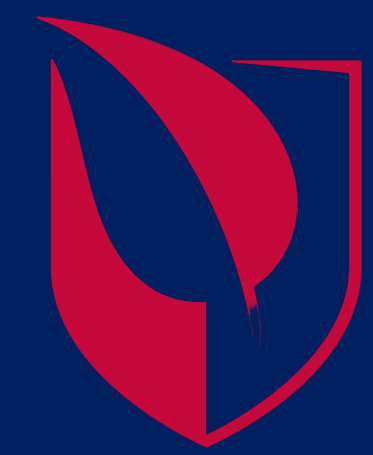


# Metadata-Driven End-to-End Automation of Pharmacokinetic Analysis and Reporting from NCA to Submission

A single platform that reduces manual effort and cycle time while improving consistency, traceability, and reproducibility across NCA PK deliverables. The platform is designed for extensibility and ease of use, enabling efficient and standardized analytical reporting within regulated settings.



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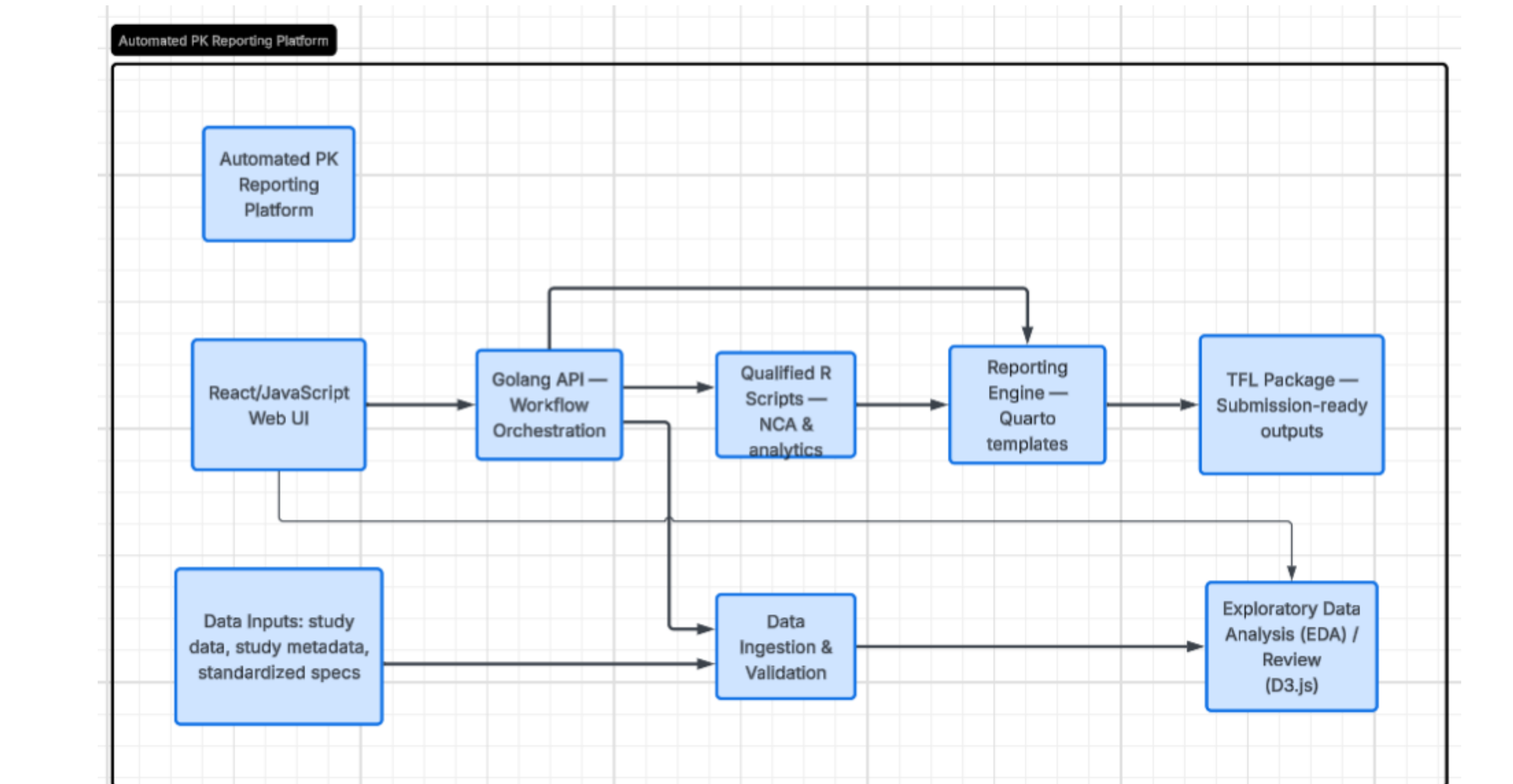
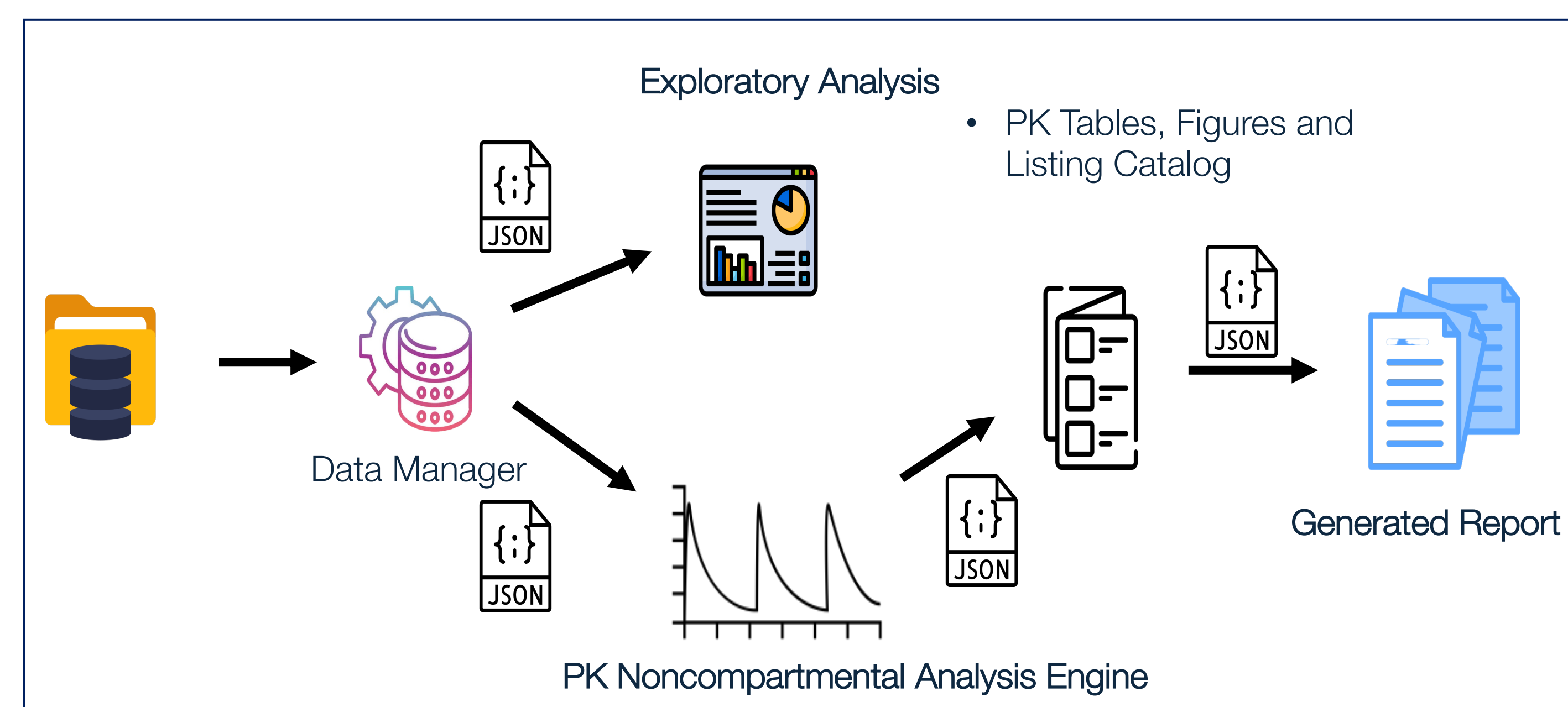
## OVERVIEW

