



CLYMB
CLINICAL

TFL Automation Through Design, Specify, Execute, and Report: A Seamless End-to-End Framework

Paper & Presentation # ADo8

PHUSE APAC Connect 2026

Feb 20th, 2026

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Bhavin Busa, Principal & Co-Founder, Clymb Clinical

SAP to CSR



Problem statement

The **problem**:

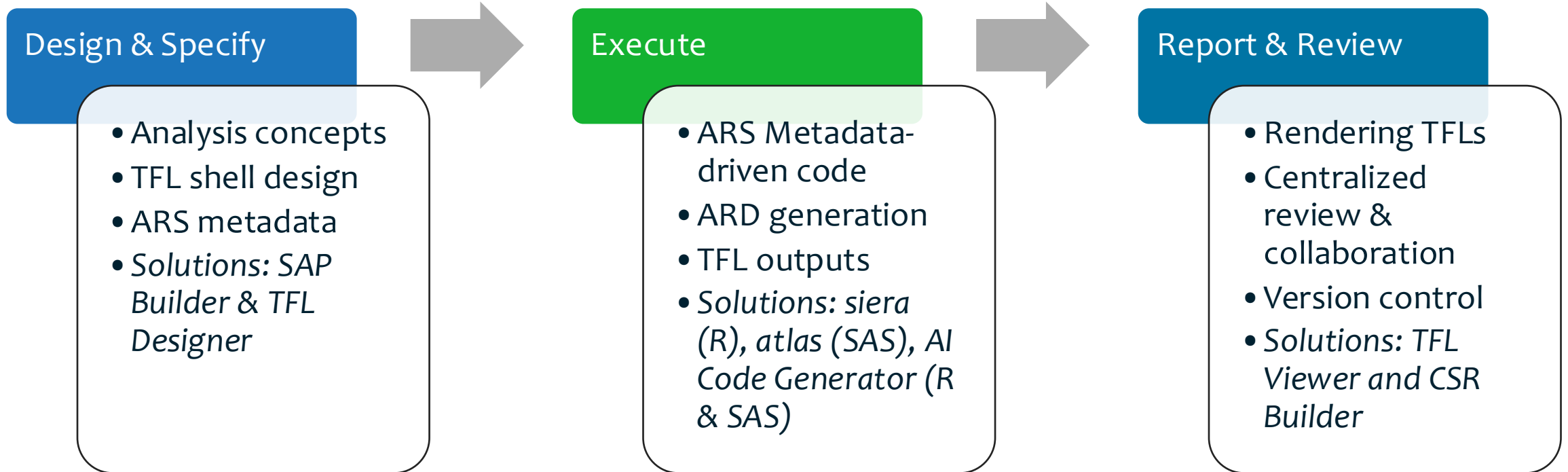
- Fragmented and manual
- No unified framework
- Limited / no use of CDISC ARS

The **need**:

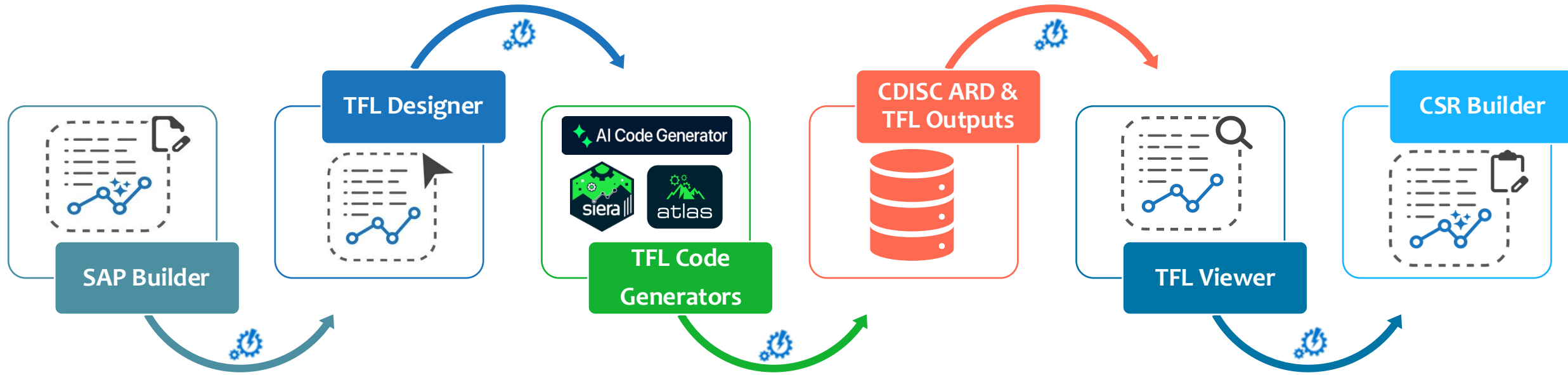
- Improved traceability of analysis results
- Integration: Planning to Submission
- Full leverage of CDISC Standards



Clymb's Analysis Results Framework Overview

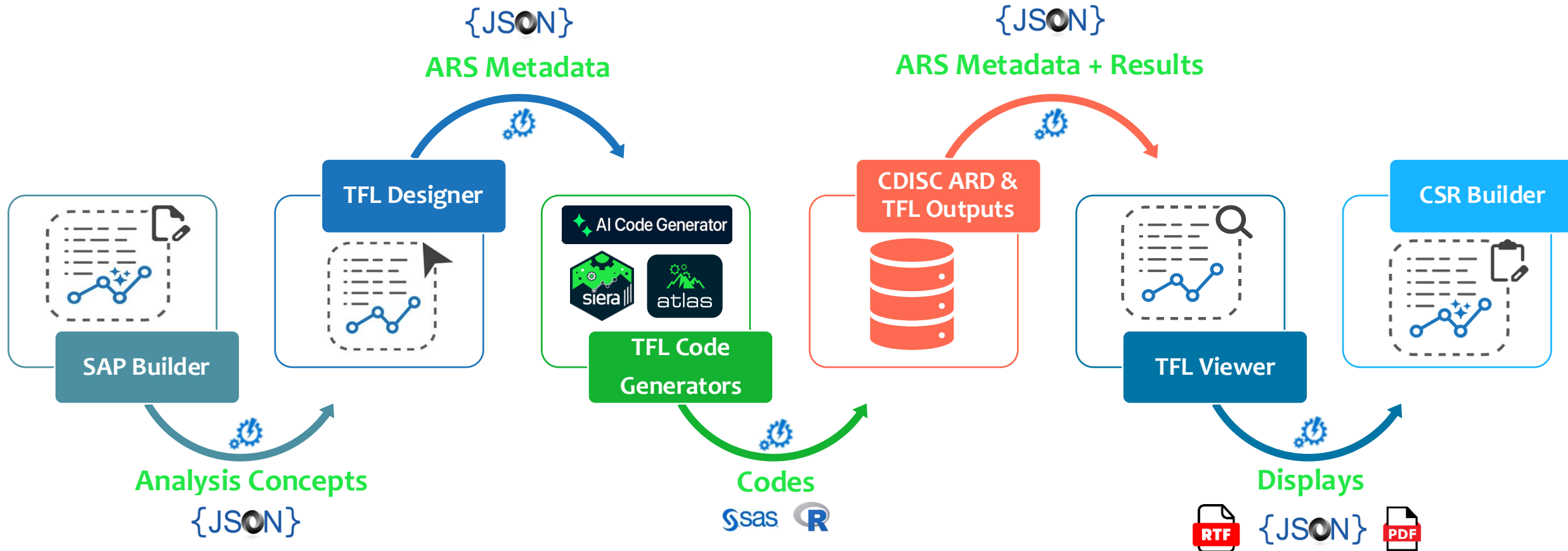


Clymb's Analysis Results Automation Workflow: Planning to Submission



 = Automated Process; ARS = Analysis Results Standard; ARD = Analysis Results Dataset

