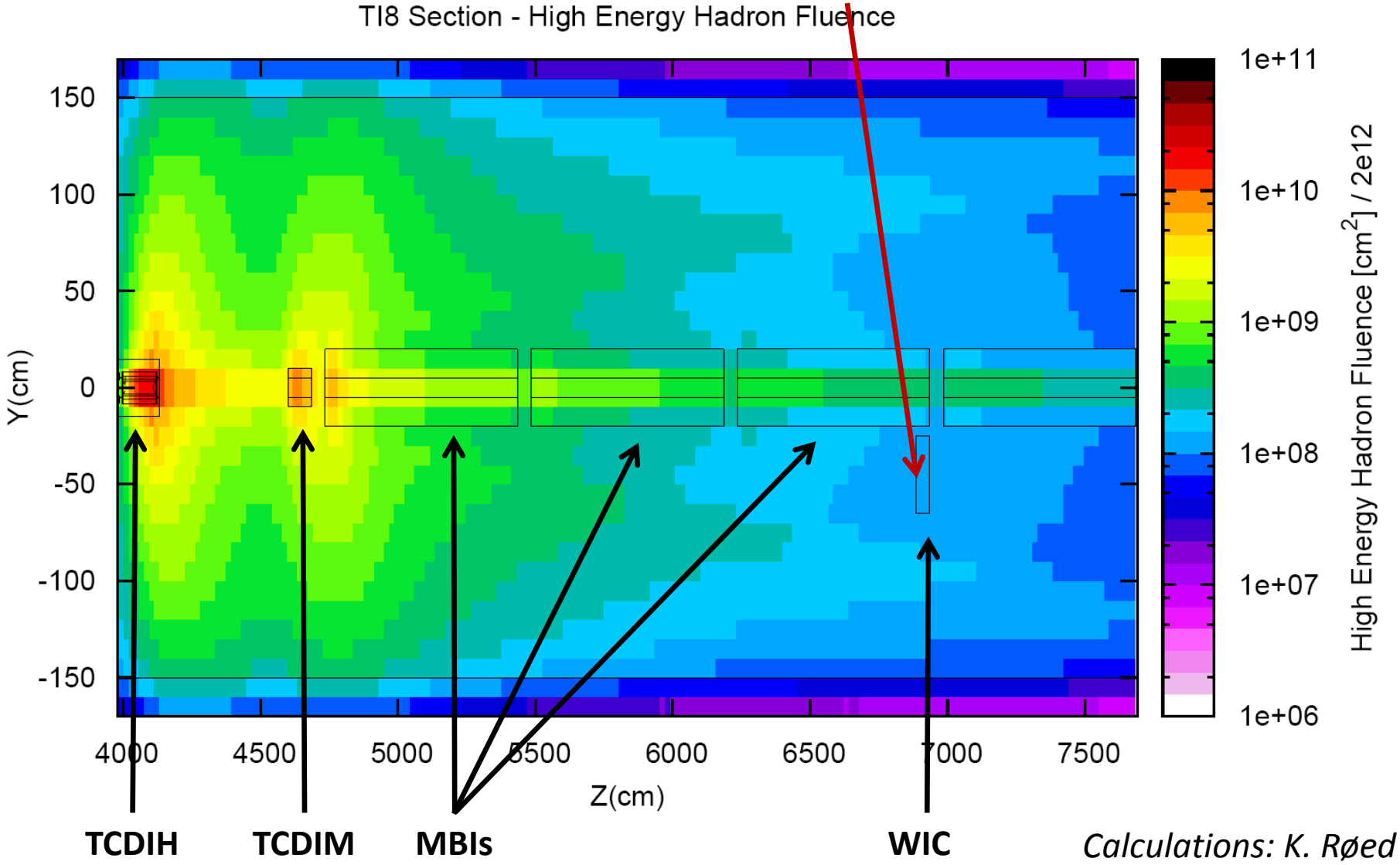
Radiation Levels

- a **FLUKA simulation** (collimator + downstream magnets) was put in place **to have a quick check on the radiation and particle energy spectra at the location of the electronics** (see following slides)
  - 1.2×10^{11} 450 GeV protons on collimator
  - radiation map downstream looking at the rack location below the magnet
  - analysing:
    - high-energy hadron fluence
    - particle energy spectra
    - possible low-energy neutron component
- an **over-the-thumb (very rough) estimate** based on available calculations at IR7 currently gave the following conservative estimate:
  - **a few 10^8 to 10^9 high-energy hadron fluence (per 1×10^{11} protons dumped on the collimator)**