Pharmacokinetic (PK) noncompartmental analysis (NCA) is a standard, model-independent method used in drug development to assess drug exposure and characterize absorption and disposition characteristics of the drug. Outputs from PK NCA support the generation of PK-driven tables, figures, and listings (TFLs), which can be time-intensive to produce. Conventional workflows are often manual and non-standardized across and within PK studies, creating challenges for reproducibility and contributing to longer cycle times, increased audit burden, and fragmented deliverables.

A unified, metadata-driven PK reporting platform was developed to standardize data preparation, noncompartmental analysis (NCA), and submission-ready output generation in alignment with Gilead's NCA Guidance and TFL standards. The platform comprises of four integrated components, which are listed below:

1. **Data manager** for data mapping, validation, and filtering;
2. Visualization and tabular functionality for **exploratory data analysis (EDA)**;
3. A **PK NCA engine** built using the pharmaverse PKNCA package; and
4. A metadata-driven **PK TFL catalog** that assembles submission-ready TFLs using reusable, validated templates.

Architecture of the unified metadata-driven PK reporting platform. The platform standardizes PK data processing from data preparation through noncompartmental analysis (NCA) and generation of submission-ready tables, figures, and listings (TFLs). Metadata specifications centrally drive data management, exploratory data analysis, NCA execution, and automated TFL production, ensuring consistency with Gilead's NCA Guidance and TFL standards.



The platform automates PK reporting by using study metadata and standardized specifications to drive:

1. Data ingestion, validation, exploratory review, NCA execution using qualified R scripts,
2. Generation of submission-ready tables, figures, and listings through reusable validated templates built using **Quarto**.
3. The **React/JavaScript** interface enables user interaction
4. The **Golang API** orchestrates workflow execution, and R scripts perform analytical computation.