Clymb's Analysis Results Automation Workflow: Planning to Submission



= Automated Process; ARS = Analysis Results Standard; ARD = Analysis Results Dataset

1. Design & Specify

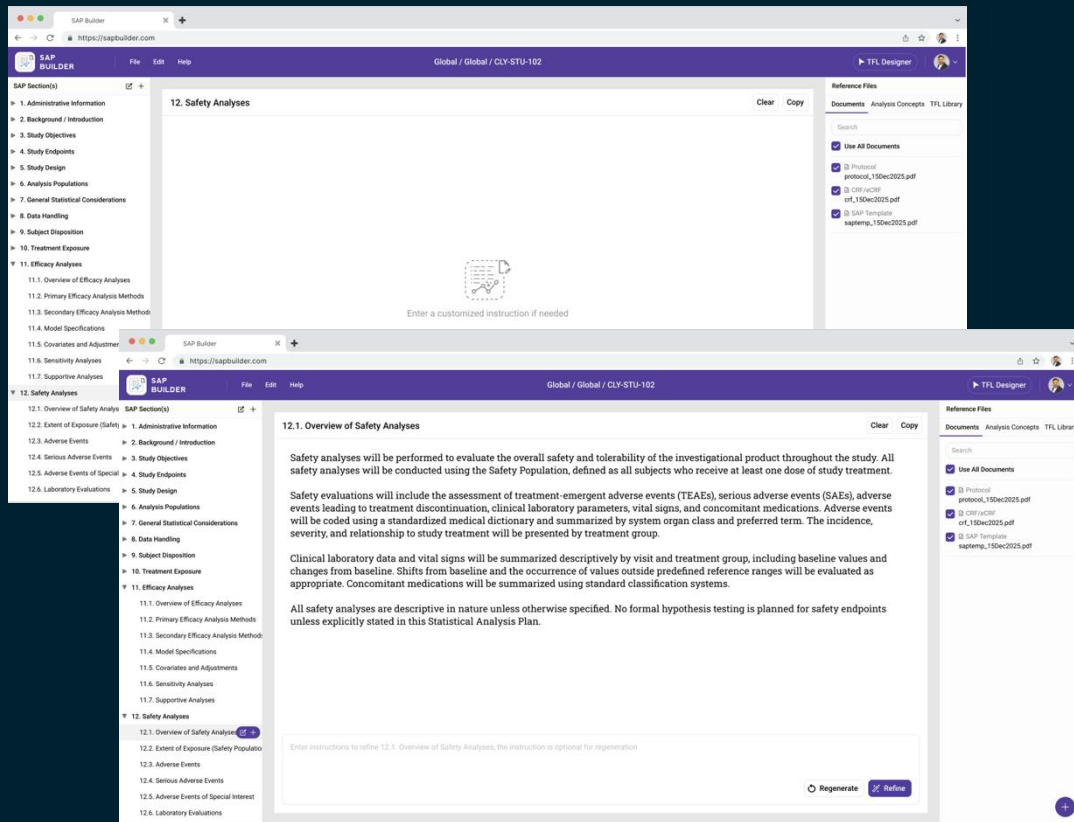
Metadata-Driven SAP & TFL Definition



SAP BUILDER



SAP BUILDER



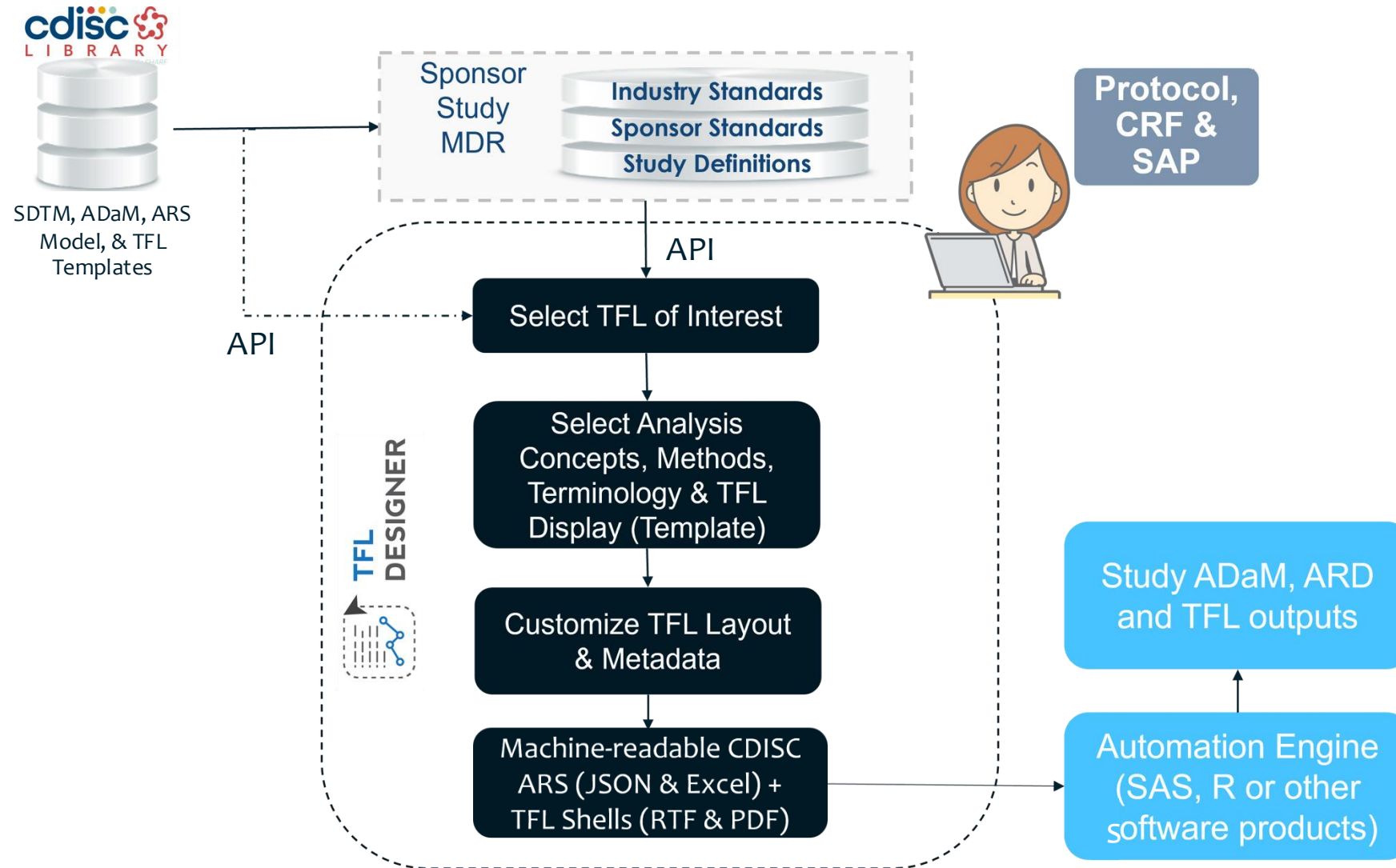
SAP Builder is an AI-powered solution that accelerates the **creation, standardization, and maintenance** of Statistical Analysis Plans (SAPs).

