GBP MC WG

Standalone MC for LUXE GBP

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Contents

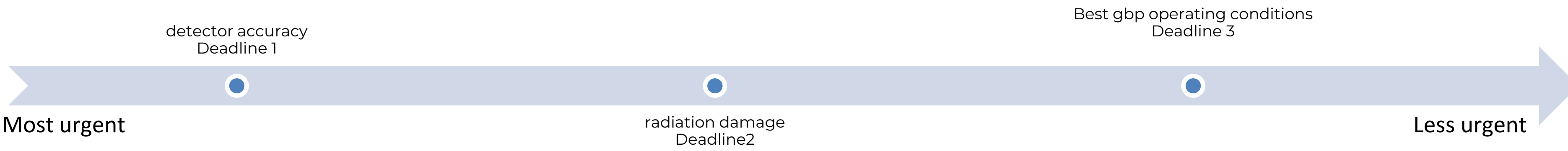
Priorities – in short

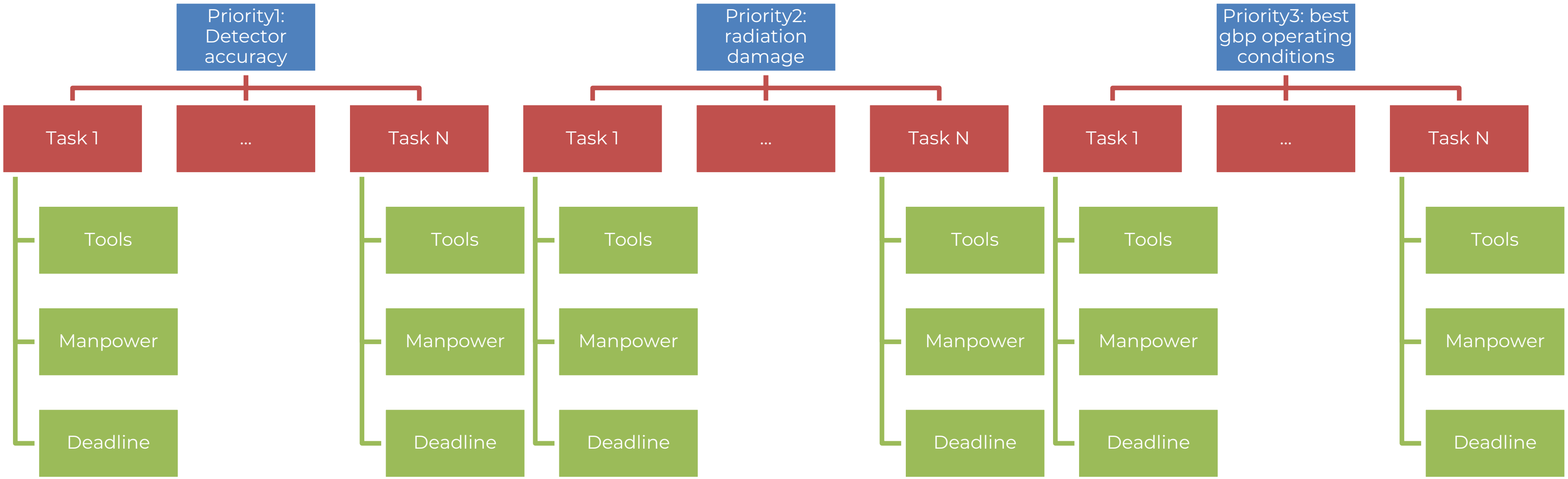
1. What is the **detector accuracy** in measuring \xi, intensity?
   - What is the impact of detector geometry (thickness) and strip layout (strip width & spacing) on detector accuracy?
   - What is the performance of the II station and the I+II stations combined?
2. How long can a detector work on the LUXE gamma beam? (**radiation damage**)
   - Assumed that we can perform three independent measurements of the radiation damage with:
     - electron gun and X-ray source to measure the IEL induced damage
     - high energy electron beam at Elbe to measure IEL and NIEL effects
     - neutrons produced at the TIGRA nuclear reactor (link) to assess purely NIEL related damage
   - Necessary steps:
     - check that NIEL is reproduced with sufficient reliability
     - data on beam configurations (generation of e-laser, gamma-laser events at LUXE)
     - check impact of threshold values and systematic effects of algorithm based on highest localized dose
3. What are the best operating conditions to apply to the GBP? (**GBP setup**)
4. What is the size of the beam in LUXE gamma-laser mode? (**γ-laser**)