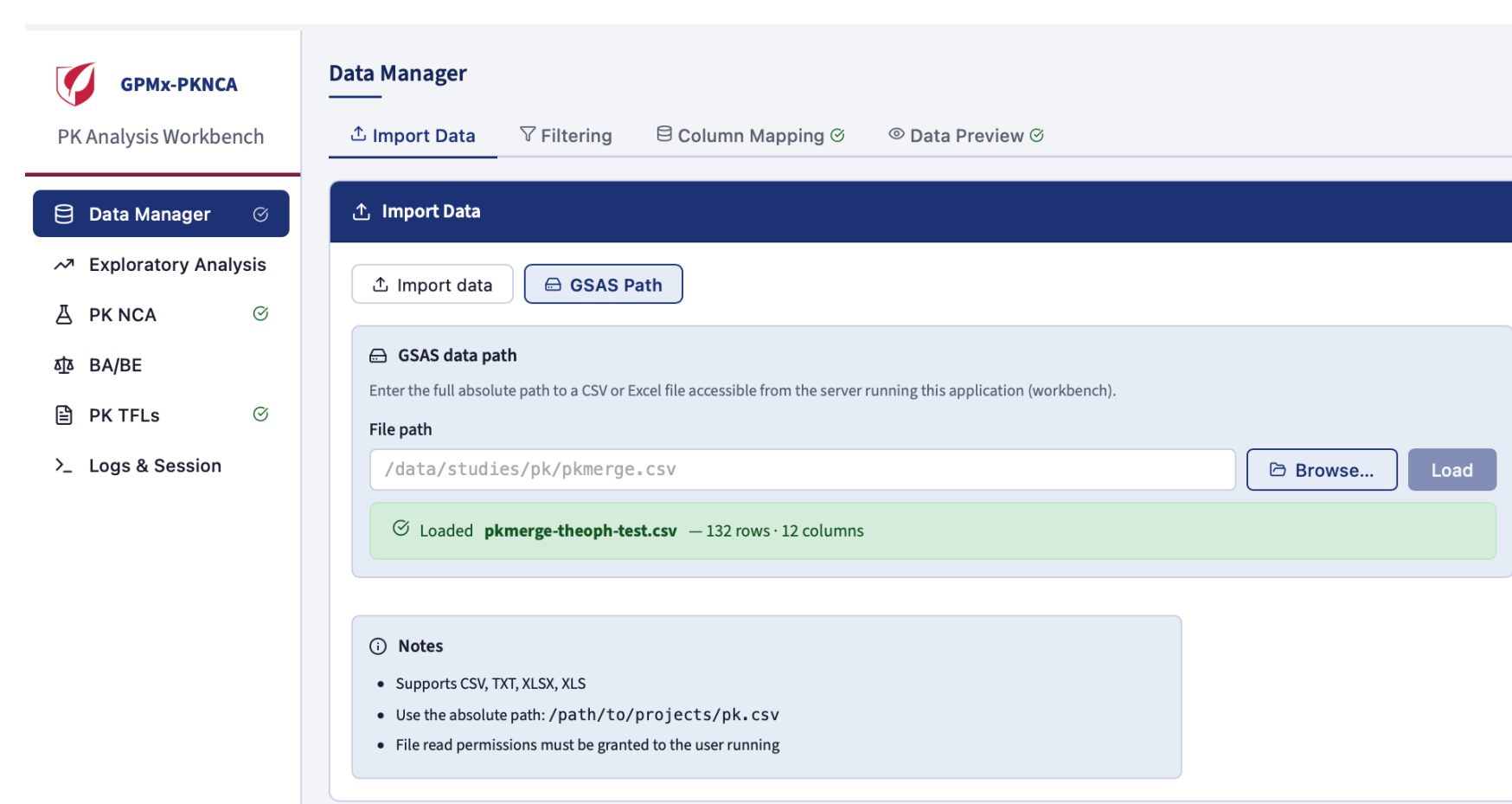


Figure 1. Data import & validation from the Filesystem (data repository). This hold PKMERGE data