Built as an extension of TFL Designer and integrated across the Clymbr Hub, SAP Builder helps biostatistics teams move from protocol and CRF to a **review-ready** SAP.



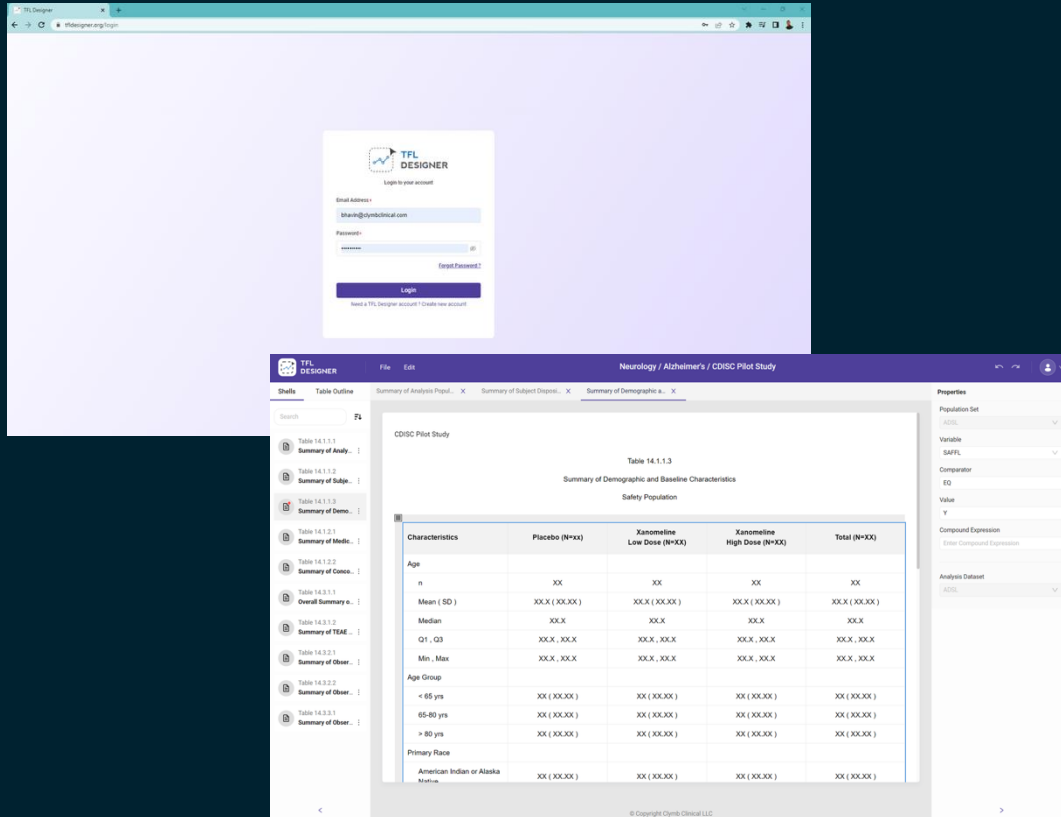
TFL DESIGNER

Analysis Results Deliverables w/ TFL Designer






TFL DESIGNER




- TFL Designer **accelerates** the process of generating:
 - ✓ Table, Figure, and Listing **Shells**
 - ✓ Associated **CDISC ARS metadata**
 - ✓ **Company-wide libraries** that users can contribute to and access across a variety of studies

- It allows users to work **collaboratively** to build and review TFL shells – the basis of study outputs














Illustration of TFL Library: Library of Pre-Built TFL Templates

 TFL DESIGNER

 Test User
 Product Owner

My Studies
Tables
All
Clymb
Community
My Library

 Search
Showing 30/38
List View
Grid View
Select

	Name	Analysis Of Interest	Compound	Reporting Event	Disease Area	Therape Action	
	Table 02 Baseline Demographic and Clinical Characteristics [FDA STF-IG]	Demographics	Global	CSR	Global	Global	⋮
	Table 04 Subject Populations [FDA STF-IG]	Disposition	Global	CSR	Global	Global	⋮
	Table 06 Duration of Treatment Exposure [FDA STF-IG]	Exposure	Global	CSR	Global	Global	⋮
	Table 07 Overview of Adverse Events [FDA STF-IG]	Adverse Events	Global	CSR	Global	Global	⋮
	Table 08 Deaths [FDA STF-IG]	Adverse Events	Global	CSR	Global	Global	⋮
	Table 10 Patients With Serious Adverse Events by System Organ Class and Preferred Term [FDA STF-IG]	Adverse Events	Global	CSR	Global	Global	⋮
	Table 11 Subjects With Serious Adverse Events by Organ System and OCMQ (Narrow) [FDA STF-IG]	Adverse Events	Global	CSR	Global	Global	⋮
	Table 12 Subjects With Adverse Events Leading to Treatment Discontinuation by System Organ Class and Preferred Term [FDA STF-IG]	Adverse Events	Global	CSR	Global	Global	⋮
	Table 13 Subjects With Adverse Events Leading to Treatment Discontinuation by Organ System and OCMQ (Narrow) [FDA STF-IG]	Adverse Events	Global	CSR	Global	Global	⋮
	Table 15 Subjects With Common Adverse Events Occurring at \geq X% Frequency by Preferred Term	Adverse Events	Global	CSR	Global	Global	⋮
	Table 17 Subjects With Adverse Events by Organ System and OCMQ [FDA STF-IG]	Adverse Events	Global	CSR	Global	Global	⋮
	Table 18 Summary Assessment of [Insert AE of Interest] [FDA STF-IG]	Adverse Events	Global	CSR	Global	Global	⋮
	Table 20 Subjects With Kidney Function Analyte Values Exceeding Specified Levels [FDA STF-IG]	Adverse Events	Global	CSR	Global	Global	⋮

[Load More](#)

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Metadata-Driven TFL Shell Design

TFL DESIGNER File Edit View Help Neurology / Alzheimer's / CDISC - eTFL Portal

T Sans-serif Tr 14 T 20 B I U [List Icons] A ● #000000 ○ #ffffff

All Tables Figures Listings Table Of Contents **Baseline Demographic and ...** Properties Outline

Search [] []

Table of Contents
CDISC - eTFL Portal

FDA-DM-T02
1. Baseline Demographic and Clinical Characteristics

FDA-DS-T04
2. Subject Disposition

FDA-EX-T05
3. Duration of Treatment Exposure

FDA-AE-T06
4. Overview of Adverse Events

FDA-AE-T36
5. Subjects With Adverse Events by System Organ Class and...

FDA-AE-T12
6. Subjects With Adverse Events Leading to Treatment...

FDA-AE-T09
7. Subjects With Serious Adverse Events by System...

FDA-AE-T07
8. Deaths

FDA-AE-T13
9. Subjects With Common Adverse Events Occurring at...