Radiation Levels per $2x10^{12}$ protons lost

!!! SIMPLIFIED CALCULATION !!!

- **At the WIC location one gets about: $2x10^{8}$ cm^{-2} of High Energy Hadron Fluence**

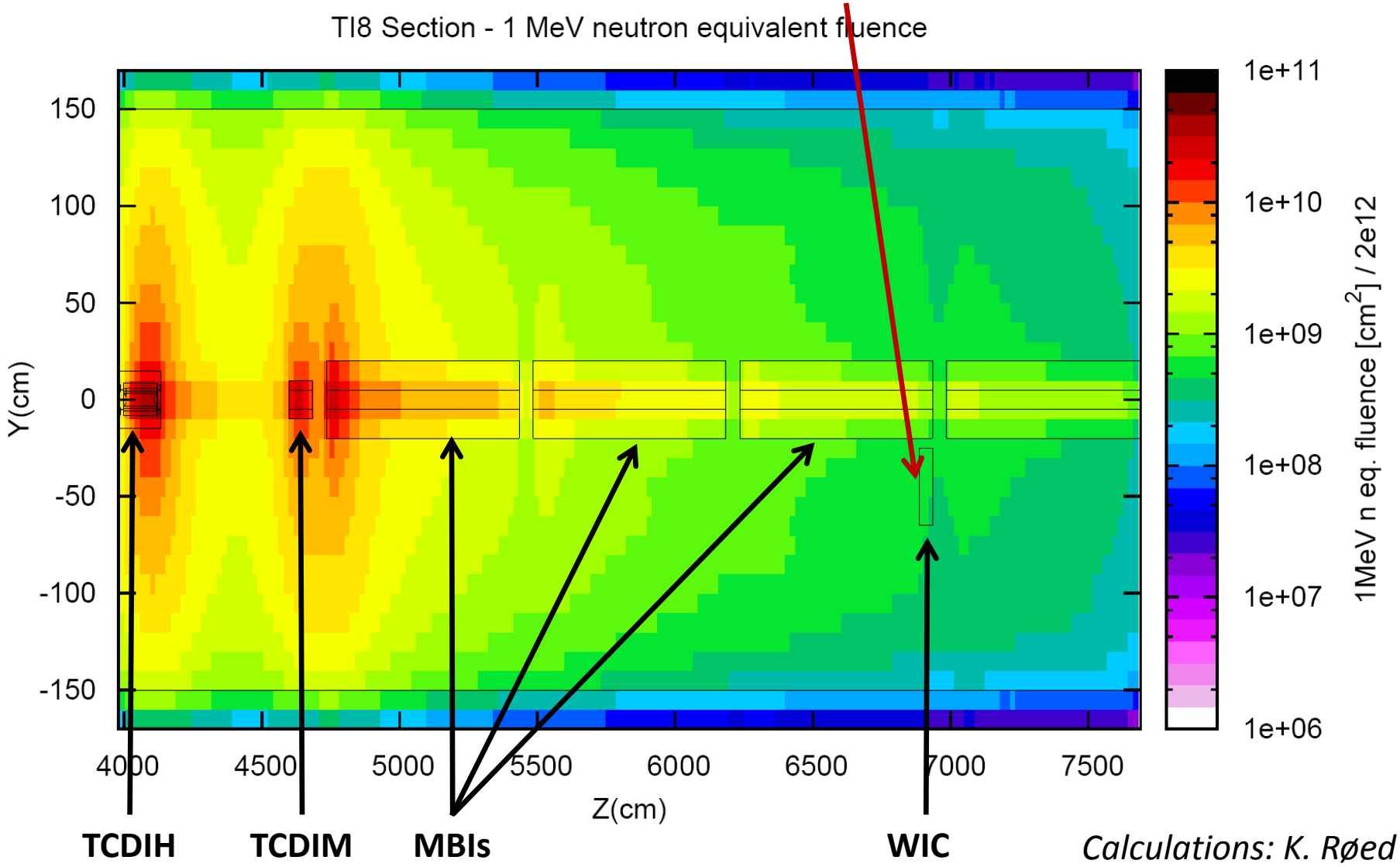


Calculations: K. Røed

Radiation Levels per $2x10^{12}$ protons lost

!!! SIMPLIFIED CALCULATION !!!

- **At the WIC location one gets about: : $6x10^{8}$ cm^{-2} of 1MeV Neutron Equivalent**