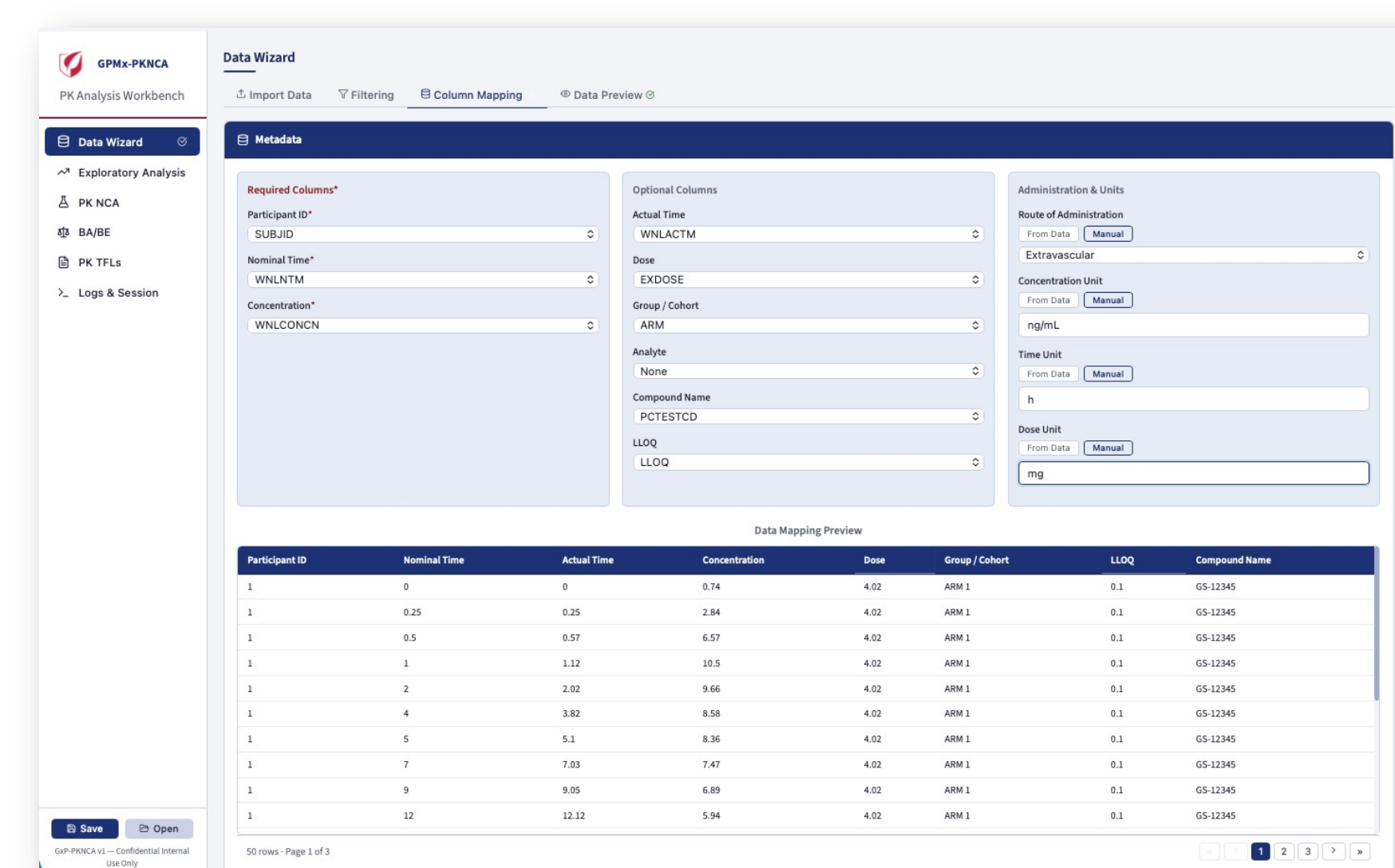


Figure 2. Metadata-driven column mapping with live data preview.



Figure 3. Exploratory Data Analysis including population concentration-time profiles, individual profiles and summary by time points stratified by group.