ARS-LB-T01
10. Summary of Observed and Change from Baseline by...

ARS-LB-T02

12 Shells

CDISC - eTFL Portal Generated using TFL Designer (Community, v1.0) Page x of y

FDA-DM-T02

Baseline Demographic and Clinical Characteristics

Safety Population

Characteristics	Xanomeline Low Dose (N=XX) n (%)	Xanomeline High Dose (N=XX) n (%)	Placebo (N=XX) n (%)	Total Population (N=XX) n (%)
Sex, n(%)				
Male	XX (XX.X)	XX (XX.X)	XX (XX.X)	XX (XX.X)
Female	XX (XX.X)	XX (XX.X)	XX (XX.X)	XX (XX.X)
Intersex	XX (XX.X)	XX (XX.X)	XX (XX.X)	XX (XX.X)
Unknown	XX (XX.X)	XX (XX.X)	XX (XX.X)	XX (XX.X)
Age, Years				
n	XX	XX	XX	XX
Mean (SD)	XX.X (XX.XX)	XX.X (XX.XX)	XX.X (XX.XX)	XX.X (XX.XX)
Median	XX.X	XX.X	XX.X	XX.X
Min, Max	XX.X, XX.X	XX.X, XX.X	XX.X, XX.X	XX.X, XX.X
Age groups (years), n (%)				
65	XX (XX.X)	XX (XX.X)	XX (XX.X)	XX (XX.X)

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Properties Outline

Result Description
Sex, n (%)

Data Driven

Dataset ADSL

Variable ASEX

> Where Clause for Sex, n (%) [Configure](#)

Top Row Statistics

Statistics Set
Statistics Set 1

> Advanced

> Programing Code

> Documentation 1 [+ Add](#)

Export Analysis Results (ARS) Metadata from TFL Designer: JSON or Excel

The screenshot displays the TFL Designer interface. The main window shows a table titled "Baseline Demographic and Clinical Characteristics" for a "Safety Population". The table has columns for "Characteristics", "Xanomeline Low Dose (N=XX) n (%)", "Xanomeline High Dose (N=XX) n (%)", "Placebo (N=XX) n (%)", and "Total Pop (N=XX) n (%)". The rows include "Sex, n(%)", "Age, Years", and "Age groups (years), n (%)".