Priorities divided by Tools

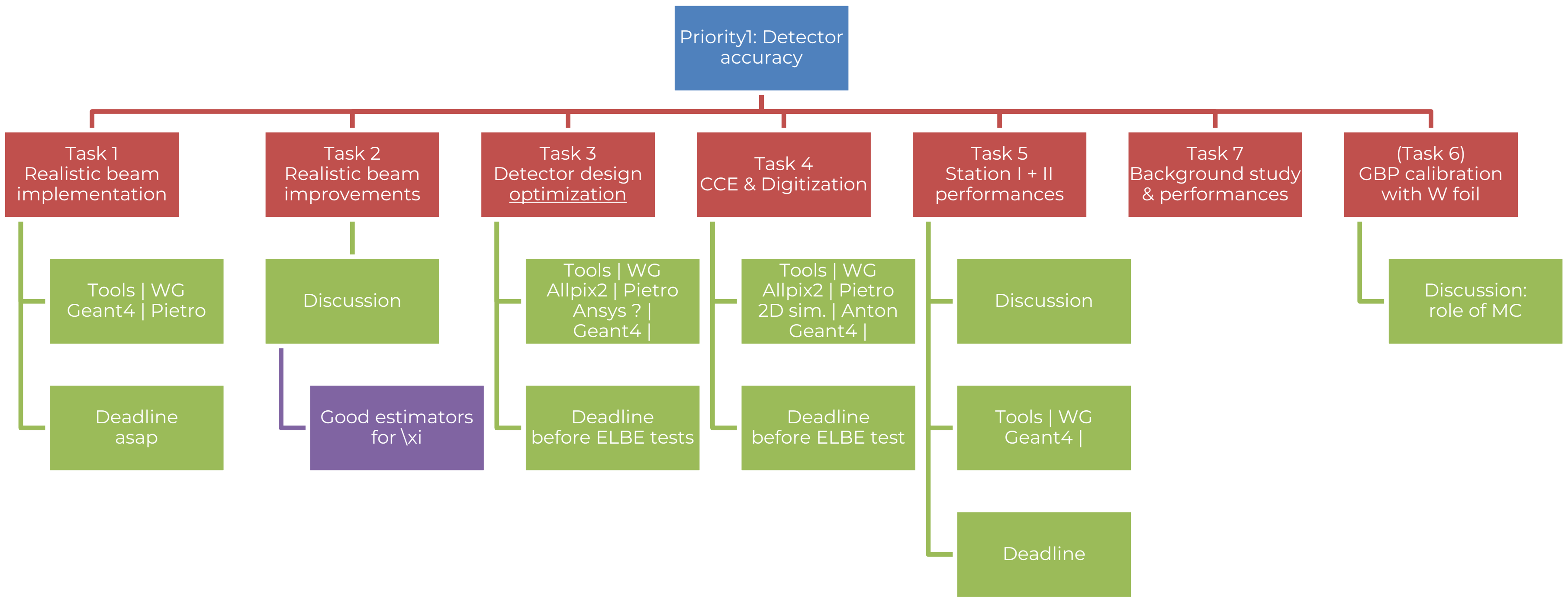
Geant4	Allpix2	ANSYS (?)	(?)
Detector accuracy	Detector accuracy	Radiation damage	γ-laser data
Radiation damage	GBP best operating conditions		

Work strategy





Work strategy – Detector accuracy



Work strategy – Radiation damage

detector accuracy
Deadline 1

radiation damage
Deadline2

Best gbp operating conditions
Deadline 3

Most urgent → Less urgent

- Priority2: Radiation damage
  - Task 2 Dose evaluation
    - Tools | WG Geant4 | Pietro | ?
    - Deadline ?
  - ~~Task 3 Mechanical stress~~
    - ~~Tools | WG edep | Anton | Pietro~~
  - Task 1 Discussion
    - What affects radiation damage?
    - Measuring IEL and NIEL (check MC)
  - Task 4 Dose abs. from the ‘supports’

- Priority3: Simulations for experiments at
  - Useful for
    - CCE
    - volume (for the dose)
  - Padova
    - for CCE
  - Legnaro
    - Tools | WG Allpix2 | Geant4 |
    - Deadline ?
  - Elbe
    - Tools | WG Allpix2 | Geant4 |
    - Deadline beginning 2022
  - Tigra
    - Tools | WG Allpix2 | Geant4 |
    - Deadline ?