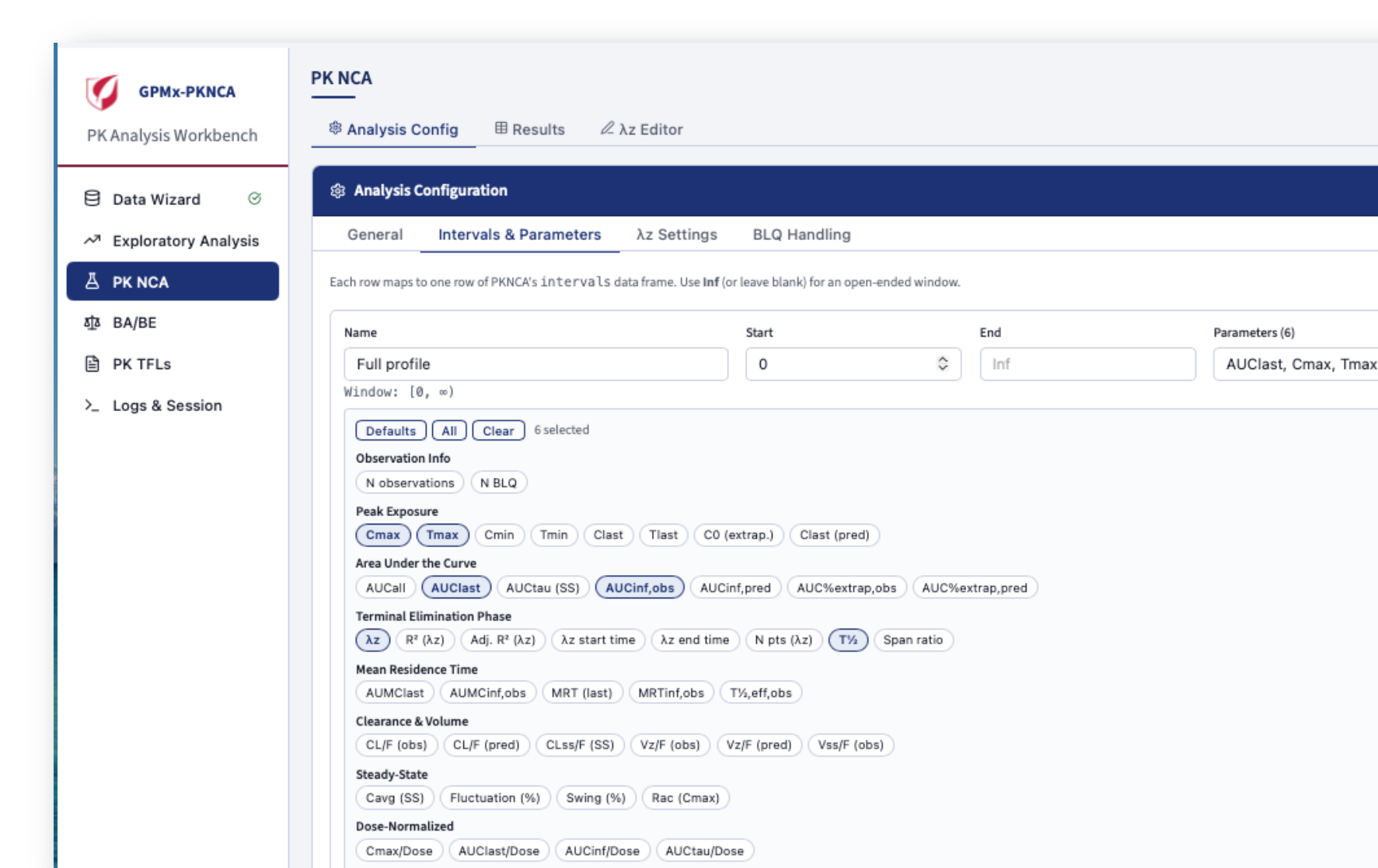


Figure 4. PK NCA engine – Endpoints selection and NCA settings. The defaults are standardized to Gilead Clinical Pharmacology guidance.

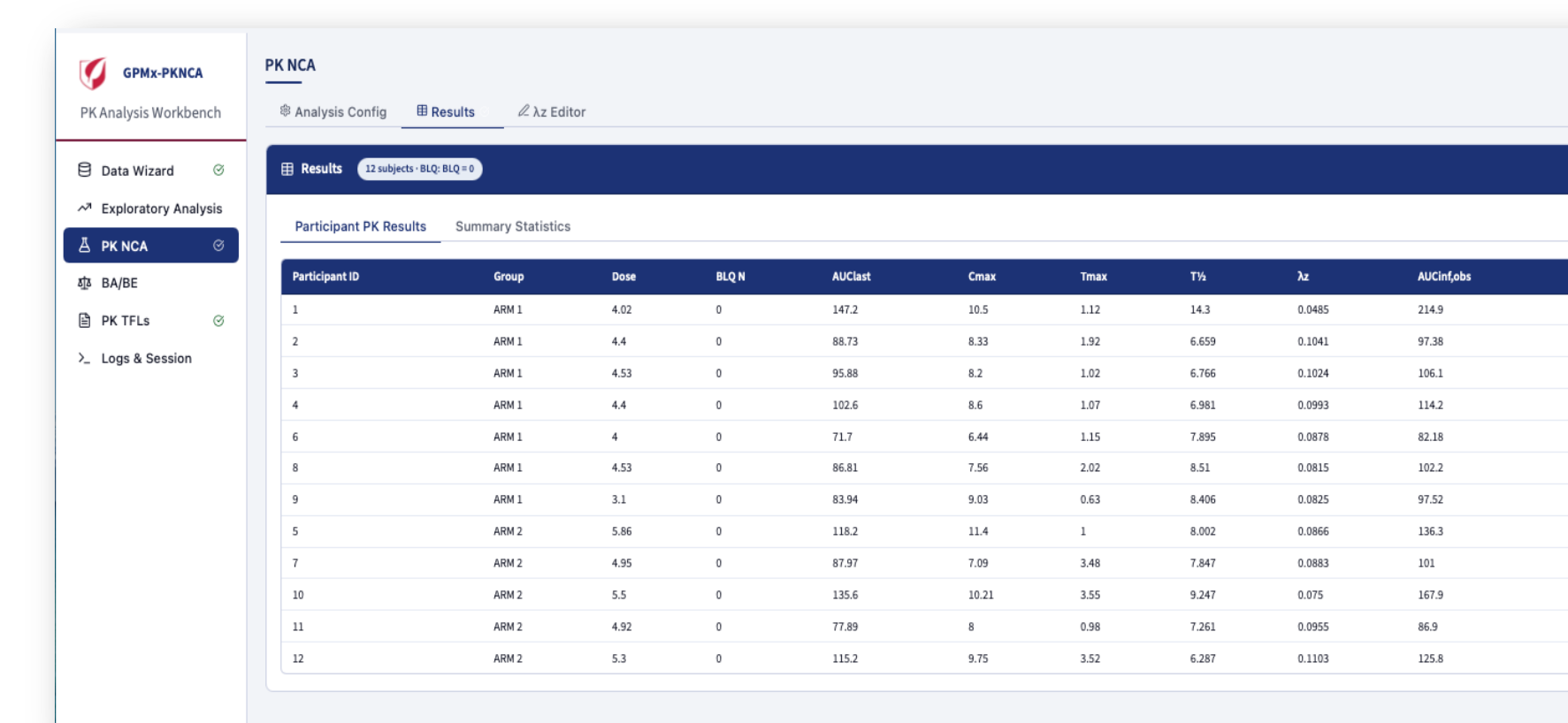


Figure 5. NCA results - per-participant parameters & summary statistics stratified by group