An orange arrow points from the table to a JSON export window. The JSON file, named "portal-export_tables.json", contains the following metadata:

```
{
  "about": {
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    "version": "1.4.0",
    "note": "The metadata provided herein has been generated using the TFL Designer Enterprise version 1.4.0. The representation of metadata fields av"
  },
  "studyInfo": {
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    "studyTitle": "Safety and Efficacy of the Xanomeline Transdermal Therapeutic System (TTS) in Patients with Mild to Moderate Alzheimer's Disease.",
    "phase": "Phase II",
    "compoundUnderStudy": "Xanomeline Transdermal",
    "description": "",
    "diseaseArea": "Neurology",
    "therapeuticArea": "Alzheimer's"
  },
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        }
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}
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2. Execute

Metadata-Driven TFL Code Generation and Analysis

TFL Code Generators

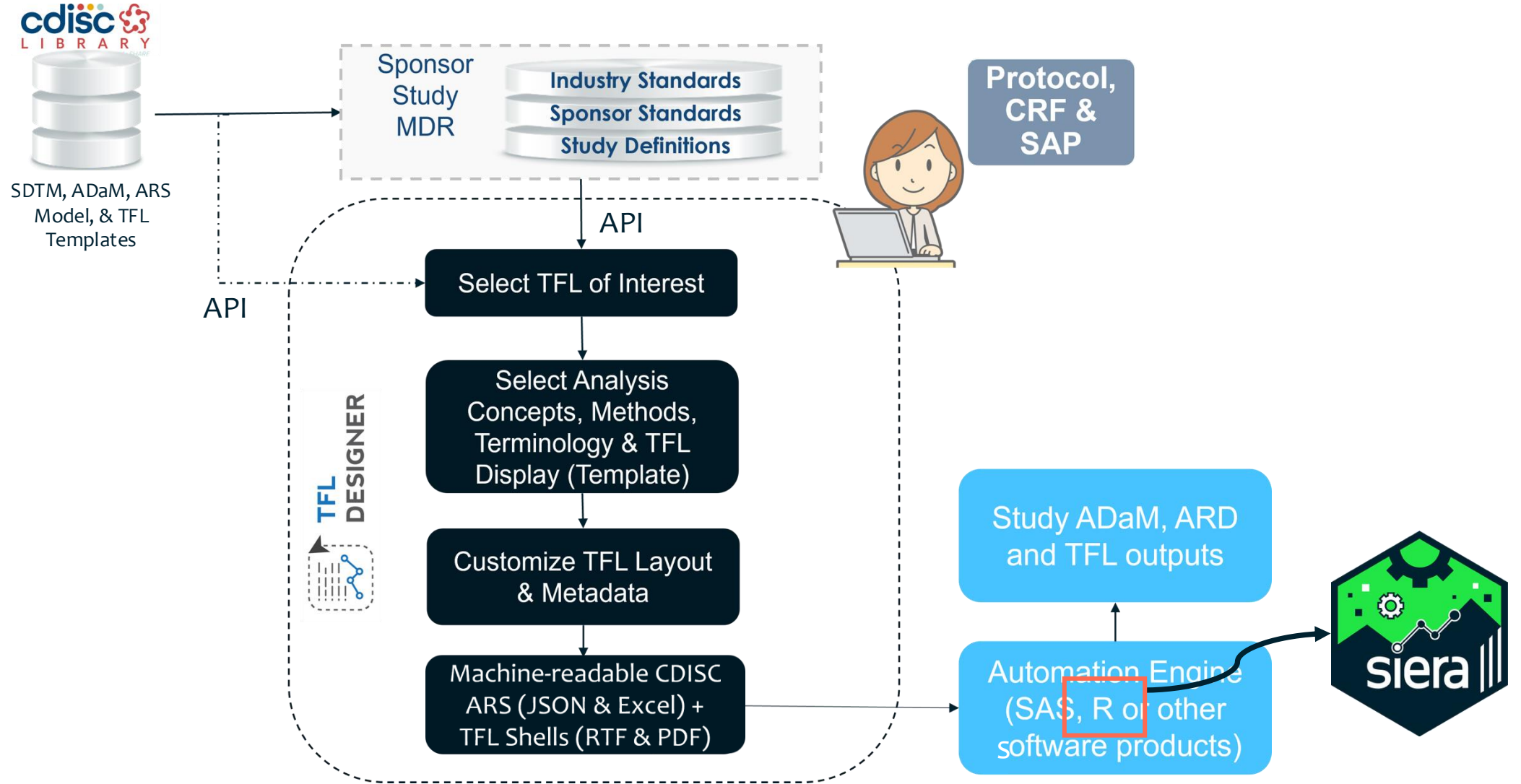


AI Code Generator

TFL Code Generator



Metadata-driven TFL Deliverable Workflow



What is siera?

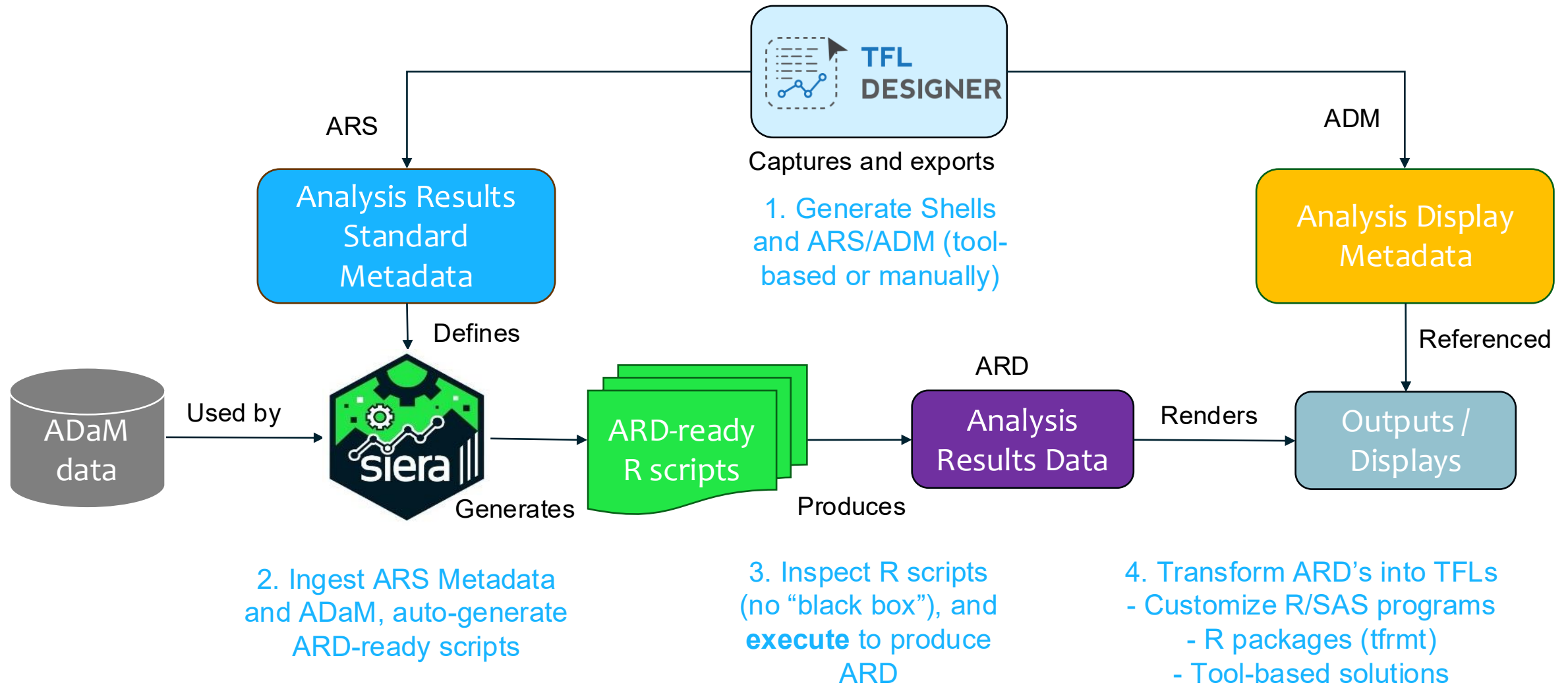
siera* is an open-source **R package** that **ingests ARS metadata** for a reporting event and converts the metadata to **produce executable R scripts**. These R scripts can be run as-is (combined with the relevant ADaM dataset) to **produce each output's ARD**.

<https://github.com/clymbclinical/siera>



* on CRAN and approved by pharmaverse & COSA!

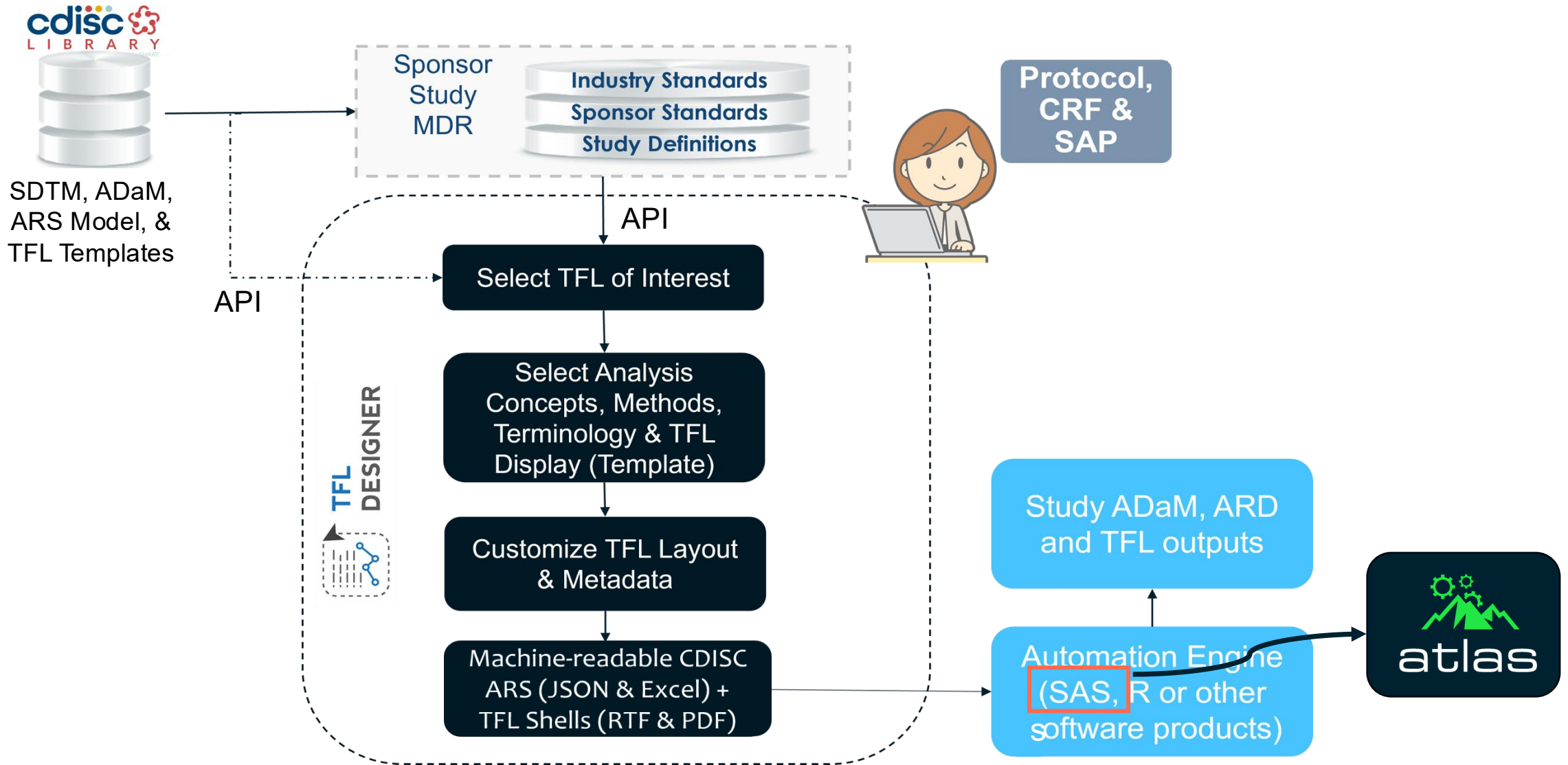
siera Workflow [Design to Execution]



TFL Code Generator



Metadata-driven TFL Deliverable Workflow



Characteristics	Xanomeline Low Dose (n(N))	Xanomeline High Dose (n(N))	Placebo (n(N))	Total Population (n(N))
Sex	30(100.0)	30(100.0)	30(100.0)	90(100.0)
Female	30(100.0)	30(100.0)	30(100.0)	90(100.0)
Unknown	30(100.0)	30(100.0)	30(100.0)	90(100.0)