A first approach with the 2D gaussian beam

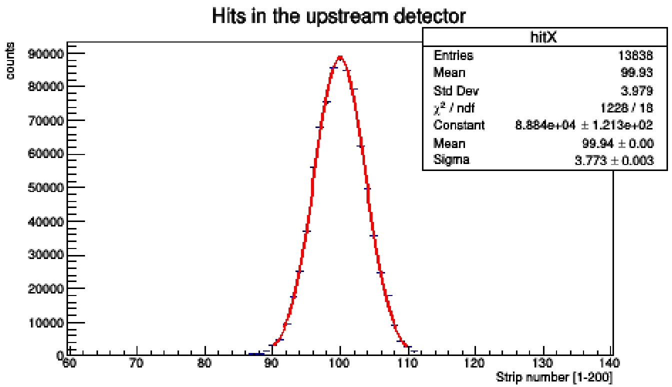
Detector accuracy and radiation damage

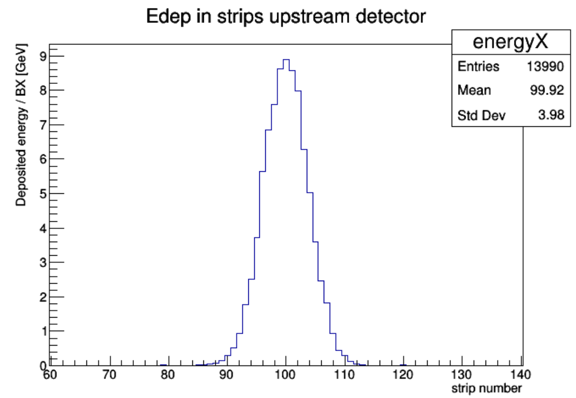
A first approach with 2D gaussian beam

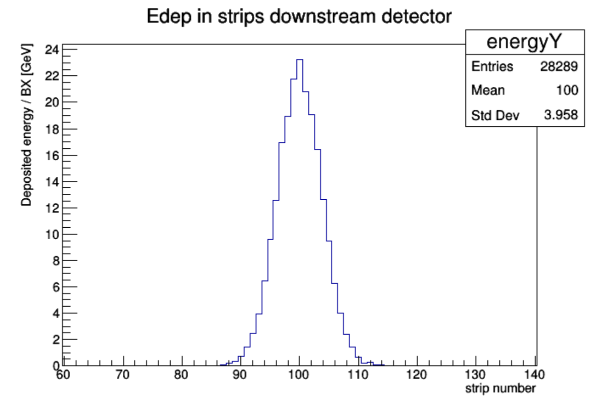
simulation shows that most of the profile is contained in a $2 \times 2\ \mathrm{cm}^2$ square, although there are long tails. In the case of the beam profiler placed just out of the vacuum pipe, at about 6 m from the interaction point, the central high-energy component of the gamma beam can be approximated with a Gaussian having standard deviations $\sigma_x = \max(1, \xi) \times 180\ \mu\mathrm{m}$ for $\xi > 1$, $\sigma_y = 180\ \mu\mathrm{m}$ (see also Sec. 2.9.5). For instance, for $\xi = 5$, $\sigma_x = 900\ \mu\mathrm{m}$ while for $\xi < 1$ the spot size remains $\sigma_x = 180\ \mu\mathrm{m}$.

- A first approach, from a MC sim. with 2D gaussian beam, gave us some insights about detector performances and radiation damage.

Detector	Total E_{dep} [GeV]	E_{dep} @strip100 [GeV]	Dose @strip100 [Gy]	Charge @strip100 [pC]	Total average dose [Gy]	Peak energy [GeV]	Peak dose [Gy]
Upstream	85.63	8.89	0.358	507.44	0.013	1.088	0.044
Downstream	213.3	23.25	0.937	1264.15	0.032	2.648	0.107







Standalone MC - Geant4 approach

Geant4 approach

- **Description**
  - The simulation is based on Geant4 C++ framework. Configuration is done both by writing code and by using a meta language (macros) which call pre-coded functions.
  - Detector geometry is hard coded. At the present time, it includes the GBP latest design (w. strip spacing & metallization) but it does not include pcb supports and additional geometry (which may contribute to the background)
  - Physics is both hard coded and customizable with macro commands. The physics list used is emstandard_opt4 which includes: link
  - Source code on GitHub
- **Recorded data**
  - For each particle, it is recorded: its position & momentum; the energy deposition; the step length and the physical process responsible for the e.dep.
  - File format: ROOT.
  - The analysis macros then give us total energy deposited, strip events (with energy), dose, hit, etc.

Geant4 approach

- **Latest feature**
  - Arbitrary uncorrelated primaries x/p distributions (using a ROOT input file)

- **Next in the schedule (for geant4MC)**
  - Arbitrary correlated primaries x/p distributions (neglecting px,py)
  - Clone the sim. for Legnaro, ELBE, Tigra experimental setups
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