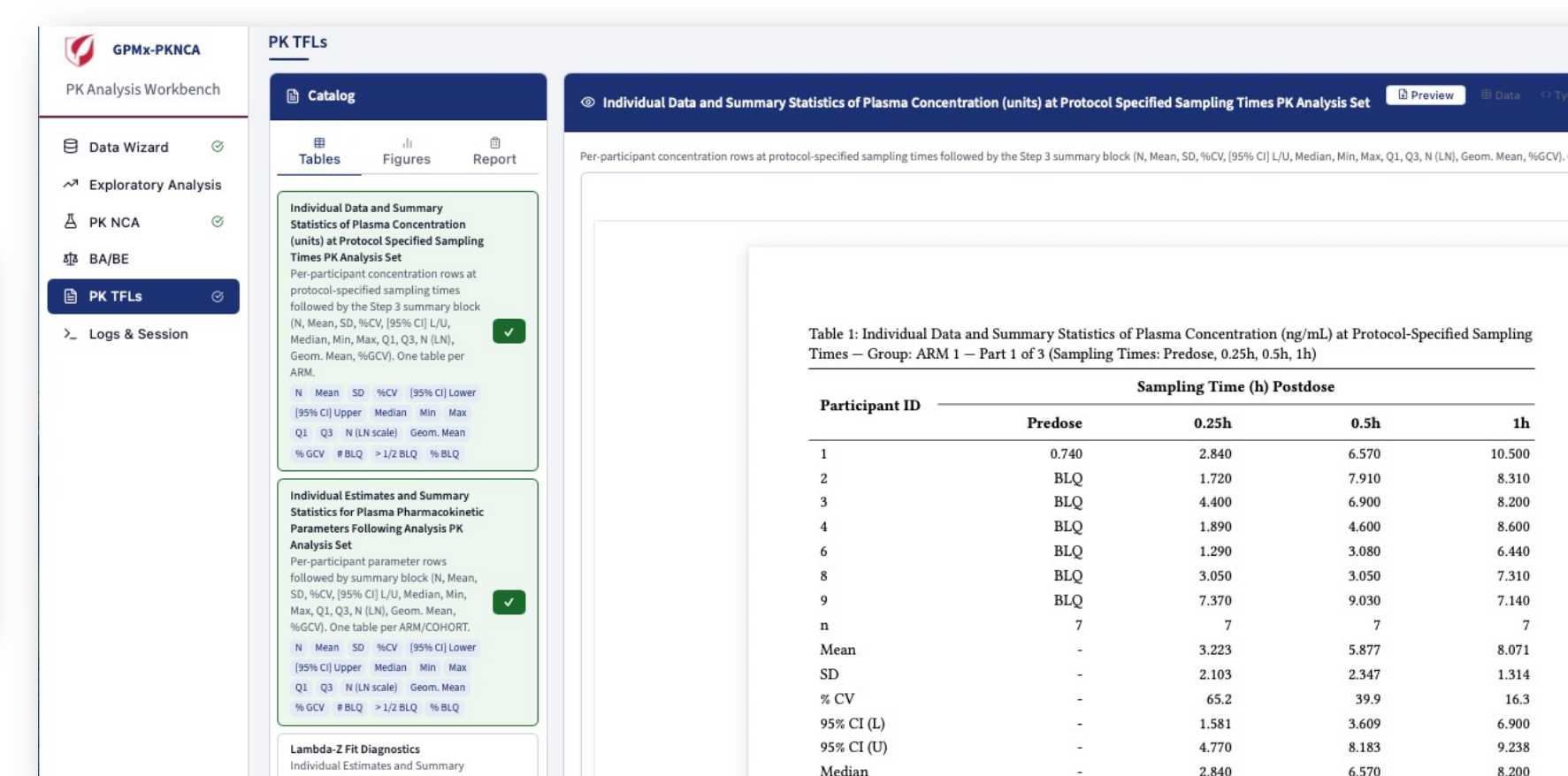


Figure 6. PK TFL catalog, including Tables, listings and Figures - validated, reusable table templates.