```

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    "studyTitle": "Safety and Efficacy of the Xanomeline Transdermal Therapeutic System (TTS) in Patients with Mild to Moderate Alzheimer's Disease - Phase II",
    "compoundIdentifier": "Xanomeline Transdermal",
    "description": "",
    "diseaseArea": "Neurology",
    "therapeuticArea": "Alzheimer's",
    "name": "Clinical Study Report",
    "type": "CSR"
  },
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                "analysisId": "An_01"
              }
            ]
          }
        }
      ]
    }
  }
}

```

```

*****
* PROGRAM:                t_FDA_DM_T02_demo.sas
* DATE:                   10FEB2025
* AUTHOR
* INPUT PATH and data:    F:\VFL Designer\TFL-Automation\data\adam\sm-13\adam.ADSL
* OUTPUT PATH and output name: t_FDA_DM_T02_demo.rtf, t_FDA_DM_T02_demo.sas\tdat
* ASSUMPTION:
* CHANGE HISTORY:
* Date      Author      Code Change History Description
* -----
* yyyymmdd  A. Prog  <Code Change description/reason 1>
*****
proc datasets library=work kill nolist;
quit;

%include 'F:\VFL Designer\TFL-Automation\tools\sm13_setup.sas';

%let tfidcn = t_FDA_DM_T02_demo ;

***Summary of Subjects by Treatment and Sex, n (%)***
%eventfreq (inds=adam.ADSL,
acrossvar= TRT01A,
freqvar= ASEX,
freqvarfat= NONE,
order= 2,
rowlabel=%quote(Sex, n (%)),
fmtlib=work
);

***Summary of Subjects by Treatment and Age groups (years), n (%)***
%eventfreq (inds=adam.ADSL,
acrossvar= TRT01A,
freqvar= AGEGR,
freqvarfat= NONE,
order= 4,
rowlabel=%quote(Age groups (years), n (%)),
fmtlib=work
);

***Summary of Subjects by Treatment and Race, n (%)***
%eventfreq (inds=adam.ADSL,
acrossvar= TRT01A,
freqvar= ARACE,
freqvarfat= NONE,
order= 5,
rowlabel=%quote(Race, n (%)),
fmtlib=work
);