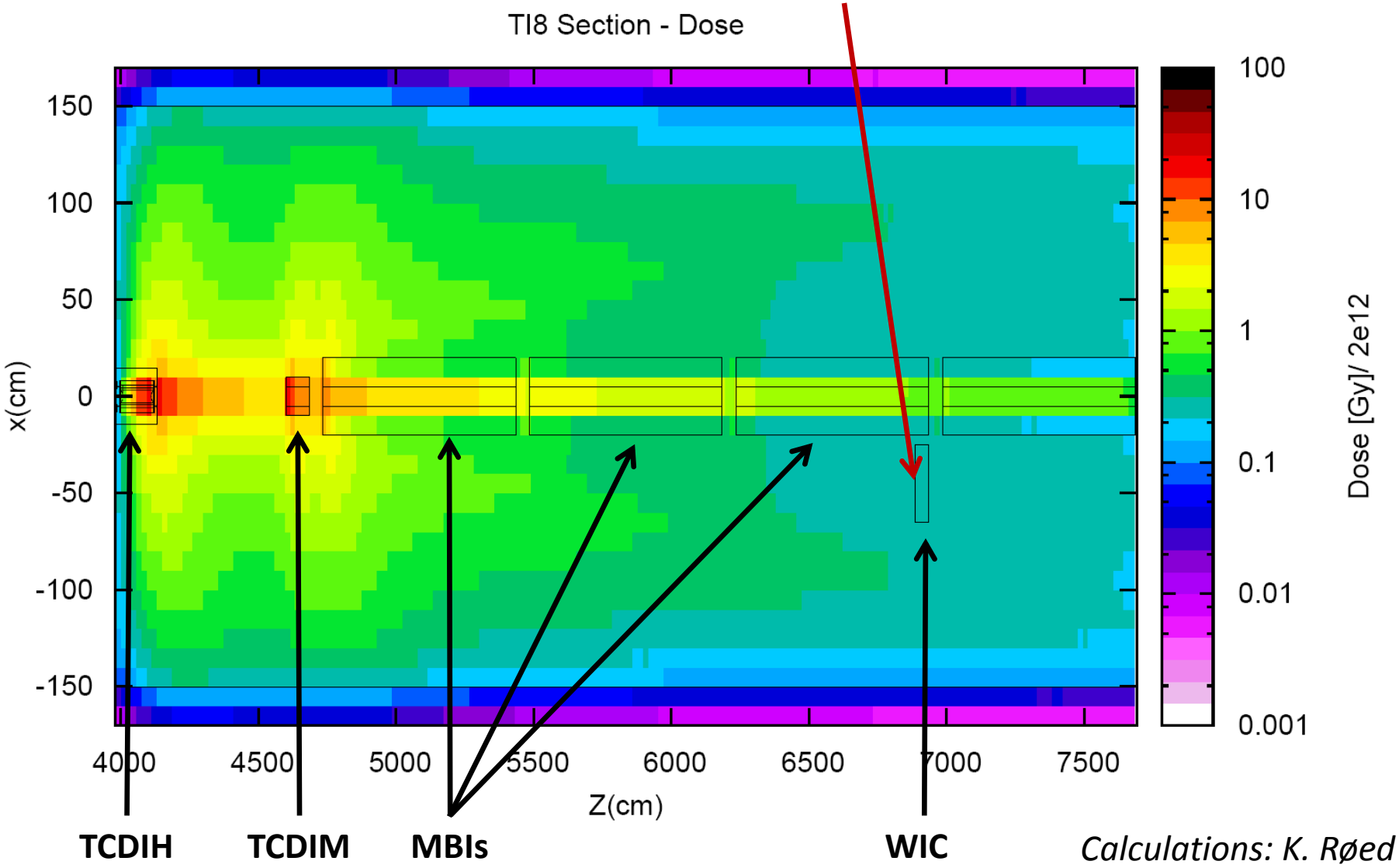


Calculations: K. Røed

Radiation Levels per $2x10^{12}$ protons lost

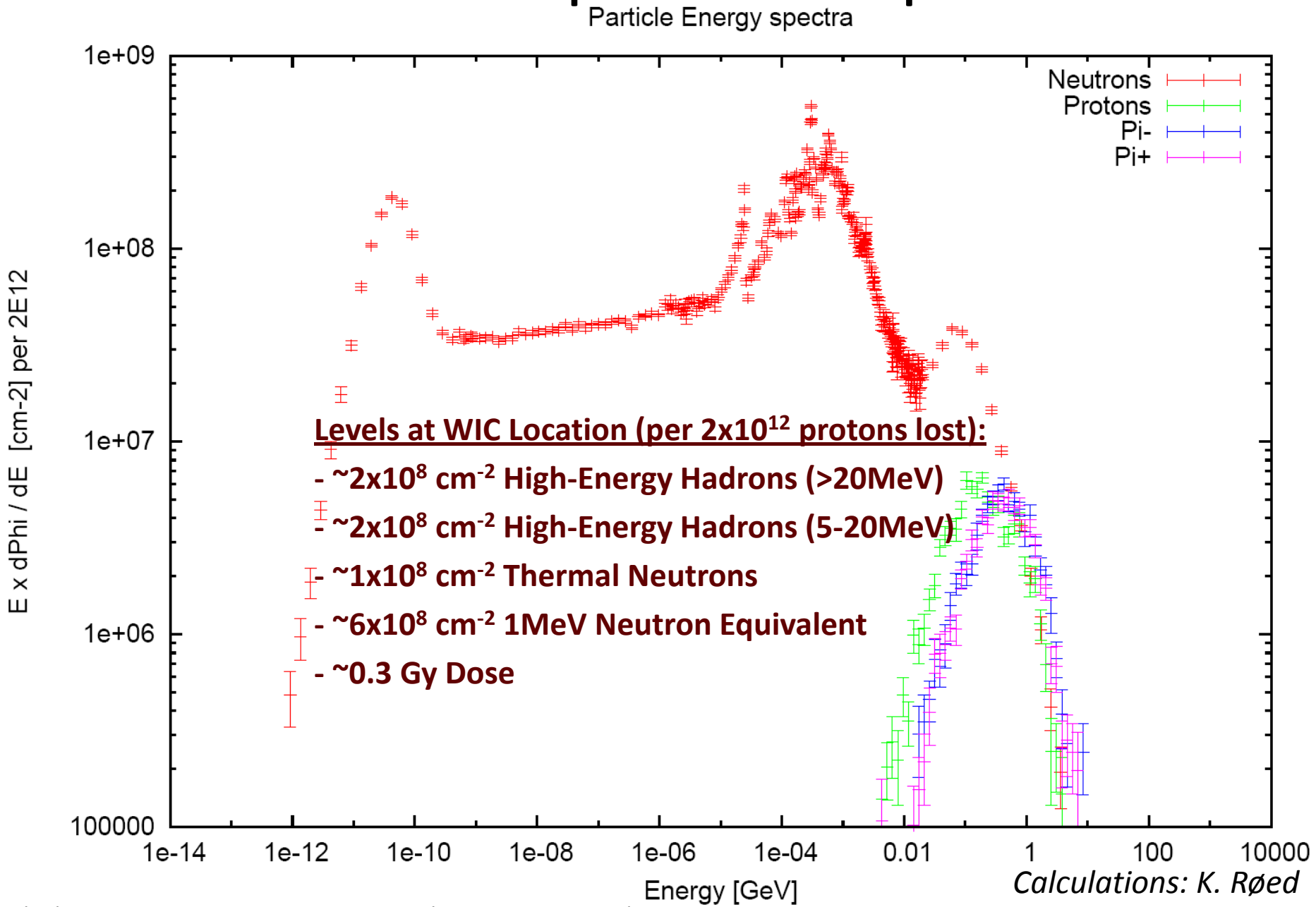
!!! SIMPLIFIED CALCULATION !!!