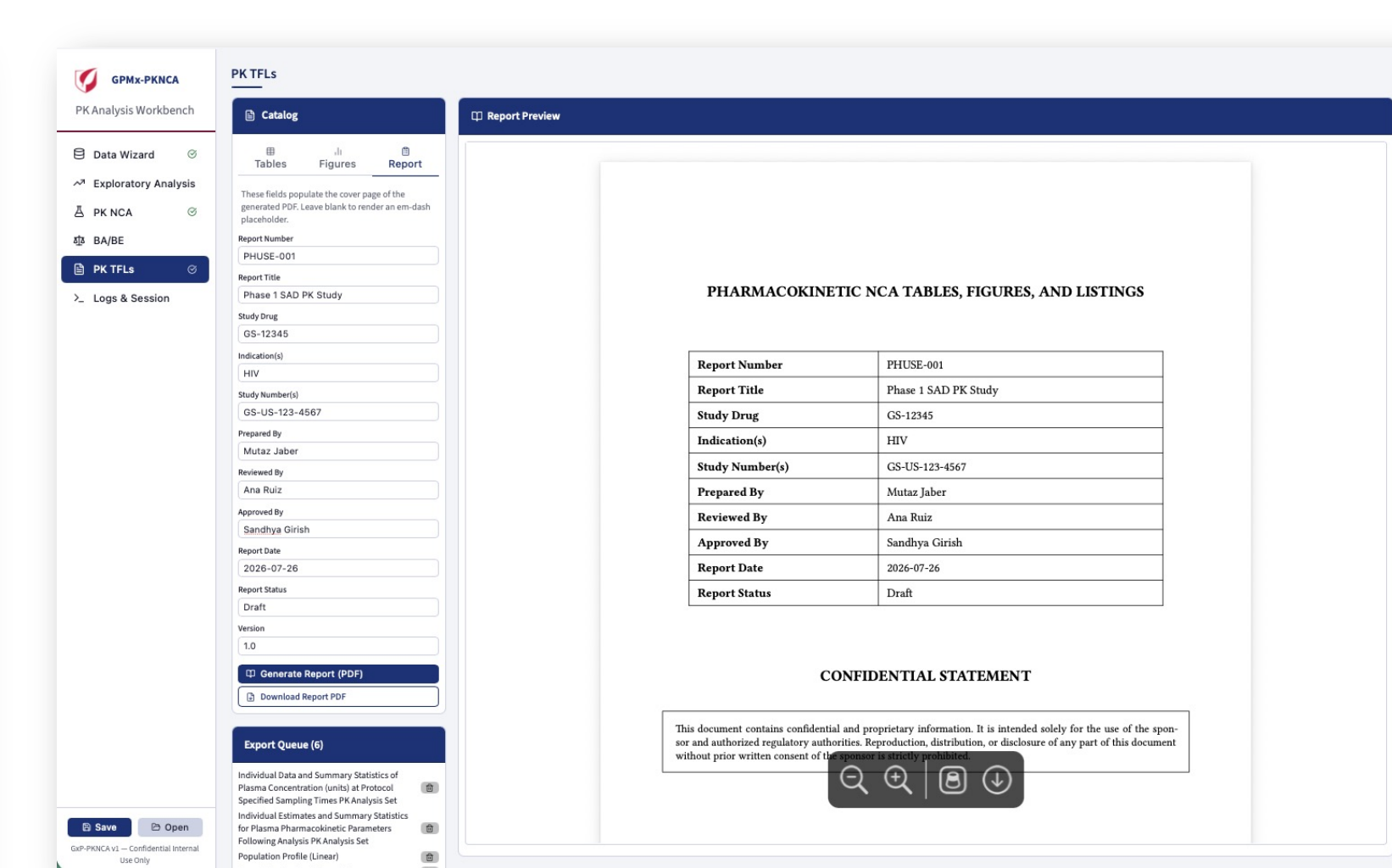


Figure 7. Metadata-driven report elements rendered to PDF document

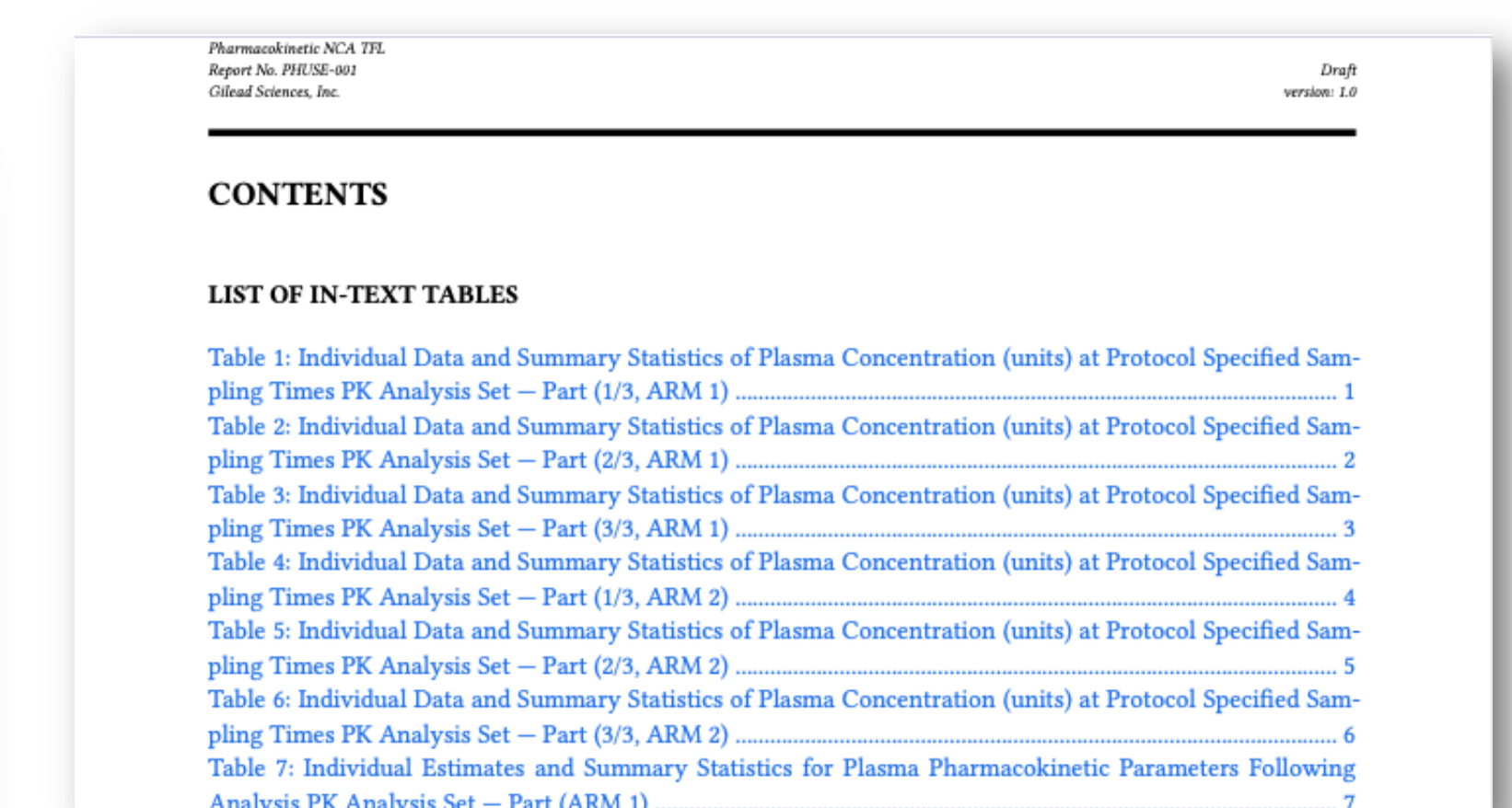


Figure 8. Auto-generated report compiling the selected TFL exported