***Summary of Subjects by Treatment and Ethnicity, n (%)***
%eventfreq (inds=adam.ADSL,
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freqvar= AETHNIC,
freqvarfat= NONE,
order= 6,
rowlabel=%quote(Ethnicity, n (%)),
fmtlib=work
);

```

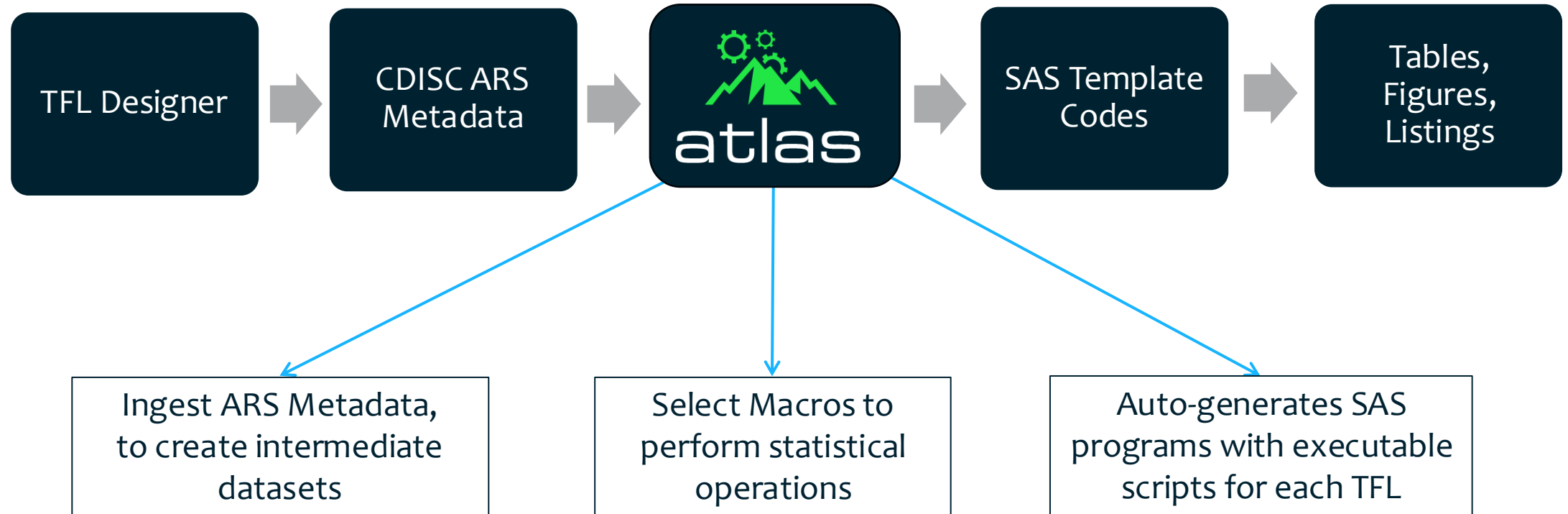
What is atlas?



atlas is a SAS-based automation engine developed by Clymb that ingests CDISC ARS metadata, applies statistical operations, and generates ready-to-use, executable SAS programs for each TFL.



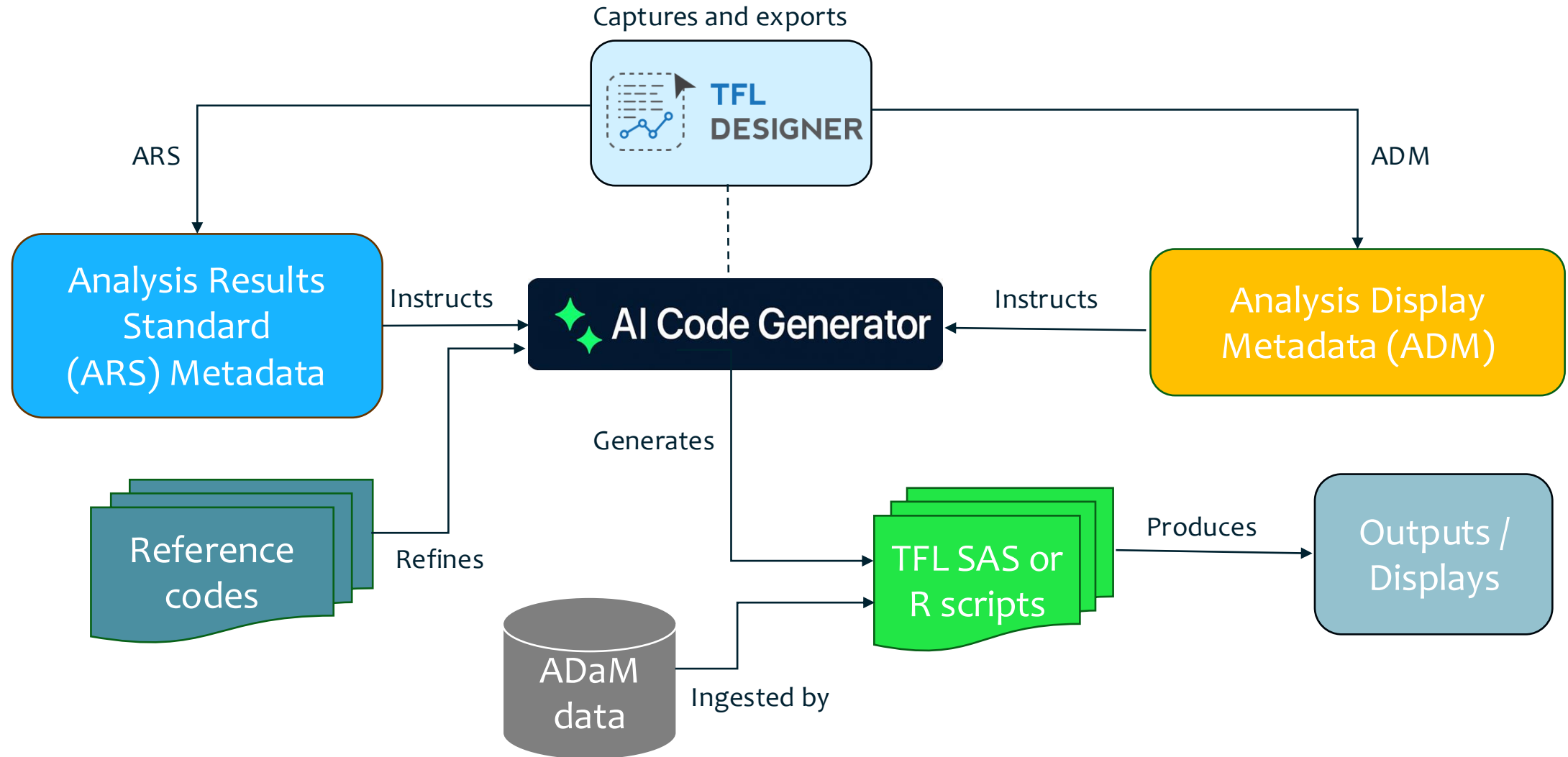
High-level atlas meta-programming process flow: Shells -> TFLs





AI Code Generator

AI Code Generator Process



3. Report and Review

Centralized Reporting, Review and Submission via TFL Viewer & CSR Builder



TFL VIEWER



TFL VIEWER

The screenshot displays the TFL Viewer web application interface. At the top, there is a login form with fields for Email Address (shavin@clymbclinical.com) and Password. Below the login form, a navigation menu is visible on the left, listing various tables and figures. The main content area shows a detailed data table for 'Table 14.1.1.3 Summary of Demographic and Baseline Characteristics Safety Population'. The table includes columns for Characteristics, Xanome Low Dose (n, %), Xanome Low High Dose (n, %), Placebo (n, %), and Total Population (n, %). The table lists various demographic characteristics such as Sex, Age, Race, and Ethnicity, along with their respective counts and percentages for each treatment group.

Characteristics	Xanome Low Dose n (%)	Xanome Low High Dose n (%)	Placebo n (%)	Total Population n (%)
Sex, n (%)				
Male	34 (48.5)	44 (52.4)	33 (38.4)	111 (49.7)
Female	20 (28.5)	48 (57.6)	53 (62.6)	121 (53.5)
Unknown	0	0	0	0
Age, years				
n	34	44	33	111
Mean (SD)	70.7 (20.2)	74.4 (21.8)	75.2 (24.5)	73.5 (23.2)
Median	77.5	78.8	78.8	77.8
Min, Max	51, 88	56, 88	52, 89	51, 89
Age groups (years), n (%)				
<65	8 (23.5)	11 (25.0)	14 (42.4)	33 (29.8)
65-80	47 (138.5)	55 (125.0)	42 (127.3)	144 (129.7)
>80	23 (67.6)	33 (75.0)	38 (115.2)	94 (84.5)
Race, n (%)				
American Indian or Alaska Native	0	1 (2.3)	0	1 (0.9)
Asian	0	0	0	0
Black or African American	4 (11.8)	9 (20.5)	8 (24.2)	21 (18.9)
Native Hawaiian or Other Pacific Islander	0	0	0	0
White	78 (228.2)	74 (168.2)	79 (237.3)	231 (208.6)
Not Reported	0	0	0	0
Other	0	0	0	0
Unknown	0	0	0	0

TFL Viewer is a web-based platform designed to streamline the **review, feedback, and approval process** for tables, figures, and listings (TFLs) generated during clinical trials.



CSR BUILDER



CSR BUILDER

Table of Contents

S.no	Title	File Name	Size
1	Table 14.1.9.1: Subjects With Common Adverse Events Occurring at >=5% Frequency (Safety Population)	tsa-ae-t13.pdf	67.10 KB
2	Table 14.1.3.1: Duration of Treatment Exposure (Safety Population)	tsa-ev-t05.rtf	93.93 KB
3	Table 14.1.2.1: Subject Disposition (All Subjects)	tsa-ds-t04.rtf	118.78 KB
4	Table 14.1.1.1: Baseline Demographic and Clinical Characteristics (Safety Population)	tsa-dm-t02.rtf	178.73 KB
5	Table 14.1.6.1: Subjects With Adverse Events Leading to Treatment Discontinuation by System Organ Class and Preferred Term	tsa-ae-t12.rtf	75.45 KB

10. Efficacy Evaluation

The 118 subjects (60 placebo; 28 xanomeline low dose; 30 xanomeline high dose) who were in the Efficacy Population and completed their Week 24 visit (Visit 12) comprised the Completers Population. Eight (8) subjects discontinued between Week 24 and Week 26, leaving 110 subjects (58 placebo; 25 xanomeline low dose; 27 xanomeline high dose) who completed the study.