- **At the WIC location one gets about: 0.3 Gy of Dose**



Calculations: K. Røed

Radiation Levels per $2x10^{12}$ protons lost



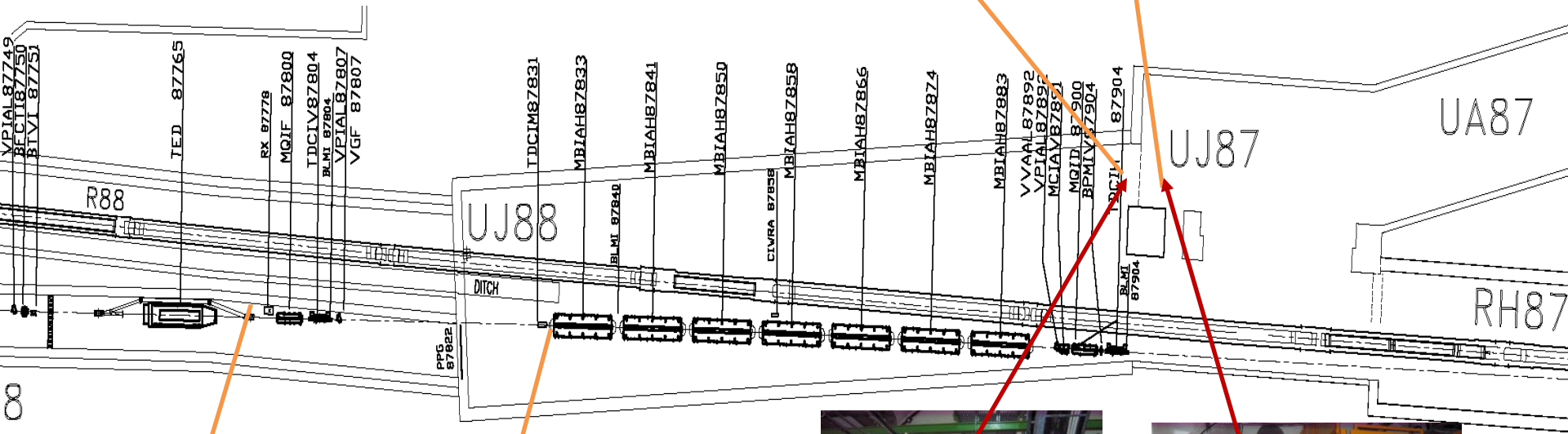
UJ88/UJ87/UA87 Observations

- **RadMon Positions and Settings (some are set to 3V)!**
- Integrated values Hadrons>20MeV:
  - UJ88 – 8: 6.96e+9 cm^{-2}
  - UJ88 – 7: 2.68e+8 cm^{-2}
  - UJ88 – 6: 9.32e+6 cm^{-2}
  - **UJ87 – 1: 1.69e+6cm^{-2}** (two counts only!)

RMon 1 — 3V

RMon 6 — 3V

Refers to total losses of this weekend, *i.e.*, ~5.6x10^{13} !!!