from the catalog, with its list of in-text tables & figures.

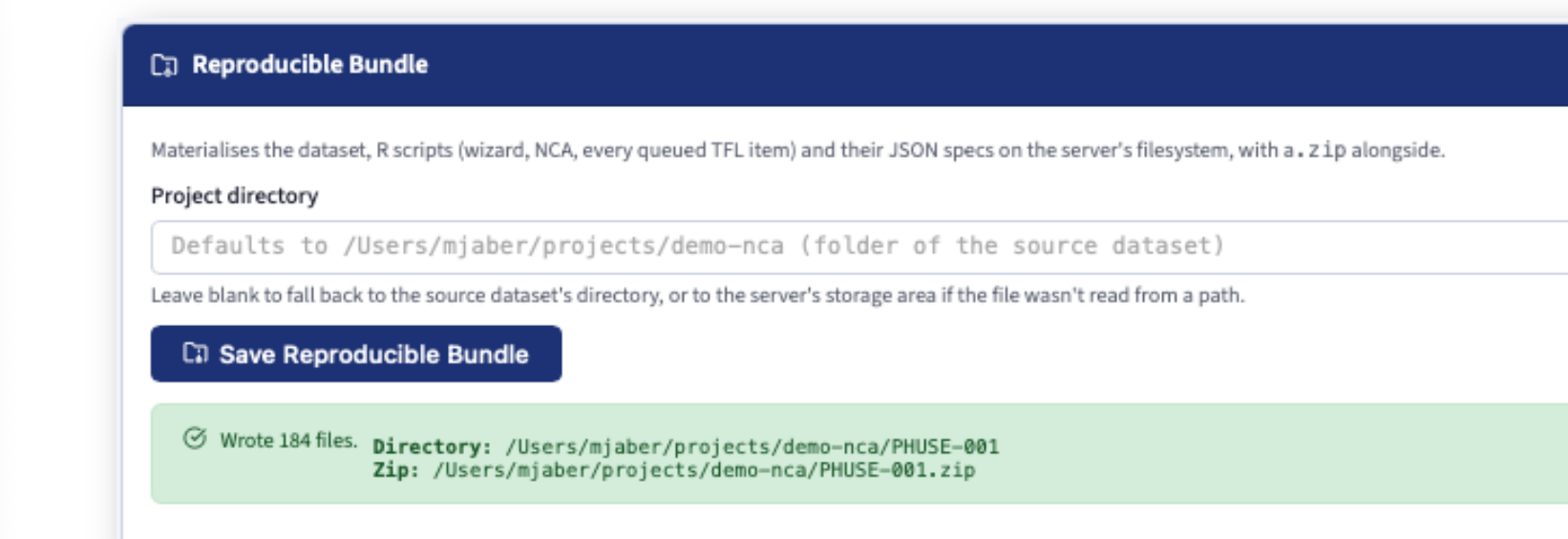


Figure 9. Reproducible bundle - dataset, R scripts, NCA & exported TFLs saved with JSON specs as a portable archive.