Table 11-1. Demographic Characteristics

	Placebo (N=86)	Xan Low (N=84)	Xan High (N=84)	Total (N=254)
Age (years), mean (range)	75.2 (52-89)	75.7 (51-88)	74.4 (56-88)	75.1 (51-89)
Gender (%)				
Male	38%	40%	52%	44%
Female	62%	60%	48%	56%
Race (%)				
White/Caucasian	87%	86%	85%	86%
Other	13%	14%	15%	14%
Education (years), mean (range)	12.6 (6-21)	13.2 (3-24)	12.5 (6-20)	12.8 (3-24)

Source: Table 14-2.01

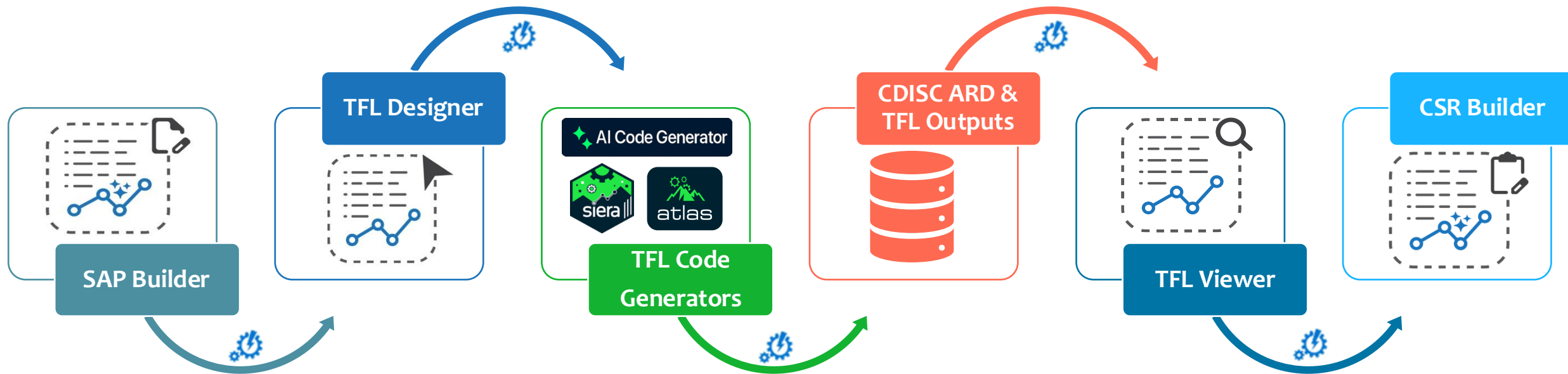
Enter your prompt here

Regenerate Refine

CSR Builder is an AI-powered module developed by Clymb that seamlessly integrates with TFL Viewer to accelerate and enhance Clinical Study Report (CSR) development.

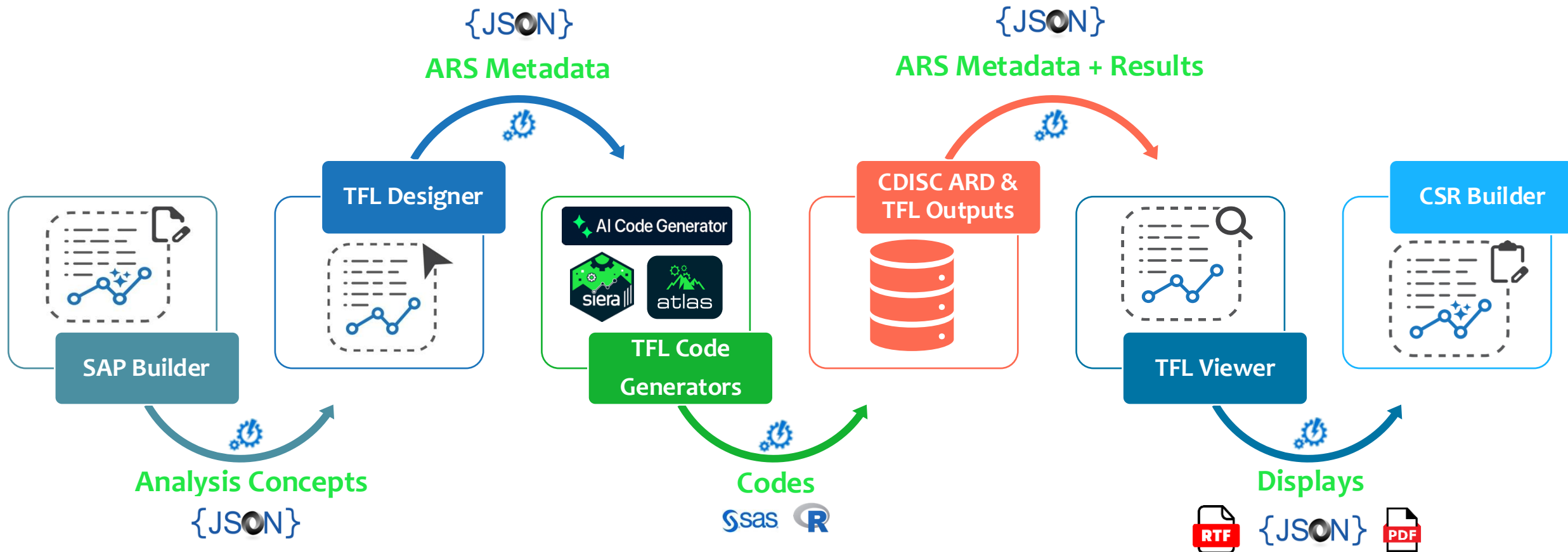
The tool assists medical writers by generating draft narratives and summaries for key CSR sections using a combination of machine-readable TFLs and advanced large language models (GPT, Claude, Grok, and Gemini).

Process Summary



 = Automated Process; ARS = Analysis Results Standard; ARD = Analysis Results Dataset

Clymb's Analysis Results Automation Workflow: Planning to Submission



= Automated Process; ARS = Analysis Results Standard; ARD = Analysis Results Dataset

Concluding Remarks

- The framework demonstrates how **ARS/ARD** can function as an operational **backbone** across the full **SAP → Shells → ADaM → TFL → CSR lifecycle**
- Key observations include:
 - **Reduced duplication** across shells, SAPs, programs, and outputs
 - **Flexible execution paths** supporting R, SAS, and AI-assisted workflows
 - **Improved traceability** linking analysis intent to reported results
 - **Future readiness** for Dataset-JSON, ARD, and AI-enabled reporting

References

- CDISC ARS Model: <https://cdisc-org.github.io/analysis-results-standard/>
- CDISC ARS User Guide version 1.0: <https://wiki.cdisc.org/display/ARSP/Analysis+Results+Standard+User+Guide+v1.0>
- CDISC ARS Repository <https://github.com/cdisc-org/analysis-results-standard/tree/main/utilities/sas>
- eTFL Portal: <https://cdisc.org/kb/etfl>
- TFL Designer Community v2.0.0, 2025: <https://tfl designer.org/>
- Busa, Bhavin; Marshall, Richard; LeRoy, Bess; ‘All You Need to Know about the New CDISC Analysis Result Standards!’ at PharmaSUG (May 2023). [Paper Link](#)
- Busa, Bhavin; LeRoy, Bess; ‘Pre-launching CDISC Analysis Results Standards’ at PHUSE US Connect (Mar 2023) [Presentation Link](#), [Video Link](#)
- Dedhia, Navin; ‘[Gen-AI for Statistical Reporting and CSR Writing Leveraging CDISC ARS Model](#)’ at PHUSE US Connect (March 2025).
- Marshall, Richard; ‘[Selecting GeARS: Analysis Results Standard Implementation Options for Accelerated Analysis and TFL Automation](#)’ at PHUSE US Connect (March 2025).
- Bosman, Malan; ‘[Advancing TFL Automation: R-Based Meta-Programming Powered by ARS](#)’ at PHUSE US Connect (March 2025).
- Wachara, Julie; ‘[Let the Machine Do the Coding: A SAS-based Framework for Automating TFL Generation with ARS Metadata](#)’ at PHUSE US Connect (March 2025).
- Busa, Bhavin; ‘[Introducing TFL Viewer: Centralized Platform for TFL Review, Collaboration, and Approval](#)’ at PHUSE US Connect (March 2025).

Q&A



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