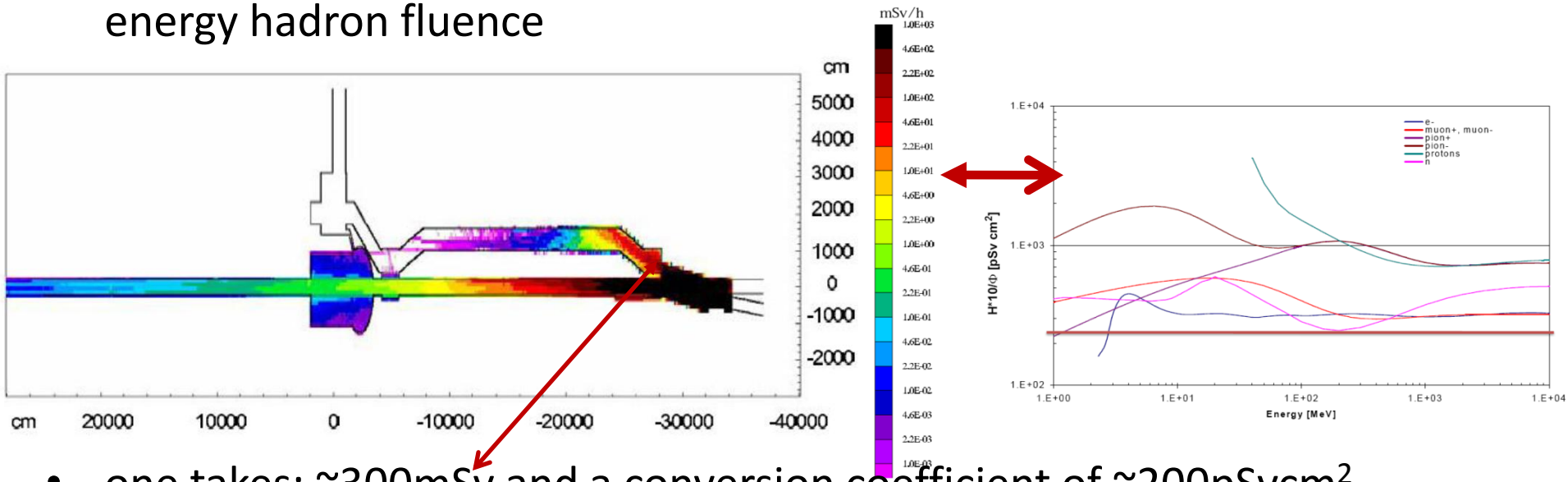


RMon 8

RMon 7

UJ88/UJ87/UA87 Analysis

- Estimate **based on RP Calculations** [H. Vincke et al.] as already **analysed through R2E** end of 2008, where estimates for prompt dose equivalent can be used to get a rough estimate of a maximum equivalent high-energy hadron fluence



- one takes: ~300mSv and a conversion coefficient of ~200pSvcm^2
- this referred to 1.44x10^{16} protons on the TED (maximum annual estimate)
- this gave an estimated maximum **high-energy hadron fluence of ~10^8-10^9/cm^2/year**, however not including the 80cm of concrete and some other conservative assumptions
- **fully consistent to the current RadMon reading: ~2x10^6 (@3V), thus ~some 10^5 (@5V) high-energy hadrons, which would give ~10^8/year**

UJ88/UJ87/UA87 Conclusions

- The situation was **identified through R2E already in 2008**
- The observed (and estimated radiation levels) refer to the **worst case location** just behind the shielding wall (levels in the UA are lower!)
- The **shielding wall** between the UJ88 and UJ87 **can be improved** and this area is in the list of suggested actions
- The final radiation levels in the UJ87 and especially in the UA87 will strongly depend on the **chosen operation scheme** (how many full intensity batches are dumped on the TED), thus any action was so far put on hold
- This TI8 test **measurements are fully consistent with the expectations and the simulation estimates** are confirmed within the given uncertainties
- **Later tests this year (ideally with high-intensity), as well as a decision on the operational scenario shall trigger the decision if and when to improve the concerned shielding wall**